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SEVENTH EDITION

Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens

Richard P. Pohanish

Volume 1: A – D

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Contents

Preface

For more than 35 years *Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens* has continued to serve an ever-widening audience of users. It has been proven to be among the most easy-to-use and essential reference works on hazardous materials. The 7th edition has been updated and expanded, once again, to keep pace with world events and to respond to the ever-expanding need for reliable information on chemicals used in the workplace and the tool shed.

Most users of this work understand the potential dangers of chemicals. Hazardous and toxic substances pose a wide range of health hazards, including irritation, sensitization, and carcinogenicity. Chemicals can possess physical properties of flammability, explosion and corrosion. Many chemicals can harm the environment by poisoning aquatic and plant life.

The chemical industry and its many component businesses are forced to strike a delicate balance because the same properties that make a chemical substance highly useful can also make it extremely harmful. We are told by some industrialists that toxic chemicals are present in nature and that industrial contributions are just the price we have to pay for progress. There is little argument about the chemical industry's critical place in the nation's economy. The United States is the number one chemical producer in the world, generating more than $550 billion a year and employing more than 5 million people. So, somewhere in between lies the truth—or at least an area in which we can function. Information is vital in a world where virtually every aspect of our lives is touched by chemical hazards.

Each year, in the United States, over 2 billion tons of hazardous and toxic chemicals are manufactured. Including imports, more than 3 billion tons are transported employing 800,000 shipments each day. It is estimated that 1.3 billion tons are moved by truck and hundreds of billions of pounds of these hazardous materials are transported through populated areas. The average American household generates approximately 15 pounds of hazardous waste per year. Nearly five million poisonings occur in the United States annually, resulting in thousands of deaths. Based on 2004 TRI data (publically released April 2006), over 4 billion pounds of toxic chemicals are released into the nation's environment each year, including 72 million pounds of recognized carcinogens from nearly 24,000 industrial facilities.

Chemical accidents and spills can range from small to large and can occur anywhere chemicals are manufactured, transported, stored or used. Today's media headlines constantly point out both the information gaps and the need for constantly updated information. On January 9, 2014, for example, an estimated 10,000 gallons[CDC,NTP] of chemicals used to process coal spilled from a damaged 45,000 gallon storage tank into the Elk River in the US state of West Virginia. As the news of the spill developed, it became clear to the public (and many experts) that federal and state officials had sparse data about the health risks of the two potentially toxic organic solvents involved in the spill: primarily crude 4-methylcyclohexanemethanol and a minor component of mixed glycol ethers consisting of glycol phenyl ether and dipropylene glycol phenyl ether. The latter mixture of chemicals was not reported by the manufacturer to the public until 12 days after the initial spill. The unfortunate truth is that the Elk River is a municipal water source that serves approximately 300,000 people in and around Charleston, the state capitol. For weeks following the spill, residents were instructed not to drink or bathe with local tap water.

The problem of toxic chemicals in the United States; and, indeed, in all the world frightens many people. Over the years, these fears are heightened by news stories such as the huge accidental plant fire in Saudi Arabia that killed at least 12 people and injured another dozen (April 2016); the huge explosion at a vinyl chloride plant in Coatzacoalcos, Mexico—A few days later (also April 2016) that killed 24 workers and injured 136; the worst environmental disaster in Vietnam history caused by a chemical spill of cyanide, phenols and iron hydroxide which poisoned tons of marine life and killed people along 120 miles of coastline and stretching some 20 nautical miles out to sea (June 2016); the chemical plant explosion and subsequent spill of highly flammable liquids in Guizhou Province, China (February 2012) that killed more than 20 people and forced the evacuation of almost 30,000. Whether the chemical involves an aluminum dust explosion (Huntington, IN, 2003), a fertilizer explosion in West Texas (April 2013) leads in the water supply (Flint, MI, 2016), the massive Deepwater Horizon oil spill (Gulf of Mexico, 2010), or older problems—Bhopal, India, Love Canal, New York, the disastrous Valley of the (100,000) Drums (Kentucky), the Valley of Death in Brazil, and the like−these incidents generate emotional responses, often from people uninformed about science or technology and confirm the charge of critics that chemicals are "accidents waiting to happen."

In 2001, the 4th Edition of *Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens* was published shortly before the tragic events of the morning of September 11. The decade that followed brought many changes to life in the civilized world. The United States government, for example, established the Department of Homeland Security and enacted laws such as the *Chemical Facilities Security Act of 2003.* These actions were prompted by concerns involving infrastructure protection and the anticipation of another attack, possibly on the nation's chemical and energy facilities or by using trucks

or tank cars that transport highly dangerous and possibly lethal chemicals. "These facilities are found around the country in industrial parks, in seaports, and near the major population centers. Dangerous chemicals routinely travel along our highways, inland waterways, and on railcars that pass through the heart of major cities including Washington, D.C., just a short distance from Capitol Hill. Terrorist attacks on the US chemical industry have the potential to kill tens of thousands of Americans and seriously injure many more. In many instances, these attacks hold the potential for having a cascading effect across other infrastructures, particularly in the energy and transportation sectors. This is both because of the damage that can be caused by the attack, and the enormous expense and effort associated with the clean-up to an affected area in its aftermath."[83] To put it more simply, using the same low tech/high concept approach that turned passenger planes into missiles, terrorists do not need to produce or amass chemical weapons or smuggle them into the United States in order to produce great damage.

"Commercial chemical incidents occur tens of thousands of times each year, often with devastating and exorbitantly expensive consequences. They are indiscriminate in their effects. Workers, companies, the public, emergency response organizations, and all levels of government pay the figurative and literal price. Yet, until now and with few exceptions, chemical incidents have been invisible. Perhaps it is due to their pervasiveness, or to the common tendency to overlook what is taken for granted."[84] This quote is from the highly publicized *600K Report* prepared by the Chemical Safety and Hazard Investigation Board (CSB), an independent, nonpartisan, quasi-legislative US government agency. The CSB described our nation's lack of definitive knowledge of the "big picture" surrounding chemical incidents as "… the industrial equivalent of two 737 airplanes "crashing" year after year, killing all passengers (256 people) without anyone seeming to notice."[84]

Almost 40 years ago, the United States Government Accounting Office (GAO) estimated that 62,000 chemicals were in commercial use. Today, that number has grown to beyond 82,000.

Given the reality of problems inherent to chemical hazards, including accidents and spills, the advent of new threats to our way of life, and the challenges of communicating complex data, it is the goal of this work to provide data so that responsible decisions can be made by all who may have contact with chemicals covered in this reference work. With this in mind the work can be used by those in the following chemical fields and related professions:

Applied research and product development
Attorneys
Campus safety and health
Certified chemical hygiene officer (CCHO)
Chemical engineering
Chemical health and safety
Chemical informatics and information management
Chemicals manufacturers and distributors
Chemical technology
Certified hazardous materials manager (CHMM)
Certified health physicist (CHP)
Certified industrial hygienist (CIH)
Certified safety professional (CSP)
Dyes, pigments and inks
Emergency response personnel
Environmental protection and management
Forensic chemistry
Formulation chemistry
Hazardous waste management
Industrial management
Laboratory management
Loss control management
Pesticide distributors
Process chemistry
Process safety
Project management
Public information and outreach
Public health
Quality control and assurance
Regulatory affairs
Researchers
Science policy
Technical communications
Technical support
Toxicology
Water chemistry

The chemicals chosen for inclusion are officially recognized substances, many identified as carcinogens, as belonging to some designated category of hazardous or toxic materials; with numerically defined safe limits in air in the workplace, ambient air, water; in waste effluents. For the most part these are materials of commerce that can be heavily used and may be transported in bulk.

The 7th edition contains more chemicals and data for each material. In keeping with the broad changes initiated with the fourth edition, contents of the 7th edition are focused on the concept of "regulated chemicals." The carcinogen potential of each chemical was compared to listings and reports from eminent authorities as the International Agency for Research on Cancer (IARC), the US National Toxicology Program (NTP) and the US Environmental Protection Agency.

The "Regulatory Authority and Advisory Bodies" section contains new items including, where available, EPA Gene-Tox Program findings, and many of the individual listings now contain useful advice sought after by the regulated community. As a result, the new volume should be even

more practical for those users of specific chemicals, and to those concerned with both adherence to, and enforcement of, regulations.

Data is furnished, to the extent currently available, in a uniform multisection uniform format to make it easy for users who must find information quickly and/or compare the data contained within records, in any or all of these important categories:

Chemical Name and Record Number
Chemical Formula
Synonyms (including trade names)
Code Numbers (including CAS Registry, HSDB, RTECS, UN/NA & ERG, EC)
Regulatory Authority and Advisory Information (summary)
Description (including physical properties, explosion and fire data and water reaction and solubility)
Potential Exposure
Incompatibilities
Permissible Exposure Limits in Air
Determination in Air
Permissible Concentration in Water
Determination in Water
Routes of Entry
Short-Term Exposure
Long-Term Exposure
Points of Attack
Medical Surveillance
First Aid
Decontamination (selected records)
Personal Protective Methods
Respirator Selection
Storage
Shipping
Spill Handling
Fire Extinguishing
Disposal Method Suggested
References

A Brief history of this work

Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens was first published more than 35 years ago. This work continues to provide first responders and occupational and environmental health and safety professionals with an accessible and portable reference source. Based on a count of CAS numbers, the seventh edition of this handbook contains data on almost 2600 toxic and hazardous chemicals (up from nearly 600 in the first edition, nearly 800 in the second edition, nearly 1300 in the third edition, and nearly 1500 in the fourth edition, and 2200 in the sixth edition).

According to the United State Library of Congress, the history of the project is as follows: 1st edition published in 1981; 2nd edition published in 1985; 3rd edition published in 1991; 4th edition published in 2001; 5th edition November 2007; 6th edition 2012, 7th edition: 2017.

Acknowledgments

The compilation of this 7th edition could not have been realized without the contributions of many of the researchers, scientists, contract employees and institutions that developed the excellent documents and databases that provided so much of the essential data that appear in this work. A full list of these contributors is impossible to compile. Nevertheless, In no particular order, I wish to acknowledge the those associated with US Environmental Protection Agency (EPA); United States Department of Labor; Occupational Safety and Health Administration (OSHA); Department of Health and Human Services; National Institute for Occupational Safety and Health (NIOSH); US Department of Energy (DOE); Agency for Toxic Substances and Disease Registry (ATSDR); American Conference of Governmental Industrial Hygienists (ACGIH); Deutsche Forschungsgemeinschaft (DFG); Centers for Disease Control and Prevention (CDC); NOAA; United States National Library of Medicine (NLM) National Institutes of Health (NIH); Hazardous Substance Data Bank (HSDB) and (TOXNET); US Department of Health and Human Services, Public Health Service, National Toxicology Program (NTP); Federal Emergency Management Agency (FEMA); US Department of Transportation (DOT); US Coast Guard (USCG); National Fire Protection Association (NFPA); International Agency for Research on Cancer; (IARC); New Jersey Department of Health and Senior Services; Chemical Safety and Hazard Investigation Board (CSB); United Nations Environment Programme; the states of New York and New Jersey, and many other government organizations, organizations and companies. It is nearly impossible to express the extent of my gratitude to all of them for their contributions to my research.

Although every effort has been made to produce an accurate and highly useful handbook, the editors and Publisher appreciates the need-for constant improvement. Any comments, corrections, or advice from users of this book are welcomed by the author who asks that all correspondence be submitted in writing and mailed directly to the publisher who will maintain a file for reprints and future editions.

How to Use This Book

Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens focuses on critical data for more than 2600 commercially important, regulated and hazardous, to one degree or another, substances. A large number of these chemicals are known or suspected potentially dangerous carcinogens. Many are found in the workplace and fewer are found in the medical and research fields. Some are found in home basements and worksheds. For the most part, importance is defined by inclusion in official, regulatory, and advisory listings. Much of this information, found in US government sources, has been supplemented by a careful search of many publications and databases.

This handbook is becoming more encyclopedic in nature. When one looks at many, if not most published works in this field, the user simply expects to find numerical data. Here, we have tried, wherever possible, to provide useful descriptive material and references which hopefully opens the door to additional of published materials.

Nevertheless, this is not a seminal research work and it is recommended that this book be used as a guide. This work is not meant to be a substitute for workplace hazard communication programs required by regulatory bodies such as OSHA, and/or any other United States or international government agencies. If data are required for legal purposes, the original source documents [such as Code of Federal Regulations (CFR)], appropriate Federal and State agencies, which are often referenced, should be consulted.

In the pages which follow, the following categories of information will be presented, for each chemical record, discussed with reference to scope, sources, nomenclature employed, and the like. Omission of a category generally indicates a lack of available information.

Chemical name: Each record is arranged alphabetically by a chemical name. These are names used by regulatory and advisory bodies. In very few cases the name may be a popularly-used product name or trade name. The chemical name section of each chemical record is backed-up with the "Synonyms" section and Appendix 5, "Synonym and Trade Name-Cross Index."

Formula: Generally, this has been limited to a commonly used one-line empirical or atomic formula. In the *Molecular Formula* field, the Hill system has been used showing number of carbons (if present), number of hydrogens (if present), followed by alphabetically listed element (s). Multiple carbon−carbon (double and triple) bonds have been displayed where appropriate.

Synonyms: This section contains scientific, product, trade, and other synonym names that are commonly used for each hazardous substance. Some of these names are registered trade names. Some are provided in other major languages other than English, including Spanish, French, and German. In some cases, "trivial" and nicknames (such as MEK for methyl ethyl ketone) have been included because they are commonly used in general communications, especially in the workplace. This section is important because the various "regulatory" lists published by federal, state, international agencies and advisory bodies do not always use the same name for a given hazardous substance. Every attempt has been made to ensure the accuracy of the synonyms and trade names found in this work, but errors of highly complex names are inevitable in compilations of this magnitude. Please note that this work may not include the names of all products currently found in commerce, particularly mixtures that may contain ingredients that are regulated chemicals.

The synonym index contains all synonym names listed in alphabetical order. It should be noted that organic chemical prefixes and interpolations such as (α-) alpha-, (β-) beta-, (γ-) gamma-, (δ-) delta-, (o-) ortho-, (m-) meta-; (p-) para-; sec- (secondary-), trans-, cis-, (n-) normal-, and numbers (1-; 1,2-), etc. are not used when searching for a chemical name. In other words, these prefixes are not treated as part of the chemical name for the purposes of alphabetization. Users should use the substance name without the prefix. For example, to locate *n*-butane, search for butane; to locate 3,3′-dichlorobenzidine; search for dichlorobenzidine; and to locate α-cyanotoluene or *alpha*-cyanotoluene, search for cyanotoluene. *Note*: All product names, company names, trademarks, and brands are the registered property of their respective owners. All company, product and service names used in this work are for identification purposes only. Use of these names, logos, and brands does not imply endorsement by the Author, Editors or the Publisher.

CAS Registry Number: The Chemical Abstracts Service (CAS) number is a unique identifier assigned to each chemical registered with the CAS of the American Chemical Society. This number is used to identify chemicals on the basis of their molecular structure. CAS numbers, in the format "nnn-nn-n" [two or more numeric characters (dash) two numeric characters (dash) followed by a single numeric check digit]. CAS numbers should always be used in conjunction with substance names to insure positive identification and to avoid confusion with like-sounding names, i.e., benzene (71-43-2) and benzine (8032-32-4). This 7th edition contains some alternate CAS numbers that may now be considered related, retired, obsolete and/or widely and incorrectly used in the literature. In this section, the first CAS number(s), before the abbreviation "alt." for the word "alternate," is considered (based on several sources) to be the correct CAS number(s). Ultimately, it is the responsibility of the user to find and use the correct number. *Note*: CAS Registry Number is a Registered Trademark of the American Chemical Society.

HSDB Number: HSDB is a toxicology data file on the National Library of Medicine's (NLM's) Toxicology Data Network (TOXNET). HSDB is organized into individual chemical records, and contains over 5000 such records. HSDB is a database focused primarily on the toxicology of potentially hazardous chemicals. The information in HSDB has been assessed by a Scientific Review Panel. Using your computer browser and entering a search such as "HSDB (followed by the Number)" should take you to the exact record you are seeking.

RTECS Number: RTECS (Registry of Toxic Effects of Chemical Substances) is a compendium of data extracted from the open scientific literature. The data are recorded in the format developed by the RTECS staff at NIOSH and arranged in alphabetical order by prime chemical name.[NIOSH] The RTECS numbers are unique identifiers assigned NIOSH. The RTECS number in the format "AAnnnnnnn" (two alphabetic characters followed by seven numeric characters) may be useful for online searching for additional toxicologic information on specific substances. It can, for example, be used to provide access to the MEDLARS computerized literature retrieval services of the NLM in Washington, DC. The RTECS number and the CAS number can serve to narrow down online searches. The RTECS Database is currently available from a growing list of "value-added" vendors that are listed on the Internet from NIOSH or CDC. In the US 1-800-232-4636; Outside the US 1-513-533-8328 or by Email: cdcinfo@cdc.gov.

UN/NA & ERG Number: United Nations-North America numbers are four-digit numbers that identify an individual chemical or group of hazardous substances, chemicals or articles (such as explosives, corrosive substances, pesticides, grenades, etc.) with similar characteristics. These four-digit numbers are normally preceded by UN or NA (e.g., UN1759-NA1759). UN/NA numbers are required to appear on shipping documents, and are often displayed on warning labels, the exterior of packages, and on specified containers such as truck or railway placards. These ID (identification) numbers may also be called NA (North American) numbers or DOT (Department of Transportation) numbers.[cameo] UN numbers are assigned by the United Nations Committee of Experts on the Transport of Dangerous Goods. Identification numbers containing a UN prefix (United Nations numbers) are authorized for use with all international shipments of hazardous materials. NA numbers are assigned by the United States DOT and usually correspond closely, but not always precisely, to the UN listing. The "NA" prefix is used for shipments between Canada and the United States *only*, and may *not* be used for other international shipments. Some chemicals without an assigned UN number may have an NA number. These latter NA numbers are usually in the format and range of NA8000−NA9999. Use of these ID numbers for hazardous materials will (1) serve to verify descriptions of chemicals; (2) provide for rapid identification of materials when it might be inappropriate or confusing to require the display of lengthy chemical names on vehicles; (3) aid in speeding communication of information on materials from accident scenes and in the receipt of more accurate emergency response information; and (4) provide a means for quick access to immediate emergency response information in the *North American Emergency Response Guidebook* (ERG) and also in the international publication, *Recommendations on the Transport of Dangerous Goods*, also known as the *Orange Book*.

EC Number: The European Commission number is a seven digit identification code used in countries of the European Union (EU) for commercially available chemical substances within the EU. This number is an identification number (ID) from *European Inventory of Existing Commercial Chemical Substances*, published by the European Environment Agency, Copenhagen, Denmark. The EC number supercedes the outmoded EINECS, ELINCS and NLP numbers. This section also includes "Annex I, Index Number" for the Export and Import of Dangerous Chemicals found in Annex I of Regulation (EC) No. 689/2008.

Regulatory Authority and Advisory Bodies:

This section contains a listing of major regulatory and advisories for the chemical of concern, including, but not limited to, Homeland Security, OSHA, US EPA, DFG (Germany), US DOT, ACGIH, IARC, NTP, WHMIS (Canada) and the EC, etc. Many law or regulatory references in this work have been abbreviated. For example, Title 40 of the CFR, Part 261, subpart 32 has been abbreviated as 40CFR261.32. The symbol "§" may be used as well to designate a "section" or "part."

- United States Department of Homeland Security. Includes "chemicals of interest" from The Chemical Facility Anti-Terrorism Standards (CFATS Act of 2014) program and the *Federal Register*, Appendix A, including all provisions of 6 CFR Part 27, including § 27.210(a)(1)(i). In developing the list, the DHS looked to existing expert sources of information including other federal regulations related to chemicals, including the following: chemicals covered under the United States Environmental Protection Agency's Risk Management Program. Chemicals included in the Chemical Weapons Convention. Hazardous materials, such as gases that are poisonous by inhalation. Explosives regulated by the DOT. The Department of Homeland Security has identified three security issues related to chemicals: *Release*—Toxic, flammable, or explosive chemicals or materials that, if released from a facility, have the potential for significant adverse consequences for human life or health. *Theft or Diversion*—Chemicals or materials that, if stolen or diverted, have the potential to be misused as weapons or easily converted into weapons using chemical

manipulation and techniques and related equipment with the intent of creating significant adverse consequences for human life or health. *Sabotage or Contamination*—Chemicals or materials that, if mixed with other and possibly readily available materials, have the potential to create significant adverse consequences for human life or health. Also considered were these security issues as well as to determine their potential future inclusion in the final version of Appendix A, and/or coverage under *Chemical Facility Anti-Terrorism Standards: Critical to Government Mission*—Chemicals or facilities the loss of which could create significant adverse consequences for national security or the ability of the government to deliver essential services, and *Critical to National Economy*—Chemicals or facilities the loss of which could create significant adverse consequences for the national or regional economy.

- Carcinogenicity: lists known and suspected human carcinogens, the agency making such a determination, the nature of the carcinogenicity. The following lists and agencies were consulted: *US Department of Health and Human Services 13th Report on Carcinogens (10/2/2014)*. United States Environmental Protection Agency: US EPA's general categories recognized by the 2005 guidelines are as follows: *Group A*: Carcinogenic to Humans: Agents with adequate human data to demonstrate the causal association of the agent with human cancer (typically epidemiologic data). *Group B*: Probably Carcinogenic to Humans: Agents with sufficient evidence (i.e., indicative of a causal relationship) from animal bioassay data, but either limited human evidence (i.e., indicative of a possible causal relationship, but not exclusive of alternative explanations; Group B1), or with little or no human data (Group B2). *Group C*: Possibly Carcinogenic to Humans: Agents with limited animal evidence and little or no human data. *Group D*: Not Classifiable as to Human Carcinogenicity: Agents without adequate data either to support or refute human carcinogenicity. *Group E*: Evidence of Noncarcinogenicity for Humans: Agents that show no evidence for carcinogenicity in at least two adequate animal tests in different species or in both adequate epidemiologic and animal studies.[USEPA] US Department of Health and Human Services *13th Report on Carcinogens (RoC)*, (2014), a science-based document prepared by the National Toxicology Program (NTP) that identifies chemical, biological, and physical agents that are considered cancer hazards for people living in the United States. IARC (International Agency for Research on Cancer),[12] are classified as to their carcinogenic risk to humans by IARC as follows: Group 1: Human Carcinogen; Group 2A: Probable Human Carcinogen; Group 2B: Possible Human Carcinogen.
- Chemicals on California's Proposition 65 List, revised as of September 30, 2016. Officially known as the Safe Drinking Water and Toxic Enforcement Act of 1986. The proposition requires that the Governor protect the state's drinking water sources from being contaminated with chemicals known to cause cancer, birth defects or other reproductive harm, and to revise and republish at least once per year a list of such chemicals. It also requires businesses to inform Californians about exposures to chemicals on the revised list[OEHHA].
- This 7th edition contains a brief summary labeled "Hazard Alert". The purpose of this section is to quickly notify users of specific dangers related to each chemicals of interest. Following is a *sample* of warnings appearing in this section: Asphyxiation hazard • Combustible liquid • Contains gas under pressure • may explode if heated • Endocrine disruptors (high/medium/low, where available) • Dangerous nerve agent • Extremely flammable gas • Flammable liquid • Frostbite/Cryogenic burn hazard • Poison inhalation hazard: exposure can be lethal • Polymerization hazard (high) • Polymerization hazard $>$ 30°C • Possible risk of forming tumors • Primary irritant (w/o allergic reaction) • Sensitization hazard (skin, respiratory) • Suspected of causing genetic defects • Suspected reprotoxic hazard • Environmental hazard, etc. *Warning*: This section is merely a guide and does not purport to be complete for every chemical covered in this work.
- A banned or severely restricted product as designated by the United Nations[13] or by the US EPA Office of Pesticide Programs under FIFRA (Federal Insecticide, Fungicide and Rodenticide Act).[14]
- A substance with an air pollutant standard set or recommended by OSHA and/or NIOSH,[58] ACGIH,[1] DFG.[3] The OSHA limits are the enforceable pre-1989 PELs. The transitional limits that were vacated by court order have not been included. However, the vacated limits are used and enforced by some states. Some airborne limits, for example, such as those from NIOSH and ACGIH are recommendations that do not carry the force of law.
- A substance whose allowable concentrations in workplace air are adopted or proposed by the American Conference of Government Industrial Hygienists

(ACGIH),[1] DFG [Deutsche Forschungsgemeinschaft (German Research Society)].[3] Substances whose allowable concentrations in air and other safety considerations have been considered by OSHA and NIOSH.[2] Substances which have limits set in workplace air, in residential air, in water for domestic purposes or in water for fishery purposes as set forth by the former USSRUNEP/IRPTC Project.[43]

- Substances that are specifically regulated by OSHA under 29CFR1910.1001 to 29CFR1910.1050
- Highly hazardous chemicals, toxics, and reactives regulated by OSHA's "*Process Safety Management of Highly Hazardous Chemicals*" under 29CFR1910.119, Appendix A. Substances that are Hazardous Air Pollutants (Title I, Part A, § 112) as amended under 42USC7412. This list provided for regulating at least 189 specific substances using technology-based standards that employ Maximum Achievable Control Technology (MACT) standards; and, possibly health-based standards if required at a later time. § 112 of the Clean Air Act (CAA) requires emission control by the EPA on a source-by-source basis. Therefore, the emission of substances on this list does not necessarily mean that a firm is subject to regulation.
- Regulated Toxic Substances and Threshold Quantities for Accidental Release Prevention. These appear as Accidental Release Prevention/Flammable Substances, Clean Air Act (CAA) §112(r), Table 3, TQ (threshold quantity) in pounds and kilograms under 40 CFR68.130. The accidental release prevention regulations applies to stationary sources that have present more than a threshold quantity of a CAA § 112(r) regulated substance.
- Clean Air Act (CAA) Public Law 101−549, Title VI, *Protection of Stratospheric Ozone*, Subpart A, Appendix A, class I and Appendix B, Class II, Controlled Substances, (CFCs) Ozone depleting substances under 40CFR82.
- Clean Water Act (CWA) Priority toxic water pollutants defined by the US Environmental Protection Agency for 65 pollutants and classes of pollutants which yielded 129 specific substances.[6]
- Chemicals designated by EPA as "Hazardous Substances"[4] under the Clean Water Act (CWA) 40CFR116.4, Table 116.4A.
- Clean Water Act (CWA) § 311 Hazardous Materials Discharge Reportable Quantities (RQs). This regulation establishes reportable quantities for substances designated as hazardous (see §116.4, above) and sets forth requirements for notification in the event of discharges into navigable waters. Source: 40 CFR117.3, amended at 60FR30937.
- Clean Water Act (CWA) § 307 List of Toxic Pollutants. Source: 40CFR401.15.
- Clean Water Act (CWA) § 307 Priority Pollutant List. This list was developed from the List of Toxic Pollutants classes discussed above and includes substances with known toxic effects on human and aquatic life, and those known to be, or suspected of being, carcinogens, mutagens, or teratogens. Source: 40CFR423, Appendix A.
- Clean Water Act, § 313 Water Priority Chemicals. Source: 57FR41331.
- RCRA Maximum Concentration of Contaminants for the Toxicity Characteristic with Regulatory levels in mg/L. Source: 40CFR261.24.
- RCRA Hazardous Constituents. Source: 40CFR261, Appendix VIII. Substances listed have been shown, in scientific studies, to have carcinogenic, mutagenic, teratogenic or toxic effects on humans and other life forms. This list also contains RCRA waste codes. The words, "waste number not listed" appears when a RCRA number is NOT provided in Appendix VIII.

Characteristic Hazardous Wastes

Ignitability	A nonaqueous solution containing less than 24% alcohol by volume and having a closed cup flash point below 60°C/140°F using Pensky−Martens tester or equivalent An ignitable compressed gas A nonliquid capable of burning vigorously when ignited or causes fire by friction, moisture absorption, spontaneous chemical changes at standard pressure and temperature An oxidizer. See §261.21
Corrosivity	Liquids with a pH equal to or less than 2 or equal to or more than 12.5 or which corrode steel at a rate greater than 6.35 mm (0.25 in.) per year @ 55°C/130°F. See §261.22
Reactivity	Unstable substances that undergo violent changes without detonating Reacts violently with water or other substances to create toxic gases Forms potentially explosive mixtures with air. See §261.23
Toxicity	A waste that leaches specified amounts of metals, pesticides, or organic chemicals using Toxicity Characteristic Leaching Procedure (TCLP). See §261, Appendix II, and §268, Appendix I. **Listed Hazardous Wastes**

“F” wastes	Hazardous wastes from nonspecific sources §261.31
“K” Wastes	Hazardous wastes from specific sources §261.32
“U” Wastes	Hazardous wastes from discarded commercial products, off-specification species, container residues §261.34. Covers some 455 compounds and their salts and some isomers of these compounds
“P” Wastes	Acutely hazardous wastes from discarded commercial products, off-specification species, container residues §261.33. Covers some 203 compounds and their salts plus soluble cyanide salts

Note: If a waste is not found on any of these lists, it may be found on state hazardous waste lists.

RCRA Maximum Concentration of Contaminants for the Toxicity Characteristic. Source: 40CFR261.24, Table I. These are listed with regulatory level in mg/L and “D” waste numbers representing the broad waste classes of ignitability, corrosivity, and reactivity.

EPA Hazardous Waste code(s), or RCRA number, appears in its own field. Acute hazardous wastes from commercial chemical products are identified with the prefix “P.” Nonacutely hazardous wastes from commercial chemical products are identified with the prefix “U.”

RCRA Universal Treatment Standards. Lists hazardous wastes that are banned from land disposal unless treated to meet standards established by the regulations. Treatment standard levels for wastewater (reported in mg/L) and nonwastewater [reported in mg/kg or mg/L TCLP (Toxicity Characteristic Leachability Procedure)] have been provided. Source: 40CFR268.48 and revision, 61FR15654.

RCRA Ground Water Monitoring List. Sets standards for owners and operators of hazardous waste treatment, storage, and disposal facilities, and contains test methods suggested by the EPA (see Report SW-846) followed by the Practical Quantitation Limit (PQL) shown in parentheses. The regulation applies only to the listed chemical; and, although both the test methods and PQL are provided, they are *advisory only*. Source: 40CFR264, Appendix IX.

Safe Drinking Water Act (SDWA) Maximum Contaminant Level Goals (MCLG) for Organic Contaminants. Source: 40CFR141 and 40CFR141.50, amended 57FR31776.

- Maximum Contaminant Levels (MCL) for Organic Contaminants. Source: 40CFR141.61.
- Maximum Contaminant Level Goals (MCLG) for Inorganic Contaminants. Source: 40CFR141.51.
- MCL for Inorganic Contaminants. Source: 40CFR141.62.
- MCL for Inorganic Chemicals. The MCL for arsenic applies only to community water systems. Compliance with the MCL for arsenic is calculated pursuant to §141.23. Source: 40CFR141.11.
- Secondary Maximum Contaminant Levels (SMCL). Federal advisory standards for the states concerning substances that effect physical characteristics (i.e., smell, taste, color, etc.) of public drinking water systems. Source: 40CFR143.3.
- CERCLA Hazardous Substances (“RQ” Chemicals). From Consolidated List of Chemicals Subject to the Emergency Planning and Community Right-to-Know Act (EPCRA) and § 112(r) of the Clean Air Act, as Amended. Source: EPA 550-B-98-017 *Title III List of Lists*.
- Releases of CERCLA hazardous substances in quantities equal to or greater than their reportable quantity (RQ), are subject to reporting to the National response Center under CERCLA. Such releases are also subject to state and local reporting under §304 of SARA Title III (EPCRA). CERCLA hazardous substances, and their reportable quantities, are listed in 40CFR302, Table 302.4. RQs are shown in pounds and kilograms for chemicals that are CERCLA hazardous substances. For metals listed under CERCLA (antimony, arsenic, beryllium, cadmium, chromium, copper, lead, nickel, selenium, silver, thallium, and zinc), no reporting of releases of the solid is required if the diameter of the pieces of solid metal released is 100 μm (0.004 in.) or greater. The RQs shown apply to smaller particles.
- EPCRA §302 Extremely Hazardous Substances (EHS). From Consolidated List of Chemicals Subject to the Emergency Planning and Community Right-to-Know Act (EPCRA) and § 112(r) of the Clean Air Act, as Amended. Source: EPA 550-B-98-017 *Title III List of Lists*. The presence of Extremely Hazardous Substances in quantities in excess of the Threshold Planning Quantity (TPQ), requires certain emergency planning activities to be conducted. The Extremely Hazardous Substances and their TPQs are listed in 40CFR355, Appendices A and B. For chemicals that are solids, there may be two TPQs given (e.g., 500/10,000). In these cases, the lower quantity applies for solids in powder form with particle size less than 100 μm; or, if the substance is in solution or in molten form. Otherwise, the higher quantity (10,000 pounds in the example) TPQ applies.
- EPCRA §304 Reportable Quantities (RQ). In the event of a release or spill exceeding the reportable quantity, facilities are required to notify State Emergency Response Commissions (SERCs) and Local Emergency Planning Committees (LEPCs). From Consolidated List of Chemicals Subject to the

Emergency Planning and Community Right-to-Know Act (EPCRA) and § 112(r) of the Clean Air Act, as Amended. Source: EPA 550-B-98-017 *Title III List of Lists*.

- EPCRA § 313 Toxic Chemicals. From Consolidated List of Chemicals Subject to the Emergency Planning and Community Right-to-Know Act (EPCRA) and § 112(r) of the Clean Air Act, as Amended. Source: EPA 550-B-98-017 *Title III List of Lists*. Chemicals on this list are reportable under §313 and §6607 of the Pollution Prevention Act. Some chemicals are reportable by category under §313. Category codes needed for reporting are provided for the EPCRA§313 categories. Information and Federal Register references have been provided where a chemical is subject to an administrative stay, and not reportable until further notice.
- From "*Toxic Chemical Release Inventory Reporting Form R and Instructions, Revised 2005 Version*," EPA document 260-B-06-001 was used for *de minimis* concentrations, toxic chemical categories.
- Chemicals which EPA has made the subject of Chemical Hazard Information Profiles or "CHIPS" review documents.
- Chemicals which NIOSH has made the subject of "Information Profile" review documents on "Current Intelligence Bulletins."
- Carcinogens identified by the National Toxicology Program of the US Department of Health and Human Services at Research Triangle Park, NC.[10]
- Substances regulated by EPA[7] under the major environmental laws: Clean Air Act, Clean Water Act, Safe Drinking Water Act, RCRA, CERCLA, EPCRA, etc. A more detailed list appears above. Substances with environmental standards set by some international bodies including those in Europe and Canada.[43]
- Hazard Symbols, Risk Phrases, and Safety Phrases. Explanation of these symbols and phrases can be found in Appendix 4. In the year 2018 it is expected that the Globally Harmonized System of Classification and Labeling of Chemicals (GHS) will be phased in by many countries. Hazard statements are an essential element under the GHS, and will eventually replace the risk phrases (R-phrases) described earlier in the paragraph. In addition to hazard statements, containers and Material Safety Data Sheets (MSDS) will often contain, where necessary, one or multiple pictograms, a signal word such as "Warning" or "Danger," and precautionary statements. The precautionary statements will indicate proper handling procedures aimed at protecting the user and other people who might come in contact with the substance during an accident or in the environment. The container and MSDS will also contain the name of the supplier, manufacturer, or importer. Each hazard statement contains a four-digit code, starting with the letter H (in the format Hxxx). Statements appear under various headings grouped together by code number. The purpose of the four-digit code is for reference only; however, following the code is exact *phrase* as it should appear on labels and MSDS. The collection of Risk and Safety phrases in this work my go beyond those found in some, more generalized Material Safety Data Sheets. It is also possible that some of the warnings are based on animal rather than human studies. These statements are usually preceded by the word "suspected" or "potential".
- Water hazard classifications from the German Federal Water Management Act on Water Hazard Classification, *Verwaltungsvorschrift Wassergefährdende Stoffe* (VwVwS). This law requires all chemical substances be evaluated for their detrimental impact on the physical, chemical, or biological characteristics of water. Substances can be classified as nonhazardous to water (*nwg, nicht wassergefährdende*) or assigned to one of three numeric water hazard classes, WGK-1: low hazard to waters (low polluting to water), WGK-2: hazard to waters (water pollutant), or WGK: 3 severe hazard to waters (severe pollutant). The English acronym for WGK is WHC (water hazard class). This work uses the German initial-acronym "WGK" so there is no confusion as to its source. Material Safety Data Sheets (MSDS) that use these water hazards also use the German acronym. If a value was not assigned or not found in the German database, an estimated has been provided using the format, "*WGK (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]*." These estimates are based on other sources, for example, the US DOT *List of Marine Pollutants (§172.101—Appendix B)*. *Warning*: These estimates are to be used only as a guide. In the case of limited information, it is the responsibility of the users of this work to recognize and address those limitations and to engage in additional research, including direct contact with chemical suppliers and all forms of supplier communications such as the legally required Material Safety Data Sheets (MSDSs), Technical Bulletins, etc.

Description: This section contains a quick summary of properties of the substance including physical state (solid, liquid or gas), color, odor description, molecular weight, density, boiling point, freezing/melting point, vapor

pressure, flash point, autoignition temperature, explosion limits in air, Hazard Identification (based on NFPA-704 M Rating System) in the format: Health (ranked 1 to 4), Flammability (ranked 1 to 4), Reactivity (ranked 1 to 4) (see also below for a detailed explanation of the System and Fire Diamond), and solubility or miscibility in water. This section may also contain special and relevant comments about the substance. Terms in this section are also defined in the glossary.

Odor threshold: This is the lowest concentration in air that most humans can detect by smell. Some value ranges are reported. The value cannot be relied on to prevent overexposure, because human sensitivity to odors varies over wide limits, some chemicals cannot be smelled at toxic concentrations, odors can be masked by other odors, and some compounds rapidly deaden the sense of smell.

Molecular weight: The MW as calculated from the molecular formula using standard elemental molecular weights (e.g. carbon = 12.1).

Boiling point at 1 atm: The value is the temperature of a liquid when its vapor pressure is 1 atm. For example, when water is heated to 100°C/212°F its vapor pressure rises to 1 atm and the liquid boils. The boiling point at 1 atm indicates whether a liquid will boil and become a gas at any particular temperature and sea-level atmospheric pressure.

Melting/Freezing point: The melting/freezing point is the temperature at which a solid changes to liquid or a liquid changes to a solid. For example, liquid water changes to solid ice at 0°C/32°F. Some liquids solidify very slowly even when cooled below their melting/freezing point. When liquids are not pure (e.g., salt water) their melting/freezing points are lowered slightly.

Flash point: This is defined as the lowest temperature at which vapors above a volatile combustible substance will ignite in air when exposed to a flame. Depending on the test method used, the values given may be either Tag Closed Cup (cc) (ASTM D56) or Cleveland Open Cup (oc) (ASTM D93). The values, along with those in *Flammable Limits in Air* and *Autoignition temperature* below, give an indication of the relative flammability of the chemical. In general, the open cup value is slightly higher (perhaps 10 to 15°F higher) than the closed cup value. The flash points of flammable gases are often far below 0° (F or C) and these values are of little practical value, so the term “flammable gas” is often used instead of the flash point value.

Autoignition Temperature: This is the minimum temperature at which the material will ignite without a spark or flame being present. Values given are only approximate and may change substantially with changes in geometry, gas, or vapor concentrations, presence of catalysts, or other factors.

Flammable Limits in Air: The percent concentration in air (by volume) is given for the LEL (lower explosive-flammable limit in air, % by volume) and UEL (upper explosive flammable limit in air, % by volume), at room temperature, unless other specified. The values, along with those in “Flash point” and “Autoignition temperature” give an indication of the relative flammability of the chemical.

NFPA Hazard Classifications: The NFPA 704 Hazard Ratings (Classifications) are based on those found in “*Fire Protection Guide to Hazardous Materials*,” 2001 edition, National Fire Protection Association, Quincy, MA, ©1994. The classifications are defined in Table 1.

Table 1. *Explanation of NFPA Hazard Classifications*

Classification	*Definition*
HEALTH HAZARD (blue)	
4	Materials which on very short exposure could cause death or major residual injury (even though prompt medical treatment was given), including those that are too dangerous to be approached without specialized protective equipment
3	Materials which on short exposure could cause serious temporary or residual injury (even though prompt medical treatment was given), including those requiring protection from all bodily contact
2	Materials that, on intense or continued (but not chronic) exposure, could cause temporary incapacitation or possible residual injury, including those requiring the use of protective clothing that has an independent air supply
1	Materials which on exposure would cause irritation but only minor residual injury, including those requiring the use of an approved air-purifying respirator
0	Materials that, on exposure under fire conditions offer no hazard beyond that of ordinary combustible material
FLAMMABILITY (red)	
Classification number and Definition	
4	This degree includes flammable gases, pyrophoric liquids, and Class IA flammable liquids. Materials which will rapidly or completely vaporize at atmospheric pressure and normal ambient temperature, or which are readily dispersed in air and which will burn readily
3	Includes Class IB and IC flammable liquids and materials that can be easily ignited under almost all normal temperature conditions
2	Materials that must be moderately heated before ignition will occur and includes Class II and Class IIIA combustible liquids and solids and semisolids that readily give off ignitable vapors
1	Materials that must be preheated before ignition will occur, such as Class IIIB combustible liquids, and solids and semisolids whose flash point exceeds 200°F/93.4°C, as well as most ordinary combustible materials
0	Materials that will not burn

REACTIVITY (yellow)

4 Materials that, in themselves, are readily capable of detonation, explosive decomposition or explosive reaction at normal temperatures and pressures

3 Materials that, in themselves, are capable of detonation, or explosive reaction, but require a strong initiating source or heating under confinement. This includes materials that are sensitive to thermal and mechanical shock at elevated temperatures and pressures and materials that react explosively with water

2 Materials that are normally unstable and readily undergo violent chemical change, but are not capable of detonation. This includes materials that can undergo chemical change with rapid release of energy at normal temperatures and pressures. This also includes materials that may react violently with water or that may form potentially explosive mixtures in water

1 Materials that are normally stable, but that may become unstable at elevated temperatures and pressures and materials that will react with water with some release of energy, but not violently

0 Materials that are normally stable, even under fire exposure conditions, and that do not react with water

OTHER (white)

₩ Materials which react so violently with water that a possible hazard results when they come in contact with water, as in a fire situation. Similar to Reactivity Classification 2. Oxy—Oxidizing material; any solid or liquid that readily yields oxygen or other oxidizing gas, or that readily reacts to oxidize combustible materials

It should be noted that OSHA and DOT have differing definitions for the term “flammable liquid” and “combustible liquid.” DOT defines a flammable liquid as one which, under specified procedures, has a flash point of 140°F/60°C or less. A combustible liquid is defined as “having a flash point above 140°F/60°C and below 200°F/93°C.” OSHA defines a combustible liquid as having a flash point above 100°F/37.7°C.

Detection: Only those materials having specific or specialized testing materials have this section. For example, the chemical Abrin or Ricin can be detected using BTA (BioThreat Alert) test strips.

History of the material: This section is reserved for those materials having a useful and interesting background. Some of these materials may be, for example, invasive botanicals that may be found in populated areas Dangerous to both people and pets, these invasive plants may have to be professionally removed to prevent both spreading and accidental poisonings.

Potential Exposure: A brief indication is given of the nature of exposure to each compound in the industrial environment. Where pertinent, some indications are given of background concentration and occurrence from other than industrial discharges such as water purification plants. Obviously in a work of this magnitude, this coverage must be very brief. It is of course recognized that nonoccupational exposures may be important as well.

Incompatibilities: Important, potentially hazardous incompatibilities of each substance are listed where available. Where a hazard with water exists, it is described. Reactivity with other materials are described including structural materials such as metal, wood, plastics, cement, and glass. The nature of the hazard, such as severe corrosion formation of a flammable gas, is described. This list is by no means complete or all inclusive. In some cases a very small quantity of material can act as a catalyst and produce violent reactions such as polymerization, disassociation and condensation. Some chemicals can undergo rapid polymerization to form sticky, resinous materials, with the liberation of much heat. The containers may explode. For these chemicals the conditions under which the reaction can occur are given.

Permissible Exposure Limits in Air: The permissible exposure limit (PEL), has been cited as the federal standard where one exists. Inasmuch as OSHA has made the decision to enforce only pre-1989 PELs, we decided to use these values rather than the transitional limits that were vacated by court order. Except where otherwise noted, the PELs are 8-hour work-shift time-weighted average (TWA) levels. Ceiling limits, Short-Term Exposure Limits (STEL), and TWAs that are averaged over other than full work-shifts are noted.

The Short-Term Exposure Limit (STEL) values are derived from NIOSH,[58] ACGIH,[1] and HSE[33] publications. This value is the maximal concentration to which workers can be exposed for a period up to 15 minutes continuously without suffering from: irritation; chronic or irreversible tissue change; or narcosis of sufficient degree to increase accident proneness, impair self-rescue, or materially reduce work efficiency, provided that no more than four excursions per day are permitted, with at least 60 minutes between exposure periods, and provided that the daily TWA also is not exceeded. The “Immediately Dangerous to Life or Health” (IDLH) concentration represents a maximum level from which one could escape within 30 minutes without any impairing symptoms or any irreversible health effects. However, the 30-minute period is meant to represent a MARGIN OF SAFETY and is NOT meant to imply that any person should stay in the work environments any longer than necessary. In fact, every effort should be made to exit immediately. The concentrations are reported in either parts per million (ppm) or milligrams per cubic meter (mg/m^3).

Most US specifications on permissible exposure limits in air have come from ACGIH[1] or NIOSH.[2] In the In

Germany the DFG has established Maximum Concentrations in the workplace.[3] This section also contains numerical values for allowable limits of various materials in ambient air[60] as assembled by the US EPA. Where available, this field contains legally enforceable airborne Permissible Exposure Limits (PELs) from OSHA. It also contains recommended airborne exposure limits from NIOSH, ACGIH, and international sources and special warnings when a chemical substance is a Special Health Hazard Substance. Each are described below. TLVs have not been developed as legal standards and the ACGIH does not advocate their use as such. The TLV is defined as the time-weighted average (TWA) concentration for a normal 8-hour work-day and a 40-hour work-week, to which nearly all workers may be repeatedly exposed, day after day, without adverse effects. A ceiling value (TLV-C) is the concentration that should not be exceeded during any part of the working exposure. If instantaneous monitoring is not feasible, then the TLV-C can be assessed by sampling over a 15-minute period except for those substances that may cause immediate irritation when exposures are short. As some people become ill after exposure to concentrations lower than the exposure limits, this value cannot be used to define exactly what is a "safe" or "dangerous" concentration. ACGIH threshold limit values (TLVs) are reprinted with permission of the American Conference of Governmental Industrial Hygienists, Inc., from the booklet entitled, *Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices*. This booklet is revised on an annual basis. No entry appears when the chemical is a mixture; it is possible to calculate the TLV for a mixture only when the TLV for each component of the mixture is known and the composition of the mixture by weight is also known. According to ACGIH, "Documentation of the Threshold Limit Values and Biological Exposure Indices, 7th Edition" is necessary to fully interpret and implement the TLVs.

OSHA Permissible Exposure Limits (PELs), are found in Tables Z-1, Z-2, and Z-3 of OSHA, "General Industry Air Contaminants Standard (29CFR1910.1000)" that were effective on July 1, 2001 and which are currently enforced by OSHA.

Unless otherwise noted, PELs are the Time-Weighted Average (TWA) concentrations that must not be exceeded during any 8-hour shift of a 40-hour work-week. An OSHA ceiling concentration must not be exceeded during any part of the work-day; if instantaneous monitoring is not feasible, the ceiling must be assessed as a 15-minute TWA exposure. In addition there are a number of substances from Table Z-2 that have PEL ceiling values that must not be exceeded except for a maximum peak over a specified period (e.g., a 5- minute maximum peak in any 2 hours).

NIOSH Recommended Exposure Limits (RELs) are Time-Weighted Average (TWA) concentrations for up to a 10-hour work day during a 40-hour work week. A ceiling REL should not be exceeded at any time. Exposure limits are usually expressed in units of parts per million (ppm), i.e., the parts of vapor (gas) per million parts of contaminated air by volume at 25°C/77°F and one atmosphere pressure. For a chemical that forms a fine mist or dust, the concentration is given in milligrams per cubic meter (mg/m^3).

Protective Action Criteria (PAC) is emergency exposure limits developed by the US Department of Energy (DOE) for more than 3400 chemicals in revision 29, published May 2016. These exposure limits can be used to estimate the consequences of the uncontrolled release of hazardous materials and to plan for emergency response. These PACs have been added to the 7th edition of Sittig because other well established exposure limits in air are available for an only a limited number of chemicals from other governmental and advisory sources. PAC values are given in parts per million (ppm) for volatile liquids and gases; in milligrams per cubic meter (mg/m^3) for solids, particulates, solids, and nonvolatile liquids. Chemicals for which Acute Emergency Guideline Levels (AEGLs) and Emergency Response Planning Guidelines (ERPGs) have their values displayed in *bolded* font.

PAC Definitions[SCAPA]:

There are subtle difference in the definitions of AEGLs, ERPGs, and TEELs and major differences in how they are developed and issued. Differences in their definitions include:

AEGLs pertain to the "general population, including susceptible individuals," but ERPGs and TEELs pertain to "nearly all individuals."

AEGLs are defined as the level "above which" certain health effects are expected, while ERPGs and TEELs are defined as the level "below which" certain health effects are *not* expected.

Acute Emergency Guideline Levels (AEGLs) are defined as follows:

- *AEGL-1*: the airborne concentration (expressed as ppm or mg/m^3) of a substance above which it is predicted that the general population, including susceptible individuals, could experience notable discomfort, irritation, or certain asymptomatic, nonsensory effects. However, these effects are not disabling and are transient and reversible upon cessation of exposure.
- *AEGL-2*: the airborne concentration (expressed as ppm or mg/m^3) of a substance above which it is predicted that the general population, including susceptible individuals, could experience irreversible or other serious, long-lasting, adverse health effects or an impaired ability to escape.
- *AEGL-3*: the airborne concentration (expressed as ppm or mg/m^3) of a substance above which it is predicted that the general population, including susceptible individuals, could experience life-threatening adverse health effects or death.

Emergency Response Planning Guidelines (ERPGs) are defined as follows:

- *ERPG-1*: the maximum concentration in air below which it is believed nearly all individuals could be exposed for up to one hour without experiencing other than mild transient adverse health effects or perceiving a clearly defined objectionable odor.
- *ERPG-2*: the maximum concentration in air below which it is believed nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action.
- *ERPG-3*: the maximum concentration in air below which it is believed nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects.

Additional information on PAC values and links to other sources of information can be found on the webpage for the *Subcommittee for Consequence Assessment and Protective Action (SCAPA)*: http://orise.orau.gov/emi/scapa/teels.htm

The German MAK (DFG MAK) values are conceived and applied as 8-hour time-weighted average (TWA) values.[3]

Short-Term Exposure Limits (15-minute TWA): This field contains Short-Term Exposure Limits (STELs) from ACGIH, NIOSH and OSHA. The parts of vapor (gas per million parts of contaminated air) by volume at 25°C/77°F and one atmosphere pressure is given. The limits are given in milligrams per cubic meter (mg/m^3) for chemicals that can form a fine mist or dust. Unless otherwise specified, the STEL is a 15-minute TWA exposure that should not be exceeded at any time during the work-day.

Determination in Air: The citations to analytical methods are drawn from various sources, such as the *NIOSH Manual of Analytical Methods*.[18] In addition, methods have been cited in the latest US Department of Health and Human Services publications including the *"NIOSH Pocket Guide to Chemical Hazards"* August, 2006.

Permissible Concentrations in Water: The permissible concentrations in water are drawn from various sources also, including: The National Academy of Sciences/National Research Council, Safe Drinking Water Committee Board on Toxicology and Environmental Health Hazards, *Drinking Water and Health*, 1980.[16]

The priority toxic pollutant criteria published by US EPA 1980.[6]

The multimedia environmental goals for environmental assessment study conducted by EPA.[32] Values are cited from this source when not available from other sources.

The US EPA has come forth with a variety of allowable concentration levels:

For allowable concentrations in "California List" wastes.[38] The California List consists of liquid hazardous wastes containing certain metals, free cyanides, polychlorinated biphenyls (PCBs), corrosives with a pH of less than or equal to 2.0, and liquid and nonliquid hazardous wastes containing halogenated organic compounds (HOCs).

For regulatory levels in leachates from landfills.[37]

For concentrations of various materials in effluents from the organic chemicals and plastics and synthetic fiber industries.[51]

For contaminants in drinking water.[36]

For National Primary and Secondary Drinking Water Regulations.[62]

In the form of health advisories for 16 pesticides,[47] 25 organics,[48] and 7 inorganics.[49]

For primary drinking water standards starting with a priority list of 8 Volatile Organic Chemicals.[40]

State drinking water standards and guidelines [61] as assembled by the US EPA.

Determination in Water: The sources of information in this field have been primarily US EPA publications including the test procedures for priority pollutant analysis[25] and later modifications.[42]

Routes of Entry: The toxicologically important routes of entry of each substance are listed. In other words, the way in which the people or experimental animals were exposed to the chemical is listed, e.g. eye contact, skin contact, inhalation, intraperitoneal, intravenous. Many of these are taken from the *NIOSH Pocket Guide*,[2] but are drawn from other sources as well.

Harmful Effects and Symptoms: These are primarily drawn from NIOSH, EPA publications, and New Jersey and New York State fact sheets on individual chemicals, and are supplemented from information from the draft criteria documents for priority toxic pollutants[26] and from other sources. The other sources include the following:

EPA Chemical Hazard Information Profiles (CHIPS) cited under individual entries.

NIOSH Information Profiles cited under individual entries.

EPA Health and Environmental Effect Profiles cited under individual entries.

Particular attention has been paid to cancer as a "harmful effect" and special effort has been expended to include the latest data on carcinogenicity. See also "Regulatory Authority and Advisory Bodies" section.

Short-Term Exposure: These are brief descriptions of the effects observed in humans when the vapor (gas) is inhaled, when the liquid or solid is ingested (swallowed), and when the liquid or solid comes in contact with the eyes or skin. The term LD50 signifies that about 50% of the animals given the specified dose by mouth will die. Thus, for a Grade 4 chemical (below 50 mg/kg) the toxic dose for 50% of animals weighing 70 kg (150 lb) is $70 \times 50 = 3500$ mg = 3.5 g, or less than 1 teaspoonful; it might be as little as a few drops. For a Grade 1 chemical (5−15 g/kg), the LD50 would be between a pint and a quart for a 150-lb man. All LD50 values have been obtained using small laboratory animals such as rodents,

cats, and dogs. The substantial risks taken in using these values for estimating human toxicity are the same as those taken when new drugs are administered to humans for the first time.

Long-Term Exposure: Where there is evidence that the chemical can cause cancer, mutagenic effects, teratogenic effects, or a delayed injury to vital organs such as the liver or kidney, a description of the effect is given.

Points of Attack: This category is based, in part, on the "Target Organs" in the *NIOSH Pocket Guide*[2] but the title has been changed as many of the points of attack are not organs (blood, for example). This is human data unless otherwise noted.

Medical Surveillance: For each chemical, this information is drawn from many and various government publications and sources including, for example, CDC, NIOSH publications,[27] *New Jersey* or *New york State Fact Sheets*,[70] HSDB/Toxnet, etc. In many cases, statements may refer to known and suspected carcinogen, known or suspected mutagens, reproductive affecters, skin and/or respiratory sensitizers, etc.

First Aid: Guides and guidance to first aid found in this work should not be construed as authorization to emergency personnel to perform the procedures or activities indicated or implied. Care of persons exposed to toxic chemicals must be directed by a physician or other recognized professional or authority. Simple first aid procedures are listed for response to eye contact, skin contact, inhalation, and ingestion of the toxic substance as drawn to a large extent from the *NIOSH Pocket Guide*[2] but supplemented by information from recent commercially available volumes in the United States,[29] in the United Kingdom, and in Japan[24] as well as from state fact sheets. They deal with exposure to the vapor (gas), liquid, or solid and include inhalation, ingestion (swallowing) and contact with eyes or skin. The instruction "Do NOT induce vomiting" is given if an unusual hazard is associated with the chemical being sucked into the lungs (aspiration) while the patient is vomiting. "*Seek medical attention*" or "*Call a doctor*" is recommended in those cases where only competent medical personnel can treat the injury properly. In all cases of human exposure, seek medical assistance as soon as possible. In many cases, medical advice has been included for guidance only. Dosage information has been avoided because dosage recommendations constantly change. Emergency personnel are urged to check all manufacturers' information particularly before administering any drug with which they are not familiar or have not used for some period of time. Also, medications suggested to be administered by qualified medical personnel presume no immediate prior administration of the same, similar or complicating medications.

Personal Protective Methods: This information is drawn heavily from NIOSH publications[2][77] and supplemented by information from the United States,[29] the United Kingdom, and Japan.[24] There are indeed other "personal protective methods" which space limitations prohibit describing here in full. One of these involves limiting the quantities of carcinogens to which a worker is exposed in the laboratory. The items listed are those recommended by (1) NIOSH and/or OSHA, (2) manufacturers, either in technical bulletins or in material safety data sheets (MSDS), (3) the Chemical Manufacturers Association (CMA), or (4) the National Safety Council (NSC), for use by personnel while responding to fire or accidental discharge of the chemical. They are intended to protect the lungs, eyes, and skin.

Respirator Selection: The 7th edition, like its predecessors, presents respirator selection with a full text description. For each line a maximum use concentration (in ppm, mg/m^3, μg/m^3, fibers/m^3, or mppcf) condition (e.g., escape) followed by the NIOSH code and full text related to respirator recommendations. All recommended respirators of a given class, can be utilized at any concentration equal to or less than the class's listed maximum use concentration. Respirator selection should follow recommendations that provide the greatest degree of protection. Respirator codes found in the *NIOSH Pocket Guide* have been included to ease updating.

All respirators selected must be approved by NIOSH under the provisions of 42CFR84. The current listing of NIOSH/MSHA certified respirators can be found in the *NIOSH Certified Equipment List*, which is available on www.cdc.gov/niosh/npptl/topics/respirators/cel. This is the NIOSH Web site.

For firefighting, only self-contained breathing apparatuses with full facepieces operated in pressure-demand or other positive pressure modes are recommended for all chemicals in the *NIOSH Pocket Guide*. In the case of chemical warfare agents, use only SCBA Respirator certified by NIOSH For CBRN environments. CBRN stands for "Chemical, Biological, Radiological, and Nuclear."

Pesticides are not identified as such in the respirator selection tables. For those substances that are pesticides, the recommended air-purifying respirator must be specifically approved by NIOSH/MSHA. Specific information on choosing the appropriate respirator will be provided on pesticide labels. Approved respirators will carry a "TC" number prefix, which signifies they have been tested and certified for a specific level of protection. New respirators may carry a "TC-84A" prefix in compliance with 42 CFR 84 for testing and certifying nonpowered, air-purifying, particulate-filter respirators. The new Part 84 respirators have passed a more demanding certification test than the old respirators (e.g., dust and mist [DM], dust, fume and mist [DFM], spray paint, pesticide, etc.) certified under 30 CFR 11.

Additionally, a complete respirator protection program should be implemented including all requirements in 29CFR1910.134 and 42CFR84. At a minimum, a respirator protection program should include regular training, fit-testing, periodic environmental monitoring, maintenance inspection, and cleaning. The selection of the actual respirator to be used within the classes

of recommended respirators depends on the particular use situation, and should only be made by a knowledgeable person. Remember, air-purifying respirators will not protect from oxygen-deficient atmospheres. For firefighting, only self-contained breathing apparatuses with full facepieces operated in pressure-demand or other positive pressure modes are recommended for all chemicals in the *NIOSH Pocket Guide*.

Storage: The 7th edition now provides, as general guidance, a color-coded classification system similar to those often found in commerce and laboratories. It is the objective of any chemical storage classification system to prevent accidental combination of two or more incompatible materials that might be stored in the same space. To prevent an unwanted and possibly dangerous reaction, chemicals must be separated by space and/or physical barriers. Chemical storage areas should be appropriately labeled. Users must be careful to check the MSDS for both additional and specific information. Some chemical entries contain multiple storage codes because the chemical profile fits more than a single category.

Code	***Hazard***
Red	Flammables (Flash point <100°F)
Blue	Health hazards/toxics/poisons
Yellow	Reactives/oxidizers
White	Contact hazards
Green[a]	General storage

[a] For general storage, the colors gray and orange may also be used by some companies.

- Chemical containers that are not color coded should contain hazard information on the label.
- Check the MSDS to learn what personal protective equipment is required when using the substance
- *Red*: Flammability hazard: Store in a flammable (liquid or materials) storage area or approved cabinet away from ignition sources and corrosive and reactive materials.
- *Blue*: Health hazard/toxics/poisons: Store in a secure poison location.
- *Yellow*: Reactive hazard; store in a location separate from other materials, especially flammables and combustibles.
- *White*: Corrosive or contact hazard; store separately in a corrosion-resistant location.
- *Green (or gray or orange)*: General storage may be used. Generally, for flammability, health, and corrosivity with an NFPA rating of no higher than "2."
- Chemicals with labels that are colored and diagonally striped may react with other chemicals in the same hazard class. See MSDS for more information.
- *Red Stripe*: Flammability hazard: store separately from all other flammable materials. Example: sodium metal.
- *Yellow Stripe*: Reactivity hazard; store separately in an area isolated from flammables, combustibles, or other yellow coded materials. *Example*: reducing agents.
- *White stripe*: Contact hazard; not compatible with materials in solid white category. Store separately. *Example*: Bases.

Other data in this field is drawn from, or based on, various resources, including the NFPA,[17] from Japanese sources[24] and from publications such as the *Hazardous Substance Fact Sheets* published by the New Jersey Department of Health and Senior Services.[70]

Shipping: The shipping guidance offered herein does not replace the training requirements of the DOT and in no way guarantees that you will be in full compliance with the DOT Regulations. *Labeling*: This section refers to the type label or placard required by regulation on any container or packaging of the subject compound being shipped. In some cases a material may require more than one hazardous materials label. *Quantity limitation*: This section lists quantities of material that may be shipped on passenger aircraft, rail, and cargo aircraft. Materials in certain hazard classes may be shipped under the small quantities exception (see 49 CFR 173.4) with specific approval from the Associate Administrator for Hazardous Materials Safety, DOT. *Hazard class or division*: This number refers to the division number or hazard class that must appear on shipping papers. This information is drawn from DOT publications[19] as well as UN publications[20] and also NFPA publications.[17] The US DOT[19] has published listings of chemical substances which give a hazard classification and required labels. The US DOT listing now corresponds with the UN listing[20] and specifies first a hazard class of chemicals as defined in the following table, and then a packing group (I, II, or III) within each of the classes. These groups are variously defined depending on the hazard class but in general define materials presenting: I—a very severe risk (great danger); II—a serious risk (medium danger); and III—a relatively low risk (minor danger).

Hazard Classification System

The hazard class of dangerous goods is indicated either by its class (or division) number or name. For a placard corresponding to the primary hazard class of a material, the hazard class or division number must be displayed in the lower corner of the placard. However, no hazard class or division number may be displayed on a placard representing the subsidiary hazard of a material. For other than Class 7 or the OXYGEN placard, text indicating a hazard (for example, "CORROSIVE") is not required. Text is shown only in the United States. The hazard class or division number must appear on the shipping document after each shipping name.

Class 1—Explosives
Division 1.1: Explosives with a mass explosion hazard
Division 1.2: Explosives with a projection hazard
Division 1.3: Explosives with predominantly a fire hazard
Division 1.4: Explosives with no significant blast hazard
Division 1.5: Very insensitive explosives with a mass explosion hazard
Division 1.6: Extremely insensitive articles
Class 2—Gases
Division 2.1: Flammable gases
Division 2.2: Nonflammable, nontoxic* gases
Division 2.3: Toxic* gases
Class 3—Flammable liquids [and combustible liquids (United States)]
Class 4—Flammable solids; spontaneously combustible materials; and dangerous when wet materials/Water-reactive substances
Division 4.1: Flammable solids
Division 4.2: Spontaneously combustible materials
Division 4.3: Water-reactive substances/dangerous when wet materials
Class 5—Oxidizing substances and organic peroxides
Division 5.1: Oxidizing substances
Division 5.2: Organic peroxides
Class 6—Toxic* substances and infectious substances
Division 6.1: Toxic* substances
Division 6.2: Infectious substances
Class 7—Radioactive materials
Class 8—Corrosive substances
Class 9—Miscellaneous hazardous materials/Products, Substances or Organisms

**Note*: The words "poison" or "poisonous" are synonymous with the word "toxic."

Spill Handling: Spill or leak information provided is intended to be used only as a guide. The term *Issue warning* is used when the chemical is a poison, has a high flammability, is a water contaminant, is an air contaminant (so as to be hazardous to life), is an oxidizing material, or is corrosive. *Restrict access* is used for those chemicals that are unusually and immediately hazardous to personnel unless they are protected properly by appropriate protective clothing, eye protection, and respiratory protection equipment, etc. *Evacuate area* is used primarily for unusually poisonous chemicals or these that ignite easily. *Mechanical containment* is used for water-insoluble chemicals that float and do not evaporate readily. *Should be removed* is used for chemicals that cannot be allowed to disperse because of potentially harmful effects on humans or on the ecological system in general. The term is not used unless there is a reasonable chance of preventing dispersal, after a discharge or leak, by chemical and physical treatment. *Chemical and physical treatment* is recommended for chemicals that can be removed by skimming, pumping, dredging, burning, neutralization, absorption, coagulation, or precipitation. The corrective response may also include the use of dispersing agents, sinking agents, and biological treatment. *Disperse and flush* is used for chemicals that can be made nonhazardous to humans by simple dilution with water. In a few cases the response is indicated even when the compound reacts with water because, when proper care is taken, dilution is still the most effective way of removing the primary hazard. This material safety data sheet information is drawn from a variety of sources including New Jersey Department of Health and Senior Services *Hazardous Substance Fact Sheets*[70] and EPA *Profiles on Extremely Hazardous Substances.*[82]

Fire Extinguishing: Fire information provided is intended to be used only as a guide. Certain extinguishing agents should not to be used because the listed agents react with the chemical and have the potential to create an additional hazard. In some cases they are listed because they are ineffective in putting out the fire. Many chemicals decompose or burn to give off toxic and irritating gases. Such gases may also be given off by chemicals that vaporize in the heat of a fire without either decomposing or burning. If no entry appears, the combustion products are thought to be similar to those formed by the burning of oil, gasoline, or alcohol; they include carbon monoxide (poisonous), carbon dioxide, and water vapor. The specific combustion products are usually not well known over the wide variety of conditions existing in fires; some may be hazardous. This information is drawn from NFPA publications,[17] FEMA,[78] and other sources. Any characteristic behavior that might increase significantly the hazard involved in a fire is described. The formation of flammable vapor clouds or dense smoke, the possibility of polymerization, and explosions is stated in this section and/or the incompatibility section. Unusual difficulty in extinguishing the fire is noted.

Disposal Method Suggested: The disposal methods for various chemical substances have been drawn from various sources, including government documents and a UN publication.[22,79]

References: The general bibliography for this volume follows immediately. It includes both general reference sources and references dealing with analytical methods. The references at the end of individual chemical records are generally restricted to: references dealing only with that particular compound; and references which, in turn, contain bibliographies giving references to the original literature on toxicological and other behavior of the substance in question.

Key to Abbreviations and Acronyms

α	the Greek letter *alpha*; used as a prefix to denote the carbon atom in a straight chain compound to which the principal group is attached.
as-	prefix for asymmetric
ACGIH	American Conference of Governmental Industrial Hygienists
AEGL	Acute Emergency Guideline Level, developed by the EPA
AIHA	American Industrial Hygeine Association
approx	approximately
asym-	prefix for asymmetric
@	at
atm.	atmosphere
ATSDR	Agency for Toxic Substances and Disease Registry
β	the Greek letter *beta*
BEI	Biological Exposure Indices (ACGIH in the USA; South Africa; New Zealand)
BLV	Biological Limit Values
BP	boiling point.
°C	degrees Centigrade
CAA	Clean Air Act
CAAA	Clean Air Act Amendments of 1990
CAMEO	Computer-Aided Management of Emergency Operations (NOAA)
carc.	carcinogen
CAS	Chemical Abstract Service
cc	cubic centimeter
cc	closed cup (Flash point)
CDC	U.S. Center for Disease Control
CEPA	Canadian Environmental Protection Act
CERCLA	Comprehensive Environmental Response, Compensation, And Liability Act
CFCs	chlorofluorocarbons
CFR	*Code of Federal Regulations*
cis-	(Latin: on this side). Indicating one of two geometrical isomers in which certain atoms or groups are on the same side of a plane
CMA	Chemical Manufacturers Association
CPR	Cardiopulmonary Resuscitation
CWA	Clean Water Act
cyclo-	(Greek, circle). Cyclic, ring structure; as cyclohexane
Δ or δ	Greek letter *delta*
DFG	Deutsche Forschungs-gemeinschaft
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
DOT ID	Department of Transportation Identification Numbers
EEC or EC	European Economic Community
EEGL	Emergency Exposure Guidance Level
EHS	Extremely Hazardous Substances
EINECS	European Inventory of Existing Commercial Chemical Substances
ε	Greek letter epsilon
EPA (US)	Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
ESLI	End of Service Life Indicator
est.	estimate
EU	European Union
°F	degrees Fahrenheit
FDA	Food and Drug Administration
FEMA	Federal Emergency Management Agency
FR	*Federal Register* (United States)
γ	Greek letter *gamma*
GHS	Globally Harmonized System of Classification and Labeling of Chemicals
h	hour(s)
HCFC	hydrochlorofluorocarbons
HCS	Hazard Communication Standard
HSDB	Hazardous Substances Data Bank
IARC	International Agency for Research on Cancer
IATA	International Air Transport Association
IDLH	Immediately Dangerous to Life or Health
ILO	International Labor Office
IRIS	Integrated Risk Information System (EPA)
iso-	(Greek, equal, alike). Usually denoting an isomer of a compound.
kg	kilogram(s)
l	liter(s)
lb	pound(s)
$\mathbf{LC_{50}}$	The concentration of a substance in air that kills 50% of the test population.
$\mathbf{LC_{Lo}}$	The lowest concentration of a substance in air that has been shown to cause death in a test population.
$\mathbf{LD_{50}}$	The dose of a substance administered by any route (other than inhalation) that causes death to 50% of the test population.
$\mathbf{LD_{LO}}$	The lowest dose of a substance administered by any route (other than inhalation)that has been shown to cause death in a test population.

LEL	Lower explosive (flammable) limit in air, % by volume at room temperature or other temperature as noted
LEPC	Local Emergency Planning Committees
LTEL	Long Term Exposure Limit (UK)
m-	an abbreviation for “*meta-*,” a prefix used to distinguish between isomers or nearly related compounds
m^3	cubic meter
MACT	Maximum Achievable Control Technology (CAA)
MAK	airborne exposure limit “Maximale Arbeitsplatz-Konzentration” (maximum workplace concentration) from the Deutsche Forschungsgemeinschaft (DFG), German Research Foundation.
MCL	Maximum Contaminant Level (SDWA)
MCLG	Maximum Contaminant Level Goal (SDWA)
mg	milligram(s)
μ	micro
μg	microgram(s)
min	minute(s)
mmHg	millimeters of mercury (non-SI symbol for pressure) Also known as “torr.”
mppcf	million particles per cubic foot
MSDS	Material Safety Data Sheets
n-	abbreviation for “normal,” referring to the arrangement of carbon atoms in a chemical molecule prefix for normal
N-	Symbol used in some chemical names, indicating that the next section of the name refers to a chemical group attached to a nitrogen atom. The bond to the nitrogen atom
NCI	National Cancer Institute (USA)
NFPA	National Fire Protection Association (USA)
NIOSH	National Institute for Occupational Safety and Health (USA)
NLM	National Library of Medicine (USA)
NOAA	National Oceanic and Atmospheric Administration (USA)
NOAEL	No Observed Adverse Effect Level
NOS	not otherwise specified
NPRI	National Pollutant Release Inventory (Canada)
NTIS	National Technical Information Service (USA)
NTP	National Toxicology Program (USA)
o-	*ortho-*, a prefix used to distinguish between isomers or nearly related compounds.
OEL	Occupational Exposure Limit
ω	Greek letter *omega*
oc	open cup
OSHA	Occupational Safety and Health Administration (USA)
Oxy	Oxidizer or oxidizing agent
p-	an abbreviation for “*para-*,” a prefix used to distinguish between isomers or nearly related compounds
PAC	Protective Action Criterion (U.S. DOE)
PBB	polybrominated biphenyl
PCB	polychlorinated biphenyl
PE	polyethylene
PEL	Permissible Exposure Limit (USA, Japan, Mexico)
PNOS	Particulates Not Otherwise Specified
POTW	Publicly Owned Treatments Works
PP	polypropylene
ppb	parts per billion
PPE	Personal Protective Equipment
ppm	parts per million
PQL	Practical Quantitation Limit (RCRA)
prim-	prefix for primary
REL	Recommended Exposure Limits (NIOSH)
RQ	Reportable Quantity
RTECS	Registry of Toxic Effects of Chemical Substances
RTK	Right-to-Know
SARA	Superfund Amendments and Reauthorization Act
s. carc	Suspected Carcinogen
SCAPA	Subcommittee on Consequence Assessment and Protective Actions (DOE)
SCBA	Self-Contained Breathing Apparatus
SDWA	Safe Drinking Water Act
sec-	prefix for secondary
SERC	State emergency response commissions
SMCL	Secondary Maximum Contaminant Levels (SDWA)
STEL	Short-Term Exposure Limit
sym-	abbreviation for “symmetrical,” referring to a particular arrangement of elements within a chemical molecule
t-	prefix for tertiary
TC_{Lo}	The lowest concentration of a substance in air that has been shown to produce toxic effects in a test population.
TD_{Lo}	The lowest dose of a substance that has been shown to produce toxic effects in a test population
TEEL	Temporary Emergency Exposure Limit
TRK	Technical Guiding Concentrations (DFG) for workplace control of carcinogens

***tert*-**	abbreviation for "tertiary," referring to a particular arrangement of elements within a chemical molecule
TLV	Threshold Limit Value (ACGIH)
TQ	Threshold Quantity
***trans*-**	(Latin: across). Indicating that one of two geometrical isomers in which certain atoms or groups are on opposite sides of a plane
TRI	Toxic Release Inventory
TSCA	Toxic Substances Control Act
TWA	Time-Weighted Average. Often shown as TWA - 8h (8 hours)
UEL	Upper Explosive (flammable) Limit in air, % by volume at room temperature or other temperature as noted
UN	United Nations
***unsym*-**	prefix for asymmetric
USDA	United States Department of Agriculture
USCG	United States Coast Guard
VOCs	Volatile Organic Compounds
WEEL	Workplace Environmental Exposure Level (AIHA)
WHMIS	Workplace Hazardous Materials Information System (Canada)
>	symbol for "greater than"
<	symbol for "less than"
≤	symbol for "less than or equal to"
≥	symbol for "greater than or equal to"
°	degrees of temperature
%	percent

A

Abrin A:0025

Formula: None found. *Note*: *Do not confuse with the alkaloid* "L-Abrine, aka Abrine" CAS:526-31-8.

Synonyms: Abrins; *Abrus precatorius* seed; Agglutinin; Aivoeiro; Arraccu-mitim; Buddhist rosary bead; Carolina muida; Crab's eyes; Deadly crab's eye; Indian bead; Indian licorice seed; Jequirite; Jequirity bean; John Crow bead Jumble bead; Juquiriti; Lectin protein; Love bean; Lucky bean; Mienie-Mienie; Phytotoxin (*abrus precatorius* seed); Prayer bead; Precatory bean; Rosary beads; Rosary Pea; Ruti; Seminole bead; Tentos da America (Spanish); Tentos dos mundos (Spanish); Toxalbumin; Vegetable Toxalbumin; Weather plant; Wild licorice

CAS Registry Number: 1393-62-0; 53597-23-2 (A-toxin); 53597-24-3 (C-toxin)

RTECS Number: AA5250000; AA5250100 (A-toxin); AA5250300 (C-toxin)

UN/NA & ERG Number: UN3462 (Toxin, extracted from living sources, solid)/153; UN3172 (Toxins, extracted from living sources, n.o.s.)/153

EC Number: Not assigned

Regulatory Authority and Advisory Bodies

Hazard Alert: Exposure can be lethal, Biotoxin, Suspected of causing genetic defects, Sensitization Hazard, Suspected reprotoxic hazard, Drug

Report any release of WMD to National Response Center 1-800-424-8802

Hazard symbols, risk, & safety statements: Hazard symbol: T + , Xi; risk phrases: R26/27/28; R42/43; R62; R63; safety phrases: S23; S28; S36/37; S41; S45 (see Appendix 4).

Description: Abrin is a lethal, delayed-action cytotoxin/biotoxin. It is stable under ambient conditions and can persist in the environment for a long time despite extreme conditions and temperatures. Abrin is a yellowish-white powder. Molecular weight = (approx.) 63,000–67,000 Da; boiling point = decomposes @ 80°C (most of the toxicity is lost in 30 minutes); volatility = negligible; vapor pressure = negligible @ 20°C. Hazard identification (based on NFPA-704 M Rating System): Health 4; flammability—unknown; reactivity 0. Sparingly soluble in water; solubility = 160 mg/L.

Detection: The BTA (BioThreat Alert) test strips (Tetracore Inc., 9901 Belward Campus Drive, Rockville, MD; phone: 240/268-5400) allows for screening of Abrin. Abrin is detectable in urine, plasma, and environmental samples. Instant Chek Abrin/Ricin Detection Kit, Catalog Number: IC-RA-003-10 Kit Contents: 10 test units each test contains 2 tests (1 Abrin and 1 Ricin) per unit, lyophilized reagent, reconstitution buffer, wash buffer, transfer pipettes, instruction booklet. Ey Laboratories, Inc, 107 N. Amphlett Blvd, San Mateo, CA. 94401 USA, Toll Free (North America)1-800-821-0044; Telephone: 1-650-342-3296, Option 2 or 3 Fax. +1 (650) 342 2648.

History of the material: Abrin has not been known to have been used as a biological weapon in any wars or terrorist attacks. Rosary pea vines, or abrus precatorius, are perennial plants that are native to India and other tropical areas throughout the world. The vines can grow to 10 to 20 ft, producing smallish colored flowers ranging in color from pink to red and purple bean-bearing legume pods that are 1 to 1.5 in. in length. Rosary peas or jequirity beans are uniform in size and weight and are an attractive bright red color with black spots on one end. Rosary pea vines are capable of growing in warm climates around the world, including the United States, where they are established in Florida. The beans, in Florida, are called "Seminole beads." Dangerous to both people and pets, these invasive plants should be professionally removed to prevent both spreading and accidental poisonings.

Potential Exposure: Abrin is a lectin, plant glycoprotein, and cytotoxin that is present in the rosary pea (*abrus precatorius*). The poison in Abrin binds and agglutinates animal cells. Abrin is among the most potent and lethal substances known to humankind. A single seed can be fatal; a single milligram is capable of killing an adult within a few days. When the seeds of the rosary pea are damaged, these drilled beads (drilled with holes for making beaded jewelry or rosaries/prayer beads) can be fatally dangerous if swallowed. The dust inside the beads remains stable, and years following collection some people can be poisoned if the beads are broken, and the dust is inhaled, ingested, gets in the eyes, or comes in contact with broken skin. Many, perhaps most, cases of *abrus* seed poisonings are unintentional and in children who are attracted to the colorful looking beans. The severity of an exposure is often dependent on how much Abrin is released when the seeds are chewed or masticated, releasing poisonous vegetable *toxalbumins*. Some cases of *abrus* exposure, even after ingestion of large amounts of plant material, may result in little or no clinical effects. This situation may reflect variations in toxicity and/or poor GI absorption. If the seeds of these plants are *not chewed and swallowed whole*, symptoms are much less likely to occur. Due to the hard shell, it is possible for the seeds to pass through the gastrointestinal (GI) tract without incident.

This relatively inexpensive, accessible, natural source may allow for easy preparation of large and dangerous quantities of Abrin. It can be made in various forms: as a powder or mist that can be inhaled; in the form of a pellet for injection in the skin; or, a powder that can be dissolved in water and ingested. One can also be exposed by touching surfaces on which Abrin particles or droplets of Abrin have landed; or, if particles or droplets of Abrin land on injured or broken skin, or in the eyes. Abrin can contaminate water and food, and it can be released into outdoor air as an aerosol which has the potential to contaminate agricultural products.

Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens.
DOI: http://dx.doi.org/10.1016/B978-0-323-38968-6.00001-6

Abrin is much more poisonous than a related cytotoxin, Ricin [LD_{50} = (Ricin) 3 μg/kg; (Abrin) 0.04 μg/kg in laboratory mice]. Abrin poisoning is not contagious and does not spread from person to person. Because Abrin isn't a living thing but rather a chemical made by living things, it probably would NOT make as effective a military weapon such as viruses or bacteria (i.e., ebola virus or anthrax). Nevertheless, it would make an effective terrorist weapon because it's both easy to make and use. With no known antidote, vaccine, or other effective therapy available for Abrin poisoning, the threat of this agent being released into the environment as an aerosol, or added to the food or water supply, could be catastrophic. Leaves and roots have of the rosary pea vine have been used as a herbal remedy in traditional or folk medicine. It should be noted that although Abrin has the potential to be used as a terrorist weapon, it also has some potential medical uses. In modern medicine, Abrin may be used in medical research and to kill malignant cells in cancer treatment. Ricin is extremely hazardous when freeze-dried, forming a light, easily dispersed powder. For this reason, researchers are directed to avoid freeze−drying Ricin. Abrin potentially has similar properties and dangers.

Incompatibilities: Toxic proteins of Abrin are resistant to digestive enzymes but are destroyed in cooking. The toxic portion of Abrin is heat stable at ambient temperatures and begins to decompose at 60°C/140°F. At 80°C/176°F, most of the toxicity is lost in about 30 minutes. Incompatible with strong oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air:

No standards or Protective Action Criteria (PAC) available. This substance may still be harmful or dangerous; follow safe work and usage practices.

ChemWatch: 0.00006 milligram per cubic meter, ceiling limit (sensitizer)[92]

Determination in Air: No NIOSH or OSHA methods available.

Routes of Entry: Abrin can be absorbed by all routes of exposure but normally enters the body by ingestion. Aerosolized Abrin can enter the body by inhalation. The toxin attaches to cell surfaces of various tissues, particularly the stomach lining if ingested; or, in the moist, upper respiratory tissues if inhaled.

Harmful Effects and Symptoms

Abrin inhibits protein synthesis by penetrating the body's cells and blocks the body's ability to regenerate essential proteins in vital organs of the body such as the liver, central nervous system (CNS), kidneys, and adrenal glands. The toxin A-chain is an *N-glycosidase* protein that removes an adenine residue from 28S RNA, which disrupts protein synthesis throughout the body. Once this cellular protein synthesis mechanism is disrupted, within hours the body's systems begins to shut down and die due to multisystem organ failure. EXTREMELY TOXIC-estimated human fatal dose after oral consumption by humans is approximately 0.005−0.007 mg/kg[77]. LD_{50} = (oral-mice) about 3 g/kg by injection or aerosol; LD_{50} = (oral-mice) 0.04 μg/kg.

The major symptoms of Abrin poisoning are dependent on the purity, route, and level (dose) of exposure (inhalation, ingestion, or injection), though multiple organs may be affected in severe cases. Initial symptoms of Abrin poisoning by inhalation may occur within 8 hours of exposure. The American Medical Association's *Quick Reference Guide to Biological Weapons* estimates "8−24 hours (acute symptoms may appear as early as 4−8 hours following exposure)." Following ingestion of Abrin, initial symptoms may occur in less than 6 hours but are often delayed for 1 to 3 days. Intravenous or intramuscular injection (parenteral administration) of Abrin is of greatest concern because a high fatality rate is normally expected. Although symptoms may be delayed for several days, patients frequently develop the GI effects in under 6 hours[88]. It is possible for death from Abrin poisoning to take place within 36 to 72 hours of exposure. Within several days, the person's liver, spleen, and kidneys might stop working, and the person will die. If death has not occurred after 5 days following symptoms of exposure, without complications, it is possible that the victim may not die and recovery is possible.

When directly exposed, toxalbumins (poisonous vegetable matter) in Abrin can cause severe GI lesions with irritation of the area of the throat, at the back of the mouth (oropharynx), esophagus, or stomach. Although clinically similar to alkaline caustic burns, they are usually delayed two or more hours following exposure. This exposure can be severe and life threatening, particularly in those locales not having advanced healthcare systems. There are a few reported cases of Abrin causing an acute and diffuse inflammation of the brain and spinal cord usually caused by a hypersensitivity response to tissue surrounding a blood vessel.

Short-Term Exposure: The following lists do not convey prioritization or indicate specificity. ***Ingestion:*** Generally within a few hours symptoms will appear, including nausea, profuse vomiting, abdominal pain and cramping, watery diarrhea (possibly bloody), later vomiting of blood (hematemesis) and stools or vomit stained black by blood pigment or dark blood products melena (melena), hemagglutination (the agglutination of red blood cells caused by an antibody either for red blood cell antigens or for antigens that coat red blood cells or by the presence of viruses or other microbes); lowered blood pressure, hallucinations, seizures, tetany, GI bleeding, pancreatitis, tachycardia, low or no urinary output, dilation of the pupils, hallucinations, drowsiness, fever, thirst, sore throat, headache, dilated pupils, vascular collapse, and shock. *Note*: abnormal liver function tests (elevated liver enzymes); multiple ulcerations, and hemorrhages of gastric and small-intestinal mucosa on endoscopy. Severe vomiting and diarrhea may result from severe dehydration (hypovolaemic-shock), followed by low blood pressure, and multisystem organ failure. Within 36 to 72 hours following exposure, organs (liver, spleen, and kidneys) might stop working, and the victim may die. *Inhalation*: Within a few hours of inhaling significant amounts of Abrin, the likely symptoms would be respiratory distress, difficult or labored breathing; shortness of breath; chest tightness, hypoxemia, fever, cough, nausea, sweating, aching muscles. Heavy sweating may follow as noncardiogenic pulmonary edema develops.* This would make breathing even more difficult, and the skin might turn blue. Excess fluid in the lungs would be diagnosed by X-ray or by listening to the chest with a stethoscope. Finally, low blood pressure, Blue skin, multisystem organ failure, respiratory failure may occur, and possible death. *Skin*: It is generally believed that the risk of Abrin toxicity is low from contact with unbroken skin; however, it may be absorbed through irritated, damaged, abraded, wounded, or injured skin; or, through normal skin when Abrin is dissolved in solvents, such as hydrocarbons or petroleum products. If enough Abrin gets through the skin, the symptoms will be similar to those described for ingestion. If Abrin is injected, the muscles and lymph nodes near the injection site would die. This could lead to possible seizures, liver and kidney failure, cardio-collapse, and death. *Eyes*: Abrin in the powder or mist form can cause redness and pain of the skin and the eyes. Tearing, swelling of the eye-lids, pain, redness, corneal injury, fever, fatigue, weakness, muscle pain, dehydration, possible seizures, cardio-collapse, and death. Like Ricin, urinary excretion of Abrin is probably slow and limited, with the estimated half-life being about 8 days. *Late phase complications*: based on Ricin, it is expected that complications are related to Abrin's cell killing (cytotoxic) effects on the liver, central nervous, kidneys, and adrenal glands, typically 2 to 5 days after exposure. The patient may be asymptomatic (showing no symptoms of exposure) during the preceding 1 to 5 days[92]. *Note:* Based on Ricin, Abrin-induced pulmonary edema would be expected to occur much later (1−3 days postexposure) compared to that induced by other agents such as phosgene (about 6 hours postexposure).

Long-Term Exposure: Based on its similarity to Ricin, repeated exposure to Abrin may cause allergic/asthma-like symptoms with congestion of nose and throat; itchy, watery eyes; hives; tightness of the chest; and in acute cases, wheezing. May affect kidneys, liver, pancreas. Based on exposure of Ricin to animals, Abrin may be capable of causing severe lung damage in humans. Information about carcinogenicity, developmental toxicity, or reproductive toxicity from chronic or repeated exposure to Abrin is unknown at this time.

Points of Attack: Lungs, eyes, skin (primarily through cuts and bruises). The risk of toxicity from unbroken skin exposure to Abrin is low, but there may still be a danger of allergic skin reactions.

Medical Surveillance: On the contrary, Abrin symptoms resemble those that are similar to other diseases, especially the common flu. Laboratory testing might include metabolic acidosis; increased liver function tests; increased renal function tests; hematuria; leukocytosis (2-to-5-fold higher than normal).

First Aid: No antidote exists for Abrin. Make all exposed people go to the nearest hospital emergency department. Make all potentially exposed people shower and change clothes. In case you have gotten Abrin on your skin or your clothing, immediately shower and change clothes. See a doctor as soon as possible: as it can take only a day and a half for symptoms to appear, all exposed persons should get to a doctor the same day. If exposure includes contact with Abrin, remove it *off or out* of the body as quickly as possible. Treatment needs to be provided in a hospital setting. Make the doctors and nurses aware of the potential for exposure so that they can protect themselves and provide the most appropriate treatments and therapies. If you have to wait for medical assistance, make the victim comfortable. If Abrin has been ingested, the airway must be secured and stomach pumping (gastric lavage) may be considered. Gastric lavage is recommended only if it can be done shortly after ingestion (generally within 1 hour). Risk of aggravating injury to the lining of the GI tract must be considered.

To minimize the effects of the poisoning and to keep the patient stable, Abrin poisoning is treated through supportive therapy. The types of supportive medical care would depend on several factors, such as the route by which victim(s) were poisoned (i.e., whether poisoning was by inhalation, ingestion, eye, or skin exposure). Do not induce vomiting. Rinse mouth, flush stomach with activated charcoal* (if the Abrin has been very recently ingested), washing out the victim's eyes with water, especially if the eyes are red and irritated. Supportive care could include intravenous fluid input and support of circulation and respiration; giving medications to treat conditions such as seizure and low blood pressure. Fluid input is critical, as fluid losses of up to 2.5 L are probable. If individual is drowsy or unconscious, do not give anything by mouth. In the event of vomiting, lean patient forward or place on left side (head-down position, if possible) to maintain open airway and prevent aspiration. Fluid and electrolyte balance should be monitored and restored if abnormal. Early and aggressive IV fluid and electrolyte replacement. If the victim's lungs fill with fluid, you administer oxygen if his breathing is difficult or labored. **Note*: Superactivated charcoal may be of little value for large molecules such as Abrin and Ricin[191].

Decontamination: When Abrin symptoms appear and you know the location of the attack, the area should be decontaminated with responders wearing level A (fully encapsulated suit with SCBA). Otherwise, stay away. Move as fast as possible; extra minutes before decontamination might make a big difference. If the Abrin attack was by small particles floating in the air (aerosol), and you have the equipment, (*this is very important*) then you have to decontaminate as soon as you can. If you don't have the equipment and training, don't enter the hot zone to rescue and decontaminate victims. Even if you think you are not contaminated, be sure to thoroughly shower and change clothes as soon as you can after the incident. If possible, place all clothing in a labeled durable 6-mil polyethylene bags. If the victim can't move, decontaminate, if possible, without touching and without entering the hot zone. To prevent spreading the agent, be certain that victims are decontaminated as much as possible before allowing them to leave the area. During the decontamination process, be careful not to break the patient/victim's skin and take care to cover all open wounds. The centers for disease control and prevention (CDC) recommends a decontamination procedure solution of detergent and water (with a pH value in the alkaline range of more than 8 but less than 10.5). Soft brushes should be available to remove contamination from the personal protective equipment (PPE). Also recommended for cleanup of people and surfaces is household bleach. Use a fresh (made daily) solution of 0.5% sodium hypochlorite [diluted household bleach (10%, or one part bleach to nine parts water)]. Contact time: 15 minutes. Do not get bleach solution in the victim's eyes, open wounds (especially of the abdomen, spinal cord, or brain), or mouth. Wash off the diluted bleach solution after 15 minutes. Labeled, durable 6-mil polyethylene bags should be available for disposal of clothing and contaminated PPE. In the absence of pH-adjusted solutions, wash the victim with lots of warm water with soap. Use clean water from any source; if possible, use a hose (spray or fog to prevent injury to the victim) or other system so that you won't have to touch the victim; don't even wait for soap or for the victim to remove clothing (at least down to undergarments), begin washing immediately. Immediate flush the eyes with water for at least 15 minutes. Wash—strip—wash—evacuate up wind and uphill: The idea is to immediately wash with water, then have the victim (not the responder) remove all the victim's clothing, then wash again (with soap if available) and then move away from the hot zone in an upwind and up-hill direction.

Personal Protective Methods:

General information: First responders should use a NIOSH-certified chemical, biological, radiological, nuclear (CBRN) self-contained breathing apparatus (SCBA) with a level a protective suit when entering an area with an unknown contaminant or when entering an area where the concentration of the contaminant is unknown. Level a protection should be used until monitoring results confirm the contaminant and the concentration of the contaminant. *Note*: Safe use of protective clothing and equipment requires specific skills developed through training and experience.

LEVEL A: (*RED ZONE*): select when the greatest level of skin, respiratory, and eye protection is required. This is the maximum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than the AEGL-2. A NIOSH-certified CBRN full-face-piece SCBA operated in a pressure-demand mode or a pressure-demand supplied air-hose respirator with an auxiliary escape bottle. A totally encapsulating chemical protective (TECP) suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, and a hard hat worn under the TECP suit are optional items.*

LEVEL B: (RED ZONE): Select when the highest level of respiratory protection is necessary but a lesser level of skin protection is required. This is the minimum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than AEGL-2. It differs from Level A in that it incorporates a nonencapsulating, splash-protective, chemical-resistant splash suit that provides Level A protection against liquids but is not airtight. A NIOSH-certified CBRN full-face-piece SCBA operated in a pressure-demand mode or a pressure-demand supplied air-hose respirator with an auxiliary escape bottle. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL C: (YELLOW ZONE): Select when the contaminant and concentration of the contaminant are known and the respiratory protection criteria factors for using air purifying respirators (APR) or powered APR (PAPR) are met. This level is appropriate when decontaminating patient/victims. A NIOSH-certified CBRN tight-fitting APR with a canister-type gas mask or CBRN PAPR for air levels greater than AEGL-2. A NIOSH-certified CBRN PAPR with a loose-fitting face-piece, hood, or helmet and a filter or a combination organic vapor, acid gas, and particulate cartridge/filter combination or a continuous flow respirator for air levels greater than AEGL-1. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Escape mask, face shield, coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL D: (GREEN ZONE): Select when the contaminant and concentration of the contaminant are known and the concentration is below the appropriate occupational exposure limit or less than AEGL-1 for the stated duration times. Limited to coveralls or other work clothes, boots, and gloves.

Notes: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Recommenced protective clothing and materials may include Tychem BR or Responder CSM. Safe use of protective clothing and equipment requires specific skills developed through training and experience. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Pressure demand, SCBA(CBRN), if available, is recommended in response to nonroutine emergency situations.

Storage: Color code—Blue: Health Hazard/Poison (Toxic): Store in a secure, locked poison location. Store in a cool, dry, well-ventilated area, and away from food stuff containers.

Shipping: UN3462 Toxins, extracted from living sources, solid, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN3172 Toxins, extracted from living sources, solid or liquid, Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: You must be careful! Avoid generating dust. Since an Abrin attack may be by small particles of Abrin floating in the air (aerosol), don't breathe it or get it on you. Remember that the victim's clothes or body may have Abrin; touch them and you can become a victim. If you think Abrin particles might be in the area, stay out until you are equipped with level A (fully encapsulated suit with SCBA), proper PPE, including protective clothing and respiratory protection. Shut off heating, ventilation, and air conditioning (HVAC) systems to prevent the tiny aerosolized (floating in the air) Abrin droplets from spreading throughout the building. Keep the public away. Immediately call for medical assistance. For those contaminated by Abrin, don't allow anyone to leave the hot zone. The Abrin chemical doesn't dissipate quickly, and "survives" in clothing and bedding for long periods of time. Consequently, people as well as "things" must be quarantined and decontaminated. Don't allow anyone leave until medical people examine them. Don't breathe, touch, or eat anything that might be contaminated with Abrin. Notify the federal authorities, local health, and pollution/environmental agencies. See Decontamination.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen and carbon. If a tank, rail car, or tank truck is involved in a fire, isolate it for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions[92]. On fire, use foam, dry chemical powder, BCF [bromochlorodiflouromethane (Halon 1211)] where regulations permit, carbon dioxide, water spray or fog-large fires only. If the situation allows, control and properly dispose of run-off (effluent).

Disposal Method Suggested: Do not clean up or dispose of Abrin, except under supervision of a specialist. Disposal of spillage in sealed 6 mi polyethylene or polypropylene containers.

References

(31); (77); (103); (105); (163); (176); (93); (94); (92); (86); (88); (103); (105); (175); (31); (191).

Defence Research and Development Canada, *Unique Partnership Provides Promising Lead on Medical Countermeasures Against Ricin* http://www.css.drdc-rddc.gc.ca/crti/invest/stories-exemplaires/02_0007ta-eng.asp, Suffield, Alberta, Canada, 2010.

Acenaphthene A:0050

Formula: $C_{12}H_{10}$; $C_{10}H_6(CH_2)_2$

Synonyms: Acenafeno (Spanish); Acenaphthylene, 1,2-dihydro; 1,8-Dihydroacenaphthalene; 1,2-Dihydro-acenaphthylene; 1,8-Dihydroacenaphthylene; 1,8-Ethylenenaphthalene; Ethylenenaphthalene; Naphthyleneethylene; Periethylenenaphthalene

CAS Registry Number: 83-32-9

HSDB Number: 1178 as naphthenic acids; 7092 as polycyclic aromatic hydrocarbons (PAHs).

RTECS Number: AB0000000

UN/NA & ERG Number: UN3082 (environmentally hazardous substances, liquid, n.o.s.)/171

EC Number: 201-469-6

Regulatory Authority and Advisory Bodies

Carcinogenicty: NIOSH has recommended that coal tar pitch volatiles, including PAHs be treated as potential human carcinogen. Acenaphthene has not been identified as a carcinogen. Handle with caution as several related PAHs are known carcinogens.

Hazard Alert: Combustible, Environmental hazard.

OSHA, 29CFR1910 Specifically Regulated Chemicals (see CFR1910.1002) as coal tar pitch volatiles

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; Section 307(a)(1) Toxic pollutant designated, pursuant to of the and is subject to effluent limitations as PAHs

United States National Primary Drinking Water Regulations: MCLG = 0 mg/L; MCL = 0.0002 mg/L as PAHs.

RCRA 40CFR258, Appendix 2

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.059; Nonwastewater (mg/kg), 3.4

RCRA, 40CFR264, Appendix 9, Ground Water Monitoring List, Suggested Testing Methods (PQL μg/L): 8100 (200); 8270 (10)

Superfund/EPCRA 40CFR302.4, Appendix A, Reportable Quantity (RQ): 100 lb (45.4 kg)

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%. as coal tar pitch volatiles

Mexico, Drinking Water, Criteria (Ecological): 0.02 mg/L; wastewater: organic toxic pollutant

United States DOT Regulated marine pollutant (49CFR172.101, Appendix B) as naphthalenes

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: Xi, N, T, F, Xn; risk phrases: R40; R11; R36/37/38; R50/53; R23/24/25; R39; R51/53; R67; R65; safety phrases: S7; S16; S26; S29; S36/37/39; S45; S60; S61; S62 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Acenaphthene is a white combustible, crystalline solid. PAHs are compounds containing multiple benzene rings and are also called polynuclear aromatic hydrocarbons. Molecular weight = 154.2; specific gravity (H_2O:1) = 1.024; boiling point = 277.5−279°C; freezing/melting point = 93.6−97°C; vapor pressure = 2.8×10^{-3} mmHg @ 20°C; vapor density = 5.32. Flash point = 135°C; explosive limits: LEL: 6000 ppm[138]; UEL: Unknown. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 1; reactivity 1. Practically insoluble in water; solubility = 3.5−7.4 mg/L @ 25°C.

Potential Exposure: Acenaphthene occurs naturally in coal tar and in coal tar produced during the high-temperature carbonization or coking of coal; coal tar distilling; petroleum processing; shale oil processing. It is used as an intermediate for dyes, fungicides, insecticides, herbicides, pharmaceuticals, plant growth hormones; 1,8 naphthalic acid; in the manufacture of some plastics; and has been detected in cigarette smoke and gasoline exhaust condensates; a constituent of coal tar creosote, asphalt, and diesel fuel. It has been used as an polyploidy agent.

Incompatibilities: Ozone and strong oxidizing agents, including perchlorates, chlorine, fluorine, and bromine.

Permissible Exposure Limits in Air

NIOSH IDLH = 80 milligram per cubic meter as coal tar pitch volatiles

OSHA PEL: 0.2 milligram per cubic meter TWA[1910.1002] (benzene, soluble fraction). OSHA defines “coal tar pitch volatiles” in 29 CFR 1910.1002 as the fused polycyclic hydrocarbons that volatilize from the distillation residues of coal, petroleum (excluding asphalt), wood, and other organic matter.

NIOSH REL: 0.1 milligram per cubic meter (*cyclohexane-extractable fraction*). NIOSH considers coal tar products (i.e., coal tar, coal tar pitch, or creosote) to be potential occupational carcinogens.

ACGIH TLV[1]: 0.2 milligram per cubic meter TWA (as benzene soluble aerosol); Confirmed Human Carcinogen

PAC Ver. 29[138]

PAC-1: 3.6 milligram per cubic meter

PAC-2: 40 milligram per cubic meter

PAC-3: 240 milligram per cubic meter

Determination in Air: Use NIOSH Analytical Method #5506 PAHs by HPLC; #5515, PAHs by GC; OSHA Analytical Method ID-58.

Permissible Concentration in Water: For the maximum protection of human health from the potential carcinogenic effects due to exposure of polynuclear aromatic hydrocarbons through ingestion of contaminated water and contaminated aquatic organisms, therefore, the levels that may result in incremental increase of cancer risk over the lifetime are estimated at 1×10^{-5}, 1×10^{-6}, and 1×10^{-7}. The corresponding criteria are 28.0, 2.8, and 0.28 ng/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 311.0, 31.1, and 3.11 ng/L, respectively. State Drinking Water Standards: Minnesota 400 μg/L.

Determination in Water: Gas chromatography (GC) or high performance liquid chromatograph (EPA Method 610) or GC and mass spectrometry (EPA Method 625). Octanol−water coefficient: Log $K_{ow} \geq 4$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood. Naphthalenes and naphthenic acids are listed as United States DOT marine pollutants and may persist in the environment.

Routes of Entry: Ingestion, inhalation, eye and/or skin contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Acenaphthene is irritating to eyes, skin and respiratory tract, causing coughing and wheezing. May cause vomiting if swallowed in large quantities. LD_{50} = (ipr-rat) 600 mg/kg.

Long-Term Exposure: Although acenaphthene has not been identified as a carcinogen, it should be handled with care as several related PAHs are carcinogens. NIOSH has recommended that coal tar pitch volatiles, including polycyclic aromatic hydrocarbons (PAHs) be treated as potential human carcinogen. The DFG[3] states that PAHs are present at particularly high levels in coal tar oils and related pyrolysis products of organic materials and are carcinogenic (category 1) in animal studies. Repeated or high exposures may cause lung irritation, bronchitis with cough, phlegm, and/or shortness of breath. Acenaphthene may affect the liver and kidneys. The most thoroughly investigated effect of acenaphthene is its ability to produce nuclear and cytological changes in microbial and plant species. Most of these changes, such as an increase in cell size and DNA content, are associated with disruption of the spindle mechanism during mitosis and the biological impact of acenaphthene on mammalian cells. These effects are reported here because they are the only substantially investigated effects of acenaphthene. Reported to be a mutagen[11]. Points of attack: Skin, respiratory system; bladder, liver, kidneys. Lung cancer.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Preplacement and regular physical examinations are indicated for workers having contact with acenaphthene in the workplace. Complete blood count (CBC), chest X-ray, pulmonary function tests, photopatch testing, sputum cytology, urinalysis (cytology, hematuria), liver, kidney, and bladder function tests recommended.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. If this chemical contacts the skin, remove contaminated clothing and wash with soap immediately. When this chemical has been swallowed, get immediate medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If this chemical has been inhaled, remove from exposure and transfer promptly to a medical facility.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, Available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *NIOSH* (as coal tar pitch volatiles): *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration*: SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN3082 Environmentally hazardous substances, liquid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. May be isolated using bentonite lined dam.

Fire Extinguishing: This chemical is a combustible solid; containers may explode when heated. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated run-off enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office. Incineration or permanganate oxidation.

References

(31); (2); (3); (75); (138); (173); (205); (100).

United States Environmental Protection Agency, *Acenaphthene: Ambient Water Criteria, Report PB 296-782*, Washington, DC (1980).

Sax, N. I., Ed., D*angerous Properties of Industrial Materials Report*, 4, No. 1, 38−41 (1984).

New Jersey Department of Health and Senior Services, *Hazardous Substance Fact Sheet: Acenaphthene*, Trenton NJ (November 1998).

Acenaphthylene A:0075

Formula: $C_{12}H_8$
Synonyms: Acenaftelen (Spanish); Cyclopenta(d,e)-naphthalene (French)
CAS Registry Number: 208-96-8
HSDB Number: 2661
RTECS Number AB1254000; AB1254200
UN/NA & ERG Number: UN3143/151; UN3077 (environmentally hazardous substances, solid, n.o.s.)/171
EC Number: 205-917-1
Regulatory Authority and Advisory Bodies
Carcinogenicty: Acenaphthylene has not been identified as a carcinogen. Handle with caution as several related PAHs are known carcinogens. NIOSH has recommended that coal tar pitch volatiles, including PAHs be treated as potential human carcinogen.
Hazard Alert: Combustible, Suspected of causing genetic defects, Environmental hazard.
OSHA, 29CFR1910 Specifically Regulated Chemicals (see CFR1910.1002) as coal tar pitch volatiles
United States National Primary Drinking Water Regulations: MCLG = 0 mg/L; MCL = 0.0002 mg/L as PAHs.
Clean Water Act: Section 307 Toxic Pollutants, 40CFR401.15 (effluent limitations); 40CFR413.02, Total
Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; Section 307(a)(1) Toxic pollutant designated, pursuant to of the and is subject to effluent limitations as PAHs.
United States National Primary Drinking Water Regulations: MCLG = 0 mg/L; MCL = 0.0002 mg/L as PAHs.
Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%. As coal tar pitch volatiles
OSHA, 29CFR1910 Specifically Regulated Chemicals (see CFR1910.1002) as coal tar pitch volatiles.
United States National Primary Drinking Water Regulations: MCLG = 0 mg/L; MCL = 0.0002 mg/L as PAHs.
RCRA 40CFR258, Appendix 2, List of Hazardous Constituents
RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.059; Nonwastewater (mg/kg), 3.4
RCRA, 40CFR264, Appendix 9, Ground Water Monitoring List, Suggested Testing Methods (PQL μg/L): 8100 (200); 8270 (10)
EPCRA Section 313 Form R *de minimus* concentration reporting level: 0.1%. Form R Toxic Chemical Category Code: N590 as polycyclic aromatic compounds (PACs)
Superfund/EPCRA 40CFR302.4, Appendix A, RQ: 5000 lb (2270 kg)
Highly persistent in the environment (PACs)
Mexico: Wastewater, Organic Toxic Pollutant
United States DOT Regulated marine pollutant (49CFR172.101, Appendix B) as naphthalenes
Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%. *as coal tar pitch volatiles*; Class D2B; NDSL list.
Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.
Hazard symbols, risk, & safety statements: Hazard symbols: Xi; risk phrases: R40; R36/37/38; R62; safety phrases: S26; S29/35; S36/37/39; S61 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to waters
Description: Acenaphthylene is a flaky yellow crystalline powder or solid. Molecular weight = 152.19; specific gravity (H_2O:1) = 0.8987 @ 16°C; boiling point = 280°C; freezing/melting point = 91.8°C; vapor pressure = 9.12×10^{-4} mmHg @ 25°C; flash point = 122°C. Explosive limits: LEL: 0.6%; UEL: unknown. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 1; reactivity 0. Water soluble; solubility = l6 mg/L @ 25°C; <1 mg/mL @ 21°C[193].
Potential Exposure: PAHs are compounds containing multiple benzene rings and are also called polynuclear aromatic hydrocarbons. Acenaphthylene is an aromatic hydrocarbon used in coal tar processing, as a dye intermediate; making insecticides, fungicides, plastics.
Incompatibilities: Keep away from ozone and strong oxidizing agents. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.
Permissible Exposure Limits in Air
NIOSH IDLH = 80 milligram per cubic meter, *coal tar pitch volatiles*
OSHA PEL: 0.2 milligram per cubic meter TWA[1910.1002] (benzene-soluble fraction). OSHA defines "coal tar pitch volatiles" in 29 CFR 1910.1002 as the fused polycyclic hydrocarbons that volatilize from the distillation residues of coal, petroleum (excluding asphalt), wood, and other organic matter.
NIOSH REL: 0.1 milligram per cubic meter (cyclohexane-extractable fraction). NIOSH considers coal tar products (i.e., coal tar, coal tar pitch, or creosote) to be potential occupational carcinogens
ACGIH TLV[1]: 0.2 milligram per cubic meter TWA (as benzene soluble aerosol); confirmed human carcinogen; BEIp assigned *as*
PAC Ver. 29[138]
PAC-1: 10 milligram per cubic meter
PAC-2: 110 milligram per cubic meter
PAC-3: 660 milligram per cubic meter
DFG MAK: [skin]; Category 1, human carcinogen
Determination in Air: Use NIOSH Analytical Method #5506 PAHs by HPLC; NIOSH Analytical Method #5515, PAHs by GC; OSHA Analytical Method ID-58.

Permissible Concentration in Water: For the maximum protection of human health from the potential carcinogenic effects due to exposure of polynuclear aromatic hydrocarbons through ingestion of contaminated water and contaminated aquatic organisms, therefore, the levels that may result in incremental increase of cancer risk over the lifetime are estimated at 1×10^{-5}, 1×10^{-6}, and 1×10^{-7}. The corresponding criteria are 28.0, 2.8, and 0.28 ng/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 311.0, 31.1, and 3.11 ng/L, respectively. Kansas[61] has set a guideline for drinking water of 0.03 μg/L.

Determination in Water: Use EPA Method #610. Octanol−water coefficient: Log $K_{ow} \geq 4$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood. Naphthalenes and naphthenic acids are listed as United States DOT marine pollutants and may persist in the environment.

Routes of Entry: Ingestion, inhalation, eye and/or skin contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Acute systemic toxin: short-term high hazard effects [SCAPA].

Long-Term Exposure: May cause dermatitis. May cause lung irritation; bronchitis may develop. May be a potential occupational carcinogen based on being a PAH compound. The DFG[3] states that PAHs are present at particularly high levels in coal tar oils and related pyrolysis products of organic materials and are carcinogenic (category 1) in animal studies.

Points of Attack: Skin, respiratory system; bladder, liver, kidneys as PAH.

Medical Surveillance: NIOSH has recommended that coal tar pitch volatiles, including PAHs be treated as potential human carcinogen. This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Preplacement and regular physical examinations are indicated for workers having contact with acenaphthene in the work-place. CBC, chest X-ray, pulmonary function tests, photopatch testing, sputum cytology, urinalysis (routine) [cytology, hematuria], liver, kidney, and bladder function tests recommended for coal tar pitch volatiles[2].

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. If this chemical contacts the skin, remove contaminated clothing, and wash with soap immediately. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If this chemical has been inhaled, remove from exposure and transfer promptly to a medical facility.

Personal Protective Methods: Good particulate emission controls are the indicated engineering control scheme. Contact lenses should not be worn when working with coal tar pitch volatiles. Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *NIOSH* (as coal tar pitch volatiles): *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration*: SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv100 [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: UN3143 Dye intermediates, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous material, Hazard, Technical Name Required. UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of carbon. Use foam, dry chemical, and carbon dioxide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Product residues and sorbent media may be packaged in epoxy-lined drums, then destroyed by incineration, permanganate oxidation or microwave plasma treatment. The United States Environmental Protection Agency has investigated chemical precipitation for wastewater treatment.

References

(31); (2); (173); (138); (100); (193).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report* 4, No. 2, 35–37, New York (1984).

United States Environmental Protection Agency, Management of Hazardous Waste Leachate, Washington, DC (1982).

United States Environmental Protection Agency, "*Identification of Organic Compounds in Effluents from Industrial Sources*," EPA-560/3-75-002, April 1975.

Acephate A:0080

Formula: $C_4H_{10}NO_3PS$

Synonyms: Acecap systemic insecticide implants; Acefal 75 ps; Acehero; Acephate 97 eg; Acephate 75sp; Acephate pco sp insecticide; Acesul; Ace-tox; Acetylphosphoramidothoic acid, *O,S*-dimethyl ester; Achero; Acifat; Address; Aimthene; Amcothene; Asataf; Asify; Attack; Chevron RE 12420; Clean crop acephate 80 DF seed protectorant; Fatel; Forphate; Forward; *O,S*-Dimethyl acetylphos-phoramidothioate; *O,S*-Dimethyl acetic phosphoramidothioate; Drexel acephate 75 WSP; Drexel acephate PCO SP insecticide; ENT-27822; Kitron; Koranda (acephate + fenvelerate); Lancer; *N*-[Methoxy (methylthio)phosphinoyl] acetamide; Orcephate; Orthene; Orthene 755; Ortho 12420; Ortran; Ortril; Pace; Payload; Phosphoramidothoic acid, *N*-acetyl-,*O,S*,-dimethyl ester; Phosphoramidothoic acid, *N*-acetyl-,*O,S*,-dimethyl ester; Pilarthene; Pinpoint; Precise acephate; Racet; RE 12420; Saphate; 75 SP; Valent orthene technical; Vegfru target

CAS Number: 30560-19-1

HSDB Number: 6549

RTECS Number: TB4760000

UN/NA & ERG Number: UN2783 (organophosphorus pesticide, solid, n.o.s.)/152

EC Number: 250-241-2 [*Annex I Index No.*: 015-079-00-7]

Regulatory Authority and Advisory Information

Carcinogenicity[83]: EPA Group C, possible human carcinogen

Hazard Alert: Poison inhaltion hazard, Neurotoxin (cumulative), Suspected of causing genetic defects, Suspected reprotoxic hazard, Agricultural chemical.

Potential Ground water Pollutant [California FAC Section 13145(d)/12811, active]

United States DOT 49CFR172.101, Inhalation Hazard Chemical as organophosphates.

Hazard symbols, risk, & safety statements: Hazard symbol: Xn; risk phrases: R22; R33; R51; R62; safety phrases: S2; S36; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Colorless crystalline solid (80% or more pure) or white powder (technical). Has an odor of rotten cabbage or mercaptans (like sulfur). Molecular weight = 183.17; specific gravity (H_2O:1) = 1.347 @ 20°C; freezing/melting point = 92–93°C; 82–89°C (technical grade 80% to 90% purity); vapor pressure = 1.7×10^{-6} mmHg @ 25°C. Hazard identification (based on NFPA-704M Rating System): Health 1; flammability 0; reactivity 0. Soluble in water; solubility = 800 mg/kg @ 20°C.

Potential Exposure: Acephate is a general use contact and systemic insecticide. Banned in the EU for use as a biocide and agricultural insecticide. Used on green- and limabeans, Brussels sprouts, cauliflower, celery, cotton, cottonseed, cranberries, head lettuce, macadamia nuts, peanuts, bell-and nonbell peppers, peppermint, spearmint, tobacco, and soybeans (Special Local Need Registration required in Mississippi and Texas only). Also used to control cockroach (spot treatment only) in residential and industrial buildings and insect control in forests, and on ornamental plants and to target armyworms, aphids, beetles, bollworms, borers, budworms, cankerworms, crickets, cutworms, fire ants, fleas, grasshoppers, leafhoppers, loopers, mealybugs, mites, moths, roaches, spiders, thirps, wasps, weevils, whiteflies, etc. banned for use in the EU.

Incompatibilities: May react with strong oxidizers such as chlorates, peroxides, nitrates, etc. In the presence of strong reducing agents such as hydrides, organophosphates form highly toxic and flammable phosphine gas. Contact with oxidizers can cause the release of toxic oxides of phosphorus. Compounds of the carboxyl group react with all bases, both inorganic and organic (i.e., amines) releasing substantial heat, water, and a salt that may be harmful. Incompatible with arsenic compounds (releases hydrogen cyanide gas), diazo compounds, dithiocarbamates, isocyanates, mercaptans, nitrides, and sulfides (releasing heat, toxic and possibly flammable gases), thiosulfates and dithionites (releasing hydrogen sulfate and oxides of sulfur).

Determination in Air: OSHA versatile sampler-2; Toluene/Acetone; GC/Flame ionization detection; NIOSH IV(18), Method #5600, Organophosphorus pesticides.

Determination in Water: NIOSH Method #1657. The determination of organophosphorus pesticides in municipal and industrial wastewater by GC. Detection limit = 6.0 ηg/L. Octanol−water coefficient: $\log K_{\mathrm{ow}} \leq 1.0$. Unlikely to bioaccumulate in marine organisms. Fish toxicity (threshold)[101]: Very low—2725.54621 ppb, MATC (Maximum Acceptable Toxicant Concentration).

Routes of Entry: Inhalation, ingestion, dermal contact, passes through the skin

Harmful Effects and Symptoms

Acephate can cause cholinesterase inhibition in humans—it can overstimulate the nervous system—causing nausea, dizziness, confusion, and at very high exposures (e.g., accidents or major spills), respiratory paralysis and death[118].

Short-Term Exposure: Poisonous; may be fatal if inhaled, swallowed, or absorbed through skin. Because this material has a low vapor pressure, significant inhalation of vapors is unlikely at ordinary temperatures. Contact may cause burns to skin and eyes. Eye pupils appear small; blurred vision; eye watering; runny nose; cough; shortness of breath; salivation; dizziness; nausea, stomach cramps, diarrhea, and vomiting; increased blood pressure; profuse sweating; hypermotility, hallucinations; irritability; tingling of the skin; drowsiness; slow heartbeat; convulsions; fluid in lungs; loss of consciousness; incontinence; breathing stops; death. Organophosphates inhibit the action of acetylcholinesterase enzymes, and alter the way in which nervous impulses are transmitted. The effects can last for hours, days, or much longer. The action of the enzymes is reestablished after new enzymes are formed. Delayed pulmonary edema may occur after inhalation. LD_{50} = (rat, oral) 1.4 g/kg[9]; LD_{50} (dermal, rat) ≥ 2.5 g/kg[83]. Human toxicity (long-term)[101]: High −2.80 ppb, health advisory.

Long-Term Exposure: May cause cancer. Cholinesterase inhibitor; cumulative effect is possible. A neurotoxin. Organophosphates may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage. May cause skin sensitization; reproductive effects. A suspected neurotoxin. May cause reproductive and fetal effects.

Points of Attack: Skin, respiratory system, CNS, cardiovascular system, blood cholinesterase. Reproductive cells.

Medical Surveillance: This chemical is a suspected or known human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and advice for medical monitoring. Medical observation is recommended for 24 to 48 hours following breathing overexposure, as pulmonary edema may be delayed. Routine biological monitoring of pesticide applicators and field workers includes testing of plasma and red blood cell acetylcholinesterase levels (for enzyme poisoned by this chemical). These tests are normally accurate only if done within about 2 hours of exposure. If exposure stops, plasma levels return to normal in 1−2 weeks, whereas red blood cell levels may be reduced for 1−3 months. When acetylcholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate pesticides is recommended until enzyme levels recover. Do not drink any alcoholic beverages before or during use as it promotes absorption of organophosphates. Evaluation by a qualified allergist, including exposure history and testing, may help diagnose allergy.

First Aid: Treatment for organophosphate poisoning consists of thorough decontamination, cardiorespiratory support, and administration of the antidotes atropine and pralidoxime. In cases of severe poisoning, diazepam, an anticonvulsant, should also be administered. Antidotes should be administered as prevention even if the diagnosis is in doubt. Speed in removing material from eyes and skin is of extreme importance. *Eyes*: Contact can cause dangerous amounts of these chemicals to be quickly absorbed through the mucous membrane into the bloodstream. Immediately and gently flush eyes with plenty of warm or cold water (NO hot water) for at least 15 minutes, occasionally lifting the upper and lower eyelids. Get medical aid immediately. *Skin*: Get medical aid. Dermal contact can cause dangerous amounts of these chemicals to be absorbed into the bloodstream. Wearing the appropriate PPE equipment and respirator for organophosphate pesticides, immediately flush skin with plenty of soap and water for at least 15 minutes while removing contaminated clothing and shoes. Shampoo hair promptly if contaminated. The removed, contaminated clothing and shoes should be double-bagged and left in Hot Zone for later disposal by hazardous materials experts. Skin may also be decontaminated with diluted hypochlorite solution. *Inhalation*: Get medical aid. Do not contaminate yourself. Wearing the appropriate PPE equipment and respirator for organophosphate pesticides, immediately remove the victim from the contaminated area to fresh air. If the victim is not breathing, administer artificial respiration. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. If breathing is difficult, administer oxygen through bag/mask apparatus until medical help arrives. Do not leave victim unattended. *Ingestion*: Call poison control. Loosen all clothing. Never give anything by mouth to an unconscious person. If victim is *unconscious or having convulsions*, do nothing except keep victim warm. Get medical aid. Transfer promptly to a medical facility. In cases of ingestion, *do not induce vomiting*. If the victim is alert and asymptomatic, administer a slurry of activated charcoal at a dose of 1 g/kg (infant, child, and adult dose). A soda can and straw may be of assistance when offering charcoal to a child. In some cases you may be specifically instructed by poison control to induce vomiting by way of 2 tablespoons of syrup of ipecac (adult) washed down with a cup of water. Do NOT give activated charcoal before or with ipecac syrup.

Note to physician or authorized medical personnel: Treat cases of respiratory compromise, coma, or excessive pulmonary secretions with respiratory support using protocols and techniques available and within the scope of training. Some cases may necessitate procedures such as endotracheal intubation or cricothyrotomy by properly trained and equipped personnel. When possible, atropine (see *Antidotes*, below) should be given under medical supervision. Patients who are comatose, hypotensive, or having seizures or cardiac arrhythmias should be treated according to advanced life support protocols. *Antidotes*: Two antidotes are administered to treat organophosphate poisoning. Atropine is a competitive antagonist of acetylcholine at muscarinic receptors and is used to control the excessive bronchial secretions that are often responsible for death. Pralidoxime relieves both the nicotinic and muscarine effects of organophosphate poisoning by regenerating acetylcholinesterase and can reduce both the bronchial secretions and the muscle weakness associated with poisoning. The initial intravenous dose of atropine in adults should be determined by the severity of symptoms: An initial adult dose of 1.0 to 2.0 mg or pediatric dose of 0.01 mg/kg (minimum 0.01 mg) should be administered intravenously. If intravenous access cannot be established, atropine may also be given intramuscularly, subcutaneously or via endotracheal tube. Doses should be repeated every 15 minutes until excessive secretions and sweating have been controlled. Once bronchial secretion has been controlled, atropine administration should be repeated whenever the secretions begin to recur. In seriously poisoned patients, very large doses may be required. Alterations of pulse rate and pupillary size should not be used as indicators of treatment adequacy. Pralidoxime should be administered as early in poisoning as possible as its efficacy may diminish when given more than 24 to 36 hours after exposure. Doses are as follows: adult 1.0 g; pediatric 25 to 50 mg/kg. The drug should be administered intravenously over 30 to 60 minutes, but in a life-threatening situation, one-half of the total dose can be given per minute for a total administration time of 2 minutes. Treatment should begin to take effect within 40 minutes with a reduction in symptoms and the amount of atropine necessary to control bronchial secretion. The initial dose can be repeated in 1 hour and then every 8 to 12 hours until the patient is clinically well and no longer requires atropine. If intravenous access cannot be established, pralidoxime may also be given intramuscularly. Early administration of diazepam in addition to the combined atropine and pralidoxime treatment may help prevent the onset of seizures and potential brain and cardiac morphologic damage following high-level organophosphate poisoning. As first aid for pulmonary edema, a doctor or authorized paramedic might consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of dermal and/or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Check oxygen content prior to entering storage area. Color code—Blue: Health Hazard/Poison. Store in a secure poison location. Prior to working with this pesticide, all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong bases. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN2783 Organophosphorus pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN3018 Organophosphorus pesticides, liquid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous material.

Spill Handling:

Initial isolation and protective action distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the

United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).
Small spills (from a small package or a small leak from a large package)
First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.3/0.4
Night 0.8/1.2
Large spills (from a large package or from many small packages)
First: Isolate in all directions (ft/m) 600/200
Then: Protect persons downwind (mi/km)
Day 1.4/2.3
Night 2.8/4.5
Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of phosphorus, sulfur, nitrogen, and carbon. Combustible material: may burn but does not ignite readily. Containers may explode when heated. Runoff may pollute waterways. *Fire involving storage or vehicular tanks*: Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. Highly toxic, may be fatal if inhaled, swallowed or absorbed through skin. Contact with molten substance may cause severe burns to skin and eyes. Avoid any skin contact. Effects of contact or inhalation may be delayed. Runoff from fire control or dilution water may be corrosive and/or toxic and cause pollution. *Small fire*: Dry chemical, carbon dioxide, or water spray. *Large fire*: Dry chemical, carbon dioxide, or regular foam. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal; do not scatter the material. *Fire involving tanks or car/trailer loads*: Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Do not get water inside containers. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in the case of rising sound from venting safety devices or discoloration of tank. Always stay away from tanks engulfed in fire. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies.

Disposal Method Suggested: Alkaline hydrolysis or incineration. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (138); (96); (131); (100).

United States Environmental Protection Agency, Office of Prevention, Pesticides and Toxic Substances, *Acephate Facts*, September, (2001).

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EXTOXNET, *Pesticide Information Profiles, Acephate*, University of Oregon, September, 1995, http://ace.orst.edu/cgi-bin/mfs/01/pips/acephate.htm?6#mfs.

Christiansen, A., Gervais, J.; Buhl, K., Stone, D., *Acephate Technical Fact Sheet*; National Pesticide Information Center, Oregon State University Extension Services (2011).

Acetal A:0100

Formula: $C_4H_{14}O_2$: $CH_3CH(OC_2H_5)_2$

Synonyms: Acetal (Spanish); Acetaldehyde diethyl acetal; Acetal diethylique (French); Acetehyde; 1,1-Diaethoxy-aethan (German); Diethyl acetal; 1,1-Diethoxyethane; Diethyl acetal; Ethane, 1,1-diethoxy-; Ethylidene diethyl ether

CAS Registry Number: 105-57-7

HSDB Number: 1635

RTECS Number: AB2800000

UN/NA & ERG Number: UN1088/127

EC Number: 203-310-6

Regulatory Authority and Advisory Information

Carcinogenicity: Not listed. However, similar aldehydes are known to be carcinogenic.

Hazard Alert: Poison, Highly flammable, Primary irritant (w/o allergic reaction), Environmental hazard.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Hazardous to aquatic life or environment, with possible long-lasting effects[194]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xi; risk phrases: R11; R36/37/38; R52; safety phrases S9; S16; S21; S33 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Acetal, an aldehyde, is a clear, volatile liquid with an agreeable odor. Molecular weight: 118.2[136]; boiling point = 138°C @ 1 atm[136]; melting/freezing point = −100°C[136]; vapor pressure = 0.83 mmHg @ 20°C; flash point = −5°C. Autoignition temperature = 230°C; hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 3; reactivity 0. Explosive limits: LEL: 1.65%; UEL: −5%. Slightly soluble in water.

Potential Exposure: Used as a solvent; in synthetic perfumes, such as jasmine, cosmetics, flavors; in organic synthesis.

Incompatibilities: Aldehydes are frequently involved in self-condensation or polymerization reactions. These reactions are exothermic; they are often catalyzed by acid. Aldehydes are readily oxidized to give carboxylic acids. Flammable and/or toxic gases are generated by the combination of aldehydes with azo, diazo compounds, dithiocarbamates, nitrides, and strong reducing agents. Aldehydes can react with air to give first peroxo acids, and ultimately carboxylic acids. These autoxidation reactions are activated by light, catalyzed by salts of transition metals, and are autocatalytic (catalyzed by the products of the reaction). The addition of stabilizers (antioxidants) to shipments of aldehydes retards autoxidation[101]. Presumed to form explosive peroxides on contact with air and light. May accumulate static electrical charges, and may cause ignition of its vapors.

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Permissible Concentration in Water: No criteria established. Harmful to aquatic organisms.

Routes of Entry: Ingestion, inhalation, eye and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritation of the eyes with redness and pain. Inhalation can cause coughing, headache, and dizziness. Skin contact can cause irritation with redness and pain. Ingestion can cause stomach pain; nausea, sleepiness, and high exposure can cause unconsciousness. Affects the CNS; acts as a narcotic or hypnotic.

Long-Term Exposure: A narcotic; may be addictive.

Medical Surveillance: Test for narcotic effects.

Points of Attack: Inhalation, ingestion; skin and/or eye contact.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. If this chemical contacts the skin, remove contaminated clothing and wash with soap immediately. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If this chemical has been inhaled, remove from exposure, and transfer promptly to a medical facility.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At concentrations above the NIOSH REL, or where there is no REL, At any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode).

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. May form peroxides in storage. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers and other incompatible materials. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gal or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1088 Acetal, Hazard Class: 3; Labels: 3-Flammable liquid. UN1988 Aldehydes, flammable, toxic, n.o.s., Hazard Class: 3; Labels: 3-Flammable liquid, 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until

clean-up is complete. Remove all ignition sources. Establish ventilation to keep levels below explosive limit. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Vapors are heavier than air and will collect in low areas. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Use dry chemicals, Alcohol-resistant foam, carbon dioxide. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substance Fact Sheet: Acetal*, Trenton, NJ (May 2000).

Acetaldehyde A:0110

Formula: C_2H_4O; CH_3CHO

Synonyms: Acetaldehido (Spanish); Acetaldehyd (German); Acetehyde; Acetic aldehyde; Aldehyde acetique (French); Ethanal; Ethyl aldehyde

CAS Registry Number: 75-07-0

HSDB Number: 230

RTECS Number: AB1925000

UN/NA & ERG Number: UN1089/129

EC Number: 200-836-8

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Animal Sufficient Evidence, Human Inadequate Evidence, possibly carcinogenic to humans, Group 2B, 1999.

California Proposition 65 Chemical[102]: Cancer 4/1/1988.

Hazard Alert: Extremely flammable, Polymerization hazard, Possible risk of forming tumors, Reproductive toxin: Suspected of causing genetic defects, Primary irritant (w/o allergic reaction), Neurotoxin, Environmental hazard. Listed for Tier 1 screening as an endocrine disruptor[88].

Air Pollutant standard set. See below, "Permissible Exposure Limits in Air" section.

OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 2500 lb (1135 kg)

Clean Air Act 42USC7412; Title I, Part A, §112 hazardous pollutants; Accidental Release Prevention/Flammable Substances (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg)

Clean Water Act 40CFR116.4A, hazardous substances, 40CFR413.02, Total Toxic Organics

RCRA 40CFR266, Appendix 5, Air concentrations

United States Environmental Protection Agency Federal Water Pollution Control Act

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U001

Superfund/EPCRA 40CFR302.4, Appendix A, RQ: 1000 lb (454 kg), SARA 313: Form R *de minimis* Concentration Reporting Level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%; National Pollutant Release Inventory (NPRI); DSL list.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Hazardous to aquatic life or environment, with possible long-lasting effects[194]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbols: F + , Xn; risk phrases: R45; R12; R19; R36/37; R40; R62; safety phrases: S1; S2; S16; S33; S36/37 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Acetaldehyde is a flammable, volatile, colorless liquid, or gas. It has a characteristic, penetrating, fruity odor. Molecular weight = 44.05; specific gravity (H_2O:1) = 0.7834 @ 18°C; boiling point = 20 to 21°C; melting/freezing point = −123 to 124°C; electrical conductivity = 1.2×10^8 pS/m; flash point = −38°C(oc); autoignition temp 185−193°C. Heat of combustion = −5890 cal/g[136]; maximum ignition energy = 0.37 mJ; vapor pressure = 740 to 750 mmHg @ 20°C; specific gravity (water: 1) = 0.804. Flammable limits: LEL: 4.1%; 40,000 ppm; UEL: 60%; hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 4; reactivity 2. Freely soluble in water.

Potential Exposure: Acetaldehyde is used as a chemical intermediate and can be found in many processed foods; in crafts, arts, automotive, and home improvement products.

Incompatibilities: Reacts with air to form unstable peroxides which can explode. Contact with air causes acetaldehyde to chemically degrade to acetic acid. Strong oxidizers, acids, bases, alcohols, ammonia, amines, halogens, phenols, acid anhydrides, ketones, hydrogen cyanide, hydrogen sulfide. May dissolve rubber. Slightly corrosive to mild steel. May explode without warning when exposed to heat, dust, corrosives, or oxidizers.

Permissible Exposure Limits in Air

NIOSH IDLH = 2000 ppm

Odor threshold = 0.067 ppm. (mean)

OSHA PEL: 200 ppm/360 milligram per cubic meter TWA

NIOSH REL: Potential occupational carcinogen. Limit exposure to lowest feasible level.

ACGIH TLV[1]: 25 ppm/45 milligram per cubic meter Ceiling Concentration, confirmed animal carcinogen with unknown relevance to humans.

PAC* Ver. 29[138]

PAC-1: $\mathbf{45}_{\mathrm{A}}$ ppm

PAC-2: $\mathbf{270}_{\mathrm{A}}$ ppm

PAC-3: $\mathbf{840}_{\mathrm{A}}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript “A” and correspond to 60 minute values.

DFG MAK: 50 ppm/91 milligram per cubic meter TWA; Peak Limitation Category I [a momentary value of 100 mL/m^3/180 milligram per cubic meter should not be exceeded]; Carcinogen Category 5; Pregnancy risk Group C

Arab Republic of Egypt: (TWA) 100 ppm (180 milligram per cubic meter), 1993; Australia: (TWA) 100 ppm (180 milligram per cubic meter); STEL 150 ppm, 1993; Austria: MAK 50 ppm (90 milligram per cubic meter), suspected carcinogen, 1999; Belgium: (TWA) 100 ppm (180 milligram per cubic meter); STEL 150 ppm (270 milligram per cubic meter), 1993; Denmark: (TWA) 25 ppm (45 milligram per cubic meter), 1999; Finland: (TWA) 50 ppm (90 milligram per cubic meter); STEL 75 ppm (135 milligram per cubic meter), 1993; France: VME 100 ppm (180 milligram per cubic meter), continuous; carcinogen, 1999; the Netherlands: MAC-TGG 180 milligram per cubic meter, 2003; India: (TWA) 100 ppm (180 milligram per cubic meter); STEL 150 ppm (270 milligram per cubic meter), 1993; Japan: 50 ppm (90 milligram per cubic meter), 2B carcinogen, 1999; the Philippines: (TWA) 200 ppm (360 milligram per cubic meter), 1993; Poland: MAC: (TWA) 5 milligram per cubic meter, MAC (STEL) 10 milligram per cubic meter, 1999; Russia: STEL 5 milligram per cubic meter [skin] 1993; Sweden: NGV 25 ppm (45 milligram per cubic meter), KTV 50 ppm (90 milligram per cubic meter), carcinogen, 1999; Switzerland: MAK-W 50 ppm (90 milligram per cubic meter), KTV 100 ppm (180 milligram per cubic meter), 1999; Turkey: (TWA) 200 ppm (360 milligram per cubic meter), 1993; United Kingdom: (TWA) 20 ppm (37 milligram per cubic meter); STEL 50 ppm (92 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV[1]: 25 ppm. ceiling concentration.

Determination in Air: NIOSH Analytical Method, #1994: Acetaldehyde by GC, #2538; by HPLC, #3507; Aldehydes, screening, #2539; OSHA ANALYTICAL METHOD ID-68.

Permissible Concentration in Water: Human exposure to acetaldehyde probably antedates recorded history, inasmuch as acetaldehyde is the major metabolite of ethyl alcohol. An additional source of widespread human exposure is tobacco smoke. The pharmacology and toxicology of acetaldehyde have been studied most extensively in its relationship to alcohol toxicity and human metabolism. Because of this background of human and laboratory experience, there appears to be no need to establish limits for acetaldehyde in drinking water[32]. However, EPA has set an ambient environmental goal of 2480 μg/L for acetaldehyde on a health basis. This compares with a standard of 0.2 mg/L for domestic water supplies set by Russia[43].

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 0.39$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion, eye, and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: This chemical can cause intense irritation and cause severe eye burns. Inhalation can irritate the nose, throat and lungs, causing coughing and/or shortness of breath. When the victim is removed from exposure, the symptoms may clear up. Higher exposure can affect the CNS causing symptoms similar to acute alcoholic intoxication, sleepiness, dizziness, and possible unconsciousness. High levels may cause pulmonary edema, a medical emergency, which may be delayed. LD_{50} = (oral-rat) 50 g/kg.

Long-Term Exposure: Acetaldehyde may be a carcinogen in humans since it has been shown to cause cancer in animals and may be a teratogen in humans since it has been shown to be a teratogen in animals. Exposure to acetaldehyde has produced nasal tumors in rats and laryngeal tumors in hamsters. Exposure to malonaldehyde has produced thyroid gland and pancreatic islet cell tumors in rats. NIOSH therefore recommends that acetaldehyde be considered a potential occupational carcinogen in conformance with the OSHA carcinogen policy. This chemical may cause dermatitis and skin allergy. If allergy develops, very low future exposure can cause itching and skin rash. Repeated exposure may cause chronic irritation of the eyes leading to permanent damage. May affect the CNS; respiratory tract, and kidneys, causing chronic alcohol-like intoxication. See also “NIOSH Current Intelligence Bulletin 55: Carcinogenicity of Acetaldehyde and Malonaldehyde, and Mutagenicity of Related Low-Molecular-Weight Aldehydes” [DHHS (NIOSH), Publication No. 91-112].

Points of Attack: Eyes, skin, respiratory system; kidneys, CNS; reproductive system. Cancer site in animals: nasal cancer.

Medical Surveillance: NIOSH lists the following tests: whole blood (chemical/metabolite), expired air; urine (chemical/metabolite), during exposure. Consideration should be given to skin, eyes, and respiratory tract in any preplacement or periodic examinations. Lung function tests are recommended. If symptoms develop or overexposure is suspected, consider chest X-ray and evaluation by a qualified allergist, including careful exposure history and special testing may help diagnose skin allergy. This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure.

First Aid: If this chemical gets into the eyes remove any contact lenses at once and irrigate immediately for at least 30 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, quickly remove contaminated clothing. Immediately wash area with large amounts of soap and water. If a person breathes in large amounts of this chemical, move the exposed person to fresh air at once, and perform artificial respiration. Transfer promptly to medical facility. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Prevent skin contact; **8 hours** (more than 8 hours of resistance to breakthrough $>0.1\ \mu m > g/cm^2/min$): butyl rubber (gloves, Suits, Boots), Responder suits; Trychem 1000 suits; **4 hours** (At least 4 but <8 hours of resistance to breakthrough $>0.1\ \mu m > g/cm^2/min$): Teflon gloves, suits, boots; 4H, and Silver Shield gloves. Wear eye protection to prevent any potential for eye contact. Employees should wash promptly when skin is wet. Remove clothing immediately if wet or contaminated to avoid flammability hazard. Provide eye-wash.

Respirator Selection*: At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Red Stripe: Flammability Hazard: Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Keep away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. See incompatibilities. Acetaldehyde should be stored in tightly closed airtight containers in a cool, dark, well-ventilated area. Nitrogen or other inert gas should be used as an "inert gas blanket" over liquid acetaldehyde in storage containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of acetaldehyde should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers.

Shipping: UN1088 Acetaldehyde, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: *Liquid:* Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, or a similar noncombustible absorbent material and deposit in sealed containers. Keep liquid out of a confined space, such as a sewer, because of the potential for an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Gas: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Stop flow of gas. If source of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty.

Fire Extinguishing: Acetaldehyde is a flammable and reactive liquid or gas. Poisonous decomposition products may include oxides of carbon. Vapors are heavier than air and will collect in low areas. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Use dry chemicals, alcohol-resistant foam, CO_2. Water or regular foam may be ineffective on fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming),

withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration.

References

(109); (31); (173); (138); (188); (102); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: *Acetaldehyde*, (Preliminary), Washington, DC (1979).

United States Environmental Protection Agency, *Acetaldehyde, Health and Environmental Effects Profile No. 1*, Washington, DC, Office of Solid Waste (April 30, 1980).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 1, No. 1, 25−26 (1980) and 3, No. 6, 23−27, (Nov./Dec. 1983).

United States Environmental Protection Agency, Chemical Hazard Information Profile *Draft Report; Acetaldehyde*, Washington, DC (April 29, 1983).

New Jersey Dept. of Health and Senior Services, *Hazardous Substance Fact Sheet: Acetaldehyde*, Trenton, NJ (December 2005).

Acetaldehyde Oxime A:0130

Formula: C_2H_5NO; $CH_3CH = NOH$

Synonyms: β-Acetaldehyde oxime; Acetaldoxime; β-Acetaldoxime; Aldoxime; Ethanal oxime; Ethylidenehydroxylamine

CAS Registry Number: 107-29-9

RTECS Number: AB2975000

UN/NA & ERG Number: UN2332/129

EC Number: 203-479-6

Regulatory Authority and Advisory Information

Hazard Alert: Extremely flammable, Polymerization hazard (*beta* form), Chronic health hazard

Hazard symbols, risk, & safety statements: Hazard symbols: F, Xi, Xn; risk phrases: R11; R20/21/22; R36/37/38; R40; safety phrases: S16; S21; S24/25/26; S36/37 (see Appendix 4).

Description: Acetaldehyde oxime is an extremely flammable, colorless liquid or crystalline solid; low melting crystalline compound. Pungent odor. Molecular weight = 59.12; boiling point = 115°C (decomposes); freezing/melting point = 46.5°C (α-); 12°C (β-); vapor pressure = 9.8 mmHg @ 20°C; 9.9 mmHg @ 26°C; specific gravity (H_2O:1) = 0.97; flash point = 38−40°C (pure); <22°C (technical grade); explosive limits: LEL: 4.2%, UEL: 50%; hazard identification Health 2; flammability 3[70]; reactivity 0. Soluble in water.

Potential Exposure: Used as a chemical intermediate and as an antioxidant and radical scavenger with applications in many industries, including detergents, pharmaceuticals, plastics, paints and lacquers, rubber, and textiles.

Incompatibilities: Vapor may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong acids (such as hydrochloric, sulfuric, and nitric), strong bases. The beta-form is able to form unstable peroxides.

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Routes of Entry: Inhalation, dermal and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Contact can irritate the eyes and skin. Inhalation can irritate nose, throat, and respiratory tract.

Long-Term Exposure: Chronic health effects are unknown at this time.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: Preemployment and regular physical exams are recommended. For those with frequent or high exposure, lung function tests are recommended.

First Aid: Immediately remove any contact lenses and flush eyes with water for 15 minutes, occasionally lifting upper and lower lids. Quickly remove contaminated clothing. Immediately wash contaminated skin with soap and water. Remove person from exposure area and begin (using universal precautions, including resuscitation mask) if breathing has stopped and cardiopulmonary resuscitation (CPR) if heart action has stopped. Transfer promptly to a medical facility.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear impact-and splash-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of acetaldehyde should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers.

Shipping: UN2332 Acetaldehyde oxime, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Use foam spray to reduce vapors. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. Ventilate area of spill or leak after clean-up is complete. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Keep acetaldehyde oxime out of a confined space, such as a sewer, because of the potential for an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable solid. Thermal decomposition products may include nitrous oxides; and carbon monoxide. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (138).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Acetaldehyde Oxime*, Trenton, NJ (August 1998).

Acetamide A:0140

Formula: C_2H_5NO; CH_3CONH_2

Synonyms: Acetamido (Spanish); Acetic acid amide; Acetimidic acid; Ethanamide; Methane carboxamide; NCI-C02108

CAS Registry Number: 60-35-5

HSDB Number: 4006

RTECS Number: AB4025000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 200-473-5 [*Annex I Index No.*: 616-022-00-4]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Sufficient Evidence; Human No Adequate Data, *not classifiable as carcinogenic to humans*, Group 2B

California Proposition 65 Chemical[102]: Cancer 1/1/1990

Hazard Alert: Combustible, Suspected of causing genetic defects, Suspected reprotoxic hazard. Listed for Tier 1 screening as an endocrine disruptor[88].

California No Significant Risk Level (NSRL) = 10 μg/day.

Clean Air Act 42USC7412; Title I, Part A, §112 hazardous pollutants

Superfund/EPCRA 40CFR302.4, Appendix A, RQ: 1 lb (0.454 kg), SARA 313: Form R *de minimis* Concentration Reporting Level: 0.1%.

EPCRA Section 304 RQ: CERCLA RQ, 1 lb. (0.454 kg.).

TSCA 40CFR704.225(a), CAIR list reporting required

Hazard symbols, risk, & safety statements: Hazard symbol: Xn; risk phrases: R45; R40; R62; R63; safety phrases: S2; S36/37; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Acetamide is a colorless to yellow, deliquescent, crystalline solid. Odorless if pure, “mousy” odor if impure. Odor threshold = 140−160 milligram per cubic meter. Molecular weight = 59.07; specific gravity (H_2O:1) = 1.159 @ 20°C; boiling point = 222°C; freezing/melting point = 80.16°C; vapor pressure = 133 Pa @ 65°C; autoignition temperature: 558°C. Flammable limits: LEL: 36,000 ppm; UEL: unknown; hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 1; reactivity 0. Decomposes slowly in cold water; solubility in water = 200 g/100 mL.

Potential Exposure: Used as a stabilizer, plasticizer, wetting agent; solvent in plastics, lacquers, explosive; soldering flux ingredient; and chemical manufacturing.

Incompatibilities: Reacts with strong acids, such as hydrochloric, sulfuric, and nitric, strong oxidizers; strong bases; strong reducing agents such as hydrides; ammonia, isocyanates, phenols, cresols. Contact with water causes slow hydrolyzation to ammonia and acetate salts.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 21 milligram per cubic meter

PAC-2: 230 milligram per cubic meter

PAC-3: 1400 milligram per cubic meter

DFG MAK: Carcinogen Category 3B (2004)

Austria: suspected carcinogen, 1999; Finland: carcinogen, 1993; Sweden: TWA 10 ppm (23 milligram per cubic meter); STEL 25 ppm (60 milligram per cubic meter), carcinogen, 1999; the Netherlands: MAC-TGG 25 milligram per cubic meter, 2003

New York State: 0.03 μ/m^3 for ambient air[60].

Permissible Concentration in Water: No criteria set; not very toxic to fish but increases biological oxygen demand.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = -1.25$; -1.16. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Powdered form irritates eyes and respiratory tract. Acute systemic toxin: short-term high hazard effects [SCAPA]. LD_{50} = (oral-rat) 7000 mg/kg.

Long-Term Exposure: Acetamide may be a carcinogen in humans since it has been shown to cause cancers in animals. May cause injury to the liver, kidney, and brain. Reproductive toxin [SCAPA].

Points of Attack: Cancer site in animals: liver and lymph cancer.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once, and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If this chemical has been inhaled, remove from exposure and transfer promptly to a medical facility.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn.

Respirator Selection: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Green: General storage may be used. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Should be stored in cool, well-ventilated area. Store in a dry area away from water because of deliquescent properties. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. Material is very water soluble and hydrolyzes slowly to ammonia and acetate salts. May be removed from alkaline solutions with adsorbent carbon. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This substance is a combustible solid. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include oxides of carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming),

withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Add to alcohol or benzene as a flammable solvent and incinerate; oxides of nitrogen produced may be scrubbed out with alkaline solution. All federal, state, and local environmental regulations must be observed.

References

(102); (31); (173); (138); (100).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 1, No. 4, 20−21 (1981), and 3, No. 6, 29−31 (Nov./Dec. 1983).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Acetamide, Trenton, NJ (September 1998).

Acetanilide A:0150

Formula: C_8H_9NO

Synonyms: Acetamide, *N*-phenyl-; Acetamidobenzene; Acetanil; Acetanilid; Acetic acid anilide; Acetoanilide; Acetylaminobenzene; *N*-Acetylaniline; Acetylaniline; AN; Aniline, *N*-acetyl-; Antifebrin; Benzenamine, *N*-acetyl; *N*-Fenilacetamida (Spanish); Phenalgene; Phenalgin; *N*-Phenylacetamide

CAS Registry Number: 103-84-4

HSDB Number: 2665

RTECS Number: AD735000

UN/NA&ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 203-150-7

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Combustible, Suspected of causing genetic defects

Banned or Severely Restricted (in analgesic drugs) (Japan)[13]

Hazard symbols, risk, & safety statements: Hazard symbols: Xn; risk phrases: R22; R33; R36; R62 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Acetanilide orthorhombic plates or scales; or white, shining, crystalline solid or powder. Odorless. Molecular weight = 135.18; specific gravity (H_2O:1) = 1.2105 @ 4°C; boiling point = 304.8°C @ 760 mmHg; freezing/melting point = 113.7°C; vapor pressure = 1 mmHg @ 114.0°C, vapor density = 4.65; flash point = 169°C (oc); autoignition temperature = 530°C; specific gravity (H_2O:1) = 1.21 @ 4°C. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 1; reactivity 0. Sinks in water; slightly soluble; solubility = 0.541 g/mL; <1 mg/mL @ 22°C.

Potential Exposure: This amide compound is used in rubber industry as accelerator, in plastics industry as cellulose ester stabilizer, in pharmaceutical manufacture, stabilizer for hydrogen peroxide, azo dye manufacture.

Incompatibilities: Dust may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, alkyl nitrates, alkalis (liberate aniline), chloral hydrate, phenols, ferric salts.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 2 milligram per cubic meter

PAC-2: 22 milligram per cubic meter

PAC-3: 130 milligram per cubic meter

Permissible Concentration in Water: Russia MAC is 0.004 mg/L in water bodies used for fishery purposes[43].

Determination in Water: Octanol−water coefficient: Log $K_{ow} \leq 1.2$ @ 23°C. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Routes of Entry: Ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Poisonous if ingested; may cause hallucinations, sleepiness, cyanosis, respiratory, kidney damage, cyanosis, blood toxin: methemoglobinemia, decreased body temperature. Acute respiratory irritant and may be toxic. LD_{50} = (oral-rat) 800 mg/kg. Animals tolerate doses of 200−400 mg/kg for many weeks[11]. Has been lethal to man @ 59 mg/kg.

Long-Term Exposure: May cause kidney damage, skin allergy, eczema. An allergen. Causes contact dermatitis; inhalation or ingestion can cause eczema and cyanosis and methemoglobinemia.

Points of Attack: Skin and blood stream.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In the case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Note to Physician: If warranted, treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear skin protection. Avoid dust inhalation (see respirator selection below).

Respirator Selection: Wear filter mask unless high vapor concentrations are encountered; then use NIOSH/MSHA or European Standard EN 149-approved supplied-air respirator with a full facepiece operated in a pressure-demand or other positive-pressure mode. For increased protection use in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health hazard/poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation distance, spill: 25 m/75 ft.(NJ). Isolation distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. Solids may be dredged. Carbon adsorbent may be used on dissolved portion. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Add to flammable solvents (alcohol or benzene) and incinerate. Oxides of nitrogen may be scrubbed from combustion gases with alkaline solution[22].

References

(31); (173); (138); (100).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 1, No. 4, 21–23 (1981) and 3, No. 6, 27–29 (Nov./Dec. 1983).

Acetic Acid A:0160

Formula: $C_2H_4O_2$; CH_3COOH

Synonyms: 777 etch; Acetic acid (aqueous solution); Acetic acid, glacial; Acide acetique (French); Acido acetico (Spanish); Aluminum etch 16-1-1-2; Aluminum etch 82-3-15-0; As-1; As-1400; As-18CZ10A; As-18CZ6E; As-1CE; As-5CE; As-CZ5E; CEA-100 microchrome etchant; Copper, brass brite DIP 1127; Copper, brass brite DIP 127; Dazzlens cleaner; EPF B20 fixer; Essigsaeure (German); Ethanoic acid; Ethylic acid; Freckle etch; Glacial acetic acid (pure compound); Glass etch; Kodak 33 stop bath; Kovar bright DIP (412X); KTI aluminum etch I/II; Lens cleaner M6015; Mae etchants; Metal etch; Methane carboxylic acid; Mixed acid etch (5-2-2); Mixed acid etch (6-1-1); Pad etch; PFC; Poly etch 95%; Processor fixer concentrate; Rapid film fix; RDH lime solvent; Silicon etch solution; Stress relief etch; Vinegar (4%–6% solution in water); Vinegar acid; Wet K-etch; Wright etch

CAS Registry Number: 64-19-7

HSDB Number: 40

RTECS Number: AF1225000

UN/NA & ERG Number: UN2789 (glacial or $>80\%$ acid, by mass)/132; UN2790 (10%–80% acid, by mass)/153

EC Number: 200-580-7 [*Annex I Index No.*: 607-002-00-6]

Regulatory Authority and Advisory Information

Hazard Alert: Flammable, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction).

Clean Water Act: 40CFR116.4 Hazardous Substances; RQ 40CFR117.3 (same as CERCLA)

Superfund/EPCRA 40CFR302.4, Appendix A, RQ: 5000 lb (2270 kg)

Canada WHMIS Ingredients Disclosure List Concentration Reporting Level: 1%.

Hazard symbols, risk, & safety statements: Hazard symbol: F, C, Xi; risk phrases (conc. $>90\%$): R10; R35; R36/37/38; R61; R62; safety phrases: S1/2; S23; S25; S45 (see Appendix 4); risk phrases: (conc. 25%–90%) R34; R35; R62; R63; safety phrases: S1/2; S23; S26; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Acetic acid is a colorless liquid or crystals with a sour, vinegar-like odor. Pure compound is a solid below 17°C. Often used in an aqueous solution. Glacial acetic acid contains 99% acid. Molecular weight = 60.05; specific gravity (H_2O:1) = 1.0446 @ 20°C (aq. solution)[136]; boiling point = 117.9°C[136]; melting/freezing point = 16.7°C[136]; electrical conductivity = 6×10^5 pS/m; critical pressure = 57.1 atm; heat of combustion = −3136 cal/g[136]; vapor pressure = 11 mmHg @ 20°C; 7.5 mmHg @ 14.2°C; flash point = 39°C [NFPA] (glacial); autoignition temperature = 425−463°C (glacial) [NFPA]. Explosive limits: LEL: 4.0%; 40,000 ppm[138]; UEL: 19.9%. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 2; reactivity 2; freely soluble in water.

Potential Exposure: Acetic acid is widely used as a chemical feedstock for the production of vinyl plastics, acetic anhydride, acetone, acetanilide, acetyl chloride, ethyl alcohol, ketene, methyl ethyl ketone, acetate esters, and cellulose acetates. It is also used alone in the dye, rubber, pharmaceutical, food preserving, textile, and laundry industries. It is utilized, too; in the manufacture of Paris green, white lead, tint rinse, photographic chemicals, stain removers, insecticides, and plastics.

Incompatibilities: Vapor may form explosive mixture with air. Violent reaction with oxidizers, organic amines, and bases, such as hydroxides and carbonates. Incompatible with strong acids; aliphatic amines; alkanolamines, isocyanates, alkylene oxides; epichlorohydrin, acetaldehyde, 2-aminoethanol, ammonia, ammonium nitrate, chlorosulfonic acid, chromic acid; ethylene diamine, ethyleneimine, halides, peroxides, perchlorates, perchloric acid, permanganates, phosphorus isocyanate, phosphorus trichloride, potassium *tert*-butoxide, and xylene. Attacks cast iron, stainless steel; and other metals forming flammable/explosive hydrogen gas. Will attack many forms of rubber or plastic.

Permissible Exposure Limits in Air

NIOSH IDLH = 50 ppm

Conversion factor: 1 ppm = 2.46 milligram per cubic meter @ 25°C & 1 atm

Odor threshold = 0.3 to 0.9 ppm

OSHA PEL: 10 ppm/25 milligram per cubic meter TWA

NIOSH REL: 10 ppm/25 milligram per cubic meter TWA; 15 ppm/37 milligram per cubic meter STEL

ACGIH TLV[1]: 10 ppm/25 milligram per cubic meter TWA; 15 ppm/37 milligram per cubic meter ppm STEL

PAC* Ver. 29[138]

PAC-1: $\mathbf{5}_{\mathbf{E}}$ ppm

PAC-2: $\mathbf{35}_{\mathbf{E}}$ ppm

PAC-3: $\mathbf{250}_{\mathbf{E}}$ ppm

*PAC values marked with a subscript "**E**" correspond to ERPG (Emergency Response Planning Guideline) values.

DFG MAK: 10 ppm/25 milligram per cubic meter TWA; Peak Limitation Category I(2)

Australia: TWA 10 ppm (25 milligram per cubic meter); STEL 15 ppm, 1993; Austria: MAK 10 ppm (25 milligram per cubic meter), 1999; Belgium: TWA 10 ppm (25 milligram per cubic meter); STEL 15 ppm, 1993; Denmark: TWA 10 ppm (25 milligram per cubic meter), 1999; Finland: TWA 10 ppm (25 milligram per cubic meter); STEL 15 ppm (37 milligram per cubic meter) [skin] 1993; France: VLE 10 ppm (25 milligram per cubic meter), 1999; Hungary: TWA 10 milligram per cubic meter; STEL 20 milligram per cubic meter, 1993; the Netherlands: MAC-TGG 25 milligram per cubic meter, 2003; Japan; 10 ppm (25 milligram per cubic meter), 1999; Norway: TWA 10 ppm (25 milligram per cubic meter), 1999; the Philippines: TWA 10 ppm (25 milligram per cubic meter), 1993; Poland: MAC (TWA) 5 milligram per cubic meter, MAC (STEL) 35 milligram per cubic meter, 1999; Russia: TWA 10 ppm; STEL 5 milligram per cubic meter [skin] 1993; Sweden: NGV 5 ppm (13 milligram per cubic meter), KTV 10 ppm (25 milligram per cubic meter), 1999; Switzerland: MAK-W 10 ppm (25 milligram per cubic meter), KZG-W 20 ppm (50 milligram per cubic meter), 1999; Thailand: TWA 10 ppm (25 milligram per cubic meter), 1993; Turkey: TWA 10 ppm (25 milligram per cubic meter), 1993; United Kingdom: TWA 10 ppm (25 milligram per cubic meter); STEL 15 ppm (37 milligram per cubic meter), Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 15 ppm. Russia[43] MAC for ambient air in residential areas is 0.2 milligram per cubic meter on a momentary basis and 0.06 milligram per cubic meter on a daily average basis. Several states have set guidelines or standards for acetic acid in ambient air[60]. They range from 0.25 milligram per cubic meter (North Dakota) to 0.4 milligram per cubic meter (Virginia) to 0.5 milligram per cubic meter (Connecticut and South Dakota) to 0.595 milligram per cubic meter (North Carolina).

Determination in Air: Use NIOSH Analytical Method (IV) #1603, OSHA Analytical Method 186SG.

Permissible Concentration in Water: No United States limit has been established. However, EPA[32] has proposed an ambient environmental goal of 345 μg/L based on health effects.

Determination in Water: Acetic acid in water may be determined by titration. Harmful to aquatic life. Octanol−water coefficient: Log $K_{\mathrm{ow}} = -0.2$ to -0.31. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Can cause severe irritation, burns, and permanent eye damage. Skin contact can cause severe irritation and burns. Breathing can cause irritation of the mouth, nose, and throat; coughing, and shortness of breath. Higher exposures can cause bronchopneumonia and pulmonary edema, a medical emergency.

Long-Term Exposure: Repeated exposure may cause bronchitis to develop, with cough, phlegm, and/or shortness of breath. Repeated skin exposure can cause thickening and cracking of the skin, particularly the skin of the hands. Chronic exposure may result in pharyngitis and catarrhal bronchitis. Ingestion, though not likely to occur in industry, may result in penetration of the esophagus, bloody vomiting, diarrhea, shock, hemolysis; and hemoglobinuria that is followed by anuria. Repeated or prolonged exposure to acetic acid may cause darkening, irritation of the skin, erosion of the exposed front teeth, and chronic inflammation of the nose, throat and bronchi.

Points of Attack: Respiratory system, skin, eyes, teeth.

Medical Surveillance: Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Lung function tests. Consider chest X-ray following acute overexposure. Consideration should be given to the skin, eyes, teeth, and respiratory tract in placement or periodic examinations.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing, and wash with soap immediately. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. If this chemical has been inhaled, remove from exposure, begin (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. If swallowed, do not induce vomiting. Transfer promptly to a medical facility. Medical observation recommended for 24 to 48 hours following inhalation overexposure, as pulmonary edema may be delayed.

Personal Protective Methods: Contact lenses should not be worn when working with acetic acid. Prevent skin contact; 8 hours (more than 8 hours of resistance to breakthrough $>0.1\ \mu m > g/cm^2/min$): Butyl rubber (gloves, suits, and boots), Teflon gloves, suits, boots; Viton, 4H, and Silver Shield gloves, Responder suits; Trychem 1000 suits; **4 hours** (at least 4 but <8 hours of resistance to breakthrough $>0.1\ \mu m > g/cm^2/min$.) Neoprene, Barricade. Remove clothing immediately if wet or contaminated with liquids containing 50% and promptly remove if liquid contains 10%−49% acetic acid. Provide emergency eyewash if liquids containing $>5\%$ acetic acid are involved, drench if $>50\%$ acetic acid is involved.

Respirator Selection: NIOSH/OSHA *50 ppm*: Sa:Cf$^{£}$ (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOv$^{£}$ (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge (s)]; CcrFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, SCBA). *Note*$^{£}$: Substance causes eye irritation or damage; eye protection needed.

Storage: (1) Color code—White: Corrosive or contact hazard; store separately in a corrosion-resistant location. (2) Color code—Red: Flammability hazard: store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Should be stored in cool dry place away from heat and incompatible substances listed above. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical.

Shipping: UN2789 Acetic acid, glacial or Acetic acid solution, with >80 % acid, by mass, hazard class: 8; labels: 8-Corrosive material, 3-flammable liquid. UN2790 acetic acid solution, not $<50\%$ but not $>80\%$ acid, by mass, hazard class: 8; labels: 8-Corrosive material; acetic acid solution, with $>10\%$ and $<50\%$, by mass, hazard class: 8; labels: 8-Corrosive material.

Spill Handling: Warn other workers of spill. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; or similar material and deposit in sealed containers, and transport to outdoor location. With expert help, cautiously neutralize spilled liquid with lime or sodium bicarbonate. Wash away remainder with plenty of water (extra personal protection: chemical protection suit including SCBA). Alternatively cover with soda ash and then flush to sewer with water[24]. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of carbon. Use water spray, dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers.

Wear goggles and SCBA when fighting fires. Vapors are heavier than air and will collect in low areas. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (2); (138); (173); (100).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 1, No. 4, 23−25 (1981), and 3, No. 6, 31−35 (Nov./Dec. 1983).

New Jersey Dept. of Health and Senior Services, *Hazardous Substances Fact Sheet*: Acetic Acid, Trenton, NJ (June 1998).

New York State Dept. of Health, Bureau of Toxic Substances Assessment Chemical Fact Sheet: Acetic Acid, Albany, NY (March 1986).

Hazmap, National Institute of Health, U.S. National Library of Medicine, Specialized Information Services 8600 Rockville Pike, Bethesda, MD 20894, July 2016.

Acetic Anhydride A:0170

Formula: $C_4H_6O_3$; $(CH_3CO)_2O$

Synonyms: Acetic acid, anhydride; Acetic oxide; Acetyl anhydride; Acetyl ether; Acetyl oxide; Anhidrido acetico (Spanish); Anhydride acetique (French); Essigsaeureanhydrid (German); Ethanoic anhydrate; Ethanoic anhydride

CAS Registry Number: 108-24-7

HSDB Number: 233

RTECS Number: AK1925000

UN/NA & ERG Number: UN1715/137

EC Number: 203-564-8 [*Annex I Index No.*: 607-008-00-9]

Regulatory Authority and Advisory Information

Hazard Alert: Flammable, Primary irritant (w/o allergic reaction), Violently water reactive.

Banned or Severely Restricted (Singapore) (UN)[13]

List II, DEA chemical code 8519 (Title 21 CFR1310.02)

FDA, Controlled Substance Act, Essential Chemicals

Clean Water Act: 40CFR116.4 Hazardous Substances; RQ 40CFR117.3 (same as CERCLA)

Superfund/EPCRA 40CFR302.4, Appendix A, RQ: 5000 lb (2270 kg)

Controlled Substance Act (FDA): TV (domestic and import/export) = 250 gal (1023 kg weight)

Canada, WHMIS, Ingredient Disclosure Concentration: 1%. Hazard symbols, risk, & safety statements: Hazard symbol: F, C; risk phrases: R10; R20/21/22; R29; R34; R36/37/38; safety phrases: S1/2; S26; S36/37/39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Acetic anhydride is a combustible, colorless, strongly refractive, liquid which has a strongly irritating odor. Molecular weight = 102.09[136]; specific gravity (H_2O:1) = 1.082 @ 20°C; boiling point @ 1 atm = 139.55°C; melting/freezing point = −73.1°C; critical temperature = 296°C[136]; critical pressure = 679 psia = 46.2 atm = 4.68 MN/m^2[136]; vapor pressure = 10 mmHg @ 36°C; flash point = 49.4°C (cc); heat of combustion = −7058 Btu/lb = −3921 cal/g[136]; autoignition temperature = 316°C. Explosive limits: LEL: 2.7%; 27.000 ppm; UEL: 10.3%. Specific gravity (H_2O:1) = 1.08[136]; hazard Identification (based on NFPA-704 M Rating System): Health 3; flammability 2, reactivity 2~~W~~; soluble in water; violent reaction.

Potential Exposure: Acetic anhydride is used as an acetylating agent or as a solvent in the manufacture of cellulose acetate, acetanilide, aspirin, synthetic fibers, plastics, explosives, resins, perfumes, and flavorings; and it is used in the textile dyeing industry. It is widely used as a pharmaceutical intermediate and as a pesticide intermediate.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, alcohols, chromic acid (violent reaction), amines, strong caustics; finely divided metals. Contact with water forms acetic acid and liberates a large amount of heat. Corrosive to iron, steel and other metals.

Permissible Exposure Limits in Air

NIOSH IDLH = 200 ppm

Odor threshold = 0.14 ppm.

OSHA PEL: 5 ppm/20 milligram per cubic meter TWA

NIOSH REL: 5 ppm/21 milligram per cubic meter Ceiling Concentration

ACGIH TLV[1]: 5 ppm TWA

PAC* Ver. 29[138]

PAC-1: $\mathbf{0.5_E}$ ppm

PAC-2: $\mathbf{15_E}$ ppm

PAC-3: $\mathbf{100_E}$ ppm

*PAC values marked with a subscript "**E**" correspond to ERPG (Emergency Response Planning Guideline) values.

DFG MAK: 5 ppm/21 milligram per cubic meter TWA; Peak Limitation Category I(1); Pregnancy Risk Group C

Austria: MAK 5 ppm (20 milligram per cubic meter), 1999; Denmark: TWA 5 ppm (20 milligram per cubic meter), 1999; France: VLE 5 ppm (20 milligram per cubic meter), 1999; Japan: 5 ppm (21 milligram per cubic meter), 1999; Poland: TWA 10 milligram per cubic meter, 1999; Sweden: Ceiling 5 ppm (20 milligram per cubic meter), 1999; the

Netherlands: MAC-TGG 0.1 milligram per cubic meter, 2003; United Kingdom: TWA 0.1 ppm (0.5 milligram per cubic meter); STEL 0.4 ppm (2 milligram per cubic meter), 2000.

Determination in Air: Use NIOSH Analytical Method #3506[18]. OSHA Analytical Methods 82, 102.

Permissible Concentration in Water: No criteria set.

Determination in Water: Octanol−water coefficient: $\text{Log}\,K_{\text{ow}} = -0.2$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Routes of Entry: Inhalation, ingestion, and eye and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: This chemical can cause severe skin and eye irritation. Permanent damage to the eyes may result from exposure to high concentrations. Breathing acetic anhydride can irritate the respiratory tract and high concentrations can cause severe lung damage and/or coughing and shortness of breath. In high concentrations, vapor may cause conjunctivitis, photophobia, lacrimation, and severe irritation of the nose and throat. Liquid acetic anhydride does not cause a severe burning sensation when it comes in contact with the skin. If it is not removed, the skin may become white and wrinkled, and delayed severe burns may occur. Both liquid and vapor may cause conjunctival edema and corneal burns, which may develop into temporary or permanent interstitial keratitis with corneal opacity due to progression of the infiltration. Contact and, occasionally, hypersensitivity dermatitis may develop. Immediate complaints following concentrated vapor exposure include conjunctival and nasopharyngeal irritation, cough, and dyspnea. Necrotic areas of mucous membranes may be present following acute exposure. Inhalation may cause pulmonary edema, a medical emergency. Medical observation recommended for 24 to 48 hours following inhalation overexposure, as pulmonary edema may be delayed.

Long-Term Exposure: Prolonged or repeated exposure to this chemical may cause skin disorders or allergy. If allergy develops, very low future exposure can cause itching and a skin rash.

Points of Attack: Respiratory system, eyes, skin.

Medical Surveillance: Consideration should be given to the skin, eyes, and respiratory tract (lung function tests) in any placement or periodic examinations. Evaluation by a qualified allergist, including careful exposure history and special testing may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately with large amounts of water. If this chemical contacts the skin, quickly remove clothing and immediately wash area with large amounts of water. If a person breathes this chemical, move the exposed person to fresh air at once and perform (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if hearth action has stopped. When this chemical has been swallowed, get medical attention immediately. If victim is conscious, administer water or milk. Do not induce vomiting.

Personal Protective Methods: Prevent skin contact. 8 hours (more than 8 hours of resistance to breakthrough $>0.1\ \mu\text{m} > \text{g/cm}^2\text{/min}$): butyl rubber gloves, suits, boots; 4H and Silver Shield gloves; Barricade, Trellchem HPS suits; Trychem 1000 suits; **4 hours** (at least 4 but <8 hours of resistance to breakthrough $>0.1\ \mu\text{m} > \text{g/cm}^2\text{/min}$): Teflon gloves, suits, boots. Contact lenses should not be worn when working with this chemical. Wear splash proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA, *125 ppm*: Sa:Cf$^{£}$ (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOv$^{£}$ (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]. *200 ppm*: CcrFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-, mounted organic vapor canister]; or PaprTOv$^{£}$ (APF = 50) [any powered, air-purifying respirator with a tight-fitting facepiece, and organic vapor cartridge(s)]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd, Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-, mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA). *Note* $^{£}$: Substance causes eye irritation or damage; eye protection needed.

Storage: (1) Color code—White: Corrosive or contact Hazard; store separately in a corrosion resistant location. (2) Red: Flammability hazard: Store in a flammable (liquid or solid materials) storage area or approved cabinet away from sources if ignition. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Protect against physical damage. Outside or detached storage is preferred. Store in tightly closed containers in a cool, well-ventilated place, away from moisture, sources of ignition, and heat. Avoid pits, depressions and basements. Separate from other storage. Inside storage should be in a standard flammable liquids storage room or cabinet. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical.

Shipping: UN1715 Acetic anhydride, Hazard class: 8; Labels: 8-Corrosive material, 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Use foam spray to reduce vapors. Cover with vermiculite, dry sand; earth, or similar absorbent material and neutralize with lime or sodium bicarbonate. Deposit absorbent material in sealed containers. Alternatively cover with soda ash and then flush away with water[24]. Ventilate area of spill or leak after clean-up is complete. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Keep acetic anhydride out of a confined space, such as a sewer, because of the potential for an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. You may want to seek assistance from EPAs Environmental Response Team at (908) 548-8730. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include acetic acid and oxides of carbon. Firefighting gear (including SCBA) may not provide adequate protection. If exposure occurs, remove and isolate gear immediately and thoroughly decontaminate personnel. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Use water spray to disperse vapors only, as water contact will form acetic acid. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed[24].

References

(31); (2); (138); (173); (100).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 3, No. 3, 32–35 (1983).

New York State Dept. of Health, Chemical Fact Sheet: Acetic Anhydride, Albany, NY, Bureau of Toxic Substances Assessment (Jan. 1986).

New Jersey Dept. of Health and Senior Services, *Hazardous Substances Fact Sheet*: Acetic Anhydride, Trenton, NJ (December 2005).

Acetone A:0180

Formula: C_3H_6O; CH_3COCH_3

Synonyms: Aceton (German); Acetona (Spanish); Dimethylformaldehyde; Dimethylformehyde; Dimethylketal; Dimethyl ketone; Ketone; Ketone, dimethyl; Ketone propane; β-Ketopropane; Methyl ketone; 2-Propanone; Propanone; Pyroacetic acid; Pyroacetic ether

CAS Registry Number: 67-64-1

HSDB Number: 41

RTECS Number: AL3150000

UN/NA & ERG Number: UN1090/127

EC Number: 200-662-2

Regulatory Authority and Advisory Information

Carcinogenicity: EPA: Available data are inadequate for an assessment of human carcinogenic potential.

Gene-Tox Program, Negative: SHE-clonal assay; cell transformation-mouse embryo; negative: Cell transformation-RLV F344 rat embryo; Negative: In vitro cytogenetics-nonhuman; negative: Histidine reversion-Ames test; In vitro SCE-nonhuman.

Hazard alert: Highly flammable, possible risk of forming tumors, suspected of causing genetic defects, suspected reprotoxic hazard, primary irritant (w/o allergic reaction).

List II, DEA chemical code 6532 (Title 21 CFR1310.02)

Safe Drinking Water Act, 40CFR148.10, solvent waste prohibitions

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U002

RCRA 40CFR258, Appendix 1, constituents for detection monitoring

RCRA 40CFR258, Appendix 2, list of inorganic and organic constituents

RCRA, 40CFR264, Appendix 9, Ground Water Monitoring List, Suggested Testing Methods (PQL μg/L): 8240 (100)

RCRA Land Ban Substance

Superfund/EPCRA 40CFR302.4, Appendix A, RQ: 5000 lb (2270 kg)

TSCA: 40CFR799.5000; 40CFR716.120(d)1 as aldehydes

Canada WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1%; B2, D2B.

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xi; risk phrases: R11; R36/37/38; R66; R67; R37; R42/43; R62; R63; safety phrases: S9; S16; S21; S23; S26; S33 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Acetone is a highly flammable, colorless liquid with a sweet, mint-like odor. Molecular weight: 58.08; boiling point = 56°C; melting/freezing point = −95°C; critical temperature = 235°C[136]; critical pressure = 682 psia = 46.4 atm = 4.70 MN/m^2[136]; specific gravity (H_2O:1) = 0.791 @ 20°C (liquid)[136]; relative vapor density (air = 1) = 2.0[136]; ratio of specific heats of vapor (gas) = 1.127; latent heat of vaporization = 122 cal/g[136]; heat of combustion = −12,250 Btu/lb = −6808 cal/g[136]; heat of fusion = 23.42 cal/g[136]; vapor pressure = 75 mmHg @ 1.3°C; minimum ignition energy = 1.15 mJ; electrical conductivity = 4.9×10^5 pS/m; autoignition temperature = 465°C; flash point = −18°C (cc). Hazard identification (based on NFPA-704 M Rating System): Health 1; flammability 3; reactivity 2. Explosive limits: LEL: 2.5%; 25,000 ppm; UEL: 12.8%. Freely soluble in water.

Potential Exposure: It is used as a solvent in nail polish remover and many other chemicals. Used in the production of lubricating oils and as an intermediate in the manufacture of chloroform and of various pharmaceuticals and pesticides.

Incompatibilities: May explode when mixed with chloroform, chromic anhydride. Incompatible with acids, bases, and oxidizing materials, such as peroxides, chlorates, perchlorates, nitrates, and permanganates. Unstable peroxides formed with strong oxidizers. May accumulate static electrical charges and may cause ignition of its vapors. Dissolves most rubber, resins, and plastics.

Permissible Exposure Limits in Air

NIOSH IDLH is 2500 ppm (10% LEL)

Odor threshold = 4.58 ppm

OSHA PEL: 1000 ppm/2400 milligram per cubic meter TWA

NIOSH REL: 250 ppm/590 milligram per cubic meter TWA

ACGIH TLV®[1]: 250 ppm/594 milligram per cubic meter TWA; 500 ppm/1187 milligram per cubic meter STEL; not classifiable as a human carcinogen; BEI: 25 mg[acetone]/L in urine/end-of-shift

PAC* Ver. 29[138]

PAC-1: **200**$_{\mathbf{A}}$ ppm

PAC-2: **3200**$_{\mathbf{A}}$ ppm

PAC-3: **5700**$_{\mathbf{A}}$ ppm

AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "A**" and correspond to 60 minute values.

MAK: 500 ppm/1200 milligram per cubic meter; Peak Limitation Category I(2); BAT: 80 mg[acetone]/L in urine/end-of-shift; Pregnancy Risk Group D; (2006)

Australia: TWA 500 ppm (1185 milligram per cubic meter); STEL 1000 ppm, 1993; Austria: MAK 750 ppm (1780 milligram per cubic meter), 1999; Belgium: TWA 750 ppm (1780 milligram per cubic meter); STEL 1000 ppm, 1993; Denmark: TWA 250 ppm (600 milligram per cubic meter, 1999; Finland: TWA 500 ppm (1200 milligram per cubic meter); STEL 625 ppm (1500 milligram per cubic meter), 1993; France: VME 750 ppm (1800 milligram per cubic meter), 1999; Hungary: TWA 600 milligram per cubic meter; STEL 1200 milligram per cubic meter, 1993; the Netherlands: MAC-TGG 1780 milligram per cubic meter, 2003; Japan; 200 ppm (470 milligram per cubic meter), 1999; Norway: TWA 125 ppm (295 milligram per cubic meter), 1999; the Philippines: TWA 1000 ppm (2400 milligram per cubic meter), 1993; Poland: MAC (TWA) 600 milligram per cubic meter, MAC (STEL) 1800 milligram per cubic meter, 1999; Russia: TWA 200 ppm; STEL 200 milligram per cubic meter, 1993; Sweden: NGV 250 ppm (600 milligram per cubic meter), KTV 500 ppm (1200 milligram per cubic meter), 1999; Switzerland: MAK-W 500 ppm (1200 milligram per cubic meter); STEL 1000 ppm (2400 milligram per cubic meter), 1999; Turkey: TWA 1000 ppm (2400 milligram per cubic meter), 1993; United Kingdom: TWA 750 ppm (1810 milligram per cubic meter); STEL 1500 ppm (3620 milligram per cubic meter); Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 750 ppm.

Determination in Air: Use NIOSH Analytical Method #1300, #2555, #3800[1,18]. OSHA Analytical Method 69.

Permissible Concentration in Water: Massachusetts has set a guideline of 250 μg/L and Maryland a guideline of 3,600 μg/L[61].

Determination in Water: Octanol−water coefficient: Log $K_{\text{ow}} = -0.23$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Contact can irritate the skin. Exposure can irritate the eyes and respiratory tract. Exposure to high concentrations can cause dizziness, lightheadedness, and unconsciousness. Alcohol consumption exacerbates toxic effects. LD_{50} (oral, rat) = 5800 mg/kg.

Long-Term Exposure: Repeated skin exposure can cause dryness and skin cracking. This chemical has not been adequately evaluated to determine whether brain or nerve damage could occur with repeated exposure. However, many solvents and other petroleum-based chemicals have been shown to cause such damage. Effects may include reduced memory and concentration; personality changes (withdrawal, irritability) and fatigue; sleep disturbances; reduced coordination; and/or effects on the nerves to the arms and legs (weakness, "pins and needles").

Points of Attack: Eyes, skin, respiratory system; CNS.

Medical Surveillance: NIOSH lists the following tests: whole blood (chemical/metabolite); expired exposure, during exposure; pulmonary function tests; urine (chemical/metabolite); end-of-shift. Evaluation for brain effects, such as changes in memory, concentration, sleeping patterns and mood, as well as headaches and fatigue. Consider evaluations of the cerebellar, autonomic, and peripheral nervous systems. Positive and borderline individuals should be referred to for neuropsychological testing. See also NIOSH Criteria Document: 78-173 *Ketones*.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once, and irrigate immediately with large amounts of water for at least 15 minutes. If this chemical contacts the skin, quickly remove contaminated clothing, and wash with large amounts of soap immediately. If a person breathes in large amounts of this chemical, move the exposed person to fresh air at once, and perform (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Prevent skin contact. **8 hours** (more than 8 hours of resistance to breakthrough $>0.1\ \mu m > g/cm^2/min$): butyl rubber gloves, suits, boots; 4H and Silver Shield gloves; Barricade, CPF3 suits; Responder suits, Trellchem HPS suits; Trychem 1000 suits. Wear splash-proof chemical goggles and face shield when working with liquid unless full facepiece respiratory protection is worn. Provide emergency showers and eyewash.

Respirator Selection: NIOSH, *2500 ppm*: CcrFOv* (APF = 50) [any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s)]; or PaprOv* (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister]; or Sa* (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

*Note**: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—Red: Flammability hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN1090 Acetone, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. Keep acetone out of a confined space, such as a sewer, because of the potential for an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of carbon. Acetone is a highly flammable liquid. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration[22].

References

(31); (2); (138); (173); (100).

National institute for Occupational Safety and Health (NIOSH), Criteria for a Recommended Standard. Occupational Exposure to Ketones, NIOSH Pub. No. 78-173, Cincinnati OH (1978).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 1, No. 4, 25−27 (1981).

New York State Department of Health, *Chemical Fact Sheet: Acetone*, Bureau of Toxic Substance Assessment, Albany, NY (March 1986).

New Jersey Department of Health and Senor Services, *Hazardous Substances Fact Sheet*: Acetone, Trenton, NJ (December 2005).

Acetone Cyanohydrin A:0190

Formula: C_4H_7NO; $(CH_3)_2C(OH)CN$

Synonyms: Acetoncyanhydrin (German); Acetonecyanhydrine (French); Acetone cyanohydrin; Cianhidrina de acetona (Spanish); Cyanhydrine d'acetone (French); 2-Cyano-2-propo-nal; α-Hydroxyisobutyronitrile; 2-Hydroxyisobutyronitrile; Hydroxy isobutyronitrite; 2-Hydroxy-2-methylpropionitrile; 2-Methylactonitrile; 2-Propane cyanohydrin; Propanenitrile, 2-hydroxy-2-methyl-

CAS Registry Number: 75-86-5

HSDB Number: 971

RTECS Number: OD9275000

UN/NA & ERG Number: (PIH) UN1541/155

EC Number: 200-909-4 [*Annex I Index No.*: 608-004-00-X]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade).

Hazard Alert: Highly toxic, Poison inhalation hazard: exposure can be lethal, Flammable, Environmental hazard.

Clean Water Act: 40CFR116.4 Hazardous Substances; RQ 40CFR117.3 (same as CERCLA); 40CFR423, Priority Pollutants

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P069

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

CERCLA/SARA 40CFR302, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg)

Superfund/EPCRA 40CFR302.4, Appendix A, RQ: 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

United States DOT 49CFR172.101, Inhalation Hazardous Chemical as EDF Substance ID#-041

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1%.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T + , N; risk phrases: R26/27/28; R50/R53; safety phrases: S1/2; S7/9; S27; S29; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Acetone cyanohydrin is a flammable, colorless to light yellow liquid. Almond-like odor. Molecular weight = 85.10[136]; specific gravity (H_2O:1) = 0.932 @ 19°C (liquid)[136]; boiling point = 95°C @ 760 mmHg; freezing/melting point = − 19°C[136]; vapor pressure = 0.8 mmHg @ 20°C[136]; relative vapor density (air = 1) = 2.93[136]; ratio of specific heats of vapor (gas) = (estimate) 1.074[9]. Flash point = 74°C; hazard identification (based on NFPA-704 M Rating System): Health 4; flammability 2; reactivity 2; autoignition temperature = 688°C. LEL: 2.2%, 9800 ppm; UEL: 12.0%. Freely soluble in water but decomposes, forming hydrogen cyanide.

Potential Exposure: Used in the manufacture of insecticides and making other chemicals, such as methyl methacrylate.

Incompatibilities: May form explosive mixture with air. Not compatible with strong reducers, strong bases; strong oxidizers, and strong acids, such as hydrochloric, sulfuric (explosive), and nitric. Contact with strong acid and strong bases may cause explosions. Slowly decomposes to acetone and hydrogen cyanide gas at room temperatures; rate is accelerated by an increase in pH, contact with water, or temperature.

Permissible Exposure Limits in Air

Conversion 1 ppm = 3.48 milligram per cubic meter

OSHA PEL: None

NIOSH REL: 1 ppm/4 milligram per cubic meter [15 min] Ceiling Concentration

ACGIH TLV[1]: 5 mg[CN]/m^3 Ceiling Concentration [skin]

PAC* Ver. 29[138]

PAC-1: $\mathbf{2}_{\mathbf{A}}$ ppm

PAC-2: $\mathbf{7.1}_{\mathbf{A}}$ ppm

PAC-3: $\mathbf{15}_{\mathbf{A}}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

DFG MAK: 2 ppm TWA; 5 ppm STEL; Peak Limitation Category II(1) [skin]; Pregnancy Risk Group C

Hungary: STEL 0.9 milligram per cubic meter, carcinogen, 1993; Russia: STEL 0.9 milligram per cubic meter [skin] 1993; the Netherlands: MAC-TGG 3.5 milligram per cubic meter [skin] 2003

Determination in Air: NIOSH Analytical Method 2506[18].

Permissible Concentration in Water: Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment. Federal Drinking Water Guidelines: EPA 200 μg[CN]/L; State Drinking Water Standards: California 150 μg[CN]/L; State Drinking Water Guidelines: Arizona 220 μg[CN]/L; Maine. 140 μg[CN]/L; Minnesota 100 μg[CN]/L. United States Army field drinking-water standards for cyanide: 2 mg[CN]/L assuming a water consumption of 15 L/day and 6 mg[CN]/L assuming a water consumption of 5 L/day. United States Army field drinking-water standards for cyanide, long-term consumption 0.5 mg[CN]/L; short-term consumption; raw water constituents (maximum) 20 mg[CN]/L.

Determination in Water: Use NIOSH Analytical Method #7904; #6010, cyanides.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact. May be absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Contact can cause eye and skin irritation. Breathing this chemical can irritate the respiratory tract causing wheezing and shortness of breath. Slows down tissue respiration. High exposure can cause sudden death without warning. Symptoms of exposure include weakness, headache, confusion, nausea, vomiting, and a pounding heart. High exposure can cause liver and kidney damage. Inhalation may cause pulmonary edema, which can be delayed for several hours; there is a risk of death in serious cases.

Long-Term Exposure: Can cause thyroid gland to enlarge and interfere with normal thyroid function. May cause kidney and liver injury. See NIOSH Criteria Document 212 *Nitriles*.

Points of Attack: Eyes, skin, respiratory system; CNS; cardiovascular system, liver, kidneys, GI tract.

Medical Surveillance: Test for urine thiocyanate and blood cyanide levels.

First Aid: Move victim to fresh air; call emergency medical care. If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, quickly remove contaminated clothing and wash with large amounts of water. Speed in removing material from skin is of extreme importance. Seek medical attention immediately. When this chemical has been swallowed, get medical attention immediately. If this chemical has been inhaled, remove from exposure, and transfer promptly to a medical facility. If not breathing, give artificial respiration (avoid mouth to mouth resuscitation). If breathing is difficult, give oxygen. If heart has stopped begin CPR. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation. Avoid contact with contaminated skin. A cyanide antidote kit should be kept in the immediate work area and must be rapidly available. Kit ingredients should be replaced every 1–2 years to ensure freshness. Persons trained in the use of this kit; oxygen use, and CPR must be available within 1–2 minutes of exposure.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See NIOSH Criteria Document 212 *Nitriles*.

Respirator Selection: NIOSH, *10 ppm*: Sa (APF = 10) (any supplied-air respirator); 25 ppm: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); *50 ppm*: SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece); *250 ppm*: SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode. *Escape*: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, SCBA).

Storage: Poison inhalation chemical (PIH); check oxygen content prior to entering storage area. Color code—Blue: Health hazard/poison (Toxic): Store in a secure, locked, and cool, ventilated area. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Do not store for long periods of time; toxic fumes may form in closed container. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Outside storage and separated storage is preferred.

Shipping: UN1541 Acetone cyanohydrin, stabilized, Hazard Class: 6.1; Labels: 6.1-Poison Inhalation Hazard, Inhalation Hazard Zone B.

Spill Handling:

Acetone cyanohydrin when spilled in water

Initial Isolation and Protective Action Distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small Spills (from a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30

Then: Protect persons downwind (mi/km)

Day 0.1/0.2

Night 0.1/0.2

Large Spills (from a large package or from many small packages)

First: Isolate in all directions (ft/m) 300/2500

Then: Protect persons downwind (mi/km)

Day 0.2/0.3

Night 0.7/1.2

Issue poison warning. Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the potential for an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Acetone cyanohydrin is a combustible liquid. Thermal decomposition products may include hydrogen cyanide and oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode. *Note*: Water may cause frothing if it gets below surface of liquid and turns to steam. Water fog gently applied to surface will cause frothing which may extinguish fire.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Add with stirring to strong alkaline calcium hypochlorite solution. Alternatively dissolve in flammable solvent and burn in incinerator with afterburner and scrubber.

References

(31); (2); (138); (173); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Acetone Cyanohydrin, Washington, DC, Chemical Emergency Preparedness Program (Nov. 30, 1987).

National Institute for Occupational Safety and Health (NIOSH), "Criteria for a Recommended Standard: Occupational Exposure to Nitriles, Report No. 78-212, Cincinnati OH (1978).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report* 4, No. 1, 41–43 (1984).

New Jersey Department of Health and Senor Services, *Hazardous Substances Fact Sheet*: *Acetone cyanohydrin*, Trenton, NJ (June 2003).

Acetone Thiosemicarbazide A:0200

Formula: $C_4H_9N_3S$

Synonyms: Acetone, thiosemicarbazone; Hydrazinecarbothioamide, 2-(1-methylethylidene); Thiosemicarbazone acetone; Tiosemicarbazida de la acetona (Spanish)

CAS Registry Number: 1752-30-3

HSDB Number: 6422

RTECS Number: AL7350000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 217-137-9

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Combustible, Highly toxic (oral).

CERCLA/SARA 40CFR302, Extremely Hazardous Substances: TPQ = 1000/10,000 lb (454/4540 kg)[72]. *Note*: The lower quantity applies for solids in powder form with particulate size less than 100 μm. Otherwise the 10,000 pound TPQ applies.

Hazard symbols, risk, & safety statements: Hazard symbol: T; risk phrases: R21; R25; R26; R50/53; safety phrases: S2; S28; S36/37/39; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)]

Description: Acetone thiosemicarbazide is a white to yellow crystalline solid. Molecular weight = 131.22; freezing/melting point = 172–175°C. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 1; reactivity 0. No reaction with water.

Potential Exposure: Acetone thiosemicarbazone is used as an intermediate in the manufacture of pharmaceuticals and pesticides. May be used as an agricultural chemical.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

PAC* Ver. 29[138]

PAC-1: 9.1 milligram per cubic meter

PAC-2: 100 milligram per cubic meter

PAC-3: 600 milligram per cubic meter

Routes of Entry: Ingestion.

Harmful Effects and Symptoms

High oral toxicity reported. The LD_{low} oral (rat) = 10 mg/kg (highly toxic). LD_{50} = (oral-rat) 48,500 μg/kg[RTECS, NTIS].

Points of Attack: Eyes, skin, respiratory system; CNS; cardiovascular system; liver, kidneys, GI tract.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In the case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Contact lenses should not be worn when working with this chemical. Wear splash proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: For emergency situations, wear a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in a pressure-demand or other positive-pressure mode. For increased protection use in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft.(NJ). Isolation distance, Fire: 800 m/0.5 mi[70]. Restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen, sulfur, and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position.

Disposal Method Suggested: It is inappropriate and possibly dangerous to the environment to dispose of expired or waste drugs and pharmaceuticals by flushing them down the toilet or discarding them to the trash. Household quantities of expired or waste pharmaceuticals may be mixed with wet cat litter or coffee grounds, double-bagged in plastic, discard in trash. Larger quantities shall carefully take into consideration applicable DEA, EPA, and FDA regulations. If possible return the pharmaceutical to the manufacturer for proper disposal being careful to properly label and securely package the material. Alternatively, the waste pharmaceutical shall be labeled, securely packaged and transported by a state licensed medical waste contractor to dispose by burial in a licensed hazardous or toxic waste landfill or incinerator.

References

(31); (173); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: *Acetone Thiosemicarbazide*, Washington, DC, Chemical Emergency Preparedness Program (Nov. 30, 1987).

Acetonitrile A:0210

Formula: C_2H_3N; CH_3CN

Synonyms: Acetonitril (German); Acetonitrilo (Spanish); Cyanomethane; Cyanure de methyl (French); Ethanenitrile; Ethyl nitril; Ethylnitrile; Methane carbonitril; Methane carbonitrile; Methane, cyano-; Methyl cyanide

CAS Registry Number: 75-05-8

HSDB Number: 42

RTECS Number: AL7700000

UN/NA & ERG Number: UN1648/127

EC Number: 200-835-2 [*Annex I Index No.*: 608-001-00-3]

Regulatory Authority and Advisory Information

Carcinogenicity: NTP: Carcinogenesis studies (inhalation); equivocal evidence: rat, no evidence: mouse; EPA, Class D, Not classifiable as to human carcinogenicity.

Hazard Alert: Extremely flammable; Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction).

Clean Air Act 42USC7412; Title I, Part A, §112 hazardous pollutants

Clean Water Act 40CFR116.4A, hazardous substances, 40CFR413.02, Total Toxic Organics

RCRA 40CFR258, Appendix 2, list of inorganic and organic constituents

RCRA 40CFR261, Appendix 8; 40CFR261.11 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 5.6; Nonwastewater (mg/kg), 1.8

RCRA 40CFR264, Appendix 9; Ground Water Monitoring List Suggested methods (PQL μg/L): 8015 (100)

RCRA 40CFR266, Appendix 4, air Concentrations List

RCRA 40CFR266, Appendix 7, Basis for Listing Hazardous Waste

RCRA Land Ban Waste Restrictions

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U003

Superfund/EPCRA 40CFR302.4, Appendix A, RQ: 5000 lb (2270 kg), SARA 313: Form R *de minimis* Concentration Reporting Level: 1.0%.

Canada WHMIS Ingredients Disclosure List concentration reporting Level: 0.1%.

Hazard symbols, risk, & safety statements: Hazard symbol: F + , T, Xn, Xi; risk phrases: R12; R23/24/25; R36/37/38; R52; R62; R63; safety phrases: S2; S16; S27; S36/37; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Acetonitrile is an extremely flammable, colorless liquid with an ethereal odor. Molecular weight = 41.05; specific gravity (H_2O:1) = 0.78745 @ 15°C; boiling point @ 1 atm = 81.6°C[9]; melting/freezing point = −45.7°C[9]; critical temperature = 274.7°C[9]; critical pressure = 47.7 atm; specific gravity (H_2O:1) = 0.787 @ 20°C (liquid)[9]; relative vapor density (air = 1) = 1.4[9]; ratio of specific heats of vapor (gas) = 1.192[9]; ionization potential = 12.20 eV; latent heat of vaporization = 313 Btu/lb = 174 cal/g; heat of combustion = − 13,360 Btu/lb = −7420 cal/g[9]; vapor pressure = 73.7 mmHg @ 20°C[9]; electrical conductivity = 6×10^4 pS/m. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 4; reactivity 2; flash point = 6°C (oc) [NFPA]; 12.8°C (c.c.); autoignition temperature = 524°C. Explosive limits: LEL: 3.0%, 30,000 ppm[138]; UEL: 16.0%. Freely soluble in water.

Potential Exposure: Acetonitrile is used as an extractant for animal and vegetable oils, as a solvent; particularly in the pharmaceutical industry, and as a chemical intermediate in pesticide manufacture; making batteries and rubber products. It is present in cigarette smoke.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, chlorosulfonic acid, oleum, epoxides. May accumulate static electrical charges, and may cause ignition of its vapors. Nitriles may polymerize in the presence of metals and some metal compounds. They are incompatible with acids; mixing nitriles with strong oxidizing acids can lead to extremely violent reactions. Nitriles are generally incompatible with other oxidizing agents such as peroxides and epoxides. The combination of bases and nitriles can produce hydrogen cyanide. Nitriles are hydrolyzed in both aqueous acid and base to give carboxylic acids (or salts of carboxylic acids). These reactions generate heat. Peroxides convert nitriles to amides. Nitriles can react vigorously with reducing agents. Acetonitrile and propionitrile are soluble in water, but nitriles higher than propionitrile have low aqueous solubility. They are also insoluble in aqueous acids[101].

Permissible Exposure Limits in Air

NIOSH IDLH = 500 ppm

Conversion factor: 1 ppm = 1.68 milligram per cubic meter @ 25°C & 1 atm

Odor threshold = 40 ppm; Irritating: 875 milligram per cubic meter.

OSHA PEL: 40 ppm/70 milligram per cubic meter TWA

NIOSH REL: 20 ppm/34 milligram per cubic meter TWA

ACGIH TLV[1]: 20 ppm/34 milligram per cubic meter TWA [skin]; not classifiable as a human carcinogen

PAC* Ver. 29[138]

PAC-1: **13**$_{\mathbf{A}}$ ppm

PAC-2: **50**$_{\mathbf{A}}$ ppm

PAC-3: **150**$_{\mathbf{A}}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values. DFG MAK: 20 ppm/34 milligram per cubic meter; [skin]; Peak Limitation Category II(2); Pregnancy Risk Group C (2006)

Arab Republic of Egypt: TWA 40 ppm (70 milligram per cubic meter) [skin] 1993; Australia: TWA 40 ppm (70 milligram per cubic meter); STEL 60 ppm [skin] 1993; Austria: MAK 40 ppm (70 milligram per cubic meter), 1999;

Belgium: TWA 40 ppm (67 milligram per cubic meter); STEL 60 ppm (101 milligram per cubic meter) [skin] 1993; Denmark: TWA 40 ppm (70 milligram per cubic meter), 1999; Finland: TWA 40 ppm (70 milligram per cubic meter); STEL 60 ppm (105 milligram per cubic meter), 1993; France: VME 40 ppm (70 milligram per cubic meter) [skin] 1999; the Netherlands: MAC-TGG 70 milligram per cubic meter, 2003; Norway: TWA 30 ppm (50 milligram per cubic meter), 1999; the Philippines: TWA 40 ppm (70 milligram per cubic meter), 1993; Poland: TWA 70 milligram per cubic meter; STEL 140 milligram per cubic meter, 1999; Russia: STEL 10 milligram per cubic meter, 1993; Sweden: TWA 30 ppm (50 milligram per cubic meter); STEL 50 ppm (100 milligram per cubic meter), 1999; Switzerland: MAK-W 500 ppm (1200 milligram per cubic meter); STEL 1000 ppm (2400 milligram per cubic meter), 1999; Turkey: TWA 40 ppm (70 milligram per cubic meter), 1993; United Kingdom: TWA 40 ppm (68 milligram per cubic meter); STEL 60 ppm (102 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 60 ppm.

Determination in Air: Use NIOSH Analytical Method 1606[18].

Permissible Concentration in Water: Acetonitrile is infinitely soluble and stable in water. No criteria have been set, but EPA has proposed[32] an ambient environmental goal of 970 μg/L based on health effects. Russia[43] set a MAC of 0.7 mg/mL for water bodies used for domestic purposes. Harmful to aquatic organisms.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = -0.3$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Routes of Entry: Inhalation, percutaneous absorption, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates eyes, skin and respiratory tract. Exposure can cause fatal cyanide poisoning. Symptoms include flushing of the face, chest tightness, headache, nausea, and vomiting, weakness, and shortness of breath. These reactions may begin hours following overexposure.

Long-Term Exposure: Repeated exposure may cause the thyroid gland to enlarge and cause permanent damage. Acetonitrile may cause damage to the developing fetus. See NIOSH Criteria Document 212 *Nitriles*.

Points of Attack: Kidneys, liver, lungs, skin, eyes, CNS; cardiovascular system.

Medical Surveillance: Consider the lung, skin, respiratory tract, heart, CNS; renal and liver function in placement and periodic examinations. A history of fainting spells or convulsive disorders might present an added risk to persons working with toxic nitriles. Blood cyanide test and/or urine thiocyanate test. Blood cyanide over 0.1 mg/L or urine thiocyanate over 20 mg/L indicate overexposure. Maintain close medical monitoring. Slow release of cyanide from absorbed acetonitrile may cause delayed symptoms. Blood plasma, expired air, urine (chemical/metabolite).

First Aid: Acetonitrile can cause fatal Cyanide poisoning. A cyanide antidote kit should be kept in the immediate work area and must be rapidly available. Kit ingredients should be replaced every 1−2 years to ensure freshness. Persons trained in the use of this kit; oxygen use, and CPR must be available within 1−2 minutes. In the event of overexposure, and/or symptoms: move victim to fresh air; call emergency medical care. Give Amyl Nitrate capsules (as directed, by trained personnel only). If this chemical gets into the eyes, remove any contact lenses at once, and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, quickly remove contaminated clothing and wash with large amounts of water. Speed in removing material from skin is of extreme importance. Seek medical attention immediately. When this chemical has been swallowed, get medical attention immediately. If this chemical has been inhaled, remove from exposure and transfer promptly to a medical facility. If not breathing, give artificial respiration (avoid mouth to mouth resuscitation). If breathing is difficult, give oxygen. If heart has stopped, begin CPR. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation. Avoid contact with contaminated skin. Observe victim for 24 to 48 hours.

Personal Protective Methods: Prevent skin contact. **8 hours** (More than 8 hours of resistance to breakthrough $>0.1\ \mu m > g/cm^2/min$): butyl rubber gloves, suits, boots; Teflon gloves, suits, boots; 4H and Silver Shield gloves; Barricade, Responder suits, Trellchem HPS suits; Trychem 1000 suits. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See also NIOSH Criteria Document 212 *Nitriles*.

Respirator Selection: NIOSH: *200 ppm*: CcrOv (APF = 10) [any air-purifying half-mask respirator equipped with an organic vapor cartridge(s)]; Sa (APF = 10) (any supplied-air respirator); or SCBA (any SCBA); *500 ppm*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge (s)]; or CcrFOv (APF = 50) [any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s)]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-, or back-mounted acid gas canister]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA

(APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode. *Escape*: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-, mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where acetonitrile may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN1648 Acetonitrile, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling:

Nitriles spill

Initial isolation and protective action distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.1/0.2

Large spills (from a large package or from many small packages)

First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.3/0.5
Night 0.5/0.8

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include hydrogen cyanide and oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Water may be ineffective for fighting fires. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration with nitrogen oxide removal from effluent gases by scrubbers or incinerators[22].

References

(31); (2); (138); (173); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: *Acetonitrile*, Washington, DC (March 9, 1979).

United States Environmental Protection Agency, *Acetonitrile*, Health and Environmental Effects Profile No. 2, Washington, DC, Office of Solid Waste (April 30, 1980).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 4, No. 1, 44–46 (Jan./Feb. 1984).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: *Acetonitrile*, Trenton, NJ (June 1998).

Acetophenetidin A:0220

Formula: $C_{10}H_{13}NO_2$: $C_2H_5OC_6H_4NHCOCH_3$

Synonyms: Acetamide, *N*-(4-ethoxyphenyl)-; 1-Acetamido-4-ethoxybenzene; Acetofenetidna (Spanish); Aceto-*p*-phenalide; *p*-Acetophenetide; Aceto-*p*-phenetidide; Acetophenetidin; Aceto-4-phenetidine; Acetophenetidine;

Acetophenetin; Acet-*p*-phenalide; *p*-Acetphenetidin; Acet-*p*-phenetidin; Acetphenetidin; Acetylphenetidin; *N*-Acetyl-*p*-phenetidine; Achrocidin; Anapac; APC; ASA compound; *p*-Ethoxyacetanilide; 4-Ethoxyacetanilide; *N*-(4-Ethoxyphenyl)acetamide; *N*,*p*-Ethoxyphenylacetamide; *p*-Phenacetin; Phenacetin; Phorazetim

CAS Registry Number: 62-44-2

HSDB Number: 3182

RTECS Number: AM4375000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 200-533-0

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, Known to be a Human Carcinogen (Phenacetin and analgesic mixtures containing phenacetin); IARC: (phenacetin) Human Limited Evidence, animal Sufficient Evidence, *probably carcinogenic to humans*, Group 1.

California Proposition 65 Chemical[102]: Cancer 10/1/1989 (phenacetin and analgesic mixtures containing phenacetin)

Hazard Alert: Poison, Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard.

RCRA 40CFR258, Appendix 2, list of inorganic and organic constituents

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U187, as phenacetin

RCRA 40CFR261.33, Appendix 8; 40CFR261.11 Hazardous Constituents

RCRA 40CFR264, Appendix 9; Ground Water Monitoring List Suggested methods (PQL μg/L): 8270 (10)

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.081; Nonwastewater (mg/kg), 16.

RCRA Land Ban Waste Restrictions

Superfund/EPCRA 40CFR302.4, Appendix A, RQ: 100 lb (45.4 kg)

Hazard symbols, risk, & safety statements: Hazard symbol: T; risk phrases: R45; R22; R50/53; R62; R63; safety phrases: S53; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Acetophenetidin is a fine, white, crystalline powder or solid. Odorless with a slightly bitter taste. Molecular weight = 179.22; boiling point = about 100°C (decomposes); freezing/melting point = 134−137°C. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 0; reactivity 0. Slightly soluble in water.

Potential Exposure: Phenacetin is used as an analgesic and antipyretic drug. It is used alone or in combination with aspirin and caffeine for mild to moderate muscle pain relief. Phenacetin has also been used as a stabilizer for hydrogen peroxide in hair bleaching preparations. A laboratory reagent. In veterinary medicine; it is used as an analgesic and antipyretic.

Incompatibilities: Oxidizing agents, iodine and nitrating agents[52].

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 7.3 milligram per cubic meter

PAC-2: 80 milligram per cubic meter

PAC-3: 330 milligram per cubic meter

Russia[43] set a MAC of 0.5 milligram per cubic meter in working zones for phenacetin.

Determination in Water: EPA Method 8250A. Octanol−water coefficient: Log $K_{ow} \leq$ 3.0. Values above 3.0 are likely to bioaccumulate in aquatic organisms.

Routes of Entry: Ingestion, inhalation, eye and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Exposure to high levels of this chemical can cause methemaglobinemia which lowers the ability of the blood to carry oxygen. This can result in a bluish color to skin and lips (cyanosis), headache, dizziness, collapse, and possible death.

Long-Term Exposure: This chemical is a probable cancer-causing agent in humans. It has been shown to cause bladder, urinary tract, and nose cancer in animals. Mutation, reproductive, teratogenic data reported. There is limited evidence that this chemical may damage the developing fetus. High or repeated exposures can destroy red blood cells, causing low blood count; aplastic anemia; jaundice, kidney damage; and brownish color to urine. Can lead to a general allergic reaction with rash and itching.

Points of Attack: Bladder, kidneys, eyes, skin.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: Kidney function tests. If symptoms develop or overexposure is suspected, the following may be useful: Blood test for methemoglobin level, CBC and reticulocyte count, Blood and urine bilirubin, Blood Phenacetin level.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In the case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy. *Note to Physician*: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Wear chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any exposure level*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-, or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health hazard: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. A regulated, marked area should be established where Phenacetin is handled, used, or stored. Store in tightly closed containers in a cool, well-ventilated area away from heat.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft.(NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak after clean-up is complete. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include nitrogen oxides. Use any extinguishing agent suitable for surrounding fire. If material or contaminated run-off enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: It is inappropriate and possibly dangerous to the environment to dispose of expired or waste pharmaceuticals by flushing them down the toilet or discarding them to the trash. Household quantities of expired or waste pharmaceuticals may be mixed with wet cat litter or coffee grounds, double-bagged in plastic, discard in trash. Larger quantities shall carefully take into consideration applicable DEA, EPA, and FDA regulations. If possible, return the pharmaceutical to the manufacturer for proper disposal being careful to properly label and securely package the material. Alternatively, the waste pharmaceutical shall be labeled, securely packaged, and transported by a state licensed medical waste contractor to dispose by burial in a licensed hazardous or toxic waste landfill or incinerator. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Permanganate oxidation, microwave plasma treatment, alkaline hydrolysis or incineration.

References

(109); (102); (31); (173); (138); (100).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 1, No. 1, 26−27, (as Phenacetin) (1980); and 6, No. 1, 107−110 (1986).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: *Phenacetin*, Trenton, NJ (May 2000).

Acetophenone A:0230

Formula: C_8H_8O; $CH_3COC_6H_5$

Synonyms: Acetofenona (Spanish); Acetylbenzene; Benzoyl methide hypnone; Dymex; Ethanone, 1-phenyl-; Hypnone; Ketone methyl phenyl; Methyl phenyl ketone; 1-Phenylethanone; Phenyl methyl ketone

CAS Registry Number: 98-86-2

HSDB Number: 969

RTECS Number: AM5250000

UN/NA & ERG Number: UN1993 (flammable liquids, n.o.s.)/128

EC Number: 202-708-7 [*Annex I Index No.*: 606-042-00-1]

Regulatory Authority and Advisory Information

Hazard Alert: Flammable liquid, Suspected reprotoxic hazard, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction).

Clean Air Act 42USC7412; Title I, Part A, §112 Hazardous Pollutants

RCRA 40CFR261, Appendix 8; 40CFR261.11 Hazardous Constituents

RCRA 40CFR264, Appendix 9; Ground Water Monitoring List Suggested methods (PQL μg/L): 8270 (10)

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.010; Nonwastewater (mg/kg), 9.7

RCRA 40CFR266, Appendix 7, Basis for Listing Hazardous Waste

RCRA Land Ban Waste

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U0034

Superfund/EPCRA 40CFR302.4, Appendix A, RQ: 5000 lb (2270 kg), SARA 313: Form R *de minimis* Concentration Reporting Level: 1.0%.

WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1%.

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xn, Xi; risk phrases: R10; R22; R36/37/38; R61; R62; R63; safety phrases: S2; S26 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Acetophenone is a colorless, oily liquid with a sweet, floral odor. Molecular weight = 120.15[9]; specific gravity (H_2O:1) = 1.028 @ 20°C (liquid)[9]; boiling point @ 1 atm = 201.7°C[9] @ 760 mmHg; melting/freezing point = 19.7°C[9]; critical temperature = 428°C[9]; critical pressure = 38 atm[9]; surface tension = 39.8 dyn/cm @ 20°C (in contact with vapor); Liquid surface tension = 12 dyn/cm = 0.012 N/m @ 30°C[9]; liquid water interfacial tension = (estimate) 40 dyn/cm = 0.04 N/m @ 27°C[9]; relative vapor density (air = 1) = 4.15[9]; ratio of specific heats of vapor (gas) = (estimate) 1.071[9]; latent heat of vaporization = 150 Btu/lb = 83.6 cal/g[9]; 11,731.5 gcal/gmole; heat of combustion = −14,850 Btu/lb = −8250 cal/g[9]; 991.60 kcal/g @ 25°C (liquid); vapor pressure = 0.99 mmHg @ 20°C[9]; electrical conductivity = 3.12 × 105 pS/m[52]. Hazard identification (based on NFPA-704 M Rating System): Health 1; flammability 2; reactivity 0; flash point = 77°C (cc); 82°C (oc); autoignition temperature = 570°C. Explosive limits: LEL: 1.1%, 11,000 ppm; UEL: 6.7%. Poor solubility in water; solubility = 0.73 g/100 mL @ 20°C.

Potential Exposure: Acetophenone is used as a solvent and in perfume manufacture to impact a pleasant jasmine or orange-blossom odor. It is used as a catalyst in olefin polymerization and as a flavorant in tobacco. It is also used in the synthesis of pharmaceuticals.

Incompatibilities: May form explosive mixture with air. See flash point, above. Reacts violently with strong oxidizers, many acids, bases, amines, amides, and inorganic hydroxides; alkali metals; hydrides, and nitrides. Reacts with reducing agents; alkali metals; hydrides, nitrides. Contact with all preceding materials release heat and flammable gases, including hydrogen; the heat may be sufficient enough to result in fire. Incompatible with aldehydes, aliphatic amines, alkanolamines, cyanides, isocyanates, organic acids, peroxides; perchloric acid. May attack plastics, and some rubbers and coatings.

Permissible Exposure Limits in Air

ACGIH TLV[1]: 10 ppm/49 milligram per cubic meter TWA

PAC Ver. 29[138]

PAC-1: 30 milligram per cubic meter

PAC-2: 330 milligram per cubic meter

PAC-3: 2000 milligram per cubic meter

Permissible Concentration in Water: Russia[43] set a MAC of 0.1 mg/L in water for domestic purposes and 0.04 mg/L in water used for fishery purposes.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 1.6$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates eyes, skin, and respiratory tract. Skin contact can cause burning and rash. Exposure can result in headache, dizziness, nausea, and loss of coordination. A hypnotic, high levels of exposure may affect the nervous system. Toxic effects exacerbated by alcohol consumption.

Long-Term Exposure: There is evidence that this chemical can cause genetic changes; mutations, and acne-like skin rash. Long-term exposure may cause CNS damage.

Points of Attack: Skin, eyes, CNS.

Medical Surveillance: Testing for hippuric acid levels in the urine is recommended.

First Aid: Remove any contact lenses at once, then flush eyes, wash contaminated areas of body with soap and water. If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear solvent-resistant gloves and clothing to prevent any reasonable probability of skin or eye contact. ACGIH recommends Teflon as a protective material. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Red: Flammability hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where acetophenone may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN1993 Flammable liquids, n.o.s., Hazard Class: 3; Labels: 3-Flammable liquid, Technical Name Required.

Spill Handling: Restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Use foam spray to reduce vapors. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. Ventilate area of spill or leak after clean-up is complete. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Keep acetophenone out of a confined space, such as a sewer, because of the potential for an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; water spray; or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration, preferably with a flammable solvent.

References

(31); (173); (138); (100).

United States Environmental Protection Agency, acetophenone, Health and Environmental Effects Profile No. 3, Washington, DC, Office of Solid Waste (April 30, 1980).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: *Acetophenone*, Trenton, NJ (November 1998).

Acetylaminofluorene A:0260

Formula: $C_{15}H_{13}NO$

Synonyms: 2-AAF; AAF; Acetamide, *N*-9H-fluoren-2-yl; Acetamide, *N*-fluoren-2-yl-; 2-Acetamidofluorene; Aceto-minofluorine; 2-2-Acetylamidofluorene; 2-Acetylamino-fluoren (German); *N*-Acetyl-2-aminofluorene; 2-Acetylaminofluorene; Azetylaminofluoren; 2-FAA; FAA; *N*-2-Fluoren-2-yl acetamide; 2-Fluorenylacetamide

CAS Registry Number: 53-96-3

HSDB Number: 4077

RTECS Number: AB9450000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 200-188-6

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen. Gene-Tox Program, Negative: In vitro SCE-human lymphocytes; In vitro SCE-human; Negative: Sperm morphology-mouse; V79 cell culture-gene mutation; Negative: S *cerevisiae* gene conversion; S *cerevisiae-homozygosis*; Inconclusive: Cell transformation-RLV F344 rat embryo; Inconclusive: In vivo SCE-nonhuman; D *melanogaster* sex-linked lethal; Inconclusive: In vitro UDS-human fibroblast; Positive: CHO gene mutation

California Proposition 65 Chemical[102]: Cancer 7/1/1987.

Hazard Alert: Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard.

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR1910.1014)

Clean Air Act 42USC7412; Title I, Part A, §112 Hazardous Pollutants

RCRA 40CFR261, Appendix 8; 40CFR261.11 Hazardous Constituents

RCRA 40CFR264, Appendix 9; Ground Water Monitoring List Suggested methods (PQL μg/L): 8270 (10)

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.059; Nonwastewater (mg/kg), 140.

RCRA 40CFR266, Appendix 7, Basis for Listing Hazardous Waste

RCRA Land Ban Waste

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U005

Superfund/EPCRA 40CFR302.4, Appendix A, RQ: 1 lb (0.454 kg), SARA 313: Form R *de minimis* Concentration Reporting Level: 0.1%.

Banned or Severely Restricted (In Industrial Chemicals) (Belgium, Finland, Sweden) (UN)[13]

Canadas WHMIS Ingredients Disclosure List concentration reporting Level: 0.1%.

Hazard symbols, risk, & safety statements: T, N; Risk phrases: R45; R22; R50/53; Suspected reprotoxic hazard Safety phrases S36/37/39; S45; S53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to waters

Description: 2-Acetylaminofluorene (AAF) is a combustible, tan powder or crystalline solid. Molecular weight = 223.27; freezing/melting point = 193°C. Hazard identification (based on NFPA-704 M Rating System): Health 1; flammability 1; reactivity 0.

Potential Exposure: 2-AAF was intended to be used as a pesticide, but it was never marketed because this chemical was found to be carcinogenic. AAF is used frequently by biochemists and technicians engaged in the study of liver enzymes and the carcinogenicity and mutagenicity of aromatic amines as a positive control. Therefore, these persons may be exposed to AAF.

Incompatibilities: Hygroscopic. Contact with strong oxidizers may cause fire and explosions. Not compatible with cyanides, acids, and/or acid anhydrides. May form unstable and explosive peroxides; a possible polymerization hazard. Contact with strong oxidizers or strong reducing agents may form flammable gases and cause fire and explosions. A weak base that may react as an acid. Incompatible with strong bases (forming potentially dangerous salts), chlorinated hydrocarbons, nitro compounds. Reacts with azo and diazo compounds, generating toxic gases. Contact with mixture of acetic acid + dinitrogen trioxide may cause explosion.

Permissible Exposure Limits in Air

NIOSH IDLH = Not determined. Potential occupational carcinogen.

OSHA PEL: Cancer suspect agent. Exposures of workers to this chemical is to be controlled through the required use of engineering controls, work practices; and PPE, including respirators. See 29 CFR 1910.1003-1910.1016 for specific details of these requirements.

NIOSH REL: potential occupational carcinogen; limit exposure to the lowest feasible concentration.

PAC Ver. 29[138]

PAC-1: 1.2 milligram per cubic meter

PAC-2: 14 milligram per cubic meter

PAC-3: 480 milligram per cubic meter

Belgium carcinogen, 1993; Finland: carcinogen, 1993; Sweden; carcinogen, 1999

New York: 0.03 μ/m^3 for ambient air[60].

Routes of Entry: Ingestion, inhalation, mucous membrane; skin absorption; skin and/or eye contact.

Harmful Effects and Symptoms

A carcinogen. Handle with extreme care.

Short-Term Exposure: This chemical has limited use in industry, and contact is kept to a minimum to prevent cancer. Reduced function of liver, kidneys, bladder, pancreas (Potential occupational carcinogen).

Long-Term Exposure: Reduced function of liver, kidneys, bladder, pancreas. Incorporation of this compound in feed caused increased incidences of malignant tumors in a variety of organs in the rat. Long-term studies in which mice were given 2-AAF in their diet showed that this compound caused increased incidences of tumors and cancer of the liver, kidney, urinary bladder, lung, skin, and pancreas. There is limited evidence that this chemical is a teratogen in animals.

Points of Attack: Liver, bladder, kidney, pancreas, skin, lungs.

Medical Surveillance: Urine cytology for abnormal cells in the urine. This chemical is a suspected or known human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. If this chemical has been inhaled, remove from exposure. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention.

Personal Protective Methods: Prevent skin contact Contact the manufacturer for recommendations. Because AAF is a carcinogen, on February 11, 1974, OSHA promulgated a standard for this chemical designating protective clothing, hygiene procedures for workers, and special engineering requirements for the manufacture or processing of AAF. Open vessel operations are prohibited. Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Eye protection is included in the recommended respiratory protection. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *At any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air-purifying, full facepiece respirator with an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Green: General storage may be used. Prior to working with this chemical, personnel should be trained on its proper handling and storage. A regulated, marked area should be established where 2-AAF is handled, used, or stored. 2-AAF must be stored to avoid contact with cyanides, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: If 2-AAF is spilled or leaked, only specifically trained personnel should be involved in the clean-up. Restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Cover with lime or soda ash; collect material in the most convenient and safe manner, and deposit in sealed containers. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include oxides of nitrogen and carbon. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Presumably high-temperature incineration with scrubber for any produced nitrogen oxides can be used.

References

(109); (102); (31); (173); (138); (100).

United States DOL OSHA, Reduced Immunologic Competence, Code of Federal Regulations. 29CFR1910, air Contaminants, July 1, 1996. United States DHHS NIOSH and United States DOL OSHA, urine (chemical/metabolite), NIOSH/OSHA Occupational Health Guidelines for Chemical Hazards. DHHS (NIOSH) Pub Nos. 81-123.

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: 2-Acetylaminofluorene, Trenton, NJ (June 1998).

Acetyl Benzoyl Peroxide A:0270

Formula: $C_9H_8O_4$; $CH_3CO \cdot OO \cdot COC_6H_5$

Synonyms: Acetozone; Benzozone; Peroxide, acetyl benzoyl; Peroxido de acetil benzoilo (Spanish)

CAS Registry Number: 644-31-5

HSDB Number: 968

RTECS Number: SD7860000

UN/NA & ERG Number: UN3105/145

EC Number: 211-412-7

Regulatory Authority and Advisory Information

Hazard Alert: Powerful oxidizer, Explosive (when dry); Violently water reactive.

Hazard symbols, risk, & safety statements: Hazard symbol: O, E; Risk phrases: R1; R14; R8; R9; R23/24/25; R41; Safety phrases: S7/8; S24/25; S27/28; S36/37/39; S45(see Appendix 4).

Description: Acetyl benzoyl peroxide is a white crystalline solid, forming needles. Molecular weight = 180.16;

freezing/melting point = 36−39°C; boiling point = 130°C; flash point: 104°C. Decomposes in water; violent reaction; solubility = 639 mg/L @ 25°C.

Potential Exposure: Used in disinfectants, to bleach flour; and in medications.

Incompatibilities: Acetyl benzoyl peroxide is an organic peroxide which can detonate if shocked, heated, or on contact with contaminants. A powerful oxidizer. Violent reaction with many compounds, including reducing agents; chemically active metals; combustible materials, strong acids, alkaline earth sulfides, aluminum carbides, aluminum, amines, calcium sulfide, carbides, chlorine trifluoride, glycerin, hydrides, hydrochloric acid, hydrogen peroxide, hydrogen sulfide, hydroxylamine, magnesium, metal powders, metal sulfides, molybdenum, phenylhydrazine, phosphorous red/friction, phosphorous trichloride, silicon, sulfides, sulfur, sulfur dioxide, sulfur/friction, sulfuric acid, tungsten, hydrogen trisulfide. Avoid contact with moisture, water, steam, sources of ignition, combustible materials. Not compatible with strong bases; reducing materials; other oxidizers.

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Permissible Concentration in Water: No criteria set. Reacts violently with water.

Determination in Water: Octanol−water coefficient: Log $K_{ow} \leq 2$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: This chemical can be absorbed through the skin, thereby increasing exposure. Contact can severely irritate and burn the eyes and skin. It may cause permanent damage. Breathing Acetyl benzoyl peroxide can irritate the nose, throat and lungs, causing a cough, difficulty breathing and chest tightness. Higher levels of exposure can cause pulmonary edema, a medical emergency, which can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: Repeated exposure may cause chronic irritation of the skin and eczema-like rash. Repeated lung exposure can cause bronchitis with cough, phlegm, and/or shortness of breath.

Points of Attack: Eyes, skin, nose, throat, lungs.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once, and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed.

Personal Protective Methods: Avoid skin contact with Acetyl Benzoyl Peroxide. Wear protective gloves and clothing. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day and put on before work. Contact lenses should not be worn when working with this chemical. Wear impact-resistant goggles and face shield when working with powders or dust, unless full facepiece respiratory protection is worn. Wear splash-proof chemical goggles and face shield when working with liquid, unless full facepiece respiratory protection is worn.

Respirator Selection: Where there is potential exists for exposures to solid acetyl benzoyl peroxide, use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece respirator with a high efficiency particulate filter. Greater protection is provided by a powered-air purifying respirator. Where there is potential for high exposures and to the liquid form of Acetyl Benzoyl Peroxide exists, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Storage: Color code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. Oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage.

This chemical is an organic peroxide that can detonate if shocked or heated. Before entering confined space where acetyl benzoyl peroxide may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: UN3105 Organic peroxide type D, liquid, Hazard Class: 5.2; Labels: 5.2-Organic peroxide, Technical Name Required.

Spill Handling: Restrict persons not wearing butyl rubber protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Keep this substance out of a confined space, such as a sewer, because of the potential for an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical or carbon dioxide extinguishers. Irritating fumes. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (138).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Acetyl Benzoyl Peroxide, Trenton, NJ (September 1998).

Acetyl Bromide A:0280

Formula: C_2H_3BrO; CH_3COBr

Synonyms: Acetic acid bromide; Acetic bromide; Acetilo de bromura (Spanish); Ethanoyl bromide

CAS Registry Number: 506-96-7

HSDB Number: 663

RTECS Number: AO5955000

UN/NA & ERG Number: UN1716/156

EC Number: 208-061-7

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade).

Hazard Alert: Combustible, Corrosive, Temperature sensitive, Violently water reactive, Air reactive (forms hydrogen bromide gas).

Clean Water Act: 40CFR116.4 Hazardous Substances; RQ 40CFR117.3 (same as CERCLA)

Superfund/EPCRA 40CFR302.4, Appendix A, RQ: 5000 lb (2270 kg)

Canada, WMIS Ingredients Disclosure List Concentration Reporting Level: 1%.

Hazard symbols, risk, & safety statements: Hazard symbol: C; Risk phrases: R14; R34; R36/R37; Safety phrases: S1; S25; S36/37/39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [1-Low hazard to water. (est.)]

Description: Acetyl bromide is a colorless, fuming liquid that turns yellow on contact with air. It has a sharp, unpleasant odor. Molecular weight = 122.95; specific gravity (H_2O:1) = 1.52 @ 9.5°C; boiling point = 76.7°C; freezing/melting point = −97°C; vapor pressure = 101 mmHg @ 20°C; relative vapor density (air = 1) = 4.2; difficult to ignite; flash point = 75°C[92]; 110°C [lit.S-A]. Explosive limits: LEL: 35,960 ppm; UEL: unknown. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 1; reactivity 2₩. Sinks in water with violent decomposition, releasing toxic hydrogen bromide.

Potential Exposure: Acetyl bromide is used as an acetylating agent in the organic synthesis of other chemicals, pesticides, perfume, pharmaceuticals, and it is also used as a dye intermediate.

Incompatibilities: Acetyl bromide Vapor may form explosive mixture with air. Instability increases as temperature rises, Contact with moisture, water, steam, alcohols cause a violent reaction releasing corrosive carbonyl bromide, hydrogen bromide, and bromine gases. Incompatible with organic solvents, ethers, oxidizers, and strong bases. Corrodes or attacks most metals and wood in the presence of moisture. Contact with combustibles may cause ignition.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 0.16 ppm

PAC-2: 1.8 ppm

PAC-3: 11 ppm

Routes of Entry: Eye and/or skin contact, inhalation; and ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: This chemical can be absorbed through the skin, thereby increasing exposure. Skin and eye contact can cause severe irritation and possible permanent damage including blindness. Inhalation and swallowing are very toxic Exposure can irritate the nose, throat, air passages, and lungs with coughing and/or shortness of breath. Higher exposures may cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: Repeated respiratory exposure can cause bronchitis to develop with cough, phlegm, and/or shortness of breath. Repeated skin exposure can cause chronic skin irritation.

Points of Attack: Skin, lungs.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, lung function tests are recommended. If symptoms develop or overexposure is suspected, consider chest X-ray.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Do not induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed.

Personal Protective Methods: Wear corrosive-resistant gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures to Acetyl Bromide exists, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: (1) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. (2) Color code—Blue: Health hazard/poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from moisture and sunlight. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN1716 Acetyl bromide, Hazard class: 8; Labels: 8-Corrosive material.

Spill Handling:

Acetyl bromide when spilled in water

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (from a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.2/0.3

Large spills (from a large package or from many small packages)

First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.4/0.6
Night 1.1/1.8

Prevent liquid from reaching water if possible. This material creates large amounts of toxic hydrogen bromide (HBr) vapor when spilled in water, and is considered by the North American Emergency Response Guide to be dangerous from 0.5 to 10 km (0.3−6.0 mi downwind). Evacuate area and issue warning of danger, including possible explosion. Stay upwind and uphill. Isolate the area of release or fire and deny entry. Remove all ignition sources. Stop the release if it can be done safely from a distance. All equipment used to handle this material must be grounded. *Small spill*: Cover with *dry* earth, *dry* sand, or other noncombustible material followed with plastic sheet to minimize spreading or contact with water or rain. Use clean nonsparking tools to collect material and place material into loosely covered plastic containers for later disposal. Prevent material and runoff from entering sewers and waterways if it can be done safely well ahead of the release. Use vapor suppressing foam to disperse vapors-containing runoff. Water spray may reduce vapor but may not prevent ignition in enclosed spaces. Ventilate confined area if it can be done without placing personnel at risk. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable

Fire Extinguishing: This chemical is a combustible liquid but does not readily ignite. Thermal decomposition products may include hydrogen bromide, carbonyl bromide, and oxides of carbon. Reacts violently with water-based extinguishers, such as foam. *Do not use water or foam extinguishers. Small fire*: use *dry* chemical, CO_2, *dry* sand, or alcohol-resistant foam. May react with foams releasing corrosive/toxic gases. *Large fire*: use water spray or alcohol-resistant foam if it is available in sufficient amounts. Under favorable conditions, experienced crews can use coordinated fog streams to sweep the flames off the surface of the burning liquid. Combustible material: may burn but does not ignite readily. Most vapors are heavier than air. They will spread along ground and collect in low or confined areas (sewers, basements, tanks). Vapors may travel to source of ignition and flash back. Containers may explode when heated or if contaminated with water. Keep exposures cool long after fire is out to protect against reignition. Do not direct straight streams into the liquid. Cool exposed containers with large quantities of water from unattended equipment or remove intact containers if it can be done safely. *Do not get water on spilled substance or inside containers*. If cooling streams are ineffective (*venting sound increases in volume and pitch, tank discolors or shows signs of deforming*), withdraw immediately to a secure location. Always stay away from ends of tanks, especially when engulfed in flames. If material or contaminated runoff from fire control enters waterways, notify downstream users of potentially contaminated water. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156.

Disposal Method Suggested: Dispose of contents and container to an approved waste disposal plant. All federal, state, and local environmental regulations must be observed. Slow addition to sodium bicarbonate solution in a glass or plastic container. Mix slowly in another container containing lots of water. It is inappropriate and possibly dangerous to the environment to dispose of chemical waste by flushing them down the toilet or discarding them to the trash.

References

(31); (92); (173)(100).

Sax, I. N., Ed., *Dangerous Properties of Industrial Materials Report*, 1, No. 8, 29−30 (1981).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Acetyl Bromide, Trenton, NJ (September 1998).

Acetyl Chloride A:0290

Formula: C_2H_3ClO; CH_3COCl

Synonyms: Acetic acid chloride; Acetic chloride; Cloruro de acetilo (Spanish); Ethanoyl chloride

CAS Registry Number: 75-36-5

HSDB Number: 662

RTECS Number: AO6390000

UN/NA & ERG Number: UN1717/155

EC Number: 200-865-6

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade).

Hazard Alert: Highly flammable, Suspected of causing genetic defects.

United States National Primary Drinking Water Regulations: SMCL = 250 mg[Cl-]/L as Chloride

Clean Air Act 42USC7412; Title I, Part A, §112 Hazardous Pollutants; RQ 40CFR117.3 (same as CERCLA)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U006

RCRA 40CFR261, Appendix 8; 40CFR261.11 Hazardous Constituents

RCRA Land Ban Waste Restrictions

Superfund/EPCRA 40CFR302.4, Appendix A, RQ: 5000 lb (2270 kg)

Banned or Severely Restricted (Singapore) (UN)[13]

Hazard symbols, risk, & safety statements: Hazard symbol: F, C; Risk phrases: R11; R14; R34; R62; Safety phrases: S1; S9; S16; S21; S26; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Acetyl chloride is a highly flammable, colorless, fuming liquid with a pungent odor. The odor threshold is 1.0 ppm (as acetic acid or as HCl). Molecular weight = 78.5[9]; specific gravity (H_2O:1) = 1.1[9]; boiling point @ 1 atm = 51°C[9]; melting/freezing point = −112°C[9]; critical temperature = (estimate) 246°C[9]; critical pressure = (estimate) 845 psia = 57.5 atm[9]; specific gravity (H_2O:1) = 1.1039 @ 21°C (liquid); liquid surface tension = 26 dyn/cm = 0.026 N/m @ 20°C[9]; relative vapor density (air = 1) = 2.7[9]; electrical conductivity = 4×10^7 [du]; ratio of specific heats of vapor (gas) = 1.1467[9]; latent heat of vaporization = 160 Btu/lb = 88 cal/g[9]; heat of combustion =

−6000 Btu/lb = −3300 cal/g[9]; heat of solution = (estimate) −54 Btu/lb = −30 cal/g[9]; vapor pressure = 213 mmHg @ 20°C[9]; 287 mmHg @ 25°C; flash point = 4°C; autoignition temperature = 390°C. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 3; reactivity 3 ₩. Explosive limits: LEL: 7.3%, UEL: 19.0%. Violent decomposition in water.

Potential Exposure: Acetyl chloride is used in organic synthesis as an acetylating agent and in testing for water and/or cholesterol in organic liquids, in the pharmaceutical industry and in pesticide manufacture.

Incompatibilities: Avoid contact with moisture, steam, water, alcohols, dimethylsulfoxide, strong bases; phosphorus trichloride; oxidizers, and amines, since violent reactions may occur. Keep away from heat, fire, and welding operations.

Permissible Exposure Limits in Air

PAC Ver. 29[138]
PAC-1: 0.85 ppm
PAC-2: 9.4 ppm
PAC-3: 56 ppm

Permissible Concentration in Water: No criteria set. However, acetyl chloride reacts violently with water. Thus, its half-life in ambient water should be short and exposure from water should be nil. The degradation products should likewise pose no exposure problems if the pH of the water remains stable.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Acetyl chloride is an irritant and a corrosive. Cutaneous exposure results in skin burns, while vapor exposure causes extreme irritation of the eyes and mucous membranes. Inhalation of 2 ppm acetyl chloride has been found irritating to humans. Death or permanent injury may result after short exposures to small quantities of acetyl chloride. An aquatic toxicity rating has been estimated to range from 10 to 100 ppm.

Short-Term Exposure: This chemical can be absorbed through the skin, thereby increasing exposure. Skin and eye contact can cause severe irritation and possible permanent damage including blindness. Inhalation and swallowing are very toxic Exposure can irritate the nose, throat, air passages, and lungs with coughing and/or shortness of breath. Higher exposures may cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: Repeated respiratory exposure can cause bronchitis to develop with cough, phlegm, and/or shortness of breath. Repeated skin exposure can cause chronic skin irritation.

Points of Attack: Skin, lungs.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, lung function tests are recommended. If symptoms develop or overexposure is suspected, consider chest X-ray.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once, and irrigate immediately for at least 30 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Do not induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed.

Personal Protective Methods: Wear corrosive-resistant gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures to Acetyl Chloride, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: (1) Color code—Red Stripe: Flammability hazard: Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. (2) White: Corrosive or contact hazard; store separately in a corrosion-resistant location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from moisture and sunlight. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN1717 Acetyl chloride, Hazard Class: 3; Labels: 3-Flammable liquid, 8-Corrosive material

Spill Handling: Acetyl chloride, when spilled in water.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (from a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.2/0.3

Large spills (from a large package or from many small packages)

First: Isolate in all directions (ft/m) 300/60
Then: Protect persons downwind (mi/km)
Day 0.6/0.9
Night 1.8/2.8

Prevent liquid from reaching water if possible. This material creates large amounts of toxic hydrogen chloride (HCl) vapor when spilled in water and is considered by the North American Emergency Response Guide to be dangerous from 0.5 to 10 km (0.3−6.0 mi downwind). Enter area from upwind side. Evacuate area and issue warning of danger, including possible explosion. Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Absorb liquids using dry lime or soda ash. *Do not use water or wet method*. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid, but does not ignite readily. Thermal decomposition products may include hydrogen bromide, carbonyl bromide and bromine. ***IMPORTANT*:*Use dry chemical or carbon dioxide (CO_2) extinguishers only***. *Do not use water or foam extinguishers*. Vapors are heavier than air and will collect in low areas. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. May be mixed slowly with sodium bicarbonate solution and then flushed to sewer with large volumes of water. May also be incinerated.

References

(31); (173); (138); (100).

United States Environmental Protection Agency, acetyl Chloride, Health and Environmental Effects Profile No. 4, Washington, DC, Office of Solid Waste (April 30, 1980).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 1, No. 8, 30−32 (1981) and 3, No. 3, 35−36 (1983).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Acetyl Chloride, Trenton, NJ (September 1998).

Acetylene A:0310

Formula: C_2H_2; $HC\equiv CH$

Synonyms: Acetileno (Spanish); Acetylen; Acetylene, dissolved; Ethene; Ethine; Ethyne; Narcylen

CAS Registry Number: 74-86-2

HSDB Number: 166

RTECS Number: AO9600000

UN/NA & ERG Number: UN1001/116

EC Number: 200-816-9 [*Annex I Index No*.: 601-015-00-0]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Hazard Alert: Extremely flammable, Highly Reactive Substance, Explosive, Electrostatic hazard, Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated.

Clean Air Act 42USC7412; Title I, Part A, §112 Hazardous Pollutants, accidental Release Prevention/Flammable Substances (Section 68.130) TQ = 10,000 lb (4540 kg)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): D001

Hazard symbols, risk, & safety statements: Hazard symbol: F+; Risk phrases: R5; R6; R12; R21; R44; Safety phrases: S1/2; S9; S16; S33; S38 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): Nonhazardous to water

Description: Acetylene is an extremely flammable, colorless, compressed gas. It has a faint ethereal odor when pure; a garlic-like odor when contaminated. Molecular weight = 26.04[9]; specific gravity (H_2O:1) = 0.613 @ −80°C (liquid)[9]; boiling point @ 1 atm = 84.0°C (sublimes)[9]; melting/freezing point = −81°C (sublimes)[9]; critical temperature = 35.2°C[9]; critical pressure = 890.7 psia = 60.59 atm = 6.138 MN/m^2[136]; relative vapor density (air = 1) = 0.907[9]; ratio of specific heats of vapor (gas) = 1.235[9]; heat of combustion = −20,747 Btu/lb = −11,526 cal/g = −482.57 × 10^5 J/kg[9]; vapor pressure = 44.2 atm[77]; 33,592 mmHg @ 25°C; autoignition temperature: 305°C; adiabatic flame temperature: 1597°C (estimate)[9]; minimum ignition energy = 0.017 mJ[du]; stoichiometric air-to-fuel ratio: 13.18 (estimate); explosive limits: LEL: 2.5%, 25,000 ppm; UEL: 82%. Hazard identification (based on NFPA-704 M Rating System): Health 1; flammability 4; reactivity (gas) 3; (dissolved in acetone) 2. Low solubility in water = 1.65 g/100 mL @ 20°C.

Potential Exposure: Acetylene can be burned in air or oxygen and is used for brazing, welding, cutting, metallizing, hardening, flame scarfing; and local heating in metallurgy. The flame is also used in the glass industry. Chemically, acetylene is used in the manufacture of vinyl chloride, acrylinitrile, synthetic rubber; vinyl acetate; trichloroethylene, acrylate, butyrolactone, 1,4-butanediol, vinyl alkyl ethers, pyrrolidone, and other substances.

Incompatibilities: The substance may polymerize due to heating. The substance decomposes on heating and increasing pressure, causing a fire and explosion hazard. The substance is a strong reducing agent and reacts violently with oxidants and with fluorine or chlorine under influence of light, causing fire and explosion hazard. Reacts with copper, silver, and mercury or their salts, forming shock-sensitive compounds (acetylides). The content of lines carrying acetylene must not exceed 63% copper. May form explosive mixture with air. Forms shock-sensitive mixture with copper and copper salts; mercury and mercury salts; and silver and silver salts. Reacts with brass, bromine, cesium hydride, chlorine, cobalt, cuprous acetylize; fluorine, iodine, mercuric nitrate; nitric acid, potassium, rubidium hydride; trifluoromethyl hypofluorite; and sodium hydride.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 1.06 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: none established.

NIOSH REL: 2500 ppm/2662 milligram per cubic meter Ceiling Concentration.

ACGIH TLV[1]: simple asphyxiant with no TLV value.

PAC Ver. 29[138]

PAC-1:65,000 ppm*

PAC-2: 230,000 (2.30E + 05) ppm*

PAC-3: 400,000 (4.00E + 05) ppm*

* All PAC values are higher than the LEL (lower explosive limit)

Arab Republic of Egypt: TWA 1 ppm (14 milligram per cubic meter), 1993; Australia: asphyxiant, 1993; Belgium: asphyxiant, 1993; Hungary: asphyxiant, 1993; Switzerland: MAK-W 1000 ppm (1080 milligram per cubic meter), 1999; United Kingdom: asphyxiant, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV

Determination in Air: see NIOSH Acetylene Criteria Document.

Permissible Concentration in Water: No criteria set but EPA[32] suggests an ambient water limit of 73,000 μg/L based on health effects.

Routes of Entry: Inhalation, ingestion, eye, and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Rapid evaporation of the liquid may cause frostbite. Initial signs and symptoms of exposure to harmful concentrations of impure acetylene are rapid respiration, air hunger, followed by impaired mental alertness and muscular uncoordination. Other manifestations include cyanosis, weak and irregular pulse, nausea; vomiting, prostration, impairment of judgment and sensation; loss of consciousness; convulsions, and death. Low-order sensitization of myocardium to epinephrine resulting in ventricular fibrillation may be possible. At high concentrations pure acetylene may act as a mild narcotic and asphyxiant. Most accounted cases of illness or death can be attributed to acetylene containing impurities of arsine, hydrogen sulfide; phosphine, carbon disulfide; or carbon monoxide.

Long-Term Exposure: The substance may cause effects on the nervous system.

Points of Attack: CNS; respiratory system.

Medical Surveillance: Watch for complications due to impurities, such as arsine, hydrogen sulfide, phosphine, carbon disulfide; or carbon monoxide.

First Aid: Move victim to fresh air. Call emergency medical care. Apply artificial respiration if victim is not breathing. If breathing is difficult, give oxygen. Remove and isolate contaminated clothing and shoes. In the case of contact with liquefied gas, thaw frosted parts with lukewarm water. Keep victim warm and quiet. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. See also NIOSH criteria document cited below. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Acetylene poisoning can quite easily be prevented if (1) there is adequate ventilation and (2) impurities are removed when acetylene is used in poorly ventilated areas. General industrial hygiene practices for welding, brazing, and other metallurgical processes should also be observed.

Respirator Selection: See NIOSH criteria document for Acetylene, cited below. In an emergency use NIOSH/MSHA or European Standard EN 149-approved SCBA.

Storage: Check oxygen content prior to entering storage area. Flammable gas. Color code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials. Oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. After use for welding, turn valve off, regularly check tubing, etc. and test for leaks with soap and water. Acetylene in process may be stored in atmospheric gas holders. May be stored in conventional compressed gas cylinders. Content of lines carrying acetylene must not exceed 63% copper (Cu). Storage of liquid acetylene should be avoided. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: UN1001 Acetylene, dissolved, Hazard Class: 2.1; Labels: 2.1-Flammable gas. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit and to disperse the gas. Stop the flow of gas. If source of leak is a cylinder and the leak cannot be stopped in place, remove leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. Keep this chemical out of confined space, such as a sewer because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: If possible, stop flow of gas. Vapors in confined areas may explode when exposed to fire. Gases may travel long distances to ignition sources and flash back. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Do not extinguish the fire unless the flow of the gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Use dry chemicals, carbon dioxide. From a secure explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors or shows any signs of deforming), withdraw immediately to a secure position.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration.

References

(31); (173); (138); (100).

National institute for Occupational Safety and Health (NIOSH), "Criteria for a Recommended Standard: Occupational Exposure to Acetylene," NIOSH Document Number 76-195, Cincinnati OH (1976).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 1, No. 2, 23−25 (1980).

New York State Department of Health, Bureau of Toxic Substance Assessment "*Chemical Fact Sheet*: *Acetylene*." Bureau of Toxic Substance Assessment, Albany NY (March 1986).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: *Acetylene*, Trenton, NJ (December 1999).

Acetylene Tetrabromide A:0320

Formula: C_2H_2Br4; $CHBr_2CHBr_2$

Synonyms: Ethane, 1,1,2,2-tetrabromo-; Muthmanns liquid; TBE; 1,1,2,2-Tetrabromaethan (German); Tetrabromo-acetylene; *sym*-Tetrabromoethane; 1,1,2,2-Tetrabromoethane; 1,1,2,2-Tetrabromoethane, *sym*-; Tetrabromuro de acetileno (Spanish)

CAS Registry Number: 79-27-6

HSDB Number: 1600

RTECS Number: K18225000

UN/NA & ERG Number: UN2504/159

EC Number: 201-191-5 [*Annex I Index No*.: 602-016-00-9]

Regulatory Authority and Advisory Information

United States Environmental Protection Agency Gene-Tox Program, Positive: *E. coli polA* without S9.

Hazard Alert: Poison, Possible risk of forming tumors, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction), Neurotoxin, Environmental hazard.

Canada, WHMIS, Ingredient Disclosure List Concentration Reporting Level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Hazardous to aquatic life or environment, with possible long-lasting effects[194]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N, Xi; Risk phrases: R26; R36/37/38; R52/53; R62; Safety phrases: S1/2; S27; S41; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Acetylene tetrabromide is a combustible, colorless to yellow liquid. Strong odor. Molecular weight = 345.7; specific gravity (H_2O:1) = 2.96; boiling point = 245.5°C (decomposes); freezing/melting point = −1°C; vapor pressure = 0.02 mmHg @ 20°C; relative vapor density (air = 1) = 11.9; autoignition temperature = 335°C. Explosive limits: LEL: 23,000 ppm[138]; UEL: unknown; hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 0; reactivity 1. Very slightly soluble in water; solubility = 0.07%.

Potential Exposure: Acetylene tetrabromide is used as a solvent; a gauge fluid, and as a refractive index liquid in microscopy.

Incompatibilities: Chemically active metals (sodium, potassium, magnesium, and zinc), strong caustics; hot iron. Contact with strong oxidizers may cause fire and explosions.

Permissible Exposure Limits in Air

NIOSH IDLH = 8 ppm

OSHA PEL: 1 ppm/14 milligram per cubic meter TWA

NIOSH REL: After reviewing available published literature, NIOSH provided comments to OSHA on August 1, 1988, regarding the "Proposed Rule on Air Contaminants" (29 CFR 1910, Docket No. H-020). In these comments, NIOSH questioned whether the PELs proposed for this chemical were adequate to protect workers from recognized health hazards.

ACGIH TLV[1]: 0.1 ppm/1.4 milligram per cubic meter, inhalable fraction and vapors TWA

PAC Ver. 29[138]

PAC-1: 0.3 ppm

PAC-2: 4.3 ppm

PAC-3: 10 ppm

DFG MAK: No numerical value established. Data may be available.

Australia: TWA 1 ppm (15 milligram per cubic meter), 1993; Austria: MAK 1 ppm (14 milligram per cubic meter), 1999; Belgium: TWA 1 ppm (14 milligram per cubic meter), 1993; Denmark: TWA 1 ppm (14 milligram per cubic meter), 1999; Finland: TWA 1 ppm (14 milligram per cubic meter); STEL 3 ppm (42 milligram per cubic meter), 1999; France: VME 1 ppm (15 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 7 milligram per cubic meter [skin] 2003; the Philippines: TWA 1 ppm (14 milligram per cubic meter), 1993; Sweden: TWA 1 ppm (14 milligram per cubic meter); STEL 2 ppm (30 milligram per cubic meter), 1999; Turkey: TWA 1 ppm (14 milligram per cubic meter), 1993; United Kingdom: 0.5 ppm (7.2 milligram per cubic meter) [skin] 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 1 ppm.

Determination in Air: Silica absorption followed by THF treatment and gas chromatographic analysis. See NIOSH Analytical Method, 1994: 1,1,2,2-Tetrabromoethane, #2003.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates eyes, skin, and respiratory tract. Can cause headaches, fatigue, dizziness, lightheadedness, and unconsciousness. High concentrations can cause death. Prolonged skin contact can cause burns.

Long-Term Exposure: There is limited evidence that acetylene tetrabromide causes cancer; possibly stomach cancer. Repeated exposures can cause liver, kidney, and lung damage, and drying and cracking of the skin.

Points of Attack: Eyes, upper respiratory system; liver, kidneys, lungs, CNS.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Liver function tests; expired air[58].

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of salt water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear solvent-resistant gloves and clothing to prevent any reasonable probability of skin or eye contact. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 8 ppm*: Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry in unknown concentrations or IDLH conditions*: SCBAF:Pd, Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Acetylene tetrabromide begins to decompose @ 245°C producing flammable and highly toxic vapors of bromine and carbonyl bromide. Avoid contact with incompatible materials cited above. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2504 Tetrabromoethane, Hazard Class: 6.1; Labels: 6.1-Poisonous materials

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. Ventilate area of spill or leak after clean-up is complete. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Thermal decomposition products may include bromine and carbonyl bromide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration in admixture with combustible fuel and with scrubber to remove halo acids produced.

References

(31); (173); (101); (138); (202); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile *Draft Report*: *Tetrabromoethane*, Washington, DC (June 14, 1983).

Linch, A.L., *Biological Monitoring for Industrial Chemical Exposure Control*, CRC Press, Boca Raton, FL, 1974.

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Acetylene Tetrabromide, Trenton, NJ (January 2001).

Acetylsalicylic Acid A:0340

Formula: C_9H_8O4; $HOOCC_6H_4OCOCH_3$

Synonyms: Acenterine; Acesa; Acetaldehyde diethyl acetal; Acetal diethylique (French); Aceticyl; Acetol; Acetophen; Acetosal; Acetosalin; Acetylin; 2-(Acetyloxybenzoic) acid; Acetylsal; Acisal; Acylpyrin; Asagran; Aspirin; Aspro; Asteric; Benzoic acid, 2-(acetyloxy)-; Caprin; 1,1-Diaethoxy-aethan; Diaethylacetal (German); 1,1-Diethoxyethane; Diethyl acetal; Duramax; Ecotrin; Empirin; Ethylidene diethyl ether; Neuronika; Polopiryna; Rhodine; Salacetin; Salicylic acid, acetate; Xaxa

CAS Registry Number: 50-78-2; *(alt.)* 2349-94-2; *(alt.)* 11126-35-5; *(alt.)* 11126-37-7; *(alt.)* 26914-13-6; (alt.) 98201-60-6

HSDB Number: 652

RTECS Number: VO0700000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 200-064-1

Regulatory Authority and Advisory Information

California Proposition 65 Chemical[102]: developmental, female (*Note*: It is especially important not to use aspirin during the last three months of pregnancy, unless specifically directed to do so by a physician because it may cause problems in the unborn child or complications during delivery) developmental, female. (Aspirin: CAS: 50-78-2) 7/1/1990.

United States Environmental Protection Agency Gene-Tox Program, Negative: Sperm morphology-mouse; Inconclusive: Mammalian micronucleus

Hazard alert: poison, neurotoxin. Possible risk of forming tumors, suspected of causing genetic defects, suspected reprotoxic hazard.

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xn; Risk phrases: R22; R25; R36/37/38; R62; R63; Safety phrases: S24; S26; S27; S36/37/39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Acetylsalicylic acid is a white crystalline solid with a slightly bitter taste. It is odorless but hydrolyzes in moist air to give an acetic acid odor. Molecular weight = 180.15; boiling point = decomposes @ $<140°C$; freezing/melting point = 135°C [A1]; density = 1.4 g/cm^3; vapor pressure = 0 mmHg @ 20°C. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 0; reactivity 0. Poor solubility in water = 0.3% @ 15°C.

Potential Exposure: Used as an over-the counter and proprietary pharmaceutical and veterinary drug. Those engaged in manufacture of aspirin or, more likely, in its consumption in widespread use as an analgesic, antipyretic, and antiinflammatory agent.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, carbonates, moisture. Dust dispersed in air is explosive.

Permissible Exposure Limits in Air

OSHA PEL: None

NIOSH REL: 5 ppm TWA

ACGIH TLV[1]: 5 ppm TWA

Australia: TWA 5 milligram per cubic meter, 1993; Austria: MAK 5 milligram per cubic meter, 1999; Belgium: TWA 5 milligram per cubic meter, 1993; Denmark: TWA 5 milligram per cubic meter, 1999; Norway: TWA 5 milligram per cubic meter, 1999; Russia: STEL 0.5 milligram per cubic meter, 1993; Switzerland: MAK-W 5 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 5 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 5 milligram per cubic meter Some states have set guidelines or standards for aspirin in ambient air[60] ranging from 80 μ/m^3 (Virginia) to 100 μ/m^3 (Connecticut) to 119 μ/m^3 (Nevada).

Determination in Air: Filter; none; Gravimetric; NIOSH Analytical Method (IV) #0500, Particulates NOR, total dust.

Determination in Water: Octanol−water coefficient: $\text{Log}\,K_{ow} \leq 1.3$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Primarily oral in medicinal use.

Harmful Effects and Symptoms

Short-Term Exposure: Eye and skin contact can cause irritation. Burns to the eyes and scarring can occur. High exposures may cause headache, dizziness, depression, and irritability. This chemical can be absorbed through the skin, thereby increasing exposure. Adverse effects from the usual doses of aspirin are infrequent, most common are GI disturbances. Prolonged administration of large doses results in occult bleeding and may result in anemia. LD_{50} = (oral-rat) 200 mg/kg.

Long-Term Exposure: Repeated exposures may cause headache, dizziness, depression, and irritability; allergy may develop causing hives. Animal tests show that this substance possibly causes toxic effects upon human reproduction; possible teratogen. This chemical can decrease the clotting ability of blood.

Points of Attack: *Cancer site*: Eyes, skin, respiratory system' blood, liver, kidneys.

Medical Surveillance: Pregnant women should avoid contact. Employees should be notified by a physician that this chemical may affect the reproductive system. In addition to comprehensive initial medical and work histories emphasizing reproductive experience and menstrual history, patient should have physical examination and testing of genitourinary tract, sperm count, motility, and morphology. If required, other tests, such as serum testosterone, serum follicle stimulating hormone (FSH), and serum lutenizing hormone (LH) may be indicated. Tests of blood clotting ability. People taking anticoagulants may be at increased risk. Skin testing with dilute Acetylsalicylic acid may help diagnose allergy, if done by a qualified allergist. If allergy is confirmed, all future exposure to this chemical should be avoided, since even small exposure can cause an allergic reaction. It is possible for severe allergic reaction to occur.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In the case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Specific respirator(s) have not been recommended by NIOSH; however, where the potential exists for exposure, the following might be considered: P2 filter respirator for harmful particles meeting NIOSH classified N95. The use of N95 respirators is restricted to use in atmospheres free of oil aerosols. In Europe, similar respirators may contain the prefix “FF” (for filtering facepiece), and may be classified as FFP2.

Storage: Color code—Blue: Health Hazard/Poison (Toxic): Store in a secure, locked, and cool, ventilated area. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from all forms of moisture.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft.(NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Sweep spilled substance into containers; if appropriate, moisten first to prevent dusting. Carefully collect remainder, then remove to safe place (extra personal protection: P2 filter respirator for harmful particles). Use a vacuum or wet method to reduce dust during clean-up. *Do not dry sweep*. The spilled material may be dampened with 60%−70% ethanol to avoid airborne dust and the material then scooped up for disposal. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Acetylsalicylic acid itself may burn but does not readily ignite. Dust of this chemical dispersed in air is explosive. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include oxides of carbon. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: May be flushed to sewer with large volumes of water.

References

(102); (31); (101); (173); (203); (100).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 1, No. 3, 20−22 (1981) (as Acetol).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Acetylsalicylic Acid, Trenton, NJ (June 1998).

1-Acetyl-2-Thiourea A:0350

Formula: $C_3H_6N_2OS$; $CH_3CONHCSNH_2$

Synonyms: Acetamide, *N*-(aminothioxomethyl)-; Acetyl thiourea

CAS Registry Number: 591-08-2

HSDB Number: 6034

RTECS Number: YR7700000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154; UN2588 (pesticides, solid, toxic, n.o.s.)/155

EC Number: 209-699-9

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Highly toxic, Corrosive.

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P002, as Acetamide, *N*-(aminothioxomethyl)-

RCRA Land Ban Waste Restrictions

Superfund/EPCRA 40CFR302.4, Appendix A, RQ: 1000 lb (454 kg)

Hazard symbols, risk, & safety statements: Hazard symbol: T; risk phrases: R23/24/25; safety phrases: S23; S24/25; S36/37/39; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to waters

Description: 1-Acetyl-2-thiourea is a white crystalline solid; forming needles. Molecular weight = 118.16; freezing/melting point = 165−168°C; flash point = 80°C. Slightly soluble in water.

Potential Exposure: Studied as possible rodenticide; used in organic synthesis.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Routes of Entry: Ingestion.

Harmful Effects and Symptoms

An LD_{50} value (oral-rat) has been reported as 50 mg/kg and is the apparent basis for EPA classification as hazardous substance[4] and hazardous waste[5]. Acts as poison in humans by ingestion and intraperitoneal routes.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In the case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection*:*Where potential for exposure exists: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air-purifying, full facepiece respirator with an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from moisture.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation distance, spill: 25 m/75 ft.(NJ). Isolation distance, fire: 800 m/0.5 mi[70]. Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include oxides of nitrogen and sulfur. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

Acifluorfen A:0360

Formula: $C_{14}H_7ClF_3NO_5$; $F_3C\text{-}C_6H3(Cl)\text{-}O\text{-}C_6H_3(NO_2)(COOH)$

Synonyms: Acifluorfen; Acifluorfene; Benzoic acid, 5-[2-chloro-4-(trifluoromethyl)phenoxy]-2-nitro-; Blazer; Carbofluorfen; 5-[2-Chloro-4-(trifluoromethyl)phenoxy]-2-nitrobenzoic acid; 5-(2-chloro-α,α,α-trifluoro-*p*-tolyloxy)-2-nitrobenzoic acid; Tackle

CAS Registry Number: 50594-66-6; 62476-59-9 (sodium salt, the parent chemical)

HSDB Number: 6551

RTECS Number: DG5643200

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 256-634-5 [*Annex I Index No.*: 604-041-00-0]

Regulatory Authority and Advisory Information

Carcinogenicity: Possible human; animal positive (EPA), possibly carcinogenic to humans, Group 2B, as sodium salt

Clean Water Act: CFR 455, Table 1

California Proposition 65 Chemical[102]: Cancer 1/1/1990 (CAS: 62476-59-9)

Hazard Alert: Poison, Environmental hazard.

SARA 313: Form R *de minimis* Concentration Reporting Level: 1.0% (sodium salt)

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

European/International Regulations (*includes sodium*): Hazard symbol: Xn, N; Risk phrases: R45; R22; R38; R41; R50/53; safety phrases: S2; S24; S29; S39; S41; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [2-Hazard to waters (est.)].

Description: A diphenyl ether, is a combustible, off-white, light tan or brown solid. Molecular weight = 361.65; freezing/melting point = 152−157°C;[23] 124−126°C (sodium salt). Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 0; reactivity 0. The sodium salt is soluble in water.

Potential Exposure: A potential danger to those involved in the manufacture, formulation and application of this selective preemergence and postemergence herbicide used to control weeds and grass in soybean and peanut crops.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Avoid contact with all sources of ignition.

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Permissible Concentration in Water: Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment. A no-adverse-effect level (NOAEL) has been determined to be 20 mg/kg. Body weight/day based on fetotoxicity. However, a NOAEL of 5.6 was determined on the basis of increase in liver size of male rats; further a NOAEL of 1.25 mg/kg/day was determined in a 2-generation rat reproduction study. On this last basis, a long-term health advisory for acifluorfen has been set at 0.44 mg/L for a 70-kg adult. A lifetime health advisory: for that same adult of 0.009 mg/L. The EPA has also determined a reference dose (acceptable daily intake) of 0.013 mg/kg/day. *Fluoride ion*: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guidelines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg[F]/L. SafeDrinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg [F]/L; SMCL = 2 mg/F/L, as Fluoride.

Determination in Water: Analysis of acifluorfen is by a gas chromatographic (GC) method applicable to the determination of certain chlorinated acid pesticides in water samples. In this method, approximately 1 L of sample is acidified. The compounds are extracted with ethyl ether using a separatory funnel. The derivatives are hydrolyzed with potassium hydroxide, and extraneous organic material is removed by a solvent wash. After acidification, the acids are extracted and converted to their methyl esters using diazomethane as the derivatizing agent. Excess reagent is removed, and the esters are determined by electron capture GC. The method detection limit has not been determined for this compound, but it is estimated that the detection limits for analytes included in this method are in the range of 0.5−2 μg/L. Fish Tox: 1499.99565000 ppb MATC (VERY LOW).

Routes of Entry: Ingestion, inhalation.

Harmful Effects and Symptoms

Short-Term Exposure: Acifluorfen is a moderate dermal irritant. LD_{50} (oral, male rat) = 2025 mg/kg; (oral, female rats) = 1370 mg/kg.

Long-Term Exposure: A known carcinogen. Similar chlorinated diphenyl ethers have caused liver damage in laboratory animals. Human Tox = 3.27103 ppb CHCL (Chronic Human Carcinogen Level) (HIGH)

Points of Attack: Skin and liver.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/ manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: At any detectable concentration: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air-purifying, full facepiece respirator with an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2588 Pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after clean-up is complete. Do not flush spilled material into sewer. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Reverse osmosis (RO) is a promising treatment method for pesticide-contaminated water. As a general rule, organic compounds with molecular weights greater than 100 are candidates for removal by RO, which yields 99% removal efficiency of chlorinated pesticides by a thin-film composite polyamide membrane operating at a maximum pressure of 1000 psi and at a maximum temperature of 45°C. More operational data are required, however, to specifically determine the effectiveness and feasibility of applying RO for the removal of acifluorfen from water. Also, membrane adsorption must be considered when evaluating RO performance in the treatment of acifluorfen-contaminated drinking water supplies. Soil Adsorption Index (K_{oc}) = 113 (Estimate).

Fire Extinguishing: This chemical is a combustible solid but does not easily ignite. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. Thermal decomposition products may include nitrogen oxides; carbon monoxide, chlorides, and fluorides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers.

References

(102); (31); (122); (100).

United States Environmental Protection Agency, Office of Drinking Water, *Health advisory*: Acifluorfen, Washington DC (August 1987).

Acridine A:0370

Formula: $C_{13}H_9N$

Synonyms: 10-Azaanthracene; 9-Azaanthracene; 2,3-Benzoquinoline; Benzo(*b*)quinoline; Dibenzo(*b*,*e*)pyridine; Dibenzopyridine

CAS Registry Number: 260-94-6

HSDB Number: 634

RTECS Number: AR7175000

UN/NA & ERG Number: UN2713/153

EC Number: 205-971-6

Regulatory Authority and Advisory Information

Carcinogenicity: Coal-tar and similar materials may contain dibenzo(*b*,*e*)pyridine, a carcinogen. (See also Coal Tar Pitch Volatiles.) Acridine has not been identified as a carcinogen. Handle with caution as several related polynuclear aromatic hydrocarbons (PAHs) are known carcinogens. NIOSH has recommended that coal tar pitch volatiles, including PAHs be treated as potential human carcinogen.

California Proposition 65 Chemical[102]: (*Coke oven emissions*) Cancer 2/27/1987

Hazard Alert: Poison, Combustible, Suspected of causing genetic defects, Environmental hazard.

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; Section 307(a)(1) Toxic pollutant designated, pursuant to of the and is subject to effluent limitations as PAHs

United States National Primary Drinking Water Regulations: MCLG = 0 mg/L; MCL = 0.0002 mg/L as PAHs.

OSHA, 29CFR1910 Specifically Regulated Chemicals (see CFR1910.1002) as coal tar pitch volatiles

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1% as coal tar pitch volatiles

Hazardous to aquatic life or environment, with possible long-lasting effects[194]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: Xi, Xn; Risk phrases: R22; R36/37/38; R62; Safety phrases: S22; S24/25; S36; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)]

Description: Acridine is crystalline solid made up of small, colorless or light yellow orthorhombic plates or needles. Molecular weight 179.22; density = 1.005 @ 20°C; boiling point = 346°C @ 760 mmHg; freezing/melting point = 108−110.5°C (sublimes @ 100°C); vapor pressure = 1 mmHg; heat of combustion = −15,800 Btu/lb = −8790 cal/g = −368 × 105 J/kg. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 2; reactivity 0.

Solubility in water = 38 mg/L; highly soluble in boiling water.

Potential Exposure: Acridine and its derivatives are widely used in the production of dyestuffs, such as acriflavine, benzoflavine, and chrysaniline; and in the synthesis of pharmaceuticals; such as aurinacrine, proflavine, and rivanol. A constituent of coal tar, coal tar creosote; found in wastes from gas and tar plants and coke oven emissions.

Incompatibilities: Strong acids, strong oxidizers.

Permissible Exposure Limits in Air

NIOSH IDLH = 80 milligram per cubic meter as benzene soluble aerosol or coal tar pitch volatiles

No PAC available.

OSHA PEL: 0.2 milligram per cubic meter TWA [1910.1002] (benzene-soluble fraction). OSHA defines "coal tar pitch volatiles" in 29 CFR 1910.1002 as the fused polycyclic hydrocarbons that volatilize from the distillation residues of coal, petroleum (excluding asphalt), wood, and other organic matter.

NIOSH REL: 0.1 milligram per cubic meter (cyclohexane-extractable fraction). NIOSH considers coal tar products (i.e., coal tar, coal tar pitch, or creosote) to be potential occupational carcinogens

ACGIH TLV[1]: 0.2 milligram per cubic meter TWA (as benzene soluble aerosol); Confirmed Human Carcinogen

DFG MAK: Category 1, human carcinogen

EPA[32] suggests an ambient air limit of 162 μ/m^3 based on health effects.

Determination in Air: By fluorometry; NIOSH Analytical Method 5800, PACs

Permissible Concentration in Water: For the maximum protection of human health from the potential carcinogenic effects due to exposure of polynuclear aromatic hydrocarbons through ingestion of contaminated water and contaminated aquatic organisms; therefore, the levels that may result in incremental increase of cancer risk over the lifetime are estimated at 1×10^{-5}, 1×10^{-6}, and 1×10^{-7}. The corresponding criteria are 28.0, 2.8, and 0.28 ng/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 311.0, 31.1, and 3.11 ng/L, respectively.

Determination in Water: Harmful to aquatic life in small quantities. Octanol−water coefficient: Log $K_{ow} = \sim 3.5$. Values above 3.0 are likely to bioaccumulate in aquatic organisms.

Routes of Entry: Inhalation, ingestion, eye, and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Acridine is a severe irritant to the conjunctiva of the eyes, the mucous membranes of the respiratory tract, and the skin. It is a powerful photosensitizer of the skin. Acridine causes sneezing on inhalation. Poisonous by ingestion and subcutaneous routes. Toxicity by ingestion = Grade 2; LD_{50} oral rat = 2000 mg/kg.

Long-Term Exposure: Yellowish discoloration of sclera and conjunctiva may occur. Mutational properties have been ascribed to acridine, but its effect on humans is not known. The DFG[3] states that PAHs are present at particularly high levels in coal tar oils and related pyrolysis products of organic materials and are carcinogenic (category 1) in animal studies.

Points of Attack: Eyes, skin, and respiratory tract.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Evaluate the skin, eyes, and respiratory tract in the course of any placement or periodic examinations. CBC, chest X-ray, pulmonary function tests, photopatch testing, sputum cytology, urinalysis (routine) [cytology, hematuria], liver, kidney, and bladder function tests recommended for coal tar pitch volatiles[2].

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If this chemical has been inhaled, remove from exposure and transfer promptly to a medical facility.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. A protective layer of petroleum jelly, lanolin or castor oil has been recommended in ILO literature. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *NIOSH* (as coal tar pitch volatiles): *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration*: SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health hazard/poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2713 Acridine, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Apply carbon or peat absorbants to dissolved material. Dredge up solid material for removal to disposal area. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use water spray; or foam extinguishers, CO_2 and dry chemicals may not be effective. Thermal decomposition products may include oxides of nitrogen and carbon. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration with nitrogen oxide removal from the effluent gas by scrubber, catalytic, or thermal device.

References

(102); (31); (173); (101); (18); (100).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 1, No, 8, 32−33 (1981) and 8, No. 5, 49−55 (1988).

Eller PM, Cassinelli ME, eds. "*NIOSH Manual of Analytical Methods* (NMAM®), 4th ed., 2nd Supplement." National Institute for Occupational Safety and Health, DHHS (NIOSH), Publication No. 98-119, Cincinnati, OH (1998).

Acrolein A:0380

Formula: C_3H_4O; CH_2CHCHO

Synonyms: Acquinite; Acrehyde; Acroleine (French); Acrylaldehyde; Acrylehyd (German); Acrylehyde; Acrylic aldehyde; Aldehyde acrylique (French); Allylaldehyde; Aqualin; Aqualine; Biocide; Ethylene aldehyde; 2-Propenal; Prop-2-en-1-al; Propenal; 2-Propen-1-one; Propylene aldehyde; Slimicide

CAS Registry Number: 107-02-8; *(alt.)* 25314-61-8; 100-73-2 (dimer)

HSDB Number: 177

RTECS Number: AS1050000

UN/NA & ERG Number: UN1092 (stabilized)/131P; UN2607 (dimer, inhibited)/129 (P)

EC Number: 203-453-4 [*Annex I Index No.*:605-008-00-3]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 5000 (≥1.00% concentration).

Carcinogenicity: IARC: Animal Inadequate Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1995.

Hazard Alert: Poison inhalation hazard (extremely toxic), Highly flammable liquid, Polymerization hazard, Water reactive, Agricultural chemical, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction), Environmental hazard. Listed for Tier 1 screening as an endocrine disruptor[88].

OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 150 lb

Clean Air Act 42USC7412; Title I, Part A, §112 Hazardous Pollutants; Part A, §112(r), accidental Release Prevention/Flammable Substances (Section 68.130) TQ = 5000 lb (1275 kg)

Clean Water Act: 40CFR116.4 Hazardous Substances; RQ 40CFR117.3 (same as CERCLA); 40CFR423, Appendix A Priority Pollutants; 40CFR401.15 Toxic Pollutant

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P003

RCRA 40CFR261, Appendix 8; 40CFR261.11 Hazardous Constituents

RCRA Land Ban Waste.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.29; Nonwastewater, N/A.

RCRA 40CFR264, Appendix 9; Ground Water Monitoring List Suggested methods (PQL μg/L): 8030 (5); 8240 (5)

CERCLA/SARA Section 302, Extremely Hazardous Substances: TPQ = 500 lb (228 kg).

Superfund/EPCRA 40CFR302.4, Appendix A, RQ: 1 lb (0.454 kg), SARA 313: Form R *de minimis* Concentration Reporting Level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Mexico: Drinking Water 0.3 mg/L (ecological criteria); listed as an organic toxic pollutant in wastewater

Hazardous to aquatic life or environment, with possible long-lasting effects[194]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: F, T+, N, Xi; risk phrases: R11; R19; R24/25; R26; R34; R36/37/38; R50; R62; R63; safety phrases: S1; S3/9/14; S21; S23; S26; S28; S36/37/39; S38; S41; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Acrolein is a highly flammable, clear to yellowish liquid. It has a piercing, disagreeable odor and causes tears. Molecular weight = 56.06; specific gravity (H_2O:1) = 0.843 @ 20°C (liquid)[9]; boiling point @ 1 atm = 53°C[9]; melting/freezing point = −88°C[9]; critical temperature = (estimate) 254°C[9]; critical pressure = (estimate) 737 psia = 50.0 atm[9]; Liquid surface tension = 24 dyn/cm = 0.024 N/m @ 20°C[9]; liquid water interfacial tension = (estimate) 35 dyn/cm = 0.035 N/m @ 20°C; relative vapor density (air = 1) = 1.94[9]; ratio of specific heats of vapor (gas) = 1.1487[9]; latent heat of vaporization = 216 Btu/lb = 120 cal/g[9]; heat of combustion = −12,500 Btu/lb = −6,950 cal/g[9]; heat of polymerization = (estimate) −50 Btu/lb = −28 cal/g = −1.2 × 105 J/kg[9]; vapor pressure = 210 mmHg @ 20°C[9]; 274 mmHg @ 25°C; flash point = −26°C (cc); autoignition temperature (unstable) = 220°C. Hazard identification (based on NFPA-704 M Rating System): Health 4; flammability 3; reactivity 3; *(dimer)*: Health 1; flammability 2; reactivity 1₩. Explosive limits: LEL: 2.8%, UEL: 31.0%. Soluble in water; 20 g/100 mL @ 20°C.

Potential Exposure: Used as pharmaceutical; slimicide; and in production of cosmetics and food supplements; as an intermediate in the production of glycerine and in the production of methionine analogs (poultry feed protein supplements). It is also used in chemical synthesis (1,3,6-hexametriol and glutaraldehyde); as a liquid fuel; antimicrobial agent, in algae and aquatic weed control; and as a slimicide in paper manufacture; making plastics, drugs, and tear gas. Also, most allyl compounds may be metabolized to allyl alcohol which is metabolized to acrolein.

Incompatibilities: May form explosive mixture with air. Elevated temperatures or sunlight may cause explosive polymerization. A strong reducing agent; reacts violently with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Polymerizes exothermically on contact with small amounts of acids (including sulfur dioxide), alkalis, volatile amines and pyridines, salts, thiourea, oxidizing agents (air) and on exposure to light, and heat. Polymerization initiated by amines and pyridines occurs after a deceptive induction period. Water solutions of mineral acids and metal ions can initiate polymerization. The inhibitor (usually hydroquinone) greatly reduces tendency to polymerize[101]. Reacts with acids, alkalis, ammonia, amines, oxygen, peroxides. Shock-sensitive peroxides or acids may be formed over time. Attacks zinc and cadmium.

Permissible Exposure Limits in Air

NIOSH IDLH = 2 ppm

Conversion factor: 1 ppm = 2.33 milligram per cubic meter [A1]@ 25°C & 1 atm

Odor threshold = 0.174 ppm.

OSHA PEL: 0.1 ppm/0.25 milligram per cubic meter TWA

NIOSH REL: 0.1 ppm/0.25 milligram per cubic meter TWA; 0.3 ppm/ 0.8 milligram per cubic meter STEL

ACGIH TLV[1]: 0.1 ppm/0.23 milligram per cubic meter Ceiling concentration [skin]; not classifiable as a human carcinogen

PAC* Ver. 29[138]

PAC-1: **0.030**$_{\mathbf{A}}$ ppm

PAC-2: **0.10**$_{\mathbf{A}}$ ppm

PAC-3: **1.4**$_{\mathbf{A}}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

DFG MAK: Carcinogen Category 3B

Arab Republic of Egypt: TWA 0.1 ppm (0.25 milligram per cubic meter), 1993; Australia: TWA 0.1 ppm (0.25 milligram per cubic meter); STEL 0.3 ppm, 1993; Austria: MAK 0.1 ppm (0.25 milligram per cubic meter), 1999; Belgium: TWA 0.1 ppm (0.23 milligram per cubic meter); STEL 0.3 ppm, 1993; Finland: STEL 0.1 ppm (0.25 milligram per cubic meter) [skin] 1993; France: VLE 0.1 ppm (0.25 milligram per cubic meter), 1999; Hungary: TWA 0.25 milligram per cubic meter; STEL 0.5 milligram per cubic meter, 1993; the Netherlands: MAC-TGG 0.05 milligram per cubic meter, 2003; Japan; 0.1 ppm (0.23 milligram per cubic meter), 1999; Norway: TWA 0.1 ppm (0.25 milligram per cubic meter), 1999; the Philippines: TWA 0.1 ppm (0.25 milligram per cubic meter), 1993; Poland: MAC (TWA) 0.2 milligram per cubic meter, MAC (STEL) 0.5 milligram per cubic meter, 1999; Russia: TWA 0.1 ppm; STEL 0.2 milligram per cubic meter, 1993; Sweden: NGV 0.1 ppm (0.2 milligram per cubic meter), KTV 0.3 ppm (0.7 milligram per cubic meter), 1999; Switzerland: MAK-W 0.1 ppm (0.25 milligram per cubic meter), KZG-W 0.2 ppm (0.5 milligram per cubic meter), 1999; Turkey: TWA 0.1 ppm (0.25 milligram per cubic meter), 1993; United Kingdom: TWA 0.23 milligram per cubic meter; STEL 0.70 milligram per cubic meter, carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: ceiling 0.1 ppm [skin].

Determination in Air: Use NIOSH Analytical Method #2501, OSHA Analytical Method #52.

Permissible Concentration in Water: To protect freshwater aquatic life on an acute basis 68 μg/L and on a chronic basis 21 μg/L. *To protect saltwater aquatic life*: 55 μg/L on an acute toxicity basis. To protect human health-320 μg/L[6]. In addition, two states have set guidelines for acrolein in drinking water[61]. These are both 320 μg/L as set by Arizona and Kansas.

Determination in Water: GC (EPA Method #603) or GC and mass spectrometry (EPA Method #624).

Octanol–water coefficient: Log $K_{ow} = 0.88$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: LD_{50} = (oral-rat) 44 mg/kg. This chemical can be absorbed through the skin, thereby increasing exposure. Eye and skin contact may cause intense tearing, irritation, blisters, and burns. Inhalation can irritate the lungs, causing irritation, coughing, wheezing, and/or shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. If swallowed, produces acute abdominal pains. Extremely toxic; probable oral human lethal dose is 5–50 mg/kg, between sevendrops and one teaspoon for a 70-kg (150 lb) person. Inhalation of air containing 10 ppm of acrolein may be fatal in a few minutes. Death from cardiac failure accompanied by hyperemia and hemorrhage of the lungs and degeneration of the bronchial epithelium is possible. Acrolein causes acute respiratory and eye irritation; severe GI distress with slowly developing pulmonary edema (lung fill up with fluid), and skin irritation.

Long-Term Exposure: This chemical is a metabolite of cyclophosphamide, a well-recognized carcinogen and animal teratogen. Acrolein may cause mutations. Such chemicals have a cancer risk. Long-term exposure can cause drying and cracking of the skin. High or repeated lower exposure may cause permanent lung damage. Testing has not been completed to determine the carcinogenicity of acrolein. However, the limited studies to date indicate that these substances have chemical reactivity and mutagenicity similar to acetaldehyde and malonaldehyde. Therefore, NIOSH recommends that careful consideration should be given to reducing exposures to this aldehyde. Further information can be found in the *NIOSH Current Intelligence Bulletin 55*: *Carcinogenicity of Acetaldehyde and Malonaldehyde, and Mutagenicity of Related Low-Molecular-Weight Aldehydes* [DHHS (NIOSH), Publication No. 91-112].

Points of Attack: Heart, lungs, eyes, skin, respiratory system.

Medical Surveillance: Preplacement and periodic medical examinations should consider respiratory, skin, and eye disease. For those with frequent or potentially high exposure, lung function tests are recommended before beginning work and at regular times after that. Chest X-ray, expired air, pulmonary function tests[2].

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed.

Personal Protective Methods: Prevent skin contact. **8 hours** (more than 8 hours of resistance to breakthrough $>0.1\ \mu m > g/cm^2/min$): butyl rubber gloves, suits, boots; Barricade coated suits; Trychem 1000 suits. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: OSHA/NIOSH *2 ppm*: Sa:Cf * (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOv* (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge (s)]; or CcrFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SAF:Pd,Pp:ASCBA (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode. *Escape*: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

Note*: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: PIH; check oxygen content prior to entering storage area. (1) Color code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Oxidizers, including oxidizing gases, should have a boundary separation of 8–10 m or a 1-hour fire wall from flammable or reactive materials. (2) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. *Do not* store uninhibited acrolein under any circumstances. Protect against physical damage. Outside or detached storage is preferable. Inside storage should be in a standard flammable liquids storage room or cabinet. Before entering confined space where acrolein may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from heat and light. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Acrolein, stabilized, Hazard class: 6.1; Labels: 6.1-Poison Inhalation Hazard, 3-Flammable liquids. Inhalation Hazard Zone A.

Spill Handling:

Initial isolation and protective action distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (from a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 500/150
Then: Protect persons downwind (mi/km)
Day 0.9/1.5
Night 2.5/4.1

Large spills (from a large package or from many small packages)

First: Isolate in all directions (ft/m) 2500/800
Then: Protect persons downwind (mi/km)
Day 5.8/9.3
Night 7.0+/11.0+*

*+ means distance can be larger in certain atmospheric conditions.

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Take up very small spills for disposal by absorbing it in vermiculite, dry sand; or earth and disposing in a secured landfill or combustion chamber. Alternatively, cover with sodium bisulfite, add small amount of water and mix. Then, after 1 hour, flush with large amounts of water and wash site with soap solution. Liquid should not be allowed to enter confined space, such as a sewer, because of potential for explosion. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of carbon. This chemical is a flammable liquid and explosion hazard. Under fire conditions, polymerization may occur, blocking relief valves leading to tank explosion. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration. Conditions are 816°C, 0.5 second minimum for primary combustion; 1093°C, 1.0 second for secondary combustion.

References

(173); (101); (138); (202).

(31); (100).

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New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Acrolein, Trenton, NJ (December 2005).
United States Environmental Protection Agency, *Toxicological review of Acrolein, In Support of Summary Information on the Integrated Risk Information System (IRIS)* (EPA/635/R-03/003) Washington, DC, 2003.

Acrylamide A:0390

Formula: C_3H_5NO; $CH_2CHCONH_2$
Synonyms: Acrilamida (Spanish); Acrylamide monomer; Acrylic acid amide (50%); Acrylic amide; Acrylic amide 50%; Ethylenecarboxamide; Ethylene monoclinic tablets carboxamide; 2-Propenamide; Propenamide; Vinyl amide
CAS Registry Number: 79-06-1
HSDB Number: 191
RTECS Number: AS3325000
UN/NA & ERG Number: UN2074/153 (P)
EC Number: 201-173-7 [*Annex I Index No.*: 616-003-00-0]
Regulatory Authority and Advisory Information
Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Animal Sufficient Evidence; Human Inadequate Evidence, *probably carcinogenic to humans*, Group 2A, 1994; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies.
California Proposition 65 Chemical[102]: Cancer 1/1/1990
Hazard Alert: Poison, Polymerization hazard (nonstabilized), Sensitization hazard, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction). Listed for Tier 1 screening as an endocrine disruptor[88], Environmental hazard.
United States National Primary Drinking Water Regulations: zero
Clean Air Act 42USC7412; Title I, Part A, §112 Hazardous Pollutants
United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U007
RCRA 40CFR261, Appendix 8; 40CFR261.11 Hazardous Constituents
RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 19; Nonwastewater, 23
United States National Primary Drinking Water Regulations: MCLG = 0 mg/L; MCL = Each water system must certify annually, in writing, to the state (using third-party or manufacturers certification) that when it uses acrylamide to treat water, the combination of dose and monomer level does not exceed the levels specified, as follows: 0.05% dosed at 1 mg/L (or equivalent).
Safe Drinking Water Act, MCL, treatment technique; MCLG = 0 mg/L; Regulated Chemical (47FR9352)
CERCLA/SARA 40CFR302, Extremely Hazardous Substances: TPQ = 1000/10,000 lb (454/4540 kg).
Superfund/EPCRA 40CFR302.4, Appendix A, RQ: 5000 lb (2270 kg), SARA 313: Form R *de minimis* Concentration Reporting Level: 0.1%.
United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)
Canada, WHMIS, Ingredients Disclosure List concentration reporting Level: 0.1%.
Hazardous to aquatic life or environment, with possible long-lasting effects[194]. Do not allow release to the environment unless proper permits are obtained from the federal government.
Hazard symbols, risk, & safety statements: Hazard symbol: T, Xi; Risk phrases: R45; R46; R19; R20/21; R24/25; R33; R36/37/38; R43; R48/23/24/25; S41; R46; R53; R62; R63; Safety phrases: S41; S45; S53 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Acrylamide, in monomeric form, is an odorless, flake-like crystals. May be dissolved in a flammable liquid. Molecular weight = 71.08; specific gravity (H_2O:1) = 1.05 @ 25°C (liquid); 1.122 @ 30°C; boiling point = (decomposes) 175−300°C @ 1 atm; melting/freezing point = 85°C; vapor pressure = 0.0068 mmHg @ 20°C; relative vapor density (air = 1) = 1.0 @ 20; vapor density = 2.46; autoignition temperature = 240°C; flash point = 138°C (cc). Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 2; reactivity 2. Soluble in water; solubility = 2155 g/L @ 30°C; 2045 g/L @ 25°C.

Potential Exposure: Added to water during sewage/wastewater treatment. Used in the manufacture of plastics, resins, rubber, synthetic textiles; as a dye, pigment. A major application for monomeric acrylamide is in the production of polymers as polyacrylamides. Polyacrylamides are used for soil stabilization, gel chromatography, electrophoresis, papermaking strengtheners, clarifications, and treatment of potable water and foods.

Incompatibilities: Acrylamide may decompose with heat and polymerize at temperatures above 84°C, or exposure to light, releasing ammonia gas. Reacts violently with strong oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Reacts with reducing agents; peroxides, acids, bases, and vinyl polymerization initiators. Fine particles of dust form explosive mixture with air.

Permissible Exposure Limits in Air
NIOSH IDLH = 60 milligram per cubic meter, potential occupational carcinogen.
OSHA PEL: 0.3 milligram per cubic meter TWA [skin]
NIOSH REL: 0.03 milligram per cubic meter TWA [skin] Potential occupational carcinogen. Limit exposure to lowest feasible level.

ACGIH TLV[1]: 0.03 milligram per cubic meter TWA inhalable fraction and vapors [skin]; confirmed animal carcinogen with unknown relevance to humans (2003)
PAC Ver. 29[138]
PAC-1: 0.09 milligram per cubic meter
PAC-2: 44 milligram per cubic meter
PAC-3: 100 milligram per cubic meter
DFG MAK: [skin]; danger of skin sensitization; Carcinogen Category 2; Germ Cell Mutagen Group 2 (2004).
Australia: TWA 0.3 milligram per cubic meter [skin], carcinogen, 1993; Austria:[skin], carcinogen, 1999; Belgium: TWA 0.3 milligram per cubic meter [skin], Carcinogen 1993; Denmark: TWA 0.03 milligram per cubic meter [skin], 1999; Finland: TWA 0.3 milligram per cubic meter; STEL 0.9 milligram per cubic meter, 1993; France: VME 0.1 ppm (0.3 milligram per cubic meter) [skin], continuous; carcinogen, 1999; Hungary: STEL 0.3 milligram per cubic meter [skin], carcinogen, 1993; Japan; 0.3 milligram per cubic meter [skin], 2A carcinogen, 1999; Norway: TWA 0.3 milligram per cubic meter, 1999; the Philippines: TWA 0.3 milligram per cubic meter [skin], 1993; Poland: TWA 0.1 milligram per cubic meter, 1999; Russia: STEL 0.2 milligram per cubic meter [skin], 1993; Sweden: NGV 0.03 milligram per cubic meter, KTV 0.1 milligram per cubic meter [skin], 1999; Switzerland; MAK-W 0.03 milligram per cubic meter [skin], carcinogen, 1999; United Kingdom: TWA 0.3 milligram per cubic meter [skin], carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: confirmed animal carcinogen with unknown relevance to humans.

Determination in Air: Filter/Si gel; Methanol; GC/nitrogen/phosphorus detection; OSHA Analytical Method 21: The sampling train consists of a 13-mm glass fiber filter in a Swinnex cassette (available from the laboratory), followed by a standard silica gel tube. The filter and gaskets, within the cassette used to hold the filter, are extracted in the field in exactly 1 mL of methanol. This extraction is very important so a volumetric pipette calibrated to 1 mL must be used. The silica gel tube is extracted with methanol at the laboratory. Analysis is performed by GC using a nitrogen/phosphorous detector; or OSHA Analytical Method PV 2004: Samples are collected by drawing known volumes of air through OSHA versatile sampler (OVS-7) tubes, each containing a glass fiber filter and two sections of XAD-7 adsorbent. Samples are desorbed with a solution of 5% methanol 95% water and analyzed by high performance liquid chromatography (HPLC) using an ultraviolet detector.

Permissible Concentration in Water: Health advisories have been developed by EPA[48] on a long-term (7-year) basis as 0.02 mg/L for a 10-kg child and 0.07 mg/L for a 70-kg adult. A guideline for acrylamide in drinking water of 0.10 μg/L has been developed by the state of Minnesota[61].

Determination in Water: There is no standardized method for the determination of acrylamide in drinking water. An analytical procedure for the determination of acrylamide has been reported in the literature. This procedure consists of bromination, extraction of the brominated product from water with ethyl acetate and quantification using HPLC with an ultraviolet detector. The concentration of the ethyl acetate to dryness and dissolution in a small volume of distilled water prior to HPLC analysis allows the detection of acrylamide at concentrations of 0.2 μg/L[48]. Octanol−water coefficient: Log $K_{ow} = -0.65$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Eyes, skin, central, and peripheral nervous systems, reproductive system. Acrylamide can be absorbed through unbroken skin.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin, and respiratory tract. Symptoms of exposure include: complaints of drowsiness, fatigue, tingling of fingers. A stumbling, propulsive type of walking with sense of unsteadiness have been reported. Motor and sensory impairment, numbness, tremor, abnormal feelings in the lower limbs accompanied by weakness, and speech disturbances were also reported. Classified as very toxic; probably oral lethal human dose is between 50 and 500 mg/kg or between 1 teaspoon and 1 ounce for a 150-lb person. Polymerized acrylamide may not be toxic, but the monomer can cause peripheral nerve damage. Toxic effects exacerbated by alcohol consumption.

Long-Term Exposure: There is evidence that acrylamide causes cancer in animals. It may cause skin and lung cancer in humans. There is limited evidence that this chemical damages the male testes. It can cause damage to the CNS; causing numbness, and weakness of the hands and feet. Acrylamide is a cumulative neurotoxin and repeated exposure to small amounts may cause serious injury to the nervous system. The neurological effects may be delayed. Polymer inhibitors or stabilizers added to the monomer may also produce toxicity. The symptoms of acrylamide toxicity are consistent with mid-brain lesions and blocked transport along both motor and sensory axons.

Points of Attack: CNS; peripheral nervous system; skin and eyes.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Since skin contact with the substance may result in localized or systemic effects, NIOSH recommends that medical surveillance be made available to all employees working in an area where acrylamide is stored, produced, processed, or otherwise used, except as an unintentional contaminant in other materials at a concentration of less than 1% by weight. For those with frequent or potentially high exposure, nerve condition tests should be considered The use of alcoholic beverages may enhance the harmful effects. Nerve conduction studies[2].

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately. If this chemical contacts the skin, flush with water immediately. If a person breathes in large amounts of this chemical, move the exposed person to fresh air at once and perform artificial respiration. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Prevent skin contact. **8 hours** (More than 8 hours of resistance to breakthrough $>0.1\ \mu m > g/cm^2/min$): butyl rubber gloves, suits, boots; Tychem 1000 suits; **4 hours** (At least 4 but <8 hours of resistance to breakthrough $>0.1\ \mu m > g/cm^2/min$): nitrile rubber gloves, suits, boots; polyvinyl chloride gloves, suits, boots; Viton gloves, suits; 4H; and Silver Shield gloves. Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls, and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit. Wear-protective eye protection, gloves, and clothing to prevent repeated or prolonged skin contact. Wear dust-proof eye protection to prevent any reasonable probability of eye contact. Employees should wash immediately when skin is wet or contaminated. Work clothing should be changed daily if clothing is contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers.

Respirator Selection: NIOSH: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store only if stabilized, under inert gas. Before entering confined space where acrylamide may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2074 Acrylamide, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Use water spray to reduce vapors. Remove all ignition sources. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills*: with clean shovel place material into clean, dry container and cover; move containers from spill area. *Large spills*: dike far ahead of spill for later disposal. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Should you need to seek emergency information, call CHEMTREC at (800) 424-9300, or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Fire Extinguishing: A combustible solid. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. Thermal decomposition products may include oxides of nitrogen and carbon. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. Dike fire control water for later disposal; do not scatter the material.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥ 100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Acrylamide residue and sorbent material may be packaged in epoxy-lined drums and taken to an EPA-approved disposal site. Incineration with provisions for scrubbing of nitrogen oxides from flue gases. Deep well injection.

References

(109); (102); (31); (173); (100).

National institute for Occupational Safety and Health (NIOSH), "Criteria for a Recommended Standard: Occupational Exposure to Acrylamide", NIOSH Document Number 77-112, Cincinnati OH (1977) (173); (101); (138).

United States Environmental Protection Agency, assessment of Testing Needs: Acrylamide, Report No. EPA-560/11-80-016, Washington, DC, Office of Toxic Substances (July 1980).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 2, No. 4, 24−27 (1982).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Acrylamide, Washington, DC, Chemical Emergency Preparedness Program (Nov. 30, 1987).

LaDou, J., *Nerve Conduction Studies*, Occupational Medicine, Appleton and Lange, Norwalk, CT, 1990.

New York State Department of Health, Chemical Fact Sheet: Acrylamide, Bureau of Toxic Substance Assessment, Albany, NY (May 1986).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Acrylamide, Trenton, NJ (December 1999).

Acrylic Acid A:0400

Formula: $C_3H_4O_2$: $CH_2CHCOOH$

Synonyms: Acido acrilico (Spanish); Acroleic acid; Acrylic acid, glacial; Acrylic acid, inhibited; Aqueous acrylic acid (technical grade is 94%); Ethylenecarboxylic acid; Glacial acrylic acid; Propene acid; 2-Propenoic acid; Propenoic acid; Vinylformic acid

CAS Registry Number: 79-10-7

HSDB Number: 1421

RTECS Number: AS4375000

UN/NA & ERG Number: UN2218 (stabilized)/132 (P)

EC Number: 201-177-9 [*Annex I Index No.*: 607-061-00-8]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal No Adequate Data; Human No Adequate Data, *not classifiable as carcinogenic to humans*, Group 3, 1999

Hazard Alert: Flammable, Chemically unstable, Polymerization Hazard (nonstabilized), Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction), Environmental hazard.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U008, D002

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 5000 lb (2270 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%; NPRI

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

Hazardous to aquatic life or environment, with possible long-lasting effects.[291] Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: F, C, N, Xi; Risk phrases: R10; R19; R20/21/22; R35; R36/37/38; R50; R62; R63; Safety phrases: S1/2; S26; S29/35; S36/37/39; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Acrylic acid is a colorless, flammable, and corrosive liquid or solid (below 13°C) with an irritating, rancid, odor. Sinks and mixes with water; irritating vapor is produced. Molecular weight = 72.07; specific gravity (H_2O:1) = 1.05; vapor pressure = 3 mmHg @ 20°C; freezing/melting point = 12−14°C; boiling point = 141°C; relative vapor density (air = 1): 2.48; flash point = 50°C (oc) [glacial]; 54°C (oc); autoignition temperature = 438°C[17]; 360°C. Explosive limits: LEL: 2.4%, UEL: 8.02%. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 2; reactivity 2. Soluble in water.

Potential Exposure: Acrylic acid is chiefly used in manufacture of plastics, acrylates, polyacrylic acids, polymer, and resins; as a monomer in the manufacture of acrylic resins and plastic products, leather treatment, and paper coatings. Also, it is used as a tackifier and flocculant.

Incompatibilities: May form explosive mixture with air. Light, heat, and peroxides can cause polymerization. Use MEHQ (monomethyl ether of hydroquinone) as an inhibitor. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Incompatible with sulfuric acid, caustics, ammonia, amines, isocyanates, alkylene oxides; epichlorohydrin, toluene diamine, oleum, pyridine, methyl pyridine, *n*-methyl pyrrolidone, 2-methyl-6-ethyl aniline, aniline, ethylene diamine, ethyleneimine, and 2-aminoethanol. Severely corrodes carbon steel and iron; attacks other metals. May accumulate static electrical charges and may cause ignition of its vapors.

Permissible Exposure Limits in Air

Conversion: 1 ppm = 2.95 milligram per cubic meter

Odor threshold = 0.092 ppm.

OSHA PEL: None

NIOSH REL: 2 ppm/6 milligram per cubic meter TWA [skin]

ACGIH TLV[1]: 2 ppm/5.9 milligram per cubic meter TWA [skin]; not classifiable as a human carcinogen

PAC* Ver. 29[138]

PAC-1: $\mathbf{1.5_A}$ ppm

PAC-2: $\mathbf{46_A}$ ppm

PAC-3: **180_A** ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60-minute values.

DFG MAK: 10 ppm/30 milligram per cubic meter; Peak Limitation Category I(1); Pregnancy Risk Group C

Australia: TWA 10 ppm (30 milligram per cubic meter), 1993: Belgium: TWA 10 ppm (29 milligram per cubic meter), 1993: Denmark: TWA 2 ppm (5.9 milligram per cubic meter) [skin], 1999: France: VME 10 ppm (30 milligram per cubic meter), 1999:Norway: TWA 10 ppm (30 milligram per cubic meter), 1999: Russia: STEL 5 milligram per cubic meter, 1993: The Netherlands: MAC-TGG 5.9 milligram per cubic meter, 2003: Switzerland: MAK-W 0.03 milligram per cubic meter [skin], carcinogen, 1999: United Kingdom: TWA 10 ppm (30 milligram per cubic meter), STEL 20 ppm (60 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen.

Determination in Air: XAD[2]; Methanol/Water; High-pressure liquid chromatography/Ultraviolet detection; OSHA Analytical Method #28.

Determination in Water: Toxic to marine organisms. Octanol−water coefficient: Log $K_{ow} \leq 0.4$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, skin and eye contact, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Skin and eye contact can cause burns and permanent damage. Inhaling this chemical can cause respiratory tract irritation.

Long-Term Exposure: Acrylic acid may cause skin allergy and lung and kidney damage.

Points of Attack: Skin, eyes, respiratory system.

Medical Surveillance: Consider Lung function tests in preplacement and regular physical examinations. Kidney function tests if symptoms develop or overexposure is suspected. Skin testing with dilute acrylic acid may be used by a qualified allergist to diagnose allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting.

Personal Protective Methods: Prevent skin contact. **8 hours** (More than 8 hours of resistance to breakthrough $>0.1\ \mu m > g/cm^2/min$): butyl rubber gloves, suits, boots; Saranex, Responder suits, Trellchem HPS suits; **4 hours** (At least 4 but <8 hours of resistance to breakthrough $>0.1\ \mu m > g/cm^2/min$): Teflon gloves, suits, boots; Viton gloves, suits; 4H and Silver Shield gloves. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Specific respirator(s) have not been recommended by NIOSH. In an emergency use NIOSH/MSHA or European Standard EN 149-approved SCBA.

Storage: (1) Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. (2) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Do not allow to solidify. Can be stored only in glass, stainless steel, aluminum, or polyethylene-lined containers. Before entering confined space where acrylic acid may be present, check to make sure that an explosive concentration does not exist. Acrylic acid is a dangerous explosion hazard unless it is stored with an inhibitor. Store in tightly closed containers in a cool, well-ventilated area away from heat and sunlight. Do not freeze or refrigerate acrylic acid. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2218 Acrylic acid, stabilized, Hazard class: 8; Labels: 8-Corrosive material, 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Cover spill with soda ash or sodium bicarbonate. Mix and add water. Neutralize and flush into sewer. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after clean-up is complete. Keep acrylic acid out of a confined space, such as a sewer, because of the potential for an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. In advanced or massive fires, firefighting should be done from a safe distance or from a protected location. If a leak or spill has not ignited, use water spray to disperse the vapors. Water spray may be used to flush spills away from exposures and to dilute spills to nonflammable mixtures. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration. 100−500 ppm potassium permanganate will degrade acrylic acid to a hydroxy acid which can be disposed of at a sewage treatment.

References

(31); (173); (101); (138); (100).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 1, No. 7, 26−28 (1981).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Acrylic Acid, Trenton, NJ (June 1998).

Acrylonitrile A:0410

Formula: $C_3H_3N_4$; CH_2CHCN_4; $CH_2 = CH-CN$

Synonyms: Acrilonitrilo (Spanish); Acrinet; Acrylnitril (German); Acrylon; Acrylonitrile monomer; AN; Carbacryl; Cyanoethylene; Cyanure de vinyle (French); ENT 54; Fumigrain; Miller's fumigrain; Nitrile acrylique (French); 2-Propenenitrile; Propenenitrile; TL 314; VCN; Ventox; Vinyl cyanide; Vinyl cyanide, propenenitrile

CAS Registry Number: 107-13-1; *(alt.)* 29754-21-0; *(alt.)* 63908-52-1

HSDB Number: 176

RTECS Number: AT5250000

UN/NA & ERG Number: (PIH) UN1093 (stabilized)/131 (P)

EC Number: 203-466-5 [*Annex I Index No.*: 608-003-00-4]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC[12]: Animal Sufficient Evidence, Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B, 1999; NCI: Carcinogenesis Studies (gavage); clear evidence: mouse; EPA-B1 Limited evidence of carcinogenicity based on epidemiologic studies.

Hazard Alert: Poison inhalation hazard: exposure can be lethal, Highly flammable liquid, Polymerization hazard (nonstabilized), Sensitization hazard, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction); Environmental hazard.

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR1910.1045)

Banned or Severely Restricted (Germany) (U.N.)[13]

Clean Air Act, 42USC7412; Title I, Part A, §112 Hazardous Pollutants; Section 112[r], accidental Release Prevention/Flammable Substances (Section 68.130), TQ = 20,000 lb (9150 kg).

Clean Water Act, 40CFR116.4 Hazardous Substances; RQ 40CFR117.3, (same as CERCLA)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U009

RCRA 40CFR261, Appendix 8; 40CFR261.11 Hazardous Constituents

RCRA Land Ban Waste Restrictions

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.24; Nonwastewater, 84

RCRA 40CFR264, Appendix 9; Ground Water Monitoring List Suggested methods (PQL μg/L): 8030 (5); 8240 (5).

Safe Drinking Water Act, 55FR1470 Priority List

CERCLA/SARA 40CFR302, Extremely Hazardous Substances: TPQ = 10,000 lb (4540 kg).

Superfund/EPCRA 40CFR302.4, Appendix A, RQ: 100 lb (45.5 kg), SARA 313: Form R *de minimis* Concentration Reporting Level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List concentration reporting Level: 0.1%.

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Mexico, Wastewater, organic pollutants.

Hazardous to aquatic life or environment, with possible long-lasting effects[293]. Toxic to aquatic life with long-lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T+ , F, N, Xi; Risk phrases: R45; R11; R19; S21; R23/24/25; R36/37/38; R41; R43; R50/53; R62; R63; Safety phrases: S1; S; S16; S29/35; S36/36; S41; S45; S53; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Acrylonitrile is a highly flammable, clear, colorless or light yellowish liquid. Irritating, faint garlic- or onion-like odor. Its odor threshold is 17 ppm; odor can only be detected above the PEL. Molecular weight = 53.06; specific gravity (H_2O:1) = 0.801 @ 20°C; boiling point = 77.4°C @ 1 atm; melting/freezing point = −83.6°C; critical temperature = 263°C; critical pressure = 660 psia = 45 atm = 4.6 MN/m^2; specific gravity (H_2O:1) = 0.8075 @ 20°C; relative vapor density (air = 1) = 1.83; ratio of specific heats of vapor (gas) = 1.151; latent heat of vaporization = 265 Btu/lb = 147 cal/g = 6.16 × 105 J/kg; heat of combustion = −14,300 Btu/lb = −7930 cal/g = −332 × 105 J/kg; ionization potential = 10.9 eV; vapor pressure = 83 mmHg @ 20°C; saturation concentration in air = 257 g/m^3 @ 20°C; flash point = 0°C[17]; −5°C[52]; autoignition temperature = 480°C; explosive limits: LEL = 3%, 30,000 ppm; UEL = 17%. Hazard identification (based on NFPA-704 M Rating System) = Health 4; flammability 3; reactivity 2. Floats on water and is moderately soluble; solubility = 7.3 g/mL @ 20°C.

Potential Exposure: Acrylonitrile is used in the manufacture of synthetic fibers, polymers, acrylostyrene plastics, acrylonitrile−butadiene−styrene plastics, nitrile rubbers, chemicals, and adhesives. It is also used as a pesticide. In the past, this chemical was used as a room fumigant and pediculicide (an agent used to destroy lice).

Incompatibilities: May form explosive mixture with air. Reacts violently with strong acids; strong alkalis; bromine, and tetrahydrocarbazole. Copper, copper alloys, ammonia, and amines may cause breakdown to poisonous products. Unless inhibited (usually with methylhydroquinone), acrylonitrile may polymerize spontaneously. It may also polymerize on contact with oxygen, heat, strong light, peroxides, and concentrated or heated alkalis. Reacts with oxidizers, acids, bromine, amines. Attacks copper and copper alloys. Attacks aluminum in high concentrations. Heat and flame may cause release of poisonous cyanide gas and nitrogen oxides.

Permissible Exposure Limits in Air

NIOSH IDLH = 85 ppm, potential occupational carcinogen.

Conversion factor: 1 ppm = 2.21 milligram per cubic meter @ 25°C & 1 atm

Odor threshold = 17 ppm; odor can only be detected above the PEL.

OSHA PEL:[1910.1045] 2 ppm TWA [skin]; 10 ppm [15 min.] Ceiling Concentration

NIOSH REL: 1 ppm TWA; 10 ppm [15 min.] Ceiling Concentration; [skin] potential occupational carcinogen

ACGIH TLV[1]: 2 ppm/4.3 milligram per cubic meter TWA [skin]; confirmed animal carcinogen with unknown relevance to humans.

PAC* Ver. 29[138]

PAC-1: 0.15 ppm

PAC-2: $\mathbf{1.7_A}$ ppm

PAC-3: $\mathbf{28_A}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60-minute values.

DFG MAK: [skin]; Carcinogen Category: 2; Danger of skin sensitization (2006); TRK: 3 mL/m^3/7 milligram per cubic meter; Sampling time: not fixed; 420 μg[erythrocytes cyanoethylvaline]/L blood.

Arab Republic of Egypt: TWA 2 ppm [skin], 1993; Australia: TWA 2 ppm (4.5 milligram per cubic meter) [skin], carcinogen, 1993; Austria [skin], carcinogen, 1999; Belgium: TWA 2 ppm (4.3 milligram per cubic meter) [skin], Carcinogen 1993; Denmark: TWA 2 ppm (4 milligram per cubic meter) [skin], 1999; Finland: TWA 2 ppm (4.5 milligram per cubic meter); STEL 4 ppm [skin], carcinogen, 1993; France: VME 2 ppm (4.5 milligram per cubic meter), VLE 15 ppm (32.4 milligram per cubic meter), carcinogen, 1999; Hungary: STEL 0.5 milligram per cubic meter [skin], carcinogen, 1993; India: TWA 2 ppm (4.5 milligram per cubic meter) [skin], carcinogen, 1993; Japan; 2 ppm (4.3 milligram per cubic meter) [skin], 2A carcinogen, 1999; Norway: TWA 2 ppm (4 milligram per cubic meter), 1999; the Philippines: TWA 20 ppm (45 milligram per cubic meter) [skin], 1993; Poland: MAC (TWA) 2 milligram per cubic meter, MAC (STEL) 10 milligram per cubic meter, 1999; Russia: TWA 2 ppm; STEL 0.5 milligram per cubic meter [skin], 1993; Sweden: NGV 2 ppm (4.5 milligram per cubic meter), KTV 6 ppm [skin], carcinogen, 1999; Switzerland: MAK-W 2 ppm (4.5 milligram per cubic meter) [skin], carcinogen, 1999; Turkey: TWA 20 ppm (45 milligram per cubic meter) [skin], 1993; United Kingdom: TWA 2 ppm (4.4 milligram per cubic meter) [skin], carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: confirmed animal carcinogen with unknown relevance to humans. Several states have set guidelines or standards for acrylonitrile in ambient air[60]: 0.0147 μ/m^3 (Indiana) to 0.145 μ/m^3 (North Carolina) to 0.15 μ/m^3 (Massachusetts) to 11.3 μ/m^3 (Pennsylvania) to 15.0 μ/m^3 (New York) to 22.0 μ/m^3 (Connecticut and South Dakota) to 22.5 μ/m^3 (South Carolina) to 45.0 μ/m^3 (Florida and Virginia).

Determination in Air: Charcoal adsorption followed by acetone extraction and gas chromatographic analysis. Use NIOSH Analytical Method 1604[18], or OSHA Analytical Method 37 where samples are collected on charcoal, desorbed with acetone, and analyzed by GC using a nitrogen/phosphorus detector.

Permissible Concentration in Water: The substance is toxic to aquatic organisms. Acrylonitrile usually breaks down in about 1 or 2 weeks, but this can vary depending on conditions. For example, high concentrations (such as might occur following a spill) tend to be broken down more slowly. In one case, measurable amounts of acrylonitrile were found in nearby wells 1 year after a spill (ATSDR public Health Statement, December 1990). See RCRA and Clean Water Act under "Regulatory Authority and Advisory Information." To protect freshwater aquatic life (on an acute basis), 7550 μg/L and on a chronic basis, 2600 μg/L over 30 days. *To protect saltwater aquatic life*: insufficient data to yield a value. *To protect human health*: preferably zero. Water concentration should be below 0.58 μg/L to keep lifetime cancer risk below 10^{-5}. Russia[43] set a MAC of 2.0 mg/L for water bodies used for domestic purposes. The Mexico drinking water ecological criteria is 0.0006 mg/L, reduce human exposure to a minimum. Several states have set guidelines for acrylonitrile in drinking water[61] ranging from 0.67 μg/L (Minnesota) to 3.8 μg/L (Kansas) to 10 μg/L (Arizona) to 35 μg/L (Connecticut).

Determination in Water: GC/Flame ionization detection; NIOSH Analytical Method (IV) #1604. Also, by GC (EPA Method #603) or GC plus mass spectrometry (EPA Method #624). Octanol−water coefficient: $\text{Log}\,K_{\text{ow}} = -0.91$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation and percutaneous absorption. It may be absorbed from contaminated rubber or leather. Routes include ingestion and eye and skin contact. Acrylonitrile vapor is absorbed readily from the lungs; and inhalation is an important route of exposure. This chemical's odor generally provides inadequate warning of hazardous concentrations and olfactory fatigue develops rapidly.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates eyes, skin, and respiratory tract. Splashes in the eye may result in corneal damage. Skin contact can cause severe irritation and blistering. Breathing acrylonitrile can irritate the lungs, causing coughing, and shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can result in death. Skin contact contributes significantly in overall exposure and can lead to systemic toxicity. Acrylonitrile reaction causes redness, blisters and some systemic signs. Symptoms derive from tissue anoxia in order of onset: limb weakness, dyspnea (difficult breathing); burning sensation in throat; dizziness, impaired judgment; cyanosis (turning blue); nausea, collapse, irregular breathing; convulsions and death. In later stages collapse, irregular breathing or convulsions and cardiac arrest may occur without warning. Some patients appear hysterical or may even be violent. Acrylonitrile is classified as very toxic. Probable oral lethal dose for human is 50−500 mg/kg (between 1 teaspoon and 1 oz.) for a 70-kg (150 lb) person. Toxic concentrations have been reported @ 16 ppm/20 min. Acute toxicity is similar to that due to cyanide poisoning and the level of cyanide ion in blood is related to the level of poisoning. Inhalation or ingestion can result in fatal systemic poisoning, collapse and death due to tissue anoxia (lack of oxygen) and cardiac arrest (heart failure). At higher concentrations, there may be damage to red blood cells and the liver. Jaundice may develop 24 hours following exposure and persist for several days. Because of continued metabolic release of cyanide, symptoms of severe poisoning may recur and the patient may relapse.

Long-Term Exposure: This chemical is a probable carcinogen in humans. There is some evidence that it causes lung and large intestine cancer in humans and has been shown to cause brain and stomach cancer in animals. Exposure may cause the thyroid gland to enlarge and interfere with normal thyroid function. There is limited evidence that acrylonitrile may damage the developing fetus and the male reproductive system. Repeated exposure can irritate the nose, causing discharge, nose bleeds, and sores inside the nose. Acrylonitrile may affect the liver function.

Points of Attack: Eyes, skin, cardiovascular system, liver, kidneys, CNS. *Cancer site*: brain tumors, lung, and bowel cancer.

Medical Surveillance: For those with frequent or high exposure, consider urine thiocyanate levels, blood cyanide levels, liver function tests; fecal occult blood screening, pulmonary function tests. Consider the skin, respiratory tract, heart, CNS; renal and liver function in placement and periodic examinations. A history of fainting spells or convulsive disorders might present and added risk to persons working with toxic nitriles. Fecal occult blood screening for workers 40 years of age or older and chest X-ray *Code of Federal Regulations. 29 CFR Part 1910* Occupational Safety and Health Standards. Part 1910.1045, Page 319[2]. Pulmonary function tests, Blood cyanide, Blood plasma, Blood serum, Expired air, Urine (chemical/metabolite)[2].

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. Use amyl nitrate capsules if symptoms develop. All area employees should be trained regularly in emergency measures for cyanide poisoning and in CPR. A cyanide antidote kit should be kept in the immediate work area and must be rapidly available. Kit ingredients should be replaced every 1−2 years to ensure freshness. Persons trained in the use of this kit; oxygen use, and CPR must be quickly available.

Personal Protective Methods: Prevent skin contact. **8 hours** (More than 8 hours of resistance to breakthrough $>0.1\ \mu\text{m} > \text{g/cm}^2\text{/min}$): butyl rubber gloves, suits, boots; 4 H and Silver Shield gloves; Barricade coated suits; Responder suits; Trychem 1000 suits. Wear-protective eye protection, gloves, and clothing to prevent repeated or prolonged skin contact. Leather should not be used in protective clothing since it is readily penetrated by acrylonitrile; contaminated leather shoes and gloves should be destroyed. rubber clothing should be frequently washed and inspected because it will soften and swell. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Contact lenses should not be worn when working with this substance. Employees should wash immediately when skin is wet or contaminated. Remove clothing immediately if wet or contaminated to avoid flammability hazard. Provide emergency showers. See also NIOSH Criteria Document 212 *Nitriles*.

Respirator Selection: < or = 20 ppm (parts per million): (1) Chemical cartridge respirator with organic vapor cartridge(s) and half-mask facepiece; or (2) Supplied-air respirator with half-mask facepiece. < or = 100 ppm or maximum use concentration of cartridges or canisters, whichever is lower: (1) Full-facepiece respirator with (A) organic vapor cartridges, (B) organic vapor gas mask, chin-style, or (C) organic vapor gas mask canister, front- or back-mounted; (2) Supplied-air respirator with full facepiece; or (3) SCBA with full facepiece. < or = 4000 ppm: Supplied-air respirator operated in positive-pressure mode with full facepiece, helmet, suit, or hood. >4000 ppm or unknown concentration: (1) Supplied-air and auxiliary SCBA with full facepiece in positive-pressure mode or (2) SCBA with full facepiece in positive-pressure mode.

Firefighting: SCBA with full facepiece in positive-pressure mode. *Escape*: (1) Any organic vapor respirator or (2) Any SCBA.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Protect against physical damage. See incompatibilities for materials and physical conditions not permitted in storage room or cabinet. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Store in tightly closed containers in a cool, well-ventilated area. Do not store uninhibited acrylonitrile under any conditions. Store drums on end with bungs up, no more than two high. Outside tanks should be above ground and surrounded with dikes of sufficient capacity to hold entire tank contents. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN1093 Acrylonitrile, stabilized, Hazard Class 3; Labels: 3 Flammable liquids, 6.1-Poisonous materials.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Keep acrylonitrile out of a confined space, such as a sewer, because of the potential for an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Acrylonitrile is a dangerously reactive and flammable liquid. Thermal decomposition products may include hydrogen cyanide. A few "whiffs" of vapor could cause death. Vapor or liquid could be fatal on penetrating the fire fighter's normal full protective clothing. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode. Firefighting gear (including SCBA) does not provide adequate protection. If exposure occurs, remove and isolate gear immediately and thoroughly decontaminate personnel. May react with itself without warning, blocking relief valves, and leading to container explosion. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. *Small fires*: dry chemical, carbon dioxide; water spray or foam. *Large fires*: water spray, fog, or foam. Stay away from ends of tanks. Do not get water inside container. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. For massive fire in cargo area, use unmanned hose holder or monitor nozzles; if this is impossible, withdraw from area and let fire burn. From a secure explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration with provision for nitrogen oxides removal from effluent gases by scrubbers or afterburners. A chemical disposal method has also been suggested involving treatment with alcoholic NaOH; the alcohol is evaporated and calcium hypochlorite added; after 24 hours the product is flushed to the sewer with large volumes of water. Recovery of acrylonitrile from acrylonitrile process effluents is an alternative to disposal.

References

(109); (31); (173); (101); (138); (2); (202); (96); (100); (193).

United States Department of Health and Human Services, Public Health Service, *Public Health Statements*: *Acrylonitrile*, Atlanta, GA (December, 1990).

National institute for Occupational Safety and Health (NIOSH), *Criteria for a Recommended Standard*: *Occupational Exposure to Acrylonitrile*, NIOSH Doc, No. 78−116, Cincinnati OH (1978).

United States Department of Labor, *Economic Impact Assessment for Acrylonitrile*, Washington, DC, Occupational Safety and Health Administration (February 21, 1978).

United States Environmental Protection Agency, *Status Assessment of Toxic Chemicals*: *Acrylonitrile*, Report EPA-600/2-79-210A, Washington, DC (December 1979).

United States Environmental Protection Agency, *Acrylonitrile*: *Ambient Water Quality Criteria*, Washington, DC (1980).

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United States Environmental Protection Agency, *Acrylonitrile, Health and Environmental Effects Profile No. 7*, Washington, DC, Office of Solid Waste (April 30, 1980).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 1, No. 2, 25−27 (1980) and 3, No. 3, 41−46 (1988) and 5, No. 4, 31−33 (1985).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Acrylonitrile, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

New York State Department of Health, Chemical Fact Sheet: Acrylonitrile, Bureau of Toxic Substance Assessment, Albany, NY (March 1986).

Code of Federal Regulations. 29 CFR Part 1910, *Occupational Safety and Health Standards*. Part 1910.1045. United States GPO. July 1, 2000. Pages 315−333.

Baselt R.C., *Biological Monitoring Methods for Industrial Chemicals. 2nd Edition*. Year Book Medical Publishers, Inc, Chicago, IL, 1988.

Ladou, J., *Occupational Medicine*, Appleton and Lange, Norwalk, CT, 1990.

Linch, A.L., *Biological Monitoring for Industrial Chemical Exposure Control*, CRC Press, Boca Raton, FL, 1974.

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Acrylonitrile, Trenton, NJ (December 2005).

Acryloyl Chloride A:0420

Formula: C_3H_3ClO; $CH_2 = CHCOCl$

Synonyms: Acrylic acid chloride; Cloruro de acriloilo (Spanish); 2-Propenoyl chloride

CAS Registry Number: 814-68-6

HSDB Number: 6330

RTECS Number: AT7350000

UN/NA & ERG Number: UN3383/131 (P); UN2924/139[101]

EC Number: 212-399-0

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Hazard Alert: Poison, Highly flammable, Corrosive (skin & eyes), Violently water reactive, Polymerization hazard.

United States National Primary Drinking Water Regulations: SMCL = 250 mg[Cl-]/L as Chloride

OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 250 lb (114 kg)

Clean Air Act 42USC7412; Title I, Part A, §112(r), Regulated Chemicals for Accidental Release Prevention/Flammable Substances (Section 68.130) TQ = 5000 lb (2270 kg)

CERCLA/SARA 40CFR302, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg)[7]

578-94-9

Hazard symbols, risk, & safety statements: Hazard symbol: F,T+; Risk phrases: R11; R14; R21/22; R26; R34; R37; R42/42; R51; Safety phrases: S1; S7/9; S16; S21; S26; S28; S36/37/39; S45.

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Acryloyl chloride is a highly flammable, polymerizable, and toxic (inhalation), light yellow liquid. A lacrimator. Molecular weight = 90.51; boiling point = 75°C; specific gravity (H_2O:1) = 1.114 @ 20°C. Flash point = 14°C (cc). Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 3; reactivity 2₩. Reacts violently with water.

Potential Exposure: May be used as a monomer in preparation of specialty polymers or as a chemical intermediate.

Description: Molecular weight = 90.5; specific gravity (H_2O:1) = 1.114 @ 20°C; boiling point = 72−77°C; vapor pressure = 300 mmHg @ 20°C (more?).

Incompatibilities: Use MEHQ (monomethyl ether of hydroquinone) as an inhibitor. Incompatible with oxidizers, polymerizes on contact with oxygen; alcohols, amines, alkalis. Reacts violently with water, releasing hydrochloric acid and acrylic acid. Attacks some metals.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 0.022 ppm

PAC-2: 0.24 ppm

PAC-3: 0.87 ppm

Routes of Entry: Inhalation and percutaneous absorption. Can be absorbed through the eyes.

Harmful Effects and Symptoms

Short-Term Exposure: A highly toxic and corrosive lacrimator. Inhalation, skin absorption, or ingestion can be fatal. Highly destructive to the mucous membranes and upper respiratory system, skin, and eyes. May cause blindness. Skin contact can cause burns.

Harmful Effects and Symptoms

LC_{50} (inh., mouse, 2 hours) = 92 milligram per cubic meter; this may be the basis for inclusion in the EPA "Extremely Hazardous Substances" list[72]. Inhalation may cause burning feeling, coughing, shortness of breath, headache, dizziness, nausea, and vomiting; spasm, inflammation; chemical pneumonitis. Exposure an cause pulmonary edema, a medical emergency that can result in death.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Storage: PIH; check oxygen content prior to entering storage area. Polymerizable on contact with oxygen. Use MEHQ (monomethyl ether of hydroquinone) as an inhibitor. (1) Color code—Red: Flammability Hazard: Store in a flammable (liquid or solid materials) storage area or approved cabinet away from sources if ignition. (2) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location; keep acids away from bases and red, yellow, and blue-coded chemicals. (3) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN3383 Poisonous Toxic by inhalation liquid, flammable, n.o.s. with an LC50 $\leq$ 200 mL/m^3 and saturated vapor concentration $\geq$500 LC50, Hazard class: 6.1; Labels: 6.1-Poisonous materials, 3-Flammable liquid, Technical Name Required, Inhalation Hazard Zone A. UN2924 Flammable liquids, corrosive, n.o.s., Hazard Class: 3; Labels: 3-Flammable liquid, 8-Corrosive material, Technical Name Required.

Spill Handling:

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (from a small package or a small leak from a large package)

when spilled in water

First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.5/0.8
Night 1.1/1.8

Large spills (from a large package or from many small packages)

First: Isolate in all directions (ft/m) 1000/300
Then: Protect persons downwind (mi/km)
Day 2.5/4.1
Night 4.1/6.6

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Violent reaction with water. Thermal decomposition products may include oxides of carbon. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, C*hemical Hazard Information Profile*: Acrylyl Chloride, Washington, DC, Chemical Emergency Preparedness Program, November 30, 1987.

Actinomycin D A:0430

Formula: $C_{62}H_{86}N_{12}O_{16}$

Synonyms: Actinomicina D (Spanish); Actinomycindioic D acid, dilactone; Actinomycin I; AD; Cosmegen; Dactinomycin; Dactinomicina (Spanish); Dilactone actinomycindioic D acid; HBF 386; Lyovac cosmegen; Meractinomycin; Oncostatin K

CAS Registry Number: 50-76-0

HSDB Number: 3220 as Dactinomycin

RTECS Number: AU1575000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 200-063-6

Regulatory Authority and Advisory Information

Carcinogenicity: NCI: Carcinogenesis Studies (ipr); clear evidence rat; no evidence mouse; IARC: Animal Inadequate Data; Human No Available Data, Group 3, 1987

California Proposition 65 Chemical[102]: Cancer 10/1/1989; Developmental/Reproductive toxin 1/1/1989.

Hazard Alert: Exposure can be lethal, Possible risk of forming tumors, Reproductive toxin: Suspected of causing genetic defects, Primary irritant (w/o allergic reaction), Drug.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, Xi; Risk phrases: R45; R61; R14; R26/27/28; R36/37/38; R40; R61; Safety phrases: S1; S22; S28; S36/37/39; S41; S45; S53; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (Est.)]

Description: Actinomycin D is a combustible, bright red crystalline solid. Molecular weight = 1255.5; freezing/melting point = 241.5° to 243°C. Hazard identification (based on NFPA-704 M Rating System): Health 4; flammability 0; reactivity 0. Soluble in water.

Potential Exposure: An antibiotic product from *streptomyces*, used as anticancer and veterinary drug.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Routes of Entry: intravenous, skin, eyes.

Harmful Effects and Symptoms

Short-Term Exposure: Highly Toxic. Irritates eyes and skin. A poison if ingested. LD_{50} = (oral-rat) 7.2 mg/kg.

Long-Term Exposure: Has been shown to cause peritoneal and local sarcomas in animals. May damage the developing fetus.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure. CBC, EKG.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers may be able to provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a refrigerator or other cool, dry place.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft.(NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen with 60%−70% ethanol to avoid airborne dust then transfer to a suitable sealed container in the most convenient and safe manner. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide; water spray; or foam extinguishers. Thermal decomposition products may include oxides of nitrogen and carbon. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: It is inappropriate and possibly dangerous to the environment to dispose of expired or waste pharmaceuticals by flushing them down the toilet or discarding them to the trash. Household quantities of expired or waste pharmaceuticals may be mixed with wet cat litter or coffee grounds, double-bagged in plastic, discard in trash. Larger quantities shall carefully take into consideration applicable DEA, EPA, and FDA regulations. If possible return the pharmaceutical to the manufacturer for proper disposal being careful to properly label and securely package the material. Alternatively, the waste pharmaceutical shall be labeled, securely packaged and transported by a state licensed medical waste contractor to dispose by burial in a licensed hazardous or toxic waste landfill or incinerator

References

(102); (31); (173); (101); (138); (100).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 1, No. 3, 23−24 (1981).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Actinomycin D, Trenton, NJ (April 1998).

Adamsite (Agent DM) A:0435

Formula: $C_{12}HgAsClN$; $C_6H_4 \cdot NH \cdot C_6H_4 \cdot AsCl$; HN-$(C_6H_4)_2$-AsCl

Synonyms: Dibenzo-1-chloro-1,4-arsenine; DM (United States Army code); Diphenylamine (DPA) chloroarsine; Phenarsazine chloride

CAS Registry Number: 578-94-9

HSDB Number: 7599

RTECS Number: SG0680000

UN/NA & ERG Number: (PIH) UN1698/154

EC Number: 209-433-1

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen: Arsenic and inorganic arsenic compounds; IARC: Human Sufficient Evidence, 1980; Animal Limited Evidence, *carcinogenic to humans*, Group 1, 1987

California Proposition 65 Chemical[102]: Cancer 2/27/1987

Hazard Alert: Poison inhalation hazard, Vomiting agent, Inhalation hazard, Combustible, Toxic, Organometallic, Strong reducing agent, Environmental hazard.

United States DOT 49CFR172.101, Inhalation Hazardous Chemical (PIH).

Clean Air Act, 42USC7412; Title I, Part A, §112 Hazardous Pollutants (arsenic compounds)

OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 100 lb (45 kg)

Clean Water Act Section 307 Toxic Pollutants, 40CFR401.15 (effluent limitations); as arsenic and compounds

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, D004 (arsenic compounds)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg) (arsenic compounds)

EPCRA Section 313: Form R *de minimis* concentration reporting level: 0.1% (inorganic arsenic compounds); Form R *de minimis* concentration reporting level: 1.0%. Source of aqueous ammonia. NH_3 equivalent weight 19.35

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) arsenic compounds

Canada: Priority Substance List & Restricted Substances/ Ocean Dumping FORBIDDEN (CEPA), NPRI (arsenic compounds)

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N, Xi; Risk phrases: R45; R23/25; R36/37/38; R50/53; R68/20; Safety phrases: S29; S41; S45; S53; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Adamsite, or Agent DM, is a light green to yellow, crystalline, organometallic solid at room temperature; it can be dark green depending on purity and age; canary yellow when concentrated; colorless when diluted with air. Odorless but irritating; similar to pepper. Molecular weight = 277.6; specific gravity (H_2O:1) = 1.65; boiling point = 410°C; freezing/melting point = 193−195°C; vapor pressure = very low; 2×10^{-13} mmHg @ 20°C. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 1; reactivity 0. Practically insoluble in water. Not readily soluble in any of the liquid chemical warfare agents.

Potential Exposure: Adamsite (military designation DM), a chloroarsenical, was first produced during World War I. Adamsite (DM) is used as a riot control or harassing agent, tear gas, and (vomiting agent) gas. It was designed as a battlefield agent and can be dissolved in acetone and dispersed as an aerosol. Adverse health effects due to exposure to adamsite (DM) are generally self-limited and do not require specific therapy. Most adverse health effects resolve within 30 minutes. Exposure to large concentrations of adamsite (DM), or exposure to adamsite (DM) within an enclosed space or under adverse weather conditions, may result in more severe adverse health effects, serious illness, or death. Adamsite (DM) is more disagreeable than tear gas, but less dangerous than sarin. It is considered to be too extreme for use against civilian populations, and was banned for this use in the 1930s by western nations. Produced worldwide, DM was superseded by the CN series of tear agents. It produces irritation to the upper respiratory tract and the eyes. Although DM has been replaced by CS, it might be mixed with a nerve agent. This may cause a vomiting victim to remove respiratory protection and be exposed to the more lethal agent.

Persistence of Chemical Agent: Short, because compounds are disseminated as an aerosol. *Soil*: persistent; *Surface of materials* (wood, metal, masonry, rubber, paint): persistent. *Water*: persistent; when material is covered with water, an insoluble film forms which prevents further hydrolysis.

Incompatibilities: A reducing agent and an organometallic, reacts, possibly violently, with oxidizers, acids and bases. Slowly hydrolyzes in water. *Stability*: stable in pure form; after 3 months, caused extensive corrosion of aluminum, anodized aluminum, and stainless steel; will corrode iron, bronze, and brass when moist. *Corrosive properties*: titanium—71°C, 6 months, appeared good. Stainless steel—43°C, 30 days, slight discoloration. Common steel—43°C, 30 days, covered with rust. Aluminum anodized—43°C, 30 days, minor corrosion and pitting. Aluminum—43°C, 30 days, severe corrosion. Contact with metals may evolve flammable hydrogen gas.

Permissible Exposure Limits in Air

PAC* ver.29

PAC-1: $\mathbf{0.016_A}$ milligram per cubic meter

PAC-2: $\mathbf{2.6_A}$ milligram per cubic meter

PAC-3: $\mathbf{6.4_A}$ milligram per cubic meter

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

NOAEL (no-observed-adverse-effect-level, inhalation) = 4 mg min/m^3.

Determination in Air: No method is available to detect Adamsite in environmental samples.

Permissible Concentration in Water: Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.

Determination in Water: The atomic absorption graphite furnace technique is often used for measurement of total arsenic in water. It also has been standardized by EPA. Total arsenic may be determined by digestion followed by silver diethyldithiocarbamate; an alternative is atomic absorption; another is inductively coupled plasma (ICP) optical emission spectrometry. People should not drink water containing DM. Warn pollution control authorities and advise shutting water intakes. Octanol−water coefficient: Log K_{ow} = ~4. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation

Harmful Effects and Symptoms

Adamsite (Agent DM) is a vomiting compound. It is normally a solid, but upon heating, DM first vaporizes and then condenses to form aerosols. It is toxic through inhalation, ingestion, and skin contact. Adamsite is dispersed as an aerosol, irritating to the eyes and respiratory tract but not necessarily to the skin. Under field conditions, vomiting agents can cause great discomfort to the victims; when released indoors, they can cause serious illness or death. Symptoms include irritation of eyes and mucous membranes; coughing, sneezing, severe headache, acute pain, and tightness in the chest; nausea and vomiting. DM has been noted to cause necrosis of corneal epithelium in humans. The human body will detoxify the effects of mild exposures within 30 minutes of evacuation. Severe exposures may take several hours to detoxify and minor sensory disturbances may persist for Up to one day. The majority of exposures occur by inhalation and typically lead to symptoms of ocular, nasal, and respiratory tract irritation. Nonspecific GI symptoms (e.g., vomiting or diarrhea) might also occur. The effects of adamsite poisoning take minutes to begin and might last for hours. If a rapid onset of manifestations of one of the following respiratory effects occurs, the clinical description for adamsite poisoning has been met: nose or throat irritation, cough, or dyspnea.

Short-Term Exposure: The majority of exposures occur by inhalation and typically lead to symptoms of ocular, nasal, and respiratory tract irritation. Nonspecific GI symptoms (e.g., vomiting or diarrhea) might also occur. The effects of adamsite poisoning appear within minutes of exposure and might last for hours. If a rapid onset of manifestations of one of the following respiratory effects occurs, the clinical description for adamsite poisoning has been met: nose or throat irritation, cough, or dyspnea (CDC).

Long-Term Exposure: No assessment has been made of possible long-term effects of short-term exposures to Adamsite. However, see medical surveillance, below.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Pulmonary function tests and radiographic imaging, especially those who have persistent symptoms of dyspnea, cough, or chest discomfort.

First Aid: *Inhalation*: *Never* perform mouth to mouth resuscitation, or you will get sick. Remove victim to fresh air; wear a mask/respirator in spite of coughing, sneezing, salivation, and nausea; lift the mask from the face briefly, if necessary, to permit vomiting or to drain saliva from the facepiece; seek medical attention immediately. *Eye contact*: Don a respiratory protective mask; seek medical attention immediately. *Skin contact*: Rinse the nose and throat with saline water or bicarbonate of soda solution; wash exposed skin and scalp with soap and water and allow to dry on the skin; dust the skin with borated talcum. *Ingestion*: seek medical attention immediately; carry on duties as vigorously as possible; this will help to lessen and shorten the symptoms.

Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Decontamination: Decontaminate as soon as possible. This is extremely important. Victims will be removed immediately to an uncontaminated atmosphere. Personnel handling casualty cases will give consideration to their own safety and will take precautions and employ the prerequisite protective equipment to avoid becoming exposed themselves. If you don't have the equipment and training don't enter the hot or the warm zone to rescue and decontaminate victims. If the victim can't move, begin the decontamination process without touching and without entering the hot zone. Use clean water from any source; if possible, use a hose (spray or fog to prevent injury to the victim) or other system so that you won't have to touch the victim; don't even wait for soap or for the victim to remove clothing, begin washing immediately. Immediately flush the eyes with water for at least 15 minutes. Wash—strip—wash—evacuate up wind and uphill: The approach is to immediately wash with water, then have the victim (not the first responder) remove all the victim's clothing, then wash again (with soap if available); and subsequently move away from the hot zone in an upwind and up-hill direction. Contaminated clothes and personal belongings should be placed in a sealed double bag. Wash the victim with warm water and soap. Decontaminate with diluted household bleach (10%, or one part bleach to nine parts water), but don't let any of the bleach solution get in the victim's eyes, open wounds, or mouth. Rinse off the diluted bleach solution after 15 minutes. In order to prevent spreading the agent, be certain the victims have been decontaminated as much as possible before they leave the decontamination area. If you get any amount of the agent on yourself, decontaminate immediately. Even if you think you are not contaminated, be sure to thoroughly shower and change clothes as soon as you can after the incident.

Personal Protective Methods:

General information: first responders should use a NIOSH-certified CBRN SCBA with a level a protective suit when entering an area with an unknown contaminant or when entering an area where the concentration of the contaminant is unknown. Level a protection should be used until monitoring results confirm the contaminant and the concentration of the contaminant. Note: safe use of protective clothing and equipment requires specific skills developed through training and experience.

LEVEL A: (*RED ZONE)*: select when the greatest level of skin, respiratory, and eye protection is required. This is the maximum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than the AEGL-2. A NIOSH-certified CBRN full-face-piece SCBA operated in a pressure-demand mode or a pressure-demand supplied air-hose respirator with an auxiliary escape bottle. A TECP suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, and a hard hat worn under the TECP suit are optional items.

LEVEL B: (RED ZONE): Select when the highest level of respiratory protection is necessary but a lesser level of skin protection is required. This is the minimum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than AEGL-2. It differs from Level A in that it incorporates a nonencapsulating, splash-protective, chemical-resistant splash suit that provides Level A protection against liquids but is not airtight. A NIOSH-certified CBRN full-face-piece SCBA operated in a pressure-demand mode or a pressure-demand supplied air-hose respirator with an auxiliary escape bottle. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL C: (YELLOW ZONE): Select when the contaminant and concentration of the contaminant are known and the respiratory protection criteria factors for using APR or PAPR are met. This level is appropriate when decontaminating patient/victims. A NIOSH-certified CBRN tight-fitting APR with a canister-type gas mask or CBRN PAPR for air levels greater than AEGL-2. A NIOSH-certified CBRN PAPR with a loose-fitting face-piece, hood, or helmet and a filter or a combination organic vapor, acid gas, and particulate cartridge/filter combination or a continuous flow respirator for air levels greater than AEGL-1. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Escape mask, face shield, coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL D: (GREEN ZONE): Select when the contaminant and concentration of the contaminant are known and the concentration is below the appropriate occupational exposure limit or less than AEGL-1 for the stated duration times. Limited to coveralls or other work clothes, boots, and gloves.

Notes: Take all necessary precautions to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Eye protection is included in the recommended respiratory protection. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Specific engineering controls are required under OSHA 1910.1018, *Inorganic Arsenic*. See also NIOSH Criteria Document #75-149, *Inorganic Arsenic*. Protective Gloves: Wear Norton chemical protective glove set, Wear chemical goggles; wear a mask/respirator in open areas.

Respirator Selection: *When used as a weapon, use SCBA Respirator Certified By NIOSH For CBRN Environments.*

At any detectable concentration: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location away from acids. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a refrigerator or cool, well-ventilated area. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN1698 DPA chloroarsine, Hazard class: 6.1; Label: 6.1-Poisonous materials. Military driver shall be given full and complete information regarding shipment and conditions in case of emergency. AR 50-6 deals specifically with the shipment of chemical agents. Shipments of agent will be escorted in accordance with AR 740-32.

Spill Handling: Issue poison warning. Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the potential for an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Agent DM when used as a weapon

Initial Isolation and Protective Action Distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small Spills (from a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.2/0.3

Large Spills (from a large package or from many small packages)

First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 0.9/1.5

Fire Extinguishing: Thermal decomposition products may include hydrogen chloride, arsenic, arsine, and oxides of nitrogen and carbon. In case of fire, *do not put out the fire*. DM vapor and liquid are so bad that the fire is safer than the unburned DM. If there is some reason that you have to put out the fire—for example, there are things you can't let burn nearby—use water or ordinary foam. It's always best to use a spray or fog pattern rather than a solid stream, to avoid spreading the burning liquid around. In the unlikely situation where there is a pile of DM canisters adjacent to a fire, cool the canisters with large amounts of water, but first evacuate the area—if the canisters rupture from heating, toxic gases could kill. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Approximately 9 t of Adamsite were discovered on the territory of Poland after World War II. This agent was stored in steel barrels and special preventive measures were undertaken in order to protect it against spreading. The Polish government decided to destroy the abandoned Adamsite and different suitable technologies were considered. The first laboratory experiments have started in 1996 and elimination of the Adamsite on semitechnical scale will begin by June 1998. In this paper, methods of neutralization of Adamsite, based on its hydrolysis with hydrochloric acid, reduction with phosphorous acid and fusion with sulfur are discussed. These methods were found to be useful at the laboratory scale. Advantages and disadvantages of considered methods of destruction of organic arsenical agents have been discussed. The most promising method seems to be the reduction of Adamsite with phosphorous acid. The products of this reaction are: metallic arsenic, DPA and hydrogen chloride. These products can be separated and reused or neutralized.

References

(109); (102); (31); (173); (101); (138); (85); (100).

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Department of the Army, *Technical Manual (DA TM) 3-250, Storage, Shipment, Handling and Disposal of Chemical Agents and Hazardous Chemicals*, 1969.

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Neffe, S., Military Technical Academy, Warsaw Institute of Chemistry, *Polish Experience in Safe Disposal of Arsenic Containing Chemical Warfare Agents*, aDD756706, Conference Paper, Warsaw, Poland, 22 March1998 (copies available in English from NTIS).

Adipic Acid A:0440

Formula: $C_6H_{10}O_4$; $HOOC(CH_2)_4COOH$
Synonyms: Acido adipico (Spanish); Acifloctin; Acinetten; Adilac-tetten; Adipinic acid; 1,4-Butanedicarboxylic acid; Dicarboxylic acid C_6; 1,6-Hexanedioic acid; Hexanedioic acid
CAS Registry Number: 124-04-9
HSDB Number: 188
RTECS Number: AU8400000
UN/NA & ERG Number: UN3077 (solid)/177
EC Number: 204-673-3 [*Annex I Index No*.: 607-144-00-9]
Regulatory Authority and Advisory Information

United States Environmental Protection Agency Gene-Tox Program, Negative: Cell transformation-SA7/SHE; TRP reversion.

Hazard Alert: Combustible, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction).

Clean Water Act, 40CFR116.4 Hazardous Substances; RQ 40CFR117.3 (same as CERCLA)

Superfund/EPCRA 40CFR302.4, Appendix A, RQ: 5000 lb (2270 kg), SARA 313[4]

Canada, WHMIS, Ingredients Disclosure List Concentration 1%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xi; Risk phrases: R36/37/38; R62; Safety phrases: S26; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Adipic acid is a combustible, white, crystalline solid or powder. Odorless. Molecular weight = 146.15; specific gravity (H_2O:1) = 1.37 @ 20°C (solid); boiling point = (decomposes) 337.5°C @ 760 mmHg; freezing/melting point = 152°C; vapor pressure = 7.7×10^{-4}; 10 Pa @ 18.5°C; relative vapor density (air = 1) = 5.04; flash point = 196°C (cc). Explosive limits: LEL: 16,000 ppm: 3% (*dust*): 10−15 mg/L; autoignition temperature = 421°C; heat of combustion = −8242 Btu/lb = −4579 cal/g = -191.6×10^5 J/kg; heat of vaporization = 19,570.2 g cal/g mol. Hazard identification (based on NFPA-704 M Rating System): Health 1; flammability 1; reactivity 0. Slightly soluble in hot water; solubility = 1.5%.

Potential Exposure: Workers in manufacture of nylon, plasticizers, urethanes, adhesives, and food additives.

Incompatibilities: Dust may form explosive mixture with air. Compounds of the carboxyl group react with all bases, both inorganic and organic (i.e., amines) releasing substantial heat, water and a salt that may be harmful. Incompatible with arsenic compounds (releases hydrogen cyanide gas), diazo compounds, dithiocarbamates, isocyanates, mercaptans, nitrides, and sulfides (releasing heat, toxic, and possibly flammable gases), thiosulfates, and dithionites (releasing hydrogen sulfate and oxides of sulfur). Reacts with oxidizers, reducing agents; and strong bases. Dust forms an explosive mixture with air. Friction from stirring, pouring, or pneumatic transfer can form electrostatic charge on dry material. React violently with strong oxidizers, bromine, 90% hydrogen peroxide, phosphorus trichloride, silver powders or dust. Mixture with some silver compounds forms explosive salts of silver oxalate. Incompatible with silver compounds. Corrosive to some metals.

Permissible Exposure Limits in Air

ACGIH TLV 5 milligram per cubic meter TWA, averaged over an 8-hour work-shift.

No PAC available

Netherlands: MAC-TGG 5 milligram per cubic meter, 2003

Permissible Concentration in Water: Regulated as a hazardous substance by the Clean Water Act.

Determination in Water: Octanol−water coefficient: Log $K_{ow} \leq 0.1$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: inhalation.

Harmful Effects and Symptoms

Short-Term Exposure: Inhalation can cause burns to nose, throat and respiratory tract. May cause eye irritation and burns. There may be an asthmatic reaction.

Long-Term Exposure: Repeated prolonged exposure may cause asthma. The symptoms of asthma may not be apparent for hours following exposure and may be aggravated by physical effort. Anyone with symptoms of asthma due to this chemical should avoid all further contact with it.

Medical Surveillance: Consult a qualified allergist if asthma is suspected.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If this chemical has been inhaled, remove from exposure and transfer promptly to a medical facility.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved

SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—White (liquid): Corrosive or Contact Hazard. Store separately in a corrosion resistant location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Moisten spilled material to prevent dust buildup. This is a weak acid: use lime or sodium bicarbonate to neutralize, and absorb with peat, vermiculite, or carbon. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. Thermal decomposition products may include acidic vapors and valeric acid. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (100).

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New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Adipic Acid, Trenton, NJ (September 1998).

New York State Department of Health, Chemical Fact Sheet: Adipic Acid, Bureau of Toxic Substance Assessment, Albany, NY (March 1986).

Adiponitrile A:0450

Formula: $C_6H_8N_2$; $NC(CH_2)_4CN$

Synonyms: Adipic acid dinitrile; Adipic acid nitrile; Adipodinitrile; Adiponitrilo (Spanish); 1,4-Dicyanobutane; Hexanedinitrile; Hexanedioic acid, dinitrile; Tetramethylene cyanide

CAS Registry Number: 111-69-3

HSDB Number: 627

RTECS Number: AV2625000

UN/NA & ERG Number: UN2205/153

EC Number: 203-896-3

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Combustible, Suspected reprotoxic hazard, Environmental hazard.

CERCLA/SARA 40CFR302, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg)[7]

CERCLA/SARA 40CFR304, Appendix A, RQ (EHS, RQ): 1 lb (0.454 kg), SARA 313: (as cyanide compounds) Form R *de minimis* Concentration Reporting Level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as cyanide mixtures or solutions

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1%.

Hazardous to aquatic life or environment, with possible long-lasting effects[194]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T; Risk phrases: R23/25; R36/37/38; R63; Safety phrases: S26; S36; R45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Adiponitrile is a combustible, water-white to yellow, oily liquid. A solid below 1.1°C. Practically odorless. Molecular weight = 108.16; specific gravity (H_2O:1) = 0.97 @ 25°C (liquid); boiling point = 295°C; freezing/melting point = 1 to 2.3°C; latent heat of vaporization = (estimate) 240 Btu/lb = 134 cal/g = 5.59×10^5 J/kg; heat of combustion = −14,230 Btu/lb = −7910 cal/g = -331×10^5 J/kg; flash point = 93°C, technical grade (oc); 163°C (pure); vapor pressure = 6.8×10^{-4} mmHg @ 25°C; explosive limits: LEL: 1%, 10,000 ppm; UEL: 5.0%; autoignition temperature = 550°C. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 2; reactivity 1. Floats on water; slightly soluble.

Potential Exposure: Is used to manufacture corrosion inhibitors, rubber accelerators, and Nylon 66; and in organic synthesis.

Incompatibilities: May form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause violent reactions: fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Also incompatible with strong reducing agents such as hydrideds and active metals.

Permissible Exposure Limits in Air

OSHA PEL: None

NIOSH REL: 4 ppm/18 milligram per cubic meter TWA

ACGIH TLV[1]: 2 ppm/8.8 milligram per cubic meter TWA [skin]

PAC Ver. 29[138]

PAC-1: 0.35 ppm

PAC-2: 3.8 ppm

PAC-3: 8.1 ppm

Russia: STEL 10 milligram per cubic meter, 993; the Netherlands: MAC-TGG 8.8 milligram per cubic meter, 2003A guideline or standard in ambient air has been set in Connecticut[60] @ 360 μ/m^3.

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 200 μg[CN]/L; State Drinking Water Standards: California 150 μg[CN]/L; State Drinking Water Guidelines: Arizona 220 μg[CN]/L; Maine. 140 μg[CN]/L; Minnesota 100 μg[CN]/L. United States Army field drinking-water standards for cyanide: 2 mg[CN]/L assuming a water consumption of 15 L/day and 6 mg[CN]/L assuming a water consumption of 5 L/day. United States Army field drinking-water standards for cyanide, long-term consumption 0.5 mg [CN]/L; Short-term consumption; Raw water constituents (maximum) 20 mg[CN]/L.

Determination in Water: Octanol–water coefficient: $\text{Log}\ K_{\text{ow}} = -0.32$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact

Harmful Effects and Symptoms

Short-Term Exposure: Irritates eyes, skin and respiratory tract. Skin and eye contact can cause burns. This chemical can be absorbed through the skin, thereby increasing exposure. Inhalation can cause coughing and shortness of breath. Exposure can cause fatal cyanide poisoning with symptoms of flushing of the face, chest tightness; nausea and vomiting; weakness, lightheadedness, confusion, headache, trouble breathing; and convulsions. Higher exposure can lead to convulsions, irregular heartbeat; coma, and death. Ingestion of a few milliliters may cause weakness, mental confusion; vomiting, rapid respiration; fast heartbeat; and convulsions.

Long-Term Exposure: Adiponitrile produces disturbances of the respiration and circulation, irritation of the stomach and intestine; and loss of weight. Repeated exposure may cause personality changes; depression, anxiety, and irritability, thyroid gland damage and enlargement; and nervous system damage. Adiponitrile may damage the developing fetus. Adiponitrile may have effects on the blood and adrenal gland, resulting in anemia and tissue lesions. See also NIOSH Criteria Document 212 *Nitriles*.

Points of Attack: Eyes, skin, respiratory system; CNS; cardiovascular system.

Medical Surveillance: Consider urine thiocyanate test for preemployment and regular medical testing. If symptoms develop or overexposure is suspected, have blood cyanide levels, nervous system; and thyroid function tested.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Use amyl nitrate capsules if symptoms develop. All area employees should be trained regularly in emergency measures for cyanide poisoning and in CPR. A cyanide antidote kit should be kept in the immediate work area and must be rapidly available. Kit ingredients should be replaced every 1–2 years to ensure freshness. Persons trained in the use of this kit; oxygen use, and CPR must be quickly available. Effects may be delayed; keep victim under observation.

Personal Protective Methods: Prevent skin contact **4 hours** (At least 4 but < 8 hours of resistance to breakthrough >0.1 μm > g/cm^2/min): Teflon gloves, suits, boots. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash. See also NIOSH Criteria Document 212 *Nitriles*.

Respirator Selection: Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls, and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit. *Up to 40 ppm*: Sa (APF = 10) (any supplied-air respirator). *100 ppm*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *200 ppm*: SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *250 ppm*: SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other *positive-pressure mode*). *Emergency or planned entry into unknown concentrations* *or IDLH Conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode. *Escape*: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Outside or detached storage is preferred. Before entering confined space where adiponitrile may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2205 Adiponitrile, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. *Small spills*: absorb liquids in vermiculite, dry sand; earth, peat, activated carbon, or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: dike far ahead of spill for later disposal. Seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line). Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Keep adiponitrile out of a confined space, such as a sewer, because of the potential for an explosion. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include deadly hydrogen cyanide, nitrogen oxides; hydrogen, and carbon monoxide. Use dry chemical, carbon dioxide; water spray; alcohol foam or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Add excess alcoholic KOH. Than evaporate alcohol and add calcium hypochlorite. After 24 hours, flush to sewer with water[22]. Can also be incinerated with afterburner and scrubber to remove nitrogen oxides.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Adiponitrile, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 6, 22–24 (1981).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Adiponitrile, Trenton, NJ (November 1998).

Adriamycin A:0460

Formula: $C_{27}H_{29}O_{11}N$

Synonyms: ADM; Adriablastine; Adriamycin-HCl; Adriamycin semiquinone; Adriblastina; Doxorubicin; DX; 14′-Hydroxydaunomycin; 14-Hydroxydaunomycin; 14-Hydroxydaunorubicine

CAS Registry Number: 23214-92-8; 25316-40-9

HSDB Number: 3070 as doxorubicin

RTECS Number: AV9800000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Animal Sufficient Evidence; Human Inadequate Evidence, *probably carcinogenic to humans*, Group 2A, 1987.

California Proposition 65 Chemical[102]: cancer, 7/1/1987; developmental, male 1/29/1999, as doxorubicin hydrochloride (adriamycin) CAS: 25316-40-9.

Hazard Alert: Poison, Drug.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, Xi; Risk phrases: R45; R22; R26/27/27; R34; R36/38; R40; R61; Safety phrases: S7/9; S22; S36/37/39; S41; S45; S53 (see Appendix 4).

Description: Adriamycin is an orange to red cake-like or needle-like crystalline solid. Molecular weight = 543.6; freezing/melting point = 205°C. Slightly soluble in water.

Potential Exposure: An antibiotic product from streptomyces, used as anticancer drug.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Routes of Entry: Intravenous, skin, eyes.

Harmful Effects and Symptoms

Short-Term Exposure: Highly toxic. Irritates eyes and skin. A poison if ingested. This chemical can be absorbed through the skin, thereby increasing exposure.

Long-Term Exposure: Has been shown to cause breast cancer in animals. There is limited evidence that adriamycin is a teratogen in animals. Causes baldness, stomatitis, and bone marrow aphasia in humans. Fatal human cardiac disturbances have been reported.

Points of Attack: Cardiovascular system.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. CBC, EKG, examination of the nervous system.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: A regulated, marked area should be established where Adriamycin is handled, used, or stored. All operations should be enclosed and locally ventilated through high efficiency particulate absolute (HEPA) filters. Wear protective work clothing. Wash thoroughly immediately after exposure to Adriamycin and at the end of the work-shift. Medical personnel preparing solutions of Adriamycin should only do so under a biological safety hood with a vertical laminar flow. Workers whose clothing has been contaminated by Adriamycin should change into clean clothing promptly. Do not take contaminated work clothes home. Family members could be exposed. Contaminated work clothes should be laundered by individuals who have been informed of the hazards of exposure to Adriamycin. Do not eat, smoke, or drink where Adriamycin is handled, processed, or stored, since the chemical can be swallowed. Wash hands carefully before eating or smoking. When vacuuming, a HEPA filter should be used, not a standard shop vacuum.

Respirator Selection: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. A regulated, marked area should be established where Adriamycin is handled, used, or stored.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft.(NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material using a HEPA filter vacuum cleaner and deposit in sealed containers. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide; water spray; alcohol foam; or polymer foam extinguishers. Thermal decomposition products may include nitrogen oxides and hydrogen chloride. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: It is inappropriate and possibly dangerous to the environment to dispose of expired or waste pharmaceuticals by flushing them down the toilet or discarding them to the trash. Household quantities of expired or waste pharmaceuticals may be mixed with wet cat litter or coffee grounds, double-bagged in plastic, discard in trash. Larger quantities shall carefully take into consideration applicable DEA, EPA, and FDA regulations. If possible return the pharmaceutical to the manufacturer for proper disposal being careful to properly label and securely package the material. Alternatively, the waste pharmaceutical shall be labeled, securely packaged and transported by a state licensed medical waste contractor to dispose by burial in a licensed hazardous or toxic waste landfill or incinerator.

References

(109); (102); (31); (173); (101); (138).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 1, No. 3, 24–25 (1981).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Adriamycin, Trenton, NJ (October 1998).

Aflatoxins A:0470

Formula: $C_{16\text{-}17}H_{10\text{-}14}O_{6\text{-}7}$; $C_{17}H_{12}O_6$ (b; b1; b2); $C_{17}H_{12}O_7$ (g1; m1); $C_{17}H_{14}O_7$ (g2; m2); $C_{16}H_{10}O6$ (p1)

Synonyms: AFL; Aflatoxicol; Aflatoxin B1 dichloride; Cyclopenta[*c*]furo(3′,2′:4,5)furo(2,3-*H*)(1)benzopyran-1,11-dione, 2,3,6a,8,9,9a-hexahydro-8,9-dichloro-4-methoxy-[6aS-(6a-A-8-B,9-A-9aa-)]-; 2,3-Dichloroaflatoxin B1; Dihydroaflatoxin B1; Dihydroaflatoxin G1; 4-Dihydroxyaflatoxin B1

CAS Registry Number: 1402-68-2 (aflatoxin); 1162-65-8 (aflatoxin b); 1162-65-8 (aflatoxin b1); 7220-81-7 (aflatoxin b2); 1165-39-5 (aflatoxin g1); 58209-98-6 (aflatoxin b1 dichloride); 7241-98-7 (aflatoxin g2); 6795-23-9 (aflatoxin m1); 6885-57-0 (aflatoxin m2); 32215-02-4 (aflatoxin p1); 29611-03-8 (aflatoxin Ro)

HSDB Number: 3411

RTECS Number: AW5950000 (aflatoxin); GY1925000 (b); GY1925000 (b1); GY1722000 (b2); LV1700000 (g1); LV1700000 (g2); GY1880000 (m1); GY1720000 (m2); GY1775000 (p1)

UN/NA & ERG Number: UN3172/153; UN2811 (toxic solid, organic, n.o.s.)/154

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, Known to be a Human Carcinogen; IARC: Naturally occurring aflatoxins, *carcinogenic to humans*, Group 1; Aflatoxin M_1, *possibly carcinogenic to humans*, Group 2B, 1997; Human Sufficient Evidence, naturally occurring mixtures of aflatoxins and aflatoxin B_1; Animals Sufficient Evidence, naturally occurring mixtures of aflatoxins and aflatoxins B_1, G_1, and M_1; Human Inadequate Evidence, aflatoxin M1; Animal Limited Evidence aflatoxin B_2; Animal Inadequate Evidence aflatoxin G_2; NTP: Known to be a human carcinogen

California Proposition 65 Chemical[102]: Cancer 1/1/1988.

Hazard Alert: 1402-68-2: Poison, Suspected of causing genetic defects, Suspected reprotoxic hazard.

RCRA 40CFR261, Appendix 8; 40CFR261.11 Hazardous Constituents[5].

Hazard symbols, risk, & safety statements: Hazard symbol: T; Risk phrases: R45; R10; R27/28; R50; R62; R63; Safety phrases: S13; S28; S45 (see Appendix 4)

Description: The aflatoxins are a group of molds produced by the fungus *Aspergillus flavus*. They are natural contaminants of fruits, vegetables, and grains. They are also described as a series of condensed ring heterocyclic compounds. They form colorless to pale yellow crystals. Practically insoluble in water. Molecular weight = 312.3 (b1), 383.2 (b1 dichloride), 314.3 (b2), 328.3 (g1), 330.3 (g2), 328.3 (m1), 314.3 (Ro); freezing/melting point = 268–269°C (b1), 247–250°C (g1), 237–240°C (g2), 290°C (m1), 225°C (Ro).

Potential Exposure: Aflatoxins are a group of toxic metabolites produced by certain types of fungi. Aflatoxins are not commercially manufactured; they are naturally occurring contaminants that are formed by fungi on food during conditions of high temperatures and high humidity. Most human exposure to aflatoxins occurs through ingestion of contaminated food. The estimated amount of aflatoxins that Americans consume daily is estimated to be 0.15–0.50 μg. Grains, peanuts, tree nuts, and cottonseed meal are among the more common foods on which these fungi grow. Meat, eggs, milk, and other edible products from animals that consume aflatoxin-contaminated feed may also contain aflatoxins. Aflatoxins can also be breathed in.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air
No standards or PAC available.
DFG MAK: [skin]; Carcinogen Category 2B [CAS: 6795-23-9 (m1)].

Routes of Entry: Ingestion and inhalation. An unavoidable contaminant in foods: the FDA limits the levels of aflatoxin contamination that are permitted in food. The complete elimination of aflatoxin contamination of food is probably not technically feasible. The FDA has lowered the maximum amount allowed in food products as methods of detection and methods of control have improved. Upper limits of 20 ppb (total B1, B2, G1, and G2) in foods and feeds and 0.5 ppm (M1) in milk are now in effect.

Harmful Effects and Symptoms
Aflatoxins are carcinogenic in mice, rats, fish, ducks, marmosets, tree shrews and monkeys by several routes of administration (including oral), producing mainly cancers of the liver, colon and kidney. Epidemiological studies have shown a positive correlation between the average dietary concentrations of aflatoxins in populations and the incidence of primary liver cancer. These studies were undertaken to test this specific hypothesis; however, no studies have been carried out which could link an increased risk of liver cancer to actual aflatoxin intake in individuals.

Short-Term Exposure: May be fatal by ingestion, inhalation and skin contact.

Long-Term Exposure: Aflatoxins are carcinogens in humans. They may cause liver cancer. They have also been shown to be teratogens in animals. Aflatoxins may cause liver and kidney damage.

Points of Attack: Liver, kidneys.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Liver and kidney function tests.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: A Class I, Type B, biological safety hood should be used when handling, mixing, or preparing aflatoxins. Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Latex gloves are recommended as a protective material, *unless using aflatoxins in chloroform.* Contact lenses should not be worn when working with this chemical. Wear indirect-vent, impact and splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air-purifying, full facepiece respirator with an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. A regulated, marked area should be established where aflatoxins are handled, used, or stored. Store in a refrigerator and protect from exposure to air and light.

Shipping: UN3172 Toxins, extracted from living sources, solid or liquid, Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft.(NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen spilled material with 60%–70% of acetone to avoid airborne dust then transfer to a suitable sealed container for disposal. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material may burn, but will not easily ignite. Thermal decomposition products may include oxides of a carbon. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Use of oxidizing agents, such as hydrogen peroxide or 5% sodium hypochlorite bleach. Acids and bases may also be used[22].

References

(109); (102); (31); (173); (101); (138).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 1, No. 4, 31−33 (1981), and 7, No. 2, 36−43 (1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Aflatoxins, Trenton, NJ (August 1998).

Alachlor A:0480

Formula: $C_{14}H_{20}ClNO_2$

Synonyms: Acetamide, 2-chloro-*N*-(2,6-diethylphenyl)-*N*-(methoxymethyl)-; Acetanilide, 2-chloro-2′,6′-diethyl-*N*-methoxymethyl)-; Al3-51506; Alachlor; Alanex; Alanox; Alatox480; α-Chloro-2′,6′-diethyl-*N*-(methoxymethyl)acetanilide; 2-Chloro-*N*-(2,6-diethylphenyl)-*N*-(methoxymethyl) acetamide; EPA pesticide chemical code 090501; Glyphosate isopropylamine salt; Lassagrin; Lasso; Lasso Micro-tech; Lazo; Metachlor; Methachlor; *N*-(Methoxymethyl)2,6-diethylchloroacetamide; Pillarzo

CAS Registry Number: 15972-60-8

HSDB Number: 1014

RTECS Number: AE1225000

UN/NA & ERG Number: UN2588 (pesticides, solid, toxic, n.o.s.)/155; UN3077

EC Number: 240-110-8 [*Annex I Index No*.: 616-015-00-6]

Regulatory Authority and Advisory Information

Carcinogenicity: (EPA) Probable human; likely for high doses; not likely for low doses[47] United States Environmental Protection Agency Gene-Tox Program, Positive: S *cerevisiae* gene conversion.

California Proposition 65 Chemical[102]: Cancer 1/1/1989

Hazard Alert: Poison, Endocrine disruptor (high) [EU], Possible risk of forming tumors, Suspected of causing genetic defects, Sensitization hazard [skin], Environmental hazard. Listed for Tier 1 screening as an endocrine disruptor[88].

United States Environmental Protection Agency, FIFRA 1998 Status of Pesticides: Supported

Banned or Severely Restricted (EPA-FIFRA) (See “References” below)

(102); (31).

United States National Primary Drinking Water Regulations: MCL = 0 mg/L; MCL = 0.002 mg/L.

Superfund/EPCRA 40CFR302.4, Appendix A, RQ: 1 lb (0.454 kg), SARA 313: Form R *de minimis* Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: Xn, N, Xi; Risk phrases: R45; R22; R40; R43; R50/53; Safety phrases: S2; S29; S36/37; S41; S46; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Alachlor is an acetanilide pesticide is a cream-colored solid. Molecular weight = 269.79; density = 1.1 g/cm^3; freezing/melting point = 39.5−41.5°C; flash point = 137°C (cc). Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 0; reactivity 0. Slightly soluble in water.

Potential Exposure: A chloracetanilide herbicide. In manufacture, formulation and application of this preemergence herbicide, personnel may be exposed. Its major use (99%) is as a preemergence herbicide for field crops (corn, soybeans, and peanuts, etc.).

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Corrosive to iron and steel.

Permissible Exposure Limits in Air

ACGIH TLV[1]: 1 milligram per cubic meter TWA (inhalable fraction and vapor). Excursion Limit Recommendation: Excursions in worker exposure levels may exceed 3 times the TLV-TWA for no more than a total of 30 minutes during a work day, and under no circumstances should they exceed 5 times the TLV-TWA, provided that the TLV-TWA is not exceeded. A3: Confirmed animal carcinogen with unknown relevance to humans. A3, confirmed animal carcinogen with unknown relevance to humans.

Permissible Concentration in Water: Safe Drinking Water Act, MCL, 0.002 mg/L; MGLC, zero. No adverse-effect-level in drinking water has been calculated by NSA/NRC[46] as 0.7 mg/L. Acceptable daily intake (ADI) has been calculated at 0.1 mg/kg/day. More recently, the EPA[47] has reviewed alachlor and determined a 10-day Health advisory: value of 0.1 mg/L for a 10-kg child. An acceptable daily intake was calculated as 0.01 mg/kg/day in the study. A maximum level in drinking water of 0.002 mg/L has been proposed by EPA[62]. Several states[61] have set guidelines for alachlor in drinking water ranging from 0.15 μg/L (Arizona) to 0.2 μg/L (Illinois) to 2.0 μg/L (Massachusetts) to 10.0 μg/L (Minnesota) to 15 μg/L (Kansas) to 200 μg/L (Maine).

Determination in Water: May be accomplished by liquid extraction gas chromatographic procedure[47]. Octanol−water coefficient: Log $K_{ow} \geq 3.5$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Ingestion, dermal contact.

Harmful Effects and Symptoms

No effects found in human studies[47]. Exhibits relatively low acute oral toxicity; the LD_{50} value for rats is 0.93 g/kg. The technical product has only slight skin and eye irritation potential after an acute exposure[47]. However, alachlor feeding studies have demonstrated oncogenic effects including lung tumors in mice, and stomach, thyroid and nasal turbinate tumors in rats.

Short-Term Exposure: Toxic by skin contact, ingestion, and inhalation. Eye contact may cause severe irritation or injury. Skin contact may irritate and burn skin.

Long-Term Exposure: Repeated or prolonged contact may cause skin sensitization. May cause liver damage. A suspected endocrine disruptor and carcinogen; developmental toxin. Human mutation data reported.

Points of Attack: Liver.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If this chemical has been inhaled, remove from exposure and transfer promptly to a medical facility.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Do not reuse container; see disposal methods, below.

Shipping: UN2588 Pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Ventilate area of spill or leak. Use water spray to reduce vapors. Take up with diatomite, clay, expanded mineral, foamed glass, or synthetic treated absorbent material and deposit in sealed containers for later disposal. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. For *large spills* seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Fire Extinguishing: This chemical is not flammable, but may support combustion. Thermal decomposition products may include hydrogen chloride and oxides of nitrogen and carbon. Stay upwind of fire. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: This compound is hydrolyzed under strongly acid or alkaline conditions, to chloroacetic acid, methanol, formaldehyde and 2,6-diethylanilne. Incineration is recommended as a disposal procedure. Techniques for alachlor removal from potable water have been reviewed by EPA[47] but the data revealed no superior method. Improper disposal of pesticides is a violation of federal law. Dispose In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers.

References

(31); (61); (101); (173); (201); (138); (100).

United States Environmental Protection Agency, "Alachlor: Notice of Intent to Cancel Registrations; Conclusion of Special Review," Federal Register 52, No. 251, pp. 49480−49504 incl. (December 31, 1987).

Aldicarb A:0490

Formula: $C_7H_{14}N_2O_2S$; $CH_3SC(CH_3)2CH = NOCONHCH_3$

Synonyms: A13-27093; Aldecarb; Aldecarbe (French); Ambush; Carbamic acid, methyl-,*O*-([2-methyl-2-(methylthio)propylidene]amino) derivative; Carbanolate; Caswell No. 011A; EPA pesticide chemical code 098301; 2-Methyl-2-(methylthio)propanaldehyde, *O*-(methylcarbamoyl) oxime; 2-Methyl-2-(methylthio)propanal, *O*-[(methylamino)carbonyl] oxime; 2-Methyl-2-methylthio-propionaldehyd-*O*-(*n*-methyl-carbamoyl)-oxim (German); Permethrin; Propanal, 2-methyl-2-(methythio)-, *O*-[(methylamino)carbonyl] oxime; Propionaldehyde, 2-methyl-2-(methylthio)-, *O*-(methylcarbamoyl) oxime; Sulfone aldoxycarb; Temic; Temik; Temik 10G; Temik G10; Tedmik 150 G; UC 21149 (Union Carbide); Union Carbide 21149; Union Carbide UC-21149.

CAS Registry Number: 116-06-3

HSDB Number: 1510

RTECS Number: UE2275000

UN/NA & ERG Number: UN2757 (carbamate pesticides, solid, toxic)/151

EC Number: 204-123-2 [*Annex I Index No.*: 006-017-00-X]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Inadequate Data; Human No Available Data, *not classifiable as carcinogenic to humans*, Group 3, 1991; NCI: Carcinogenesis Bioassay (feed); no evidence: mouse, rat. United States Environmental Protection Agency Gene-Tox Program, Negative: Carcinogenicity-mouse/rat.

Hazard Alert: Poison, Possible neurotoxic effects (methyl carbamate), Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Environmental hazard, Agricultural chemical (potent carbamate).

Classified by the EPA as Restricted Use Pesticide (RUP)

United States Environmental Protection Agency, FIFRA 1998 Status of Pesticides: Supported

Banned or Severely Restricted (Austria, Belgium, Germany, Israel, Norway, Philippines) (UN)[13]

United States Environmental Protection Agency Hazardous waste number (RCRA No.): P070

RCRA 40CFR261, Appendix 8; 40CFR261.11 Hazardous Constituents

RCRA Land Ban Waste Restrictions

Federal Drinking Water Standards and Guidelines: MCL, 0.003 mg/L; MCLG 0.001 mg/L.

CERCLA/SARA 40CFR302, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg).

Superfund/EPCRA 40CFR302.4, Appendix A, RQ: CERCLA 1 lb (0.454 kg), SARA 313: Form R *de minimis* Concentration Reporting Level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T + , N; Risk phrases: R24; R26/28; R50/53; R62; Safety phrases: S1/2; S22; S29; S36/37; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Aldicarb is a noncombustible, white crystalline solid with a slight sulfurous odor. Molecular weight = 190.3; boiling point = (decomposes); freezing/melting point = 99−100°C; specific gravity (H_2O:1) = 1.18; vapor pressure = 2.9×10^{-5} mmHg @ 25°C. Relative vapor density (air = 1) = 6.59. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 1; reactivity 1. Slightly soluble in water; solubility = 0.6 g/L @ 25°C.

Potential Exposure: A systemic, restricted use (RUP), carbamate pesticide. It is available for purchase and use by certified pesticide applicators or by those under their direct supervision. Personnel involved in manufacture, formulation, or application of this insecticide to crops are at risk.

Incompatibilities: Strong alkalis.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 0.027 milligram per cubic meter

PAC-2: 0.3 milligram per cubic meter

PAC-3: 1.8 milligram per cubic meter

Finland: TWA 0.5 milligram per cubic meter; STEL 1.5 milligram per cubic meter, 1999.

Determination in Air: Organonitrogen pesticides. OSHA versatile sampler-2; Reagent; High-pressure liquid chromatography/Ultraviolet detection; NIOSH Analytical Method (IV) #5601.

Permissible Concentration in Water: EPA/Safe Drinking Water Act levels: MCL, 0.003 mg/L; MCLG 0.001 mg/L. Federal Drinking Water Guidelines: United States Environmental Protection Agency 7 μg/L for Aldecarb,

Aldecarb sulfoxide, & Aldecarb sulfone; State Drinking Water Standards: Illinois 2 μg/L for Aldecarb & Aldecarb sulfone; 4 μg/L for Aldecarb sulfoxide; New York 3 μg/L for Aldecarb; 2 μg/L Aldecarb sulfone; 4 μg/L for Aldecarb sulfoxide; State Drinking Water Guidelines: Arizona 9 μg/L; California 7 μg/L; Maine 7 μg/L for Aldecarb & Aldecarb sulfone; Minnesota 1 μg/L; Wisconsin 10 μg/L; Massachusetts 3 μg/L for Aldecarb; 4 μg/L for Aldecarb sulfoxide; 2 μg/L for Aldecarb sulfone.

Determination in Water: Aldicarb may be determined in water by gas−liquid chromatography with flame photometric detection after oxidation to the sulfone (aldoxycarb) by peracetic acid or 3-chloro-perbenzoic acid. Colorimetric methods have also been used based on hydrolysis to hydroxyl-amine which is oxidized to nitrous acid, the latter used to diazotize sulfanilic acid which is then coupled to give a dye[23]. Fish Tox = 3.75027000 MATC (HIGH). Octanol−water coefficient: Log $K_{ow} \leq 1.2$. Unlikely to bioaccumulate in marine organisms. $EC_{50} = 0.41$ mg/L (48 h, *Daphnia magna*).

Routes of Entry: Ingestion, skin contact.

Harmful Effects and Symptoms

Aldicarb is a carbamate pesticide. This material is super toxic; the probable oral lethal dose for humans is less than 5 mg/kg, or a taste (less than 7 drops) for a 150-lb person; it is extremely toxic by both oral and dermal routes. Symptoms include headache, blurred vision; nausea, vomiting, diarrhea, and abdominal pain. In severe cases, unconsciousness and convulsions may occur.

Short-Term Exposure: This chemical is one of the most highly toxic pesticides. It can be harmful or fatal if swallowed, inhaled or absorbed through the skin. Exposure can cause rapid severe poisoning with headache, sweating, nausea, and vomiting; diarrhea, loss of coordination; and possible death. Aldicarb may affect the nervous system causing convulsions and respiratory failure. It is a cholinesterase inhibitor. Exposure may result in death. The effects may be delayed; medical observation is recommended. $LD_{50} = 1$ mg/kg[77]

Long-Term Exposure: Human mutation data reported. May affect the immune system. Aldicarb is a questionable carcinogen with no firm human evidence. Human tox = 7.00 ppb (MCL) (HIGH)[77]

Points of Attack: skin, lungs.

Medical Surveillance: Plasma and red-blood-cell cholinesterase levels (test for enzyme poisoned by this chemical). For this substance, these tests are accurate only if done within about 2 hours of exposure.

First Aid: Move victim to fresh air; call emergency medical care. Speed in removing material from eyes and skin is of extreme importance. If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/ manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. All users of Temik 150G must have attended a training program and be issued with a Bayer CropScience Certificate of Temik Accreditation prior to purchase and use of this product.

Respirator Selection: *At any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air-purifying, full facepiece respirator with an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. A regulated, marked area should be established where Aldicarb is handled, used, or stored. Store in tightly closed containers in a cool, well-ventilated area away from strong alkalis (such as sodium hydroxide, sodium bicarbonate, etc.).

Shipping: UN2757 Carbamate pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Wear positive-pressure breathing apparatus and special protective clothing. Remove and isolate contaminated clothing at the site. Do not touch spilled material; stop leak if you can do it without risk. Use water spray to reduce vapors. *Small spills*: take up with diatomite, clay, expanded mineral, vermiculite, sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills*: with clean shovel place material into clean, dry container and cover; move containers from spill area. *Large spills*: dike far ahead of spill for later disposal. Seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line). It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Soil Adsorption Index (K_{oc}) = 30.

Fire Extinguishing: May burn but does not ignite readily. Thermal decomposition products may include hydrogen chloride and oxides of nitrogen sulfur and carbon. Toxic gases may also contain fumes of aldicarb nitrile, aldicarb oxime, and methylamine. *Small fires*: dry chemical, carbon dioxide; water spray; or alcohol foam. *Large fires*: water spray, fog or alcohol foam. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Wear positive-pressure breathing apparatus and special protective clothing. Move container from fire area if you can do it without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Do not discharge into drains or sewers. Dispose of waste material as hazardous waste using a licensed disposal contractor to an approved landfill. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration with effluent gas scrubbing is recommended[22]. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (201); (100).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 4, No. 2, 37–41 (1984).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Aldicarb, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Aldicarb, Trenton, NJ (January 2001).

NIOSH Manual of Analytical Methods, 4th Edition, Issue 1, *Organonitrogen pesticides*, page 7of 21, Cincinnati, OH, 1/15/1998.

NCBI/NLM/PubMed http://www.ncbi.nlm.nih.gov/pubmed/6763154.

Aldol A:0500

Formula: $C_4H_8O_2$

Synonyms: Acetaldol; Aldehido, β-hidroxibutirico (Spanish); 3-Butanolal; Butyraldehyde, 3-hydroxy-; 3-Hydroxybutanal; β-Hydroxybutyraldehyde; 3-Hydroxybutyraldehyde; Oxybutanal; Oxybutyric aldehyde

CAS Registry Number: 107-89-1

HSDB Number: 2663

RTECS Number: ES1500000

UN/NA & ERG Number: UN2839/153 (P)

EC Number: 203-530-2

Regulatory Authority and Advisory Information

Hazard Alert: Flammable, Polymerization hazard.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, F; Risk phrases: R10; R19; R24; R36; Safety phrases: S26; S28; S36/37; S41; S45 (see Appendix 4).

Description: Aldol is a flammable, colorless to pale yellow, syrupy liquid. Pungent odor. Molecular weight = 88.1; specific gravity (H_2O:1) = 1.1; boiling point = 80°C @ 20 mmHg[17] (decomposes above 83°C); freezing/melting point = 0°C; vapor pressure ≤ 7.6×10^{-3} mmHg @ 20°C[52]; vapor density (air = 1) = 2.98; flash point = 66°C; autoignition temperature = 250°C. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 2; reactivity 2. Good solubility in water.

Potential Exposure: Aldol is used as a solvent and to manufacture rubber accelerators, perfumes; in fungicides; and in engraving, cadmium plating.

Incompatibilities: Danger! May be subject to spontaneous polymerization. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Contact with metals may evolve flammable hydrogen gas. Heat above 83°C causes the formation of crotonaldehyde vapor (which may cause explosion) and water.

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the skin, eyes and respiratory tract. This chemical can be absorbed through the skin, thereby increasing exposure. Exposure to vapor may cause sore throat, coughing, dizziness, lightheadedness, and unconsciousness. Ingestion causes abdominal pain.

Long-Term Exposure: Prolonged or repeated skin contact may cause redness, irritation and dryness.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear solvent-resistant gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where Aldol may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2839 Aldol, Hazard Class: 6.1; Labels: 6.1-Poison Inhalation Hazard.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Ventilate area of spill or leak. Use water spray to reduce vapor. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: *Aldol*, Trenton NJ (September 1998).

Aldrin A:0510

Formula: $C_{12}H_8C_{16}$

Synonyms: Aldocit; Aldrec; Aldrex; Aldrex-30; Aldrex-40; Aldrina (Spanish); Aldrin y dieldrin (Spanish); Aldrine (French); Aldrite; Aldron; Aldrosol; Algran; Altox; 1,4,5,8-Dimethanonaphthalene,1,2,3, 4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-(1a,4a,4b, 5a,8a,8b)-; 1,4:5,8-Dimethanonaphthalene, 1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-, endoexo-; Drinox; ENT15949; 1,2,3,4,10,10-Hexachloro-1,4,4a,5,8,8a-hexahydro-1,4,5,8-dimethanonaphthalene; 1,2,3,4,10,10-Hexachloro-1,4,4a, 5,8,8a-hexahydro-1,4-endoexo-5,8-dimethanonaphthalene; 1,2,3,4,10-10-Hexachloro-1,4,4a,5, 8,8a-hexahydro-1,4,5, 8-endoexo-dimethanonaphthalene; Hexachlorohexahydro-endoexo-dimethanonaphthalene; 1,2,3,4,10,10-Hexachloro-1,4,4a,5,8,8a-hexahydro-exo-1,4-endo-5,8-dimethanonaphthalene; HHDN; Octalene; Octalene; Seedrin; Seedrin; Toxadrin

CAS Registry Number: 309-00-2; *(alt.)* 34487-55-3

HSDB Number: 1178 as naphthenic acids

RTECS Number: IO2100000

UN/NA & ERG Number: UN2761 (Organochlorine pesticides, solid toxic)/151; UN2762 (Organochlorine pesticides liquid, flammable, toxic, flash point < 23°C)/131

EC Number: 206-215-8 [*Annex I Index No.*: 602-048-00-3]

Regulatory Authority and Advisory Information

Carcinogenicity: NCI: Carcinogenesis Bioassay (feed); clear evidence: mouse; (feed); equivocal evidence: rat; IARC: Animal Limited Evidence; Human Inadequate Evidence Group 3, 1987; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies.

California Proposition 65 Chemical[102]: Cancer 7/1/1988.

Hazard Alert: Exposure can be lethal, Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Environmental hazard, Agricultural chemical.

Persistent Organic Pollutants (POP) (UN)

Clean Water Act: 40CFR116.4 Hazardous Substances; 40CFR117.3 (same as CERCLA); 40CFR423, Appendix A Priority Pollutants; 57FR41331 Priority Chemicals; 40CFR401.15 Toxic Pollutant

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P004

RCRA 40CFR261, Appendix 8; 40CFR261.11 Hazardous Constituents

RCRA Land Ban Waste Restrictions

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.021; Nonwastewater (mg/kg), 0.066

RCRA 40CFR264, Appendix 9; Ground Water Monitoring List: Suggested methods (PQL μg/L): 8080 (0.05); 8270 (10)

CERCLA/SARA 40CFR302, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg).

Superfund/EPCRA 40CFR302.4, Appendix A, RQ: 1 lb (0.454 kg); SARA 313: Form R *de minimis* Concentration Reporting Level: 1.0%.

Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)]

List of Stockholm Convention POPs: Annex A (Elimination)

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T + , N; Risk phrases: R45; R24/25; R40; R45; R48/24/25; R50/53; R62; R63; Safety phrases: S1/2; S22; S29; S36/37; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Aldrin is a colorless, crystalline solid. The technical grade is a tan to dark brown solid. It has a mild, chemical odor. Molecular weight = 364.93; boiling point = 145°C (decomposes); freezing/melting point = 104°C (pure); 49−60°C (technical grade); specific gravity (H_2O:1) = 1.6 @ 20°C (solid); vapor pressure = 6.6×10^{-6} mmHg. Although noncombustible, aldrin may be dissolved in a flammable liquid. Hazard identification (based on NFPA-704 M Rating System): Health 4; flammability 1; reactivity 0. Practically insoluble in water; solubility = 0.003%[2].

Potential Exposure: Compound

Description: Formerly used as an insecticide in the United States Pesticide manufacturers, formulators and applicators. Some people in the United States may be exposed to aldrin (and dieldrin) in air, water and food because of its persistence in the environment. See "Dieldrin" for more details.

Incompatibilities: Avoid concentrated mineral acids; acid catalysts; acid oxidizing agents; phenol, or active metals.

Permissible Exposure Limits in Air

NIOSH IDLH = 25 milligram per cubic meter, potential occupational carcinogen.

Odor threshold = 0.3 milligram per cubic meter.

OSHA PEL: 0.25 milligram per cubic meter TWA [skin]

NIOSH REL: 0.25 milligram per cubic meter TWA [skin], potential occupational carcinogen; Limit exposure to lowest feasible level.

ACGIH TLV[1]: 0.05 milligram per cubic meter TWA inhalable fraction and vapors [skin]; confirmed animal carcinogen with unknown relevance to humans (2006)
PAC Ver. 29[138]
PAC-1: 0.91 milligram per cubic meter
PAC-2: 10 milligram per cubic meter
PAC-3: 100 milligram per cubic meter
DFG MAK: 0.25 milligram per cubic meter measured as, inhalable fraction [skin]; Peak limitation Category II(8)
Australia: TWA 0.25 milligram per cubic meter [skin], 1993; Austria: MAK 0.25 milligram per cubic meter [skin], 1999; Belgium: TWA 0.25 milligram per cubic meter [skin], 1993; Denmark: 0.25 milligram per cubic meter [skin], 1999; Finland: TWA 0.25 milligram per cubic meter; STEL 0.75 milligram per cubic meter [skin], 1999; France: VME 0.25 milligram per cubic meter [skin], carcinogen, 1999; the Netherlands: MAC-TGG 0.25 milligram per cubic meter [skin], 2003; Norway: TWA 0.25 milligram per cubic meter, 1999; the Philippines: TWA 0.25 milligram per cubic meter [skin], 1993; Poland: MAC (TWA) 0.5 milligram per cubic meter; STEL 1.5 milligram per cubic meter, 1999; Russia: STEL 0.01 milligram per cubic meter [skin], 1993; Switzerland: MAK-W 0.25 milligram per cubic meter [skin], 1999; Thailand: TWA 0.25 milligram per cubic meter, 1993; Turkey: TWA 0.25 milligram per cubic meter [skin], 1993; United Kingdom: TWA 0.25 milligram per cubic meter; STEL 0.75 milligram per cubic meter [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: confirmed animal carcinogen with unknown relevance to humans. Several states have set guidelines or standards for Aldrin in ambient air:[60] 0.035 μ/m^3 (Pennsylvania) to 0.595 μ/m^3 (Kansas) to 1.5 μ/m^3 (Connecticut) to 2.5 μ/m^3 (North Dakota) to 4.0 μ/m^3 (Virginia) to 6.0 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method #5502[18]. A filter plus bubbler containing isooctane followed by workup with isooctane and analysis by GC.

Permissible Concentration in Water: State Drinking Water Standards: Illinois 1 μg/L; State Drinking Water Guidelines: Arizona 0.002 μg/L; Florida 0.002 μg/L; California 0.02 μg/L; New Hampshire 0.002 μg/L; Maine 0.02 μg/L. Aldrin is highly toxic to aquatic organisms and every care must be taken to avoid release to the environment. In the food chain important to humans, bioaccumulation takes place, specifically in aquatic organisms. It is strongly advised not to let the chemical enter into the environment because of its persistence.

Determination in Water: GC (EPA Method 608) or GC plus mass spectrometry (EPA Method 625). Octanol−water coefficient: Log $K_{\text{ow}} \geq 7$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood. Naphthalenes and naphthenic acids are listed as United States DOT marine pollutants and may persist in the environment. Fish toxicity (threshold)[77]: 0.18049 ppb MACT. (EXTRA HIGH).

Routes of Entry: Inhalation, skin absorption; ingestion, eye and skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Eye and skin contact can cause irritation and burns. Can be fatal if swallowed or absorbed through the skin. Aldrin tends to produce convulsions before other, less serious signs of illness have appeared. Victims have reported headache, nausea, vomiting, dizziness, and mild chronic jerking. Some victims have convulsions without warning. Poisoning by Aldrin usually involves convulsions due to its effects on the CNS. Probable oral lethal dose for humans is between 7 drops and one ounce for a 150-pound adult human.

Long-Term Exposure: May cause tumors, cancer, mutations, reproductive effects. Reproductive effects and liver effects have also been reported. It is classified as an extremely toxic chemical. Conflicting reports of carcinogenicity of this compound remain an area of controversy. Similar chemically and toxicologically to dieldrin. Cancer site in animals: tumors of the lungs, liver, thyroid & adrenal glands[2]. Human Tox = 0.02058 ppb CHCL (Chronic Human Carcinogen Level)(EXTRA HIGH).

Points of Attack: CNS; liver, kidneys, skin.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Consider the points of attack in preplacement and periodic physical examinations. NIOSH recommends the following tests: blood plasma, CBC; liver function tests; urinalysis (routine), reticulocyte count.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give a slurry of activated charcoal in water to drink. Do NOT induce vomiting.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: SCBA. 0.91 milligram per cubic meter *At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration*: SCBAF: Pd,Pp (APF = 10,000): (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus). *Escape*: GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area, preferably outdoors. Always store pesticides in their original containers, complete with labels that list ingredients, directions for use, and first aid steps in case of accidental poisoning. Never store pesticides in cabinets with or near food, animal feed, or medical supplies. Do not store pesticides in places where flooding is possible or in places where they might spill or leak into wells, drains, ground water, or surface water[72].

Shipping: UN2761 Organochlorine pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Ventilate area of spill or leak. Use water spray to reduce vapor. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. For large spill seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Fire Extinguishing: The solid material is not combustible, but Aldrin is often dissolved in a flammable liquid. Thermal decomposition products may include hydrogen chloride and chlorine. Move container from fire area if you can do so without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Aldrin is very stable thermally with no decomposition noted @ 250°C. Aldrin (along with the structurally related compounds dieldrin and isodrin) is remarkably stable to alkali (in contrast to chlordane and heptachlor) and refluxing with aqueous or alcoholic caustic has no effect. Incineration methods for aldrin disposal involving 816°C, 0.5 second minimum for primary combustion, 1760°C, 1.0 second for secondary combustion, with adequate scrubbing and ash disposal facilities have been recommended. The combustion of aldrin in polyethylene on a small scale gave more than 99% decomposition. Aldrin can be degraded by active metals, such as sodium in alcohol (a reaction which forms the basis of the analytical method for total chlorine), but this method is not suitable for the layman. A disposal method suggested for materials contaminated with aldrin, dieldrin or endrin consists of boring 8−12 ft underground in an isolated area away from water suppliers, with a layer of clay, a layer of lye and a second layer of clay beneath the wastes. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(102); (31); (173); (101); (138); (2); (202); (203); (100).

United States Environmental Protection Agency, *Aldrin/Dieldrin*: *Ambient Water Quality Criteria*, Washington, DC (1979).

United States Environmental Protection Agency, *Aldrin, Health and Environmental Effects Profile No. 8*, Washington, DC, Office of Solid Waste (April 30, 1980).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 1, No. 5, 31−32 (1981) and 3, No. 5, 25−29 (1983), and 5, No. 2, 23−39 (1988)

United States Environmental Protection Agency, Chemical Hazard Information Profile: Aldrin, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

New York State Department of Health, Chemical Fact Sheet: *Aldrin*, Bureau of Toxic Substance Assessment, Albany, NY (January 1986).

United States Public Health Service, *Toxicological Profile for Aldrin/Dieldrin*, Atlanta, Georgia, agency for Toxic Substances and Disease Registry (November 1987).

Baselt R.C., *Biological Monitoring Methods for Industrial Chemicals. 2nd Edition*. Year Book Medical Publishers, Inc. 1988.

Proctor N.H., Hughes J.P., *Chemical Hazards of the Workplace*, Van Nostrand Reinhold, New York, 1991 (currently published by John Wiley and Sons, Inc.).

Allethrin A:0520

Formula: $C_{19}H_{26}O_3$ (I); $C_{10}H_{26}O_5$ (II)

Synonyms: (+)-Allelrethonyl; D-Allethrin; D-*trans* Allethrin; Allethrin I; Alleviate; Allyl cinerin; Allyl homolog of cinerin I; DL-2-Allyl-4-hydroxy-3-methyl-2-cyclopenten-1-one-DL-chrysanthemum monocarboxylate; 3-Allyl-4-keto-2-methylcyclopentenyl chrysanthemummonocarboxylate 3; 3-Allyl-2-methyl-4-oxo-2-cyclopenten-1-yl chrysanthemate; DL-3-Allyl-2-methyl-4-oxocyclopent-2-enyl DL-*cis,trans*-chrysanthemate; Allylrethronyl DL-*cis,trans*-chrysanthemate; Bioallethrin; Bioaltrina; (+)-*cis,trans*-Chrysanthemate; Cinerin I allyl homolog; Depallethrin; ENT 17,510; Exthrin; FDA 1446; FMC 249; Necarboxylic acid; NIA 249; OMS 468; Pallethrine; Pynamin; Pynamin-forte; Pyresin; Pyresyn; Synthetic pyrethrins

CAS Registry Number: 584-79-2 (I); 497-92-7 (II)

HSDB Number: 1511

RTECS Number: GZ1925000

UN/NA & ERG Number: UN3082 (environmentally hazardous substances, liquid, n.o.s.)/171; UN2902 (Pesticides, liquid, toxic, n.o.s.)/151

EC Number: 584-79-2 (I) 209-542-4 [*Annex I Index No.*: 006-025-00-3]; 497-92-7 (II) not listed.

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Highly toxic, Environmental hazard, Agricultural chemical.

AB 1803-Well Monitoring Chemical (CAL) as pyrethrins

Permissible Exposure Limits for Chemical Contaminants (CAL/OSHA) as pyrethrum

Clean water act: Section 311 Hazardous Substances/RQ (same as CERCLA) as pyrethrins

EPCRA Section 304 RQ: CERCLA, 1 lb (0.454 kg) as pyrethrins.

Water Polluting Substance Annex II

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

European/International Regulations [584-79-2 (I)]: Hazard symbol: Xn, N; Risk phrases: R20/22; R50/53; Safety phrases: S2; S29/35; S36; S46; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Allethrin is a clear, yellow to amber, oily liquid which is also available as a wettable powder or granules. Boiling point = 140−160°C; flash point = approx. 120−123°C. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 0-1; reactivity 0. Practically insoluble in water.

Potential Exposure: Allethrin is used to control insects in homes and animal shelters, and to treat lice in humans.

Incompatibilities: Strong alkalis and oxidizers.

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Determination in Water: Octanol−water coefficient: Log $K_{ow} \geq 4.7$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood. Water Polluting Substance Annex II.

Routes of Entry: Skin, inhalation.

Harmful Effects and Symptoms

Short-Term Exposure: Skin and eye contact causes irritation and burns. Inhalation can cause respiratory tract irritation with coughing and wheezing. High exposure may cause dizziness, shaking, irritability, seizures, and unconsciousness. Allethrins may affect the nervous system.

Long-Term Exposure: May cause skin allergy. If the allergy develops, very low future exposure can cause itching and skin rash. Allethrin may cause an asthma-like allergy. Future exposure can cause asthma attacks with shortness of breath; wheezing, cough and/or chest tightness. Allethrin can cause bronchitis to develop with cough, phlegm, and/or shortness of breath. This chemical may cause liver and kidney damage. There is no evidence that allethrin affects reproduction[2].

Points of Attack: Skin, lungs, liver, and kidneys.

Medical Surveillance: Liver and kidney function tests. Lung function test. (These could be normal if the person is not having an attack at the time of the test). Evaluation by a qualified allergist may help to diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation.

All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA *for pyrethrum*: *50 milligram per cubic meter*: CcrOv95 (APF = 10) [any air-purifying half-mask respirator equipped with an organic vapor cartridge(s) in combination with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *125 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOvHie (APF = 25) (any air-purifying full facepiece respirator equipped with an organic vapor cartridge in combination with a high-efficiency particulate filter). *250 milligram per cubic meter*: CcrFOv100 (APF = 50) [any air-purifying full facepiece respirator equipped with organic vapor cartridge(s) in combination with an N100, R100, or P100 filter]; or PaprTOvHie (APF = 50) [any powered, air-purifying respirator with a tight-fitting facepiece and organic vapor cartridge(s) in combination with a high-efficiency particulate filter]; or SCBAF (APF = 50) (any SCBA with full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *5000 milligram per cubic meter*: SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA). *Note*: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: UN3082 Environmentally hazardous substances, liquid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required. UN2902 Pesticides, liquid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Ventilate area of spill or leak. Use water spray to reduce vapor. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: *Allethrin*", Trenton, NJ (January 2007).

Allidochlor A:0525

Formula: $C_8H_{12}ClNO$

Synonyms: Acetamide, 2-Chloro-*N*,*N*-di-2-propenyl-; Alidochlor; CDAA; CDAAT; 2-Chloro-*N*,*N*-diallylacetamide; α-Chloro-*N*,*N*-diallylacetamide; 2-Chloro-*N*,*N*-di-2-propenylacetamide; CP 6343; Diallylchloroacetamide; *N*,*N*-Diallylchloroacetamide; *N*,*N*-Diallyl-α-chloroacetamide; *N*,*N*-Diallyl-2-chloroacetamide; Actox; Radox; Randox; Rantox T

CAS Registry Number: 93-71-0

HSDB Number: 1560 as Randox
RTECS Number: AB5250000
UN/NA & ERG Number: UN2996 (organochlorine pesticides, liquid, toxic, n.o.s.)/151; UN2902 (Pesticides, liquid, toxic, n.o.s)/151
EC Number: 202-277-7 [*Annex I Index No.*: 616-004-00-6]

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Organochlorine herbicide, Poison Category: 4

Hazard symbols, risk, & safety statements: Hazard symbol: Xn, N; Risk phrases: R21/22; R36/38; R51/R53; Safety phrases: S2; S26; S28; S36/37/39; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [2-Hazard to water. (est.)]

Description: An oily, amber liquid. Slightly irritating odor. Molecular weight = 173.66; boiling point = 240; 116; 74°C @ 0.3 mm; freezing/melting point = 145−150°C; vapor pressure = 1.0×10^{-2} mmHg. Slightly soluble in water.

Potential Exposure: Acetamide, and organochlorine herbicide, primarily used to control weeds growing in onion crops. Used as a preemergence and postemergence control for most annual grasses and broadleaf weeds on corn, sorghum, lima beans, snap beans, soybeans, cabbage, peas for canning, celery, onions and some fruits and ornamentals. There are no products registered with the United States Environmental Protection Agency revoked all tolerances on July 21, 1999. There are 25 manufacturers worldwide with 6 located in the U.S.

Incompatibilities: Oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); strong acids. Slowly hydrolyzes in water, releasing ammonia and forming acetate salts. Compounds of the carboxyl group react with all bases, both inorganic and organic (i.e., amines) releasing substantial heat, water and a salt that may be harmful. Incompatible with arsenic compounds (releases hydrogen cyanide gas), diazo compounds, dithiocarbamates, isocyanates, mercaptans, nitrides, and sulfides (releasing heat, toxic, and possibly flammable gases), thiosulfates and dithionites (releasing hydrogen sulfate and oxides of sulfur).

Permissible Concentration in Water: No criteria set. Runoff from spills or fire control may cause water pollution.

Determination in Water: Fish toxicity (threshold)(77): Low—269.85657 ppb, MATC (Maximum Acceptable Toxicant Concentration).

Routes of Entry: Inhalation, ingestion. Absorbed through the intact skin.

Harmful Effects and Symptoms

Short-Term Exposure: Attacks the CNS. Apprehension, anxiety, confusion, nervous excitation; dizziness; headache; numbness and weakness in limbs; muscle twitching, tremors; nausea and vomiting; slow, shallow respiration, bluish face; convulsions; loss of consciousness; breathing stops; death. LD_{50} (oral, rat) = 700 mg/kg; LD_{50} (dermal, rat) = 360 mg/kg.

Long-Term Exposure: Organochlorine pesticides are highly toxic to mammals and will accumulate in the tissues of living organisms. May cause kidney damage.

Points of Attack: May be fatal if inhaled, ingested, or absorbed through the skin.

Medical Surveillance: Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a drug or other inhalation therapy. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure.

First Aid: Speed in removing material from eyes and skin is of extreme importance. *Eyes*: Contact can cause dangerous amounts of these chemicals to be quickly absorbed through the mucous membrane into the bloodstream. Directly, irrigate with large amounts of plain, tepid water or saline for 20 minutes, occasionally lifting the lower and upper lids. During this time, remove contact lenses, if easily removable without additional trauma to the eye. Get medical aid immediately. Have physician check for possible delayed damage. *Skin*: Get medical aid. Dermal contact can cause dangerous amounts of these chemicals to be absorbed into the bloodstream. Wearing the appropriate PPE equipment and respirator for organochlorine pesticides, immediately flush exposed skin, hair, and under nails with plain, running, tepid water for 20 minutes, then wash twice with mild soap. Shampoo hair promptly if contaminated; protect eyes. Do not scrub skin or hair, since this can increase absorption through the skin. Rinse thoroughly with water. Victims who are able and cooperative may assist with their own decontamination. Remove and double-bag contaminated clothing and personal belongings. Leather absorbs many organochlorines; therefore, items such as leather shoes, gloves, and belts should be discarded. If the skin is swollen or inflamed, cool affected areas with cold compresses. Ingestion: Call poison control. Loosen all clothing. Never give anything by mouth to an unconscious person. Get medical aid. In cases of ingestion, Do not induce vomiting *; the patient is at risk of CNS depression or seizures, which may lead to pulmonary aspiration during vomiting. If the victim is conscious and able to swallow, *administer an aqueous slurry of activated charcoal at 1 g/kg (usual adult dose 60−90 g, child dose 25−50 g). A soda can and straw may be of assistance when offering charcoal to a child. The efficacy of activated charcoal for some organochlorine poisoning (such as chlordane) is uncertain. If victim is *UNCONSCIO United States OR HAVING CONVULSIONS*, do nothing except keep victim warm. **In some cases you may be specifically instructed by Poison Control to induce vomiting by way of 2 tablespoons of syrup of ipecac (adult) washed down with a cup of water*. Do NOT give activated charcoal *before or with* ipecac syrup. *Inhalation*: Get medical aid. Do not contaminate yourself. Wearing the appropriate PPE equipment and respirator for organochlorine pesticides, immediately remove the victim from the contaminated area to fresh air. For inhalation exposures, monitor for respiratory distress. If the victim is not breathing, administer artificial respiration. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. If cough or breathing difficulty develops, evaluate for respiratory tract irritation, bronchitis, or pneumonitis. If breathing is difficult, administer 100% humidified supplemental oxygen through bag/mask apparatus until medical help arrives. Do not leave victim unattended.

Respirator Selection: Wherever and whenever workplace conditions warrant respirator use, a respiratory protection program must be followed that meets one or more of the following requirements: OSHA's 29 CFR 1910.134, ANSI Z88.2, or European Standard EN 149.

Storage: Color code—Blue: Health Hazard/Poison (Toxic): Store in a secure, locked and cool, ventilated area.

Shipping: UN2996 Organochlorine pesticides, liquid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN2902 Pesticide, liquid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Do not touch spilled material. Use water spray to reduce vapors. Stay upwind. Avoid breathing vapors. Wear positive-pressure breathing apparatus and full protective clothing. Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. *Small spills*: absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. *Large spills*: dike far ahead of spill for later disposal. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical may be dissolved in flammable or combustible liquids for commercial application. Thermal decomposition products may include chlorine, phosgene, hydrogen chloride. If the flammable or combustible commercial material catches fire, use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Organochlorines may be completely dechlorinated by sodium in isopropyl alcohol. The UN Recommends incineration methods for disposal of organochlorines. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (204); (100).

Pesticide Management Education Program, *Allidochlor (Randox) Herbicide Profile 3/85*, Cornell University, Ithaca, NY (March 1985). http://pmep.cce.cornell.edu/profiles/herb-growthreg/24-d-butylate/allidochlor/herb-prof-allidochlor.html.

Allyl Acetate A:0530

Formula: $C_5H_8O_2$

Synonyms: Acetic acid, allyl acetate; Acetic acid, 2-propenyl ester; 3-Acetoxypropene; 2-Propenyl methanoate

CAS Registry Number: 591-87-7

HSDB Number: 2697

RTECS Number: AF1750000

UN/NA & ERG Number: UN2333/131

EC Number: 209-734-8

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Highly flammable, Possible risk of forming tumors, Primary irritant (w/o allergic reaction).

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1%.

Hazard symbols, risk, & safety statements: Hazard symbol: F,T, Xi; Risk phrases: R11; R21; R23; R25; R26; R34; R36/37/38; Safety phrases: S16; S21; S25; S26; S36; S45.

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)]

Description: Allyl acetate is a flammable, colorless liquid with an acrid odor. Molecular weight = 100.13; boiling point = 103−104°C; freezing/melting point = −95°C; flash point = 22°C; autoignition temperature = 374°C. Explosive limits: LEL: 21,000 ppm; UEL: unknown. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 3; reactivity 0. Insoluble in water.

Potential Exposure: Allyl Acetate is used to control insects in homes and animal shelters, and to treat lice in humans. May be used to enhance taste of dairy products and fruit. Generally speaking, most allyl compounds may be metabolized to allyl alcohol (see A:0540) which is metabolized to acrolein (see A:0380).

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Incompatible with strong acids (liberates heat), nitrates, strong alkalis (liberates heat). Contact with alkali metals and strong reducing agents such as hydrides evolves highly flammable hydrogen gas. Attacks some plastics, coatings, and rubber. Flow or agitation of substance may generate electrostatic charges due to low conductivity; ground all equipment containing this material

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 0.42 ppm

PAC-2: 4.6 ppm

PAC-3: 28 ppm

Determination in Water: Octanol−water coefficient: Log $K_{ow} \leq 1$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Skin, inhalation.

Harmful Effects and Symptoms

Short-Term Exposure: This chemical can be absorbed through the skin, thereby increasing exposure. Prolonged or repeated contact can cause rash, redness, and itching. Skin and eye contact causes irritation, severe burns, and permanent damage. Inhalation can cause respiratory tract irritation with coughing and wheezing. High exposure may cause pulmonary edema, a medical emergency, with severe shortness of breath. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: Allyl acetate can cause bronchitis to develop with cough, phlegm, and/or shortness of breath. This chemical may cause liver and kidney damage.

Points of Attack: Skin, lungs.

Medical Surveillance: If symptoms develop or overexposure is suspected, chest X-ray should be considered.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode).

Storage: (1) Color code—Red: Flammability hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. (2) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where allyl acetate may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2333 Allyl acetate, Hazard Class: 3; Labels: 3-Flammable liquid, 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Use water spray to reduce vapor. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Allyl acetate is a highly flammable liquid. Irritating gases, including carbon dioxide and carbon monoxide. Use propylene foam extinguishers. Water may be ineffective. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Allyl Acetate, Trenton, NJ (September 1998).

Allyl Alcohol A:0540

Formula: C_3H_6O; CH_2CHCH_2OH

Synonyms: AA; Alcool allylique (French); Alilico alcohol (Spanish); Allyl al; Allyl alcohol; Allylalkohol (German); Allylic alcohol; 3-Hydroxypropene; Orvinylcarbinol; 1-Propen-3-ol; 2-Propen-1-ol; 2-Propenol; Propenol; Propen-1-ol-3; 2-Propenyl alcohol; Propenyl alcohol; Shell Unkrautted A; Vinyl carbinol; Vinyl carbinol,2-propenol

CAS Registry Number: 107-18-6

HSDB Number: 192

UN/NA & ERG Number: (PIH) UN1098/131 (P)

EC Number: 203-470-7 [*Annex I Index No.*: 603-015-00-6]

RTECS Number: BA5075000

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 15,000 (≥1.00% concentration).

Hazard Alert: Poison inhalation hazard: exposure can be lethal, Highly flammable, Polymerization hazard; Highly toxic, Strong reducing agent, Possible risk of forming tumors, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction), Environmental hazard. Listed for Tier 1 screening as an endocrine disruptor[88].

Clean Air Act 42USC7412; Title I, Part A, §112(r), accidental Release Prevention/Flammable Substances (Section 68.130) TQ = 15,000 lb (5825 kg)

Clean Water Act,40CFR116.4 Hazardous Substances; RQ 40CFR117.3 (same as CERCLA)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P005

RCRA Land Ban Waste Restrictions

CERCLA/SARA 40CFR302, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg)

Superfund/EPCRA 40CFR302.4, Appendix A, RQ: 100 lb (45.5 kg), SARA 313: Form R *de minimis* Concentration Reporting Level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%; NPRI

United States DOT 49CFR172.101, Inhalation Hazardous Chemical (PIH).

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Hazardous to aquatic life or environment, with possible long-lasting effects.[291] Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, N, Xi; Risk phrases: R11; R19; R23/24/25; R36/37/38; R51; R62; Safety phrases: S1/2; S21; S29/35; S36/37/39; S38; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Allyl alcohol is a flammable, colorless liquid. It has a pungent, mustard-like odor. Molecular weight = 58.08. Boiling point = 97.4°C; melting/freezing point = −129°C; critical temperature = 271.9°C; critical pressure = 840 psia = 57 atm = 5.8 MN/m^2; specific gravity (H_2O:1) = 0.852 @ 20°C (liquid); relative vapor density (air = 1) = 2.0; ratio of specific heats of vapor (gas) = 1.12; latent heat of vaporization = 295 Btu/lb = 164 cal/g = 6.87×10^5 J/kg; saturation concentration in air = 57 g/m^3 @ 20°C; heat of combustion = −13,720 Btu/lb = −7620 cal/g = -319.0×10^5 J/kg; heat of polymerization = 100°C; vapor pressure = 24 hPa @ 20°C; 18 mmHg @ 20°C; electrical conductivity = 6.5 × 105 pS/m; flash point = 21°C (cc); 32°C (oc); autoignition temperature = 378°C. Explosive limits: LEL: 2.5%, 25,000 ppm. UEL: 18.0%. Hazard identification (based on NFPA-704 M Rating System): Health 4; flammability 3; reactivity 1. Highly soluble in water.

Potential Exposure: Used to make other chemicals and pharmaceuticals; as a laboratory chemical. Not currently registered in the United States as a pesticide or fungicide.

Description: Allyl alcohol is used without formulation for weed control and applied as a drench to tobacco beds; in the production of allyl esters. These compounds are used as monomers and prepolymers in the manufacture of resins and plastics. Allyl alcohol is also used in the preparation of pharmaceuticals; in organic syntheses of glycerol and acrolein; and as a fungicide and herbicide.

Incompatibilities: May form explosive mixture with air. Reacts explosively with carbon tetrachloride, strong bases. Also incompatible with strong acids. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Polymerization may be caused by heat above 99°C, peroxides, or oxidizers.

Permissible Exposure Limits in Air

NIOSH IDLH value = 20 ppm.

Conversion factor: 1 ppm = 2.38 milligram per cubic meter

Odor threshold = 1.4−2.1 ppm. The odor @ 25°C @ 1 atm and irritant properties of allyl alcohol is above the TLV and nearly the same as the PEL.

OSHA PEL: 2 ppm/5 milligram per cubic meter TWA [skin]

NIOSH REL: 2 ppm/5 milligram per cubic meter TWA; 4 ppm/10 milligram per cubic meter STEL [skin]

ACGIH TLV[1]: 0.5 ppm/1.19 milligram per cubic meter TWA [skin]; not classifiable as a human carcinogen

PAC* Ver. 29[138]

PAC-1: $\mathbf{0.09_A}$ ppm

PAC-2: $\mathbf{1.7_A}$ ppm

PAC-3: $\mathbf{13_A}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

DFG MAK: [skin]; Carcinogen Category 3B

Arab Republic of Egypt: TWA 2 ppm (5 milligram per cubic meter) [skin], 1993; Australia: TWA 2 ppm (5 milligram per cubic meter); STEL 4 ppm [skin], 1993; Austria: MAK 2 ppm (5 milligram per cubic meter) [skin], 1999; Belgium: TWA 2 ppm (4.8 milligram per cubic meter); STEL 4 ppm (9.5 milligram per cubic meter) [skin], 1993; Denmark: TWA 2 ppm (5 milligram per cubic meter) [skin], 1999; Finland: TWA 2 ppm (5 milligram per cubic meter); STEL 4 ppm (10 milligram per cubic meter) [skin], 1993; France: VME 2 ppm (5 milligram per cubic meter), VLE 4 ppm (10 milligram per cubic meter) [skin], 1999; the Netherlands: MAC-TGG 5 milligram per cubic meter [skin], 2003; Japan: 1 ppm (2.4 milligram per cubic meter) [skin], 1999; Norway: TWA 2 ppm (5 milligram per cubic meter), 1999; the Philippines: TWA 2 ppm (5 milligram per cubic meter) [skin], 1993; Poland: MAC (TWA) 2 milligram per cubic meter, MAC (STEL) 10 milligram per cubic meter [skin], 1999; Russia: TWA 1 ppm, 1993; Sweden: NGV 2 ppm (5 milligram per cubic meter), KTV 6 ppm (14 milligram per cubic meter) [skin], 1999; Switzerland: MAK-W 2 ppm (5 milligram per cubic meter), KZG-W 4 ppm (10 milligram per cubic meter) [skin], 1999; Turkey: TWA 2 ppm (5 milligram per cubic meter) [skin], 1993; United Kingdom: TWA 2 ppm (4.8 milligram per cubic meter); STEL 4 ppm (9.7 milligram per cubic meter) [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen.

Determination in Air: Adsorption on charcoal, workup with CS_2 and gas chromatographic analysis. Use NIOSH Analytical Method #1402[18].

Permissible Concentration in Water: No criteria set. Toxic to aquatic organisms.

Determination in Water: Octanol−water coefficient: Log $K_{ow} \leq$ 0.2. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Allyl alcohol vapor can cause serious irritation and burns of eyes, nose and throat. Eye irritation may be accompanied by sensitivity to light, pain, blurred vision leading to permanent damage. The pain may not begin until 6 hours after exposure. Contact with the liquid may cause first and second degree burns of skin and blister formation. Areas of contact will become swollen and painful and local muscle spasms may occur. Allyl alcohol causes burns on contact; and may cause pulmonary edema, a medical emergency, if inhaled. It is poisonous in small quantities. The probable oral lethal dose is 50−500 mg/kg, or between 1 teaspoonful and 1 ounce for a 150-lb person.

Long-Term Exposure: Allyl alcohol may cause mutations; such chemicals may have a cancer or reproductive risk. This chemical may cause liver and kidney damage. Repeated exposure may cause bronchitis with cough, phlegm, and/or shortness of breath.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: Preplacement and periodic examinations should include lung function tests, liver and kidney function tests. Following acute exposure, chest X-ray should be considered.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed.

Personal Protective Methods: Prevent skin contact. **8 hours** (More than 8 hours of resistance to breakthrough $>0.1\ \mu m > g/cm^2/min$): butyl rubber gloves, suits, boots; Teflon gloves, suits, boots; Barricade coated suits; Responder suits; Trychem 1000 suits; **4 hours** (At least 4 but $<$ 8 hours of resistance to breakthrough $>0.1\ \mu m > g/cm^2/min$): Viton gloves, suits. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *20 ppm*: Sa:Cf * (APF = 25)* (any supplied-air respirator operated in a continuous-flow mode); or PaprOv* [any powered, air-purifying respirator with organic vapor cartridge(s)]; or CcrFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode. *Escape*: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA). *Substance reported to cause eye irritation or damage; may require eye protection.

Storage: PIH; check oxygen content prior to entering storage area.(1) Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. (2) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in a fireproof tightly closed containers under an inert atmosphere separated from strong oxidants, strong bases; strong acids. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN1098 Allyl alcohol Hazard class: 6.1; Labels: 6.1-Poison Inhalation Hazard, 3-Flammable liquids, Inhalation Hazard Zone B.

Spill Handling:

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (from a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.1/0.2

Large spills (from a large package or from many small packages)

First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 0.3/0.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. Keep allyl alcohol out of a confined space, such as a sewer, because of the potential for an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of nitrogen and carbon. Firefighting gear (including SCBA) does not provide adequate protection. If exposure occurs, remove and isolate gear immediately and thoroughly decontaminate personnel. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration after dilution with a flammable solvent.

References

(31); (173); (101); (138); (2); (100).

United States Environmental Protection Agency, allyl Alcohol, Health and Environmental Effects Profile No. 9, Washington, DC, Office of Solid Waste (April 30, 1980).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 1, No. 7, 29−31 (1981).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Allyl Alcohol, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Allyl Alcohol, Trenton, NJ (June 1998).

Allylamine A:0550

Formula: C_3H_7N: $CH_2{=}CHCH_2NH_2$

Synonyms: Alilamina (Spanish); 3-Aminopropene; 3-Aminopropylene; Monoallylamine; 2-Propen-1-amine; 2-Propenamine

CAS Registry Number: 107-11-9

HSDB Number: 2065

RTECS Number: BA5425000

UN/NA & ERG Number: (PIH) UN2334/131

EC Number: 203-463-9 [*Annex I Index No.*: 612-046-00-4]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Hazard Alert: Poison inhalation hazard: exposure can be lethal, Highly Flammable, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction).

OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 10,000 lb (4540 kg)

Clean Air Act 42USC7412; Title I, Part A, §112(r), accidental Release Prevention/Flammable Substances (Section 68.130) TQ = 10,000 lb (4540 kg)

CERCLA/SARA 40CFR302 Extremely Hazardous Substances: TPQ = 500 lb (227 kg)[72]

Superfund/EPCRA 40CFR302.4, Appendix A, RQ: EHS lb (0.454 kg), SARA 313: Form R *de minimis* Concentration Reporting Level: 1.0%.

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: F+, T+, N, Xi; Risk phrases: R11; R23/24/25; R36/37/38; R51/53; R62; Safety phrases: S1/2; S9; S16; S21; S24/25; S41; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Allylamine is a highly flammable, colorless liquid. Strong ammonia odor. Molecular weight = 57.11; freezing/melting point = −88°C; boiling point = 53° to 58°C; specific gravity (H_2O:1) = 0.760 @ 20°C; flash point = −29°C; autoignition temperature = 374°C; vapor pressure = 195 mmHg @ 20°C. Explosive limits: LEL: 2.2%, 22,000 ppm; UEL: 22.0%. Vapors are highly disagreeable; it is unlikely that any person would voluntarily stay in dangerous concentration. Hazard identification (based on NFPA-704 M Rating System): Health 4; flammability 3; reactivity 1. Highly soluble in water.

Potential Exposure: Compound

Description: Used in manufacture of pharmaceuticals (mercurial diuretics, e.g.,) and in organic synthesis. Used to improve dyeability of acrylic fibers.

Incompatibilities: May form explosive mixture with air. Oxidizing materials and acids may cause a violent reaction. Attacks copper and corrodes active metals (i.e., aluminum, zinc, etc.).

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 2.23 milligram per cubic meter @ 25°C & 1 atm

Odor threshold = 2.5 ppm.

PAC* Ver. 29[138]

PAC-1: $\mathbf{0.42}_{\mathbf{A}}$ ppm

PAC-2: $\mathbf{3.3}_{\mathbf{A}}$ ppm

PAC-3: $\mathbf{18}_{\mathbf{A}}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

Denmark: TWA 2 ppm (4.7 milligram per cubic meter) [skin], 1999; Norway: TWA 2 ppm (5 milligram per cubic meter), 1999; Russia: STEL 0.05 milligram per cubic meter [skin], 1993; Sweden: NGV 2 ppm (5 milligram per cubic meter), KTV 6 ppm (14 milligram per cubic meter) [skin], 1999

Permissible Concentration in Water: No criteria set. Toxic to aquatic organisms.

Routes of Entry: Inhalation, ingestion and skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Corrosive to eyes, skin, and respiratory tract which is highly toxic if inhaled or ingested and moderately toxic if absorbed on skin. Ingestion or inhalation may cause death or permanent injury after very short exposure to small quantities. Inhalation may cause pulmonary edema, which can be delayed for several hours; there is a risk of death in serious cases. Swallowing liquid may cause pneumonia. Vapors are extremely unpleasant and may ensure voluntary avoidance of dangerous concentrations. Symptoms include irritation of nose, eyes, and mouth with tearing, runny nose; and sneezing. Can cause excitement, convulsions, and death. Skin absorption may cause irreversible and reversible changes. Toxic air concentration in humans is 5 ppm over 5 minutes.

Long-Term Exposure: Mutation data reported. May cause heart muscle damage.

Points of Attack: Skin, pulmonary, system, cardiovascular system.

Medical Surveillance: Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Lung function tests. Following acute exposure, consider chest X-ray.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear solvent-resistant gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers recommend butyl rubber as a protective material. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode).

Storage: PIH; check oxygen content prior to entering storage area. (1) Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. (2) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area separated from strong oxidants, strong bases; strong acids. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2334 Allylamine, Hazard class: 6.1; Labels: 6.1-Poison Inhalation Hazard, 3-Flammable liquids, Inhalation Hazard Zone B.

Spill Handling:

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (from a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2

Night 0.4/0.6

Large spills (from a large package or from many small packages)

First: Isolate in all directions (ft/m) 500/150

Then: Protect persons downwind (mi/km)

Day 1.1/1.8

Night 1.9/3.1

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish ventilation to keep levels below explosive limit. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after clean-up is complete. Keep allylamine out of a confined space, such as a sewer, because of the potential for an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: High temperature incineration; encapsulation by resin or silicate fixation.

References

(31); (173); (101); (138); (100).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 2, No. 6, 28−30 (1982).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Allylamine, Washington DC, Chemical Emergency Preparedness Program (November 30, 1987).

Allyl Bromide A:0560

Formula: C_3H_5Br: $BrCH_2CH = CH_2$

Synonyms: Bromallylene; 1-Bromo-2-propene; 3-Bromopropeno (Spanish); 3-Bromopropylene; Bromuro de alilo (Spanish); 1-Propene, 3-bromo-

CAS Registry Number: 106-95-6

HSDB Number: 662

RTECS Number: UC7090000

UN/NA & ERG Number: UN1099/131

EC Number: 203-446-6

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Highly flammable liquid, Possible risk of forming tumors, Suspected of causing genetic defects, Environmental hazard.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects.[291] Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: Xn, N; Risk phrases: R11; R23/25; R34; R40; R48/20; R45; R51/53; R62; R68; Safety phrases: S2; S16; S21; S25; S26; S29/35; S36/37/39; S46; S53; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Allyl bromide is a highly flammable, colorless to light yellow liquid with an unpleasant, pungent odor. Molecular weight = 120.98; boiling point = 71.3°C; freezing/melting point = −119°C; specific gravity (H_2O:1) = : 1.4161 @ 20°C; vapor pressure = about 111−112 mmHg @ 20°C; liquid surface tension = : 0.0269 N/m @ 20°C; relative vapor density (air = 1) = 4.2; latent heat of vaporization = (estimate) 2.5×10^5 J/kg; heat of combustion = (estimate) -150×10^5 J/kg; flash point = −1°C; autoignition temperature = 295°C. Explosive limits: LEL: 4.4%, UEL: 7.3%. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 3; reactivity 1. Insoluble in water.

Potential Exposure: Used as an insecticide; in the manufacture of resins, fragrances, and other chemicals.

Incompatibilities: Vapor may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Heat or light exposure may cause decomposition and corrosive vapors.

Permissible Exposure Limits in Air

ACGIH TLV[1]: 0.1 ppm TWA [skin] Not classifiable as a human carcinogen.

PAC Ver. 29[138]

PAC-1: 0.2 ppm
PAC-2: 12 ppm
PAC-3: 71 ppm
DFG MAK: Suspended 2004
European OEL: 0.1 ppm/0.7 milligram per cubic meter TWA (2004)

Permissible Concentration in Water: No criteria set. Toxic to aquatic organisms.

Routes of Entry: Skin, inhalation, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Poisonous if swallowed. This chemical can be absorbed through the skin, thereby increasing exposure. Irritates eyes, skin, and respiratory tract. Can cause burns and permanent damage. Inhalation can cause respiratory tract irritation with coughing and wheezing. Exposure can cause headache, dizziness, nausea, and vomiting. High exposure may cause pulmonary edema, a medical emergency, with severe shortness of breath. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: Allyl bromide can cause bronchitis to develop with cough, phlegm, and/or shortness of breath. Allyl bromide may damage cardiovascular system, kidneys, liver, nervous system. May cause skin disorders and affect the unborn fetus.

Points of Attack: Skin, lungs, reproductive system.

Medical Surveillance: If symptoms develop or overexposure is suspected, chest X-ray should be considered. Kidney and Liver function tests. Consult a dermatologist if skin disorders result from exposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: For bromine, OSHA/NIOSH: *2.5 ppm*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprS (APF = 25) (any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern. *3 ppm*: CcrFS (APF = 50) [any chemical cartridge respirator with a full facepiece and cartridge(s) providing protection against the compound of concern]; or GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern]; or PaprTS (APF = 50) (any powered, air-purifying respirator with a tight-fitting facepiece and cartridge(s) providing protection against the compound of concern); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode. *Escape*: GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern]; or SCBAE (any appropriate escape-type, SCBA). *Note*: Substance causes eye irritation or damage; eye protection needed. Only non-oxidizable sorbents are allowed (not charcoal).

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where allyl bromide may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN1099 Allyl bromide, Hazard Class: 3; Labels: 3-Flammable liquid, 6.1-Poisonous materials

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Cover with activated charcoal adsorbent and deposit in sealed containers. Keep allyl bromide out of a confined space, such as a sewer, because of the potential for an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Allyl bromide a highly flammable liquid. Irritating gases, including carbon monoxide and hydrogen bromide gas. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR 165 recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Allyl Bromide, Trenton NJ (November 1998).

Allyl Chloride A:0570

Formula: C_3H_5Cl; CH_2CHCH_2Cl

Synonyms: Allylchlorid (German); Allyl chloride; Allyle (chlorure d') (French); Chlorallylene; 3-Chloroprene; 1-Chloro propene-2; 1-Chloro-2-propene; 3-Chloro-1-propene; 3-Chloropropene; 3-Chloropropene-1; α-Chloropropylene; 3-Chloropropylene; 3-Chlorpropen (German); Cloruro de alilo (Spanish)

CAS Registry Number: 107-05-1

HSDB Number: 178

RTECS Number: UC7350000

UN/NA & ERG Number: UN1100/131 (P)

EC Number: 203-457-6 [*Annex I Index No.*: 602-029-00-X]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Inadequate Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1999; NCI: Carcinogenesis Bioassay (gavage); equivocal evidence: mouse; no evidence: rat. United States Environmental Protection Agency Gene-Tox Program, Positive: *E coli polA* without S9; S *cerevisiae* gene conversion; Positive: S *cerevisiae-homozygosis*

California Proposition 65 Chemical[102]: *Delisted as a cancer causing agent 10/29/1999.*

Hazard Alert: Poison, Highly flammable, Polymerization hazard (nonstabilized), Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction), Environmental hazard.

OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 1000 lb (450 kg)

Clean Air Act 42USC7412; Title I, Part A, §112 Hazardous Pollutants

United States National Primary Drinking Water Regulations: SMCL = 250 mg[Cl-]/L as Chloride

Clean Water Act: 40CFR116.4 Hazardous Substances; RQ 40CFR117.3 (same as CERCLA); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

RCRA Hazardous Constituents 40 CFR261, Appendix 8, waste number not listed

RCRA Land Ban Waste Restrictions

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.036; Nonwastewater (mg/kg), 30

RCRA 40CFR264, Appendix 9; Ground Water Monitoring List: Suggested methods (PQL μg/L): 8010 (5); 8240 (5)

Superfund/EPCRA 40CFR302.4, Appendix A, RQ: CERCLA 1000 lb (454 kg)

EPCRA Section 313 Form R *de minimis* Concentration Reporting Level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%; NPRI.

Hazardous to aquatic life or environment, with possible long-lasting effects[194]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xn, N, Xi; Risk phrases: R11; R20/21/22; R36/37/38; R48/20; R51; R68; R50; R62; R63; Safety phrases: S2; S16; S21; S25; S26; S36/37; S41; S46; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Allyl chloride is a highly reactive and flammable, colorless, brown or purple liquid, with an unpleasant, pungent odor. Molecular weight = 76.53; specific gravity (H_2O:1) = 0.938 @ 20°C; boiling point = 45.1°C; freezing/melting point = −135°C; relative vapor density (air = 1) = 4.15; ratio of specific heats of vapor (gas) = 1.0804; latent heat of vaporization = (estimate) 2.3×10^5 J/kg; heat of combustion = (estimate) -180×10^5 J/kg; vapor pressure = 295 mmHg @ 20°C; 393 hPa @ 20°C; flash point = −32°C; autoignition point = 485°C. Explosive limits: LEL: 2.9%, 29,000 ppm, UEL: 11.1%. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 3; reactivity 1. Slightly soluble in water; solubility = 0.4%.

Potential Exposure: Allyl chloride is used as a chemical intermediate and in making allyl compounds, epichlorohydrin, and glycerol.

Incompatibilities: Contact with water forms hydrochloric acid. Keep away from strong oxidizers, acids, aluminum, amines, peroxides, chlorides of iron and aluminum; magnesium, zinc.

Permissible Exposure Limits in Air

NIOSH IDLH value = 250 ppm

Conversion factor: 1 ppm = 3.13 milligram per cubic meter @ 25°C & 1 atm

Odor threshold = 0.48−5.9 ppm.

OSHA PEL: 1 ppm/3 milligram per cubic meter TWA

NIOSH REL: 1 ppm/3 milligram per cubic meter TWA; 2 ppm/6 milligram per cubic meter STEL

ACGIH TLV[1]: 1 ppm/3 milligram per cubic meter TWA; 2 ppm/6 milligram per cubic meter STEL [skin]; Confirmed Carcinogen with unknown relevance to humans

PAC* Ver. 29[138]

PAC-1: **2.8**$_{\mathbf{A}}$ ppm

PAC-2: **54**$_{\mathbf{A}}$ ppm

PAC-3: **140**$_{\mathbf{A}}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minutes values.

DFG MAK: [skin] Carcinogen Category 3B (2004)

Australia: TWA 1 ppm (3 milligram per cubic meter); STEL 2 ppm, 1993; Austria: MAK 1 ppm (3 milligram per cubic meter), suspected carcinogen, 1999; Belgium: TWA 1 ppm (3 milligram per cubic meter); STEL 2 ppm, 1993; Denmark: TWA 1 ppm (3 milligram per cubic meter), 1999; Finland: TWA 1 ppm (3 milligram per cubic meter); STEL 3 ppm (9 milligram per cubic meter), 1999; France: VME 1 ppm (3 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 3 milligram per cubic meter, 2003; India: TWA 1 ppm (3 milligram per cubic meter); STEL 2 ppm (6 milligram per cubic meter), 1993; Norway: TWA 1 ppm (3 milligram per cubic meter), 1999; Russia: STEL 0.3 milligram per cubic meter [skin], 1993; Sweden: TWA 1 ppm (3 milligram per cubic meter); STEL 3 ppm (9 milligram per cubic meter) [skin], 1999; Switzerland: MAK-W 1 ppm (3 milligram per cubic meter), KZG-W 2 ppm (6 milligram per cubic meter), 1999; Turkey: TWA 1 ppm (3 milligram per cubic meter), 1993; United Kingdom: LTEL 1 ppm (3 milligram per cubic meter); STEL 2 ppm (6 milligram per cubic meter), 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 2 ppm.

Determination in Air: Charcoal tube; Benzene; GC/Flame ionization detection; Use NIOSH Analytical Methods (IV) #1000.

Permissible Concentration in Water: State Drinking Water Guidelines: Florida 35 μg/L; New Hampshire 7.4 μg/L; Minnesota 30 μg/L.

Determination in Water: Toxic to aquatic organisms.

Routes of Entry: Employees may be exposed by dermal or eye contact, inhalation, or ingestion. This chemical can be absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: This chemical can be absorbed through the skin, thereby increasing exposure. Corrosive to eyes, skin, and respiratory tract; can cause burns and permanent damage. In addition to burns, skin contact can cause deep aching and "bone pain." Effects on the skin may not be apparent for some hours following contact. Inhalation can cause respiratory tract irritation with coughing and wheezing. Exposure can cause headache, dizziness, nausea, and vomiting. High exposure may cause pulmonary edema, a medical emergency, with severe shortness of breath. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: May cause liver and kidney damage, lung irritation and bronchitis, drying and cracking skin. Allyl chloride has caused mutations. There is limited evidence that this chemical causes cancer of the stomach. The potential for damage to the respiratory tract, liver, and kidneys from inhalation was recognized through experimental evidence during the early commercial development of the industry involving this compound and is reflected in the precautions taken during its manufacture and use. Industrial experience in the United States has pointed to such problems as orbital pain and deep-seated aches after eye or skin contact. Both of these phenomena are believed to be transient when they occur and have been minimized through improved work practices.

Points of Attack: Respiratory system, lungs, skin, eyes, liver and kidneys, nervous system.

Medical Surveillance: Preplacement and periodic physical examinations have been detailed by NIOSH. They give special attention to the respiratory system, liver, kidneys, skin and eyes. Urine, blood, and pulmonary function testing are required by NIOSH[45]. If symptoms of over exposure develop, chest X-ray should be considered. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Prevent skin contact. **8 hours** (More than 8 hours of resistance to breakthrough $>0.1\ \mu m > g/cm^2/min$): Tychem 1000 suits; **4 hours** (At least 4 but <8 hours of resistance to breakthrough $>0.1\ \mu m > g/cm^2/min$): Teflon gloves, suits, boots; 4H and Silver Shield gloves. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove non impervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Engineering controls shall be used to maintain allyl chloride vapor concentrations below the permissible exposure limits. Compliance with the permissible exposure limits may be achieved by the use of respirators only in the following situations: (1) During the time necessary to install or test the required engineering controls. (2) For nonroutine operations, such as maintenance or repair activities, in which concentrations in excess of the permissible exposure limits may occur. (3) During emergencies when air concentrations of allyl chloride may exceed the permissible limits. When a respirator is permitted, it shall be selected as follows: *Up to 25 ppm*: Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *50 ppm*: SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *250 ppm*: SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode. *Escape*: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA). *Note*: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: (1) Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. (2) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area separated from strong oxidants, strong bases; strong acids. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN1100 Allyl chloride, Hazard Class: 3; Labels: 3-Flammable liquid, 6.1-Poisonous materials

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Cover with activated charcoal adsorbent and deposit in sealed containers. Do not wash into sewer. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Allyl chloride is a highly flammable liquid. Thermal decomposition products may include hydrogen chloride and phosgene. Use dry chemical, carbon dioxide; polymer or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Controlled incineration at a temperature of 982°C for 2 seconds minimum.

References

(102); (31); (173); (101); (138); (2); (100).

National Institute for Occupational Safety and Health (NIOSH), "Criteria for a Recommended Standard: Occupational Exposure to Allyl Chloride", NIOSH Document Number 76-204, Cincinnati OH (1976).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Allyl Chloride, Washington, DC (July 1979).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 1, No. 7, 32−34 (1981) and 8, No. 1, 20−28 (1988).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Allyl Chloride, Trenton, NJ (June 1998).

Allyl Ethyl Ether A:0580

Formula: $C_6H_{10}O$: $CH_2H_5OCH_2CH = CH_2$

Synonyms: 1-Propene, 3-ethoxy-; Eter, aliletil (Spanish)

CAS Registry Number: 557-31-3

RTECS Number: KM9120000

UN/NA & ERG Number: UN2335/131 (P)

EC Number: 209-169-7

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Extremely flammable, Polymerization hazard, Environmental hazard, Environmental hazard.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects[194]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, F+, Xi; Risk phrases: R12; R19; R36/37/38; Safety phrases: S16; S26; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Allyl ethyl ether is an extremely flammable liquid. Molecular weight = 86.12; boiling point = 66°C; specific gravity (H_2O:1) = 0.79; vapor pressure = 136 mmHg @ 20°C; flash point = −21°C. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 4; reactivity 4. Insoluble in water.

Potential Exposure:Used for making other chemicals.

Incompatibilities: May form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Incompatible with strong acids. May form explosive peroxides during storage.

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Routes of Entry: Through the skin, inhalation, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: This chemical can be absorbed through the skin, thereby increasing exposure. Irritates eyes, skin, and respiratory tract. Exposure can cause headache, dizziness, nausea, and vomiting. May affect the CNS.

Long-Term Exposure: May cause CNS damage. Removes the skin's natural oils, leading to dryness, irritation, redness, possible cracking.

Points of Attack: Skin, lungs.

Medical Surveillance: If symptoms develop or overexposure is suspected, chest X-ray and nervous system tests should be considered.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce

vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid/refrigerated storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where allyl ethyl ether may be present, check to make sure that an explosive concentration does not exist. Check for peroxides and inhibit if necessary. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2335 Allyl ethyl ether, Hazard Class: 3; Labels: 3-Flammable liquid, 6.1-Poisonous materials

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Cover with activated charcoal adsorbent and deposit in sealed containers. Keep allyl chloride out of a confined space, such as a sewer, because of the potential for an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of carbon. Allyl ethyl ether is a highly flammable and reactive liquid. Use dry chemical, carbon dioxide; or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Allyl Ethyl Ether, Trenton, NJ (August 1998).

Allyl Glycidyl Ether A:0590

Formula: $C_6H_{10}O_2$

Synonyms: AGE; Alil glicidikico eter (Spanish); Allyl-2,3-epoxypropyl ether; Allylglycidaether (German); 1-Allyloxy-2,3-epoxy-propan (German); 1-(Allyloxy)-2,3-epoxypropane; 1,2-Epoxy-3-allyloxypropane; Oxirane [(2-propenyloxy) methyl]; [(2-Propenyloxy) methyl]oxirane

CAS Registry Number: 106-92-3

HSDB Number: 505

RTECS Number: RR0875000

UN/NA & ERG Number: UN2219/129

EC Number: 203-442-4 [*Annex I Index No.*: 603-038-00-1]

Regulatory Authority and Advisory Information
Carcinogenicity: NTP: Carcinogenesis Studies (inhalation); some evidence: mouse; equivocal evidence: mouse, rat.

Hazard Alert: Flammable, Possible polymerization hazard, Possible risk of forming tumors, Sensitization hazard, Suspected of causing genetic defects, Suspected reprotoxic hazard.

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xn, N, Xi; Risk phrases: R10; R20/22; R37/38; R40; R41; R43; R52/53; R62; R63; R68; Safety phrases: S2; S24/25; S26; S36/37/39; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Allyl glycidyl ether is a colorless liquid with a strong, sweet odor. Molecular weight = 114.16; boiling point = 154°C; freezing/melting point = −100°C; density (H_2O:1) = 0.97; vapor density (air = 1) = 3.9; vapor pressure = 3.69 mmHg @ 20°C; flash point = 57°C. Soluble in water.

Potential Exposure: Used as a solvent and emulsifier; making epoxy resins, chlorinated compounds; and rubber.

Incompatibilities: May form explosive mixture with air. Contact with acids or bases may cause explosive polymerization. Contact with oxidizers or amines may cause fire and explosions.

Permissible Exposure Limits in Air
NIOSH IDLH = 50 ppm.

Conversion factor: 1 ppm = 4.67 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 10 ppm/45 milligram per cubic meter Ceiling Concentration

NIOSH REL: 5 ppm/22 milligram per cubic meter TWA; 10 ppm/44 milligram per cubic meter STEL [skin]

ACGIH TLV[1]: 1 ppm/4.7 milligram per cubic meter TWA; not classifiable as a human carcinogen

No PAC available.

DFG MAK: [skin] Carcinogen Category 2; danger of skin sensitization (2004)

Australia: TWA 5 ppm (22 milligram per cubic meter); STEL 10 ppm [skin], 1993; Austria: carcinogen, 1999; Belgium: TWA 5 ppm (23 milligram per cubic meter); STEL 10 ppm (47 milligram per cubic meter) [skin], 1993; Denmark: TWA 5 ppm (22 milligram per cubic meter) [skin], 1999; Finland: STEL 5 ppm (22 milligram per cubic meter) [skin], 1999; France: VME 5 ppm (22 milligram per cubic meter) [skin], 1999; the Netherlands: MAC-TGG 0.5 milligram per cubic meter, 2003; the Philippines: TWA 10 ppm (45 milligram per cubic meter), 1993; Switzerland: MAK-W 0.05 ppm (0.1 milligram per cubic meter), 1999; Thailand: TWA 10 ppm (45 milligram per cubic meter), 1993; Turkey: TWA 10 ppm (45 milligram per cubic meter), 1993; United Kingdom: TWA 5 ppm (24 milligram per cubic meter); STEL 10 ppm (47 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Several states have set guidelines or standards for AGE in ambient air:[60] 22 milligram per cubic meter; STEL 44 22 milligram per cubic meter (California), 22 milligram per cubic meter (Connecticut), 44 milligram per cubic meter (North Dakota), 40 milligram per cubic meter (Virginia), 52.4 milligram per cubic meter (Nevada).

Determination in Air: Adsorption in a Tenax-tilled tube, workup with ethyl ether, analysis by GC. Use NIOSH Analytical Method #2545.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact. Absorbed by the skin.

Harmful Effects and Symptoms
Short-Term Exposure: Skin contact contributes significantly to overall exposure. Inhalation of vapors may irritate the eyes, skin and respiratory tract, causing shortness of breath and coughing. Higher exposure may cause dizziness, lightheadedness, unconsciousness, pulmonary edema; a medical emergency that can cause death. Skin or eye contact with the liquid may cause irritation, burns and skin rash. The DFG warns of the danger of skin sensitization. Use of alcoholic beverages enhances the harmful effect.

Long-Term Exposure: This chemical may be a human carcinogen. It may cause mutations, and damage male reproductive glands. Repeated exposures may cause permanent lung damage.

Points of Attack: Eyes, skin, respiratory system; blood, reproductive system.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Liver and kidney function tests, lung function tests, examination of the eyes for corneal opacities. A qualified allergist may be consulted concerning potential skin allergy. Following acute overexposure, consider chest X-ray.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers recommend natural rubber, butyl rubber; nitrile, polyvinyl alcohol, polyvinyl chloride, Neoprene/natural rubber material. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *50 ppm*: CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)]; or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister]; or Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with a full facepiece). *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

Storage: (1) Color code—Red: Flammability Hazard: Store in a flammable (liquid or solid materials) storage area or approved cabinet away from sources if ignition. (2) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area separated from strong oxidants, strong bases; strong acids. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2219 Allyl glycidal ether, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquid in vermiculite, dry sand; earth, or similar material and deposit in sealed containers. Wash away residue with plenty of water. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of carbon. This chemical is a combustible liquid. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (2); (100).

National Institute for Occupational Safety and Health (NIOSH), Information Profiles on Potential Occupational Hazards: Glycidyl Ethers, Report No. PB 276-678, Rockville, MD, pp. 116−123 (October 1977).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Allyl Glycidyl Ether, Trenton, NJ (January 2001).

Allyl Isothiocyanate A:0610

Formula: C_4H_5NS; $CH_2 = CHCH_2NCS$

Synonyms: AITC; Allyl isorhodanide; Allyl isosulfocyanate; Allyl mustard oil; Allylsenfoel (German); Allyl sevenolum; Allyl thiocarbonimide; Artificial mustard oil; Carbospol; Isothiocyanate d'allyle (French); 3-Isothiocyanato-1-propene; Isotiocianato de alilo (Spanish); Mustard oil; Oil of mustard, artificial; Oleum sinapis volatile; 2-Propenyl isothiocyanate

Redskin; Senf oel (German); Synthetic mustard oil; Volatile oil of mustard

CAS Registry Number: 57-06-7; *(alt.)*: 50888-64-7; *(alt.)* 50978-48-8; *(alt.)* 58391-87-0; *(alt.)* 107231-30-1

HSDB Number: 617
RTECS Number: NX8225000
UN/NA & ERG Number: (PIH) UN1545/155 (P)
EC Number: 200-309-2

Regulatory Authority and Advisory Information

Carcinogenicity: NCI: Carcinogenesis Studies (gavage); clear evidence: rat; (gavage); no evidence: mouse; IARC: Animal Limited Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1999.

Hazard Alert: Poison inhalation hazard, Flammable, Possible risk of forming tumors, Possible sensitization hazard [skin], Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction), Environmental hazard.

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: F, T, N, Xi; Risk phrases: R10; R23/24/25; R34; R36/37; R42/43; R50/53; R62; R63; Safety phrases: S16; S23; S24; S26; S29; S36/37/39; S41; S45; S60 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Allyl isothiocyanate is a highly flammable, colorless to pale yellow, oily liquid. Air contact may cause darkening. Pungent, irritating odor and acrid taste. Molecular weight = 99.16; boiling point = 151°C; flash point = 46°C. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 2; reactivity 0. Insoluble in water. Allyl isothiocyanate may be inhibited, causing a change in various toxicological, chemical and/or physical properties.

Potential Exposure: Used in fumigants, veterinary drugs, ointments and counter irritants, mustard plasters, and as a flavoring agent.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, alcohols, amines.

Permissible Exposure Limits in Air

PAC Ver. 29[138]
PAC-1: 1 ppm
PAC-2: 2.8 ppm
PAC-3: 17 ppm

DFG MAK: [skin] May cause skin sensitization.

Russia: TWA 0.3 milligram per cubic meter; STEL 0.6 milligram per cubic meter, 1993

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin and respiratory tract. Eye and skin contact can cause skin irritation. Prolonged contact can cause burns and blisters. This chemical can be absorbed through the skin, thereby increasing exposure. Potential for dermal sensitization.

Long-Term Exposure: There is limited evidence that this chemical causes cancer in animals, It may cause bladder cancer in male rats. May damage the developing fetus. Exposure can cause an allergy-type reaction to develop with symptoms of asthma, watery eyes, sneezing, runny nose; coughing, sneezing, chest tightness. Skin allergy may develop, small exposures can cause symptoms to appear.

Points of Attack: Eyes, respiratory system.

Medical Surveillance: Preemployment and regular lung function tests are recommended (these may be normal if the persons is not having an attack at the time of the test). If symptoms develop or if overexposure is suspected, evaluation by a qualified allergist may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN1545 Allyl isothiocyanate, stabilized, Hazard class: 6.1; Labels: 6.1-Poison Inhalation Hazard, 3 flammable liquids.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Cover with vermiculite, dry sand; soil, or similar adsorbent, and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the potential for an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Allyl isothiocyanate is a highly flammable liquid. Thermal decomposition products may include hydrogen cyanide and oxides of nitrogen, sulfur and carbon. Use dry chemical, carbon dioxide; or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (201); (100).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 1, No. 1, 28–29 (1980).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Allyl Isothiocyanate, Trenton, NJ (June 1998).

Allyl Trichlorosilane A:0630

Formula: $C_3H_5Cl_3Si$; $CH_2 = CHCH_2SiCl_3$

Synonyms: Aliltriclorosilano (Spanish); Allylsilicone trichloride; Allyltrichlorosilane; Allyl trichorosilane, stabilized; Silane, allyltrichloro-; Silane, trichloroallyl-; Silane, trichloro-2-propenyl-; Trichloroallylsilane; Trichloro-2-propenylsilane

CAS Registry Number: 107-37-9

HSDB Number: 2715

RTECS Number: VV1530000

UN/NA & ERG Number: UN1724/155

EC Number: 203-485-9

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade). (stabilized)

Hazard Alert: Highly flammable, Corrosive, Violently water reactive.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: F, C; Risk phrases: R11; R14; R34; R35/36/37; Safety phrases: S1; S16; S21; S26; S33; S36/37/39; S41; S43; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Allyl trichhlorosilane is a volatile, corrosive, flammable, colorless liquid. Irritating odor. Molecular weight = 175.5; specific gravity (H_2O:1) = 1.215 @ 20°C (liquid); boiling point = 117°C; liquid surface tension = (estimate) 20 dyn/cm; relative vapor density (air = 1) = 6.05; ratio of specific heats of vapor (gas) = 1.0863; latent heat of vaporization = 2.3×10^5 J/kg; heat of combustion = (estimate) = -120×10^5 J/kg; flash point = 35°C (oc). Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 3; reactivity 2₩. Reacts violently with water, rapidly releasing corrosive hydrogen chloride gas.

Potential Exposure: Used to make silicones and glass fiber finishes.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Chlorosilanes react vigorously with bases and both organic and inorganic acids generating toxic and/or flammable gases. Chlorosilanes react with water, moist air, or steam to produce heat and toxic, corrosive fumes of hydrogen chloride gas. They may also produce flammable gaseous hydrogen. Attacks metals in the presence of moisture. Avoid all sources of ignition.

Permissible Exposure Limits in Air

PAC* Ver. 29[138]

PAC-1: $\mathbf{0.60_A}$ ppm

PAC-2: $\mathbf{7.3_A}$ ppm

PAC-3: $\mathbf{33_A}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

Permissible Concentration in Water: No criteria set. Reacts vigorously with water.

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Allyl trichlorosilane is corrosive and contact can cause severe eye and skin burns. Exposure can irritate the eyes, nose and respiratory tract. Higher levels can irritate the lungs, causing coughing and shortness of breath; still higher exposures can cause pulmonary edema, a medical emergency that can cause death.

Long-Term Exposure: Corrosives may cause long-term lung problems, although it is not known at this time that this chemical causes lung damage.

Points of Attack: Eyes, skin, respiratory tract.

Medical Surveillance: Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Lung function tests. Following acute overexposure, consider chest X-ray.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA for HCl: *50 ppm*: CcrS (APF = 10) [any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern]; or GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern]; or PaprS (APF = 25) (any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern); or Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with a full facepiece).

Emergency or planned entry into unknown concentrations or IDLH conditions: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFAg (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA). Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where allyl trichlorosilane may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from contact with water and sources of ignition. Use and store allyl trichlorosilane under nitrogen. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Where this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1724 Allyltrichlorosilane, stabilized, Hazard class: 8; Labels: 8-Corrosive material, 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Use foam spray to reduce vapors. Cover with dry lime, dry sand; soda ash, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Keep allyl trichlorosilane out of a confined space, such as a sewer, because of the potential for an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (from a small package or a small leak from a large package)

when spilled in water

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.2/0.3

Large spills (from a large package or from many small packages)

First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.4/0.6
Night 1.2/1.9

Fire Extinguishing: Firefighting gear (including SCBA) does not provide adequate protection. If exposure occurs, remove and isolate gear immediately and thoroughly decontaminate personnel. This chemical is a highly flammable liquid. Thermal decomposition products may include hydrogen chloride and phosgene. Do Not Use Water. Use dry chemical, CO_2 or foam extinguishers. Low or medium expansion AFFF foam or dry chemical if available in sufficient amounts (FEMA). Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey 2Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Allyl Trichlorosilane, Trenton, NJ (June 1998).

Aluminum Alkyl Halides A:0640

Formula: $C_4H_{10}AlBr$ (Diethylaluminum bromide); $C_4H_{10}AlCl$ (Diethylaluminum chloride); $C_2H_5AlI_2$ (Ethylaluminum diiodide); $C_2H_5AlCl_2$ (Ethylaluminum dichloride); $C_6H_{15}Al_2Cl_3$ (Ethylaluminum sesquichloride); $C_3H_9Al_2Cl_3$ (Methylaluminum sesquichloride); $C_3H_9AlBr_3$ Methylaluminum sesquibromide

Catalyst for polymerization of olefins and hydrogenation of aromatics, chemical intermediate.

Synonyms: *diethylaluminum chloride*: Chlorodiethylaluminum; Diethylaluminum monochloride; Diethylchloroaluminum. *ethylaluminum dichloride*: Aluminum, dichloroethyl-; Dichloroethylaluminum; Dichloromonoethylaluminum; Ethyldichloroaluminum. *ethylaluminum sesquichloride*: Riethyldialuminum trichloride; Sesquicloruro de etilalumino (Spanish); Sesquiethylaluminum chloride; Trichlorotriethyl-dialuminum; Trichlorotriethyldialuminum; Triethylaluminum sesquichloride; Triethyltrichlorodialuminum trichlorotrimethyldi-; Methyl aluminum sesquichloride; Trichlorotrimethyldialuminum. *methylaluminum sesquichloride*: Sesquicloruro de metilalumino (Spanish)

methylaluminum sesquibromide: Sesquibromuro de metilalumino (Spanish)

CAS Registry Number: 96-10-6 (diethylaluminum chloride); 760-19-0 (diethylaluminum bromide); (ethylaluminum dichloride); 2938-73-0 (ethylalumium diiodide); 12075-68-2 (ethylaluminum sesquichloride); *methylaluminum sesquichloride*: 563-43-9; 12542-85-7

HSDB Number: 5299 (ethylalumium diiodide)

RTECS Number: BD0558000 (diethylaluminum chloride); BD0705000 (ethylaluminum dichloride); BD1950000 (ethylaluminum sesquichloride); BD1970000 (methylaluminum sesquichloride)

UN/NA & ERG Number: UN3394/135; UN3052/135 (*Note*: this number does not appear in the 49/CFR HazMat tables)[101]

EC Number: 212-075-9 (CAS: 760-19-0); 202-477-2 (CAS: 96-10-6); 209-248-6 (CAS: 563-43-9); 235-137-7 (CAS: 12075-68-2); 235-698-8 (CAS: 12542-85-7)

Regulatory Authority and Advisory Information

Hazard Alert: Pyrophoric hazard, Extremely flammable, Violently reactive with water; Organometallic, Strong reducing agent.

OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 5000 lb (2270 kg)

Canada, WHMIS, Ingredients Disclosure List 1% as aluminum alkyl compounds.

Hazard symbols, risk, & safety statements: Hazard symbol: F+, C; Risk phrases: R12; R14/15; R17; R29; R34; R35; R37; R48/20; R50/51/53; R62; R63; R65; R67; Safety phrases: S1/2; S16; S21; S26; S29; S36/37/39; S43; S45; S61; S62 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water. (*96-10-6; 760-19-0*)

Description: The aluminum alkyl halides are flammable, reactive, and may be spontaneously combustible in air. They are colorless to yellow liquids. *Ethylaluminum dichloride*: (*563-43-9*): Molecular weight = 126.95; specific gravity (H_2O:1) = 1222; boiling point = 194°C; freezing/melting point = 32°C; hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 4; reactivity 3-₩.

Ethyl aluminum sesquichloride: Molecular weight = 247.49; (Boiling point = 114.5−116.5°C; flash point = −20°C. NFPA-704 M Rating System): Health 3, flammability 3, reactivity 3-₩; violent reaction with water. *Methylaluminum sesquichloride*: Boiling point = 120−140°C; flash point = −17°C. *Methylaluminum sesquibromide*: Freezing/melting point = −3.8°C; boiling point = (about) 165°C.

Potential Exposure: These materials are used as components of olefin polymerization catalysts. The reader is referred to the entry on "Aluminum alkyls" for additional information on this entry. The aluminum alkyl halides parallel very closely the aluminum alkyls.

Incompatibilities: The aluminum alkyl halides are strong reducing agents; they react—possibly violently—with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. These chemicals react violently with nitromethane. Ethylaluminum sesquichloride reacts explosively with carbon tetrachloride at room temperature. This chemical reacts violently with water, forming corrosive hydrogen chloride and flammable ethane gas. Diethylaluminum chloride may form an explosive product with chlorine azide.

Permissible Exposure Limits in Air
as aluminum alkyls

OSHA PEL: None

NIOSH REL: 2 milligram per cubic meter TWA

96-10-6

PAC Ver. 29[138]

PAC-1: 27 milligram per cubic meter

PAC-2: 290 milligram per cubic meter

PAC-3: 1800 milligram per cubic meter

563-43-9

PAC-1: 28 ppm

PAC-2: 310 ppm

PAC-3: 1800 ppm

Determination in Air: Use NIOSH #7013 Aluminum; #7300, Elements; #7303; OSHA Analytical Method ID-121.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Points of Attack: Skin, respiratory system.

Medical Surveillance: Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Lung function tests.

Storage: Spontaneously combustible. (1) Color code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. (2) Color code—Yellow Stripe: Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Outside or detached storage is preferable. Inside storage must be in a standard flammable liquids storage room or cabinet. Before entering confined space where acrolein may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from heat and light. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN3052 Spontaneously combustible. Water reactive releasing large quantities of toxic and deadly hydrogen gas. (Note: this number does not appear in the 49/CFR HazMat tables)[101]

Spill Handling:

Ethyl aluminum sesquichloride is flammable, reactive, and a dangerous fire and explosion hazard. Ethyl aluminum sesquichloride is spontaneously combustible in air and reacts violently with water.

Initial isolation and protective action distances—aluminum alkyl halides, liquid or solids (when spilled in water)

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (from a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.1/0.2

Large spills (from a large package or from many small packages)

First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.3/0.5
Night 0.8/1.3
See ERG Guide 135

Aluminum alkyl halides

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (from a small package or a small leak from a large package)

when spilled in water

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.1/0.2

Large spills (from a large package or from many small packages)

First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.3/0.5
Night 0.8/1.3

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Ventilate area of spill or leak. These chemicals ignite spontaneously in air. Remove all ignition sources. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. *Do not use water or wet method.* It may be necessary to contain and dispose of this chemical as a hazardous waste. Ventilate area of spill or leak. Keep ethyl aluminum sesquichloride out of confined spaces, such as sewers, because of the possibility of an explosion. *Do not* wash into sewer. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

References

(31); (173); (101); (138); (170); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: *Ethyl Aluminum Sesquichloride*, Trenton, NJ (August 2009).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: *Diethyl Aluminum Chloride*, Trenton, NJ (June 2001).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: *Ethyl Aluminum Dichloride*, Trenton, NJ (April 2003).

Aluminum Alkyls A:0650

Formula: C_3H_9Al (trimethyl-); $C_6H_{15}Al$ (triethyl-); $C_9H_{21}Al$ (tripropyl-); $C_{12}H_{27}Al$ (triisobutyl)

Synonyms: Trialkylaluminum (general)

tributyl-isomer: Aluminum, Tributyl-; TNBA; Tributylalane; tri-*n*-Butyl aluminum

triethyl-isomer: Aluminum, triethyl-; TEA; Triethylalane

triisobutyl-isomer: Aluminum, triisobutyl-; Aluminum, tris (2-methylpropyl); Triisobutylalane; Tris(2-methylpropyl) aluminum

trimethyl-isomer: Trimethylalane

tripropyl-isomer: Aluminum, tripropyl-; Tripropylalane

CAS Registry Number: 75-24-1 (trimethyl-); 97-93-8 (triethyl-); 102-67-0 (tripropyl-); 1116-70-7 (tributyl-); *(alt.)* 100-99-2; 130565-62-7 (triisobutyl-)

HSDB Number:

RTECS Number: BD2204000 (trimethyl-); BD2050000 (triethyl-); BD2208000 (tripropyl-); BD1820000 (tributyl-); BD2203500 (triisobutyl-)

UN/NA & ERG Number: UN3399/138; UN3051/135 (*Note*: According to NOAA/Cameo, this number does not appear in the 49 CFR HazMat tables.)[101]

EC Number: 200-853-0 (CAS: 75-24-1); 202-619-3 (CAS: 97-93-8); 203-045-6 (CAS: 102-67-0); 214-240-0 (CAS: 1116-70-7); 202-906-3 (CAS: 100-99-2)

Regulatory Authority and Advisory Information

Hazard Alert: Pyrophoric hazard, Chemically unstable, Extremely flammable and highly reactive, Dangerously water reactive, Organometallic, Strong reducing agent.

OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 5000 lb (2270 kg)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: F+ , C, N; Risk Statements: R12; R14/15; R17; R20; R29; R34; R48; R50/51/53; R62; R65; R67; Safety Statements: S6A; S16; S24; S24/25; S26; S29; S33; S36/37/39; S41; S43; S45; S62 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: The aluminum alkyls are highly flammable and reactive, colorless to yellow liquids at room temperature. The lighter trialkylaluminums ignite spontaneously in air. They are normally supplied and used in a 20% solution with a hydrocarbon solvent, such as hexane, heptane, benzene, toluene. Properties may depend on solvent. Reacts violently with water. Molecular weight = 198.33 (triisobutyl-); 114.19 (triethyl-); specific gravity (H_2O:1) = 0.84 @ 20°C (triethyl-); boiling point = 86°C (triisobutyl-); 185−194°C (triethyl-); freezing/melting point = 4−6°C (triisobutyl); −52.5°C (triethyl-); 72.09 (trimethyl-75-24-1); vapor pressure = 69.3 mmHg @ 60°C (trimethyl, 75-24-1); 4 mmHg @ 83°C (triethyl-); flash point = ignites spontaneously in air; explosive limits: LEL: 9000 ppm 75-24-1 (trimethyl-); hazard identification (triethyl-, triisobutyl-): Health 3; flammability 4; reactivity 3₩ (water reactive; violent).

Potential Exposure: Alkyl aluminum compounds are used as components of olefin polymerization catalysts. They are also used in the synthesis of higher primary alcohols and in pyrophoric fuels, as a catalyst in making ethylene gas; and in plating aluminum.

Incompatibilities: The lighter trialkylaluminums ignite spontaneously in air; can self-heat in the air at room temperature without any added energy and may ignite. These compounds are strong reducing agents. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Incompatible with water, oxygen (air), acids, alcohols, phenols, amines, carbon dioxide; sulfur oxides; halogenated compounds, and many other substances.

Permissible Exposure Limits in Air

as aluminum alkyls

OSHA PEL: None

NIOSH REL: 2 milligram per cubic meter TWA

PAC Ver. 29[138]

75-24-1 (trimethyl-)

PAC-1: 16 milligram per cubic meter

PAC-2: 170 milligram per cubic meter

PAC-3: 1000 milligram per cubic meter

97-93-8 (triethyl-)

PAC-1: 25 milligram per cubic meter

PAC-2: 280 milligram per cubic meter

PAC-3: 1700 milligram per cubic meter

Determination in Air: Use NIOSH #7013 Aluminum; #7300, Elements; #7303; OSHA Analytical Method ID-121.

Permissible Concentration in Water: Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment. These compounds react violently with water.

Routes of Entry: Inhalation, skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Corrosive. Can cause severe eye and skin irritation and burns. Inhaling vapors or fumes can irritate the respiratory tract, causing coughing, wheezing, and/or shortness of breath. They can cause "metal fume fever" with symptoms of head-ache, nausea, vomiting, chills, cough and shortness of breath.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Lung function tests. Consider chest X-ray following acute overexposure. See also NIOSH #8310, Metals in Urine.

First Aid: I If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to Physician: In case of fume inhalation, treat pulmonary edema. Consider administering prednisone or other corticosteroid orally to reduce tissue response to fume. Positive-pressure ventilation may be necessary. Treat metal fume fever with bed rest, analgesics and antipyretics. The symptoms of metal fume fever may be delayed for 4−12 hours following exposure: it may last less than 36 hours.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation Exposure to large quantities, as in plant transfers, require full body aluminized proximity suit. Gloves, used in plant transfers or operations should be aluminized leather, preformed Neoprene, aluminized vinyl, or other fire-resistant, nonreactive material. Preformed rubber gloves may be used in the laboratory. All gloves used when handling aluminum alkyls should be loose-fitting for instant removal if necessary. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any concentrations above the NIOSH REL*: *2 milligram per cubic meter* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode).

Storage: Color code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Protect against physical damage. Outside or detached storage is preferable. Before entering confined space where aluminum alkyls may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area. All transfer lines must be free of water, oxygen and other substances that react with aluminum alkyls. All vessels must be dry and oxygen free. Transfer lines should be blanked when not in use. Vessels should be top unloading when feasible with remote manual pressure relief. Metal containers involving the transfer of this chemical should be grounded and bonded. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN3399 Organometallic substance, liquid, water-reactive, flammable, Hazard Class: 4.3; Labels: 4.3-Dangerous when wet material, 3-Flammable liquid, technical name Required. UN3051-Spontaneously combustible. Also, this material is dangerous when wet. (*Note*: this number does not appear in the 49/CFR HazMat tables)[101].

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. These chemicals ignite spontaneously in air. Remove all ignition sources. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Stop flow of liquid, if possible, before extinguishing fire. Thermal decomposition products may include poisonous and flammable gases, including ethylene and oxides of metal and carbon. These chemicals may ignite spontaneously in air, and are flammable liquids. *Do not use water, foam*, or a *halogenated* extinguishing agent. Use dry chemical, graphite powder, soda ash; or lime extinguishers. On solvent-based material use carbon dioxide or dry chemical. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, carefully use water spray to cool fire-exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Careful incineration.

References

(31); (173); (101); (138); (170); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Triethyl Aluminum, Trenton, NJ (June 2003). There are very similar fact sheets from the same source on: Trimethyl Aluminum (May 2000), Tripropyl Aluminum (May 2000), Tributyl Aluminum (November 2000), Triisobutyl Aluminum (April 2000).

Aluminum & Aluminum Oxide A:0660

Formula: Al

Synonyms: *aluminum*: A 00; A 95; A 99; A 995; A 999; AA 1099; AA 1199; AD 1; AD1M; ADO; AE; Alaun (German); Allbri aluminum paste and powder; Alumina fiber; Aluminio (Spanish); Aluminum; Aluminum flake; Aluminum 27; Aluminum dehydrated; Aluminum, metallic powder; Aluminum powder; AO A1; AR2; AV00; AV000; C.I. 77000; Emanay atomized aluminum powder; JISC 3108; JISC 3110; L16; Metana; Metana aluminum paste; Noral aluminum; Noral extra fine lining grade; Noral nonleafing grade; PAP-1

Aluminum oxide: A-1 (sorbent); A-2; Alcan AA-100; Alcan C-70; Alcan C-71; Alcan C-72; Alcan C-73; Alcoa F1; Alexite; Almite; Alon; Alon C; Aloxite; Alufrit; α-Alumina; β-Alumina; γ-Alumina; Alumina; Aluminite 37; α-Aluminum oxide; β-Aluminum oxide; γ-Aluminum oxide; Aluminum oxide (2:3); Aluminum oxide C; Aluminum sesquioxide; Aluminum trioxide; Alumite; Alundum; Alundum 600; Backlap slurry; Bauxite; Bayerite; Boehmite; Brasivol; Brockmann, aluminum oxide; C-1; Cab-O-Grip; Catapal S; Compalox; Conopal; Corundum; D 201; Dialuminum trioxide; Diaspore dirubin; Dispal; Dispal alumina; Dispal M; Dotment 324; Dotment 358; Dural; Dycron; Exolon XW 60; F 360 (Alumina); Faserton; Fasertonerde; Fast cure 45 epoxy; Flame guard; G2 (Oxide); Gibbsite; GK (Oxide); GO (Oxide); Hypalox II; Itaclor; Jubenon R; KA 101; Ketjen B; KHP 2; LA 6; Lucalox; Ludox Cl; Maftecmartipol; Martisorb; Martoxin; Microgrit WCA; Micropolish alumina; Oxido aluminico (Spanish); PS-1; PS-1 (alumina); Purdox; Q-Loid A 30; RC 172DBM; Realox

CAS Registry Number: 7429-90-5 (aluminum powder, coated, & uncoated); 1344-28-1 (aluminum oxide); 1333-84-2 (aluminum oxide hydrate); 1302-74-5 (emery/corundum, natural form of aluminum oxide)

HSDB Number: 507 (elemental)

RTECS Number: BD0330000 (aluminum metal powder); BD1200000 (aluminum oxide)

UN/NA & ERG Number: UN1309 (Aluminum powder, coated)/170; UN1396 (Aluminum powder, uncoated); UN1383 [Pyrophoric metals (of Al)]/138

EC Number: 231-072-3 [*Annex I Index No.*: 013-001-00-6] (powder); 215-691-6 (aluminum oxide)

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Theft hazard* 100 (*powder*)

Hazard Alert: *Al powder*: Highly flammable (powder), Suspected of causing genetic defects; *aluminum oxide*: Possible risk of forming tumors.

United States National Primary Drinking Water Regulations: SMCL = 0.05 to 0.2 mg[Al]/L as aluminum.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. as aluminum, elemental, alpha-alumina, or aluminum oxide.

Clean Water Act: Section 313 (57FR41331) Water Priority Chemicals (Al, dust or fume)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): D003

Safe Drinking Water Act (47FR 9352): 47FR9352, regulated contaminants; 53FR1896, list of contaminants, 55FR1470, Priority List; 40 CFR143.3, SMLC, 0.05−0.2 mg/L

SARA 313: Form R *de minimis* Concentration Reporting Level: 1.0% (Al, dust and fume); 0.1% (Aluminum oxide, fibrous form only).

Hazard symbols, risk, & safety statements: Hazard symbol: F; Risk phrases: R11; R15; R17; Safety phrases: S1; S2; S7/8; S21; S43 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): Non hazard to water.

Description: Aluminum is a combustible, light, silvery-white, soft, ductile, malleable, amphoteric metal. Molecular weight = 26.98 (aluminum); 101.96 [aluminum oxide (Al_2O_3)] and (corundum); 137.99 (aluminum oxide hydrate); specific gravity (H_2O:1) = 2.7 (aluminum); 3.99 (aluminum oxide); boiling point = 2519°C (aluminum); 7.5 mmHg @ 2351°C (aluminum oxide); freezing/melting point = 660.3°C (aluminum); 2054°C (aluminum oxide); vapor pressure = 1 mmHg @ 1284°C (aluminum); 2054°C (aluminum oxide); autoignition temperature = 590°C (aluminum). Ignition temperature of dust cloud = 650°C (aluminum); minimum explosive concentration = 0.045 oz/ft^3 [USBM] (aluminum). Hazard identification (*dust*): Health 0; flammability 3; reactivity 1. Insoluble in water. Relative explosion hazard of dust: Severe.

The primary sources are the ores cryolite, gibbsite and bauxite, found as boehmite; aluminum is never found in the elemental state. Aluminum oxide is a noncombustible, white, crystalline powder or granules. Molecular weight = 101.96; boiling point = about 3000°C; freezing/melting point = 2050°C. Insoluble in water.

Pyrophoric aluminums include aluminum powder, trimethyl aluminum (75-24-1), tripropyl aluminum (102-67-0).

Potential Exposure: Most hazardous exposures to aluminum occur in smelting and refining processes. Aluminum is mostly produced by electrolysis of Al_2O_3 dissolved in molten cryolite (Na_3AlF_6). Aluminum is alloyed with copper, zinc, silicon, magnesium, manganese, and nickel; special additives may include chromium, lead, bismuth, titanium, zirconium, and vanadium. Aluminum and its alloys can be extruded or processed in rolling mills, wire works, forges, or foundries; and are used in the shipbuilding, electrical, building, aircraft, automobile, light engineering, and jewelry industries. Aluminum foil is widely used in packaging. Powdered aluminum is used in the paints and pyrotechnic industries. Alumina, emery, and corundum has been used for abrasives, refractories, and catalysts; and in the past in the first firing of china and pottery.

Incompatibilities: Aluminum powder forms an explosive mixture with air and is a strong reducing agent that reacts violently with oxidizers, strong bases; strong acids; some halogenated hydrocarbons; nitrates, sulfates, metal oxides and many other substances. Keep away from combustible materials.

Permissible Exposure Limits in Air

as aluminum metal and insoluble compounds

OSHA PEL: 15 mg[Al]/m^3, total dust; 5 mg[Al]/m^3, respirable fraction TWA

NIOSH REL: 10 mg[Al]/m^3, total dust; 5 mg[Al]/m^3, respirable fraction TWA

ACGIH TLV[1]: 1 mg[Al]/m respirable fraction TWA

PAC Ver. 29[138]

1333-84-2, aluminum oxide hydrate

PAC-1: 15 milligram per cubic meter

PAC-2: 130 milligram per cubic meter

PAC-3: 780 milligram per cubic meter

1344-28-1, aluminum oxide

PAC-1: 15 milligram per cubic meter

PAC-2: 170 milligram per cubic meter

PAC-3: 990 milligram per cubic meter

1333-84-2, aluminum oxide hydrate

PAC-1: 15 milligram per cubic meter

PAC-2: 170 milligram per cubic meter

PAC-3: 780 milligram per cubic meter

DFG MAK: 4 mg[Al]/m^3, total dust; 1.5 mg[Al]/m^3, respirable fraction; Pregnancy risk Group D.

Australia: TWA 10 milligram per cubic meter, 1993; Australia: TWA 2 milligram per cubic meter (salts), 1993; Australia: TWA 5 milligram per cubic meter (fumes); TWA 5 milligram per cubic meter (resp. dust); MAK 6 milligram per cubic meter, dust, 1999; Belgium: TWA 10 milligram per cubic meter; TWA 2 milligram per cubic meter (salts); TWA 5 milligram per cubic meter (fumes), 1993; the Netherlands: MAC-TGG 10 milligram per cubic meter, 2003; Denmark: TWA 10 milligram per cubic meter, dust or fume, 1999; Finland: TWA 2 milligram per cubic meter (salts), 1993; France: VME 10 milligram per cubic meter; VME 5 milligram per cubic meter (fumes); VME 5 milligram per cubic meter (resp. dust), 1993; Hungary: STEL 5 milligram per cubic meter; TWA 2 milligram per cubic meter; STEL 4 milligram per cubic meter (salts), 1993; Norway: TWA 5 milligram per cubic meter, 1999; Russia: STEL 2 milligram per cubic meter, 1993; Sweden: NGV 4 milligram per cubic meter (resp. dust); NGV 10 milligram per cubic meter (total dust), 1999; Switzerland: MAK-W 6 milligram per cubic meter, 1999; United Kingdom: TWA 4 milligram per cubic meter, respirable dust, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 5 milligram per cubic meter (welding fumes-total particulates).

(Aluminum oxide)

ACGIH 10 milligram per cubic meter Not suspected as a human carcinogen; (for total dust containing no asbestos and less than 1% crystalline silica).

DFG MAK: 1.5 mg[Al]/m^3 [(fume) respirable fraction (previously "fine dust")]; 4 mg[Al]/m^3 [(fume) inhalable fraction (previously "total dust")]; Pregnancy Risk Group D; BAT: 200 μg[Al]/L in urine, end-of-shift.

Australia: TWA 10 milligram per cubic meter, 1993; Austria: MAK 5 milligram per cubic meter, dust, 1999; Belgium: TWA 10 milligram per cubic meter, 1993; Denmark: TWA 10 mg[Al]/m^3, 1999; France: VME 10 milligram per cubic meter, 1999; Norway: TWA 2 mg[Al]/m^3, 1999; Poland: MAC (TWA) 2 milligram per cubic meter, MAC (STEL) 16 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 10 milligram per cubic meter, 2003; Sweden: TWA 4 mg[Al]/m^3 (respirable dust); TWA 10 mg[Al]/m^3 (total dust), 1999; Switzerland: MAK-W 2 mg[Al]/m^3, 1999; United Kingdom: TWA 10 milligram per cubic meter, total inhalable dust; TWA 4 milligram per cubic meter, respirable dust, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen.

Determination in Air: For alumina dusts use NIOSH Analytical Method #0500, total dusts, #0600, OSHA Analytical Method ID-109SG, ID-198SG. For aluminum, metal, powder, coated and uncoated use NIOSH Analytical Method #7013, #7300, #7301, #7303, OSHA Analytical Method #ID-121. For aluminum, pyrophoric powders and welding fumes use NIOSH Analytical Method #7300, #7301, and #7303. For aluminum, soluble salts and alkyls use NIOSH Analytical Method #7013, #7300, #7301, #7303, OSHA Analytical Method #ID-12.

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 50−200 μg[Al]/L; State Drinking Water Standards: California: 1000 μg[Al]/L. State Drinking Water Guidelines: Arizona 73 μg[Al]/L; California 200 μg[Al]/L; Maine 1430 μg[Al]/L.

Routes of Entry: Inhalation, eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Aluminum dust can cause irritation, and particles can scratch the eyes. Aluminum oxide can irritate the eyes, nose and respiratory tract. Particles of aluminum deposited in the eye may cause necrosis of the cornea. Salts of aluminum may cause dermatoses, eczema, conjunctivitis, and irritation of the mucous membranes of the upper respiratory system by the acid liberated by hydrolysis. The effects on the human body caused by inhalation of aluminum dust and fumes are not known with certainty at this time. Present data suggest that pneumoconiosis might be a possible outcome. In the majority of causes investigated, however, it was found that exposure was not to aluminum dust alone, but to a mixture of aluminum, silica fume, iron dusts, and other materials.

Long-Term Exposure: There is evidence of an increase in bladder, lung, and other cancers among aluminum smelter workers. The increase appears to be due to PAC exposure, not to aluminum compounds. Aluminum salts are toxic to the animal fetus and cause fetal damage. Exposure to fine dust from aluminum or aluminum oxide can cause lung damage, pneumonia, and pulmonary fibrosis; with symptoms of coughing, wheezing and shortness of breath. Very high levels of aluminum may cause brain damage.

Points of Attack: Skin, respiratory system.

Medical Surveillance: Preemployment and periodic physical examinations should give special consideration to the skin, eyes, and lungs. Lung function should be followed, including chest X-ray, pulmonary function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Actual working conditions will determine the need and type of PPE. Determine CPC based on working conditions. Dust masks are recommended in areas exceeding the nuisance levels. Aluminum workers generally should receive training in the proper use of PPE. Workers involved with salts of aluminum may require protective clothing, barrier creams, and where heavy concentrations exist, full face air supplied respirators may be indicated. Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls, and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit.

Storage: Prior to working with this chemical, personnel should be trained on its proper handling and storage. UN1309; UN1383(1) Color code—Red Stripe: Flammability Hazard: Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Store flammable solids up to maximum allowable quantity per control area in an approved flammable storage area. Do not store in a basement. (2) Color code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. UN1396 Color code—Red Stripe: Dangerous when wet materials release flammable gases on contact with water. Do not store this material in a room protected by water sprinkler systems: Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area separated from strong oxidants, strong bases; strong acids. Metal containers involving the transfer of this chemical should be grounded and bonded. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN1309 Aluminum powder, coated, Hazard Class: 4.1; Labels: 4.1-Flammable solid. UN1383 Pyrophoric metals, n.o.s. or Pyrophoric alloys, n.o.s., Hazard Class: 4.2; Labels: 4.2-Spontaneously combustible material, Technical Name Required. UN1396 Aluminum powder, uncoated, Hazard Class: 4.3; Labels: 4.3-Dangerous when wet material.

NA9260 (North America) Aluminum, molten, Hazard class: 9; Labels: 9-Miscellaneous hazardous material.

Spill Handling: For aluminum metal spills, special care must be taken with aluminum powder which may be very reactive. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Do not use water to clean up spilled aluminum powder. Do not raise dust level by sweeping. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. May be disposed of as an inert solid in a landfill.

Fire Extinguishing: With aluminum metal, do not use water or halogenated agents. Aluminum powder is a combustible solid. Aluminum oxide is not flammable. Use dry chemical, carbon dioxide; foam extinguishers. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal of Aluminum Oxide-Disposal in a sanitary landfill. Mixing of industrial process wastes and municipal wastes at such sites is not encouraged however. Aluminum powder may be recovered and sold as scrap. Recycling and recovery is a viable option to disposal for aluminum metal and aluminum fluoride (A-57).

References

(31); (173); (101); (138); (2); (201); (170); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Aluminum and Aluminum Compounds, Washington, DC (September 1976).

National institute for Occupational Safety and Health (NIOSH), Profiles on Occupational Hazards for Criteria Document Priorities: Aluminum and Its Compounds, Report PB 274-073, Washington, DC, pp 80−84 (1977).

United States Environmental Protection Agency, *Toxicology of Metals, Vol. II*: *Aluminum*, Report EPA 600/1-77-022, Research Triangle Park, NC, pp 4−14 (May 1977).

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New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Aluminum Oxide, Trenton, NJ (June 2001).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Aluminum, Trenton, NJ (February 2007).

Aluminum Chloride A:0670

Formula: $AlCl_3$

Synonyms: Aluminum chlorid (German); Aluminum chloride (1:3); Aluminum chloride, anhydrous; Aluminum chloride solution; Aluminum trichloride; Anhydrol forte; Anhydrous aluminum chloride; Chlorure d'aluminum (French); Clorato aluminico (Spanish); Driclor; PAC; PAC (Van); Pearsall; Praestol K2001; Trichloro aluminum

CAS Registry Number: 7446-70-0

HSDB Number: 607

RTECS Number: BD0525000

UN/NA & ERG Number: UN1726 (anhydrous)/137; UN2581 (solution)/154

EC Number: 013-003-00-7

EC Number: 231-208-1 [*Annex I Index No.*: 013-003-00-7]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade). (*anhydrous*)

Hazard Alert: Dangerously water reactive, Organometallic, Strong reducing agent, Reproductive toxin: possible risk of gene damage/impaired fertility; Suspected reprotoxic hazard, Hormone, Primary irritant (w/o allergic reaction), FDA-over the counter drug.

United States National Primary Drinking Water Regulations: SMCL = 0.05 to 0.2 mg[Al]/L as aluminum; SMCL = 250 mg[Cl-]/L as Chloride.

United States Environmental Protection Agency Gene-Tox Program, Positive: In vivo cytogenetics-nonhuman bone marrow

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: C, Xi; Risk phrases: R34; R36/37/38; R62; R63; Safety phrases: S1/2; S7/8; S28; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Aluminum chloride is a noncombustible but highly reactive whitish-gray, yellow, or green powder or liquid. Strong, acidic, irritating odor like hydrochloric acid. Molecular weight = 133.34; relative density = 2.5; vapor pressure = 3×10^{-3}; hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 0; reactivity 2, ₩ (water reactive). Sinks in water and reacts, forming toxic and corrosive hydrogen chloride gas.

Potential Exposure: It is used as ethylbenzene catalyst, dyestuff intermediate, and detergent alkylate; in making other chemicals and dyes, astringents, deodorants, in the petroleum refining, and the rubber industries.

Incompatibilities: A strong reducing agent. Contact with air or water forms hydrochloric acid and hydrogen chloride gas. Reaction with water may be violent. Water, alcohol, and alkenes can cause polymerization. Incompatible with nitrobenzene, organic material, and bases. Attacks metal in presence of moisture, forming flammable hydrogen gas.

Permissible Exposure Limits in Air

Odor threshold = 6.31 ppm (as hydrogen chloride).

as aluminum, soluble salts

OSHA PEL: None

NIOSH REL: 2 mg[Al]/m^3 TWA

PAC Ver. 29[138]

7446-70-0

PAC-1: 30 milligram per cubic meter

PAC-2: 60 milligram per cubic meter

PAC-3: 360 milligram per cubic meter

Australia: TWA 2 mg[Al]/m^3, 1993; Belgium: TWA 2 mg [Al]/m^3, 1993; Denmark: TWA 2 mg[Al]/m^3, 1999; France: VME 2 mg[Al]/m^3, 1999; Norway: TWA 2 mg[Al]/m^3, 1999; Russia: TWA 2 mg[Al]/m^3, 1993; Sweden: NGV 2 mg[Al]/m^3, 1999; Switzerland: MAK-W 2 mg[Al]/m^3, 1999; United Kingdom: TWA 2 milligram per cubic meter, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 2 mg[Al]/m^3

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 50−200 μg[Al]/L; State Drinking Water Standards: California: 1000 μg[Al]/L. State Drinking Water Guidelines: Arizona 73 μg[Al]/L; California 200 μg[Al]/L; Maine 1430 μg[Al]/L.

Routes of Entry: Inhalation, ingestion, skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Corrosive to eyes, skin, and respiratory tract. Inhalation may cause pulmonary edema, which can be delayed for several hours; there is a risk of death in serious cases. Ingestion can cause severe burns of mouth, throat and stomach, vomiting, watery or bloody diarrhea; kidney damage; jaundice and liver damage; collapse and convulsions. Estimated lethal dose is about 8 ounces for an average 150 pound adult.

Long-Term Exposure: May cause pulmonary fibrosis, and reduced lung function with symptoms of coughing, wheezing, and shortness of breath.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Lung function tests. If symptoms develop or overexposure is suspected, chest X-ray should be considered.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. When working with liquid or solid, wear indirect vent, splash or dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: If dust levels are high, wear a dust mask. If hydrogen chloride is present, use: *Up to 50 ppm*: CcrS* (APF = 10) (any NIOSH/MSHA or European Standard EN 149-approved chemical cartridge respirator with cartridge(s) providing protection against the compound of concern); or GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern]; or PaprS* (APF = 25) [any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern]; or Sa* (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFAg (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

*Note**: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in a cool, dry area in tightly closed container away from moisture, heat, and sunlight.

Shipping: *UN1726 Aluminum chloride, anhydrous, Hazard class: 8; Labels: 8-Corrosive material. UN2581 Aluminum chloride solution, Hazard class: 8; Labels: 8-Corrosive material

Spill Handling:

*UN1726 Aluminum chloride, anhydrous (when spilled in water large amounts of toxic HCl gas can be released).

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase

with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (from a small package or a small leak from a large package)
First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.2/0.3

Large spills (from a large package or from many small packages)
First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.4/0.6
Night 1.4/2.3

Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Sweep carefully, being careful not to raise dust. Do not get water inside containers; keep combustibles away. For liquid aluminum chloride, absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Do not use water or water-based foams; will form poisonous fumes of hydrochloric acid. On solid material use any extinguishing medium suitable for surrounding fire. On solution, use dry chemical, carbon dioxide; or polymer foam extinguishers. Thermal decomposition products may include hydrochloric acid, aluminum oxide, and nitrogen oxides. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: May be sprayed with aqueous ammonia in the presence of ice and, when reaction is complete, flushed down drain with running water[22].

References

(31); (173); (101); (138); (201); (100).

New York State Department of Health, "*Chemical Fact Sheet* Aluminum Chloride, Albany NY, Bureau of Toxic Substance Assessment (March 1986).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Aluminum Chloride, Trenton, NJ (January 1999).

Aluminum Fluoride A:0680

Formula: AlF_3

Synonyms: Aluminum fluoride, anhydrous; Aluminum fluorure (French); Aluminum trifluoride; Fluoruro aluminico hidratado (Spanish)

CAS Registry Number: 7784-18-1; 15098-87-0 (hydrated form); 32287-65-3 (hydrated form)

HSDB Number: 600

RTECS Number: BD0725000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171 none in cameo; UN3260/154

EC Number: 232-051-1

Regulatory Authority and Advisory Information

Hazard Alert: Corrosive; Primary irritant (w/o allergic reaction).

United States National Primary Drinking Water Regulations: MCLG = 4 mg[F]/L; MCL = 4 mg[F]/L; SMCL = 2 mg[F]/L, as fluorides; SMCL = 0.05 to 0.2 mg [Al]/L as aluminum.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. as aluminum, water soluble salts.

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xi, Xn; Risk phrases: R26; R36/37/38; Safety phrases: S26; S37/39; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Aluminum fluoride is a white, odorless powder or granule. Molecular weight = 83.98; specific gravity (H_2O:1) = 2.88 @ 25°C; freezing/melting point = 1291°C. Boiling point = 1537°C; vapor pressure = 1 mmHg @ 1238.4°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 0. Slightly soluble in water.

Potential Exposure: Used as component of electrolyte from which aluminum metal is produced; in the manufacture of ceramics, enamels, aluminum silicate; as flux in metallurgy; as a fermentation inhibitor.

Incompatibilities: Reacts violently with potassium or sodium.

Permissible Exposure Limits in Air

as aluminum soluble salts

OSHA PEL: None

NIOSH REL: 2 milligram per cubic meter aluminum, soluble salts

ACGIH TLV[1]: 1 mg[Al]/m respirable fraction

as fluorides

NIOSH IDLH = 250 mg[F]/m^3

OSHA PEL: 3 ppm/2.5 mg[F]/m^3 TWA

NIOSH REL: 3 ppm/2.5 mg[F]/m^3 TWA

ACGIH TLV[1]: 2.5 mg[F]/m^3 TWA; not classifiable as a human carcinogen; BEI: 3 mg[F]/g creatinine in urine *prior* to end-of-shift; 10 mg[F]/g creatinine in urine end-of-shift

aluminum fluoride, 7784-18-1

PAC Ver. 29[138]

PAC-1: 19 milligram per cubic meter

PAC-2: 59 milligram per cubic meter

PAC-3: 360 milligram per cubic meter

DFG MAK: 1 mg[F]/m^3, inhalable fraction; [skin]; Peak Limitation Category I(4); Pregnancy Risk Group C; BAT: 7.0 mg[F]/g creatinine in urine at end-of-shift; 4.0 mg[F]/g creatinine in urine at the beginning of the next shift

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 50−200 μg[Al]/L; State Drinking Water Standards: California: 1000 μg[Al]/L. State Drinking Water Guidelines: Arizona 73 μg[Al]/L; California 200 μg [Al]/L; Maine 1430 μg[Al]/L. SafeDrinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg[F]/L; SMCL = 2 mg/F/L, as Fluoride. Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guidelines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg[F]/L.

Routes of Entry: Inhalation, cutaneous absorption.

Harmful Effects and Symptoms

Short-Term Exposure: This chemical (aerosol form) irritates eyes, skin, and respiratory tract. Skin and eye contact can cause severe burns. Inhalation can cause nose and throat irritation, with possible nose bleeding.

Long-Term Exposure: May cause lung irritation, the development of bronchitis, with coughing, shortness of breath; phlegm. This chemical may cause asthma-like allergy that may be delayed. If signs of allergy are detected, the exposed person(s) should avoid all further contact with this chemical. Also, exposure may lead to dense but brittle bones. It may also lead to stiffening of the joints.

Points of Attack: Lungs, bones, joints.

Medical Surveillance: Medical observation and rest is recommended for 24 to 48 hours after breathing overexposure, as asthma symptoms may be delayed. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. NIOSH lists the following tests for fluorides, inorganic: chest X-ray, electrocardiogram, pulmonary function tests: forced vital capacity, forced expiratory volume (1 sec); pelvic X-ray; sputum cytology; urine (chemical/metabolite); urine (chemical/metabolite) pre- and post-shift; urinalysis (routine); CBC/differential.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection:

NIOSH/OSHA *12.5 milligram per cubic meter*: Qm (APF = 25) (any quarter-mask respirator). *25 milligram per cubic meter*: 95XQ (APF = 10)*[any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or SA* (any supplied-air respirator). *62.5 milligram per cubic meter*: Sa:Cf (APF = 25) * + (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25)* *if not present as a fume* (any powered, air-purifying respirator with a high-efficiency particulate filter). *125 milligram per cubic meter*: 100F (APF = 50)$^+$ [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *250 milligram per cubic meter*: Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50)$^+$ [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or SCBAE (any appropriate escape-type, SCBA). *Substance reported to cause eye irritation or damage; may require eye protection. *Note:* $^+$May need acid gas sorbent.

Storage: Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong bases and combustible materials, such as wood, paper, and oil.

Shipping: UN3260 Corrosive solid, acidic, inorganic, n.o.s., Hazard class: 8; Labels: 8-Corrosive material, Technical Name Required. UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Avoid contact with dust. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Aluminum fluoride is not combustible. Thermal decomposition products may include fluorines. Do not use water as flammable hydrogen gas if formed. Use any extinguishing agent suitable for surrounding fires. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Neutralize with soda ash; add slaked lime; let stand for 24 hours. Transfer sludge to sewage facility.

References

(31); (173); (101); (138); (122); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Aluminum Hydride, Trenton, NJ (November 1998).

Aluminum Nitrate A:0690

Formula: $AlH_{18}N_3O18$; $AlN_3O_9 \cdot 9H_2O$

Synonyms: Aluminum nitrate, nonahydrate; Aluminum(III) nitrate, nonahydrate (1:3:9); Aluminum trinitrate nonahydrate; Nitrato aluminico (Spanish); Nitric acid, aluminum salt; Nitric acid, aluminum(3 +) salt; Nitric acid, aluminum(III) salt

CAS Registry Number: 13473-90-0

HSDB Number: 574

RTECS Number: BD1040000

UN/NA & ERG Number: UN1438/140

EC Number: 236-751-8

Regulatory Authority and Advisory Information

Hazard Alert: Combustible, Strong oxidizer, Primary irritant (w/o allergic reaction).

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

United States National Primary Drinking Water Regulations: SMCL = 0.05 to 0.2 mg[Al]/L as aluminum; 10 mg/L; MCL = 10 mg[N]/L as nitrate (measured as nitrogen).

Hazard symbols, risk, & safety statements: Hazard symbol: Xi, O; Risk phrases: R8; R36/37/38; Safety phrases: S17; S26/37/38; S41; (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Aluminum nitrate is an odorless, white crystalline solid, often in liquid solution. Molecular weight = 375.13[136]; 375.19 (nonahydrate); boiling point = 135°C (decomposes); freezing/melting point = 70–74°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 1, reactivity 0. Soluble in water; solubility = about 65 g/100 mL @ 25°C.

Potential Exposure: Aluminum nitrate is used in tanning leather; as an antiperspirant, as a corrosion inhibitor, in the extraction of uranium and as a nitrating agent.

Incompatibilities: Aluminum nitrate is a strong oxidizer; avoid contact with flammable or combustible materials; and reducing agents, including chlorides. In solution this chemical is a strong acid; avoid contact with bases. Explosions may occur when aluminum nitrate is shocked or exposed to heat.

Permissible Exposure Limits in Air

13473-90-0 & 13473-90-0, nonahydrate

PAC Ver. 29[138]

PAC-1: 47 milligram per cubic meter

PAC-2: 68 milligram per cubic meter

PAC-3: 410 milligram per cubic meter

as aluminum soluble salts

OSHA PEL: None

NIOSH REL: 2 mg[Al]/m^3 TWA

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 50–200 μg[Al]/L; State Drinking Water Standards: California: 1000 μg[Al]/L. State Drinking Water

Guidelines: Arizona 73 μg[Al]/L; California 200 μg[Al]/L; Maine 1430 μg[Al]/L.

Routes of Entry: Inhalation, eye and skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin and respiratory tract. Eye contact may cause permanent damage. High exposures can cause unconsciousness. Prolonged contact can cause skin disorders. Ingestion can cause stomach cramps, nausea, Blue skin; weakness, and possible blood problems due to formation of methemoglobin. The oral LD_{50} for rats is 264 mg/kg.

Long-Term Exposure: Repeated contact can cause skin problems and eczema. This chemical is a corrosive, and it may cause lung problems.

Points of Attack: Respiratory system, eyes, skin, gastric system.

Medical Surveillance: A qualified allergist should be consulted if skin problems occur. Medical observation and rest is recommended for 24 to 48 hours after breathing overexposure, as asthma symptoms may be delayed. If signs of allergy are detected, the exposed person(s) should avoid all further contact with this chemical. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Aluminum nitrate poisoning requires special first aid and antidote.

Personal Protective Methods: Wear acid-resistant gloves and clothing to prevent any reasonable probability of skin or eye contact. Rubber or Neoprene gloves will offer some hand protection. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash- or dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls, and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit. *At any concentrations above the NIOSH REL*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Oxidizers should be isolated from acids, metals, organic materials, and ammonium nitrate. Color code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially organic materials, flammables and combustibles, and other incompatible materials. Oxidizers, including oxidizing gases, should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly capped or sealed containers in a cool, well-ventilated area away from combustible materials; heat or flame. Protect containers from physical shock. See OSHA Standard 1910.104 and NFPA 43 A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: UN1438 Aluminum nitrate, Hazard Class: 5.1; Labels: 5.1-Oxidizer.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Sweep into a beaker. Dilute by adding slowly to water. Add soda ash then neutralize with HCl. Flush to sewer with large volume of water[22]. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Not flammable per se. Thermal decomposition products may include nitrogen oxides. Use dry chemical, carbon dioxide; or water spray. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the

containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: See Spill Handling above.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Aluminum Nitrate, Trenton, NJ (January 2001).

Aluminum Orthophosphate A:0700

Formula: $AlPO_4$; AlO_4P

Synonyms: Aluminophosphoric acid; Aluminum acid phosphate; Aluminum monophosphate; Aluminum phosphate; Aluphos; Fosfato aluminico (Spanish); Monoaluminum phosphate; Ortofosfato de alumino (Spanish); Phosphalugel; Phosphoric acid, aluminum salt (1:1), solution

CAS Registry Number: 7784-30-7

HSDB Number: 691

RTECS Number: TB6450000

UN/NA & ERG Number: UN3260 (solid)/154; UN1760 (solution)/154

EC Number: 232-056-9

Regulatory Authority and Advisory Information

Hazard Alert: Strong oxidizer, Corrosive.

United States National Primary Drinking Water Regulations: SMCL = 0.05 to 0.2 mg[Al]/L as aluminum.

Canada: On DSL List; no WHMIS classification.

Hazard symbols, risk, & safety statements: Hazard symbol: C; Risk phrases: R8; R34; Safety phrases: S26; S24/25; S36/37/39; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Aluminum orthophosphate is a white crystalline solid which is often used in liquid or gel form. Molecular weight = 121.95; freezing/melting point ≥ 1450°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 0. Soluble in water.

Potential Exposure: Used as a flux in ceramics; in dental cements; in the manufacture of special glasses, paints and varnishes, cosmetics; making pulp and paper; as an antacid.

Incompatibilities: A strong oxidizer; keep away from combustible materials. Violent reaction with reducing agents; strong bases. Material is an inorganic acid and will react, possibly violently, with bases; corrosive to metals, some plastics and body tissues.

Permissible Exposure Limits in Air

as aluminum soluble salts

OSHA PEL: None

NIOSH REL: 2 milligram per cubic meter

ACGIH TLV[1]: withdrawn

PAC Ver. 29[138]

PAC-1: 14 milligram per cubic meter

PAC-2: 200 milligram per cubic meter

PAC-3: 1200 milligram per cubic meter

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 50−200 μg[Al]/L; State Drinking Water Standards: California: 1000 μg[Al]/L. State Drinking Water Guidelines: Arizona 73 μg[Al]/L; California 200 μg[Al]/L; Maine 1430 μg[Al]/L.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short-Term Exposure: Aluminum phosphate can affect you when breathed in. Aluminum phosphate is a corrosive substance. It can cause severe burns of the eyes and skin on contact. Exposure to the liquid or dust can irritate the eyes, nose, throat, and bronchial tubes. Fine powder can irritate the lungs.

Long-Term Exposure: Can irritate the lungs, causing bronchitis with coughing, shortness of breath; and phlegm.

Points of Attack: Lungs, eyes, skin.

Medical Surveillance: Medical observation and rest is recommended for 24 to 48 hours after breathing overexposure, as bronchitis symptoms may be delayed. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear acid-resistant gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures over 2 milligram per cubic meter of aluminum, use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Check oxygen content prior to entering storage area. Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong bases and combustible materials, such as wood, paper, and oil. Store in a cool, well-ventilated area away from incompatible materials listed above. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43 A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage.

Shipping: UN1760 Corrosive liquids, n.o.s., Hazard class: 8; Labels: 8-Corrosive material, Technical Name Required. UN3260 Corrosive solid, acidic, inorganic, n.o.s., Hazard class: 8; Labels: 8-Corrosive material, Technical Name Required.

Spill Handling: Restrict persons not wearing protective equipment from the danger area of spill until clean-up is complete. Ventilate area of spill or leak. Collect spilled material in the most convenient and safe manner and deposit in sealed containers for reclamation or for disposal in an approved facility. Absorb liquid containing aluminum phosphate in vermiculite, dry sand; earth or similar material. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Aluminum Phosphate is nonflammable. Thermal decomposition products may include phosphine and phosphorus oxides. Use dry chemical powder extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Aluminum Phosphate, Trenton, NJ (June 1998).

Aluminum Phosphide A:0710

Formula: AlP

Synonyms: AIP; Al-phos; Aluminum monophosphide; Celphide; Celphos; Delicia; Fosfuro aluminico (Spanish); Phosphures d'aluminum (French); Phostoxin; Quickphos

CAS Registry Number: 20859-73-8; *(alt.)* 1302-45-0; 71751-04-7

HSDB Number: 6035

RTECS Number: BD1400000

UN/NA & ERG Number: (PIH) UN1397/139

EC Number: 244-088-0 [*Annex I Index No.*: 015-004-00-8]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade).

Hazard Alert: Poison inhalation hazard: exposure can be lethal, Extremely flammable, Pyrophoric hazard, Dangerously water reactive, Suspected of causing genetic defects.

United States National Primary Drinking Water Regulations: SMCL = 0.05 to 0.2 mg[Al]/L as aluminum.

United States Environmental Protection Agency, FIFRA 1998 Status of Pesticides: Supported

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P006[5]

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500 lb (228 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: F+, T+, N; Risk phrases: R12; R15/29; R17; R28; R32; R51; R62; Safety phrases: S1/2; S3/9/14; S30; S36/37; S41; S43; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Aluminum phosphide is a pyrophoric, dark gray or dark yellow crystalline solid. Molecular weight = 57.95; freezing/melting point = (decomposition) >1000°C; specific gravity (H_2O:1) = 2.9 @ 25°C. NFPA-704 Hazard Identification (based on NFPA-704 M Rating System): Health 4, flammability 4, reactivity 2, ₩ water reactive; decomposes slowly releasing poisonous and highly flammable phosphine gas.

Potential Exposure: Used as a rodenticide; wood preservative; as a source of phosphine; as an insecticidal fumigant for grain, peanuts, processed food, animal feed, leaf tobacco, cottonseed; and as space fumigant for flour mills, warehouses and railcars. Used in semiconductor research.

Incompatibilities: Able to ignite spontaneously in moist air; forms toxic and explosive phosphine gas on contact with moisture in air. Reacts violently with water, steam, carbon dioxide; acids, alcohols, and foam fire extinguishers. Contact with water and bases slowly releases highly flammable and toxic phosphine gas.

Permissible Exposure Limits in Air

OSHA PEL: None

NIOSH REL: 2 milligram per cubic meter aluminum, soluble salts

ACGIH 2 milligram per cubic meter aluminum, soluble salts *Note*: Metallic phosphides on clothes, skin, or hair can react with water or moisture to generate phosphine gas (colorless gas; odor of garlic or decaying fish). Vomitus containing phosphides can also off-gas phosphine. For *phosphine*: see P:0580

PAC* Ver. 29[138]

PAC-1: 1.3 ppm

PAC-2: $\mathbf{2.0_A}$ ppm

PAC-3: $\mathbf{3.6_A}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 50−200 μg[Al]/L; State Drinking Water Standards: California: 1000 μg[Al]/L. State Drinking Water Guidelines: Arizona 73 μg[Al]/L; California 200 μg[Al]/L; Maine 1430 μg[Al]/L.

Determination in Water: Toxic to aquatic organisms.

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Acute toxicity occurs primarily by the inhalation route when aluminum phosphide decomposes into the toxic gas, phosphine. The human median lethal dose for aluminum phosphide has been reported to be 20 mg/kg. Rated as super toxic: probable oral lethal dose is less than 5 mg/kg or less than 7 drops for a 70 kg (150 lb) person. Symptoms of phosphine gas poisoning include restlessness, headache, dizziness, fatigue, nausea, vomiting, coma, convulsions; lowered blood pressure; pulmonary edema; respiratory failure; and disorders of the kidney, liver, heart, and brain may be observed. LD_{50} (oral, male rat) = 13.9 mg/kg.

Short-Term Exposure: A severe health hazard. Irritates the eye, skin and respiratory tract. Inhalation can cause lung irritation with coughing, wheezing, and shortness of breath. Affects metabolism and the CNS; exposure can lead to death. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: May cause lung, kidney, and liver damage. May be able to cause skin rash or eczema.

Points of Attack: CNS; liver, kidney, lungs.

Medical Surveillance: Lung, liver, kidney, and nervous system function tests. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when

skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures over 2 milligram per cubic meter (aluminum), use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed, or where any potential for exposures to Phosphine gas exist, use a NIOSH/MSHA (US) or EN149 (Europe)-approved gas mask (Approval number TC-14-98) equipped with a canister offering protection against phosphine, chlorine, hydrogen sulfide, organic vapors, acid gases, and dusts and mists. If the potential for exposure to more than 15 ppm of phosphine gas exists, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode. See Phosphine entry.

Storage: (1) Color code—Red Stripe: Dangerous when wet materials release flammable gases On contact with water: Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. (2) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area separated from strong oxidants, strong bases; strong acids. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Aluminum phosphide decomposes in water, forming phosphine gas. Consult the entry on Phosphine for more information.

Shipping: UN1397 Aluminum phosphide, Hazard Class: 4.3; Labels: 4.3-Dangerous when wet material, 6.1-Poisonous materials.

Spill Handling:

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (from a small package or a small leak from a large package)

when spilled in water

First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 0.6/1.0

Large spills (from a large package or from many small packages)

First: Isolate in all directions (ft/m) 1500/500
Then: Protect persons downwind (mi/km)
Day 1.3/2.0
Night 4.7/7.5

Shut off ignition; no flares, smoking, or flames in hazard area. Do not touch spilled material. Do not get water on spilled material or inside container. Dike spill for later disposal. Blanket release with dry sand, clay, or ground limestone. Shovel small spill into clean, dry container, and cover. Move containers from spill area. Avoid breathing dust. Wear appropriate protective clothing and use appropriate respiratory protection. Cover large powder spill with plastic sheet or tarp to minimize spreading. Clean-up only under supervision of an expert. DOT warns that this

Fire Extinguishing: This chemical is a combustible solid. Thermal decomposition products may include phosphorus oxides and oxides of metal (aluminum). Do not use water or water-based foam, as deadly and explosive phosphine gas is formed. Small fires can be extinguished with dry chemical, soda ash; clay, or ground limestone, or use an approved Class D extinguisher. Large fires: withdraw from area and let fire burn. Move container from fire only if you can do it without risk. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode. Wear SCBA when fighting fires involving this material. If contact with the material is anticipated, wear full protective clothing.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Allow to react slowly with moisture in the open, being sure that phosphine gas evolved is dissipated. Alternatively, mix with dry diluent and incinerate at temperature above 1000°C with effluent gas scrubbing[22]. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (201); (170); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Aluminum Phosphide, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Aluminum Phosphide, Trenton, NJ (June 2005).

Aluminum Sulfate A:0730

Formula: Al_2S_3O12; $Al_2(SO_4)_3$

Synonyms: Alum; Aluminum alum; Aluminum sulfate; Aluminum trisulfate; Cake alum; Diaaluminum trisulfate; Dialuminum sulfate; Paper maker's alum; Sulfate d'aluminum (French); Sulfato aluminico (Spanish); Sulfuric acid, aluminum salt; Sulfuric acid, aluminum salt

CAS Registry Number: 10043-01-3

HSDB Number: 5067

RTECS Number: BD1700000

UN/NA & ERG Number: 3077/171 (solid); UN3264 (corrosive solution)/154

EC Number: 233-135-0

Regulatory Authority and Advisory Information

Hazard Alert: Suspected of causing genetic defects, Primary irritant (w/o allergic reaction).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 5000 lb (2270 kg)[4]

Water Polluting Substance Annex II

United States National Primary Drinking Water Regulations: SMCL = 0.05 to 0.2 mg[Al]/L as Aluminum; SMCL = 250 mg[SO_4^{-2}]/L as Sulfate.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: Xi, N; Risk phrases: R36/37/38; R41; R51/53; R62; Safety phrases: S23; S26; S29; S37; S39; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Aluminum sulfate is a white powder, often used in water solution. The solution is a strong acid. Molecular weight = 342.12; freezing/melting point = 770°C (decomposes, forming corrosive sulfur trioxide). Soluble in water.

Potential Exposure: Widely used in the paper industry, in waste and water treatment and treating sewage; in antiperspirants, deodorants; in flame-retardants; in tanning leather, sizing paper; mordant in dyeing, purifying water, waterproofing cloth, clarifying oils and fats; in agricultural pesticides; manufacturing aluminum salts and others.

Incompatibilities: In aqueous solution, aluminum sulfate forms sulfuric acid; reacts with bases and many other substances. Corrodes metals, some plastics and body tissues, especially in the presence of moisture.

Permissible Exposure Limits in Air

as aluminum soluble salts

OSHA PEL: None

NIOSH REL: 2 milligram per cubic meter aluminum, soluble salts

PAC Ver. 29[138]

PAC-1: 38 milligram per cubic meter

PAC-2: 64 milligram per cubic meter

PAC-3: 380 milligram per cubic meter

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 50−200 μg[Al]/L; State Drinking Water Standards: California: 1000 μg[Al]/L. State Drinking Water Guidelines: Arizona 73 μg[Al]/L; California 200 μg[Al]/L; Maine 1430 μg[Al]/L.

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Aluminum sulfate powder can irritate the eyes, skin and respiratory tract. It is capable of causing eye damage. Ingestion of large doses can cause stomach irritation, nausea and vomiting.

Long-Term Exposure: Aluminum sulfate may cause skin disorders; and may cause lung problems.

Points of Attack: Lungs, skin.

Medical Surveillance: Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Lung function tests.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. When working with liquid wear splash-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. When working with solid or powder wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any concentrations above 2 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]; CcrFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, SCBA). Wear a dust mask.

Storage: Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Aluminum sulfate powder should be kept dry since it forms sulfuric acid when wet.

Shipping: UN3264 Corrosive liquid, acidic, inorganic, n.o.s., Hazard class: 8; Labels: 8-Corrosive material, Technical Name Required. UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Sweep up or vacuum powdered material being careful not to raise dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Not flammable. Thermal decomposition products may include sulfur oxides. Use extinguishing agents suitable for surrounding fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode. When involved in fire, wear goggles and SCBA and rubber clothing including gloves[41].

Disposal Method Suggested: Pretreatment involves hydrolysis followed by neutralization with NaOH. The insoluble aluminum hydroxide formed is removed by filtration and can be heated to decomposition to yield alumina which has valuable industrial applications. The neutral solution of sodium sulfate can be discharged into sewers and waterways as long as its concentration is below the recommended provisional limit of 250 mg/L.

References

(31); (173); (101); (138); (201); (100).

New York State Department of Health, Chemical Fact Sheet: Aluminum Sulfate, Bureau of Toxic Substance Assessment, Albany, NY (March 1986).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Aluminum Sulfate, Trenton, NJ (June 2009).

Stauffer Chemical Co. Microfiche: OTS0571939, EPA/OTS; Doc #88-920010792(CSST), Rhône-Poulenc Inc., *Initial submission*: *Toxicology Lab Report T-4874 (regarding primary dermal and eye irritation of aluminum sulfate hydrate in rabbits with cover letter dated 102392)* (1974).

Ametryn A:0740

Formula: $C_9H_{17}N_5S$

Synonyms: Ametrex; Amyphyt; Cemerim; Doruplant; EPA pesticide code 080801; 2-Ethylamino-4-isopropylamino-6-methylmercarpo-*s*-triazine; 2 Ethylamino-4-isopropyl amino-6-methylthio triazine; 2-Ethylamino-4-isopropylamino-6-methylthio-1,3,5-triazine; Evik; Gesapax; 2-Methylmercapto-4-ethylamino-6-isopropylamino-*s*-triazine; 2-Methylmercapto-4-isopropylamino-6-ethylamino-*s*-triazine; 2-Methylthio-4-ethylamino-6-isopropylamino-*s*-triazine

CAS Registry Number: 834-12-8

HSDB Number: 1710

RTECS Number: XY9100000

UN/NA & ERG Number: UN2763 (triazine, pesticides, solid, toxic)/151

EC Number: 212-634-7 [*Annex I Index No.*: 613-010-00-0]

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Combustible, Agricultural chemical (triazine), Environmental hazard.

Superfund/EPCRA 40CFR302.4, Appendix A, RQ: 100 lb (45.5 kg), 40CFR372.65: Form R *de minimis* Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: Xn, N; Risk phrases: R22; R51/53; Safety phrases: S2; S29; S36; S41; S60; S61 (see Appendix 4).

Water Polluting Substance Annex II.

WGK[100] (German Aquatic Hazard Class): No value found. [2-Hazard to water. (est.)]

Description: Ametryn is a colorless powder. Freezing/Melting point = 84–86°C; vapor pressure = 2.7×10^{-6} mmHg. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 1, reactivity 0. Soluble in water; solubility = 200 mg/L @ 20°C. Physical and toxicological properties may be affected by the carrier solvents used in commercial formulations.

Potential Exposure: Ametryn, a triazine and an organosulfide, amine compound A potential danger to those involved in the manufacture, formulation and application of this selective herbicide.

Incompatibilities: Triazines are incompatible with nitric acid. Amines are chemical bases, they neutralize acids to form salts plus water with an exothermic reaction. May be incompatible with isocyanates, halogenated organics, peroxides, phenols (acidic), epoxides, anhydrides, and acid halides. Flammable gaseous hydrogen is generated by amines in combination with strong reducing agents such as hydrides, nitrides, alkali metals, and sulfides.

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 60 μg/L; State Drinking Water Guidelines: Florida 60 μg/L; Maine 60 μg/L. Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.

Determination in Water: Extraction with methylene chloride may be followed by GC using a nitrogen phosphorus detector. Octanol–water coefficient: $\text{Log } K_{ow} = \sim 3$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Ingestion, skin.

Harmful Effects and Symptoms

Short-Term Exposure: Ametryn is an eye and skin irritant. It is mildly toxic by skin contact. Poisonous if swallowed or inhaled.

Long-Term Exposure: It apparently causes liver degeneration. The LD_{50} value for male Charles River rats was 1207 mg/kg and 1543 mg/kg for female rats. Human Tox: 60.00000 ppb Health advisory: (LOW).

Points of Attack: Liver.

Medical Surveillance: Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Where there is no NIOSH REL, at any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong acids.

Shipping: UN2763 Triazine pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Avoid inhalation of dust; wear respirator. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Granular activated carbon will remove ametryn from water. Soil Adsorption Index (K_{oc}) = 300.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen and carbon. Wear positive-pressure SCBA when fighting fires involving this herbicide. Avoid breathing dusts and fumes from burning material. Keep upwind. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode. Use extinguishing agents suitable for surrounding fire or dry chemical, carbon dioxide; or alcohol foam. Use water in flooding quantities as fog.

Disposal Method Suggested: In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, “Health advisory: Ametryn, Washington, DC, Office of Drinking Water (August 1987).

Pohanish, Richard P., Sittig’s Handbook of Pesticides and Agricultural Chemicals, 2nd ed, William Andrew imprint of Elsevier, Inc, Page 35–36, Oxford, UK (2015).

2-Aminoanthraquinone A:0750

Formula: $C_{14}H_9NO_2$: $C_6H_4(CO)_2C_6H_3NH_2$

Synonyms: AAQ; 2-Amino-9,10-aminoanthraquinone; 2-Amino-9,10-anthracenedione; β-Aminoanthraquinone; Aminoantraquinona (Spanish); β-Anthraquinonylamine

CAS Registry Number: 117-79-3

HSDB Number: 4088

RTECS Number: CB5120000

UN/NA & ERG Number: UN3143 (dye intermediates, solid, toxic, n.o.s.)/151

EC Number: 204-208-4

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; NCI: Carcinogenesis Bioassay (feed); clear evidence: mouse, rat; IARC: Animal Limited Evidence; Human No Adequate Data; Group 3, 1987. United States Environmental Protection Agency Gene-Tox Program, Positive: Carcinogenicity-mouse/rat.

California Proposition 65 Chemical[102]: Cancer 10/1/1989.

Hazard Alert: Exposure can be lethal, Combustible, Possible risk of forming tumors, Suspected of causing genetic defects.

CERCLA/SARA 313: Form R *de minimis* Concentration Reporting Level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, Xn: Risk phrases: R45; R36/37/38; R51/53; Safety phrases: S26; S36/37/39; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: 2-Aminoanthraquinoneforms red or orange-brown needle-shaped crystalline solid. Molecular weight = 223.24; freezing/melting point = 302–306°C; flash point = 282.5°C (cc). Hazard identification (based on NFPA-704 M Rating System): Health 4, flammability 0, reactivity 0. Boiling point = sublimes. Insoluble in water.

Potential Exposure: 2-Aminoanthraquinone is used as a dye intermediate; in the industrial synthesis of anthraquinone and pharmaceuticals. It is the precursor of five dyes and one pigment, including Color Index Vat Blues 4, 6, 12, and 24; Vat Yellow 1; and Pigment Blue 22. Because AAQ is used on a commercial scale solely by the dye industry, the potential for exposure to the compound is greatest for workers at dye manufacturing facilities. However, no additional data are available on the number of facilities using AAQ. The Consumer Product Safety Commission staff believes that trace amounts of unreacted AAQ may possibly be present in some dyes based on this chemical and in the final consumer product. Exposure even to trace amounts may be a cause for concern. This concern is based on experience with other dyes derived from aromatic amines.

Incompatibilities: Keep away from strong oxidizing and reducing agents. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 9 milligram per cubic meter

PAC-2: 99 milligram per cubic meter

PAC-3: 590 milligram per cubic meter

Determination in Air: NIOSH Analytical Method #5013, Dyes

Routes of Entry: Inhalation and skin contact.

Harmful Effects and Symptoms

Technical grade 2-aminoanthraquinone (impurities unspecified), administered in the feed, was carcinogenic in male Fisher “344” rats, causing a combination of hepato-cellular carcinomas and neoplastic nodules of the liver. The compound was also carcinogenic in B6C3F1 mice, causing hepato-cellular carcinomas in both sexes and malignant gematopoietic lymphomas in females. An IARC: working group considered that the evidence for the carcinogenicity in experimental animals of the material tested was limited. In view of another evaluation of NCl bioassay results, the evidence can be considered as sufficient.

Short-Term Exposure: Irritates eyes and skin.

Long-Term Exposure: A confirmed carcinogen in animals; causes liver and lymph system cancer. May cause mutations.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a refrigerator or cool, well-ventilated area away from strong oxidizers.

Shipping: UN3143 Dyes, solid, toxic, n.o.s. or Dye intermediates, solid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Dampen spilled material with toluene to avoid airborne dust. Collect powdered material in the most convenient and safe manner and deposit in vapor-tight, sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include oxides of nitrogen and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(109); (102); (31); (173); (101); (138); (100).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report* 4, No. 6, 66−70 (1984).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: 2-Aminoanthroquinone, Trenton NJ (January 2004).

Aminoazobenzene A:0760

Formula: $C_{12}H_{11}N_3$; $C_6H_5{=}{}_6H_4NH_2$

Synonyms: AAB; *p*-Aminoazobenzene; 4-Amino-1,1′-azobenzene; 4-Aminoazobenzene; Aminoazobenzene; *p*-Aminoazobenzol; 4-Aminoazobenzol; *p*-Aminodiphenylimide; Aniline yellow; 4-Benzeneazoaniline; Brasilazina oil yellow G; Ceres yellow R; C.I. 11,000; C.I. Solvent Blue 7; C.I. Solvent yellow 1; Fast spirit yellow AAB; Oil soluble aniline yellow; Oil yellow AAB; Organol yellow; Paraphenolazo aniline; *p*-Phenolazoaniline; *p*-(Phenylazo)aniline; 4-(Phenylazo)aniline; 4-(Phenylazo)benzenamine' *p*-phenylazophenylamine; Somalia yellow 2 G; Solvent yellow 1; Stearix brown 4 R; Sudan yellow R; Sudan yellow RA

CAS Registry Number: 60-09-3

HSDB Number: 2137 as aniline yellow

RTECS Number: BY8225000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154; UN3143 (dyes, solid, toxic, n.o.s. or dye intermediates, solid, toxic, n.o.s.)/151

EC Number: 200-453-6 [*Annex I Index No.*: 611-008-00-4]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Sufficient Evidence, Possibly carcinogenic to humans, Group 2B

California Proposition 65 Chemical[102]: Cancer 1/1/1990

Hazard Alert: Poison, Flammable, Explosive, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Environmental hazard.

CERCLA/SARA 313: Form R *de minimis* Concentration Reporting Level: 0.1%.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; E; Risk phrases: R45; R18; R45; R50/53; R62; R63; Safety phrases: S29; S41; S45; S53; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: 4-Aminoazobenzene forms yellow to tan crystals or orange needles. Molecular weight = 666.4 (solid)[136]; 1235 (liquid)[136]; specific gravity (H_2O:1) = 1.7 @ 20°C; boiling point $\geq$ 360°C; freezing/melting point = 126−128°C. Hazard identification (based on NFPA-704 M Rating System) (in hydrocarbon solvent): Health 3, flammability 2, reactivity 1; (*dry*) Health 3, flammability 0, reactivity 0 [ASU]. Slightly soluble in water.

Potential Exposure: An azo compound used in form of salts in dyeing; used as intermediate in manufacture of acid yellow and diazo dyes; in insecticides, waxes, lacquers, varnishes, stains, styrene resins.

Incompatibilities: Dust may form explosive mixture with air. Azo compounds can detonate. This applies in particular to organic azides that have been sensitized by the addition of metal salts or strong acids. Toxic gases are formed by mixing materials of this class with acids, aldehydes, amides, carbamates, cyanides, inorganic fluorides, halogenated organics, isocyanates, ketones, metals, nitrides, peroxides, phenols, epoxides, acyl halides, and strong oxidizing or reducing agents. Flammable gases are formed by mixing materials in this group with alkali metals. Explosive combination can occur with strong oxidizing agents, metal salts, peroxides, and sulfides. This chemical is sensitive to prolonged exposure to heat. This chemical is incompatible with strong oxidizing agents[101].

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 0.66 milligram per cubic meter

PAC-2: 7.2 milligram per cubic meter

PAC-3: 43 milligram per cubic meter

Determination in Water: Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.

Harmful Effects and Symptoms

Short-Term Exposure: This chemical is highly toxic and may be fatal by ingestion, inhalation or skin absorption. Symptoms of exposure to this compound include methemoglobinemia, cyanosis, bluish discoloration of the lips, earlobes and fingernails, headache, dizziness and skin sensitization[193].

Long-Term Exposure: A possible human carcinogen.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is

worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN3143 Dyes, solid, toxic, n.o.s. or Dye intermediates, solid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft.(NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include oxides of nitrogen and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(102); (31); (85); (173); (101); (136); (138); (100); (101); (193).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report* 1, No. 3, 27−28 (1981).

Aminoazotoluene A:0770

Formula: $C_{14}H_{15}N_3$; $CH_3C_6H_4N = NC6_{H}3(NH_2)CH_3$

Synonyms: *o*-AAT; *o*-Amidoazotoluol (German); Aminoazotoluene (Indicator); *o*-Aminoazotoluene; 4′-Amino-2,3′-azotoluene; 4′-Amino-2:3′-azotoluene; *o*-Aminoazotolueno (Spanish); *o*-Aminoazotoluol; 4-Amino-2′,3-dimethylazobenzene; 4′-Amino-2,3′-dimethylazobenzene; *o*-AT; Brasilazina oil yellow R; Butter yellow; C.I. 11160; C.I. 11160B; C.I. Solvent yellow 3; 2′,3-Dimethyl-4-Aminoazobenzene; Fast garnet GBC Base; Fast oil yellow; Fast yellow AT; Fast yellow B; Hidaco oil yellow; 2-Methyl-4-[(2-Methylphenyl)Azo]Benzenamine; OAAT; Oil yellow; Oil yellow 21; Oil yellow 2681; Oil yellow A; Oil yellow AT; Oil yellow C; Oil yellow I; Oil yellow 2 R; Oil yellow T; Organol yellow 25; Somalia Yellow R; Sudan yellow RRA; *o*-Tolueneazo-*o*-toluidine; *o*-Toluol-Azo-*o*-toluidin (German); 5-(*o*-Tolylazo)-2-aminotoluene; 4-(*o*-Tolylazo)-o-toluidine; Tulabase fast garnet GB; Tulabase fast garnet GBC; Waxakol yellow NL

CAS Registry Number: 97-56-3

HSDB Number: 2639

RTECS Number: XU8800000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 202-591-2 [*Annex I Index No*.: 611-006-00-3]

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; NCI: IARC: Animal Sufficient Evidence, possibly carcinogenic to humans, Group 2B, 1998.

California Proposition 65 Chemical[102]: Cancer 7/1/1987

Hazard Alert: Poison, Combustible, Possible risk of forming tumors, Sensitization hazard, Suspected of causing genetic defects, Suspected reprotoxic hazard.

CERCLA/SARA 313: Form R *de minimis* Concentration Reporting Level: 1%.

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xi; Risk phrases: R45; R43; R62; R63; Safety phrases: S53; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Aminoazotoluene forms golden yellow or reddish-brown crystalline solid. Molecular weight = 225.32; freezing/melting point = 101.7°C; vapor pressure = 7.5 × 10−7 mmHg @ 25°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 0, reactivity 0. Slightly soluble in water; solubility = 7.64 mg/L @ 25°C.

Potential Exposure: An azo compound used in dyes, medicines; as a colorant in shoe polishes and other wax-based polishes.

Incompatibilities: Dust may form explosive mixture in air. Azo compounds can detonate. This applies in particular to organic azides that have been sensitized by the addition of metal salts or strong acids. Toxic gases are formed by mixing materials of this class with acids, aldehydes, amides, carbamates, cyanides, inorganic fluorides, halogenated organics, isocyanates, ketones, metals, nitrides, peroxides, phenols, epoxides, acyl halides, and strong oxidizing or reducing agents. Flammable gases are formed by mixing materials in this group with alkali metals. Explosive combination can occur with strong oxidizing agents, metal salts, peroxides, and sulfides. This chemical is sensitive to prolonged exposure to heat. This chemical is incompatible with strong oxidizing agents[101].

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 1.9 milligram per cubic meter

PAC-2: 21 milligram per cubic meter

PAC-3: 120 milligram per cubic meter

DFG MAK: [skin] danger of skin sensitization; Carcinogen Category: 2; Germ Cell Mutagen Group 3B (2006)

Permissible Concentration in Water: No criteria set.

Determination in Water: Octanol−water coefficient: Log K_{ow} = ~4 (est). Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Harmful Effects and Symptoms

Routes of Entry: Skin, inhalation, ingestion.

Short term Exposure: Symptoms of exposure to this compound may include allergic reactions. This may include eczema of the hands and arms. This compound is harmful if ingested, inhaled or absorbed through the skin. May cause irritation of the skin, eyes, and respiratory tract. Moderately toxic by several routes[44].

Long-Term Exposure: A known animal carcinogen. May cause skin sensitization; possible allergy.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Examination by a qualified allergist.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft.(NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include nitrogen oxides and phosgene. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(109); (102); (31); (44); (173); (101); (138); (100).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report* 6, No. 4, 54–63 (1986).

4-Aminobiphenyl A:0780

Formula: $C_{12}H_{11}N$; $C_6H_5C_6H_4NH_2$

Synonyms: *p*-Aminobifenilo (Spanish); 4-Aminobifenilo (Spanish); *p*-Aminobiphenyl; 4-Aminobiphenyl; 4-Amino difenil (Spanish); *p*-Aminodiphenyl; 4-Aminodiphenyl; (1,1′-Biphenyl)-4-amine; *p*-Biphenylamine; 4-Biphenylamine; Biphenyline; *p*-Phenylaniline; 4-Phenylaniline; *p*-Xenylamine; Xenylamine

CAS Registry Number: 92-67-1

HSDB Number: 1325 as 4-biphenylamine

RTECS Number: DU8925000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154; UN3143 (dye intermediates, solid, toxic, n.o.s.)/151

EC Number: 202-177-1 [*Annex I Index No.*: 612-072-00-6]

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen; IARC[9]: Animal Sufficient Evidence, Human Sufficient Evidence, *carcinogenic to humans*, Group 1, 1987; OSHA: Carcinogen (29CFRn1910.1003). United States Environmental Protection Agency Gene-Tox Program, Positive: Body fluid assay; Carcinogenicity-mouse/rat; Positive: SHE-clonal assay; Cell transformation-mouse embryo; Positive: Cell transformation-RLV F344 rat embryo; Host-mediated assay; Positive: *E. coli polA* with S9; Histidine reversion-Ames test; Positive: In vitro UDS in rat liver; *S. cerevisiae-homozygosis*; Negative: In vitro UDS-human fibroblast; Inconclusive: Mammalian micronucleus; *E. coli polA* without S9.

California Proposition 65 Chemical[102]: Cancer 2/27/1987.

Hazard Alert: Poison, Combustible, Possible risk of forming tumors, Suspected of causing genetic defects.

Banned or Severely Restricted (many countries) (UN)[13,35]

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR1910.1011)

Clean Air Act 42USC7412; Title I, Part A, §112 Hazardous Pollutants

RCRA 40CFR261, Appendix 8 Hazardous Constituents

RCRA Land Ban Waste.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.13; Nonwastewater (mg/kg), N/A

RCRA 40CFR264, Appendix 9; Ground Water Monitoring List Suggested methods (PQL μg/L): 8270 (10).

Superfund/EPCRA 40CFR302.4, Appendix A, RQ: 1 lb (0.455 kg), 40CFR372.65: Form R *de minimis* Concentration Reporting Level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xn; risk phrases: R45; R61; R20/21/22; R36; R36/37/38; R50/53; R62; safety phrases: R26; R36; S41; S45; S53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)].

Description: 4-Aminobiphenyl is a combustible, colorless to tan crystalline solid that turns purple on exposure to air. May be used in a liquid solution. Floral odor. Molecular weight = 169.24; specific gravity (H_2O:1) = 1.16; boiling point = 302°C; freezing/melting point = 49°C; autoignition temperature = 450°C. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 1, reactivity 0. Insoluble in water.

Potential Exposure: 4-Aminobiphenyl is no longer manufactured commercially and is only used for research purposes. 4-Aminobiphenyl was formerly used as a rubber antioxidant and as a dye intermediate. Is a contaminant in 2-aminobiphenyl.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides and acid anhydrides.

Permissible Exposure Limits in Air

NIOSH IDLH = Not determined; potential occupational carcinogen.

OSHA PEL: Cancer suspect agent. Exposures of workers to this chemical is to be controlled through the required use of engineering controls, work practices; and PPE, including respirators. See 29 CFR 1910.1003-1910.1016 for specific details of these requirements.

ACGIH TLV[1]: [skin] Confirmed Human Carcinogen

PAC Ver. 29[138]

PAC-1: 1.5 milligram per cubic meter
PAC-2: 17 milligram per cubic meter
PAC-3: 99 milligram per cubic meter
DFG MAK: [skin] Carcinogen Category 1

Australia: [skin] carcinogen, 1993; Austria: carcinogen, 1999; Finland: TWA 10 milligram per cubic meter; STEL 20 milligram per cubic meter [skin] carcinogen, 1999; France: VME 0.001 ppm (0.007 milligram per cubic meter), 1 carcinogen, 1999; Norway: TWA 0.1 milligram per cubic meter, 1999; Sweden: carcinogen, 1999; Switzerland: [skin], carcinogen, 1999; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Confirmed Human Carcinogen. Several states have set guidelines or standards for 4-aminobiphenyl in ambient air [60]: zero for North Dakota, New York and South Carolina; 0.8 μ/m^3 (Pennsylvania); 4.0 μ/m^3 (Virginia).

Determination in Air: Use NIOSH Analytical Method (II-4) #P&CAM 269, OSHA Analytical Method 93.

Permissible Concentration in Water: No criteria set, but EPA[32] has suggested an ambient water limit of 200 μg/L based on health effects.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 2.8$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation and percutaneous absorption.

Harmful Effects and Symptoms

Short-Term Exposure: This chemical can be absorbed through the skin, thereby increasing exposure. Irritates the skin. Exposure may cause methemoglobinemia, which interferes with the blood's ability to carry oxygen. This can cause headache, dizziness, fatigue, fast heart rate; blue color of the lips and skin. Higher levels can cause difficult breathing; collapse and death.

Long-Term Exposure: 4-Aminobiphenyl is a known human bladder carcinogen. An exposure of only 133 days has been reported to have ultimately resulted in a bladder tumor and blood in the urine. The latent period is generally 15−35 years. Acute exposure produces headaches, lethargy, cyanosis, urinary burning, and hematuria. Cystoscopy reveals diffuse hyperemia, edema, and frank slough.

Points of Attack: Bladder, skin, blood.

Medical Surveillance: OSHA mandates the following: *Increased Risk*; reduced immunologic competence; steroid treatment; pregnancy; cigarette smoking; NIOSH lists the following tests: cystoscopy, urine (chemical/metabolite), urinalysis (routine). Blood test for hemoglobin levels. Placement and periodic examinations should include an evaluation of exposure to other carcinogens; use of alcohol, smoking, and medications; and family history. Special attention should be given on a regular basis to urine sediment and cytology. If red cells or positive smears are seen, a cystoscopy should be performed by a urologist at once. The general health of exposed persons should also be evaluated in periodic examinations. Blood methemoglobin level. CBC.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy. *Note to Physician*: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash- or dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. These are designed to supplement engineering controls (such as the prohibition of open-vessel operations) and to prevent all skin or respiratory contact. Full-body protective clothing and gloves should be used by those employed in handling operations. Full-face, supplied air respirators of continuous flow or pressure demand type should also be used. On exit from a regulated area, employees should shower and change into street clothes, leaving their clothing and equipment at the point of exit to be placed in impervious containers at the end of the work shift for decontamination or disposal. Effective methods should be used to clean and decontaminate gloves and clothing.

Respirator Selection: *At any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode).

Escape: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Keep this material away from heat, sparks, flame and any sources of ignition. Store in a tightly closed container. Store in a cool, dry, well-ventilated area away from incompatible substances. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045 and 1910.1003.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN3143 Dyes, solid, toxic, n.o.s. or Dye intermediates, solid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft.(NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Cover spills with dry lime or soda ash and collect powdered material, then collect powdered material in the most convenient and safe manner and deposit in sealed containers. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include oxides of nitrogen and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Controlled incineration whereby oxides of nitrogen are removed from the effluent gas by scrubber, catalytic or thermal devices[22].

References

(109); (102); (31); (173); (101); (138); (2); (9); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: 4-Aminodiphenyl, Trenton, NJ (June 1998).

2-Amino-4-Chlorophenol A:0790

Formula: C_6H_6ClNO; $HOC_6H_3(NH_2)Cl$

Synonyms: 2-Amino-4-clorofenol (Spanish); *p*-Chloro-*o*-aminophenol

CAS Registry Number: 95-85-2

RTECS Number: SJ5700000

UN/NA & ERG Number**:**UN2673/151

EC Number: 202-458-9

Regulatory Authority and Advisory Information

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: Xn: risk phrases: R20/21/22; R36/37/38; safety phrases: S26; S36/37/39 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)].

Description: 2-Amino-4-chlorophenol is a grayish to light brown crystalline solid or powder. Molecular weight = 143.57; freezing/melting point = 134−140°C; autoignition temperature = 500°C. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 0, reactivity 0. Insoluble in water; solubility $\leq$ 0.1 g/100 mL @ 20°C.

Potential Exposure: Used as a chemical raw material, especially in dye manufacture.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, iron, moisture and temperatures >43°C.

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Determination in Air: NIOSH Analytical Method #5013, Dyes

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short-Term Exposure: Poisonous if inhaled or ingested. Exposure can lower the ability of the blood to carry oxygen. This can result in a bluish color to the skin and lips, headaches, dizziness, collapse and even death. LD_{50} = (oral-rat) <700 mg/kg.

Long-Term Exposure: Unknown at this time.

Points of Attack: Blood.

Medical Surveillance: Test for blood hemoglobin level.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/ manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area way from iron, moisture, and temperatures above 110°C.

Shipping: UN2673 2-Amino-4-chlorophenol, Hazard Class: 6.1; Labels: 6.1-Poisonous materials

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: 2-Amino-4-chlorophenol may burn, but does not readily ignite. Thermal decomposition products may include chlorides and nitrogen oxides. Use dry chemical, CO_2, water spray; or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: 2-Amino-4-Chlorophenol, Trenton, NJ (August 1998).

1-Amino-2,4-Dibromoanthraquinone A:0795

Formula: $C_{14}H_7Br_2NO_2$

Synonyms: 1-Amino-2,4-dibromo-9,10-anthracenedione; 9,10-Anthracenedione,1-amino-2,4-dibromo-; Anthraquinone, 1-amino-2,4-dibromo-; 2,4-Dibromo-1-anthraquinonylamine; NCI-C55458

CAS Registry Number: 81-49-2

HSDB Number: 5241

RTECS Number: CB5500000

UN/NA & ERG Number: UN3259 (solid)/154; UN2735 (liquid)/153

EC Number: 201-354-0

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen.

California Proposition 65 Chemical[102]: Cancer 8/26/1997.

Hazard Alert: Poison, Corrosive, Suspected reprotoxic hazard

CERCLA/SARA 313: Form R *de minimis* Concentration Reporting Level: 0.1%.

Hazard symbols, Risk & safety statements: Hazard symbol: Xn: risk phrases: R45; R36/37/38; R61; safety phrases: S26; S36/37/39; S41 (see Appendix 4).

Description: 1-Amino-2,4-dibromoanthraquinone is a red powder or a red solid needles. Odorless. Molecular weight = 381; melting point: 224°C; flash point: >200°C. Practically insoluble in water; solubility ≤ 0.2 mg/mL @

25°C. Physical and toxicological properties may be affected by the carrier solvents used in commercial formulations.

Potential Exposure: A halide-and amine-substituted aromatic compound. (halogenated amine). Intermediate in the production of dyes.

Incompatibilities: May be combustible. Powder mixture with air may be explosive. Sensitive to air and light exposure, long term. A chemical base: will neutralize acids to form salts plus water with an exothermic reaction. May be incompatible with isocyanates, halogenated organics, peroxides, phenols (acidic), epoxides, anhydrides, and acid halides. Flammable gaseous hydrogen is generated by amines in combination with strong reducing agents such as hydrides, nitrides, alkali metals, and sulfides.

Permissible Exposure Limits in Air: No value assigned.

Permissible Concentration in Water:

Determination in Water: Octanol−water coefficient: Log $K_{ow} \geq 5$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation and dermal contact.

Harmful Effects and Symptoms

Short-Term Exposure: May cause irritation of the eyes, skin and respiratory tract. Inhalation exposure may cause pulmonary edema, which can be delayed for several hours; there is a risk of death in serious cases.

Long-Term Exposure: May be tumorigenic and carcinogenic.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure.

First Aid: *Eyes*: First check the victim for contact lenses and remove if present. Flush victim's eyes with water or normal saline solution for 20 to 30 minutes while simultaneously calling a hospital or poison control center. Do not put any ointments, oils, or medication in the victim's eyes without specific instructions from a physician. Immediately transport the victim after flushing eyes to a hospital even if no symptoms (such as redness or irritation) develop. *Skin*: Immediately flood affected skin with water while removing and isolating all contaminated clothing. Gently wash all affected skin areas thoroughly with soap and water. If symptoms such as redness or irritation develop, Immediately call a physician and be prepared to transport the victim to a hospital for treatment. *Inhalation*: Immediately leave the contaminated area; take deep breaths of fresh air. If symptoms (such as wheezing, coughing, shortness of breath, or burning in the mouth, throat, or chest) develop, call a physician and be prepared to transport the victim to a hospital. Provide proper respiratory protection to rescuers entering an unknown atmosphere. Whenever possible, SCBASCBA should be used; if not available, use a level of protection greater than or equal to that advised under Protective Clothing. *Ingestion*: *Do Not induce vomiting*. If the victim is conscious and not convulsing, give 1 or 2 glasses of water to dilute the chemical and Immediately call a hospital or poison control center. Be prepared to transport the victim to a hospital if advised by a physician. If the victim is convulsing or unconscious, do not give anything by mouth, ensure that the victim's airway is open and lay the victim on his/her side with the head lower than the body. *Do Not induce vomiting*. Immediately transport the victim to a hospital. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered.

Personal Protective Methods: Wear positive-pressure SCBASCBA. Wear chemical protective clothing that is specifically recommended by the manufacturer. It may provide little or no thermal protection. Structural firefighters' protective clothing provides limited protection in fire situations ONLY; it is not effective in spill situations where direct contact with the substance is possible.

Respirator Selection: *At any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA)

Storage: You should protect this chemical from exposure to light. Keep the container tightly closed under an inert atmosphere, and store under refrigerated temperatures. Chemically stable for at least 14 days @ 54°C[72]. (1) Color code—White: Corrosive or Contact Hazard; store separately in a corrosion resistant location. (2) Color code—Blue: Health Hazard/Poison: Store in a tightly closed container in a dry, well-ventilated and secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Where possible, automatically transfer material from other storage containers to process containers.

Shipping: UN3259 Amines, solid, corrosive, n.o.s, or Polyamines, solid, corrosive, n.o.s., Hazard class: 8; Labels: 8-Corrosive material, Technical Name Required. UN2735 Amines, liquid, corrosive, n.o.s, or Polyamines, liquid, corrosive, n.o.s., Hazard class: 8; Labels: 8-Corrosive material, Technical Name Required.

Spill Handling: As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 m/150 ft for liquids and at least 25 m/75 ft for solids. For fire, see next section. *Spill*: Increase, in the downwind direction, as necessary, the isolation distance shown above. Eliminate all ignition sources (no smoking, flares, sparks or flames in immediate area). Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Stop leak if you can do it without risk. Prevent entry into waterways, sewers, basements or confined areas. Absorb or cover with dry earth, sand or other noncombustible material and transfer to containers. *Do not get water inside containers.*

Fire Extinguishing: When heated to decomposition 1-amino-2,4-dibromoanthraquinone releases poisonous and toxic fumes of hydrogen bromide, bromides, and nitrogen oxides. *Fire*: If tank, rail car or tank truck is involved in a fire, *isolate* for 800 m (1/2 m) in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. *Small fire*: Dry chemical, CO_2 or water spray. *Large fire*: Dry chemical, CO_2, alcohol-resistant foam or water spray. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal; do not scatter the material. *Fire involving tanks or car/trailer loads*: Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Do not get water inside containers. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. *Always* stay away from tanks engulfed in fire.

Disposal Method Suggested: Dispose of contents and container to an approved waste disposal plant. Use a licensed professional waste disposal service to dispose of this material. Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(109); (102); (31); (72); (173); (101); (138).

2-(2-Aminoethoxy)ethanol A:0810

Formula: $C_4H_{11}NO_2$

Synonyms: 2-Aminoethyoxyethanol; (Amino-2 éthoxy)-2 éthanol (French); 1-Amino-2-(2-hydroxyethoxy)ethane; 2-Amino-2-hydroxydiethyl ether; 2-(2-Aminoetoxi)etanol (Spanish); 5-Amino-3-oxapentan-1-ol; Diethylene glycol amine; Diethylene glycol monoamine; DGA; Diglycolamine; Ethanol, 2-(2-aminoethioxy)-; β-Hydroxy-β′-aminoethyl ether; 2-(2-Hydroxyethoxy)ethylamine; β-(β-Hydroxyethoxy) ethylamine; 2-(Hydroxyethoxy)ethylamine

CAS Registry Number: 929-06-6

HSDB Number: 5770

RTECS Number: KJ6125000

UN/NA & ERG Number: UN3055/154

EC Number: 213-195-4

Regulatory Authority and Advisory Information

Hazard Alert: Combustible, Corrosive.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, Risk & safety statements: Hazard symbol: C; risk phrases: R21; R34; safety phrases: S26; S24; R25; S36/37/39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: 2-(2-Aminoethoxy)ethanol is a combustible, colorless to light yellow, thick liquid. Fishy odor. Molecular weight = 105.1; specific gravity (H_2O:1) = 1.028 @ 25°C; boiling point @ 1 atm = ~220°C; melting/freezing point = −13°C; relative vapor density (air = 1) = 3.59; latent heat of vaporization = (estimate) 4.85 × 105 J/kg; heat of combustion = (estimate) −287 × 105 J/kg; heat of solution = (estimate) −0.1 × 105 J/kg; vapor pressure = 0.001 mmHg @ 20°C. (approximately); flash point = 127°C. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 1, reactivity 0. Soluble in water.

Potential Exposure: Used to remove gases from natural gas; in coatings in plastics; textiles, fibers, and metals; and in making other chemicals.

Incompatibilities: Reacts with oxidizers, strong acids; and chemically active metals, such as potassium, sodium, magnesium and zinc.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 9 milligram per cubic meter

PAC-2: 99 milligram per cubic meter

PAC-3: 590 milligram per cubic meter

Routes of Entry: Inhalation, skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: This chemical is highly corrosive. Contact can severely irritate and burn the eyes and skin. Inhalation can irritate the respiratory tract and lungs, causing shortness of breath; coughing and wheezing. Higher exposures can cause pulmonary edema, a medical emergency. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: May cause lung irritation, the development of bronchitis, with coughing, shortness of breath; phlegm.

Points of Attack: Lungs.

Medical Surveillance: Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Lung function tests.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way* *valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any concentrations above the NIOSH REL*: (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—White: Corrosive or Contact Hazard; store separately in a corrosion resistant location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN3055 2-(2-Aminoethoxy) ethanol, Hazard class: 8; Labels: 8-Corrosive material.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: 2-(2-Aminoethoxy)ethanol may burn, but does not readily ignite. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; water spray; or alcohol resistant foam to extinguish fire. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: 2-(2-Aminoethoxy) Ethanol, Trenton, NJ (August 1998).

3-Amino-9-Ethylcarbazole = A:0820

Formula: $C_{14}H_{14}N_2$; $C_{14}H_{14}N_2 \cdot ClH$ (hydrochloride)

Synonyms: 3-Amino-*N*-ethylcarbazole; 3-Amino-9-ethylcarbazole HCl (hydrochloride); NCI-C03043 (hydrochloride)

CAS Registry Number: 132-32-1; 6109-97-3 (hydrochloride); 57360-17-5 (hydrochloride)

HSDB Number: 4108

RTECS Number: FE3590000; FE3675000 (hydrochloride)

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 205-057-7

Regulatory Authority and Advisory Information

Carcinogenicity: NCI: Animal Positive (hydrochloride); European Directive 67/548/EEC: May cause cancer. Toxic if swallowed.

California Proposition 65 Chemical[102]: (*hydrochloride*) Cancer 7/1/1989
Hazard Alert: Poison.
Hazard symbols, Risk & safety statements: Hazard symbol: T; risk phrases: R45; R25; R23/24/25; R36/37/38; R61; safety phrases: S22; S26; S28; S36/37/39; S41; S45 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: 3-Amino-9-ethylcarbazole is a brown or tan, crystalline compound. The hydrochloride is a bluish-green powder. Molecular weight = 210.3; freezing/melting point = 99°C. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 0, reactivity 0. The hydrochloride forms blue-green crystals.

Potential Exposure: Plant workers engaged in the manufacture of this compound and its use in pigment manufacture. Laboratory workers using this material in colorimetric enzyme assays and as a biological stain.

Incompatibilities: 3-Amino-9-ethylcarbazole neutralizes acids in exothermic reactions to form salts plus water. May be incompatible with isocyanates, halogenated organics, peroxides, phenols (acidic), epoxides, anhydrides, and acid halides. May generate hydrogen, a flammable gas, in combination with strong reducing agents such as hydrides[101].

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.
DFG MAK: Germ Cell Mutagen Group 3B

Harmful Effects and Symptoms

Short-Term Exposure: Poisonous if swallowed.

Long-Term Exposure: A suspected carcinogen and mutagen.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Pregnant women should avoid contact. Employees should be notified by a physician that this chemical may affect the reproductive system. In addition to comprehensive initial medical and work histories emphasizing reproductive experience and menstrual history, patient should have physical examination and testing of genitourinary tract, sperm count, motility and morphology. If required, other tests, such as serum testosterone, serum FSH, and serum LH may be indicated.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison (Toxic): Store in a secure, locked and cool, ventilated area. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in a cool, dry place. Protect from exposure to air.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft.(NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters

waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.
Fire Extinguishing: Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include nitrogen oxides and oxides of carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.
Disposal Method Suggested: Incinerator equipped with a scrubber or thermal unit to reduce nitrogen oxides emissions.

References

(102); (31); (173); (101); (138); (100); (101).

United States Environmental Protection Agency, Chemical Hazard Information Profile: 3-Amino-9-ethylcarbazole, Washington, DC (1979).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report* 4, No. 6, 70−72 (1984) and 6, No. 2, 41−43 (Hydrochloride) (1986).

Aminoethylethanolamine A:0830

Formula: $C_4H_{12}N_2O$
Synonyms: 2-(Aminoethyl)amino-; 2-[(2-Aminoethyl)amino] ethanol; (2-Aminoethyl)ethanolamine; *N*-(2-Aminoethyl)ethanolamine; Hidroxietiletilendiamina (Spanish); Hydroxyethylenediamine
CAS Registry Number: 111-41-1
HSDB Number: 2067
RTECS Number: KJ6300000
UN/NA & ERG Number: UN2735 (amines, liquid, corrosive, n.o.s.)/153
EC Number: 203-867-5 [*Annex I Index No.*: 603-194-00-0]
Regulatory Authority and Advisory Information
Hazard Alert: Combustible, Corrosive, Sensitization hazard, Environmental hazard.
United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)
Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.
Hazard symbols, Risk & safety statements: Hazard symbol: C, T, Xi; risk phrases: R34; R43; R61; R62; safety phrases: S26; S28; S36/37/39; S41; S45; S53 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.
Description: Aminoethylethanolamine is combustible, colorless, liquid with an ammonia-like odor. A strong base [pH (10 M) = 12.3] molecular weight = 104.15; specific gravity (H_2O:1) = 1.028 @ 25°C; boiling point: 243°C; vapor pressure = 8.17×10^{-4} mmHg @ 25°C; vapor pressure = 0.01 mmHg @ 20°C; flash point = 132°C; autoignition temperature = 368°C. Explosive limits: LEL: 1.0%, 10.000 ppm; UEL: 8.0%. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 1, reactivity 0. Highly soluble in water.
Potential Exposure: Used to make textile finishing compounds, dyes, resins, rubber, insecticides, medicines, and other chemicals.
Incompatibilities: Contact with cellulose nitrate may cause fires upon contact. Reacts with Oxidizers, strong acids.
Permissible Exposure Limits in Air
PAC Ver. 29[138]
PAC-1: 9 milligram per cubic meter
PAC-2: 99 milligram per cubic meter
PAC-3: 590 milligram per cubic meter
Permissible Concentration in Water: No criteria set.
Determination in Water: Octanol−water coefficient: Log $K_{ow} \leq -1.50$. Unlikely to bioaccumulate in marine organisms.
Routes of Entry: Inhalation, skin contact.
Harmful Effects and Symptoms
Short-Term Exposure: Contact can severely irritate and burn the eyes and skin; this can lead to permanent damage. May cause second degree burns in a short period of time. Inhalation can irritate the respiratory tract and lungs, causing shortness of breath; coughing and wheezing. High exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Toxicity by Ingestion: Grade 2; LD_{50} = 0.5 to 5 g/kg[136]
Long-Term Exposure: May cause lung irritation, the development of bronchitis, with coughing, shortness of breath; phlegm. May cause skin allergy. If allergy develops, very low future exposure can cause itching and skin rash.
Points of Attack: Lungs, skin.
Medical Surveillance: Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Lung function tests. Evaluation by a qualified allergist may diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any concentrations above the NIOSH REL*: (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—White: Corrosive or Contact Hazard; store separately in a corrosion resistant location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2735 Amines, liquid, corrosive, n.o.s, or Polyamines, liquid, corrosive, n.o.s., Hazard class: 8; Labels: 8-Corrosive material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Aminoethylethanolamine is a combustible liquid. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; or alcohol resistant foam to extinguish fire. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (85); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Aminoethylethanolamine, Trenton, NJ (December 1998).

N-Aminoethylpiperazine A:0840

Formula: $C_6H_{15}N_3$

Synonyms: *N*-(2-Aminoethyl) piperazine; 1-(2-Aminoethyl) piperazine; Piperazine, 1-(2-aminoethyl)-; 1-Piperazine ethanamine

CAS Registry Number: 140-31-8

HSDB Number: 5630

RTECS Number: TK8050000

UN/NA & ERG Number: UN2815/153

EC Number: 140-31-8 [*Annex I Index No.*: 612-105-00-4]

Regulatory Authority and Advisory Information

Hazard Alert: Flammable, Corrosive, Sensitization hazard (skin), Environmental hazard.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, Risk & safety statements: Hazard symbol: F, C, N, Xi; risk phrases: R10; R21/22; R34; R43; R52/53; safety phrases: S1/2; S26; S36/37/39; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: *N*-Aminoethypiperazine is a combustible and corrosive aliphatic amine It is a colorless to light yellow liquid. Molecular weight = 129.2; specific gravity (H_2O:1) = 0.98; boiling point = 222°C; melting/freezing point = 17.7°C; flash point = 93°C; autoignition temperature ≥ 300°C; vapor pressure = 0.076 mmHg @ 20°C; hazard Identification (based on NFPA-704 M Rating System): Health 2; flammability 2, reactivity 0. Very soluble in water.

Potential Exposure: Used as an epoxy curing agent and making pharmaceuticals; synthetic fibers, and other chemicals.

Incompatibilities: Solution is a strong base. Reacts with nitrosating agents (e.g., nitrites, nitrous gases, nitrous acid); capable of releasing carcinogenic nitrosamines. Incompatible with nonoxidizing mineral acids; strong acids; organic acids, acid chlorides; acid anhydrides; organic anhydrides; isocyanates, chloroformates, vinyl acetate; acrylates, substituted allyls; alkylene oxides; epichlorohydrin, ketones, aldehydes, alcohols, glycols, phenols, cresols, caprolactum solution; strong oxidizers. Contact with copper alloys, zinc or galvanized steel may cause violent reaction.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 6.4 milligram per cubic meter

PAC-2: 71 milligram per cubic meter

PAC-3: 420 milligram per cubic meter

Determination in Water: Harmful to aquatic organisms, may cause long-term adverse effects in the aquatic environment

Routes of Entry: Inhalation, skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Contact can severely irritate and burn the eyes and skin (can cause second and third degree burns); this can lead to permanent damage. Inhalation can irritate the respiratory tract and lungs, causing shortness of breath; coughing and wheezing. Exposure can cause headache, nausea, and vomiting. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: May cause lung irritation, the development of bronchitis, with coughing, shortness of breath; phlegm. Mutation data reported.

Points of Attack: Lungs, skin.

Medical Surveillance: Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Lung function tests. If symptoms develop or overexposure is suspected, chest X-ray should be considered.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear indirect-vent, impact and splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any concentrations above the NIOSH REL*: (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—White: Corrosive or Contact Hazard; store separately in a corrosion resistant location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2815 *N*-Aminoethylpiperazined, Hazard class: 8; Labels: 8-Corrosive material.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, water, or alcohol; or polymer foam to extinguish fire. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (85); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: *N*-Aminoethylpiperazine, Trenton, NJ (December 1998).

1-Amino-2-Methylanthraquinone A:0850

Formula: $C_{15}H_{11}NO_2$

Synonyms: Acetate fast orange R; Acetoquinone light orange JL; 1-Amino-2-methyl-9,10-anthracenedione; 1-Amino-2-metilantraquinona (Spanish); 9,10-Anthracenedione, 1-amino-2-methyl-; Artisil orange 3RP; Celliton orange R; C.I. 60700; C.I. Disperse orange 11; Cilla orange R; Disperse orange; Duranol orange G; 2-Methyl-1-anthraquinonylamine; Microsetile orange RA; Nyloquinone orange JR; Perliton orange 3R; Serisol orange yl; Supracet orange R

CAS Registry Number: 82-28-0

HSDB Number: 4101

RTECS Number: CB5740000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154; UN3143 (Dye intermediates, solid, toxic, n.o.s.)/151

EC Number: 201-408-3

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Animal Limited Evidence, Human No Adequate Data, Group 2B; NCI: Animal Positive

California Proposition 65 Chemical[102]: Cancer 10/1/1989

Hazard Alert: Poison, Possible risk of forming tumors, Suspected of causing genetic defects

CERCLA/SARA Section 313, Form R *de minimis* Concentration Reporting Level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazard symbols, Risk & safety statements: Hazard symbol: T; risk phrases: R45; R20/21/22; R27/28; R46; R50/53; R61; safety phrases: S13; S22; S36/37/39; S41; S53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: 1-Amino-2-methylanthraquinone is a red crystalline substance or powder. Molecular weight = 237.27; freezing/melting point = 205−206°C. Practically insoluble in water; solubility ≤ 1 mg/mL @ 20°C.

Potential Exposure: 1-Amino-2-methylanthraquinone is used almost exclusively as a dye intermediate for the production of a variety of anthraquinone dyes. May be used as a dye for a variety of synthetic fibers, especially acetates, as well as wool, sheepskins, furs, and surface dyeing of thermoplastics. None of the dyes that can be prepared from it are presently produced in commercial quantities.1-Amino-2-methylanthraquinone had been produced commercially in the United States since 1948, but production was last reported by a single company in 1970. The potential for exposure is greatest among workers engaged in the dyeing of textiles. 1-Amino-2-methylanthraquinone is not presently used in consumer products according to the CPSC.

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Determination in Air: NIOSH Analytical Method #5013, Dyes

Routes of Entry: Inhalation, eye, and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Contact may irritate the eyes and skin.

Long-Term Exposure: There is evidence that this chemical causes liver and kidney cancer. A mutagen. Technical-grade 1-amino-2-methylanthraquinone (impurities unspecified), administered in the feed, was carcinogenic in Fischer 344 rats, inducing hepatocellular carcinomas in rats of both sexes, and kidney tumors (such as tubular-cell adenomas and adenocarcinomas) in males.

Points of Attack: Liver, kidneys.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored. Should be stored in a refrigerator in a tightly closed container under an inert atmosphere[52].

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN3143 Dyes, solid, toxic, n.o.s. or Dye intermediates, solid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft.(NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen spilled material with toluene to avoid airborne dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after clean-up is complete. Keep this chemical out of a confined space, such as a sewer, because of the potential for an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References
(109); (102); (31); (173); (101); (138); (100).
New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: *1-Amino-2-Methylanthraquinone* (January 2004).

4-Amino-2-Nitrophenol A:0860

Formula: $C_6H_6N_2O_2$: $C_6H_3NO_2NH_2OH$

Synonyms: C.I.-76555; Fourrine 57; Fourrine brown PR; Fourrine brown propyl; 4-Hydroxy-3-nitroaniline; 2-Nitro-4-amenophenol; *o*-Nitro-*p*-aminophenol; *o*-Nitro-*p*-aminofenol (Spanish)

CAS Registry Number: 119-34-6

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154; UN3143 (Dyes, solid, toxic, n.o.s. [or] Dye intermediates, solid, toxic, n.o.s.)/151

HSDB Number: 4089

RTECS Number: SJ6303000

EC Number: 204-316-1

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human Inadequate Evidence, animal Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1987; NCI: rat: positive, mouse: negative

California Proposition 65 Chemical[102]: Cancer January 1, 1999

Hazard Alert: Poison, Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, Risk & safety statements: Hazard symbol: T, Xn, Xi; risk phrases: R45; R22; R36/37/38; R62; safety phrases: S1/2; S22; S24/25; S26; S37/39; S41; S45; S53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: 4-Amino-2-nitrophenol is a dark red crystalline or reddish-purple solid. Molecular weight = 154.12; freezing/melting point = 125−131°C. Hazard identification (based on NFPA-704 M Rating System): Health 1; flammability 1; reactivity 0. Practically insoluble in water; solubility ≤ 1 mg/mL @ 21°C.

Potential Exposure: In dye formulation for furs and hair.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. It is unknown if this nitro compound is explosive; some are flammable and explosive, and the contact with alkali increases thermal sensitivity of these materials.

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

DFG MAK: [skin] Carcinogen Category 3B

Determination in Air: NIOSH Analytical Method #5013, Dyes

Routes of Entry: Inhalation of dust; eye, and/or skin contact.

Harmful Effects and Symptoms

Severe eye irritant in rabbits. A suspected carcinogen. LD_{50} (oral, rat) = 1.470 mg/kg.

Short-Term Exposure: Poisonous if swallowed or upon skin contact. Irritates eyes and may irritate skin and respiratory tract.

Long-Term Exposure: May be carcinogenic in humans. Similar compounds can cause chronic poisoning with fatigue, headache, dizziness, insomnia, cyanosis, anemia, and weight loss. May result in liver and kidneys damage, with toxic hepatitis and fatty degeneration of the kidneys.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is

worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in cool dry place away from air and from mineral acids and bases[52].

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN3143 Dyes, solid, toxic, n.o.s. or Dye intermediates, solid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft.(NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Dampen spilled material with 60%−70% acetone to avoid airborne dust and remove to sealed containers for disposal[52]. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include oxides of nitrogen and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(102); (31); (173); (101); (138); (100).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 1, No. 7, 34−35 (1981).

Aminophenols A:0870

Formula: C_6H_7NO; $C_6H_4(OH)(NH_2)$

Synonyms: *ortho-isomer*: 2-Amino-1-hydroxybenzene; *o*-Hydroxyaniline
meta-isomer: 3-Amino-1-hydroxybenzene; 3-Hydroxyaniline
para-isomer: 4-Amino-1-hydroxybenzene; *p*-Hydroxyaniline

CAS Registry Number: 591-27-5 (*m*-isomer); 95-55-6 (*o*-isomer); 123-30-8 (*p*-isomer); 27598-85-2 (mixed isomers)

HSDB Number: 2586 (*m*-isomer); 4246 (*o*-isomer); 2640 (*p*-isomer)

RTECS Number: SJ4950000 (*o*-isomer); SJ4900000 (*m*-isomer); SJ5075000 (*p*-isomer)

UN/NA & ERG Number: UN2512 (aminophenols)/152

EC Number: 202-431-1 [*Annex I Index No.*: 612-033-00-3] (*o*-isomer); 209-711-2 [*Annex I Index No.*: 612-127-00-4] (*m*-isomer); 204-616-2 [*Annex I Index No.*: 612-128-00-X] (*p*-isomer)

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Combustible, Sensitization hazard, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction), Environmental hazard.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%. (*m*-, *o*-, *p*-isomers).

Listed on the TSCA inventory, CFR721.5820.

Hazardous to aquatic life or environment, with possible long-lasting effects[293]. Toxic to aquatic life with long-lasting effects.(*m*- isomer); Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. (*o*- & *p*-isomer, mixed isomers).

Hazard symbols, Risk & safety statements: Hazard symbol (*o-isomer*): T, Xi, Xn; risk phrases: R20/22; R36/37/38, R62; R63; R68; safety phrases: S28; S36/37; (*m*-isomer): Hazard symbol: Xn, N; risk phrases: R20/22; R51/53; safety phrases: S2; S28; S29; S41; S61. (*p*-isomer): Hazard symbol: Xn, N; risk phrases: R20/22; R50/53; R68; safety phrases: S2; S28; S29; S36/37; S41; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to waters (*o*-isomer); 3-Severe hazard to water (*p*-isomer).

Description: *o*-Aminophenol appears as colorless needles or as white crystalline substance turning tan to brown on exposure to air. Molecular weight = 109.13; specific gravity (H_2O:1) = 1.33; boiling point = (sublimes) 153°C @ 11 mmHg; freezing/melting point = 172−174°C. Slightly soluble in water.

p-Aminophenol is a white or reddish-yellow crystalline or light brown powder; turns violet on exposure to light.

Molecular weight = 109.14; specific gravity (H_2O:1) = 1.2; boiling point = (sublimes) 284°C @ 11 mmHg; freezing/melting point = (decomposes) 186−187°C; vapor pressure = 5×10^{-4} @ 25°C. Slightly soluble in water.

m-Aminophenol is a white crystalline substance. Molecular weight = 143.57; boiling point = 164 C @ 11 mmHg; freezing/melting point = 123−126°C. Hazard identification (based on NFPA-704 M Rating System) (*mixed isomers*): Health 2; flammability 1; reactivity 0. Low solubility in water; solubiliy ≤ 10 mg/mL @ 24°C.

Potential Exposure: Workers may be exposed to *o*-Aminophenol during its use as a chemical intermediate; in the manufacture of azo and sulfur dyes; and in the photographic industry. There is potential for consumer exposure to *o*-Aminophenol because of its use in dyeing hair, fur, and leather. The compound is a constituent of 75 registered cosmetic products suggesting the potential for widespread consumer exposure. *p*-Aminophenol is used mainly as a dye, dye intermediate and as a photographic developer; and in small quantities in analgesic drug preparation. Consumer exposure to *p*-aminophenol may occur from use as a hair-dye or as a component in cosmetic preparations. *m*-Aminophenol is used mainly as a dye intermediate.

Incompatibilities: These phenol/cresol materials can react with oxidizers; reaction may be violent. Incompatible with strong reducing substances such as alkali metals, hydrides, nitrides, and sulfides. Flammable gas (H_2) may be generated, and the heat of the reaction may cause the gas to ignite and explode. Heat may be generated by the acid-base reaction with bases; such heating may initiate polymerization of the organic compound. Reacts with boranes, alkalies, aliphatic amines, amides, nitric acid, sulfuric acid. Phenols are sulfonated very readily (e.g., by concentrated sulfuric acid at room temperature). These reactions generate heat. Phenols are also nitrated very rapidly, even by dilute nitric acid and can explode when heated. Many phenols form metal salts that may be detonated by mild shock.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

95-55-6, *o-isomer*

PAC-1: 2.9 milligram per cubic meter

PAC-2: 31 milligram per cubic meter

PAC-3: 190 milligram per cubic meter

DFG MAK: Danger of sensitization of the skin

591-27-5, *m-isomer*

PAC-1: 3 milligram per cubic meter

PAC-2: 33 milligram per cubic meter

PAC-3: 200 milligram per cubic meter

Permissible Concentration in Water: Russia[43] has set MAC values in water used for domestic purposes. The value for *o*-aminophenol is 0.01 mg/L and for *p*-aminophenol is 0.05 mg/L.

Determination in Water: Toxic to aquatic organisms

Routes of Entry: Inhalation, ingestion, and skin absorption.

Harmful Effects and Symptoms

Short-Term Exposure: Aminophenols can be absorbed through the skin, thereby increasing exposure. Can cause lung irritation. Poisonous if swallowed. These chemicals lower the blood's ability to carry oxygen (methemoglobinemia). This condition causes a bluish color to the skin and lips, headaches, dizziness; higher exposures can result in unconsciousness and death. Irritates eyes, skin and respiratory tract. Skin contact can cause burning sensation and rash. the *o*-isomer can affect the nervous system. *o*-Aminophenol has an oral LD_{50} for rats of 1300 mg/kg and *p*-aminophenol has produced LD_{50} values in rats of 375, 671, and 1270 mg/kg which are all of low acute toxicity. The oral LD_{50} in rats for *m*-aminophenol is 1000 mg/kg. May produce dermatitits, methemoglobinemia, bronchial asthma, and restlessness.

Long-Term Exposure: Prolonged or repeated contact can cause blood damage, skin disorders; liver, kidney, and brain damage. Aminophenols may cause mutations, and there is limited teratogenic evidence. Skin allergy or asthma may develop; future exposures, even in low doses can cause symptoms to occur.

Points of Attack: Blood, liver, kidneys, brain, skin, and lungs.

Medical Surveillance: Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Lung function tests. Blood methemoglobin level. Evaluation by a qualified allergist. Any person who develops asthma from these aminophenols should avoid all future contact with them.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to Physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Aminophenols must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine), since violent reactions occur.

Shipping: UN2512 Aminophenols (*o*-; *m*-; *p*-), Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Keep dust under control. Use a vacuum or wet method to reduce dust during clean-up. Do not sweep. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Aminophenols may burn, but do not readily ignite. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, CO_2, water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (100); (193).

United States Environmental Protection Agency, Chemical Hazard Information Profile Draft Report: *o*-Aminophenol, sulfate and hydrochloride, Washington, DC (March 29, 1984).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Aminophenols (mixed isomers), Trenton, NJ (February 2007).

Aminopterin A:0880

Formula: $C_{19}H_{20}N_8O_5$

Synonyms: 4-Amino-4-deoxypteroylglutamate; 4-Aminofolic acid; 4-Amino-PGA; Aminopteridine; Aminopterine; 4-Aminopteroylglumatic acid; APGA; ENT-26,079; Folic acid, 4-amino-; Glutamic acid, *N*-[*p*-(((2,4-diamino-6-pteridinyl)methyl]amino; Glutamic acid, *N*-[*p*-[[(2,4-diamino-6-pteridinyl)methyl]amino; l-Glutamic acid, *N*-[4-[(diamino-6-pteridinyl)methyl] amino]β; *N*-[4-((2,4-Diamino-6-pteridinyl) methyl)amino)benzoyl]-l-glu; α-Ninopterin; NSC 739; Pteramina

CAS Registry Number: 54-62-6

HSDB Number: 6374

RTECS Number: MA1050000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 200-209-9

Regulatory Authority and Advisory Information

California Proposition 65 Chemical[102]: Developmental/Reproductive toxin (female) 7/1/1987.

Hazard Alert: Poison, Possible neurotoxin, Combustible, Possible risk of forming tumors, Reproductive toxin: possible risk of gene damage/impaired fertility; suspected reprotoxic hazard.

CERCLA/SARA 40CFR302 Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg)

Hazard symbols, Risk & safety statements: Hazard symbol: T+; risk phrases: R28; R26/27/28; R61; R62; R63; safety phrases: S22; S28; S36/37/39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Aminopterin is a white to yellow powder; commonly used as the dihydrate which forms clusters of yellow needles. Molecular weight = 440.46; freezing/melting point = 228−235°C; 260−265°C; vapor pressure = 2.3×10^{-19} mmHg @ 25°C. Hazard identification (based on NFPA-704 M Rating System): Health-; flammability 1; reactivity 0. Soluble in water; solubility = 3.0 × 103 mg/L @ 25°C.

Potential Exposure: Aminopterin is used as a medicine (as a folic acid antagonist), rodenticide, and agricultural chemical.

Permissible Exposure Limits in Air

PAC Ver. 28, no values found in Ver. 29[138]

PAC-1: 2.3 milligram per cubic meter

PAC-2: 25 milligram per cubic meter

PAC-3: 150 milligram per cubic meter

Routes of Entry: Ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Acts as antimetabolite; antagonizes the utilization of folic acid by the body. GI effects. Highly toxic by ingestion. Has an LD_{low} = (oral-rat) 2.5 mg/kg.

Long-Term Exposure: A potential mutagen, and a questionable carcinogen. Listed as a developmental and reproductive toxicant by the state of California (Proposition 65). NIOSH has it listed as a suspected neurotoxin; liver and skin toxin. Bone marrow-chronic blood-forming system and other chronic effects.

Medical Surveillance: Pregnant women should avoid contact. Employees should be notified by a physician that this chemical may affect the reproductive system. In addition to comprehensive initial medical and work histories emphasizing reproductive experience and menstrual history, patient should have physical examination and testing of genitourinary tract, sperm count, motility and morphology. If required, other tests, such as serum testosterone, serum FSH, and serum LH may be indicated.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Storage temperature: 2−8°C. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft.(NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Do not touch spilled material; stop leak if you can do so without risk. Do not create dust. Use a vacuum and water spray to reduce vapors. *Small wet spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills*: with clean shovel place material into clean, dry container and cover; move containers from spill area. *Large spills*: dike far ahead of spill for later disposal. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include oxides of nitrogen and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: It is inappropriate and possibly dangerous to the environment to dispose of expired or waste pharmaceuticals by flushing them down the toilet or discarding them to the trash. Household quantities of expired or waste pharmaceuticals may be mixed with wet cat litter or coffee grounds, double-bagged in plastic, discard in trash. Larger quantities shall carefully take into consideration applicable DEA, EPA, and FDA regulations. If possible return the pharmaceutical to the manufacturer for proper disposal being careful to properly label and securely package the material. Alternatively, the waste pharmaceutical shall be labeled, securely packaged and transported by a state licensed medical waste contractor to dispose by burial in a licensed hazardous or toxic waste landfill or incinerator

References

(102); (31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Aminopterin, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

2-Aminopyridine A:0890

Formula: $C_5H_6N_2$

Synonyms: α-Aminopyridine; Amino-2-Pyridine; 1,2-Dihydro-2-Iminopyridine; α-Piridilamina (Spanish); α-Pyridinamine; 2-Pyridylamine

CAS Registry Number: 504-29-0

HSDB Number: 2068

RTECS Number: US1575000

UN/NA & ERG Number: UN2671(aminopyridines)/153

EC Number: 207-988-4

Regulatory Authority and Advisory Information

Hazard Alert: Poison: High acute toxicity, Corrosive, Inhalation danger—inadequate warning properties; Human Data.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, Risk & safety statements: Hazard symbol: T + , Xi; risk phrases: R21; R23/24/25; R36/37/38; safety phrases: S26; S36/37/39; S38; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: 2-Aminopyridine is a flammable, colorless crystalline solid, or white leaflets or powder, or colorless liquid with a characteristic odor. Molecular weight = 91.13; freezing/melting point = 58°C; boiling point = 211°C; flash point = 68°C. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 0; reactivity 0. Highly soluble in water; solubility = 10−50 mg/mL @ 19°C.

Potential Exposure: 2-Aminopyridine is used in the manufacture of pharmaceuticals; especially antihistamines.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

NIOSH IDLH = 5 ppm

Conversion factor: 1 ppm = 3.85 milligram per cubic meter

OSHA PEL: 0.5 ppm/2 milligram per cubic meter TWA

NIOSH REL: 0.5 ppm/2 milligram per cubic meter TWA

ACGIH TLV[1]: 0.5 ppm/2 milligram per cubic meter TWA

DFG MAK: No numerical value established. Data may be available.

Australia: TWA 5 ppm (2 milligram per cubic meter), 1993; Austria: MAK 0.5 ppm (2 milligram per cubic meter), 1999; Belgium: TWA 0.5 ppm (2 milligram per cubic meter), 1993; Denmark: TWA 0.5 ppm (2 milligram per cubic meter), 1999; Finland: TWA 0.5 ppm (2 milligram per cubic meter); STEL 1.5 ppm (6 milligram per cubic meter), 1999; France: VME 0.5 ppm (2 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 2 milligram per cubic meter, 2003; the Philippines: TWA 0.5 ppm (2 milligram per cubic meter), 1993; Poland: MAC (TWA) 2 milligram per cubic meter, 1999; Switzerland: MAK-W 0.5 ppm (2 milligram per cubic meter), 1999; United Kingdom: TWA 0.5 ppm (2 milligram per cubic meter); STEL 2 ppm (7.8 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 0.5 ppm. Several states have set guidelines or standards for 2-aminopyridine in ambient air[61]: 0.5 ppm (2 milligram per cubic meter) TWA (California), 2 milligram per cubic meter (North Dakota), 3 milligram per cubic meter (Virginia), 4 milligram per cubic meter (Connecticut), 4.8 milligram per cubic meter (Nevada).

PAC Ver. 29[138]

PAC-1: 1.5 milligram per cubic meter

PAC-2: 1.7 milligram per cubic meter

PAC-3: 10 milligram per cubic meter

Determination in Air: Use NIOSH Analytical Method (II-4) #S-158.

Permissible Concentration in Water: No criteria set.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = -0.22$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion, eye, and skin contact (absorption through the skin).

Harmful Effects and Symptoms

Headaches, dizziness, excited state, nausea, flushed appearance; high blood pressure, respiratory distress, weakness, convulsions, stupor.

Short-Term Exposure: Skin contact contributes significantly to overall exposure. Irritates eyes, skin, and respiratory tract. May attack CNS. Inhalation or skin exposure can cause a fatal reaction that begins with a headache, dizziness, heaviness and weakness of the limbs, and may progress to convulsions; stupor; and coma. LD_{50} = (oral-rat) 0.2 g/kg.

Long-Term Exposure: May cause lung allergy.

Points of Attack: CNS; respiratory system.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Interview for brain effects including recent memory loss; change in mood; concentration, headache, listless feeling; altered sleep patterns. Consider cerebellar, autonomic, and peripheral nervous system evaluation. Positive and borderline individuals should be referred for neuropsychological testing.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash or dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *up to 5 ppm*: Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd, Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in a refrigerator under an inert atmosphere[52]; or store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2671 Aminopyridines, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Use water spray to reduce dust or vapors. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Dike large spills. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration with nitrogen oxides removal from effluent gas.

References

(31); (173); (101); (138); (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: 2-Aminopyridine, Trenton, NJ (January 2001).

4-Aminopyridine A:0900

Formula: $C_5H_6N_2$

Synonyms: 4-Aminopiridina (Spanish); γ-Aminopyridine; *p*-Aminopyridine; Amino-4-pyridine; Avitrol; 4-Pyridinamin; 4-Pyridylamine; VMI 10-3

CAS Registry Number: 504-24-5

HSDB Number: 6037

RTECS Number: US1750000
UN/NA & ERG Number: UN2671(aminopyridines)/153
EC Number: 207-987-9
Regulatory Authority and Advisory Information
Hazard Alert: Poison, Environmental hazard.
United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P008
RCRA 40CFR261, Appendix 8; 40CFR261.11 Hazardous Constituents
CERCLA/SARA 40CFR302 Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg).
Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1000 lb (454 kg)
Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.
Hazardous to aquatic life or environment, with possible long-lasting effects[293]. Toxic to aquatic life with long-lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.
Hazard symbols, Risk & safety statements: Hazard symbol: T + , N, Xn; risk phrases: R28; R23/24/25; R36/37/38; R50/53; safety phrases: S1; S22; S29; S36/37/39; S41; S45; S60; S61 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]
Description: 4-Aminopyridine is white to tan or brown crystalline material. Odorless. Molecular weight = 94.12; specific gravity (H_2O:1) = 1.2607 @ 25.3°C; boiling point = 273°C; freezing/melting point = 155−158°C; flash point = 164°C. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 0; reactivity 0. Moderately soluble in water.
Potential Exposure: Used as a chemical intermediate in pharmaceuticals; as an agricultural chemical for field crops; and as a bird repellent and poison.
Incompatibilities: Sodium nitrite, strong oxidizers. Avoid contact with acid anhydrides, acid chlorides; and strong acids.
Permissible Exposure Limits in Air
PAC Ver. 29[138]
PAC-1: 1.8 milligram per cubic meter
PAC-2: 20 milligram per cubic meter
PAC-3: 40 milligram per cubic meter
Permissible Concentration in Water: No criteria set. Harmful to aquatic life in very low concentrations.
Determination in Water: Octanol−water coefficient: Log $K_{ow} \leq 0.3$. Unlikely to bioaccumulate in marine organisms.
Routes of Entry: Inhalation, ingestion, skin absorption.
Harmful Effects and Symptoms
Short-Term Exposure: LD_{50} = (oral-rat) 21 mg/kg. May be fatal if swallowed or absorbed through the skin. Symptoms of exposure include rapid onset of disagreeable taste, immediate burning of throat; and abdominal discomfort; in addition, weakness, dizziness, disorientation, and seizures may occur. Delayed symptoms of oral ingestion include elevated liver enzymes, and respiratory arrest. Material may be fatal if inhaled, swallowed or absorbed through skin. Contact may cause burns to skin and eyes. Material affects neural transmission. In sufficient concentration, material may cause metabolic acidosis, respiratory arrest, and cardiac arrhythmias. The fatal dose to a 70 kg person is about 5 g.
Long-Term Exposure: High exposure or repeated exposure may cause liver damage.
Points of Attack: CNS; liver.
Medical Surveillance: Preemployment and regular physical examinations with emphasis on CNS. Liver function tests. Persons exposed to *strychnine* or other chemicals capable of causing seizures are probably at increased risk.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.
Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/ manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: *For reference, the information for 2-Aminopiridine follows*: Up to *5 ppm*: Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd, Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100,

R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Avoid contact with acid anhydrides, acid chlorides; strong acids and strong oxidizers (such as halogens). Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2671 Aminopyridines, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Ventilate area of spill or leak. Use water spray to reduce dust or vapors. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. *Dike large spills*. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration with nitrogen oxides removal from effluent gas.

References

(31); (173); (101); (138); (100)

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report* 5, No. 5, 39−41 (1985).

United States Environmental Protection Agency, Chemical Hazard Information Profile: 4-Aminopyridine, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Avitrol, Trenton, NJ (January 2004).

3-Amino-1,2,4-Triazole (Amitrole) A:0910

Formula: $C_2H_4N_4$

Synonyms: Amerol; 2-Amino-1,3,4-triazole; 2-Aminotriazole; 3-Amino-*s*-triazole; 3-Amino-1,2,4-triazole; 3-Amino-1*H*-1,2,4-triazole; 3-Aminotriazole; Aminotriazole; Aminotriazole Bayer; Amino triazole weedkiller 90; Amitol; Amitril; Amitrol 90; Amitrole; Amitrol-T; Amizol; Amizol DP NAU; Amizol F; 3-AT; AT; AT (Liquid); AT-90; ATA; Atlazin; Atlazine flowable; Atraflow plus; Azaplant; Azaplant kombi; Azolan; Azole; Boroflow A/ATA; Boroflow S/ATA; Campaprim A 1544; Caswell No. 040; CDA Simflow plus; Chipman path weedkiller; Clearway; Cytrol; Cytrol Amitrole-T; Cytrole; Diurol; Diurol 5030; Domatol; Domatol 88; Elmasil; Emisol; Emisol F; ENT 25445; EPA pesticide chemical code 004401; Farmco; Fenamine; Fenavar; Herbazin plus SC; Herbicide total; Herbizole; Kleer-lot; Mascot highway; MSS aminotriazole; MSS simazine; Orga-414; Primatol AD 85 WP; Primatrol SE 500 FW; Radoxone TL; Ramizol; Rassapron; Simazol; Simflow plus; Solution concentre T271; Synchemicals total weed killer; Syntox total weed killer; Torapron; 1,2,4-Triazol-3-amine; 1*H*-1,2,4-Triazol-3-amine; Triazolamine; *s*-Triazole, 3-amino-; δ-2-1,2,2,4-Triazoline, 5-imino-; 1*H*-1,2,4-Triazol-3-ylamine; Vorox; Vorox AS; Weedar ADS; Weedar AT; Weedazin; Weedazin arginit; Weedazol; Weedazol GP2; Weedazol super; Weedazol T; Weedazol TL; Weedex granulat; Weedoclor; X-All (liquid)

CAS Registry Number: 61-82-5; *(alt.)* 155-25-9

HSDB Number: 2953

RTECS Number: XZ3850000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171; UN2588 (Pesticides, solid, toxic, n.o.s.)/151

EC Number: 200-521-5 [*Annex I Index No.*: 613-011-00-6]

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Animal Sufficient Evidence; Human Inadequate Evidence, Evidence, *not classifiable as carcinogenic to humans*, Group 3; EPA Group B2, Probable human carcinogen; ACGIH A3 Confirmed animal carcinogen with unknown relevance to humans

California Proposition 65 Chemical[102]: Carcinogen (7/1/1987).

Hazard Alert: Poison, Combustible, Endocrine disruptors (medium), Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Environmental hazard.

Hazard Alert: Suspected reprotoxic hazard

EPA Hazardous Waste Number (RCRA No.): U011

RCRA Land Ban Waste Restrictions

Superfund/EPCRA 40CFR302.4 RQ: CERCLA, 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimus* concentration reporting level: 0.1%

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), severe pollutant

Hazard symbols, Risk & safety statements: Hazard symbol: Xn, N; risk phrases: R45; R48/22; R51/53; R62; R63; safety phrases: S2; S29/35; S36/37; S41; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Amitrole is a colorless to off-white crystalline solid or white powder. Odorless when pure. Molecular weight = 84.1; specific gravity = 1.138 @ 20°C[72]; freezing/melting point = 147−159°C; vapor pressure = 8×10^{-6} mmHg; 4.41×10^{-7} mmHg @ 20°C[72]. Hazard identification (based on NFPA-704 M Rating System): Health 1; flammability 1; reactivity 0. Soluble in water; solubility = Soluble in water; solubility = ≥ 100 mg/mL @ 17.5°C[72].

Potential Exposure: A potential danger to those involved in the manufacture, formulation, and application of this postemergence herbicide, which is now limited to noncrop applications as a herbicide and plant growth regulator. Some triazoles have been used as rubber components.

Incompatibilities: Dust may be explosive in air. Keep away from strong oxidizers; strong acids; light and heat (decomposes). Corrosive to iron, aluminum, and copper. Sublimes undecomposed at reduced pressure.

Permissible Exposure Limits in Air

IDLH = A potential human carcinogen[77]

OSHA PEL: None

NIOSH REL: 0.2 ppm TWA; suspected occupational carcinogen

ACGIH TLV[1]: 0.2 ppm TWA

PAC Ver. 29[138]

PAC-1: 0.6 milligram per cubic meter

PAC-2: 23 milligram per cubic meter

PAC-3: 220 milligram per cubic meter

DFG MAK: 0.2 ppm, inhalable fraction; Peak limitation Category II(8); Carcinogen Category 3B; Pregnancy Risk Group C

Australia: TWA 0.2 milligram per cubic meter, 1993; Austria: MAK 0.2 milligram per cubic meter, 1999; Belgium: TWA 0.2 milligram per cubic meter, 1993; Denmark: TWA 0.2 milligram per cubic meter, 1999; Finland: carcinogen, 1999; Switzerland: MAK-W 0.2 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 0.2 milligram per cubic meter, 2003; Argentina, Bulgaria, Colombia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: confirmed animal carcinogen with unknown relevance to humans.

Determination in Air: NIOSH Analytical Method 0500; OSHA Method PV2006.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = -0.65$. Unlikely to bioaccumulate in marine organisms.

Permissible Concentration in Water: No criteria set.

Determination in Water: Fish Tox = 12,422.37656000 ppb MATC (VERY LOW). Octanol−water coefficient: Log $K_{ow} \leq -0.6$. Unlikely to bioaccumulate in marine organisms.

Harmful Effects and Symptoms

Carcinogenicity is the primary observed effect. Amitrol is carcinogenic in mice and rats, producing thyroid and liver tumors following oral or subcutaneous administration. Railroad workers who were exposed to amitrole and other herbicides showed a slight (but statistically significant) excess of cancer when all sites were considered together. Because the workers were exposed to several different herbicides, however, no conclusions could be made regarding the carcinogenicity of amitrole alone.

Short-Term Exposure: Amitrol can be absorbed through the skin, thereby increasing exposure. May cause eye, skin and GI irritation and other effects. Toxic to the nervous and respiratory system and brain. Symptoms of exposure can include difficult breathing, muscle spasms, ataxia, anorexia, salivation, increased body temperature; weakness, exhaustion, dry skin, depression (thyroid function suppression).

Long-Term Exposure: May cause eye damage. A potential human carcinogen[77]. Hematological effects; Reproductive toxin[138]. Causes liver, thyroid, and pituitary cancer in animals. May damage the developing fetus. May cause liver, thyroid gland (possible goiter or underactive thyroid), and pituitary gland damage. Human Tox = 0.30973 ppb CHCL (Chronic Human Carcinogen Level) (EXTRA HIGH).

Points of Attack: Liver, thyroid, and pituitary gland, eyes, skin, liver carcinogen[138]

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Pregnant women should avoid contact. Employees should be notified by a physician that this chemical may affect the reproductive system. In addition to comprehensive initial medical and work histories emphasizing reproductive experience and menstrual history, patient should have physical examination and testing of genito-urinary tract, sperm count, motility and morphology. If required, other tests, such as serum testosterone, serum FSH, and serum LH may be indicated. Before beginning employment and at regular times after that, the following is recommended: Physical examination of the thyroid and thyroid function tests (T_4, TSH, and T_3). If symptoms develop or overexposure is suspected, the following may be useful: liver function tests. Pituitary gland function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Specific respirator(s) have not been recommended by NIOSH. However, based on potential carcinogenicity, and where the potential exists for exposure, the following might be considered:

At any detectable concentration: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air-purifying, full facepiece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a tightly closed container in a dry, well-ventilated and secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Where possible, automatically transfer material from other storage containers to process containers.

Shipping: UN2588 Pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Contain and isolate spill. Product residues and sorbent media may be packaged in epoxy-lined drums. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Amitrol is resistant to hydrolysis and the action of oxidizing agents. Burning the compound with polyethylene is reported to result in >99% decomposition.

References

(109); (102); (31); (173); (101); (138); (201); (18); (100).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 1, No. 4, 34−35 (1981) and 4, No. 2, 41−43 (1984).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Amitrol, Trenton, NJ (June 1998).

Amiton (Agent VG) A:0920

Formula: $C_{10}H_{24}NO_3PS$; $(C_2H_5O)_2POSCH_2CH_2N(C_2H_5)_2$

Synonyms: Chipman 6200; Citram; *S*-(2-Diethylamino) ethyl]phosphorothioic acid, *O*,*O*-diethyl ester; *O*,*O*-Diethyl *S*-2-diethylaminoethyl phosphorothioate; Diethyl *S*-2-diethylaminoethyl phosphorothioate; *O*,*O*-Diethyl *S*-(β-diethylamino) ethyl phosphorothiolate; *O*,*O*-Diethyl *S*-2-diethylaminoethyl phosphorothiolate; *O*,*O*-Diethyl *S*-diethylamino ethyl phosphorothiolate; *O*,*O*-Diethyl *S*-(2-diethylaminoethyl) thiophosphate; DSDP; Inferno; Metramac; Metramak; R-5,158; Rhodia-6200; Tetram; VG (military designation)

CAS Registry Number: 78-53-5

HSDB Number: 6379

RTECS Number: TF0525000

UN/NA & ERG Number: (PIH) UN3018 (organophosphorus pesticide, liquid, toxic)/152

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade); *Theft hazard* 2.2 ($\geq$30.00% concentration)

Hazard Alert: Poison inhalation hazard: exposure can be lethal, Neurotoxin (cumulative), Combustible, Agricultural chemical, drug.

CERCLA/SARA 40CFR302 Extremely Hazardous Substances: TPQ = 500 lb (227 kg)

CERCLA/SARA Section 304 RQ: 1 lb (0.454 kg)

Classified by EPA as a RUP

United States DOT 49CFR172.101, Inhalation Hazardous Chemical as organic phosphate, Substance ID: EDF-041

Hazard symbols, Risk & safety statements: Hazard symbol: T + ; risk phrases: R27/28; R33; R50/53; safety phrases: S1; S13; S28; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Amiton is a liquid organophosphate. Molecular weight = 269.38[72]; boiling point = 110°C @ 0.2 mmHg; vapor pressure = 0.01 mmHg @ 80°C. Hazard identification (based on NFPA-704 M Rating System): Health 4; flammability 2; reactivity 1. Soluble in water.

Potential Exposure: Amiton is used as an acaricide and an insecticide; exposure may occur in manufacture and in application and use. VG has been used as a military nerve agent.

Incompatibilities: Contact with strong oxidizers may cause release of toxic phosphorus oxides. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Organophosphates, in the presence of strong reducing agents such as hydrides, may form highly toxic and flammable phosphine gas. Keep away from alkaline materials.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 0.0099 milligram per cubic meter

PAC-2: 0.11 milligram per cubic meter

PAC-3: 0.65 milligram per cubic meter

Determination in Air: OSHA versatile sampler-2; Toluene/Acetone; GC/Flame photometric detection for sulfur, nitrogen, or phosphorus; NIOSH Analytical Method (IV) Method #5600, Organophosphorus Pesticides.

Routes of Entry: Inhalation, ingestion; skin, and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Danger-poisonous; can be fatal if swallowed, inhaled, or absorbed through the skin or eyes. This material is highly toxic orally. It is a cholinesterase inhibitor. The LD_{50} = (oral-rat) 5.4 mg/kg. The toxic effects are similar to parathion. Organic phosphorus insecticides are absorbed by the skin, as well as by the respiratory and GI tracts. They are cholinesterase inhibitors. Symptoms of exposure include headache, giddiness, blurred vision; nervousness, weakness, nausea, cramps, diarrhea, and discomfort in the chest. Signs include sweating, tearing, salivation, vomiting, cyanosis, convulsions, coma, loss of reflexes and loss of sphincter control.

Long-Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. this chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, CNS; cardiovascular system; skin, eyes, plasma, and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red-blood-cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider CBC. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to Physician: 1,1′-trimethylenebis(4-formylpyridinium bromide)dioxime (a.k.a TMB-4 dibromide and TMB-4) have been used as an antidote for organophosphate poisoning.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See entry on Parathion.

Respirator Selection: NIOSH: *(for Parathion) 0.5 milligram per cubic meter*: CcrOv95 (APF = 10) [any air-purifying half-mask respirator with organic vapor cartridge (s) in combination with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *1.25 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOvHie (APF = 25) (any air-purifying full facepiece respirator equipped with an organic vapor cartridge in combination with a high-efficiency particulate filter). *2.5 milligram per cubic meter*: CcrFOv100 (APF = 50) [any air-purifying full facepiece respirator equipped with organic vapor cartridge(s) in combination with an N100, R100, or P100 filter]; or SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTOvHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting facepiece and organic vapor cartridge(s) in combination with a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *10 milligram per cubic meter*: Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode. *Escape*: GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Where possible, automatically transfer material from other storage containers to process containers.

Shipping: UN3018 Organophosphorus pesticides, liquid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous material.

Spill Handling: *VG, when used as a weapon Note*: No Initial Isolation and Protective Action Distances have been assigned to amiton. This material is similar to parathion and may be considered a nerve agent.

Here, *for user reference*, is a sample of Initial Isolation and Protective Action Distances used for similar nerve agents:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (from a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.1/0.2

Large spills (from a large package or from many small packages)

First: Isolate in all directions (ft/m) 300/100
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.1/0.2

Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Stay upwind; keep out of low areas. Ventilate area of spill or leak. Remove and isolate contaminated clothing at the site. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: dike far ahead of spill for later disposal. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Fire Extinguishing: Amiton is a combustible liquid. Thermal decomposition products may include oxides of phosphorus, sulfur, nitrogen and carbon. Small fires: dry chemical, carbon dioxide; water spray; or foam. *Large* *fires*: water spray, fog, or foam. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Firefighting gear (including SCBA) may not provide adequate protection. If exposure occurs, remove and isolate gear immediately and thoroughly decontaminate personnel. Wear positive-pressure breathing apparatus and special protective clothing. Remove and isolate contaminated clothing at the site. Move container from fire area if you can do so without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Use a licensed professional waste disposal service to dispose of this material. All federal, state, and local environmental regulations must be observed. High-temperature incineration. Hydrolysis may also be used[22]. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical *Hazard Information Profile*: Amiton, Washington, DC, Chemical Emergency Preparedness Program (October 2002).

Amiton Oxalate A:0930

Formula: $C_{12}H_{26}NO_7PS$: $(C_2H_5O)_2POSCH_2CH_2N(C_2H_5)_2 \cdot HOOCCOOH$

Synonyms: Acid oxalate; Chipman 6199; Chipman R-6, 199; Citram; 2-(2-diethylamino)ethyl] *O*,*O*-diethyl ester, oxalate (1:1); *S*-(2-Diethylaminoethyl) *O*,*O*-diethyl phosphorothioate hydrogen oxalate; *O*,*O*-Diethyl *S*-(β-diethylamino)ethyl phosphorothioate hydrogen oxalate; *O*,*O*-Diethyl *S*-(2-diethylamino)ethyl phosphorothioate hydrogen oxalate; *O*,*O*-Diethyl *S*-(2-ethyl-*N*,*N*-diethylamino)ethyl phosphorothioate hydrogen oxalate; Hydrogen oxalate of amiton; Phosphorothioc acid; Tetram; Tetram monooxalate, *S*-

CAS Registry Number: 3734-97-2

HSDB Number: 6379, as amiton

RTECS Number: TF1400000

UN/NA & ERG Number: (PIH) UN2783 (organophosphorus pesticides, solid, toxic)/152

EC Number: 223-100-8

Regulatory Authority and Advisory Information

Hazard Alert: Poison inhalation hazard: exposure can be lethal, Neurotoxin (cumulative), Combustible, Highly toxic, Environmental hazard

CERCLA/SARA 40CFR302 Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg)

CERCLA/SARA Section 304 RQ: 1 lb (0.454 kg)

Classified by EPA as a RUP

United States DOT 49CFR172.101 Inhalation Hazardous Chemical, as organic phosphate, Substance ID: EDF-041.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbol: T+, N; risk phrases R24; R28; R33; R50/53; safety phrases: S1/2; S28; S29; S36/37; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Amiton oxalate is a crystalline solid. Molecular weight = 359.39; freezing/melting point = 98−99°C. Hazard identification (based on NFPA-704 M Rating System): Health 4; flammability 2; reactivity 1. Soluble in water.

Potential Exposure: A potential danger to those involved in manufacture and application of this insecticide.

Incompatibilities: Contact with strong oxidizers may cause release of toxic phosphorus oxides. Organophosphates, such as amiton oxalate, in the presence of strong reducing agents such as hydrides, may form highly toxic and flammable phosphine gas. Keep away from alkaline materials.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 0.009 milligram per cubic meter

PAC-2: 0.099 milligram per cubic meter

PAC-3: 0.59 milligram per cubic meter

Determination in Water: Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.

Routes of Entry: Inhalation, dermal contact, ingestion

Harmful Effects and Symptoms

Short-Term Exposure: Amiton oxalate is a cholinesterase inhibitor. Symptoms include headache, giddiness, nervousness, blurred vision; weakness, nausea, cramps, diarrhea, and discomfort in the chest. Signs include sweating, miosis, tearing, salivation and other excessive respiratory tract secretion; vomiting, cyanosis, uncontrollable muscle twitching followed by muscular weakness; convulsions, coma, loss of reflexes, and loss of muscular control. LD_{50} = (oral-rat) 3 mg/kg.

Points of Attack: See entry on “Parathion” as referred to under “Amiton.” Bear in mind that the oxalate is a solid whereas amiton is a high-boiling liquid.

Medical Surveillance: See entry on "Parathion" as referred to under "Amiton." Bear in mind that the oxalate is a solid whereas Amiton is a high-boiling liquid.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See entry on Parathion. Bear in mind that the oxalate is a solid whereas amiton is a high-boiling liquid.

Respirator Selection: NIOSH: (*for Parathion*) *0.5 milligram per cubic meter*: CcrOv95 (APF = 10) [any air-purifying half-mask respirator with organic vapor cartridge (s) in combination with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *1.25 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOvHie (APF = 25) (any air-purifying full facepiece respirator equipped with an organic vapor cartridge in combination with a high-efficiency particulate filter). *2.5 milligram per cubic meter*: CcrFOv100 (APF = 50) [any air-purifying full facepiece respirator equipped with organic vapor cartridge(s) in combination with an N100, R100, or P100 filter]; or SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTOvHie (APF = 50) [any powered, air-purifying respirator with a tight-fitting facepiece and organic vapor cartridge(s) in combination with a high-efficiency particulate filter]; or SCBAF (APF = 50) (any SCBA with full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *10 milligram per cubic meter* Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode. *Escape*: GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Check oxygen content prior to entering storage area. Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: UN2783 Organophosphorus pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling:

Initial isolation and protective action distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (from a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.3/0.4
Night 0.8/1.2

Large spills (from a large package or from many small packages)

First: Isolate in all directions (ft/m) 600/200
Then: Protect persons downwind (mi/km)
Day 1.4/2.3
Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Do not touch spilled material. Do not breathe vapors. Stay upwind; keep out of low areas. Remove all ignition sources. Ventilate area of spill or leak. This material is a combustible liquid. For a spill or leak of a combustible liquid, shut off ignition sources; no flares, smoking or flames in hazard area. Stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of phosphorus, nitrogen and carbon. *Small fires*: dry chemical, carbon dioxide; water spray; or foam. *Large fires*: water spray, fog, or foam. Stay upwind; keep out of low areas. Firefighting gear (including SCBA) may not provide adequate protection. If exposure occurs, remove and isolate gear immediately and thoroughly decontaminate personnel. Wear positive-pressure breathing apparatus and special protective clothing. Remove and isolate contaminated clothing at the site. Move container from fire area if you can do so without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Amiton Oxalate, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

Amitraz A:0940

Formula: $C_{19}H_{23}N_3$

Synonyms: A13-27967; Acarac; Amitraz estrella; BAAM; *N*,*N*-Bis(2,4-xylyliminomethyl)methylamine; Boots BTS 27419; BTS 27,419; 1,5-Di-(2,4-dimethylphenyl)-3-methyl-1,3,5-triazapenta-1,4-diene; *N*′-(2,4-Dimethylphenyl)-*N*-([(2,4-dimethylphenyl)imino]methyl)-*N*-methylmethanimidamide; *N*′-(2,4-Dimethylphenyl)-3-methyl-1,3,5-triazapenta-1,4-diene; *N*,*N*-Di-(2,4-xylyliminomethyl)methyl amine; ENT 27967; EPA pesticide chemical code 106201; Formamidine, *N*-Methyl-*N*′-2,4-xylyl-N-(N-2,4-xylylformimidoyl)-; *N*-Methylbis(2,4-xylyliminomethyl) amine; 2Methyl-1,3-di(2,4-xylylimino)-2-azapropane; *N*,*N*′-[(Methylimino)dimethylidyne]bis(2,4-xylidine); *N*,*N*′-[(Methylimino)dimethylidyne] D-2,4-xylidine; Mitac; NSC 324552; R.D. 27419; Taktic; Triatox; Upjohn U-36059; 2,4-Xylidine, *N*,*N*′-(methyliminodimethylidyne)bis-

CAS Registry Number: 33089-61-1

HSDB Number: 6939

RTECS Number: ZF0480000

UN/NA & ERG Number: UN2763 (triazine pesticides, solid toxic)/151

EC Number: 251-375-4 [*Annex I Index No.*: 612-086-00-2]

Regulatory Authority and Advisory Information

Carcinogenicity: EPA, Class C, possible human carcinogen. California Proposition 65 (pending) suspected carcinogen[13]; Developmental/Reproductive toxin 3/3/1999.

Hazard Alert: Poison, Reproductive toxin: Suspected of causing genetic defects, Environmental hazard, Sensitization hazard, Agricultural chemical.

CERCLA/SARA 40CFR372.65: Form R *de minimis* Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, Risk & safety statements: Hazard symbol: Xn, N, Xi; risk phrases: R40; R22; R43; R48/22; R50/53; R62; safety phrases: S2; S22; S24; S29; S36/37; S41; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Amitraz forms colorless needle-like crystals. Liquid formulations may contain flammable organic solvents. Molecular weight = 293.45; freezing/melting point = 86−87°C; vapor pressure = 2.6×10^{-6} mmHg. Insoluble in water.

Potential Exposure: Those engaged in the manufacture, formulation and application of this insecticide and acaricide. A rebuttable presumption against registration for amitraz was issued on April 6, 1977 by United States Environmental Protection Agency on the basis of oncogenicity.

Incompatibilities: Keep away from strong oxidizers and strong acids. Acids may render this material unstable.

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Permissible Concentration in Water: Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment. Fish toxicity: 2.00272 ppb, MATC (Maximum Acceptable Toxicant Concentration) (HIGH)

Harmful Effects and Symptoms

Amitraz metabolizes to 2,4-dimethylaniline which is a potential human carcinogen. A mouse oncogenic bioassay was conducted by Boots Chemical Company and reported by EPA; the results of that study have been disputed. Acute oral LD_{50} for rats is 800 mg/kg; for mice is greater than 1600 mg/kg.

Short-Term Exposure: Poisonous if ingested or absorbed through the skin. Eye or skin contact can cause irritation. May affect the CNS causing dizziness and a lowering of consciousness. May cause skin sensitization and possible allergic reaction.

Long-Term Exposure: Possible skin allergy. May affect the liver and CNS. Human toxicity (long-term):1.75 ppb, Health advisory: (HIGH)

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. If skin or lung sensitization is suspected, consider evaluation by a qualified allergist, including exposure history and testing, may help diagnose allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved SCBA that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full-face-piece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA)

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area, away from fertilizers, seed, and other pesticides, flammable materials and sources of heat and flame. Do not reuse containers.

Shipping: UN2763 Triazine pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. ***Spill Handling:*** Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Remove and isolate contaminated clothing at the site. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: dike far ahead of spill for later disposal. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line). Soil Adsorption Index (K_{oc}) = 1000 Estimate.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen and carbon. *Small fires*: dry chemical, carbon dioxide; water spray; or foam. *Large fires*: water spray, fog, or foam. Stay upwind; keep out of low areas. Firefighting gear (including SCBA) may not provide adequate protection. If exposure occurs, remove and isolate gear immediately and thoroughly decontaminate personnel. Wear positive-pressure breathing apparatus and special protective clothing. Remove and isolate contaminated clothing at the site. Move container from fire area if you can do so without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR 165 recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (101); (138); (201); (100).

United States Environmental Protection Agency, Rebuttable Presumption Against Registration (RPAR) of Pesticide Products Containing Amitraz, Washington, DC (April 6, 1977).

Ammonia A:0950

Formula: NH_3

Synonyms: Am-Fol; Ammonia, anhydrous; Ammoniac (French); Ammonia gas; Ammoniale (German); Ammonium amide; Ammonium hydroxide; Amoniaco (Spanish); Amoniaco anhidro (Spanish); Anhydrous ammonia; Aqua ammonia; Daxad-32S; Liquid ammonia; Pro 330 clear thin spread; R717; Spirit of hartshorn; STCC 4904210

CAS Registry Number: 7664-41-7

HSDB Number: 162

RTECS Number: BO0875000

UN/NA & ERG Number: (PIH) UN/NA1005 (anhydrous) and UN3318 (Ammonia solution, relative density < 0.880 @ 15°C in water, with >50% ammonia)/125; UN2073 (35%−50% solutions)/125; UN2672 (10 to 35% solutions)/154

EC Number: 231-635-3 [*Annex I Index No.*: 007-001-00-5]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration). (anhydrous); 20,000 (≥20.00% concentration).

United States Environmental Protection Agency Gene-Tox Program, Inconclusive: *D. melanogaster* sex-linked lethal.

Hazard Alert: Poison inhalation hazard, Flammable gas/combustible liquid, Possible risk of forming tumors, Suspected of causing genetic defects, Environmental hazard (specified list), FDA-over the counter drug; *gas*: Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated.

OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 10,000 lb (4540 kg) (anhydrous); TQ = 15,000 lb (6815 kg) (solution >44% NH_3)

Clean Air Act 42USC7412; Title I, Part A, §112(r), accidental Release Prevention/Flammable Substances (Section 68.130); (anhydrous) TQ = 10,000 lb (4540 kg) (anhydrous); (concentrations ≥20% NH3) TQ = 20,000 lb (9150 kg)

Clean Water Act: 40CFR116.4 Hazardous Substances; RQ 40CFR117.3 (same as CERCLA); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992).

CERCLA/SARA 40CFR302, Extremely Hazardous Substances: TPQ = 500 lb (228 kg).

Superfund/EPCRA 40CFR302.4, Appendix A, RQ: 100 lb (45.4 kg), 40CFR372.65: Form R *de minimis* Concentration Reporting Level: 1.0%; includes anhydrous ammonia and aqueous ammonia from water dissociable ammonium salts and other sources; 10% of total aqueous ammonia, and 100% of anhydrous forms of ammonia is reportable under this listing. If a facility manufactures, processes, or otherwise uses anhydrous ammonia or aqueous ammonia, they must report under the ammonia listing. Solutions containing aqueous ammonia at a concentration in excess of 1% of the 10% reportable under this listing should be factored into threshold and release determinations.

United States DOT 49CFR172.10; Poisonous by inhalation substances (anhydrous UN1005)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%; NPRI.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B). Ammonia, anhydrous (I); ammonia solution, relative density < 0.880 @ 15°C in H_2O, with > 50% ammonia; ammonia Solution relative density < 0.880 @ 15°C in H_2O, with > 35% but not >50% ammonia; ammonia solution, relative density between 0.880 and 0.957 @ 15°C in H_2O, with > 10% but not >35% ammonia, by mass.

Hazard symbols, Risk & safety statements: Hazard symbol: T, N; risk phrases: R12 (gas); r21 (gas); R23; R34; R50; R62; safety phrases: S1/2; S9; S16; S26; S36/37/39; S41; S45; S61; R62 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to waters (anhydrous)

Description: Ammonia is a colorless, strongly alkaline, and extremely soluble gas with a pungent, suffocating odor. Molecular weight = 17.03. Specific gravity (H_2O:1) = 0.70; boiling point = −33.35°C; freezing/melting point = −77.7°C; vapor pressure = 760 mmHg @ −33.6°C; 2070 kPa @ 50°C; flash point = (flammable gas); autoignition temperature = 630°C. Explosive limits: LEL: 13%; UEL: 28%. Hazard identification (based on NFPA-704 M Rating System) (solutions >10% but NOT >50% NH_3): Health 3; flammability 1; reactivity 0. Anhydrous ammonia is a colorless, highly irritating gas at room temperature with a pungent, suffocating odor. Ammonia gas is lighter than air; hugs the ground when cool; and flammable at high concentrations and temperatures. Easily compressed, it forms a clear, colorless liquid under pressure. Floats and “boils” on water. Readily dissolves in water, forming ammonium hydroxide, an alkaline, corrosive solution. Poisonous, visible vapor cloud is produced.

Potential Exposure: Ammonia is used as a nitrogen source for many nitrogen-containing compounds. It is used in the production of ammonium sulfate and ammonium nitrate for fertilizers; and in the manufacture of nitric acid, soda; synthetic urea, synthetic fibers; dyes; and plastics. It is also utilized as a refrigerant and in the petroleum refining and chemical industries. It is used in the production of many drugs and pesticides. Other sources of occupational exposure include the silvering of mirrors, gluemaking, tanning of leather; and around nitriding furnaces. Ammonia is produced as a by-product in coal distillation and by the action of steam on calcium cyanamide, and from the decomposition of nitrogenous materials.

Incompatibilities: Violent reaction with strong oxidizers and acids. Shock-sensitive compounds may be formed with gold, halogens, mercury, mercury oxide, and silver oxide. Fire and explosions may be caused by trimethylammonium amide, 1-chloro-2,4-dinitrobenzene, *o*-chloronitrobenzene, platinum, trioxygen difluoride, selenium difluoride dioxide, boron halides, mercury, chlorine, iodine, bromine, hypochlorites, chlorine bleach, amides, organic anhydrides; isocyanates, vinyl acetate; alkylene oxides; epichlorohydrin, and aldehydes. Attacks some coatings, plastics, rubber, copper, brass, bronze, aluminum, steel, tin, zinc, and their alloys.

Permissible Exposure Limits in Air

NIOSH IDLH = 300 ppm

Odor threshold = 5.75 ppm

OSHA PEL: 50 ppm/35 milligram per cubic meter TWA

NIOSH REL: 25 ppm/18 milligram per cubic meter TWA; 35 ppm/27 milligram per cubic meter STEL

ACGIH TLV[1]: 25 ppm/17 milligram per cubic meter TWA; 35 ppm/24 milligram per cubic meter STEL

PAC ammonia* Ver. 29[138]

PAC-1: $\mathbf{30_A}$ ppm

PAC-2: $\mathbf{160_A}$ ppm

PAC-3: $\mathbf{1100_A}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

DFG MAK: MAK: 20 ppm/14 milligram per cubic meter; Peak Limitation Category I(2); Pregnancy Risk Group: C (2006).

Arab Republic of Egypt: TWA 25 ppm (18 milligram per cubic meter), 1993; Australia: TWA 25 ppm (18 milligram per cubic meter); STEL 35 ppm, 1993; Austria: MAK 25 ppm (18 milligram per cubic meter), 1999; Belgium: TWA 25 ppm (17 milligram per cubic meter); STEL 35 ppm (24 milligram per cubic meter), 1993; Denmark: TWA 25 ppm (18 milligram per cubic meter), 1999; Finland: TWA 25 ppm (18 milligram per cubic meter); STEL 40 ppm (30 milligram per cubic meter), 1993; France: VME 25 ppm (18 milligram per cubic meter), VLE 50 ppm (36 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 14 milligram per cubic meter, 2003; India: TWA 25 ppm (18 milligram per cubic meter); STEL 35 ppm (27 milligram per cubic meter), 1993; Japan: 25 ppm (17 milligram per cubic meter), 1999; Norway: TWA 25 ppm (18 milligram per cubic meter), 1999; the Philippines: TWA 50 ppm (30 milligram per cubic meter), 1993; Poland: MAC (TWA) 20 milligram per cubic meter; MAC (STEL) 27 milligram per cubic meter, 1999; Russia: TWA 25 ppm; STEL 20 milligram per cubic meter, 1993; Sweden: NGV 25 ppm (18 milligram per cubic meter), TGV 50 ppm (35 milligram per cubic meter), 1999; Switzerland: MAK-W 25 ppm (18 milligram per cubic meter), KZG-W 50 ppm (36 milligram per cubic meter), 1999; Thailand: TWA 50 ppm (35 milligram per cubic meter), 1993; Turkey: TWA 25 ppm (35 milligram per cubic meter), 1993; United Kingdom: TWA 25 ppm (18 milligram per cubic meter); STEL 35 ppm (25 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 35 ppm. Several states have set airborne guidelines or standards for ammonia in ambient air[60]: 25 ppm (18 milligram per cubic meter) TWA and STEL of 35 ppm (27 milligram per cubic meter) (California), 0.024 milligram per cubic meter (Massachusetts), 0.042857 milligram per cubic meter (Kansas), 0.18−0.27 milligram per cubic meter (North Dakota), 0.25 milligram per cubic meter (Virginia), 0.36 milligram per cubic meter (Connecticut, Florida, New York, South Dakota), 0.429 milligram per cubic meter (Nevada, Wyoming), 2.7 milligram per cubic meter (North Carolina).

Determination in Air: Use NIOSH Analytical Method #6015, and #6016, OSHA Analytical Method ID-164; ID-188.

Permissible Concentration in Water: Russia[43] set a MAC of 2.0 mg/mL in water bodies used for domestic purposes and 0.05 mg/mL in water bodies used for fishery purposes.

Routes of Entry: Inhalation, ingestion; skin and eye contact.

Harmful Effects and Symptoms

LC_{50} (inh/4 hours, mice) = 2115 ppm

Short-Term Exposure: Eye or skin contact with ammonia can cause irritation, burns, frostbite (anhydrous), and permanent damage. Irritates the respiratory tract causing coughing, wheezing and shortness of breath. Higher exposure can cause pulmonary edema, a medical emergency, that can be delayed for several hours and is life threatening. Exposure can cause headache, loss of sense of smell; nausea, and vomiting. *Inhalation*: Nose and throat irritation have been reported @ 72 ppm after 5 minutes exposure. Exposures of 500 ppm for 30 minutes have caused upper respiratory irritation, tearing, increased pulse rate and blood pressure. Death has been reported after an exposure to 10,000 ppm for an unknown duration. *Skin*: Solutions of 2% ammonia can cause burns and blisters after 15 minutes of exposure. These burns may be slow to heal. Anhydrous ammonia may cause skin to freeze. *Eyes*: Levels of 70 ppm (gas) have caused eye irritation. If not flushed with water immediately contact with eye may cause partial or complete blindness. *Ingestion*: Ammonia will cause pain if swallowed and burning of the throat and stomach. May cause vomiting. One teaspoon of 28% aqua ammonia may cause death.

Long-Term Exposure: Repeated exposure can cause chronic eye, nose, and throat irritation. Repeated lung irritation can result in bronchitis with coughing, shortness of breath; and phlegm. Levels of 170 ppm of ammonia vapor has caused mild changes in the spleens, kidneys and livers of guinea pigs.

Points of Attack: Skin, respiratory system; eyes.

Medical Surveillance: Preemployment physical examinations for workers in ammonia exposure areas should be directed toward significant changes in the skin, eyes, and respiratory system. Persons with corneal disease, glaucoma, or chronic respiratory diseases may suffer increased risk. Periodic examinations should include evaluation of skin, eyes, respiratory system; and pulmonary function test to compare with baselines established at preemployment examination. Consider chest X-ray following acute exposure.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Prevent skin contact. **8 hours** (More than 8 hours of resistance to breakthrough $>0.1\ \mu m > g/cm^2/min$): butyl rubber gloves, suits, boots; Teflon gloves, suits, boots; Viton gloves, suits; Responder suits, Trellchem HPS suits; Trychem 1000 suits; **4 hours** (At least 4 but $<$ 8 hours of resistance to breakthrough $>0.1\ \mu m > g/cm^2/min$): nitrile rubber gloves, suits, boots Appropriate clothing should be worn to prevent any possible skin contact with liquids of $>10\%$ content or reasonable probability of contact with liquids of $<10\%$ content. Wear eye protection to prevent any potential for eye contact with liquids of $>10\%$ NH_3 content. Employees should wash immediately when skin is wet or contaminated with liquids of $>10\%$ content. Remove nonimpervious clothing immediately if wet or contaminated with liquids containing $>10\%$ and promptly remove if liquid contains $<10\%$ NH_3 are involved. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas- or splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *250 ppm*: CcrS* (APF = 10) (any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern); or Sa* (APF = 10) (any supplied-air respirator). *300 ppm*: Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprS* (APF = 25) (any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern); or CcrFS (APF = 50) [any chemical cartridge respirator with a full facepiece and cartridge(s) providing protection against the compound of concern]; or GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern]; or SCBAE (any appropriate escape-type, SCBA).

*Note**: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: PIH; check oxygen content prior to entering storage area. UN/NA1005 Nonflammable compressed gas, Poisonous gas, Corrosive material: (1) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. (2) Color code—White stripe (*strong solution >27% <31%*): Contact Hazard; not compatible with materials in solid white category. This gas is toxic and/or corrosive, nonflammable. Outside or detached storage is preferred in an area that is roofed, shaded with the cylinders stored off the ground on nonwooden floors, and away from radiant heat sources and all possible sources of ignition. If indoors or outdoors, store in a well-ventilated noncombustible location temperatures not to exceed 50°C. Automatic monitoring systems are also preferred. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Protect against physical damage. Separate from other chemicals, particularly oxidizing gases, chlorine, bromine, iodine, and acids.

Shipping: Shipped in tank cars, tank trucks, barges, and steel cylinders. Labeling and restrictions vary with concentration: NA1005 Ammonia, anhydrous, Hazard Class: 2.2; Labels: 2.2-Nonflammable compressed gas, Domestic (U.S.), Inhalation Hazard (Special Provision 13). UN1005 Ammonia, anhydrous, Hazard Class: 2.3; Labels: 2.3-Poison Gas, 8-Corrosive material International, Inhalation Hazard Zone D. UN2672* Ammonia solutions, relative density between 0.880 and 0.957 @ 15°C in water, with >10 % but NOT > 35 % ammonia, Hazard class: 8; Labels: 8-Corrosive material. UN2073 Ammonia solution, relative density less than 0.880 @ 15°C in water, with > 35% but NOT > 50% ammonia, Hazard Class: 2.2; Labels: 2.2-Nonflammable compressed gas. **Note*: Also used for Ammonium hydroxide, CAS1336-21-6, Record A:0110.

Spill Handling:

Ammonia, anhydrous

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

UN1017 Chlorine

*Small spills (from a small package or a small leak from a large package)**

First: Isolate in all directions (ft/m) 100/30

Then: Protect persons downwind (mi/km)

Day 0.1/0.2

Night 0.1/0.2

*Large spills (from a large package or from many small packages)**

First: Isolate in all directions (ft/m) 500/150

Then: Protect persons downwind (mi/km)

Day 0.5/0.8

Night 1.3/2.0

***Attention**: If dealing with a large spill from the following containers: (1) Rail tank car, (2) Highway tank truck or trailer, (3) Multiple ton cylinders or (4) Multiple small cylinders or single ton cylinder see the following: "ERG Table 3: Initial Isolation and Protective Action Distances for Different Quantities of Six Common Toxic-by-Inhalation Gases." This chart shows isolation protective distances for the transport containers listed above (numbers 1 through 4) and various wind conditions: Low wind (<6 mph); Moderate wind (6 to 12 mph); High wind (> 12 mph)

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Ventilate area of spill or leak. Stop the flow of gas it can be done safely. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Wear positive-pressure breathing apparatus and full protective clothing. If the leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, and repair the leak or allow the cylinder to empty. For small liquid spills, neutralize with hydrochloric acid. Wipe or mop or use water aspirator. Drain into sewer with sufficient water. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Firefighting gear (including SCBA) does not provide adequate protection. Thermal decomposition products may include oxides of nitrogen. This gas is under pressure; containers may rupture and explode when heated. If exposure occurs, remove and isolate gear immediately and thoroughly decontaminate personnel. Move container from fire area if you can do it without risk. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flash back. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. *Do not put water on liquid ammonia; will increase evaporation. Small fires*: dry chemical or carbon dioxide. *Large fires*: water spray, fog or foam. Apply water gently to the surface. Do not get water inside container. From a secure explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors or shows any signs of deforming), withdraw immediately to a secure position. Isolate area until gas has dispersed.

Disposal Method Suggested: Dilute with water, neutralize with HCl and discharge to sewer. Recovery is an option to disposal which should be considered for paper manufacture, textile treating, fertilizer manufacture and chemical process wastes.

References

(31); (173); (101); (138); (2); (201); (100).

National Institute for Occupational Safety and Health (NIOSH), "Criteria for a Recommended Standard: Occupational Exposure to Ammonia", NIOSH Document Number 74-136, Cincinnati, OH (1974).

United States Environmental Protection Agency, "Toxic Pollutant List: Proposal to Add Ammonia," Federal Register, 45, No. 2, 803−806 (January 3, 1980) Rescinded by Federal Register, 45, No. 232, 79692-79693 (December 1, 1980).

National Research Council, Committee on Medical and Biologic Effects of Environmental Pollutants, ammonia, Baltimore, MD, University Park Press (1979).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report* 2, No. 1, 65–68 (1982) and 3, No. 3, 49–53, (1983).

United States Environmental Properties Agency, Chemical Hazard Information Profile: Ammonia, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

New York State Department of Health, Chemical Fact Sheet: Ammonia, Bureau of Toxic Substance Assessment, Albany, NY (January 1986).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Ammonia, Trenton, NJ (June 1998).

Ammonium Acetate A:0960

Formula: $C_2H_7NO_2$: CH_3COONH_4
Synonyms: Acetic acid, ammonium salt
CAS Registry Number: 631-61-8
HSDB Number: 556
RTECS Number: AF3675000
UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171
EC Number: 211-162-9

Regulatory Authority and Advisory Information

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)

Superfund/EPCRA 40CFR302.4, Appendix A, RQ: 5000 lb (2270 kg), 40CFR372.65: Form R *de minimis* Concentration Reporting Level: 1.0%. Source of aqueous ammonia. NH_3 equivalent weight 22.09.

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Ammonium acetate is a white crystalline solid. Acetic odor. Molecular weight = 77.08; specific gravity (H_2O:1) = 1.17 @ 20°C; boiling point = decomposes; freezing/melting point = 114°C. Heat of solution = -0.13×10^5 J/kg; Soluble in water.

Potential Exposure: Ammonium acetate is used as a chemical reagent, to make drugs; foam rubber; vinyl plastics; explosives, and to preserve foods. An environmental threat.

Incompatibilities: Combustible solid. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, sodium hypochlorite, potassium chlorate, sodium nitrite.

Permissible Exposure Limits in Air

PAC Ver. 29[138]
PAC-1: 3.8 milligram per cubic meter
PAC-2: 42 milligram per cubic meter
PAC-3: 250 milligram per cubic meter

Harmful Effects and Symptoms

Short-Term Exposure: Can irritate the eyes, skin and respiratory tract. Eye contact can cause burns and permanent damage. Inhalation can irritate the nose, throat, and lungs; high levels can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: Repeated exposures can cause lung irritation and the development of bronchitis with coughing, shortness of breath and phlegm.

Points of Attack: Respiratory system, eyes, skin.

Medical Surveillance: Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Lung function tests. Consider chest X-ray following acute exposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Wash thoroughly immediately after exposure to Ammonium Acetate.

Respirator Selection: Where there is the potential for exposure to ammonium acetate: SCBAF:Pd,Pp (APF =

10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Green: General storage may be used. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from sodium hypochlorite, potassium chlorate and sodium nitrite, since violent reactions occur.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Ammonium Acetate may burn, but does not readily ignite. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. Thermal decomposition products may include ammonia, oxides of nitrogen and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (101)(100).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report* 2, No. 3, 30–31 (1982).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: *Ammonium Acetate*, Trenton, NJ (April 2002).

Ammonium Arsenate A:0970

Formula: $AsH_3O_4 \cdot 2H_3N$

Synonyms: Ammonium acid arsenate; Arsenic acid, diammonium salt; Diammonium arsenate; Diammonium monohydrogen arsenate; Dibasic ammonium arsenate

CAS Registry Number: 7784-44-3

RTECS Number: CG0850000

UN/NA & ERG Number: UN1546/151

EC Number: 232-067-9

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen: Arsenic and inorganic arsenic compounds; IARC: Human Sufficient Evidence, 1980; Animal Limited Evidence, *carcinogenic to humans*, Group 1, 1987.

California Proposition 65 Chemical[102]: Cancer 2/27/1987

Hazard Alert: Poison, Environmental hazard

Clean Air Act, 42USC7412; Title I, Part A, §112 Hazardous Pollutants (arsenic compounds)

OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 100 lb (45 kg)

United States National Primary Drinking Water Regulations: MCLG = 0 mg[As]/L; MCL = 0.010 mg[As]/L as Arsenic.

Clean Water Act Section 307 Toxic Pollutants, 40CFR401.15 (effluent limitations); as arsenic and compounds

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, D004 (arsenic compounds)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg) (arsenic compounds)

EPCRA Section 313: Form R *de minimis* concentration reporting level: 0.1% (inorganic arsenic compounds); Form R *de minimis* concentration reporting level: 1.0%. Source of aqueous ammonia. NH_3 equivalent weight 19.35

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) arsenic compounds

Canada: Priority Substance List & Restricted Substances/Ocean Dumping FORBIDDEN (CEPA), NPRI (arsenic compounds)

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R45; R23/25; R50/53; safety phrases: S29; S53; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Ammonium arsenate a combustible, white powder or plate-like colorless crystal. Molecular weight = 176.03; freezing/melting point = (decomposes). Soluble in water.

Incompatibilities: Hydrogen gas forms highly toxic arsine gas on contact with inorganic arsenic.

Permissible Exposure Limits in Air
NIOSH IDLH = 5 mg[As]/m^3
OSHA PEL: 0.010 mg[As]/m^3 TWA; cancer hazard that can be inhaled
NIOSH REL: 0.002 mg[As]/m^3 15 min. Ceiling Concentration. Limit exposure to lowest feasible level.
ACGIH TLV[1]: 0.01 mg[As]/m^3 TWA; Confirmed Human Carcinogen
No PAC available.
DFG TRK: 0.10 mg[As]/m^3; BAT: 1.30 μg[As]/L in urine/end-of-shift; Carcinogen Category 1
Arab Republic of Egypt: TWA 0.2 milligram per cubic meter, 1993; Australia: TWA 0.05 milligram per cubic meter, carcinogen, 1993; Belgium: TWA 0.2 milligram per cubic meter, 1993; Denmark: TWA 0.05 milligram per cubic meter, 1999; Finland: carcinogen, 1993; France: VME 0.2 milligram per cubic meter, 1993; Hungary: STEL 0.5 milligram per cubic meter, carcinogen, 1993; India: TWA 0.2 milligram per cubic meter, 1993; Norway: TWA 0.02 milligram per cubic meter, 1999; the Philippines: TWA 0.5 milligram per cubic meter, 1993; Poland: MAC (TWA) 0.01 milligram per cubic meter, 1999; Sweden: NGV 0.03 milligram per cubic meter, carcinogen, 1999; Switzerland: TWA 0.1 milligram per cubic meter, carcinogen, 1999; Thailand: TWA 0.5 milligram per cubic meter, 1993; Turkey: TWA 0.5 mg(As)/m^3, 1993; Turkey: TWA 0.5 milligram per cubic meter, 1993; United Kingdom: TWA 0.1 milligram per cubic meter, carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH: TLV: Confirmed Human Carcinogen

Determination in Air: NIOSH Analytical Methods (inorganic arsenic): #7300, #7301,#7303, #7900, #9102; OSHA Analytical Methods ID-105. The American Conference of Government Industrial Hygienists (ACGIH) Method 803 measures total particulate arsenic in air.

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 10 μg[As]/L; State Drinking Water Guidelines: Arizona 10 μg[As]/L; Connecticut 10 μg[As]/L EPA Maximum Contaminant Level (MCL): 0.010 mg[As]/L[40 CFR 141.62]. Canadian Drinking Water Standards: IMAC 0.025 [As] mg/L.

Determination in Water: *For arsenic*: The atomic absorption graphite furnace technique is often used for measurement of total arsenic in water. It also has been standardized by EPA. Total arsenic may be determined by digestion followed by silver diethyldithiocarbamate; an alternative is atomic absorption; another is ICP optical emission spectrometry. See OSHA Method #ID-105 for arsenic[58]

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Skin contact can contribute to overall exposure. Irritates eyes, skin and respiratory tract. Eye contact may cause burns and permanent damage. Inhalation may irritate the nose and throat causing coughing and wheezing. Repeated exposures may cause an ulcer or hole in the cartilage dividing the inner nose and poor appetite; a metallic or garlic taste; nausea, vomiting, stomach pain and diarrhea.

Long-Term Exposure: Arsenic can cause skin damage or problems with circulatory systems, and may have increased risk of cancer. Skin damage or problems with circulatory systems, and may have increased risk of cancer. May cause liver damage. Prolonged or repeated exposure may cause disturbed sleep; with a feeling of “pins and needles” and loss of coordination. While ammonium arsenate has not been identified as a carcinogen, arsenic, and certain arsenic compounds have been determined to be carcinogens. This chemical should be handled with extreme care.

Points of Attack: Liver, CNS; eyes, skin.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Liver function, nervous system; and skin tests. Urine tests for arsenic.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: For severe poisoning BAL (British Anti-Lewisite), Dimercaprol, dithiopropanol ($C_3H_8OS_2$) has been used to treat toxic symptoms of certain heavy metals poisoning—including arsenic. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Eye protection is included in the recommended respiratory protection. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Specific engineering controls are required under OSHA 1910.1018, *Inorganic Arsenic*. See also NIOSH Criteria Document #75-149, *Inorganic Arsenic*.

Respirator Selection: *At any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved SCBA that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full-face-piece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Requirements for Respiratory Protection for Inorganic Arsenic Particulate Except for Those With Significant Vapor Pressure: $<$ or $= 100\ \mu g/m^3$ (micrograms per cubic meter) (1) Half-mask air-purifying respirator equipped with high-efficiency filter*; or (2) Any half-mask supplied air respirator. $<$ or $= 500\ \mu g/m^3$ (1) Full facepiece air-purifying respirator equipped with high-efficiency filter*; (2) Any full-facepiece supplied-air respirator; or (3) Any full-facepiece SCBA. $<$ or $= 10{,}000\ \mu g/m^3$ (1) Powered air-purifying respirators in all inlet face coverings with high-efficiency filters*; or (2) Half-mask supplied-air respirators operated in positive-pressure mode. $<$ or $= 20{,}000\ \mu g/m^3$ Supplied-air respirator with full facepiece, hood, or helmet or suit, operated in positive-pressure mode. $> 20{,}000\ \mu g/m^3$, unknown concentrations, or firefighting Any full-facepiece SCBA operated in positive-pressure mode.

* A high-efficiency filter means a filter that is at least 99.97% efficient against mono-dispersed particles of 0.3 μm (micrometers) in diameter or higher.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. A regulated, marked area should be established where ammonium arsenate is handled, used, or stored. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: UN1546 Ammonium arsenate, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Remove and isolate contaminated clothing at the site. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: dike far ahead of spill for later disposal. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Ammonium arsenate is combustible solid. Thermal decomposition products may include arsenic, ammonia, and oxides of nitrogen. Use dry chemical, carbon dioxide; water spray; or foam. Firefighting gear (including SCBA) may not provide adequate protection. If exposure occurs, remove and isolate gear immediately and thoroughly decontaminate personnel. Wear positive-pressure breathing apparatus and special protective clothing. Remove and isolate contaminated clothing at the site. Move container from fire area if you can do so without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥ 100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(109); (102); (31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Ammonium Arsenate, Trenton, NJ (December 1998).

Ammonium Bicarbonate A:0980

Formula: CH_5NO_3; NH_4HCO_3

Synonyms: ABC-Trieb; Acid ammonium carbonate; Acid ammonium carbonate, monoammonium salt; Ammonium hydrogen carbonate; Bicarbonate d'ammonium (French); Bicarbonato amonico (Spanish); Bicarbonato de amonio (Spanish); Carbonic acid, monoammonium salt; Monoammonium carbonate

CAS Registry Number: 1066-33-7

HSDB Number: 491
RTECS Number: BO0860000
UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171
EC Number: 213-911-5
Regulatory Authority and Advisory Information
Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)
Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 5000 lb (2270 kg).
WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.
Description: Ammonium bicarbonate is a white crystalline solid with a faint ammonia odor. Molecular weight 79.07; specific gravity (H_2O:1) = 1.06; boiling point = decomposes; freezing/melting point = 107.5°C (if heated very rapidly; decomposition may start @ 35−60°C); heat of solution = 3.3 × 105 J/kg. Soluble in water; solubility = 17.4% @ 20°C.
Potential Exposure: It is used in leavening for some baked goods; in baking powders and fire extinguishers; to make dyes and pigments; in the manufacture of porous plastics; and as an expectorant.
Incompatibilities: Contact with strong caustics, such as potassium hydroxide or sodium hydroxide will cause the release of ammonia gas. Decomposes as temperature rises $> 35°C$.
Permissible Exposure Limits in Air
PAC Ver. 29[138]
PAC-1: 4.7 milligram per cubic meter
PAC-2: 52 milligram per cubic meter
PAC-3: 310 milligram per cubic meter
Harmful Effects and Symptoms
The dust can irritate skin, eyes and mucous membranes. Higher concentrations can cause temporary blindness, pulmonary edema and cyanosis. It can severely injure respiratory membranes with possible fatal results.
Short-Term Exposure: Irritates the eyes, skin and respiratory tract.
Long-Term Exposure: Prolonged or repeated exposure may cause lung damage.
Points of Attack: Lungs, skin, eyes.
Medical Surveillance: Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Lung function tests. Consider chest X-ray following acute exposure.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.
Personal Protective Methods: Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).
Storage: Color code—Green: General storage may be used. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from caustics (such as sodium hydroxide or potassium hydroxide), because ammonia gas is released.
Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.
Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or

federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Ammonium bicarbonate may burn, but does not readily ignite. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include ammonia gas and nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: May be buried in a chemical waste landfill. If neutralized ammonium bicarbonate is amenable to treatment at a municipal sewage treatment plant.

References

(31); (173); (101); (138); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 4, No. 2, 43−45 (1984).

New Jersey Department of Health and Senior Services, Hazardous Substances Fact Sheet: Ammonium Bicarbonate, Trenton, NJ (March 2001).

Ammonium Bifluoride A:0990

Formula: F_2H_5N; NH_4HF_2, $NH_3 \cdot H_2F_2$

Synonyms: Acid ammonium fluoride; Ammonium acid fluoride; Ammonium hydrogen difluoride; Ammonium bifluoride; Ammonium difluoride; Ammonium fluoride compound with hydrogen fluoride (1:1); Ammonium fluoride hydrofluoride; Ammonium hydrofluoride; Ammonium hydrogen bifluoride; Ammonium monohydrogen difluoride; Ammonium hydrogen fluoride; Bifluorure d'ammonium, solide (French); Bifluoruro amonico (Spanish);Bifluoruro de amonio, sólido (Spanish); Ddifluoruro ácido de amonio, sólido (Spanish); Flammon; fluorure acide d'ammonium, solide (French); Fluoruro ácido de amonio, sólido (Spanish); Hydrogénodifluorure d'ammonium, solide (French)

CAS Registry Number: 1341-49-7

HSDB Number: 480

RTECS Number: BQ9200000

UN/NA & ERG Number: UN1727 (solid)/154; UN2817 (ammonium hydrogendifluoride, solution)/154

EC Number: 215-676-4 [*Annex I Index No.*: 009-009-00-4]

Regulatory Authority and Advisory Information

United States National Primary Drinking Water Regulations: MCLG = 4 mg[F]/L; MCL = 4 mg[F]/L; SMCL = 2.0 mg [F]/L, as Fluoride.

Clean Water Act: 40CFR116.4 Hazardous Substances; RQ 40CFR117.3 (same as CERCLA)

Superfund/EPCRA 40CFR302.4, Appendix A, RQ: 100 lb (45.4 kg); Section 313: Form R *de minimis* concentration reporting level: 1.0% (as ammonia). NH_3 Equivalent molecular weight: 29.86.

Hazard symbols, risk, & safety statements: Hazard symbol: T,C; risk phrases: R25; R34; safety phrases: S1/2; S22; S26; S37; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Ammonium bifluoride. Molecular weight = 57.04; specific gravity (H_2O:1) = 1.5 @ 20°C; boiling point = 239.5°C; melting/freezing point = 125.6°C; heat of solution = 3.59×10^5 J/kg is a white crystalline compound that is commonly found in solution. Molecular weight = 57.04; boiling point = 239.5°C; melting/freezing point = 125.6°C; specific gravity (H_2O:1) = 1.5 @ 20°C; heat of solution = 3.59×10^5 J/kg. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 0; reactivity 0. Soluble in water.

Potential Exposure: It is used as a sterilizer, in dairy and brewery operations; in the ceramic, glass, and electroplating industries; as a laundry sour.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. In the presence of moisture corrodes concrete, metals, glass.

Permissible Exposure Limits in Air

NIOSH IDLH = 250 mg[F]/m^3

OSHA PEL: 3 ppm/2.5 mg[F]/m^3 TWA

NIOSH REL: 3 ppm/2.5 mg[F]/m^3 TWA; 6 ppm/5 mg [F]/m^3, 15 min. Ceiling Concentration

ACGIH TLV[1]: 2.5 mg[F]/m^3 TWA; not classifiable as a human carcinogen; BEI: 3 mg[F]/g creatinine in urine *prior* to end-of-shift; 10 mg[F]/g creatinine in urine end-of-shift.

PAC Ver. 29[138]

PAC-1: 11 milligram per cubic meter

PAC-2: 130 milligram per cubic meter

PAC-3: 750 milligram per cubic meter

DFG MAK: 1 mg[F]/m^3, inhalable fraction [skin]; Peak Limitation Category II(4); Pregnancy Risk Group C; BAT: 7.0 mg[F]/g creatinine in urine at end-of-shift; 4.0 mg[F]/g creatinine in urine at the beginning of the next shift.

Australia: TWA 2.5 mg[F]/m^3, 1993; Austria: MAK 2.5 mg [F]/m^3, 1999; Belgium: TWA 2.5 mg[F]/m^3, 1993; Finland: TWA 2.5 mg[F]/m^3, 1999; France: VME 2.5 mg[F]/m^3, 1999; Hungary: TWA 1 mg[F]/m^3; STEL 2 mg[F]/m^3, 1993; Norway: TWA 0.6 mg[F]/m^3, 1999; the Philippines: TWA 2.5 mg[F]/m^3, 1993; Poland: MAC (TWA) 1 mg

[HF]/m^3, MAC (STEL) 3 mg[HF]/m^3, 1999; Russia: STEL 0.5 ppm (2.5 milligram per cubic meter), 1993; Sweden: NGV 2 mg[F]/m^3, 1999; Switzerland: MAK-W 1.8 ppm (1.5 mg[F]/m^3), KZG-W 3.6 ppm (3.0 mg[F]/m^3), 1999; Thailand: TWA 2.5 mg[F]/m^3, 1993; United Kingdom: TWA 2.5 mg[F]/m^3, 2000; LTEL 2.5 mg[F]/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen.

Determination in Air: Fluorides (as F) may be collected on a filter and measured by an ion-specific electrode according to NIOSH Analytical Method 7902[18].

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guidelines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg[F]/L. SafeDrinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg [F]/L; SMCL = 2 mg/F/L, as Fluoride.

Routes of Entry: Inhalation, ingestion, skin absorption.

Harmful Effects and Symptoms

Short-Term Exposure: The dust irritates and burns the eyes, skin, nose, throat and lungs. Eye contact may cause permanent damage. Inhalation can irritate the lungs, causing coughing and/or shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Between 1 teaspoonful and one ounce may be fatal to humans by ingestion. Ingestion will in any case cause irritation of the mouth and stomach and can cause vomiting, convulsions, collapse and acute toxic nephritis. If absorbed through the skin this chemical may cause added exposure.

Long-Term Exposure: May cause chronic lung irritation and kidney and liver damage. Bronchitis may develop. Chronic exposure may cause weight loss; nausea, vomiting, weakness, shortness of breath.

Points of Attack: Lungs, skin.

Medical Surveillance: NIOSH lists the following tests: chest X-ray, electrocardiogram, pulmonary function tests: forced vital capacity, forced expiratory volume (1 second); pelvic X-ray; sputum cytology; urine (chemical/metabolite); urine (chemical/metabolite) pre- and postshift; urinalysis (routine); CBC/differential. Intake of fluoride from natural sources in food or water should be known. In the case of exposure to fluoride dusts, periodic urinary fluoride excretion levels have been very useful in evaluating industrial exposures and environmental dietary sources.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash or dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA *12.5 milligram per cubic meter*: Qm (APF = 25) (any quarter-mask respirator). *25 milligram per cubic meter*: 95X*[any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or SA* (any supplied-air respirator). *62.5 milligram per cubic meter*: Sa:Cf (APF = 25) *+ (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25)* *if not present as a fume* (any powered, air-purifying respirator with a high-efficiency particulate filter). *125 milligram per cubic meter*:100F (APF = 50)$^+$ [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *250 milligram per cubic meter*: Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50)$^+$ [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or SCBAE (any appropriate escape-type, SCBA). *Substance reported to cause eye irritation or damage; may require eye protection. *May need acid gas sorbent.

Storage: Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers (such as chlorine, bromine, and fluorine) since highly poisonous hydrogen fluoride gas is released. Keep in plastic, rubber or paraffined containers (because it easily etches glass).

Shipping: UN1727 Ammonium hydrogendifluoride, solid, Hazard class: 8; Labels: 8-Corrosive material.

UN2817 Ammonium hydrogendifluoride, solution, Hazard class: 8; Labels: 8-Corrosive material, 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Ammonium bifluoride may burn, but does not readily ignite. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include hydrogen fluoride gas. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: May be buried in a specially designated chemical landfill. Aqueous wastes may be reacted with an excess of lime followed by lagooning and either recovery or land disposal of the separated calcium fluoride.

References

(31); (173); (101); (138); (122); (100).

National Institute for Occupational Safety and Health (NIOSH), "Criteria for a Recommended Standard: Occupational Exposure to Inorganic Fluorides," NIOSH Document Number 76−103, Cincinnati, OH (1976).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report* 3, No. 5, 34−37 (1983).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Ammonium Bifluoride, Trenton, NJ (March 2002).

Ammonium Bisulfite A:1000

Formula: $H_3N \cdot H_2O_3S$

Synonyms: Ammonium hydrogen sulfite; Ammonium monosulfite; Monoammonium sulfite; Sulfurous acid, monoammonium salt

CAS Registry Number: 10192-30-0

HSDB Number: 486

RTECS Number: WT3595000

UN/NA & ERG Number: UN2693 (bisulfites, inorganic, aqueous solution, n.o.s.)/154

EC Number: 233-469-7

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Strong reducing agent, Corrosive,

Clean Water Act: 40CFR116.4 Hazardous Substances; RQ 40CFR117.3 (same as CERCLA)

Superfund/EPCRA 40CFR302.4, Appendix A, RQ: 5000 lb (2270 kg); Section 313: Form R *de minimis* concentration reporting level: 1.0% (as ammonia) NH_3 Equivalent molecular weight: 17.18

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: C; risk phrases: R32; R34; R41; safety phrases: S23; S26; S36/37/39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Ammonium bisulfite is a white crystalline solid or colorless to yellow solution. Molecular weight = 99.1; specific gravity (H_2O:1) = 2.026; Melting/Freezing point = (decomposes) 150°C. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 0; reactivity 0. Soluble in water; solubility = 26.7%.

Potential Exposure: Used as a preservative, in drilling fluids, making industrial explosives, hair waving and bleaching agents; for making other chemicals. A source of sulfur in liquid fertilizers.

Incompatibilities: Sulfites react explosively on contact with oxidizers. Reacts with acids, acid fumes releasing sulfur dioxide. Reacts with water. Corrosive to metals.

Permissible Exposure Limits in Air
PAC Ver. 29[138]
PAC-1: 30 milligram per cubic meter
PAC-2: 330 milligram per cubic meter
PAC-3: 2000 milligram per cubic meter
DFG MAK: Sensitizing substances, as *sulfites*.

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Ammonium bisulfite is highly corrosive. Eye and skin contact can cause severe irritation and burns with possible permanent damage. Inhalation can irritate the lungs, causing coughing and shortness of breath. Higher exposure can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long-Term Exposure: May cause lung damage.

Points of Attack: Lungs, skin, eyes.

Medical Surveillance: Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Lung function tests. Consider chest X-ray following acute exposure.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash- or dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, acids, water, combustible materials.

Shipping: UN2693 Bisulfites, inorganic, aqueous solutions, Hazard class: 8; Labels: 8-Corrosive material

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Ventilate closed spaces before entering them. Absorb liquid with sand, vermiculite, earth, or similar absorbent material and place into containers for later disposal. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Ammonium bisulfite is noncombustible. Thermal decomposition products may include ammonia, sulfur dioxide and oxides of nitrogen. Use extinguishing agents suitable for surrounding fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incinerate. It may be possible to dispose of waste material at a municipal facility if treated, neutralized, and oxidized.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Ammonium Bisulfite, Trenton, NJ (September 1998).

Ammonium Carbamate A:1010

Formula: $CH_6N_2O_2$: NH_4COONH_2

Synonyms: Ammonium aminoformate; Anhydride of ammonium carbonate; Carbamate d'ammonium (French); Carbamato amonico (Spanish); Carbamic acid, ammonium salt; Carbamic acid, monoammonium salt

CAS Registry Number: 1111-78-0

HSDB Number: 485

RTECS Number: EY8575000

UN/NA & ERG Number: UN2757 (carbamate pesticide, solid, toxic)/151

EC Number: 214-185-2

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Agricultural chemical

Clean Water Act: 40CFR116.4 Hazardous Substances; RQ 40CFR117.3, (same as CERCLA)

Superfund/EPCRA 40CFR302.4, Appendix A, RQ: 5000 lb (2270 kg); Section 313: Form R *de minimis* concentration reporting level: 1.0% (as ammonia) NH_3 Equivalent molecular weight: 21.81.

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xn; risk phrases: R22; R41; safety phrases: S24/25; S26 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Ammonium carbamate is a colorless crystalline powder or white powder. Ammonia-like odor. The odor threshold is 5 ppm as NH_3 (detection) and 46.8 ppm as NH_3 (recognition). Molecular weight = 78.07; boiling point = 60°C; freezing/melting point = (sublimes) about 60°C; heat of combustion: (estimate) @ 25°C: −2612 Btu/lb; heat of solution: (endothermic) 86.9 Btu/lb. Highly soluble in water.

Potential Exposure: It is used as a fertilizer and ammoniating agent.

Incompatibilities: Strong bases, strong oxidizers. Keep away from heat (forms urea), moisture, and direct sunlight.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 0.23 milligram per cubic meter

PAC-2: 2.6 milligram per cubic meter

PAC-3: 15 milligram per cubic meter

Harmful Effects and Symptoms

Irritates skin, respiratory tract and mucous membranes on contact.

Short-Term Exposure: Exposure can irritate the eyes and skin, causing redness and tearing. Eye damage may occur. Inhalation can irritate the nose and lungs with coughing, and/or shortness of breath.

Long-Term Exposure: Repeated or prolonged exposure can cause lung irritation and the development of bronchitis.

Points of Attack: Respiratory system, eyes, skin.

Medical Surveillance: Lung function testing. Eye examination.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from heat, moisture, and direct sunlight. See also Incompatibilities.

Shipping: UN2757 Carbamate pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.***Spill Handling:*** Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include ammonia, urea, and nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

Sax, N. I., "*Dangerous Properties of Industrial Materials Report*," 2, No. 3, 31−33 (1982).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Ammonium Carbamate, Trenton, NJ (March 2002).

Ammonium Carbonate A:1020

Formula: $CH_8N_2O_3$; $(NH_4)_2CO_3$

Synonyms: Ammoniumcarbonat (German); Carbonato amonico (Spanish); Carbonato de amonio (Spanish); Carbonic acid, ammonium salt; Carbonic acid, diammonium salt; Crystal ammonia; Diammonium carbonate; Hartshorn; Sal volatile

CAS Registry Number: 506-87-6

HSDB Number: 6305

RTECS Number: BP1925000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 208-058-0

Regulatory Authority and Advisory Information

Clean Water Act: 40CFR116.4 Hazardous Substances; RQ 40CFR117.3, (same as CERCLA)

Superfund/EPCRA 40CFR302.4, Appendix A, RQ: 5000 lb (2270 kg); Section 313: Form R *de minimis* concentration reporting level: 1.0% (as ammonia). NH_3 Equivalent molecular weight: 35.45

Hazard symbols, risk, & safety statements: Hazard symbol: Xn: risk phrases: R22; R52/53; safety phrases: S24/25; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Ammonium carbonate is a colorless crystal or white lumpy powder with a strong ammonia odor. The odor specific gravity (gas) = 2.7; Threshold is <5 ppm as ammonia gas. Molecular weight = 96.09; specific gravity (H_2O:1) = 1.59 @ 20°C; freezing/melting point = (decomposes) 58°C, and volatilizes at about 60°C. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 0; reactivity 1. Slightly soluble in water.

Potential Exposure: It is used in dyeing, tanning, medicines, fire extinguishers; to make casein glue; ammonia salts; and baking powders. A laboratory reagent.

Incompatibilities: Acids, acid salts; salts of iron and zinc, alkaloids, calomel and tartar emetic. Keep cool, below 38°C.

Contact with inorganic acids may form CO_2, heat, and dangerous spattering.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 0.31 milligram per cubic meter

PAC-2: 3.5 milligram per cubic meter

PAC-3: 21 milligram per cubic meter

Routes of Entry: Inhalation, ingestion, eye, and skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Contact can irritate eyes and nose. Ingestion may cause gastric irritation. Breathing Ammonium Carbonate can irritate the nose, throat and lungs, causing a cough and difficulty in breathing. Toxicity by Ingestion: LD_{50} = (rat) 2.15 g/kg.

Long-Term Exposure: May cause lung problems.

Points of Attack: Lungs, eyes, skin.

Medical Surveillance: Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Lung function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Green: General storage may be used. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from temperatures above 38°C.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of carbon. This material may burn but does not readily ignite. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Slowly deposit in a large container of water. Add excess amounts of soda ash and let stand for 24 hours. Decant to another container, neutralize with hydrochloric acid, and drain with an excess of water. Ship to landfill.

References

(31); (173); (101); (138); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 2, No. 3, 33–34 (1982).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Ammonium Carbonate, Trenton, NJ (April 2001).

Ammonium Chloride A:1030

Formula: NH_4Cl

Synonyms: Amchlor; Amchloride; Ammoneric; Ammonium muriate; AM solder flux; Cloruro amonico (Spanish); Salamac; Sal ammoniac; Salmiac; Slago

CAS Registry Number: 12125-02-9

HSDB Number: 483

RTECS Number: BP4550000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 235-186-4 [*Annex I Index No.*: 017-014-00-8]

Regulatory Authority and Advisory Information

Hazard Alert: Suspected of causing genetic defects, Primary irritant (w/o allergic reaction).

Clean Water Act: 40CFR116.4 Hazardous Substances; RQ 40CFR117.3 (same as CERCLA)

United States National Primary Drinking Water Regulations: SMCL = 250 mg[Cl^-]/L as Chloride

Superfund/EPCRA 40CFR302.4, Appendix A, RQ: 5000 lb (2270 kg); Section 313: Form R *de minimis* concentration reporting level: 1.0% (as ammonia) NH_3 Equivalent molecular weight: 31.84.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: Xn, Xi; risk phrases: R22; R36/37/38; R62; safety phrases: S2; S22 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Ammonium chloride is a white crystalline solid. Odorless. Molecular weight = 53.50; specific gravity (H_2O:1) = 1.518; boiling point = 520°C; freezing/melting point = 338°C (sublimes). Hazard identification (based on NFPA-704 M Rating System): Health 1; flammability 0; reactivity 0. Soluble in water; solubility = 37%.

Potential Exposure: Ammonium chloride is used as an industrial chemical, pharmaceutical, and veterinary drug; to make dry batteries; in galvanizing; as a soldering flux.

Incompatibilities: Acids, alkalis, and silver salts.

Permissible Exposure Limits in Air

OSHA PEL: None

NIOSH REL: (fume) 10 milligram per cubic meter TWA; 20 milligram per cubic meter STEL.

ACGIH TLV[1]: (fume) 10 milligram per cubic meter TWA; 20 milligram per cubic meter STEL

PAC Ver. 29[138]

PAC-1: 20 milligram per cubic meter

PAC-2: 54 milligram per cubic meter

PAC-3: 330 milligram per cubic meter

Australia: TWA 10 milligram per cubic meter; STEL 20 milligram per cubic meter (fume), 1993; Denmark: TWA 10 milligram per cubic meter, 1999; Russia: STEL 10 milligram per cubic meter (fume), 1993; United Kingdom: TWA 10 milligram per cubic meter (fume) STEL 20 milligram per cubic meter (fume), 2000; Belgium: TWA 10 milligram per cubic meter; STEL 20 milligram per cubic meter (fume), 1993; France: VME 10 milligram per cubic meter (fume), 1999; Poland: TWA 10 milligram per cubic meter; STEL 20 milligram per cubic meter (vapors and fumes), 1999; the Netherlands: MAC-TGG 10 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 20 milligram per cubic meter, fume.

Determination in Air: Collection on a filter and colorimetric analysis.

Permissible Concentration in Water: Russia[43] set a MAC of 1.2 mg/L in water for fishery purposes. May be toxic to aquatic organisms.

Routes of Entry: Inhalation, ingestion; skin, and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Ammonium chloride is an eye, skin and respiratory system irritant with a low grade systemic toxicity by ingestion.

Points of Attack: Skin, respiratory system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Prevent skin contact. Any barrier that will prevent contamination from the dry chemical. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for Exposures over *10 milligram per cubic meter*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Green: General storage may be used. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from acids, alkalis, and silver salts. Protect against physical damage[17].

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include ammonia, chlorine gas, and nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Pretreatment involves addition of sodium hydroxide to liberate ammonia and form the soluble sodium salt. The liberated ammonia can be recovered and sold. After dilution to the permitted provisional limit, the sodium salt can be discharged into a stream or sewer[22].

References

(31); (173); (101); (138); (100).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 2, No. 3, 34−36 (1982).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Ammonium Chloride, Trenton, NJ (July 2001).

Ammonium Chloroplatinate A:1040

Formula: $C_{16}H_8N_2Pt$; $(NH_4)_2PtC_{16}$

Synonyms: Ammonium platinic chloride; Diammonium hexachloroplatinate(2-); Diammonium hexachloroplatinate (VI); Platinate(2-), platinic ammonium chloride

CAS Registry Number: 16919-58-7

HSDB Number: 2069

RTECS Number: BP5425000

UN/NA & ERG Number: UN3288 (Toxic solid, inorganic, n.o.s.)/151

EC Number: 240-973-0 [*Annex I Index No.*: 078-008-00-9]

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Unstable chemical (may be explosive), Sensitization hazard, Suspected of causing genetic defects.

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Delisted from CERCLA/SARA EHS listing in 1988.

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xi; risk phrases: R25; R41; R42/43; R51; R62; safety phrases: S1/2; S26; S36/37/39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [2-Hazard to water. (est.)]

Description: Ammonium chloroplatinate is an orange-red crystalline cubic solid or yellow powder which decomposes when heated. Molecular weight = 443.5. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 0; reactivity 1. Soluble in water; solubility = 0.7 g/100 mL @ 15°C.

Potential Exposure: It is used in photography, platinum plating and in the manufacture of platinum sponge.

Incompatibilities: This material is unstable and potentially explosive[193]. Incompatible with strong oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

NIOSH IDLH = 4 mg [Pt]/m^3
OSHA PEL: 0.002 mg[Pt]/m^3 TWA
NIOSH REL: 0.002 mg[Pt]/m^3 TWA
ACGIH TLV[1]: 1 0.002 mg[Pt]/m^3 TWA

DFG MAK: No numerical value established. Data may be available; however, 2 μg[Pt]/m^3 peak should not be exceeded; danger of skin and airway sensitization, as chloroplatinates

Determination in Air: Use NIOSH II(7) Method #S-19 (soluble salts)

Routes of Entry: Inhalation, ingestion; skin and /or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Eye and skin irritation can cause irritation and burns. Inhalation can cause respiratory tract irritation, causing coughing and shortness of breath. First symptoms are pronounced irritation of the nose and upper respiratory passages, with sneezing, running of eyes, and coughing. Later, "asthmatic syndrome," with cough, tightness of chest, wheezing, and shortness of breath; develops. It is toxic by inhalation or ingestion. Toxic concentrations for inhalation are 0.9 μ/minute. LD_{50} = (oral-rat) 195 mg/kg.

Long-Term Exposure: Platinum salts can cause asthma-like allergy and skin allergy. Symptoms begin during exposure and grow worse with chronic exposure.

Points of Attack: Lungs, skin.

Medical Surveillance: Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Lung function tests. Evaluation by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. Like treatment for other platinum salts remove victim to fresh air and give oxygen. Nasal washing to remove salts is recommended. In case of skin or eye contact, irrigate with water immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. If local exhaust ventilation or enclosure is not used, respirators should be worn. Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration above 0.05 milligram per cubic meter*: Sa:Cf (APF = 25)* (any supplied-air respirator operated in a continuous-flow mode); or 0.1 milligram per cubic meter: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *4 milligram per cubic meter*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SaF:Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

*Causes eye irritation or damage; eye protection needed.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from acids and strong oxidizers.

Shipping: UN3288 Toxic solids, inorganic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Ammonium chloroplatinate may burn, but is hard to ignite. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. Thermal decomposition products may include ammonia, nitrogen oxides; chlorine. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Because of the high value of the metal, recovery is the economically indicated disposal method.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Ammonium Chloroplatinate, Washington, DC, Chemical Emergency Preparedness Program (October 31, 1985).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Ammonium Chloroplatinate, Trenton, NJ (June 2004).

Ammonium Chromate A:1050

Formula: $CrH_8N_2O_4$; $(NH_4)_2CrO_4$

Synonyms: Ammonium chromate(VI); Chromic acid, diammonium salt; Cromato amonico (Spanish); Diammonium chromate; Neutral ammonium chromate

CAS Registry Number: 7788-98-9; 52110-72-2 (diammonium salt)

HSDB Number: 482

RTECS Number: GB2880000

UN/NA & ERG Number: UN3288 (Toxic solids inorganic)/151

EC Number: 232-138-4

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human Sufficient Evidence; Animal Sufficient Evidence, *carcinogenic to humans*, Group 1, 1997; NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen; EPA *(inhalation)*: Known human carcinogen; EPA *(oral)*: Not Classifiable as to human carcinogenicity; NTP: Known to be a human carcinogen.

California Proposition 65 Chemical[102]: (*hexavalent chromium)* Cancer 2/27/1987; Developmental/Reproductive toxin (male, female) 12/19/2008

Hazard Alert: Poison, Combustible, Strong oxidizer, Corrosive, Sensitization hazard, Environmental hazard; Reproductive toxin.

Clean Air Act 42USC7412; Title I, Part A, §112 Hazardous Pollutants (as chromium compounds)

Clean Water Act: Section 311 Hazardous Substances/ 40CFR116.4 Hazardous Substances; RQ 40CFR117.3 (same as CERCLA); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992); 40CFR401.15 Section 307 Toxic Pollutants as chromium and compounds.40CFR423, Appendix A, Priority Pollutants.

EPA Acceptable daily intake (ADI): Chromium(VI) = 0.175 mg/day/man. EPA estimated adequate and safe intake (EASI) levels for chromium: **Infants**: age 0.0−0.5 years: 0.01−0.04 mg/day; age 0.5−1.0 years: 0.02−0.06 mg/day. **Children** age 1−3 years: 0.02−0.08 mg/day; age 4−6 years: 0.03−0.12 mg/day; age 7−10 years: 0.05−0.20 mg/day; age > or = to 11 yr: 0.05−0.20 mg/day. **Adults**: 0.05−0.20 mg/day.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, D007 (chromium compounds)

Superfund/EPCRA 40CFR302.4, Appendix A, RQ: 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0% (as ammonia). NH_3 Equivalent molecular weight weight = 22.40. *Also must be reported as a chromium compound*: "Includes any unique chemical substance that contains chromium as part of that chemical's infrastructure." Form R *de minimis* concentration reporting level: Chromium(VI) compounds: 0.1%.

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazardous to aquatic life or environment, with possible long-lasting effects[291]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, O, N, Xi; risk phrases: R45; R8; R22; R34; R43; R49; R50/53; R62; R63; safety phrases: S17; S26; S29/35; S36/ 37/39; S45; S53; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Ammonium chromate is a yellow crystalline compound which can be used in solution, which is yellow with an ammonia odor. Molecular weight = 152.07; specific gravity (H_2O:1) = 191 @ 12°C; boiling point = 180°C; heat of solution (endothermic @ 25°C) = 68.6 Btu/lb; freezing/ melting point = 185°C (decomposes). Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 1; reactivity 0, Oxidizer. Soluble in water.

Potential Exposure: It is used to inhibit corrosion and in dyeing, photography and many chemical reactions. Used as a fungicide and fire retardant.

Incompatibilities: A strong oxidizer and an explosive. Contact with combustible, organic and other readily oxidizable substances may cause fire and explosions. Hydrazine, other reducing agents. Corrosive to metals.

Permissible Exposure Limits in Air

NIOSH IDLH = 15 mg[Cr(VI)]/m^3

as chromium(VI) inorganic soluble compounds

OSHA PEL: 0.005 mg[Cr(VI)]/m^3 TWA Concentration. See 29CFR1910.1026

NIOSH REL: 0.001 mg[Cr]/m^3 TWA, potential carcinogen, limit exposure to lowest feasible level. NIOSH considers all Cr(VI) compounds (including chromic acid, *tert*-butyl chromate, zinc chromate, and chromyl chloride) to be potential occupational carcinogens. See *NIOSH Pocket Guide*, Appendix A & C.

ACGIH TLV[1]: 0.05 mg[Cr]/m^3 TWA, Confirmed Human Carcinogen; BEI issued

7788-98-9

PAC Ver. 29[138]

PAC-1: 0.44 milligram per cubic meter

PAC-2: 7.7 milligram per cubic meter

PAC-3: 46 milligram per cubic meter

DFG MAK: Inhalable fraction; [skin] Danger of skin sensitization; Carcinogen Category 1; TRK: 0.05 mg[Cr]/m^3; 20 μg/L [Cr] in urine at end-of-shift

Russia has set a MAK value of 0.01 milligram per cubic meter for chromates and bichromates in the work-place[43].

Determination in Air: Use NIOSH Analytical Methods #7600, 7604, 7605, 7703, 9101 and OSHA Analytical Methods ID-103, ID-215, W-4001.

Permissible Concentration in Water: The EPA[6] has designated chromium as a priority toxic pollutant. State Drinking Water Guidelines: California 10 μg[Cr(VI)]/L; Maine 35 μg[Cr(VI)]/L.

Determination in Water: Chromium(VI) may be determined by extraction and atomic absorption or calorimetry (using diphenylhydrazide).

Routes of Entry: Lungs, ingestion, skin, and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Eye contact can cause severe damage with possible loss of vision. Breathing ammonium chromate can cause a sore or hole through the inner nose (septum), sometimes with bleeding, discharge or crusting. Irritation of nose, throat and bronchial tubes can also occur, with cough and/or wheezing. Skin contact can cause deep ulcers or an allergic skin rash.

Long-Term Exposure: Some water-soluble chromium[16] compounds are inferred noncarcinogens; the water-insoluble compounds are generally deemed to be carcinogens but the border line is not precise nor universally agreed to. Ammonium chromate is a hexavalent chromium compound which may be carcinogenic and should be handled with extreme caution. Breathing ammonium chromate can cause sores or hole in the septum dividing the inner nose, sometimes with bleeding, discharge, and/or formation of a crust. May cause skin and lung allergy and kidney damage.

Points of Attack: Blood, respiratory system; liver kidneys, eyes, skin.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. NIOSH lists the following tests: Blood gas analysis, CBC; chest X-ray, electrocardiogram, liver function tests; pulmonary Function tests, sputum cytology, urine (chemical/metabolite), urinalysis (routine), white blood cell count/differential. Also consider skin and nose examination, kidney function tests, evaluation by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Prevent skin contact. (as chromic acid and chromates) **8 hours** (more than 8 hours of resistance to breakthrough $>0.1\ \mu g/cm^2/min$): polyethylene gloves, suits, boots; polyvinyl chloride gloves, suits, boots; Saranex coated suits; **4 hours** (At least 4 but $<$ 8 hours of resistance to breakthrough $>0.1\ \mu g/cm^2/min$): butyl rubber gloves, suits, boots; Viton gloves, suits Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash or dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH, as chromates: *at any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air-purifying, full facepiece respirator with an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Check oxygen content prior to entering storage area. (1) Color code—Blue (carcinogen): Health Hazard/ Poison: Store in a secure poison location. (2) Color code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from heat and away from contact with easily oxidized or combustible materials; heat or any condition which could shock it. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Store in a cool, well-ventilated area away from incompatible materials listed above. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43 A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage.

Shipping: UN3288 Toxic solids, inorganic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Ammonium chromate explodes when heated. Thermal decomposition products may include ammonia and nitrogen oxides. Use water only. *Do not* use dry chemical, carbon dioxide; halon or foam extinguishers. Storage containers may explode and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Addition of a large volume of a reducing agent solution (hypo, bisulfite or ferrous salt, and acidify with 3 M sulfuric acid). When reduction is complete, flush to drain with large volumes of water.

References

(109); (102); (31); (173); (101); (138); (2); (100).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report* 2, No. 3, 36−38 (1982).

National Institute for Occupational Safety and Health (NIOSH), “Criteria for a Recommended Standard: Occupational Exposure to Chromium (VI)”, NIOSH Document Number 76−129, Cincinnati, OH (1976).

United States Environmental Protection Agency, “Chromium: Ambient Water Quality Criteria, Washington, DC (1980).

Agency for Toxic Substances and Disease Registry, “Toxicological Profile for Chromium,” Atlanta, Georgia (1988).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Ammonium Chromate, Trenton, NJ (June 2004).

United States Environmental Protection Agency, *Health Assessment Document*: *Chromium*, EPA 600/8-83-014F, pages 6−2 & pages 7−161 Washington, DC, (1984).

Ammonium Citrate A:1060

Formula: $C_6H_{14}N_2O_7$; $NH_4COOCH_2C(OH)(COOH)CH_2COONH_4$

Synonyms: Ammonium citrate, dibasic; Citrato amonico dibasico (Spanish); Citric acid, ammonium salt; Citric acid, diammonium salt; Diammonium citrate; Diammonium hydrogen citrate; Dibasic ammonium citrate; 1,2,3-Propane tricarboxylic acid, 2-hydroxy-, ammonium salt

Ammcitrate; Ammonium monohydrogen citrate; Citrate d’ammonium, dibasique (French); Citrato de amonio, dibásico (Spanish); Microstop

CAS Registry Number: 7632-50-0; 3012-65-5 (dibasic); 3458-72-8 (tribaseic)

HSDB Number: 300 as diammonium citate

RTECS Number: GE7573000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 221-146-3

Regulatory Authority and Advisory Information

Hazard Alert: Combustible.

Clean Water Act: 40CFR116.4 Hazardous Substances; RQ 40CFR117.3 (same as CERCLA)

Superfund/EPCRA 40CFR302.4, Appendix A, RQ: 5000 lb (2270 kg); Section 313: Form R *de minimis* concentration reporting level: 1.0% (as ammonia). NH_3 Equivalent molecular weight: 15.06.

Hazard symbols, risk, & safety statements: Hazard symbol: Xi; risk phrases: R36/37/38; R50; WGK (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)] safety phrases: S16; S26; S36/37/39; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Ammonium citrate (various forms) is a white powdery material with a slight ammonia-like odor. Molecular weight: 226.19; 243.22 (tribasic); specific gravity (H_2O:1) = 1.48. Hazard identification (based on NFPA-704 M Rating System): Health 0; flammability 1; reactivity 0. Soluble in water.

Potential Exposure: It is used to make pharmaceuticals; rust-proofing compounds and plasticizers; as a food additive; stabilizing agent.

Incompatibilities: Contact with strong caustics causes the release of ammonia gas.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

7632-50-0; dibasic 3012-65-5; tribasic 3458-72-8

PAC-1: 1.1 milligram per cubic meter

PAC-2: 12 milligram per cubic meter

PAC-3: 72 milligram per cubic meter

Routes of Entry: Inhalation, eye, and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Exposure can irritate the eyes and may irritate the nose, throat and lungs. Contact may irritate the skin. Eye and skin irritant, moderate; Nervous system toxin-acute effects; Respiratory toxin-acute effects other than severe or moderate irritation[138].

Points of Attack: Eyes, lungs, skin.

Medical Surveillance: Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Lung function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash or dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. If local exhaust ventilation or enclosure is not used, respirators should be worn. Wear protective work clothing and goggles. Wash thoroughly immediately after exposure to ammonium citrate.

Respirator Selection: *At any detectable concentration*: PaprTHie (APF = 50) (any NIOSH/MSHA or European Standard EN 149-approved air-purifying respirator with a tight-fitting full facepiece and a high-efficiency particulate filter); or SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Green: General storage may be used. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from caustics (such as sodium hydroxide or potassium hydroxide) because ammonia gas is released.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Ammonium citrate may burn, but does not readily ignite. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include ammonia gas and nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: May be flushed to sewer with large volumes of water.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Ammonium citrate, Trenton, NJ (June 2005).

Ammonium Dichromate A:1080

Formula: $Cr_2H_8N_2O7$; $(NH_4)_2Cr_2O_7$

Synonyms: Ammonium bichromate; Ammonium dichromate(VI); Bicromato amonico (Spanish); Chromic acid, diammonium salt; Diammonium dichromate

CAS Registry Number: 7789-09-5

HSDB Number: 481

RTECS Number: HX7650000

UN/NA & ERG Number: UN1439/141

EC Number: 232-143-1 [*Annex I Index No.*: 024-003-00-1]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human Sufficient Evidence; Animal Sufficient Evidence, *carcinogenic to humans*, Group 1, 1997; NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen; EPA (*inhalation*): Known human carcinogen; EPA *(oral)*: Not Classifiable as to human carcinogenicity; NTP: Known to be a human carcinogen.

California Proposition 65 Chemical[102]: (*hexavalent chromium*) Cancer 2/27/1987; Developmental/Reproductive toxin (male, female) 12/19/2008.

Hazard Alert: Explosive, Combustible, Oxidizer (unstable), Sensitization hazard (skin, resp.), Possible risk of forming tumors, Reproductive toxin: Suspected of causing genetic defects.

Clean Air Act 42USC7412; Title I, Part A, §112 Hazardous Pollutants (as chromium compounds)

Clean Water Act: Section 311 Hazardous Substances/ 40CFR116.4 Hazardous Substances; RQ 40CFR117.3 (same as CERCLA); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992); 40CFR401.15 Section 307 Toxic Pollutants as chromium and compounds.40CFR423, Appendix A, Priority Pollutants.

EPA Acceptable daily intake (ADI): Chromium(VI) = 0.175 mg/day/man. EPA EASI levels for chromium: **Infants**: age 0.0−0.5 years: 0.01−0.04 mg/day; age 0.5−1.0 years: 0.02−0.06 mg/day. **Children**: age 1−3 years: 0.02−0.08 mg/day; age 4−6 years: 0.03−0.12 mg/day; age 7−10 years: 0.05−0.20 mg/day; age > or = to 11 years: 0.05−0.20 mg/day. **Adults**: 0.05−0.20 mg/day.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, D007 (chromium compounds)

Superfund/EPCRA 40CFR302.4, Appendix A, RQ: 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0% (as ammonia). NH_3. Equivalent molecular weight: 13.51. *Also must be reported as a chromium compound*: "Includes any unique chemical substance that contains chromium as part of that chemical's infrastructure." Form R *de minimis* concentration reporting level: Chromium(VI) compounds: 0.1%. Form R Toxic Chemical Category Code: N090

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: E, T + , N, Xi; risk phrases: R45; R2; R6; R8; R21; R25; R26; R46; R34; R42/43; R48/23; R50/53; R60; R62; safety phrases: S17; S29; S53; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Ammonium dichromate is a combustible, orange-red crystalline solid which is used in solution. Molecular weight = 252.06; specific gravity (H_2O:1) = 2.94; freezing/melting point = 170°C (see incompatibilities); autoignition temperature = 225°C. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 1; reactivity 1 OX. Soluble in water; solubility = 36% @ 20°C.

Potential Exposure: It is used in dyeing, leather tanning and to make fireworks and chromic oxide; in lithography and photoengraving; in manufacture of special mordants and catalysts.

Incompatibilities: An unstable oxidizer; freezing/melting point = (decomposes below MP) 180°C; decomposition becomes self-sustaining and violent at about 225°C. Contact with combustible, organic or other easily oxidized materials, strong acids; hydrazine and other reducing agents; alcohols, sodium nitrite may cause fire and explosions.

Permissible Exposure Limits in Air

NIOSH IDLH = 15 mg[Cr(VI)]/m^3

as chromium(VI) inorganic soluble compounds

OSHA PEL: 0.005 mg[Cr(VI)]/m^3 TWA Concentration. See 29CFR1910.1026

NIOSH REL: 0.001 mg[Cr]/m^3 TWA, potential carcinogen, limit exposure to lowest feasible level. NIOSH considers all Cr(VI) compounds (including chromic acid, tert-butyl chromate, zinc chromate, and chromyl chloride) to be potential occupational carcinogens. See NIOSH Pocket Guide, Appendix A & C.

ACGIH TLV[1]: 0.05 mg[Cr]/m^3 TWA, Confirmed Human Carcinogen; BEI issued

PAC Ver. 29[138]

PAC-1: 0.37 milligram per cubic meter

PAC-2: 6.3 milligram per cubic meter

PAC-3: 38 milligram per cubic meter

DFG MAK: [skin] Danger of skin sensitization; Carcinogen Category 1; TRK: 0.05 mg[Cr]/m^3; 20 μg/L [Cr] in urine at end-of-shift

Russia[43] has set a MAK value of 0.01 milligram per cubic meter for chromates and bichromates in work-place air.

Determination in Air: Use NIOSH Analytical Methods #7600, 7604, 7605, 7703, 9101 and OSHA Analytical Methods ID-103, ID-215, W-4001.

Permissible concentration in Water: State Drinking Water Guidelines: California 10 μg[Cr(VI)]/L; Maine 35 μg[Cr (VI)]/L.

Determination in Water: Chromium(VI) may be determined by extraction and atomic absorption or colorimetry using diphenylhydrazole.

Routes of Entry: Ingestion, skin, and/or eye contact.

Short-Term Exposure: Should be handled as a carcinogen, with extreme caution. Ammonium dichromate can pass through the skin and may cause overexposure. Eye contact can cause severe damage with possible loss of vision.

Irritation of nose, throat, and bronchial tubes can also occur, with cough and/or wheezing. Skin contact can cause deep ulcers or an allergic skin rash. Skin sensitization in humans.

Long-Term Exposure: Ammonium dichromate is a hexavalent chromium compound which may be carcinogenic and should be handled with extreme caution. Breathing ammonium chromate can cause sores or hole in the septum dividing the inner nose, sometimes with bleeding, discharge, and/or formation of a crust. May cause skin and respiratory allergy and kidney damage.

Points of Attack: Blood, respiratory system; liver kidneys, eyes, skin.

Medical Surveillance: NIOSH lists the following tests: Blood gas analysis, CBC; chest X-ray, electrocardiogram, liver function tests; pulmonary Function tests, sputum cytology, urine (chemical/metabolite), urinalysis (routine), white blood cell count/differential. Also consider skin and nose examination, kidney function tests, evaluation by a qualified allergist. This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Pregnant women should avoid contact. Employees should be notified by a physician that this chemical may affect the reproductive system. In addition to comprehensive initial medical and work histories emphasizing reproductive experience and menstrual history, patient should have physical examination and testing of genitourinary tract, sperm count, motility and morphology. If required, other tests, such as serum testosterone, serum FSH, and serum LH may be indicated.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. (as chromic acid and chromates) **8 hours** (more than 8 hours of resistance to breakthrough $>0.1\ \mu g/cm^2/min$): polyethylene gloves, suits, boots; polyvinyl chloride gloves, suits, boots; Saranex coated suits; **4 hours** (At least 4 but $<$ 8 hours of resistance to breakthrough >0.1 $0.1\ \mu g/cm^2/min$): butyl rubber gloves, suits, boots; Viton gloves, suits. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash or dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH, as chromates: *at any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air-purifying, full facepiece respirator with an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Oxidizers should be isolated from acids, metals, organic materials, and ammonium nitrate. (1) Color code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially organic materials, flammables and combustibles, and other incompatible materials. Oxidizers, including oxidizing gases, should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. (2) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from heat and away from contact with easily oxidized or combustible materials; heat or any condition which could shock it. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. See OSHA Standard 1910.104 and NFPA 43 A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: UN1439 Ammonium dichromate, Hazard Class: 5.1; Labels: 5.1-Oxidizer.

Spill Handling: Restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers.

Fire Extinguishing: Ammonium chromate is a combustible solid and explodes when heated. Thermal decomposition products may include ammonia and oxides of nitrogen and metal. Use water only. *Do not* use dry chemical, carbon dioxide; halon or foam extinguishers. Storage containers may explode and parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Add a large volume of a reductant solution (hypo, bisulfite or ferrous salt and acidify with sulfuric acid). Neutralize when reduction is complete and flush to sewer with large volume of water.

References

(109); (102); (31); (173); (101); (138); (2); (122); (100).

National Institute for Occupational Safety and Health (NIOSH), "Criteria for a Recommended Standard: Occupational Exposure to Chromium(VI)", NIOSH Document Number 76-129, Cincinnati, OH (1976).

United States Environmental Protection Agency, "Chromium: Ambient Water Quality Criteria, Washington, DC (1980).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 2, No. 3, 38−40 (1982) (as Ammonium Dichromate) and 3, No. 5, 29−32 (as Ammonium Bichromate).

Agency for Toxic Substances and Disease Registry, "Toxicological Profile for Chromium," Atlanta, Georgia (1988).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Ammonium Dichromate, Trenton, NJ (June 2005).

United States Environmental Protection Agency, *Health Assessment Document*: *Chromium*, EPA 600/8-83-014F, Washington, DC, (1984).

Ammonium Fluoride A:1090

Formula: FH_4N; NH_4F

Synonyms: 777 etch; Ammonium fluorure (French); B-etch; BOE (buffered oxide etch); Fluouro amonico (Spanish); Fluorure d'ammonium (French); Fluoruro de amonio (Spanish); Glass etch; Imahe etch; KTI buffered oxide etch 50:1; KTI buffered oxide etch 6:1; Neutral ammonium fluoride; Pad etch; Poly silicon etch

CAS Registry Number: 12125-01-8

HSDB Number: 6287

RTECS Number: BQ6300000

UN/NA & ERG Number: UN2505/154

EC Number: 235-185-9 [*Annex I Index No.*: 009-006-00-8]

Regulatory Authority and Advisory Information

Clean Water Act: 40CFR116.4 Hazardous Substances; RQ 40CFR117.3 (same as CERCLA); 40CFR423, Appendix A, Priority Pollutants (as inorganic fluorides)

United States National Primary Drinking Water Regulations: MCLG = 4 mg[F]/L; MCL = 4 mg[F]/L; SMCL = 2.0 mg [F]/L, as Fluoride.

RCRA, 40CFR264, Appendix 9, Ground Water Monitoring List, Suggested Testing Methods (PQL μg/L) 8100 (200): 8270 (10) (as inorganic fluorides)

RCRA Universal Treatment Standards: Wastewater (mg/L), 0.059; Nonwastewater (mg/kg), 3.4 (as inorganic fluorides)

Superfund/EPCRA 40CFR302.4, Appendix A, RQ: 100 lb (45.4 kg); Section 313: Form R *de minimis* concentration reporting level: 1.0% (as ammonia). NH_3 Equivalent molecular weight = 45.98

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. As fluoride compounds, inorganic

Mexico, Wastewater (inorganic fluorides).

Hazard symbols, risk, & safety statements: Hazard symbol: T; risk phrases: R23/24/25; safety phrases: S1/2; S26; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Ammonium fluoride is a white crystalline solid. Molecular weight: 37.05; specific gravity (H_2O:1) = 1.01; freezing/melting point = (sublimes) 238°C. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 0; reactivity 0. Soluble in water.

Potential Exposure: Ammonium fluoride is used in printing and dyeing textiles; glass etching, moth-proofing and wood preserving; in analytical chemistry, agriculture, antiseptic in brewing.

Incompatibilities: Acids, alkalis, chlorine trifluoride. Corrodes glass, cement, most metals.

Permissible Exposure Limits in Air

NIOSH IDLH = 250 mg[F]/m^3

OSHA PEL: 3 ppm/2.5 mg[F]/m^3 TWA

NIOSH REL: 3 ppm/2.5 mg[F]/m^3 TWA; 6 ppm/5 mg [F]/m^3, 15 min. Ceiling Concentration

ACGIH TLV[1]: 2.5 mg[F]/m^3 TWA; not classifiable as a human carcinogen; BEI: 3 mg[F]/g creatinine in urine *prior* to end-of-shift; 10 mg[F]/g creatinine in urine end-of-shift

PAC Ver. 29[138]

PAC-1: 15 milligram per cubic meter

PAC-2: 160 milligram per cubic meter

PAC-3: 980 milligram per cubic meter

DFG MAK: 1 mg[F]/m^3, inhalable fraction [skin]; Peak Limitation Category II(4); Pregnancy Risk Group C; BAT: 7.0 mg[F]/g creatinine in urine at end-of-shift; 4.0 mg[F]/g creatinine in urine at the beginning of the next shift

Australia: TWA 2.5 mg[F]/m^3, 1993; Austria: MAK 2.5 mg [F]/m^3, 1999; Belgium: TWA 2.5 mg[F]/m^3, 1993; Finland: TWA 2.5 mg[F]/m^3, 1999; France: VME 2.5 mg[F]/m^3, 1999; Hungary: TWA 1 mg[F]/m^3; STEL 2 mg[F]/m^3, 1993; Norway: TWA 0.6 mg[F]/m^3, 1999; the Philippines: TWA 2.5 mg[F]/m^3, 1993; Poland: MAC (TWA) 1 mg [HF]/m^3, MAC (STEL) 3 mg[HF]/m^3, 1999; Russia: STEL 0.5 ppm (2.5 milligram per cubic meter), 1993; Sweden: NGV 2 mg[F]/m^3, 1999; Switzerland: MAK-W 1.8 ppm (1.5 mg[F]/m^3), KZG-W 3.6 ppm (3.0 mg[F]/m^3), 1999; Thailand: TWA 2.5 mg[F]/m^3, 1993; United Kingdom: TWA 2.5 mg[F]/m^3, 2000; LTEL 2.5 mg[F]/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen

Determination in Air: Fluoride aerosols may be measured by collection on a filter followed by fluoride ion measurement using an ion-specific electrode. Use NIOSH Analytical Method 7902.

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guidelines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg[F]/L. SafeDrinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg [F]/L; SMCL = 2 mg/F/L, as Fluoride.

Routes of Entry: Inhalation, skin and /or eye contact, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Exposure can irritate the nose, throat and lungs. Contact can irritate or burn the skin and eyes. Higher exposures could cause pulmonary edema, a medical emergency that can be delayed for several hours. The symptoms of pulmonary edema are aggravated by physical effort. This can cause death.

Long-Term Exposure: With repeated exposure, some persons may notice poor appetite; nausea, constipation or diarrhea. Repeated overexposure to fluoride can cause brittle bones; stiff muscles and joints and eventual crippling fluorosis. This usually takes years to develop. High or repeated exposure may scar the lungs, causing shortness of breath and reduced lung function. These effects do not occur with prescribed fluoride levels in drinking water or dental use to prevent cavities.

Points of Attack: Skin, eyes, respiratory system; bones, muscles.

Medical Surveillance: NIOSH lists the following tests: chest X-ray, electrocardiogram, pulmonary function tests: forced vital capacity, forced expiratory volume (1 second); pelvic X-ray; sputum cytology; urine (chemical/metabolite); urine (chemical/metabolite) pre- and postshift; urinalysis (routine); CBC/differential. Urine fluoride level (should be less than 5 mg/L of urine).

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA *12.5 milligram per cubic meter*: Qm (APF = 25) (any quarter-mask respirator). *25 milligram per cubic meter*: 95XQ (APF = 10)*[any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or SA* (any supplied-air respirator). *62.5 milligram per cubic meter*: Sa: Cf (APF = 25) * + (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25)* *if not present as a fume* (any powered, air-purifying respirator with a high-efficiency particulate filter). *125 milligram per cubic meter*: 100F (APF = 50)$^+$ [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *250 milligram per cubic meter*: Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50)$^+$ [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or SCBAE (any appropriate escape-type, SCBA). *Substance reported to cause eye irritation or damage; may require eye protection. *May need acid gas sorbent.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Ammonium Fluoride must be stored to avoid contact with acids or alkalis, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area. Keep in plastic, rubber or paraffined containers (because it easily etches glass).

Shipping: UN2505 Ammonium fluoride, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Ammonium fluoride may burn, but does not readily ignite. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include hydrogen fluoride gas. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (173); (101); (138); (2); (122); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 3, No. 5, 32–34 (1983).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Ammonium Fluoride, Trenton, NJ (March 2002).

Ammonium Hexafluorosilicate A:1100

Formula: $F_6H_8N_2Si$; $(NH_4)_2SiF_6$

Synonyms: Ammonium fluorosilicate; Ammonium hexafluorosilicate; Ammonium silicofluoride; Ammonium silicon fluoride; Diammonium fluosilicate; Diammonium silicon hexafluoride; Fluosilicate de ammonium (French); Fluosilicato amonico (Spanish); Picrato amonico (Spanish); Silicofluoruro amonico (Spanish)

CAS Registry Number: 16919-19-0; 1309-32-6

HSDB Number: 472 as ammonium silicofluoride

RTECS Number: GQ9450000

UN/NA & ERG Number: UN2854/154

EC Number: 240-968-3 [*Annex I Index No*.: 009-012-00-0]

Regulatory Authority and Advisory Information

Hazard Alert: Poison (Inhalation may be fatal[136]), Dangerously water reactive, Air reactive, Agricultural chemical.

Clean Water Act: 40CFR116.4 Hazardous Substances; RQ 40CFR117.3 (same as CERCLA); 40CFR423, Priority Pollutants (as inorganic fluorides)

United States National Primary Drinking Water Regulations: MCLG = 4 mg[F]/L; MCL = 4 mg[F]/L; SMCL = 2 mg[F]/L, as fluorides.

RCRA Universal Treatment Standards: Wastewater (mg/L), 0.059; Nonwastewater (mg/kg), 3.4 (as inorganic fluorides)

RCRA, 40CFR264, Appendix 9, Ground Water Monitoring List, Suggested Testing Methods (PQL μg/L): 8100 (200); 8270 (10) (as inorganic fluorides)

Superfund/EPCRA 40CFR302.4, Appendix A, RQ: 1000 lb (454 kg); Section 313: Form R *de minimis* concentration reporting level: 1.0% (as ammonia). NH_3 Equivalent molecular weight: 19.12

Canada, WHMIS, Ingredients Disclosure List 1% as fluoride compounds, inorganic

Canada's DSL List

Mexico, Wastewater (inorganic fluorides).

Hazard symbols, risk, & safety statements: Hazard symbol: T, C (aq. solution); risk phrases: R26/27/28; R34; R35; R37; safety phrases: S1/2; S26; S36; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Ammonium hexafluorosilicate is a white crystalline powder. Odorless. Molecular weight: 178.18;

specific gravity (H_2O:1) = 1.02; boiling point = decomposes @ 100°C; melting/freezing point = decomposes @ 100°C; heat of solution = 85 Btu/lb; vapor pressure ≤ 0.075 mm. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 0; reactivity 0₩. Sinks and mixes with water; reaction forms highly corrosive hydrofluoric acid.

Potential Exposure: This material is used as a pesticide and miticide, wood preservative, soldering flux; light metal casting; and in the etching of glass.

Incompatibilities: Aqueous solution is highly corrosive. Contact with acids reacts to form hydrogen fluoride, which is a highly corrosive and forms a toxic gas. Corrosive to aluminum. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Ammonium fluorosilicate reacts with water [and moisture in air] to form hydrofluoric acid, a source of fluoride ions. Unlike other halide ions, the fluoride ion is highly reactive, acting as a weak base and participating in some unique reactions. In particular, fluorides react strongly with compounds containing calcium, magnesium, or silicon ions, which means that solutions containing soluble fluorides are corrosive to both living tissue and glass. Hydrofluoric acid can cause severe chemical burns and is one of the few materials that can etch glass. It is also a toxic gas in its anhydrous form[101].

Permissible Exposure Limits in Air

NIOSH IDLH = 250 mg[F]/m^3

OSHA PEL: 3 ppm/2.5 mg[F]/m^3 TWA

NIOSH REL: 3 ppm/2.5 mg[F]/m^3 TWA; 6 ppm/5 mg[F]/m^3, 15 min. Ceiling Concentration

ACGIH TLV[1]: 2.5 mg[F]/m^3 TWA; not classifiable as a human carcinogen; BEI: 3 mg[F]/g creatinine in urine *prior* to end-of-shift; 10 mg[F]/g creatinine in urine end-of-shift

16919-19-0

PAC Ver. 29[138]

PAC-1: 12 milligram per cubic meter

PAC-2: 130 milligram per cubic meter

PAC-3: 780 milligram per cubic meter

DFG MAK: 1 mg[F]/m^3, inhalable fraction [skin]; Peak Limitation Category II(4); Pregnancy Risk Group C; BAT: 7.0 mg[F]/g creatinine in urine at end-of-shift; 4.0 mg[F]/g creatinine in urine at the beginning of the next shift.

Australia: TWA 2.5 mg[F]/m^3, 1993; Austria: MAK 2.5 mg [F]/m^3, 1999; Belgium: TWA 2.5 mg[F]/m^3, 1993; Finland: TWA 2.5 mg[F]/m^3, 1999; France: VME 2.5 mg[F]/m^3, 1999; Hungary: TWA 1 mg[F]/m^3; STEL 2 mg[F]/m^3, 1993; Norway: TWA 0.6 mg[F]/m^3, 1999; the Philippines: TWA 2.5 mg[F]/m^3, 1993; Poland: MAC (TWA) 1 mg [HF]/m^3, MAC (STEL) 3 mg[HF]/m^3, 1999; Russia: STEL 0.5 ppm (2.5 milligram per cubic meter), 1993; Sweden: NGV 2 mg[F]/m^3, 1999; Switzerland: MAK-W 1.8 ppm (1.5 mg[F]/m^3), KZG-W 3.6 ppm (3.0 mg[F]/m^3), 1999; Thailand: TWA 2.5 mg[F]/m^3, 1993; United Kingdom: TWA 2.5 mg[F]/m^3, 2000; LTEL 2.5 mg[F]/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen.

Determination in Air: Fluorides may be measured by collection on a filter and measurement by ion-specific electrode according to NIOSH Analytical Method 7902[18].

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guidelines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg[F]/L. SafeDrinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg [F]/L; SMCL = 2 mg/F/L, as Fluoride.

Routes of Entry: Inhalation, eyes, and/or skin contact.

Harmful Effects and Symptoms

Inhalation of dust can cause pulmonary irritation and can be fatal in some cases. Ingestion may be fatal. Contact with dust causes irritation of eyes and irritation or ulceration of skin[136]

Short-Term Exposure: Inhalation may cause difficult breathing and burning of the mouth, throat and nose which may result in bleeding. These may be felt @ 7.5 milligram per cubic meter. Nausea, vomiting, profuse sweating and excess thirst may occur at higher levels. May cause pulmonary edema, which can be delayed for several hours; there is a risk of death in serious cases. Skin contact may cause rash, itching and burning and ulceration of skin. Solutions of 1% strength may cause sores if not removed promptly. Eye contact may cause severe irritation. Most reported instances of fluoride toxicity are due to accidental ingestion and it is difficult to associate symptoms with dose. A dose of 5−40 mg may cause nausea, diarrhea and vomiting. More severe symptoms of burning and painful abdomen, sores in mouth, throat and digestive tract; tremors, convulsions and shock will occur around a dose of 1 gram. Death may result by ingestion of 2−5 g. Also reported as 1 teaspoon to 1 ounce.

Long-Term Exposure: May cause chronic lung irritation and kidney and liver damage. Bronchitis may develop. Chronic exposure may cause weight loss; nausea, vomiting, weakness, shortness of breath. Fluoride may increase bone density, stimulate new bone growth or cause calcium deposits in ligaments. This may become a problem at levels of 20−50 milligram per cubic meter or higher. May cause mottling of teeth at this level.

Points of Attack: Lungs, eyes, skin.

Medical Surveillance: NIOSH lists the following tests: chest X-ray, electrocardiogram, pulmonary function tests: forced vital capacity, forced expiratory volume (1 second); pelvic X-ray; sputum cytology; urine (chemical/metabolite); urine (chemical/metabolite) pre- and postshift; urinalysis (routine); CBC/differential. Intake of fluoride from natural sources in food or water should be known. In the case of exposure to fluoride dusts, periodic urinary fluoride excretion levels have been very useful in evaluating industrial exposures and environmental dietary sources.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Use only with an effective and properly maintained exhaust ventilation or with a fully enclosed process. Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash or dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA *12.5 milligram per cubic meter*: Qm (APF = 25) (any quarter-mask respirator). *25 milligram per cubic meter*: 95XQ (APF = 10)*[any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or SA* (any supplied-air respirator). *62.5 milligram per cubic meter*: Sa:Cf (APF = 25) *+ (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25)* *if not present as a fume* (any powered, air-purifying respirator with a high-efficiency particulate filter). *125 milligram per cubic meter*: 100F (APF = 50)$^+$ [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *250 milligram per cubic meter*: Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50)$^+$ [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or SCBAE (any appropriate escape-type, SCBA). *Substance reported to cause eye irritation or damage; may require eye protection. *May need acid gas sorbent.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers (such as chlorine, bromine and fluorine) since highly poisonous hydrogen fluoride gas is released. Keep in plastic, rubber or paraffined containers (because it easily etches glass).

Shipping: UN2856 Fluorosilicates, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Treat with soda ash or slaked lime. Use an industrial vacuum cleaner to remove the spill. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical may burn, but does not readily ignite. Thermal decomposition products may include hydrogen fluoride, silicon fluoride fumes and oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode. Water may be used but should be contained to prevent fluoride run-off.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration.

References

(31); (173); (122); (100).

National institute for Occupational Safety and Health (NIOSH), *Criteria for a Recommended Standard*: *Occupational Exposure to Inorganic Fluorides*, NIOSH Document Number 76-103, Cincinnati, OH (1976).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 4, No. 3, 36−38 (1984). (Ammonium silicofluoride).

New York State Department of Health, Chemical Fact Sheet: *Ammonium Hexafluorosilicate*, Bureau of Toxic Substance Assessment, Albany, NY (March 1986).

Ammonium Hydroxide A:1110

Formula: H_5NO; NH_4OH

Synonyms: Ammonia aqueous; Ammonia water; Aqua ammonia; Aqueous ammonia; Burmar lab clean; Enplate NI-418B; Enstrip NP-1; Hidroxido amonico (Spanish); Household ammonia; Hydroxyde d'ammonium (French); Poly silicon etch; PPD 5932 developer; Premetal etch; RCA clean (step 1); Scan kleen; Scrubber-Vapox

CAS Registry Number: 1336-21-6

HSDB Number: 5125

RTECS Number: BQ9625000

UN/NA & ERG Number: UN2672/154

EC Number: 215-647-6 [*Annex I Index No.*: 007-001-01-2]

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Combustible, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction).

Clean Water Act: 40CFR116.4 Hazardous Substances; RQ 40CFR117.3 (same as CERCLA)

Superfund/EPCRA 40CFR302.4, Appendix A, RQ: 1000 lb (454 kg); Section 313: Form R *de minimis* concentration reporting level: 1.0% (as ammonia). NH_3 Equivalent molecular weight: 48.59.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: C, N, Xi; risk phrases: R34; R36/37/38; R51; R62; safety phrases: S1/2; S26; S36/37/39; S41; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Ammonium Hydroxide is a colorless to milky-white solution of ammonia, with a strong, irritating odor. Molecular weight: 35.05; specific gravity (H_2O:1) = 0.9 @ 25°C; boiling point = 37.8°C (25% NH_3); freezing/melting point = −77°C; −58°C (25% NH_3); vapor pressure = 720 mmHg @ 27°C (30%NH_3); 115 mmHg @ 20°C (10% NH_3). Autoigniton temperature = 650 C. Explosive limits: LEL: 15%, UEL: 25%. Hazard identification (based on NFPA-704 M Rating System) (*strong solution*): Health 3; flammability 1; reactivity 2. Soluble in water.

Potential Exposure: It is used in detergents, stain removers, bleaches, dyes, fibers, and resins.

Incompatibilities: Solution is strongly alkaline. Violent reaction with strong oxidizers, acids (exothermic reaction with strong mineral acids). Shock-sensitive compounds may be formed with halogens, mercury oxide; silver oxide. Fire and explosions may be caused by contact with β-propiolactone, silver nitrate; ethyl alcoho; silver permanganate; trimethylammonium amide; 1-chloro-2,4-dinitrobenzene, *o*-chloronitrobenzene, platinum, trioxygen difluoride; selenium difluoride dioxide; boron halides; mercury, chlorine, iodine; bromine, hypochlorites, chlorine bleach; amides, organic anhydrides; isocyanates, vinyl acetate; alkylene oxides; epichlorohydrin; aldehydes. Attacks some coatings, plastics and rubber. Attacks copper, brass, bronze, aluminum, steel, zinc, and their alloys.

Permissible Exposure Limits in Air

NIOSH IDLH = 300 ppm

odor threshold (ammonia) = 0.043−47 ppm.

ACGIH TLV[1]: 25 ppm/17 milligram per cubic meter TWA; 35 ppm/24 milligram per cubic meter STEL

NIOSH REL: 25 ppm/18 milligram per cubic meter TWA; 35 ppm/27 milligram per cubic meter STEL

OSHA PEL: 50 ppm/35 milligram per cubic meter TWA

PAC Ver. 29[138]

PAC-1: 61 ppm

PAC-2: 330 ppm

PAC-3: 2300 ppm

DFG MAK: MAK: 20 ppm/14 milligram per cubic meter TWA; Peak Limitation Category I(2); Pregnancy Risk Group C (2004).

Arab Republic of Egypt: TWA 25 ppm (18 milligram per cubic meter), 1993; Australia: TWA 25 ppm (18 milligram per cubic meter); STEL 35 ppm, 1993; Austria: MAK 25 ppm (18 milligram per cubic meter), 1999; Belgium: TWA 25 ppm (17 milligram per cubic meter); STEL 35 ppm (24 milligram per cubic meter), 1993; Denmark: TWA 25 ppm (18 milligram per cubic meter), 1999; Finland: TWA 25 ppm (18 milligram per cubic meter);

STEL 40 ppm (30 milligram per cubic meter), 1993; France: VME 25 ppm (18 milligram per cubic meter), VLE 50 ppm (36 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 14 milligram per cubic meter, 2003; India: TWA 25 ppm (18 milligram per cubic meter); STEL 35 ppm (27 milligram per cubic meter), 1993Japan: 25 ppm (17 milligram per cubic meter), 1999; Norway: TWA 25 ppm (18 milligram per cubic meter), 1999; the Philippines: TWA 50 ppm (30 milligram per cubic meter), 1993; Poland: MAC (TWA) 20 milligram per cubic meter; MAC (STEL) 27 milligram per cubic meter, 1999; Russia: TWA 25 ppm; STEL 20 milligram per cubic meter, 1993; Sweden: NGV 25 ppm (18 milligram per cubic meter), TGV 50 ppm (35 milligram per cubic meter), 1999; Switzerland: MAK-W 25 ppm (18 milligram per cubic meter), KZG-W 50 ppm (36 milligram per cubic meter), 1999; Thailand: TWA 50 ppm (35 milligram per cubic meter), 1993; Turkey: TWA 25 ppm (35 milligram per cubic meter), 1993; United Kingdom: TWA 25 ppm (18 milligram per cubic meter); STEL 35 ppm (25 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 35 ppm.

Determination in Air: Sampling by absorption in sulfuric acid followed by measurement by ion chromatography, conductivity. Use NIOSH Analytical Method #6015, #6016.

Permissible Concentration in Water: Russia[43] set a MAC of 2.0 mg/mL in water bodies used for domestic purposes and 0.05 mg/mL in water bodies used for fishery purposes.

Routes of Entry: Ingestion, skin, and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Ammonium hydroxide is a corrosive chemical and can severely burn the skin and eyes, causing permanent damage. Exposure can severely irritate the nose, throat and lungs. Inhalation may cause pulmonary edema, which can be delayed for several hours; there is a risk of death in serious cases.

Long-Term Exposure: Long-term exposure at low levels may cause chronic bronchitis. Repeated skin contact can cause dermatitis, dryness, itching, and redness.

Points of Attack: Lungs, skin, eyes.

Medical Surveillance: Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Lung function tests. Consider chest X-ray following acute exposure.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Specific engineering controls are recommended for ammonia by NIOSH in criteria document #74-136 (Ammonia).

Respirator Selection:

NIOSH: *250 ppm*: CcrS* (APF = 10) (any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern); or Sa* (APF = 10) (any supplied-air respirator). *300 ppm*: Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprS* (APF = 25) (any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern); or CcrFS (APF = 50) [any chemical cartridge respirator with a full facepiece and cartridge (s) providing protection against the compound of concern]; or GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—White stripe (*strong solution*): Contact Hazard; not compatible with materials in solid white category. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in temperatures below 25°C/77°F. Do not fill bottles completely. Store in tightly closed, strong glass, plastic or rubber-stoppered containers in a cool, well-ventilated area. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2672 Ammonia solutions, relative density between 0.880 and 0.957 at 15°C in water, with $>10\%$ but not $>35\%$ ammonia, Hazard class: 8; Labels: 8-Corrosive material.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate closed spaces before entering them. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. If professional environmental engineering assistance is required, contact the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Fire Extinguishing: Thermal decomposition products may include ammonia and nitrogen oxides. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dilute with water, neutralize with HCl and discharge to sewer[22].

References

(31); (173); (101); (138); (2); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 2, No. 3, 41−44 (1982).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Ammonium Hydroxide, Trenton, NJ (March 2002).

Ammonium Metavanadate A:1120

Formula: H_4NO_3V; NH_4VO_3

Synonyms: Ammonium vanadate; Métavanadate d'ammonium (French); Metavanadato de amonio (Spanish); Vanadate (V031-), ammonium; Vanadato amonico (Spanish); Vanadic acid, ammonium salt

CAS Registry Number: 7803-55-6

HSDB Number: 6310

RTECS Number: YW0875000

UN/NA & ERG Number: UN2859/154

EC Number: 232-261-3

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Highly toxic, Suspected of causing genetic defects, Suspected reprotoxic hazard

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P119

RCRA 40CFR261, Appendix 8, Hazardous Constituents

RCRA Land Ban Waste Restrictions

Superfund/EPCRA 40CFR302.4, Appendix A, RQ: 1000 lb (454 kg)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T + , Xn; risk phrases: R20; R22; R23/24/25; R26; R34; R36/37/38; R50; R62; R63; safety phrases: S22; S26; S28; S36/37/39; R45; (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): Vanadium and compounds: 3-Severe hazard to water, unless water solubility is <4 μg[V]/L.

Description: Ammonium metavanadate is a white or slightly yellow crystalline powder. It is an inorganic acidic salt. Molecular weight = 116.98; specific gravity (H_2O:1) = 2.33; freezing/melting point = 200°C (decomposes). Slightly soluble in water, with decomposition.

Potential Exposure: It is used in the metals industry to make alloys, chemical reactions, dyes, inks, varnishes, printing, medicines, and photography.

Incompatibilities: Moisture forms an acidic solution. React with bases and alkaline material: may generate heat and release flammable hydrogen gas.

Permissible Exposure Limits in Air

NIOSH IDLH = 35 mg[V]/m^3

OSHA PEL: 0.05 mg[V_sO_5]/m^3 TWA (*dust*):, respirable fraction; 0.1 mg[V_sO_5]/m^3 Ceiling Concentration, (fume)

NIOSH REL: 1.0 mg[V]/m^3 TWA
ACGIH TLV[1]: 0.05 mg[V_sO_5]/m^3 TWA, Not classifiable as a human carcinogen, (dust or fume)
PAC Ver. 29[138]
PAC-1: 0.01 milligram per cubic meter
PAC-2: 0.11 milligram per cubic meter
PAC-3: 80 milligram per cubic meter
DFG MAK: Carcinogen Category 2; Germ Cell Mutagen Group 2 (2005) vanadium inorganic compounds

These levels are for air levels only. When skin contact also occurs, overexposure is possible even though air levels are less than the airborne permissible limits. For fume limits see "vanadium metal" (CAS 7440-62-2).

Determination in Air: Use NIOSH Method (vanadium): #7300, #7301; #7303 Elements, #7504.

Permissible Concentration in Water: State Drinking Water Guidelines: California: 50 μg[V]/L Arizona 7 μg[V]/L; Florida: 49 μg[V]/L; Minnesota: 50 μg[V]/L; Wisconsin: 30 μg[V]/L. Runoff from spills or fire control may cause water.

Routes of Entry: Inhalation, skin, and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, nose, and respiratory tract. Inhalation can cause coughing, wheezing and phlegm. Exposure may cause headache and a green coating on the tongue. Higher exposures may cause pneumonia and/or pulmonary edema, which can be delayed for several hours; there is a risk of death in serious cases. The oral LD$_{50}$ for rats is 160 mg/kg.

Long-Term Exposure: Ammonium metavanadate may be a reproductive hazard. Repeated exposure may cause lung irritation and bronchitis.

Points of Attack: Eyes, skin, and lungs.

Medical Surveillance: Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Lung function tests. Consider X-ray following acute overexposure. Regulatory exams that include lung function, X-ray, and skin tests are proposed in criteria document NIOSH 77-222.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA (as V): *0.5 milligram per cubic meter*: 100XQ* (APF = 10) (any air-purifying respirator with an N100, R100, or P100 filter (including N100, R100, and P100 filtering facepieces) except quarter-mask respirators); or SA* (any supplied-air respirator). *1.25 milligram per cubic meter*: Sa:Cf * (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie* (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *2.5 milligram per cubic meter*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or PaprHie* (APF = 25)* (any powered, air-purifying respirator with a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd, Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

* *Note*: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from heat.

Shipping: UN2859 Ammonium metavanadate, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include ammonia, vanadium oxides; and nitrogen oxides. Extinguish fire using an agent suitable for type of surrounding fire. Ammonium metavanadate itself does not burn. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

National institute for Occupational Safety and Health (NIOSH), "Criteria for a Recommended Standard: Occupational Exposure to Vanadium," NIOSH Document Number 77-222, Cincinnati, OH (1977).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Ammonium Metavanadate, Trenton, NJ (September 1998).

Ammonium Molybdate A:1130

Formula: $H_8MoN_2O_4$; $(NH_4)_2MoO_4$

Synonyms: Ammonium paramolybdate; Diammonium molybdate; Molibdato amonico (Spanish); Molybdic acid, diammonium salt

CAS Registry Number: 13106-76-8

HSDB Number: 1802

RTECS Number: QA4900000

EC Number: 236-031-3

Regulatory Authority and Advisory Information

CERCLA/SARA Section 313: Form R *de minimis* concentration reporting level: 1.0% (as ammonia)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: Xi; risk phrases: R36/37/38; safety phrases: S23; S26l S36; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Ammonium molybdate is a colorless, white or slightly greenish-yellow powder. Molecular weight + 196.038; specific gravity (H_2O:1) = 2.28. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 0; reactivity 0. Soluble in water.

Potential Exposure: It is used as an analytical reagent, in pigments and in the production of molybdenum metal and ceramics.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides; chemically active metals (such as potassium, sodium, magnesium and zinc) may cause a violent reaction.

Permissible Exposure Limits in Air

NIOSH IDLH = 1000 mg[Mo]/m^3

ACGIH TLV[1]: 0.5 mg[Mo]/m^3 TWA soluble compounds, confirmed animal carcinogen with unknown relevance to humans.

OSHA PEL: 5 mg[Mo]/m^3 TWA soluble compounds

PAC Ver. 29[138]

PAC-1: 3.1 milligram per cubic meter

PAC-2: 22 milligram per cubic meter

PAC-3: 130 milligram per cubic meter

DFG MAK: 5 mg[Mo]/m^3 TWA soluble compounds

Russia[43] set a MAC for molybdenum in work-place air @ 2.0 milligram per cubic meter for aerosol condensates and 4 milligram per cubic meter for soluble compounds in the form of dust.

Determination in Air: Molybdenum may be sampled by filter and measured by inductively coupled argon plasma atomic emission spectroscopy as described in NIOSH Analytical Method 7300 for metals[18].

Routes of Entry: Inhalation, ingestion; skin, and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: This chemical can be absorbed through the skin, thereby increasing exposure. Symptoms of molybdenum poisoning includes stomach upset, diarrhea, coma; death from heart failure can occur. Exposure to high concentrations may cause irritation of the eyes, nose and throat. Very high exposure may cause kidney and liver damage.

Long-Term Exposure: May cause kidney and liver damage. Inhalation of dust can cause lung disease.

Points of Attack: Skin, lungs.

Medical Surveillance: Kidney, liver tests. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Lung function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Where possible, enclose operations and use local exhaust ventilation at this site of chemical release. Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: OSHA (for soluble compounds of molybdenum) *25 milligram per cubic meter*: Qm (APF = 25) (any quarter-mask respirator). *50 milligram per cubic meter*: 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *125 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or if not present as a fume PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *250 milligram per cubic meter*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *1000 milligram per cubic meter*: SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA). *Note*: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store to avoid possible contact with active metals.

Shipping: There are no known UN/DOT restrictions.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent for type of surrounding fire. Ammonium molybdate itself does not burn. Thermal decomposition products may include ammonia and nitrogen oxides. Use dry chemical appropriate for extinguishing metal fires. *Do not use* water. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Ammonium Molybdate, Trenton, NJ (May 2000).

Ammonium Nitrate A:1140

Formula: $H_4N_2O_3$; NH_4NO_3
Synonyms: Ammonium(I) nitrate(1:1); Ammonium nitrate-urea solution Ammonium saltpeter; Ansax; Emulite; German saltpeter; Herco prills; Nitram; Nitrato amonico (Spanish); Nitrate d'ammonium, avec couche organique (French); Nitrato amónico, con revestimiento orgánico (Spanish); Nitric acid, ammonium salt; Norge saltpeter; Norway saltpeter; Plenco 12203; Varioform I
CAS Registry Number: 6484-52-2
HSDB Number: 475
RTECS Number: BR9050000
UN/NA & ERG Number: UN0222 (Ammonium nitrate, with $>0.2\%$ combustible substances)/112; UN1942 (Ammonium nitrate, with not $>0.2\%$ combustible substances) (Ammonium nitrate fertilizer)/140; UN3375 (Ammonium nitrate suspension, emulsion, gel)/140; UN2072 (Ammonium nitrate fertilizers, n.o.s.)/140; UN2071 (Ammonium nitrate fertilizer, with NOT $> 0.4\%$ combustible material)/140; UN2067 (Ammonium nitrate based fertilizers)/140; UN2426 (Ammonium nitrate, liquid (hot concentrated solution)/140; UN2069* (Ammonium nitrate with ammonium sulfate)140; UN2072 (Ammonium nitrate fertilizers)/140 *Note*: *May* not appear in the 49 CFR Hazmat Table.
EC Number: 229-347-8
Regulatory Authority and Advisory Information
Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 5000 (commercial grade); *Theft hazard* 400 (commercial grade) (explosive: with more than 0.2% combustible substances, including any organic substances calculated as carbon, to the exclusion of any other substance); *Theft hazard* 2000 (*33% concentration*) (fertilizer: solid, with nitrogen concentration of $\geq 23\%$ nitrogen).
Hazard Alert: Combustible, Environmental Hazard, Agricultural chemical.
United States National Primary Drinking Water Regulations: MCLG = 10 mg[N]/L; MCL = 10 mg/L
United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as nitrate compounds
Clean Water Act: 40CFR116.4 Hazardous Substances; RQ 40CFR117.3 (same as CERCLA)
CERCLA/SARA Section 313: Form R *de minimis* concentration reporting level: 1.0% (as ammonia). NH_3 Equivalent molecular weight: 21.28 also reportable as a nitrate compound, water dissociable, (reportable only when in an aqueous solution), at the same reporting level (1.0%).
Canada, NPRI (solution only).
WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.
Description: Ammonium nitrate is a white to gray to brown, beads, pellets, or flakes. Odorless. Molecular weight: 80.04; specific gravity (H_2O:1) = 1.73; boiling point = (decomposes below BP) 210°C; freezing/melting point = about 169°C with slow decomposition; the decomposition accelerates as it reaches boiling point and may become explosive. Hazard identification (based on NFPA-704 M Rating System): Health 0; flammability 0; reactivity 3, Oxidizer. Soluble in water.
Potential Exposure: Used in the manufacture of liquid and solid fertilizer compositions, industrial explosives and blasting agents from ammonium nitrate, matches; antibiotics; in the production of nitrous oxide.
Incompatibilities: A strong oxidizer. Reducing agents; combustible materials; organic materials; finely divided (powdered) metals may form explosive mixtures or cause fire and explosions. When contaminated with oil, charcoal or flammable liquids, can be considered an explosive which can be detonated by combustion or shock.
Permissible Exposure Limits in Air
PAC Ver. 29[138]
PAC-1: 6.7 milligram per cubic meter
PAC-2: 73 milligram per cubic meter
PAC-3: 440 milligram per cubic meter
Russia: MAC 0.3 milligram per cubic meter on a daily average basis in ambient air.
Permissible Concentration in Water: Russia[43] set a MAC of 0.5 mg/L in water bodies used for fishery purposes.
Routes of Entry: Inhalation, skin, and/or eye contact.
Harmful Effects and Symptoms
Short-Term Exposure: The potential for ammonia poisoning in the course of NH_4NO_3 and fertilizer manufacture is the chief toxic effect associated with ammonium nitrate. Exposure may irritate the skin, eyes, nose, throat and lungs. Overexposure can cause nausea and vomiting, headaches, weakness, faintness and collapse. Severe overexposure may lower the ability of the blood to carry oxygen. This can result in a bluish color to skin and lips, headaches, dizziness, collapse and even death.
Long-Term Exposure: Unknown at this time.
Points of Attack: Inhalation, skin.
Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.
Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/

manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Isolate ammonium nitrate from all other chemicals. UN0222 Explosive, Oxidizer. (Ammonium nitrate, with > 0.2% combustible substances) UN1942 & UN3375 Explosive, Strong oxidizer. Color code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Oxidizers, including oxidizing gases, should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in a well-ventilated area, away from sparks and flames preferably in a noncombustible location equipped with automatic sprinkler protection. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Keep well closed, dry, separated from materials and labeled "oxidizer." Storage of 500 tons or more should be avoided[35] or at least very carefully regulated. See NFPA 490, *Code for the Storage of Ammonium Nitrate*. See also OSHA Standard 1910.104 and NFPA 43 A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: Ammonium nitrate with organic coating: UN0222 Ammonium nitrate, with > 0.2% combustible substances, including any organic substance calculated as carbon, to the exclusion of any other added substance, Hazard Class: 1D; Labels:1D-Explosive (with a mass explosion hazard); D-Substances or articles which may mass detonate (with blast and/or fragment hazard) when exposed to fire. Ammonium nitrate with NO organic coating: UN1942 Ammonium nitrate, with NOT > 0.2% of combustible substances, including any organic substance calculated as carbon, to the exclusion of any other added substance (also used for fertilizer), Hazard Class: 5.1; Labels: 5.1-Oxidizer. UN3375 Ammonium nitrate emulsion or Ammonium nitrate suspension or Ammonium nitrate gel, intermediate for blasting explosives, Hazard Class: 5.1; Labels: 5.1-Oxidizer. UN2072 Ammonium nitrate fertilizer, n.o.s., doesn't appear in the 49 CFR Hazmat Table, refer to UN1942, above). UN2071 Ammonium nitrate based fertilizer, Hazard class: 9; Labels: 9-Miscellaneous hazardous material. UN2426/140 Ammonium nitrate, liquid (hot concentrated solution), Hazard Class: 5.1; Labels: 5.1-Oxidizer.

Spill Handling: Evacuate and isolate the area of the spill and restrict persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Cover the spill with dry lime or soda ash and collect powdered material in the most convenient and safe manner and deposit in sealed containers. Flush area with water. Ventilate area after clean-up is complete. Keep ammonium nitrate out of confined space, such as a sewer, because of the potential for an explosion. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Does not burn but supports combustion. May explode under confinement and high temperatures. Exercise extreme caution. Use flooding amounts of water. Thermal decomposition products may include nitrogen oxides and ammonia. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Pretreatment involves addition of sodium hydroxide to liberate ammonia and form the soluble sodium salt. The liberated ammonia can be recovered and sold. After dilution to the permitted provisional limit, the sodium salt can be discharged into a stream or sewer[22].

References

(31); (173); (101); (138); (100).

National Institute for Occupational Safety and Health (NIOSH), *Profiles on Occupational Hazard for Criteria Document Priorities*: *Ammonium Nitrate, pp 281−285, Report PB-274,073*, Washington, DC (1977).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 2, No. 3, 44−46 (1982).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: *Ammonium Nitrate*, Trenton, NJ (June 1998).

New York State Department of Health, Chemical Fact Sheet: *Ammonium Nitrate*, Bureau of Toxic Substance Assessment, Albany, NY (January 1986).

Ammonium Oxalate A:1150

Formula: $C_2H_8N_2O_4$; $NH_4OOCCOONH_4$

Synonyms: Ethanedioic acid, diammonium salt; Oxalato amonico (Spanish)

CAS Registry Number: 1113-38-8 (hydrated salt 2:1); 5972-73-6 (monohydrate salt); 14258-49-2 (salt 2:1); 6009-70-7 (monohydrate)

HSDB Number: 1424

RTECS Number: RO2750000

UN/NA & ERG Number: UN1759 (Corrosive solids, n.o.s.)/154; UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 214-202-3

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Combustible, Reducing agent, Corrosive, Irritant.

Clean Water Act: 40CFR116.4 Hazardous Substances; RQ 40CFR117.3 (same as CERCLA)

Superfund/EPCRA 40CFR302.4, Appendix A, RQ: 5000 lb (2270 kg); Section 313: Form R *de minimis* concentration reporting level: 1.0% (as ammonia). NH_3 Equivalent molecular weight: 27.45.

Hazard symbols, risk, & safety statements: Hazard symbol: C, Xn; risk phrases: R21/22; R34; R35; R36/37/38; R40; R42; R67; safety phrases: S1; S23; S24/25; S26; S36/37/39; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Ammonium oxalate is an odorless, colorless crystalline material or powder. Molecular weight = 124.10; specific gravity (H_2O:1) = 1.48; freezing/melting point = (decomposes) 70°C. Hazard identification (based on NFPA-704 M Rating System/NJDH): Health 2; flammability 1; reactivity 0. Corrosive. Slightly soluble in water.

Potential Exposure: It is used in chemical analysis and to make blueprint paper, explosives; a rust-removal ingredient in metal polishes.

Incompatibilities: Ammonium oxalate is a reducing agent and also reacts as a base to neutralize acids and reacts with oxidizers generating carbon dioxide. Incompatible with oxidizers (chlorates, hypochlorite solutions, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 30 milligram per cubic meter

PAC-2: 330 milligram per cubic meter

PAC-3: 2000 milligram per cubic meter

Routes of Entry: Inhalation, ingestion; skin, and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Breathing ammonium oxalate can irritate the nose, throat and lungs. Harmful if swallowed or in contact with skin. Contact can irritate the skin. Overexposure may cause a kidney stone and kidney damage.

Long-Term Exposure: Repeated exposures may cause bronchitis, kidney stones, and kidney damage. Repeated contact may cause cracking of the skin and slow healing ulcers.

Points of Attack: Lungs, skin, kidneys.

Medical Surveillance: Lung function tests, Urinalysis, kidney function tests.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Gloves: Nitrile, natural rubber; Coveralls: Tyvek. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece

respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Where there is no REL, at any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: (1) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. (2) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN1759 Corrosive solids, n.o.s., Hazard class: 8; Labels: 8-Corrosive material, Technical Name Required.

Spill Handling:

UN2811: Isolation Distance, Spill: 25 m/75 ft.(NJ). Isolation distance, fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Ammonium Oxalate may burn, but does not readily ignite. Thermal decomposition products may include ammonia fumes and oxides of nitrogen and carbon. Isolation distance, fire: 800 m/0.5 mi.(NJ). Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (101); (138); (201); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Ammonium Oxalate, Trenton, NJ (April 2009).

Ammonium Permanganate A:1170

Formula: H_4MnNO_4; NH_4MnO_4

Synonyms: Permanganato amonico (Spanish); Permanganic acid ammonium salt

CAS Registry Number: 13446-10-1

RTECS Number: SD6400000

UN/NA & ERG Number: UN3085 (oxidizing solid, corrosive, n.o.s.),/140; UN0473 (Substances, explosive, n.o.s.)/112

Regulatory Authority and Advisory Information

Hazard Alert: Explosive (when dry), Poison, Neurotoxic (cumulative) as Mn, Corrosive, Explosive.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112), as manganese compounds

Safe Drinking Water Act (47FR 9352): SMCL = 0.05 mg/L

EPA TSCA chemical inventory Section 8(b) as manganese

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%, manganese compounds, Form R Toxic Chemical Category Code: N450

Superfund/EPCRA 40CFR302.4, Appendix A, Section 313: Form R *de minimis* concentration reporting level: 1.0% (as ammonia).

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. as manganese compounds, n.o.s.

Hazard symbols, risk, & safety statements: Hazard symbol: T, O; risk phrases: R8; safety phrases: S17; S41 (see Appendix 4)

Description: Ammonium permanganate is a violet-brown or dark purple crystalline (sugar-like or sand-like) solid. Molecular weight = 136.98; specific gravity (H_2O:1) = 2.21; freezing/melting point = 110°C. It explodes when heated to 60°C. Hazard identification (based on NFPA-704 M Rating System): Health 0; flammability 0; reactivity 3, OX. Soluble in water.

Potential Exposure: This material is used in bleaching and dyeing operations in the textile and leather industries.

Incompatibilities: Explosive; a strong oxidizing agent. Contact with reducing agents; fuels and other combustible materials; heat, or friction may cause a violent reaction. Ammonium permanganate, when dry, may explode from shock, friction or heating[68]. Incompatible with acetic acid, acetic anhydride, benzene, carbon disulfide, diethyl ether, ethyl alcohol, petroleum, combustibles, or organic matter.

Permissible Exposure Limits in Air

Ammonium permanganate

PAC Ver. 29[138]

PAC-1: 7.5 milligram per cubic meter

PAC-2: 12 milligram per cubic meter

PAC-3: 72 milligram per cubic meter

Manganese:

NIOSH IDLH = 500 mg[Mn]/m^3

OSHA PEL: 5 mg[Mn]/m^3 Ceiling Concentration (inorganic compounds and fume)

NIOSH REL: 1 mg[Mn]/m^3 TWA; 3 mg[Mn]/m^3 STEL

ACGIH TLV[1] 0.02 mg[Mn]/m^3, respirable fraction; 0.1 mg[Mn]/m^3, inhalable fraction; not classifiable as a human carcinogen.

DFG MAK (*inorganic compounds and fume*): 0.5 mg[Mn]/m^3 inhalable fraction (Mn and its inorganic compounds); Pregnancy Risk Group C

Determination in Air: *Manganese*: Use NIOSH Analytical Method, Elements by ICP, #7300; #7301; #7303; #9102; Elements in blood or tissue, #8005; Metals in urine, #8310; OSHA Analytical Method, ID-125G or ID121.

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 50 μg[Mn]/L; State Drinking Water Standards: New York: 300 μg[Mn]/L; State Drinking Water Guidelines: California 500 μg[Mn]/L; Connecticut: 500 μg [Mn]/L; Maine: 500 μg[Mn]/L; Minnesota: 300 μg[Mn]/L; New Hampshire: 100 μg[Mn]/L. World Health Organization (WHO) limit: 400 μg(Mn)/L.

Routes of Entry: Inhalation, skin, and/or eye contact, ingestion.

Harmful Effects and Symptoms

Ammonium permanganate can affect you when breathed in. Exposure to ammonium permanganate can cause irritation of the eyes, nose, throat and lungs. Contact can irritate the skin and eyes.

Short-Term Exposure: Highly irritating to eyes, skin and respiratory tract.

Long-Term Exposure: Very irritating substances may cause lung effects and possible damage.

Points of Attack: Skin, eyes, nasal passages, throat and lungs.

Medical Surveillance: Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Lung function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposure to Ammonium Permanganate, use a MSHA/NIOAH approved respirator equipped with particulate (dust/fume/mist) filters. More protection is provided by a full facepiece respirator than by a half-mask respirator, and even greater protection is provided by a powered-air purifying respirator. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Oxidizers, including oxidizing gases, should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Ammonium Permanganate must be stored to avoid contact with heat, friction, organic and oxidizable material, fuels and combustibles, since violent reactions occur. Always store ammonium permanganate at temperatures below 60°C/140°F. Protect containers from shock as Ammonium Permanganate may explode. See OSHA Standard 1910.104 and NFPA 43 A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: UN0473 Substances, explosive, n.o.s., Hazard Class: 1.1 A; Labels:1.1A-Explosive (with a mass explosion hazard); A-Substances which are expected to mass detonate very soon after fire reaches them, Technical Name Required. UN3085 Oxidizing solid, corrosive, n.o.s., Hazard Class: 5.1; Labels: 5.1-Oxidizer, 8-Corrosive material. Technical Name Required.

Spill Handling: As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 m (150 ft) for liquids and at least 25 m/75 ft for solids. *Large spill*: Consider initial downwind evacuation for at least 100 m/330 ft. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after clean-up is complete. Keep ammonium permanganate out of a confined space, such as a sewer, because of the potential for an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is highly reactive, heat sensitive and potentially explosive. Thermal decomposition products may include ammonia and oxides of nitrogen and metal. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Generators of waste (equal to or greater than 100 kg/mo) containing this contaminant, EPA hazardous waste number N450, must conform with USEPA regulations for storage, transportation, treatment and disposal of waste. Dispose of waste material as hazardous waste using a licensed disposal contractor to an approved landfill. Dispose of contents and container to an approved waste disposal plant. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office. All federal, state, and local environmental regulations must be observed. Do not discharge into drains or sewers.

References

(31); (173); (101); (138); (2).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Ammonium Permanganate, Trenton, NJ (August 2000).

Ammonium Persulfate A:1180

Formula: $H_8N_2O_8S2$; $(NH_4)_2S_2O_8$

Synonyms: Ammonium perosycisulfate; Ammonium perosysulfate; Ammonium peroxidodisulfate; Ammonium peroxydisulfate; Ammonium peroxysulfate; Ammonium persulfate; Bis(ammonium)peroxodisulfate; Diammonium peroxydisulfate; Diammonium persulfate; Panreac PA; Peroxydisulfuric acid diammonium salt; Persulfate d'ammonium (French); Persulfato de amonio (Spanish); Persulfato amonico (Spanish)

CAS Registry Number: 7727-54-0

HSDB Number: 7985

RTECS Number: SE0350000

UN/NA & ERG Number: UN1444/140

EC Number: 231-786-5 [*Annex I Index No.*: 016-060-00-6]

Regulatory Authority and Advisory Information

Hazard Alert: Strong oxidizer, Sensitization hazard (skin, resp.).

United States National Primary Drinking Water Regulations: SMCL = 250 mg[SO_4^{2-}]/L as Sulfate

Superfund/EPCRA 40CFR302.4, Appendix A, RQ: 100 lb (45.4 kg)

EPCRA Section 313: Form R *de minimis* concentration reporting level: 1.0% (as ammonia). NH_3 Equivalent molecular weight: 14.93.

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazard symbols, risk, & safety statements: Hazard symbol: O, Xn, Xi; risk phrases: R8; R22; R36/37/38; R42/43; safety phrases: S2; S17; S22; S24; S26; S37; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Ammonium persulfate is a colorless or white crystalline solid. Molecular weight = 228.19; freezing/melting point = (decomposes) 120°C; specific gravity (H_2O:1) = 1.982 @ 20°C; heat of decomposition = 120°C; heat of solution = 1.8×10^5 J/kg. Hazard identification (based on NFPA-704 M Rating System): Health 1; flammability 0; reactivity 1, Oxidizer, ₩. Decomposes in water.

Potential Exposure: It is used as a bleaching agent, in photographic chemicals, and to make dyes. It is also used as an ingredient of polymerization catalysts.

Incompatibilities: Decomposes in water and moist air, forming oxygen gas. A strong oxidizer; reacts with reducing agents; organic and combustible materials. Incompatible with heat, sodium peroxide (produces a friction-, heat-, and water-sensitive explosive); aluminum powder.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 0.3 milligram per cubic meter

PAC-2: 22 milligram per cubic meter

PAC-3: 130 milligram per cubic meter

ACGIH TLV[1]: 0.1 milligram per cubic meter TWA *as persulfates*

DFG MAK: Danger of sensitization of the airways and skin.

United Kingdom: TWA 1 mg(S_2O_8), 2000; the Netherlands: MAC-TGG 1 milligram per cubic meter, 2003

Routes of Entry: Inhalation, ingestion; skin, and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Exposure can irritate the skin, eyes, nose, throat and lungs. Exposure may cause an allergy-like reaction, with eye tearing, nose congestion; asthma-like wheezing and difficulty in breathing. Life-threatening shock may result. The oral LD_{50} for rats is 820 mg/kg[9].

Long-Term Exposure: May cause skin or respiratory allergies.

Points of Attack: Eye, lungs, skin.

Medical Surveillance: Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Lung function tests. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended; effects may be delayed.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. If local exhaust ventilation or enclosure is not used, respirators should be worn. Wear protective work clothing and goggles. Wash thoroughly immediately after exposure to Ammonium persulfate.

Storage: Check oxygen content prior to entering storage area. Color code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially organic materials, flammables and combustibles, and other incompatible materials. Oxidizers, including oxidizing gases, should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Ammonium persulfate must be stored to avoid contact with combustibles (such as wood, paper, and oil), sodium peroxide, aluminum and water, since violent reactions occur. Store in tightly closed containers in a cool, dry and well-ventilated area. Store in a cool, well-ventilated area away from incompatible materials listed above. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage.

Shipping: UN1444 Ammonium persulfate, Hazard Class: 5.1; Labels: 5.1-Oxidizer

Spill Handling: Restrict persons not wearing protective equipment from the danger area of spill until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Wash area down with water.

Fire Extinguishing: Ammonium persulfate is a strong oxidizing agent that can cause combustible materials, such as wood, paper, and oil to ignite. Heat above 120°C forms oxygen and sulfur dioxide. In addition, other Thermal decomposition products may include ammonia and oxides of nitrogen. Use dry chemical, CO_2 or water spray extinguishers.

Disposal Method Suggested: May be treated with large volumes of water, neutralized and flushed to sewer[22]. This applies to small quantities only.

References

(31); (101); (138); (100).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 2, No. 3, 48−49 (1982).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Ammonium Persulfate, Trenton, NJ (July 2000).

Ammonium Phosphate A:1190

Formula: $H_9N_2O_4P$; $(NH_4)_2HPO_4$
Synonyms: Ammonium orthophosphate, dibasic; Ammonium orthophosphate, monohydrogen; Ammonium phosphate, dibasic; Ammonium phosphate, hydrogen; Diammonium orthophosphate; Diammonium orthophosphate, hydrogen; Diammonium phosphate; Diammonium phosphate, hydrogen; Diammonium phosphate, monohydrogen; Dibasic ammonium phosphate; Secondary ammonium phosphate
CAS Registry Number: 7722-76-1 (monobasic); 7783-28-0 (dibasic)
HSDB Number: 301
RTECS Number: TB9375000
UN/NA & ERG Number: Not listed
EC Number: 231-987-8
Regulatory Authority and Advisory Information
CERCLA/SARA Section 313: Form R *de minimis* concentration reporting level: 1.0% (as ammonia). NH_3 Equivalent molecular weight: 25.79.
Hazard symbols, risk, & safety statements: Hazard symbol: Xi, Xn; risk phrases: R8; R20/21/22; R36/37/38; safety phrases: S26; 36/37/39; S45 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.
Description: Ammonium phosphate is a white crystalline or powdery substance. Molecular weight: 132.06 (dibasic); 115.03 (monobasic); specific gravity (H_2O:1) = 1.803 @ 20°C (dibasic/monobasic); boiling point = 100°C (decomposes); melting/freezing point = dibasic decomposes below melting point @ 102°C; 190°C (monobasic); heat of solution = 42 Btu/lb. Hazard identification (based on NFPA-704 M Rating System): (*dibasic*). Health 1; flammability 0; reactivity 0; (*monobasic*) Health 1; flammability 0; reactivity 1. Highly soluble in water.
Potential Exposure: Used in fireproofing of textiles; wood and paper; in soldering flux; as a fertilizer; a buffer; in baking powder and food additives.
Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Contact with air causes this chemical to produce anhydrous ammonia fumes.
Permissible Exposure Limits in Air
PAC Ver. 29[138]
7783-28-0
PAC-1: 20 milligram per cubic meter
PAC-2: 220 milligram per cubic meter
PAC-3: 1300 milligram per cubic meter
7722-76-1
PAC-1: 17 milligram per cubic meter
PAC-2: 190 milligram per cubic meter
PAC-3: 1100 milligram per cubic meter
Routes of Entry: Inhalation, ingestion; skin, and/or eye contact.
Harmful Effects and Symptoms
Short-Term Exposure: Monobasic is a mild eye and skin irritant. Short term exposure to dibasic can cause moderate skin and eye irritation. Ammonia fumes can cause eye irritation $>$ 70 ppm. Dibasic is a lung irritant which can range from moderate to severe, depending on exposure. In closed spaces, inhalation of ammonia fumes may cause nose and throat irritation (70 ppm, 5 minutes). Levels of 500 ppm for 30 minutes may cause irritation to throat and lungs. High levels may cause asphyxiation and/or result in accumulation of fluid in the lung and suffocation. Ammonia poisoning upon ingestion is characterized by sagging of facial muscles, tremors, anxiety, difficulty in controlling muscles; stupor and coma. There is only a slight chance of this happening from ingestion of ammonium phosphates, except in persons with impaired liver function. Large doses may cause calcium imbalance and an increased flow of urine.
Points of Attack: Liver, skin, eyes.
Medical Surveillance: Liver function tests.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Seek medical attention, if necessary. Give large quantities of water or milk. *Inhalation*: Move to fresh air. Give oxygen or artificial respiration if required. Seek medical attention, if necessary.
Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: Use a dust mask if necessary. A SCBA may be necessary if ammonia fumes are present.
Storage: Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly sealed containers in a cool location away from oxidizers, bases.
Shipping: There are no DOT/UN listed requirements.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Ventilate closed spaces before entering them. Absorb liquid with sand, vermiculite, earth, or similar absorbent material and place into containers for later disposal. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material is not flammable. Thermal decomposition products may include ammonia, phosphorus oxides; and nitrogen oxides. Use extinguishing agents suitable for surrounding fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: May be flushed to sewer with huge volumes of water.

References

(31); (173); (101); (138); (100).

New York State Department of Health, Chemical Fact Sheet: Ammonium Phosphate, Bureau of Toxic Substance Assessment, Albany, NY (March 1986).

Ammonium Picrate A:1200

Formula: $C_6H_6NO_7$; $NH_4OC_6H_2(NO_2)_3$

Synonyms: Ammonium carbazoate; Ammonium picrate, dry; Ammonium picrate, wet; Ammonium picrate (yellow); Ammonium picronitrate; Explosive D; Obeline picrate; Phenol, 2,4,6-trinitro-, ammonium salt; Picratol; Picric acid, ammonium salt; Pictarol; Picrate d'ammonium, humidifié avec au moins 10% d'eau (French); Picrato de amonio, húmedo con no menos del 10% de agua (Spanish); 2,4,6-Trinitrophenol ammonium salt

CAS Registry Number: 131-74-8

HSDB Number: 2070

RTECS Number: BS3855000

UN/NA & ERG Number: UN1310 (wetted with not <10% water, by mass)/113; UN0004 (dry)/112

EC Number: 205-038-3

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 5000 (commercial grade); *Theft hazard* 400 (commercial grade).

Hazard Alert: Powerful oxidizer, Explosive when dry, Self-reactive, Highly flammable, Sensitization hazard.

Superfund/EPCRA 40CFR302.4, Appendix A, RQ: 10 b (4.54 kg); Section 313: Form R *de minimis* concentration reporting level: 1.0% (as ammonia). NH_3 Equivalent molecular weight: 27.45.

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P009

RCRA 40CFR261, Appendix 8; 40CFR261.11 Hazardous Constituents

RCRA Land Ban Waste Restrictions

Superfund/EPCRA 40CFR302.4, Appendix A, RQ: 10 lb (4.54 kg).

Hazard symbols, risk, & safety statements: Hazard symbol: E, Xi; risk phrases: R1; R2; R8; R9; R11; R42/43; R51; safety phrases: S1; S1; S3; S4; S15; S16; S21; S33; S41; (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Ammonium picrate is a bright yellow crystalline solid, which turns red if contaminated. Molecular weight: 246.14; specific gravity (H_2O:1) = 1.72; freezing/melting point = decomposes on heating; explodes @ 423°C. Slightly soluble in water. A high explosive *when dry*, and flammable when wet. Hazard identification (Based on NFPA Rating System): Health 3; flammability 3; reactivity 3, Oxidizer.

Potential Exposure: Used in explosives, fireworks and rocket propellants.

Incompatibilities: *Explosive when dry*. A powerful oxidizer that reacts violently with reducing agents. Dangerous when heated or shocked.

Keep away from metals, sodium nitrite, perchlorates, peroxides, permanganates, and any form of shock.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 30 milligram per cubic meter

PAC-2: 330 milligram per cubic meter

PAC-3: 2000 milligram per cubic meter

Routes of Entry: Inhalation of dust, ingestion, skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Ammonium picrate can pass through the skin. This chemical can irritate the eyes and skin, and is an allergen. Ingestion can cause a bitter taste, nausea, diarrhea, vomiting, abdominal pain; skin eruptions; stupor and possible death. Breathing high levels can damage the kidneys, liver, and red blood cells. Urine may become reddish, scant or even stop; there may be drowsiness, coma, and even death.

Long-Term Exposure: Repeated exposure can cause the skin and eyes to turn yellow, skin allergy; liver, kidney and blood cell damage. A sensitizer; may cause allergies.

Points of Attack: Eyes, skin, respiratory system; kidneys, liver.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. CBC. Liver function tests. Kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures to ammonium picrate, use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece respirator with a high efficiency particulate filter. Greater protection is provided by a powered-air purifying respirator. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Check oxygen content prior to entering storage area. UN0004 EXPLOSIVE. UN1310 Color code—Red Stripe: Flammability Hazard: Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Incompatible with strong oxidizers, strong bases. Contact with air causes substance to give off corrosive anhydrous ammonia fumes. Outside, detached storage is recommended. Store to avoid heat, shock or the presence of reducing materials. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Store in a cool, well-ventilated area away from incompatible materials listed above. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage.

Shipping: UN1310 Ammonium picrate, wetted with not < 10% water, by mass, Hazard Class: 4.1; Labels: 4.1-Flammable solid. UN0004 Ammonium picrate, dry or wetted with <10 % water, by mass, Hazard Class: 1.1D; Labels: 1.1D-Explosives (with a mass explosion hazard); D-Substances or articles which may mass detonate (with blast and/or fragment hazard) when exposed to fire.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Flood area with water. *Keep Material Wet. Do not dry sweep*. Keep ammonium picrate out of a confined space, such as a sewer, because of the potential for an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. If necessary, seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Fire Extinguishing: Use extreme care as ammonium picrate will explode when heated or shocked, especially when dry. *May explode and propel fragments 1600 m (1 mi) or more if fire reaches cargo*. This chemical is a flammable solid. Thermal decomposition products may include ammonia and oxides of nitrogen and carbon. Use flooding quantities of water, applied from a distance. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full

facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. May be poured onto soda ash, packaged in paper and burned. May also be mixed with flammable solvent and sprayed into an incinerator equipped with afterburner and scrubber[24].

References

(31); (173); (101); (138); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 2, No. 3, 49–51 (1982) and 8, No. 2, 42–44 (1988).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Ammonium Picrate, Trenton, NJ (August 2000).

Department of Defense, United States Department of the Army, *Military Explosives*, TM 9-1300-214, Washington DC (1988).

Ammonium Sulfamate A:1210

Formula: $H_6N_2O_3S$; $NH_2SO_3NH_4$

Synonyms: Amcide; Amicide; Ammat; Ammate; Ammate herbicide; Ammonium amidosulfonate; Ammonium amidosulfate; Ammonium aminosulfonate; Ammonium salz der amidosulfonsaure (German); Ammonium sulphamate; AMS; Ikurin; Monoammonium salt of sulfamic acid; Monoammonium sulfamate; Sulfamate; Sulfamato amonico (Spanish); Sulfamic acid, monoammonium salt; Sulfaminsaure (German)

CAS Registry Number: 7773-06-0

HSDB Number: 703

RTECS Number: WO6125000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 231-871-7

Regulatory Authority and Advisory Information

Hazard Alert: Poisonous, Irritant, Agricultural chemical.

RCRA 40CFR261, Appendix 8; 40CFR261.11 Hazardous Constituents

Clean Water Act: 40CFR116.4 Hazardous Substances; 40CFR117.3, RQ (same as CERCLA)

Superfund/EPCRA 40CFR302.4, Appendix A, RQ: 5000 lb (2270 kg). Section 313: Form R *de minimis* concentration reporting level: 1.0% (as ammonia). NH_3 Equivalent molecular weight: 14.92

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xn, N; risk phrases: R20/21/22; R25; R36; R41; safety phrases: S16; S26; S29; S36/37/39; S45; S61; (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Ammonium sulfamate is a white to yellow crystalline solid. Molecular weight: 114.12; specific gravity (H_2O:1) = 1.767; freezing/melting point = 131°C (with decomposition); boiling point = 160°C. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 0; reactivity 2. Very soluble in water.

Potential Exposure: Ammonium sulfamate is used as a herbicide and in compositions for retarding flame in textiles and paper products; a softener for paper, cotton textiles.

Incompatibilities: Strong oxidizers, potassium, potassium chlorate, sodium nitrite, metal chlorates, and hot acid solutions. Elevated temperatures cause a highly exothermic reaction with water.

Permissible Exposure Limits in Air

NIOSH IDLH = 1500 milligram per cubic meter

OSHA PEL: 10 milligram per cubic meter, total dust/5 milligram per cubic meter, respirable fraction TWA

NIOSH REL: 10 milligram per cubic meter, total dust/5 milligram per cubic meter, respirable fraction TWA

ACGIH TLV[1]: 10 milligram per cubic meter TWA

PAC Ver. 29[138]

PAC-1: 30 milligram per cubic meter

PAC-2: 98 milligram per cubic meter

PAC-3: 5000 milligram per cubic meter

DFG MAK: No numerical value established. Data may be available.

Australia: TWA 10 milligram per cubic meter, 1993; Austria: MAK 15 milligram per cubic meter, 1993; Belgium: TWA 10 milligram per cubic meter, 1993; Denmark: TWA 10 milligram per cubic meter, 1999; Finland: TWA 10 milligram per cubic meter, STEL 20 milligram per cubic meter, 1999; France: VME 10 milligram per cubic meter, 1999; Norway: TWA 10 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 10 milligram per cubic meter, 2003; Russia: STEL 10 milligram per cubic meter, 1993; Switzerland: MAK-week 10 milligram per cubic meter, 1999; Turkey: TWA 15 milligram per cubic meter, 1993; United Kingdom LTEL 10 milligram per cubic meter, STEL 20 milligram per cubic meter, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 10 milligram per cubic meter.

Determination in Air: Collection on a filter followed by gravimetric analysis. Use NIOSH Analytical Method #S348.

Permissible Concentration in Water: The No-Observed-Adverse-Effect-Level (NOAEL) is 250 mg/kg/day according to the EPA Health advisory: cited below. From this a Health advisory: of 21.4 mg/L of water was derived for a 10-kg child on a 1-day, 10-day or longer term basis. An acceptable daily intake has been determined to be 0.214 mg/kg/day and a lifetime Health advisory: for a 70 kg adult is 1.5 mg/L.

Determination in Water: There is no standard method for determining ammonium sulfamate in water. There is, however, a method for detection in foods which is a colorimetric method based on liberation of SO_4, reduction to H_2S which is measured after treatment with zinc, *p*-aminodimethylaniline and ferric chloride to give methylene blue.

Routes of Entry: Inhalation, ingestion; skin, and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: This material is moderately toxic by ingestion and may cause GI disease. High levels may irritate the eyes, skin and respiratory tract, nausea and vomiting. The oral LD_{50} for rat is 3900 mg/kg.

Long-Term Exposure: Unknown at this time.

Medical Surveillance: Nothing special indicated.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *50 milligram per cubic meter*: Qm (APF = 25) (any quarter-mask respirator). *100 milligram per cubic meter*: 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100; or Sa (APF = 10) (any supplied-air respirator). *250 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or if not present as a fume PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *500 milligram per cubic meter*: SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter); or 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). 1500 milligram per cubic meter: Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode. *Escape*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Green: General storage may be used. Store in tightly closed containers in a cool, well-ventilated area away from Oxidizers (such as perchlorates, peroxides, permanganates, chlorates and nitrates); water, potassium, potassium chlorate, sodium nitrite, metal chlorates and hot acid solutions.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: ammonium sulfamate may burn, but does not readily ignite. Use dry chemical, CO_2, or foam extinguishers.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Dilute with water, make neutral with acid or base and flush into sewer with more water.

References

(31); (173); (101); (138); (2); (100).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 2, No. 3, 52−54 (1982).

United States Environmental Protection Agency, “Health advisory: Ammonium Sulfamate, Washington, DC, Office of Drinking Water (August 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Ammonium Sulfamate, Trenton, NJ (January 2001).

Ammonium Sulfide A:1220

Formula: H_8N_2S; H_5NS; $(NH_4)_2S$

Synonyms: Ammonium bisulfide; Ammonium hydrogensulfide; Ammonium sulfide, hydrogen; Diammonium sulfide; Sulfuro amonico (Spanish); True ammonium sulfide

CAS Registry Number: 12124-99-1 (solid); 12135-76-1 (solution)

HSDB Number: 470

RTECS Number: BS4900000 (solid); BS4920000 (solution)

UN/NA & ERG Number: UN2923/154; UN2683 (solution)/132

EC Number: 235-223-4 (solution); 235-184-3 (solid)

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Highly flammable liquid, Corrosive, Pyrophoric hazard, Environmental hazard.

Clean Water Act: 40CFR116.4 Hazardous Substances; 40CFR117.3, RQ (same as CERCLA)

CERCLA/SARA Section 313: 40CFR302.4, Appendix A, RQ: 100 lb (45.4 kg); Form R *de minimis* concentration reporting level: 1.0% (as ammonia). NH_3 Equivalent molecular weight: 33.32.

Hazardous to aquatic life or environment, with possible long-lasting effects[291]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: F, C, N; risk phrases: R11; R17; R31; R34; R51; safety phrases: S16; S21; S26; S29/35; S36/37/39; S41; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Ammonium sulfide is a yellow crystalline (sugar or sand-like) material, commonly found in liquid solution, which is flammable. Solution has an odor of rotten eggs. Molecular weight: 51.11; 68.14 (solution); boiling point = 104°C (solution); freezing/melting point = (decomposes). Flash point = 72°C; explosive limits (solution) LEL: 40,000 ppm; UEL: unknown. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 3; reactivity 2. Soluble in water.

Potential Exposure: It is used in photographic developers, synthetic flavors, coloring metals (i.e., to apply patina to bronze); and to make textiles.

Incompatibilities: Vapor form explosive mixture with air Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Evolves poisonous ammonia on contact with strong bases. Contact with acid or acid fumes releases hydrogen sulfide. Keep away from moisture[101].

Permissible Exposure Limits in Air

12135-76-1 *(solution)*
PAC Ver. 29[138]
PAC-1: 1 ppm
PAC-2: 54 ppm
PAC-3: 100 ppm

Determination in Water: Toxic to aquatic organisms.

Routes of Entry: Ingestion, skin absorption, inhalation.

Harmful Effects and Symptoms

Short-Term Exposure: Ammonium sulfide can be absorbed through the skin, thereby increasing exposure. This substance is a corrosive chemical and contact can irritate and burn the eyes and skin. Exposure can irritate the nose, throat and lungs, causing a cough and difficulty in breathing. Very high levels could cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Very high levels could cause you to feel dizzy, lightheaded, and cause you to pass out.

Long-Term Exposure: Repeated exposure can cause lung irritation and bronchitis.

Points of Attack: Lungs, skin.

Medical Surveillance: Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Lung function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. If local exhaust ventilation or enclosure is not used, respirators should be worn. Wear protective work clothing and goggles. Wash thoroughly immediately after exposure to ammonium sulfide and at the end of the work-shift.

Respirator Selection: *Where there is no REL, at any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: (1) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. (2) Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. (3) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store to avoid contact with acids and acid fumes, since violent reactions can occur. Store in tightly closed containers in cool, well-ventilated area away from moisture. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2923 Corrosive solids, toxic, n.o.s., Hazard class: 8; Labels: 8-Corrosive material, 6.1-Poisonous material, Technical Name Required. UN2683 Ammonium sulfide solution, Hazard class: 8; Labels: 8-Corrosive material, 6.1-Poisonous materials, 3-Flammable liquid.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Add ferric chloride solution to spilled material. Stir and add Soda Ash. Sweep solid material up and deposit in sealed containers. Keep ammonium sulfide out of a confined space, such as a sewer, because of the potential for an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Ammonium sulfide solution is a Flammable Liquid. Thermal decomposition products may include flammable hydrogen sulfide and ammonia. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Add to a large volume of ferric chloride solution with stirring. Neutralize with soda ash. Flush to drain with water.

References

(31); (173); (101); (138); (170); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 2, No. 4, 27−29 (1982).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: *Ammonium sulfide*, Trenton, NJ (March 2002).

Ammonium Sulfite A:1230

Formula: $H_8N_2O_3S$; $(NH_4)_2SO_3$

Synonyms: *Monoammonium salt*: Ammonium acid sulfite; Ammonium hydrogen sulfite; Ammonium hydrosulfite; Ammonium monosulfite; Ammonium sulfite, hydrogen; Monosodium sulfite; Sulfito amonico (Spanish); Sulfurous acid, monoammonium salt. *diammonium salt*: Diammonium sulfite; Sulfite d'ammonium (French); Sulfito amonico (Spanish); Sulfito de amonio (Spanish); Sulfurous acid, diammonium salt

Bisulfite: Ammonium bisulfite solid or solution; Ammonium hydrosulfite; Bisulfite d'ammonium, solide (French); Bisulfite d'ammonium, en solution (French); Bisulfito de amonio, solución de (Spanish); Bisulfito de amonio, sólido (Spanish)

CAS Registry Number: 10196-04-0; 10192-30-0 (bisulfite)

HSDB Number: 1426

RTECS Number: WT3505000 (diammonium); WT3595000 (monoammonium)

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171; UN2693/154 (bisulfite)

EC Number: 233-484-9 (diammonium salt); 233-469-7 (monoammonium salt/ammonium hydrogensulfite)

Regulatory Authority and Advisory Information

Hazard Alert: Primary irritant (w/o allergic reaction)

Clean Water Act: 40CFR116.4 Hazardous Substances; 40CFR117.3, RQ (same as CERCLA)

Diammonium salt: Superfund/EPCRA 40CFR302.4, Appendix A, RQ: 5000 lb (2270 kg); Section 313: Form R *de minimis* concentration reporting level: 1.0% (as ammonia) NH_3 Equivalent molecular weight: 17.18.

Monoammonium salt: Superfund/EPCRA 40CFR302.4, Appendix A, RQ: 5000 lb (2270 kg); Section 313: Form R *de minimis* concentration reporting level: 1.0% (as ammonia) NH_3 Equivalent molecular weight: 29.33.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: Xn; risk phrases: R22; R36/37/38; safety phrases: S16; S26; S36/37; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [1-Low hazard to water. (est.)]

Description: Ammonium sulfite is a colorless to yellow crystalline (sand-like or sugar-like) solid, normally sold or used in a 40% solution. Molecular weight = 116.13; 99.1 (bisulfite); specific gravity (H_2O:1) = 2.03 (bisulfite, solid); 1.40 (72% aqueous solution); freezing/melting point = 150°C (sublimes); heat of solution = (endothermic) = 1.01×10^5 J/kg (For dilute solution 1 mol/0.300 mol water, which is equal to 1.833 lb/volume lb of water); vapor pressure = 395 mmHg @ 20°C. Soluble in water.

Potential Exposure: Ammonium sulfite is used in medicines, metal lubricants; explosives, photography, hair wave solutions; and to make other chemicals. It is also used as a preservative, and for treating agricultural grain.

Incompatibilities: A strong reducing agent. Reacts violently with strong oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

10196-04-0; 10192-30-0 (bisulfite)

PAC Ver. 29[138]

PAC-1: 30 milligram per cubic meter

PAC-2: 330 milligram per cubic meter

PAC-3: 2000 milligram per cubic meter

Routes of Entry: Inhalation of dust, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin, and respiratory tract. Ammonium sulfite can affect you when breathed in; exposure can irritate the nose, throat, bronchial tubes, and lungs. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. Affects the CNS.

Long-Term Exposure: Ammonium sulfite may cause an asthma-like allergy. Future exposures could then cause asthma attacks with cough, shortness of breath and wheezing. Very severe (anaphylactic) reactions could also occur, and could be fatal. Bisulfite is a respiratory sensitizer.

Points of Attack: Skin, eyes, respiratory system, CNS; kidney (bisulfite).

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposure, the following are recommended: lung function tests; seek prompt medical attention if symptoms are suspected.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash or dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures over ammonium sulfite, use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece respirator with a high efficiency particulate filter. Greater protection is provided by a powered-air purifying respirator. Where there is potential exists for high exposures to ammonium sulfite, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: (1) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. (2) Color code—Yellow Stripe (strong reducing agent): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Ammonium sulfite must be stored in tightly closed containers in a cool, well-ventilated place to avoid contact with oxidizers and acids as flammable hydrogen sulfide gas is produced.

Shipping: UN2693 Bisulfites, inorganic, aqueous solutions, n.o.s., Hazard class: 8; Labels: 8-Corrosive material. UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Ammonium sulfite may burn, but does not readily ignite. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include ammonia and oxides of sulfur and nitrogen. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed. May be buried in a chemical waste landfill in accordance with federal, state, and local statutes; or, if oxidized and neutralized, it may be sent to a municipal sewage treatment plant for biological treatment Incineration.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Ammonium Sulfite, Trenton, NJ (August 2000).

Ammonium Tartrate A:1240

Formula: $C_4H_{12}N_2O_6$; $NH_4OOCCHOHCHOHCOONH_4$

Synonyms: Ammonium D-tartrate; Ammonium tartrate; Butanedioic acid, 2,3-dihydroxy-[R-(R*,R*)]-, diammonium salt; Diammonium l-(+)-tartrate; Diammonium tartrate; 2,3-Dihydroxy-butanedioic acid, diammonium salt; Tartaric acid, ammonium salt; 1-Tartaric acid, diammonium salt; Tartaric acid, diammonium salt; Tartrate d'ammonium (French); Tartrato de amonio (Spanish); Tartrato amonico (Spanish)

CAS Registry Number: 3164-29-2 (diammonium salt); 14307-43-8 [R-(R*,R*)]

HSDB Number: 25092

RTECS Number: WW8050000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171; UN9091/

EC Number: 238-245-2 [ammonium [R-(R*,R*)]-tartrate]; 221-618-9 (diammonium salt)

Regulatory Authority and Advisory Information

Hazard Alert: Combustible.

Clean Water Act: 40CFR116.4 Hazardous Substances; 40CFR117.3, RQ (same as CERCLA)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 5000 lb (2270 kg); Section 313: Form R *de minimis* concentration reporting level: 1.0% (as ammonia). NH_3 Equivalent molecular weight: 27.45.

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to waters.

Description: Ammonium tartrate is a colorless crystalline or white granular solid. Molecular weight = 184.18; specific gravity (H_2O:1) = 1.63 @ 25°C; 1.601 (diammonium salt). Hazard identification (based on NFPA-704 M Rating System): Health 1; flammability 1; reactivity 0. Soluble in water.

Potential Exposure: Ammonium tartrate is used in the textile industry and in medicine.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Strong oxidizers, especially potassium chlorate, sodium nitrite may cause violent reactions.

Permissible Exposure Limits in Air
PAC Ver. 29[138]
14307-43-8
PAC-1: 30 milligram per cubic meter
PAC-2: 330 milligram per cubic meter
PAC-3: 2000 milligram per cubic meter
3164-29-2, diammonium salt
PAC-1: 0.8 milligram per cubic meter
PAC-2: 8.8 milligram per cubic meter
PAC-3: 53 milligram per cubic meter

Routes of Entry: Inhalation, skin contact, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: A corrosive. Contact can irritate the eyes and skin, and cause permanent damage. May irritate the nose, throat and lungs. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. The symptoms of pulmonary edema are aggravated by physical effort. This can cause death.

Long-Term Exposure: Unknown at this time. However, corrosive substances may cause lung effects and damage.

Points of Attack: Lungs, eyes, skin.

Medical Surveillance: Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Lung function tests. Consider X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls, and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit. *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration*: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Green: General storage may be used. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from potassium chloride and sodium nitrite.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include ammonia and oxides of nitrogen and carbon. Ammonium tartrate may burn, but does not readily ignite. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed. May be buried in a chemical waste landfill in accordance with federal, state, and local statutes; or, if oxidized and neutralized, it may be sent to a municipal sewage treatment plant for biological treatment.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Ammonium Tartrate, Trenton, NJ (September 2000).

Ammonium Tetrachloroplatinate A:1250

Formula: $C_{14}H_8N_2Pt$; $(NH_4)_2PtCl_4$

Synonyms: Ammonium chloropalladate(2 +); Ammonium chloropalladate(II); Ammonium palladium chloride; Ammonium tetrachloropalladate(2 +); Ammonium tetrachloropalladate(II); Diammonium tetrachloropalladate; Tetramine platinum(II) chloride

CAS Registry Number: 13820-41-2

HSDB Number: 6997 as platinum compounds

RTECS Number: TP1840000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 237-499-1 [*Annex I Index No*.: 078-002-00-6]

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Organometallic; Strong reducing agent, Sensitization hazard.

Superfund/EPCRA 40CFR302.4, Appendix A, RQ: 100 lb (45.4 kg); Section 313: Form R *de minimis* concentration reporting level: 1.0% (as ammonia). NH_3 Equivalent molecular weight: 11.98.

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xi; risk phrases: R25; R38; R41; R43; safety phrases: S2; S22; S26; S36/37/39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [1-Low hazard to water. (est.)]

Description: Ammonium tetrachloroplatinate is a dark ruby-red crystalline solid. Molecular weight = 372.96; specific gravity (H_2O:1) = 2.93; freezing/melting point = 140–150°C. Soluble in water.

Potential Exposure: This material is used in photography.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

NIOSH IDLH = 4 mg [Pt]/m^3

OSHA PEL: 0.002 mg[Pt]/m^3 TWA

NIOSH REL: 0.002 mg[Pt]/m^3 TWA

ACGIH TLV[1]: 1 0.002 mg[Pt]/m^3 TWA

No PAC available.

DFG MAK: No numerical value established. Data may be available; however, 2 μg[Pt]/m^3 peak should not be exceeded; danger of skin and airway sensitization, as chloroplatinates.

Determination in Air: Use NIOSH II(7) Method #S-19 (soluble salts)

Routes of Entry: Inhalation of vapor or dust, skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Ammonium tetrachloroplatinate can affect you when breathed in. Ammonium Tetrachloroplatinate may irritate the eyes, nose and throat, high exposures can cause irritability and even seizures ("fits").

Long-Term Exposure: Skin and air passage sensitizer; severe allergy can develop to ammonium tetrachloroplatinate. Symptoms may include asthma (with cough, wheezing and/or shortness of breath), runny nose and/or skin rash, sometimes with hives. If allergy develops, even small future exposure can trigger significant symptoms. Some persons exposed to this type of chemical have developed lung scarring.

Points of Attack: Eyes, skin, nose, throat.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended: Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Lung function tests. These may be normal if person is not having an attack at the time. If symptoms develop or overexposure is suspected, the following may be useful: chest X-ray every three years should be considered if above tests are not normal. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek

medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures over 0.002 milligram per cubic meter, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Green: General storage may be used. It is a skin and inhalation sensitizer; the Color code—Blue may be used. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, strong acids; strong bases.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include hydrogen chloride, ammonia and oxides of nitrogen and metal. Use dry chemical, CO_2, water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Ammonium Tetrachloroplatinate, Trenton, NJ (March 2002).

Ammonium Thiocyanate A:1260

Formula: CH_4N_2S; NH_4SCN

Synonyms: Ammonium isothiocyanate; Ammonium rhodanate; Ammonium rhodanide; Ammonium sulfocyanate; Ammonium sulfocyanide; Ammonium thiocyanate liquor; Carbo-Tech ammonium thiocyanate; Degussa ammonium thiocyanate; Rhodanid; Thiocyanic acid, ammonium salt; Tiocianato amonico (Spanish)

CAS Registry Number: 1762-95-4

HSDB Number: 701

RTECS Number: XK7875000

UN/NA & ERG Number: UN2672 (ammonia solutions)/154; UN3077 (environmentally hazardous substances, solid, n.o.s.)/171; UN3082 (environmentally hazardous substances, liquid, n.o.s.)/171

EC Number: 217-175-6 [*Annex I Index No.*: 616-004-00-3; 615-030-00-5]

Regulatory Authority and Advisory Information Note: Contains no cyanide and therefore has low acute toxicity[101].

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P030

RCRA 40CFR261, Appendix 8; 40CFR261.11 Hazardous Constituents

Superfund/EPCRA 40CFR302.4, Appendix A, RQ: 5000 lb (2270 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0% (as ammonia). NH_3 Equivalent molecular weight: 22.37. Form R *de minimis* concentration reporting level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: Xn, Xi, C; risk phrases: R20.21/22; R32; R36/37/38; R52/53; safety phrases: S13; S26; 36/37; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Ammonium thiocyanate is a colorless solid which absorbs moisture, becoming liquid, known as the "liquor." Molecular weight: 76.12; specific gravity (H_2O:1) = 1.305; boiling point = (decomposes) 115°C[136]; freezing/melting point = (decomposes) 170°C[136]; vapor pressure = × 10^{-X} mmHg @ 25°C; heat of solution = 3.1×10^5 J/kg. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 0; reactivity 1. Freely soluble in water.

Potential Exposure: It has many uses in making matches, fabric processing; metals processing; chemical manufacturing, electroplating; zinc coating; liquid rocket propellents, fabric dyeing, polymerization catalyst, in photography. Used as a laboratory chemical. May be used as an agricultural chemical: herbicides, weed killers, defoliants.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Acts as an acid; incompatible with lead nitrate, chlorates, nitric acid, acid, acid fumes. In the presence of moisture, this chemical is corrosive to brass, copper, iron. *Ammonium thiocyanate liquor* can release ammonia vapors if mixed with a chemical base or with an acid. Violent or explosive reactions have occurred when thiocyanates are mixed with oxidizing agents [such as chlorates (potassium chlorate), nitrates, nitric acid, and peroxides]. Nitric acid violently oxidized a thiocyanate solution [Bretherick 1979 p. 121]. An explosion of guanidine nitrate demolished an autoclave built to withstand 50 atmospheres, in which it was being made from ammonium thiocyanate and lead nitrate [C. Angew. Chem. 49:23 1936][101].

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 2.3 milligram per cubic meter

PAC-2: 25 milligram per cubic meter

PAC-3: 150 milligram per cubic meter

Determination in Air: Use NIOSH Analytical Method #7904; #6010, cyanides.

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 200 μg[CN]/L; State Drinking Water Standards: California 150 μg[CN]/L; State Drinking Water Guidelines: Arizona 220 μg[CN]/L; Maine. 140 μg [CN]/L; Minnesota 100 μg[CN]/L. United States Army field drinking-water standards for cyanide: 2 mg[CN]/L assuming a water consumption of 15 L/day and 6 mg[CN]/L assuming a water consumption of 5 L/day. United States Army field drinking-water standards for cyanide, long-term consumption 0.5 mg[CN]/L; Short-term consumption; Raw water constituents (maximum) 20 mg[CN]/L.

Determination in Water: Octanol–water coefficient: Log $K_{ow} = -2.3$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Skin and/or eyes; may be absorbed through unbroken skin.

Harmful Effects and Symptoms

Short-Term Exposure: *Note*: Contains no cyanide and therefore has low acute toxicity[101]. Contact with dust irritates the eyes and cause burns to the eyes and skin. This chemical can be absorbed through the skin, and significantly to overall exposure; prolonged contact may produce various skin eruptions, nausea, dizziness, cramps, and mild to severe disturbance of the nervous system. Ingestion causes dizziness, cramps, nervous disturbances. Inhalation of material may be harmful. Contact may cause burns to skin and eyes. Inhalation of Asbestos dust may have a damaging effect on the lungs. Fire may produce irritating, corrosive and/or toxic gases. Some liquids produce vapors that may cause dizziness or suffocation.

Long-Term Exposure: Repeated exposure may cause nausea, loss of appetite; runny nose; abdominal problems, loss of weight, weakness, and skin rashes. Prolonged exposure may cause thyroid gland problems, blood cell damage, nervous system damage with personality and mood changes.

Points of Attack: Thyroid, nervous system; blood cells.

Medical Surveillance: Thyroid function tests, CBC.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Nonabsorbent material are recommended. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash or dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA (as cyanides): Up to *25 milligram per cubic meter*: Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd, Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode. *Escape*: GmFS100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern and having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Ammonium Thiocyanate must be stored to avoid contact with potassium chlorate and lead nitrate, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from moisture, acid, acid fumes; or chlorine because toxic fumes are released. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: UN2672 Ammonia solutions, relative density between 0.880 and 0.957 at 15°C in water, with $>$ 10 % but not $>$ 35 % ammonia, Hazard class: 8; Labels: 8-Corrosive material. UN3082 Environmentally hazardous substances, liquid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required. UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Use vacuum to reduce dust during clean up. *Do not dry sweep*. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Ammonium Thiocyanate may burn, but does not readily ignite. Thermal decomposition products may include ammonia, hydrogen cyanide, hydrogen sulfide, and nitrogen oxides. Use dry chemical, CO_2, water spray; or foam extinguishers. Runoff from fire control may cause pollution. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Slowly add to large container of water. Stir in slight excess of soda ash. Decant or siphon liquid from sludge, neutralize with HCl and flush to sewer. Sludge may be landfilled.

References

(31); (173); (101); (136); (138).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 2, No. 3, 54–5, (100). (1982) (2).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Ammonium Thiocyanate, Trenton, NJ (March 2002).

Ammonium Thiosulfate A:1270

Formula: $H_8N_2O_3S_2$

Synonyms: Ammonium hyposulfite; Amthio; Diammonium thiosulfate; Hypo; Thiosulfuric acid, diammonium salt; Tiosulfato amonico (Spanish)

CAS Registry Number: 7783-18-8

HSDB Number: 2688

RTECS Number: XN6465000

UN/NA & ERG Number: UN3077 (solid)/177

EC Number: 231-982-0

Regulatory Authority and Advisory Information

United States National Primary Drinking Water Regulations: SMCL = 250 mg[SO_4^{-2}]/L as Sulfate

CERCLA/SARA Section 313: Form R *de minimis* concentration reporting level: 1.0% (as ammonia). NH_3 Equivalent molecular weight: 22.98.

Hazard symbols, risk, & safety statements: Hazard symbol: T; risk phrases: R33; R36/37/38; safety phrases: S26; S37; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Ammonium thiosulfate is a white crystalline solid with an ammonia odor. Molecular weight: 148.22; specific gravity (H_2O:1) = 1.679; freezing/melting point = 150°C [decomposes $<$50°C (solution); $>$100°C (anhydrous crystals)]. Hazard identification (based on NFPA-704 M Rating System): Health 1; flammability 0; reactivity 0. Highly soluble in water.

Potential Exposure: Used as an agricultural chemical and fungicide, metal lubricant; in cleaning metals; in photographic chemicals, making other chemicals. A laboratory reagent.

Incompatibilities: Contact with sodium chlorate may cause a violent reaction. Corrodes brass, copper, and copper-based metals.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 12 milligram per cubic meter

PAC-2: 130 milligram per cubic meter

PAC-3: 790 milligram per cubic meter

Routes of Entry: Dermal contact., inhalation, ingestion

Harmful Effects and Symptoms

Short-Term Exposure: Exposure can irritate eyes, skin and respiratory tract. Respiratory irritant-acute, severe, or moderate but not mild. Acute effects: CNS, brain, respiratory system, kidneys. Hematological effects-acute, unspecified[138].

Long-Term Exposure: May affect organs and body systems listed above, as having acute problems.

Points of Attack: CNS, brain, respiratory system, blood.

Medical Surveillance: Consider the points of attack.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash- or dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Green: General storage may be used. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, acids, water, or combustible materials.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Ventilate closed spaces before entering them. Absorb liquid with sand, vermiculite, earth, or similar absorbent material and place into containers for later disposal. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Ammonium thiosulfate may burn, but does not readily ignite. Thermal decomposition products may include ammonia, hydrogen sulfide, sulfur oxides; and nitrogen oxides. Use extinguishing agents suitable for surrounding fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incinerate. It may be possible to dispose of waste material at a municipal facility if treated, neutralized and oxidized.

References
(31); (173); (101); (138); (100).
New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Ammonium Thiosulfate, Trenton, NJ (June 1988).

Ancymidol A:1275

Formula: $C_{15}H_{16}N_2O_2$
Synonyms: A-REST; α-Cyclopropyl-α-(4-methoxyphenyl)-5-pyrimidinemethanol-; α-Cyclopropyl-4-methoxy-α-(pyrimidin-5-yl)benzyl alcohol; 5-Pyrimidinemethanol, α-cyclopropyl-α-(4-methoxyphenyl); QUEL; Reducymol; Sepro; EL 531; Thritone
CAS Registry Number: 12771-68-5; 51025-96-8
RTECS Number: UV9280000
UN/NA & ERG Number: None listed
EC Number: 235-814-7
Regulatory Authority and Advisory Information
Hazard Alert: Combustible, Agricultural chemical.
Hazard symbols, risk, & safety statements: Hazard symbol: T; risk phrases: R22; R25; R61; safety phrases: S13; S22; S36/37/39; S45; S53 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): Not found.
Description: Ancymidol is a white to buff colored crystalline or granular solid. Slightly aromatic odor. Molecular weight = 256.3; freezing/melting point = 111−112°C; vapor pressure = 2.0×10^{-7} mmHg. Hazard identification (based on NFPA-704 M Rating System): Health 1; flammability 0; reactivity 0. Soluble in water; solubility = 645 ppm (approx).
Potential Exposure: Ancymidol is a plant growth regulator registered for treating container-grown herbaceous plants, ornamental woody shrubs, and bedding plants grown in greenhouses and other plant bedding areas for primarily commercial production. Growth regulator used on plants such as chrysanthemums, certain lilies, and poinsettias effects produced by ancymidol are the result of inhibition of gibberellin biosynthesis. It produces a more compact growth form by suppressing elongation.
Incompatibilities: Dust may form explosive mixture with air. Ancymidol may react vigorously with oxidizing agents. Mixtures with concentrated hydrogen peroxide or strong mineral acids (e.g., nitric, sulfuric, perchloric) may cause explosions. Mixtures with hypochlorous acid, lead perchlorate, chlorine, bleaches, including sodium hypochlorite; mixed water/carbon tetrachloride solution; trichloroisocyanuric acid form methyl hypochlorite, which can be explosive, especially when exposed to sunlight or heat. May react with metallic aluminum at high temperature. Flow or agitation of substance may generate electrostatic charges due to low conductivity; ground all equipment containing this material. May attacks some plastics, rubber, and coatings.
Permissible Concentration in Water: No criteria set. Runoff from spills or fire control may cause water pollution.
Determination in Water: Fish toxicity (threshold)[77]: Very low—19952.6231500 ppb, MATC (Maximum Acceptable Toxicant Concentration)
Routes of Entry: Inhalation, ingestion, skin contact.
Harmful Effects and Symptoms
Short-Term Exposure: May irritate the eyes, skin and respiratory system. Harmful if swallowed. May be absorbed through the skin. LD_{50} (oral, rat) = 4500 mg/kg
First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.
Storage: Color code—Green: General storage may be used. Keep container tightly closes and store @ 2 to 8°C. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, acids, water, or combustible materials.
Shipping: None listed
Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.
Fire Extinguishing: Not combustible. Thermal decomposition products may include oxides of nitrogen and carbon. Use water spray, alcohol-resistant foam, dry chemical, or carbon dioxide. Wear SCBA for firefighting if necessary.

Disposal Method Suggested: Dispose of contents and container to an approved waste disposal plant. All federal, state, and local environmental regulations must be observed.

References

(31); (204); (100).

United States Environmental Protection Agency, "Reregistration Eligibility Decision (RED), Ancymidol," Office of Prevention, Pesticides and Toxic Substances, Washington, DC (June 1995). http://www.epa.gov/REDs/3017.pdf.

Amphetamine A:1280

Formula: $C_9H_{13}N$; $C_6H_5CH_2CH(NH_2)CH_3$

Synonyms: Actedron; Adipan; Allodene; DL-Amphetamine; Anfetamina (Spanish); Anorexide; Benzedrine; Deoxynorephedrine; racemic-Desoxynorephedrine; DL-Benzedrine; DL-α-Methylbenzeneethaneamine; DL-1-Phenyl-2-aminopropane; Elastonon; Isoamycin; Isomyn; Mecodrin; α-Methylbenzeneethaneamine; Norephedrane; Novydrine; Ortedrine; Phenedrine; 1-Phenyl isopropyl amine; Profamina; Propisamine; Psychedrine; Raphetamine; Simpatedrin; Sympamine; Sympatedrine; Weckamine

CAS Registry Number: 300-62-9; 60-13-9 (sulfate); 300-42-5 (methamphetamine hydrochloride) *Note*: There are various other "amphetamines" listed in the literature, however this CAS (300-62-9) is specifically regulated by EPA. RTECS lists this CAS as "Benzedrine."

HSDB Number: 3287

RTECS Number: SH9450000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 206-096-2

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Flammable, Suspected of causing genetic defects, Suspected reprotoxic hazard, Drug, Primary irritant (w/o allergic reaction) also listed for methamphetamine hydrochloride.

Banned or Severely Restricted (UN) (U.S.)[13]

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg)

SUPERFUND/CERCLA 40CFR302.4 RQ: 1 lb (0.454 kg).

Hazard symbols, risk, & safety statements: Hazard symbol: T, F; risk phrases: R10; R23/24/25; R27/28; R36/37/38 (for 300-62-9); R39; R50/53; R62; R63; safety phrases: S7; S13; S16; S36/37; S28; S45 (see Appendix 4).

Description: Amphetamine is a mobile liquid with an amine odor. Molecular weight = 135.23; specific gravity (H_2O:1) = 0.93; boiling point = 200−203°C; flash point = 26.7°C[101]. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 1; reactivity 0. Slightly soluble in water.

Potential Exposure: Amphetamine is used as a pharmaceutical. It is a CNS stimulant.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

PAC Ver. 27; No values found in Ver. 29[138]

PAC-1: 1.8 milligram per cubic meter

PAC-2: 20 milligram per cubic meter

PAC-3: 20 milligram per cubic meter

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Symptoms of exposure include dry mouth, metallic taste; loss of appetite; nausea, vomiting, diarrhea, abdominal cramps; headache, chilliness, flushing or pallor; palpitation, restlessness, dizziness, tremor, hyperactive reflexes; talkativeness, tenseness, irritability, weakness, insomnia, fever, confusion. With large doses, irregular heartbeat; pain and difficulty in urination. Convulsions, coma, circulatory collapse. This chemical is classified as extremely hazardous. Probable lethal dose in humans is 5−50 mg/kg or 7 drops to 1 teaspoon for a 70 kg (150 lb) person. Symptoms of exposure to methamphetamine hydrochloride (aka "speed") include elevation of blood pressure, tachycardia, palpitation, psychotic episodes (rare), dizziness, dysphoria, overstimulation, euphoria, insomnia, tremor, restlessness, headache, exacerbation of motor and phonic tics, Tourette's syndrome, diarrhea, constipation, dryness of the mouth, unpleasant taste, other GI disturbances, urticaria, impotence, changes in libido and suppression of growth in children. Other symptoms include metallic taste, anorexia, difficulty in micturition, mydriasis, agitation, skin rashes and abdominal pain. Exposure can cause increased awareness, lessening of fatigue, exhilaration, sweating, flushing or pallor, dehydration, purposeless motions, bradycardia, extrasystoles, heart block, tachypnea, anxiety, paranoid and hostile behavior, and delirium. Large doses may also cause fever or chilliness, talkativeness, disorientation and aggressive behavior. Other symptoms from large doses include acts of self-destruction and mania[101].

Long-Term Exposure: Habit forming drug which affects the CNS. Chronic symptoms for methamphetamine hydrochloride (aka "speed") include severe dermatoses, marked insomnia, irritability, hyperactivity, personality changes, and psychosis. Other chronic symptoms include aplastic anemia, pancytopenia, gynecomastia, and angiitis. Exposure to large doses may cause hyperreflexia, rapid respiration, confusion, assualtiveness, hallucinations, panic states, hyperpyrexia, rhabdomyolysis, fatigue and mental depression following CNS stimulation, arrhythmias, hypertension or hypotension, circulatory collapse, nausea, vomiting, convulsions, coma and death[101].

Points of Attack: CNS.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim* *ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in a refrigerator or a cool, dry place[52].

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft.(NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Absorb liquid in dry sand, vermiculite or other absorbent material. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: It is inappropriate and possibly dangerous to the environment to dispose of expired or waste pharmaceuticals by flushing them down the toilet or discarding them to the trash. Household quantities of expired or waste pharmaceuticals may be mixed with wet cat litter or coffee grounds, double-bagged in plastic, discard in trash. Larger quantities shall carefully take into consideration applicable DEA, EPA, and FDA regulations. If possible return the pharmaceutical to the manufacturer for proper disposal being careful to properly label and securely package the material. Alternatively, the waste pharmaceutical shall be labeled, securely packaged and transported by a state licensed medical waste contractor to dispose by burial in a licensed hazardous or toxic waste landfill or incinerator Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138).

United States Environmental Protection Agency, C*hemical Hazard Information Profile*: Amphetamine, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

Ampicillin A:1290

Formula: $C_{16}H_{19}N_3O_4S$

Synonyms: Acillin; Adobacillin; Alpen; Amblosin; Amcill; Amfipen; Aminobenzyl penicillin; D-(−)-α-Aminobenzylpenicillin; D-(−)-α-Aminopenicillin; 6-[d(−)-α-Aminophenylacetamido]penicillanic acid 6; 6-(2-Amino-2-phenylacetamindo)-3,-3-dimethyl-7-oxo-4-thia-1-azabicyclo(3.2.0) heptane-2-carboxylic acid; (Aminophenylmethyl)-penicillin; Amipenix S; Amperil; Ampi-Bol; D-(−)-Ampicillin; D-Ampicillin; Ampicillin A; Ampicillin acid; Ampicillin anhydrate; Ampicillin (USDA); Ampicin; Ampikel; Ampimed; Ampipenin; Amplisom; Amplital; Ampy-penyl; Austrapen; AY-6108; Binotal; Bonapicillin; Britacil; BRL; BRL 1341; Copharcilin; Cymbi; Divercillin; Doktacillin; Grampenil; Guicitrina; Guicitrine; Lifeampil; Marisilan; NSC-528986; Nuvapen; Omnipen; P-50; Penbristol; Penbritin; Penbritin pediatric; Penbritin syrup; Penbrock penicline; Pentrex; Pfizerpen A; Polycillin; Ponecil; Principen; Qidamp; Ro-Ampen; Semicillin; SK-Ampicillin; Synpenin; Tokiocillin; Tolomol; Totacillin; Totalciclina; Totapen; Ultrabion; Ultrabron; Viccillin; Viccillin S; Vicillin; WY-5103

CAS Registry Number: 69-53-4 (anhydrous); 7177-48-2 (trihydrate)

HSDB Number: 3009

RTECS Number: XH8350000; HS8425000 (trihydrate)

EC Number: 200-709-7

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: There is inadequate evidence for the carcinogenicity of ampicillin in humans. There is limited evidence for the carcinogenicity in experimental animals. Overall evaluation: Ampicillin is not classifiable as to its carcinogenicity to humans, Group 3.

Hazard Alert: Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Drug.

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xn; risk phrases: R36/37/38; R42/43; R62; R63; safety phrases: S22; S36; S36/37; S41 (see Appendix 4).

Description: Ampicillin in anhydrous form occurs as crystals. Molecular weight = 349.44; freezing/melting point = 199-202°C (decomposes). Hazard identification (based on NFPA-704 M Rating System): (*anhydrous*) Health 1; flammability 0; reactivity 0; (*trihydrate*) Health 2; flammability 0; reactivity 0. Slightly soluble in water.

Potential Exposure: Used as an antibiotic.

Incompatibilities: May be incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Russia[43]: MAC 0.1 milligram per cubic meter in workplace air, ampicillin.

Harmful Effects and Symptoms

Short-Term Exposure: Ampicillin can affect you when breathed in. Exposure can cause skin rash. This may or may not be an allergic reaction, but if hives are present, allergy is likely. Exposure to high levels can cause upset stomach and diarrhea. The LD_{50} for rat is 10 g/kg and for mouse is 28 mg/kg[9]. Ampicillin can cause hypersensitivity reactions in allergic persons.

Long-Term Exposure: Exposure may cause allergy to develop, often accompanied with hives. Once allergy develops, even low future exposures can cause an allergic reaction. Persons having an allergy to penicillin may be more likely to develop an allergic reaction to ampicillin. Exposure can lead to a rare, but sometimes fatal reaction (aplastic anemia) in which blood cell count drops very low. Ampicillin can cause a liver-damaging reaction. Since ampicillin kills many normal germs, new resistant strains can grow after repeated exposure, resulting in a “yeast” or other types of infection.

Points of Attack: Liver, blood cells, skin.

Medical Surveillance: Liver function tests; CBC. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. If local exhaust ventilation or enclosure is not used, respirators should be worn. Wear protective work clothing. Wash thoroughly at the end of the work-shift. Post hazard and warning information in the work area. In addition, as part of an ongoing education and training effort, communicate all information on the health and safety hazards of Ampicillin to potentially exposed workers.

Respirator Selection: Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls, and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit. *Where there is no REL, at any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Green: General storage may be used. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers and moisture.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Ampicillin itself does not burn. Thermal decomposition products may include sulfur oxides and nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: It is inappropriate and possibly dangerous to the environment to dispose of expired or waste pharmaceuticals by flushing them down the toilet or discarding them to the trash. Household quantities of expired or waste pharmaceuticals may be mixed with wet cat litter or coffee grounds, double-bagged in plastic, discard in trash. Larger quantities shall carefully take into consideration applicable DEA, EPA, and FDA regulations. If possible return the pharmaceutical to the manufacturer for proper disposal being careful to properly label and securely package the material. Alternatively, the waste pharmaceutical shall be labeled, securely packaged and transported by a state licensed medical waste contractor to dispose by burial in a licensed hazardous or toxic waste landfill or incinerator.

References

(31); (173); (101); (138).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Ampicillin, Trenton, NJ (February 1989).

Amyl Acetates A:1300

Formula: $C_6H_{12}O_2$ (*n*-); $C_7H_{14}O_2$ (*sec*-); $C_7H_{14}O_2$ (*tert*-); $C_8H_{14}O_2$ (*iso*-); $CH_3COOCH_2CH_2CH_2CH_3$ (*n*-); $CH_3COOCH(CH_3)CH_2CH_2CH_3$ (*sec*-); $CH_3COOC(CH_3)_2$ C_2H_5 (*tert*-); $CH_3COOCH_2CH_2CH(CH_3)CCH_3$ (*iso*-) *Note*: *iso-isomer*: see I:0230

Synonyms: *n-isomer*: Acetate d'amyle (French); Acetato de amilo (Spanish); Acetic acid *n*-amyl ester; Acetic acid pentyl ester; Amyazetat (German); *n*-Amyl acetate; Amyl acetate, mixed isomers; Amyl-acetate (*n*-); Amyl acetic acid; Amyl acetic ester; Amyl acetic ether; Banana oil; Birnenoel; Pear oil; Pent acetate; 1-Pentanol acetate; Pentyl acetates; Pentyl ester of acetic acid; *n*-Pentyl ethanoate; Primary amyl acetate

sec-isomer: Acetic acid, 2-pentyl ester; 2-Acetoxypentane; Banana oil; 1-Methylbutyl acetate; 2-Pentanol, acetate; 2-Pentyl acetate

tert-isomer: Acetic acid, isopentyl ester; Amylacetic ester; Banana oil; Isoamyl ethanoate; Isopentyl acetate; Isopentyl alcohol acetate; 3-Methyl-1-butanol acetate; 3-Methyl-1-butyl acetate; 3-Methylbutyl acetate; 3-Methylbutyl ethanoate; Pear oil

iso-isomer: Acetic acid, isopentyl ester; Amylacetic ester; Isoamyl ethanoate; Isopentyl acetate; Isopentyl alcohol acetate; 3-Methyl-1-butanol acetate; 3-Methyl-1-butyl acetate; 3-Methylbutyl acetate; 3-Methylbutyl ethanoate; Pear oil

CAS Registry Number: 628-63-7 (*n*-); 626-38-0 (*sec*-); 675-16-1 (*tert*-); 620-11-1 (*pentyl*-); 624-41-9 (*o*-); 123-92-2 (iso-) see I:0230; 108-84-9 (Methyl isoamyl acetate) see H:0340

HSDB Number: 5126 (628-63-7)

RTECS Number: AJ1925000 (*n*-); AJ2100000 (*sec*-); NS9800000 (*iso*-)

UN/NA & ERG Number: UN1104/129; UN1993 (flammable liquids, n.o.s.)/128

EC Number: 211-047-3 [*Annex I Index No.*: 607-130-00-2] (*n*-); 210-946-8 [*Annex I Index No.*: 607-130-00-2] (*sec*-); 204-662-3 [*Annex I Index No.*: 607-130-00-2] (*iso*-); 210-843-8 [*Annex I Index No.*: 607-130-00-2] (*o*-)

Regulatory Authority and Advisory Information

Hazard Alert: Highly flammable, Primary irritant (w/o allergic reaction).

United States Environmental Protection Agency, FIFRA 1998 Status of Pesticides: Canceled (*n*-isomer)

Clean Water Act: 40CFR116.4 Hazardous Substances; 40CFR117.3, RQ (same as CERCLA)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 5000 lb (2270 kg)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. (*n*-, *sec*-, and *iso*-isomers listed).

European/International Regulations (*n*-; *sec*-; *o*-; *iso-isomers*): Hazard symbol: F + , Xn; risk phrases: R2; R11; R36/37/38; R66; safety phrases: S2; S15; S16; S21; S23; S25; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water. (*n*-; *o*-)

Description: All isomers of amyl acetate are highly flammable, colorless to yellow, watery liquids. The *n*-and *iso*-isomers have a persistent, fruity, banana-like or pear-like odor. The *sec*-isomer has a mild fruity odor. Molecular weight of isomers = 130.21. Hazard identification (based on NFPA-704 M Rating System): (*sec-isomer*) Health 2; flammability 3; reactivity 0.

n-isomer: Boiling point = 146 @ 760 mmHg; specific gravity (H_2O:1) = 0.876 @ 20°C; melting/freezing point = −78.5°C; liquid surface tension = 0.012 N/m @ 30°C; liquid water interfacial tension = (estimate) 0.05 N/m @ 17°C; relative vapor density (air = 1) = 4.5; ratio of specific heats of vapor (gas) = 1.1; latent heat of vaporization = 3.1×10^5 J/kg; heat of combustion = -310.8×10^5 J/kg; vapor pressure = 0.93 kPa @ 20; flash point = 32°C; autoignition temperature = 360°C. explosive limits: LEL: 1.0%; UEL: 7.5%; *sec*-isomer: Boiling point = 121°C; melting/freezing point = −148°C; critical temperature = 326°C; critical pressure = 411.6 psia = 28.0 atm = 2.83 MN/m^2; specific gravity (H_2O:1) = 0.861−0.866 @ 20°C; liquid surface tension = 28.9 dyn/cm = 0.0289 N/m @ 20°C; liquid water interfacial tension = (estimate) 0.0441 N/m @ 20°C; relative vapor density (air = 1) = 4.5; ratio of specific heats of vapor (gas) = (estimate) $>$ 1−1.1 @ 20°C; latent heat of vaporization = (estimate) = 3.0×10^5 J/kg; heat of combustion = −14.402 Btu/lb = −8000 cal/g = -334.9×10^5 J/kg; vapor pressure = 7 mmHg @ 20; flash point = 32°C; explosive limits: LEL: 1.1%; UEL: 7.0%.

tert-isomer: Boiling point = 125°C; flash point = 26°C; explosive limits: LEL: 1.0%; UEL: 7.5%

Potential Exposure: (*n*-isomer): Primary irritant (w/o allergic reaction), (*sec*-isomer) Human Data. Amyl acetates are used as industrial solvents and in the manufacturing and dry-cleaning industry; making artificial fruit-flavoring agents; cements, coated papers, lacquers; in medications as an inflammatory agent; pet repellents, insecticides and miticide. Many other uses.

Incompatibilities: Vapors may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, nitrates. May soften certain plastics.

Permissible Exposure Limits in Air

n-and sec-amyl acetates

NIOSH IDLH = 1000 ppm

Odor threshold = 0.0075−7.3 ppm. *(n-)*; odor threshold = 0.002 ppm. *(sec-) Note*: The range of accepted *odor threshold values* is quite broad and caution should be used in relying on odor alone as a warning of potentially hazardous exposure.

OSHA PEL (*628-63-7; 626-38-0*): 100 ppm/525 milligram per cubic meter TWA

NIOSH REL (*628-63-7; 626-38-0*): 100 ppm/525 milligram per cubic meter TWA

ACGIH TLV[1] (*628-63-7; 626-38-0; 620-11-1; 625-16-1*): 50 ppm/266 milligram per cubic meter TWA; 100 ppm/532 milligram per cubic meter STEL

628-63-7 (n-)

PAC Ver. 29[138]

PAC-1: 100 ppm

PAC-2: 670 ppm

PAC-3: 4000* ppm

* $>=$ 10% lower explosive limit (LEL) but $<$ 50% LEL

DFG MAK (*628-63-7; 626-38-0; 620-11-1; 625-16-1*): 50 ppm/270 milligram per cubic meter TWA; Peak Limitation Category I(1). Pregnancy Risk Group D

Austria: MAK 100 ppm (525 milligram per cubic meter), 1999; Denmark: TWA 100 ppm (525 milligram per cubic meter), 1999; France: VME 100 ppm (530 milligram per cubic meter), 1999; Japan: 100 ppm (530 milligram per cubic meter), 1999; Norway: TWA 50 ppm (260 milligram per cubic meter), 1999; Poland: MAC (time-weighted average) 250 milligram per cubic meter; MAC (STEL) 500 milligram per cubic meter, 1999; Sweden: TWA 100 ppm (500 milligram per cubic meter), STEL 150 ppm (800 milligram per cubic meter), 1999; Switzerland: MAK-week 100 ppm (500 milligram per cubic meter), 1999; United Kingdom: TWA 50 ppm (270 milligram per cubic meter), STEL 100 ppm (541 milligram per cubic meter), 2000

sec-isomer

OSHA PEL: 125 ppm/650 milligram per cubic meter TWA

NIOSH REL: 125 ppm/650 milligram per cubic meter TWA

ACGIH TLV[1]: 50 ppm/266 milligram per cubic meter TWA; 100 ppm/532 milligram per cubic meter STEL

DFG MAK: 50 ppm/270 milligram per cubic meter TWA; Peak Limitation Category I(1). Pregnancy Risk Group D.

Australia: TWA 125 ppm (665 milligram per cubic meter), 1993; Austria: MAK 100 ppm (525 milligram per cubic meter), 1999; Belgium: TWA 125 ppm (665 milligram per cubic meter), 1993; Denmark: TWA 100 ppm (525 milligram per cubic meter), 1999; France: VME 125 ppm (670 milligram per cubic meter), 1999; Norway: TWA 50 ppm (260 milligram per cubic meter), 1999; the Philippines: TWA 125 ppm (650 milligram per cubic meter), 1993; Sweden: TWA 100 ppm (500 milligram per cubic meter), STEL 150 ppm (800 milligram per cubic meter), 1999; Switzerland: MAK-week 100 ppm (540 milligram per cubic meter), 1999; Turkey: TWA 100 ppm (525 milligram per cubic meter), 1993; United Kingdom: TWA 50 ppm (270 milligram per cubic meter), STEL 100 ppm (541 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 100 ppm

DFG MAK: 50 ppm/270 milligram per cubic meter TWA; Peak Limitation Category I(1). Pregnancy Risk Group D.

Australia: TWA 100 ppm (525 milligram per cubic meter), 1993; Belgium: TWA 100 ppm (532 milligram per cubic meter), 1993; Denmark: TWA 100 ppm (525 milligram per cubic meter), 1999; France: VME 100 ppm (525 milligram per cubic meter), 1999; Japan: 100 ppm (530 milligram per cubic meter), 1999; Norway: TWA 50 ppm (260 milligram per cubic meter), 1999; the Philippines: TWA 100 ppm (525 milligram per cubic meter), 1993; Russia: TWA 100 ppm, 1993; Switzerland: MAK-week 50 ppm (270 milligram per cubic meter) [skin], 1999; United Kingdom: LTEL 100 ppm (525 milligram per cubic meter), STEL 125 ppm, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 100 ppm

tert-isomer

Odor threshold = 0.08−0.0006 in water. *Note*: The range of accepted *Odor Threshold values* is quite broad and caution should be used in relying on odor alone as a warning of potentially hazardous exposure.

ACGIH TLV[1]: 50 ppm/266 milligram per cubic meter TWA; 100 ppm/532 milligram per cubic meter STEL
DFG MAK: 50 ppm/270 milligram per cubic meter TWA; Peak Limitation Category I(1). Pregnancy Risk Group C.

Determination in Air: Use NIOSH Analytical Method #1450 Esters I, #2549 Volatile Organic Compounds[18] (screening).

Permissible Concentration in Water: No criteria set.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 2.18$ (*n*-isomer); 2.26 (*sec-isomer*). Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion, eye, and skin contact. Passes through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Amyl acetates can be absorbed through the skin, thereby increasing exposure. Irritates the eyes, causing burning sensation. Inhalation can irritate the respiratory tract, causing cough and wheezing. Higher exposure can cause headache, drowsiness, weakness, and loss of consciousness.

Long-Term Exposure: (*n*-) May cause liver damage. (*sec*-) May cause slight changes in the nervous system (brain wave changes). Prolonged or repeated skin contact to amyl acetates can cause irritation, dryness and cracking. Although all of these chemicals have not been adequately tested, many similar petroleum-based chemicals can cause brain or other nerve damage. Effects may include reduced memory and concentration, personality changes; such as withdrawal and irritability; fatigue, sleep disturbances; reduced coordination; and/or effects on autonomic nerves, and/or nerves to the arms and legs with weakness and sensation of "pins and needles." See also DFG MAK, above, for Pregnancy Risk Groups.

Points of Attack: Eyes, skin and respiratory system; CNS.

Medical Surveillance: Liver function tests. Positive and borderline individuals showing brain effects, changes in memory, concentration, mood and sleeping patterns, as well as headaches and fatigue should be referred for neuropsychological testing.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: *n*-Amyl acetate (CAS: 628-63-7): Prevent skin contact. **8 hours** (More than 8 hours of resistance to breakthrough $>0.1\ \mu m > g/cm^2/min$): Barricade coated suits; Responder suits; **4 hours** (At least 4 but $<$ 8 hours of resistance to breakthrough $>0.1\ \mu m > g/cm^2/min$): Polyvinyl alcohol gloves; Teflon gloves, suits, boots. Employees should wash promptly when skin is wet or contaminated. Remove clothing immediately if wet or contaminated to avoid flammability hazard. Wear solvent-resistant protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear solvent-resistant, splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA (for *n*-, *sec*-, and *iso*-isomers): *1000 ppm*: CcrFOv* (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister); or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister; PaprOv* (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]; or Sa* (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode. *Escape*: GmFOv (APF = 500) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA). *Note*: Substance reported to cause eye irritation or damage; may require eye protection. There are no specific respirator specs for *tert*-amyl acetate.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where amyl acetates may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area, preferably a detached shed. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN1993 Flammable liquids, n.o.s., Hazard Class: 3; Labels: 3-Flammable liquid, Technical Name Required.

Spill Handling: Avoid contact. Stay upwind. Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Establish forced ventilation to keep levels below explosive limit. Remove all ignition sources. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: These chemicals are flammable liquids. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (2); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 2, No. 2, 39–40 (1982) (Isoamyl Acetate).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 3, No. 6, 37–40 (November, December 1983) (*t*-Amyl Acetate).

New York State Department of Health, Chemical Fact Sheet: *n*-Amyl Acetate, Bureau of Toxic Substance Assessment, Albany, NY (March 1986).

New Jersey Department of Health and Senor Services, *Hazardous Substances Fact Sheet*: *n*-Amyl Acetate, Trenton, NJ (June 2004).

New Jersey Department of Health and Senior Services, Hazardous Substances Fact Sheet: *sec*-Amyl Acetate, Trenton, NJ (June 2004).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Isoamyl Acetate, Trenton, NJ (July 2005).

Amyl Alcohols A:1310

Formula: $C_5H_{12}O$

Synonyms: Pentanols

n-isomer: Alcohol *n*-amilico primario (Spanish); Alcohol C-5; Alcool *n*-amyl alcohol; 1-Amyl alcohol; Amyl alcohol; Amyl alcohol, *normal*; Amylique (French); Amylol; *n*-Butyl carbinol; *n*-Pentanol; 1-Pentanol; Pentan-1-ol; Pentanol; Pentanol-1; Pentasol; Pentyl alcohol; Prim-*n*-amyl alcohol; Primary amyl alcohol

sec-isomer: Alcohol *n*-amilico secundario (Spanish); *sec*-Amyl alcohol; Methyl propyl carbinol; 2-Pentanol; Pentanol-2; *sec*-Pentyl alcohol

tert-isomer: Alcohol amilico terciario (Spanish); *tert*-Amyl alcohol; Amylene hydrate; Dimethylethylcarbinol; 2-Methyl butanol-2; 2-Methyl-2-butanol; 3-Methylbutan-3-ol; *tert*-Pentanol; 3-Pentanol; *tert*-Pentyl alcohol

iso-isomer: Alcohol isoamilico primario (Spanish); Alcool isoamylique (French); *iso*-Amylalkohol (German); Diethylcarbinol; Fermentation amyl alcohol; Isoamyl alcohol; Isoamylol; Isobutylcarbinol; Isopentanol; Isopentyl alcohol; 2-Methyl-4-butanol; 3-Methyl butanol; 3-Methylbutan-1-ol; 3-Pentanol; Pentanol-3-ol

CAS Registry Number: 71-41-0 (*n-isomer*); 6032-29-7 (*sec-isomer*); 123-51-3 (*iso-, primary-isomer*); 137-32-6 (*active primary-isomer*); 584-02-1 (*iso-, secondary-isomer*); *(alt)* 26635-63-2; 75-85-4 (*tert-isomer*); 30899-19-5 (*iso-isomer*); *(alt)* 94624-12-1; 598-75-4 (*sec-isoamyl-isomer*); 75-84-3 (*neo-isomer*); 30899-19-5 (mixed isomers)

HSDB Number: 111 (*n*-isomer)

RTECS Number: SB9800000 (*n-isomer*); SA4900000 (*sec-isomer*); SC0175000 (*tert-isomer*); EL5425000 (*iso-, primary-isomer*); SA5075000(*iso-secondary-isomer*)

UN/NA & ERG Number: UN1105/129; UN1987 (alcohols, n.o.s.)/127

EC Number: 200-752-1 [*Annex I* Index No.: 603-200-00-1] (*n-isomer*); 227-907-6 (*sec-isomer*); 200-908-9 [*Annex I* Index No.: 603-007-00-2] (*tert-isomer*); 204-633-5 (*iso-,* *primary-isomer*); 209-526-7 (*iso-secondary-isomer*); 205-289-9 (*active primary-isomer*)

Regulatory Authority and Advisory Information

Hazard Alert: Flammable, Primary irritant (w/o allergic reaction)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. (*n*-, *sec*-, and *iso-primary- and secondary*-isomers listed).

European/International Regulations (*all isomers except tert-*): Hazard symbol: Xn; risk phrases: R10; R20; R37; safety phrases: S2; S41; S46; (*tert*-; *75-85-4*): Hazard symbol: F, Xn; risk phrases: R11; R20; R36/R37/38; safety phrases: S2; S21; S41; S46 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [1-Low hazard to water. (est.)]—*and sec-isomers*, mixed isomers.

Description: Amyl alcohols (pentanols) have eight isomers. All are flammable, colorless liquids, except the isomer 2,2-dimethyl-1-propanol, which is a crystalline solid. Odors* are described as "acetone-like" and "similar to fuel oil."

n-isomer, CAS 71-41-0: Molecular weight = 88.17; boiling point = 137.9°C; melting/freezing point = −78.8°C; critical temperature = 313°C; specific gravity (H_2O:1) = 0.818 @ 15°C; liquid surface tension = 0.02560 N/m @ 20°C; liquid water interfacial tension = 0.005 N/m @ 20°C; relative vapor density (air = 1): 3.04; ratio of specific heats of vapor (gas): 1.06; latent heat of vaporization = 5.049×10^5 J/kg; heat of combustion = -376.8×10^5 J/kg; electrical conductivity = 2.6×10^7 pS/m; vapor density (air = 1) = 3.0; vapor pressure = 2.29 mmHg @ 20°C. Explosive limits: LEL: 1.2%; 12.000 ppm; UEL: 10.0% @ 100°C. Hazard identification (based on NFPA-704M Rating System): Health 1; flammability 3; reactivity 0.

sec-isomer CAS 6032-29-7: Molecular weight = 88.17; boiling point = 118°C; melting/freezing point = −78.8°C; flash point = 34°C; autoignition temperature = 343°C. Explosive limits: LEL: 1.2%; UEL: 9.0. Hazard identification (based on NFPA-704M Rating System): Health 1; flammability 3; reactivity 1, Oxidizer. Slightly soluble in water; solubility = 13.5 g/100 mL.

tert-isomer CAS 75-85-4: Boiling point = 102°C; melting/freezing point = −8°C; flash point = 19°C; autoignition temperature = 436°C; explosive limits: LEL: 1.2%; UEL: 9. Hazard identification (based on NFPA-704M Rating System): Health 1; flammability 3; reactivity 0. Moderate solubility in water.

iso-primary-isomer CAS: 123-51-3: Molecular weight = 88.17; boiling point = 132°C; melting/freezing point: −117°C; critical temperature: 307°C; specific gravity (H_2O:1) = 0.82 @ 20°C; liquid surface tension = 0.0238 N/m @ 20°C; liquid water interfacial tension = 0.005 N/m @ 18°C; relative vapor density (air = 1) = 3.04; ratio of specific heats of vapor (gas) = (est.) 1.062; latent heat of vaporization = 5.016×10^5 J/kg; heat of combustion = -376.8×10^5 J/kg; heat of solution = -1.33×10^5 J/kg; vapor pressure = 28 mmHg @ 20°C; threshold limit = 0.012−10 ppm; flash point = 43°C (cc); 55°C (oc); autoignition temperature = 350°C; explosive limits: LEL: 1.2%; UEL: 9% @ 100°C. Hazard identification (based on NFPA-704M Rating System): Health 1; flammability 2; reactivity 0. Soluble in water; solubility = 2%. Threshold limit = 0.028−0.072 ppm.

iso-secondary-isomer CAS: 6032-29-7: Boiling point = 113-119°C; melting/freezing point = −50°C; specific gravity (H_2O:1) = 0.812; flash point = 35°C; autoignition temperature = 343°C; explosive limits: LEL: 1.2%; UEL: 9%.

Hazard identification (based on NFPA-704M Rating System): Health 1; flammability 2; reactivity 0.

**Note*: The range of accepted odor threshold values is quite broad and caution should be used in relying on odor alone as a warning of potentially hazardous exposure.

Amyl alcohols are obtained from fused oil which forms during the fermentation of grain, potatoes, or beets for ethyl alcohol. The fusel oil is a mixture of amyl alcohol isomers, and the composition is determined somewhat by the sugar source. Slight to moderate solubility in water.

Potential Exposure: (*n*-isomer); Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction), (*iso-, primary*): Possible risk of forming tumors, Primary irritant (w/o allergic reaction), (*sec*-, *active primary*-, and other isomers) Primary irritant (w/o allergic reaction). Used as a solvent in organic synthesis and synthetic flavoring, pharmaceuticals, corrosion inhibitors; making plastics and other chemicals; as a flotation agent. The (*n*-isomer) is used in preparation of oil additives, plasticizers, synthetic lubricants, and as a solvent.

Incompatibilities: Forms an explosive mixture with air. Contact with strong oxidizers and hydrogen trisulfide may cause fire and explosions. Incompatible with strong acids. Violent reaction with alkaline earth metals forming hydrogen, a flammable gas.

Permissible Exposure Limits in Air

NIOSH IDLH = 500 ppm (*isoamyl alcohol, primary-, and sec-*)

Conversion factor: 1 ppm = 3.61 milligram per cubic meter (*iso-, primary- and iso-, secondary-isomers*) @ 25°C & 1 atm

ACGIH TLV[1]: 100 ppm TWA; 125 ppm STEL (*isoamyl alcohol, primary-*)

OSHA PEL: 100 ppm/360 milligram per cubic meter (*isoamyl alcohol, primary-, and sec-*)

NIOSH REL: 100 ppm/360 milligram per cubic meter TWA; 125 ppm/450 milligram per cubic meter STEL (*isoamyl alcohol, primary-, and sec-*)

PAC Ver. 29[138]

584-02-1 (*iso-, secondary-isomer*) *& 123-51-3 (iso-, primary-isomer)*

PAC-1: 125 ppm

PAC-2: 1700 ppm

PAC-3: 10.000 ppm

Australia: TWA 100 ppm (360 milligram per cubic meter), STEL 125 ppm, 1993; Austria: MAK 100 ppm (360 milligram per cubic meter), 1999; Belgium: TWA 100 ppm

(361 milligram per cubic meter), STEL 125 ppm (452 milligram per cubic meter), 1993; Denmark: TWA 100 ppm (360 milligram per cubic meter), 1999; France: VME 100 ppm (360 milligram per cubic meter), 1999; Japan: 100 ppm (360 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 360 milligram per cubic meter, 2003; the Philippines: TWA 100 ppm (360 milligram per cubic meter), 1993; Russia: TWA 100 ppm, STEL 5 milligram per cubic meter, 1993; Switzerland: MAK-week 100 ppm (360 milligram per cubic meter), KZG-week 200 ppm (720 milligram per cubic meter), 1999; Turkey: TWA 100 ppm (360 milligram per cubic meter), 1993; United Kingdom: TWA 100 ppm (366 milligram per cubic meter), STEL 125 ppm (458 milligram per cubic meter), SEP2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 125 ppm

PAC Ver. 27, no values found in Ver. 29[138]

71-41-0 (n-isomer)

Australia: TWA 100 ppm (530 milligram per cubic meter), 1993; Austria: MAK 100 ppm (525 milligram per cubic meter) (all isomers), 1993; Belgium: TWA 100 ppm (532 milligram per cubic meter), 1993; Denmark: TWA 100 ppm (360 milligram per cubic meter), 1999; Finland: TWA 100 ppm (360 milligram per cubic meter), STEL 150 ppm (540 milligram per cubic meter), 1999; France: VME 100 ppm (530 milligram per cubic meter), STEL 150 ppm (800 milligram per cubic meter), 1993; Hungary: TWA 400 milligram per cubic meter, STEL 800 milligram per cubic meter, 1993; Japan: 100 ppm (530 milligram per cubic meter), 1993; the Philippines: TWA 100 ppm (525 milligram per cubic meter), 1993; Poland: MAC (time-weighted average) 100 milligram per cubic meter; MAC (STEL) 450 milligram per cubic meter, 1999; Russia: STEL 10 milligram per cubic meter, 1993; Russia: TWA 100 ppm, STEL 100 milligram per cubic meter, 1993; Switzerland: MAK-week 100 ppm (540 milligram per cubic meter) (all isomers), 1993; Turkey: TWA 100 ppm (525 milligram per cubic meter), 1993; United Kingdom: LTEL 100 ppm (530 milligram per cubic meter), STEL 150 ppm, 1993

6032-29-7 (sec-isomer)

Denmark: TWA 100 ppm (360 milligram per cubic meter), 1999; Norway: TWA 50 ppm (180 milligram per cubic meter), 1999; Poland: MAC (time-weighted average) 100 milligram per cubic meter; MAC (STEL) 450 milligram per cubic meter, 1993

584-02-1 (iso-, secondary-isomer)

Denmark: TWA 100 ppm (360 milligram per cubic meter), 1999; Norway: TWA 50 ppm (180 milligram per cubic meter), 1999; Poland: MAC (time-weighted average) 100 milligram per cubic meter; MAC (STEL) 450 milligram per cubic meter, 1993

DFG MAK (*all pentanol isomers*): 20 ppm/73 milligram per cubic meter TWA; Peak Limitation Category I(4); Pregnancy Risk Group C

Determination in Air: Use NIOSH Analytical Method #1402, #1405.

Permissible Concentration in Water: No criteria set.

Determination in Water: Octanol–water coefficient: Log K_{ow} = 1.34 (*n*-); 1.42 (*sec*-); 1.15 (*iso-, primary*-); 1.35 (*iso-, secondary*-); 0.9 (*tert*-). Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, skin contact; ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Passes through the skin; contact contributes significantly to overall exposure. Skin contact can cause skin irritation. Inhalation can irritate the eyes and respiratory system, causing headache, nausea, and vomiting. High exposure can cause dizziness, lightheadedness, confusion, and unconsciousness. Very high exposure can cause death.

Long-Term Exposure: Can cause liver damage and blood effects.

Points of Attack: Eyes, skin, respiratory system; CNS.

Medical Surveillance: Regular medical checkups are recommended, depending on degree of exposure.

First Aid: Skin contact contributes significantly to overall exposure. If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear solvent-resistant gloves and clothing to prevent any reasonable probability of skin or eye contact. ACGIH and safety equipment suppliers/manufacturers recommend polyvinyl alcohol, polyvinyl chloride, Neoprene, butyl rubber; and nitrile rubber, Neoprene + styrene-butadiene rubber (SBR), polyurethane, SBR, and SBR/Neoprene as protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *500 ppm*: Sa:Cf (APF = 25)[£] (any supplied-air respirator operated in a continuous-flow mode); CcrFOv (APF = 50) [any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s)]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister]; PaprOv[£] [any powered, air-purifying respirator with organic vapor cartridge(s)]; or SCBAF (APF = 50) (any SCBA with a full facepiece);

or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode. *Escape*: GmFOv(any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister); or SCBAE (any appropriate escape-type, SCBA).

*Note**: Substance causes eye irritation or damage; eye protection needed.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where amyl alcohols may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers; strong acids and hydrogen trifluoride; since violent reactions occur. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2811 Pentanols, Hazard Class: 3; Labels: 3-Flammable liquid. UN1987 Alcohols, n.o.s., Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of carbon. Use alcohol or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (2); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 2, No. 3, 55−56 (1982) (*n*-Amyl alcohol).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Amyl Alcohol, Trenton, NJ (June 1998).

Amyl Nitrate A:1320

Formula: $C_5H_{11}NO_3$; $C_5H_{11}ONO_2$

Synonyms: *n*-Amyl nitrate; Diesel ignition improver; Nitrate d'amyle (French); Nitrato de amilo (Spanish); Nitric acid, pentyl ester

CAS Registry Number: 1002-16-0

RTECS Number: QV0600000

UN/NA & ERG Number: UN1112/140

Regulatory Authority and Advisory Information

United States National Primary Drinking Water Regulations: MCLG = 10 mg[N]/L; MCL = 10 mg/L as nitrates.

Hazard Alert: Flammable, Oxidizing agent, Temperature sensitive (Possible explosive as temp. rises)

Hazard symbols, risk, & safety statements: Hazard symbol: F + , O; risk phrases: R9; R12; safety phrases: S13; S16; S26; S27; S41 (see Appendix 4)

Description: Amyl nitrate is a flammable, colorless liquid. Ethereal odor. Molecular weight = 133.15; specific gravity (H_2O:1) = 1.0 @ 20°C; boiling point = 145°C; 153−157°C; melting/freezing point = −123°C; flash point = 48.9°C (oc). Hazard identification (based on NFPA-704M Rating System): Health 2; flammability 2; reactivity 0, Oxidizer. Floats on water; insoluble.

Potential Exposure: Highly flammable, Amyl nitrate is used as an ignition additive in diesel fuels.

Incompatibilities: A strong oxidizer. Violent reaction with many compounds, including reducing agents; chemically active metals; combustible materials, strong acids, alkaline earth sulfides, aluminum carbides, aluminum, amines, calcium sulfide, carbides, chlorine trifluoride, glycerin, hydrides, hydrochloric acid, hydrogen peroxide, hydrogen sulfide, hydroxylamine, magnesium, metal powders, metal sulfides, molybdenum, phenylhydrazine, phosphorous red/friction, phosphorous trichloride, silicon, sulfides, sulfur, sulfur dioxide, sulfur/friction, sulfuric acid, tungsten, hydrogen trisulfide. Temperature sensitive; may explode as temperature rises.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 1.5 ppm

PAC-2: 16 ppm

PAC-3: 98 ppm

Harmful Effects and Symptoms

Short-Term Exposure: Contact can irritate the eyes and skin. Breathing amyl nitrate vapor can cause headaches, dizziness, weakness, and nausea. Higher levels can cause convulsions and death. Exposure can interfere with the ability of the blood to carry oxygen, causing headaches, weakness and a Blue color to the skin and lips.

Long-Term Exposure: Repeated exposure may cause anemia. After repeated exposure tolerance develops. If exposure stops suddenly, chest pain and heart attack could occur.

Points of Attack: Blood cells.

Medical Surveillance: Blood tests for methemoglobin level.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to Physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from heat, sparks, flames and other combustible materials, such as wood, paper or oil. Outside or detached storage is preferred. Before entering confined space where amyl nitrate may be present, check to make sure that an explosive concentration does not exist. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN1112 Amyl nitrate, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Ventilate site of spill or leak. Use water spray to reduce vapors. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. Keep Amyl Nitrate out of a confined space, such as a sewer, because of the potential for an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include Oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration with scrubber to remove nitrogen oxides in effluent gases.

References

(31); (173); (101); (138).

New Jersey Department of Health and Senior Services, ***Hazardous Substances Fact Sheet:*** Amyl Nitrate, Trenton, NJ (August 2000).

Amyl Nitrites A:1330

Formula: C5H11NO2

Synonyms: *n-isomer*: 1-Nitropentane

iso-isomer: Nitrous Acid, 3-methylbutyl ester; Isoamyl nitrite; Isopentyl alcohol nitrite; 3-Methylbutanol nitrite; 3-Methylbutyl nitrite; Nitropentane; Nitrous acid, pentyl ester; Pentyl nitrite

CAS Registry Number: 463-04-7 (*n*-); 110-46-3 (*iso*-)

HSDB Number: 606

RTECS Number: RA1140000 (*n*-); NT0187500 (*iso*-)

UN/NA & ERG Number: UN1113/129; UN1993 (flammable liquids, n.o.s.)/128 (*iso*-)

EC Number: 207-332-7 [*Annex I* Index No.: 007-020-00-9] (*n*-); 203-770-8 [*Annex I* Index No.: 007-020-00-9] (*iso*-)

Regulatory Authority and Advisory Information

Hazard Alert: Flammable, Suspected reprotoxic hazard

European/International Regulations (*n-and iso-isomers*): Hazard symbol: (*n- & iso-isomers*) F + , Xn; risk phrases: R11; R20/22; R63; safety phrases: S2; S16; S24; S41; S46 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [2-Hazard to water. (est.)]

Description: Amyl nitrites are flammable, yellowish liquid with a penetrating, fruity odor. Molecular weight = 117.17; boiling point = 104°C; 99.2°C (*iso*-); specific gravity (H_2O:1) = 0.8758 @ 20°C; 0.883 @ 20°C (*iso*-); liquid surface tension = (estimate) 0.020 N/m @ 20°C; liquid water interfacial tension = (estimate) 0.040 N/m @ 20°C; relative vapor density (air = 1) = 4; ratio of specific heats of vapor (gas) = 1.0709; latent heat of vaporization = 4.94×10^5 J/kg; heat of combustion = -290×10^5 J/kg; vapor pressure = (est.) 27 mmHg; 3.48 kPa @ 20°C; flash point = 3°C (*n*-); 3°C (*iso*-); autoignition temperature = 209−210°C. Hazard identification (based on NFPA-704M Rating System): Health 1; flammability −; reactivity 2. Floats on water; very slightly soluble; decomposes.

Potential Exposure: Amyl nitrite is used to make pharmaceuticals; perfumes, diazonium compounds, and other chemicals.

Incompatibilities: Vapors may form explosive mixture with air. Slowly decomposes in light, heat, and on contact with water. A strong oxidizer. Contact with reducing agents and easily oxidizable materials may cause fire and explosions. Reported to be an explosion hazard when exposed to air and light. Keep away from alcohols, antipyrine, alkaline materials; alkaline carbonates; potassium iodide; bromides, and ferrous salts. Attacks metals in the presence of moisture.

Permissible Exposure Limits in Air

110-46-3 (iso-)

PAC Ver. 29[138]

PAC-1: 0.48 ppm

PAC-2: 5.3 ppm

PAC-3: 32 ppm

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 2.1$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion, skin absorption.

Harmful Effects and Symptoms

Short-Term Exposure: Amyl nitrite can be absorbed through the skin, thereby increasing exposure. Contact can irritate the eyes and skin. A skin allergy can develop. Chronic overexposure can cause blood cell damage and anemia. Exposure can rapidly cause flushing, headaches, dizziness, sharp drop in blood pressure; fast pulse rate; confusion; a Blue color to lips and fingernails and possible fainting and shock.

Long-Term Exposure: Chronic overexposure can cause anemia and red blood cell damage. Repeated exposure causes tolerance to develop. If exposure stops suddenly, chest pain and heart attack could occur. May cause skin allergy to develop. Infants below the age of six months who drink water containing nitrite in excess of the MCL could become seriously ill and, if untreated, may die. Symptoms include shortness of breath and blue-baby syndrome.

Points of Attack: Blood, skin.

Medical Surveillance: Blood methemoglobin level, CBC, evaluation by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to Physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable

probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where amyl nitrite may be present, check to make sure that an explosive concentration does not exist. Store in an explosion-proof refrigerator[52]. Protect from exposure to light. Keep under an inert atmosphere. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN1993 Flammable liquids, n.o.s., Hazard Class: 3; Labels: 3-Flammable liquid, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Use water spray to reduce vapors. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. Keep amyl nitrite out of a confined space, such as a sewer, because of the potential for an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration with scrubber to remove nitrogen oxides from the combustion gases.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Amyl Nitrite, Trenton, NJ (September 2000).

Amyl Trichlorosilane A:1340

Formula: $C_5H_{11}SiCl_3$

Synonyms: Amiltriclorosilano (Spanish); Pentyltrichlorosilane; Pentylsilicon trichloride; Silane, trichloropentyl-; Trichloroamylsilane; Trichloropentylsilane

CAS Registry Number: 107-72-2

HSDB Number: 887

RTECS Number: VV4725000

UN/NA & ERG Number: UN1728/155

EC Number: 203-515-0

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade).

Hazard Alert: Flammable, Corrosive, Violently reactive with water.

Listed in the TSCA inventory.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: F, C; risk phrases: R10; R14; R23/24; R34; safety phrases: S1; S16; S26; S36; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Amyl trichlorosilane is a colorless to yellowish liquid with a sharp acrid odor (like hydrochloric acid). Molecular weight = 205.63; specific gravity (H_2O:1) = 1.137 @ 25°C; boiling point = 168°C; liquid surface tension = (estimate) 0.020 N/m @ 20°C; relative vapor density (air = 1) = 7.1; latent heat of vaporization = 2.02×10^5 J/kg; heat of combustion = -154×10^5 J/kg; heat of solution: 4.0×10^5 J/kg; flash point = 30°C. NFPA 704M Hazard Identification (based on NFPA-704M Rating System): Health 3; flammability 2; reactivity 2₩. Reacts violently with water, rapidly releasing corrosive hydrogen chloride gas.

Potential Exposure: It is used to make silicones.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Chlorosilanes react vigorously with bases and both organic and inorganic acids generating toxic and/or flammable gases. Chlorosilanes react with water, moist air, or steam releasing heat and toxic, corrosive fumes of hydrogen chloride. They may also produce flammable gaseous hydrogen. Attacks metals in the presence of moisture.

Permissible Exposure Limits in Air

PAC* Ver. 29[138]

PAC-1: $\mathbf{0.6_A}$ ppm

PAC-2: $\mathbf{7.3_A}$ ppm

PAC-3: $\mathbf{33_A}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

Harmful Effects and Symptoms

Short-Term Exposure: A corrosive chemical that can cause severe eye and skin burns. Exposure can irritate the eyes, nose and throat. Higher levels can irritate the lungs, causing coughing and/or shortness of breath; still higher exposures can cause pulmonary edema, a medical emergency which can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. The oral LD_{50} for rat is 2,340 mg/kg.

Long-Term Exposure: Similar corrosive chemicals cause lung damage; bronchitis may develop.

Points of Attack: Lungs, skin.

Medical Surveillance: Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Lung function tests. Consider lung X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Acid gas*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]; CcrFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN1728 Amyltrichlorosilane, Hazard class: 8; Labels: 8-Corrosive material.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. Keep amyl trichlorosilane out of a confined space, such as a sewer, because of the potential for an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (from a small package or a small leak from a large package)

when spilled in water

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.2/0.3

Large spills (from a large package or from many small packages)

First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.4/0.6
Night 1.2/1.9

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include phosgene and hydrogen chloride. *Do not use water or foam.* Use dry chemical, carbon dioxide extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Amyl Trichlorosilane, Trenton, NJ (September 1998).

Aniline A:1350

Formula: C_6H_5N; $C_6H_3NH_2$

Synonyms: Aminobenzene; Aminophen; Anilina (Spanish); Aniline oil; Anyvim; Arylamine; Benzeneamine; Benzene, amino-; Blue oil; C.I. 76000; Huile d'aniline (French); NCI-C03736; Phenylamine

CAS Registry Number: 62-53-3; 142-04-1 (*hydrochloride*)

HSDB Number: 43(62-53-3)

RTECS Number: BW6650000; CY0875000 (*hydrochloride*)

UN/NA & ERG Number: UN1547/153; UN1548 (hydrochloride)/153

EC Number: 200-539-3 (*Annex I Index No*. 612-008-00-7); 205-519-8 (*hydrochloride*)

Regulatory Authority and Advisory Information

Carcinogenicity: EPA Gene-Tox Program, Inconclusive: Carcinogenicity-mouse/rat; IARC: Animal Limited Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1987; NCI: (*hydrochloride*) Carcinogenesis Bioassay (feed); clear evidence: rat; no evidence: mouse; IARC: (*hydrochloride*) Animal Limited Evidence, Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1987; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies. United States Environmental Protection Agency Gene-Tox Program, Positive: *E coli polA* without S9; Positive/dose response: Cell transformation-BALB/c-3T3; Negative: SHE-clonal assay; *E coli polA* with S9; Negative: Histidine reversion-Ames test; S *cerevisiae-homozygosis*. United States Environmental Protection Agency Gene-Tox Program (*hydrochloride*), Positive: Cell transformation-RLV F344 rat embryo; Positive/dose response: In vitro SCE-nonhuman; Positive/limited: Carcinogenicity-mouse/rat; Negative: Sperm morphology-mouse.

California Proposition 65 Chemical[102]: Cancer (includes hydrochloride) 1/1/1990.

Hazard Alert: Poison, Flammable, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Sensitization hazard (skin), Primary irritant (w/o allergic reaction), Environmental hazard; *hydrochloride* Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction). Listed for Tier 1 screening as an endocrine disruptor[88].

Banned or Severely Restricted (Restricted in many countries) (UN)[35]

Clean Air Act 42USC7412; Title I, Part A, §112 Hazardous Pollutants

Clean Water Act: 40CFR116.4 Hazardous Substances; 40CFR117.3, RQ (same as CERCLA); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U012

RCRA 40CFR261, Appendix 8; 40CFR261.11 Hazardous Constituents

RCRA Land Ban Waste

RCRA 40CFR264, Appendix 9; Ground Water Monitoring List Suggested methods (PQL μg/L): 8270 (10)

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.081; Nonwastewater (mg/kg), 14

CERCLA/SARA 40CFR302, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg)

Superfund/EPCRA 40CFR302.4, Appendix A, RQ: 5000 lb (2270 kg), 40CFR372.65: Form R *de minimis* Concentration Reporting Level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%; NPRI; Priority Substance List.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as aminobenzene

Hazard symbols, risk, & safety statements: Hazard symbol: T, F, N, Xi; risk phrases: R45; R10; R23/24/25; R39; R41; R43; R48; R50/53; R62; R63; R68; safety phrases: S26; S27; S36/37/39; S41; S45; S46; S61; S63 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Aniline is a clear, colorless, oily liquid that darkens on exposure to light; with a characteristic amine-like odor. Molecular weight = 93.14; 129.60 (hydrochloride); boiling point = 184.2°C; 245°C (hydrochloride); melting/freezing point = −6°C; specific gravity (H_2O:1) = 1.022; 1.2 (hydrochloride) @ 20°C; liquid surface tension = (estimate) 0.020 N/m @ 20°C; liquid water interfacial tension = (estimate) 0.0058 N/m @ 20°C; Liquid surface tension: = 0.0455 N/m @ 20°C; critical pressure = 5.31 MN/m^2; relative vapor density (air = 1) = 4; ratio of specific heats of vapor (gas) = 1.0709; electrical conductivity = 2.4×10^6 pS/m; latent heat of vaporization = 4.61×10^5 J/kg; heat of combustion = -348.3×10^5 J/kg; vapor pressure = 0.6 mmHg @ 20; <0.076 mmHg (hydrochloride); flash point = 70°C; 193°C (hydrochloride); NFPA 704M Hazard Identification (based on NFPA-704M Rating System): Health 3; flammability 2; reactivity 0. Explosive Limits: LEL: 1.3%; UEL: 11%. Slightly soluble in water; solubility = 3.4 g/100 mL @ 20°C; the hydrochloride is more soluble ≥ 100 g/100 mL. *Note*: This chemical's odor generally provides inadequate warning of exceeded exposure limits.

Potential Exposure: Aniline is widely used as an intermediate in the synthesis of dyestuffs. It is also used in the manufacture of rubber accelerators and antioxidants, pharmaceuticals, marking inks; tetryl, optical whitening agents; photographic developers; resins, varnishes, perfumes, shoe polishes, and many organic chemicals.

Incompatibilities: May form explosive mixture with air. Unless inhibited (usually methanol), aniline is readily able to polymerize. Fires and explosions may result from contact with halogens, strong acids; oxidizers, strong base organic anhydrides; acetic anhydride, isocyanates, aldehydes, sodium peroxide. Strong reaction with toluene diisocyanate. Reacts with alkali metals and alkali earth metals. Attacks some plastics, rubber and coatings; copper and copper alloys.

Permissible Exposure Limits in Air

NIOSH IDLH = 100 ppm

Odor threshold = 0.58−10 ppm.

Aniline and homologues.

Conversion factor: 1 ppm = 3.81 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 5 ppm/19 milligram per cubic meter TWA [skin]

NIOSH REL: Potential occupational carcinogen. Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A

ACGIH TLV[1]: 2 ppm/7.6 milligram per cubic meter TWA [skin]; Confirmed animal carcinogen; BEI: 50 mg/L total *p*-aminophenol in urine at end-of-shift

PAC* Ver. 29[138]

aniline

PAC-1: $\mathbf{8_A}$ ppm

PAC-2: $\mathbf{12_A}$ ppm

PAC-3: $\mathbf{20_A}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

DFG MAK: 2 ppm/7.7 milligram per cubic meter [skin] danger of skin sensitization; Peak Limitation Category II (2); Carcinogen Category 4; Pregnancy Risk Group C; BAT: 1 mg/L urine/end-of-shift

Arab Republic of Egypt: TWA 2 ppm (10 milligram per cubic meter) [skin], 1993; Australia: TWA 2 ppm (10 milligram per cubic meter) [skin], 1993; Austria: MAK 2 ppm (8 milligram per cubic meter) [skin], suspected carcinogen, 1999; Belgium: TWA 2 ppm (7.6 milligram per cubic meter) [skin], 1993; Denmark: TWA 1 ppm (4 milligram per cubic meter) [skin], 1999; Finland: TWA 2 ppm (7.6 milligram per cubic meter), STEL 4 ppm [skin], carcinogen, 1993; France: VME 2 ppm (10 milligram per cubic meter) [skin], carcinogen, 1999; the Netherlands: MAC-TGG 1 milligram per cubic meter [skin], 2003; India: TWA 0.2 milligram per cubic meter [skin], 1993; Japan: 1 ppm (3.8 milligram per cubic meter) [skin], 1993;

Norway: TWA 1 ppm (4 milligram per cubic meter), 1999; the Philippines: TWA 5 ppm (19 milligram per cubic meter) [skin], 1993; Poland: MAC (time-weighted average) 5 milligram per cubic meter; MAC (STEL) 20 milligram per cubic meter, 1999; Russia: TWA 1 ppm, STEL 0.1 milligram per cubic meter [skin], 1993; Sweden: NGV 1 ppm (4 milligram per cubic meter), KTV 2 ppm (8 milligram per cubic meter) [skin], 1999; Switzerland: MAK-week 2 ppm (8 milligram per cubic meter), KZG-week 10 ppm (40 milligram per cubic meter) [skin], 1999; Turkey: TWA 5 ppm (19 milligram per cubic meter) [skin], 1993; United Kingdom: TWA 1 ppm (4 milligram per cubic meter) [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: confirmed animal carcinogen with unknown relevance to humans. Mexico: TWA 10 milligram per cubic meter; STEL 5 ppm (20 milligram per cubic meter). Russia[43] set a MAC of 0.05 m/mg^3 in residential air on a momentary basis and 0.03 milligram per cubic meter in residential air on an average daily basis. The California standard for work-place air is 2 ppm (7.6 milligram per cubic meter) TWA. Several states have set guidelines or standards for aniline in ambient air[60]: 0.4 milligram per cubic meter (New York), 1.4 μ/m^3 (Massachusetts), 3.0 μ/m^3 (Rhode Island), 23.81 μ/m^3 (Kansas), 50 μ/m^3 (South Carolina), 100 μ/m^3 (North Dakota), 160 μ/m^3 (Virginia), 200 μ/m^3 (Connecticut), 238 μ/m^3 (Nevada), 1000 μ/m^3 (North Carolina).

Determination in Air: Silica adsorption, workup in *n*-propanol, followed by GC. Use NIOSH Analytical Method 2002 for aromatic amines[18].

Permissible Concentration in Water: No criteria set but EPA[32] has suggested an ambient limit in water of 262 μ/mL based on health effects. Russia[43] set a MAC of 0.1 mg/L in water for domestic purposes and 0.0001 mg/L in water for fishery purposes.

Routes of Entry: Inhalation of vapors, percutaneous absorption of liquid and vapor, ingestion; skin, and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Skin contact contributes significantly to overall exposure. Direct contact with liquid aniline can cause skin burns, eye irritation and possible permanent damage. Inhalation can cause irritation of the respiratory tract with wheezing and coughing. High levels can interfere with the blood's ability to carry oxygen. Higher levels can cause difficult breathing; collapse and death. Symptoms of exposure include grayish Blue skin, headache, nausea, sometimes vomiting; dryness of throat; confusion, vertigo, lack of muscle coordination; ringing in the ears; weakness, disorientation, lethargy, drowsiness and coma. Urinary signs include painful urinating, blood in the urine; the presence of hemoglobin in the urine; and diminished amounts of urine. Aniline is classified as very toxic. Probable oral lethal dose in humans is 50−500 mg/kg for a 150-lb person. The approximate minimum lethal dose for a 150-lb human is 10 g. Serious poisoning may result from ingestion of 0.25 mL.

Long-Term Exposure: Chronic exposure can cause anemia, anorexia, weight loss; and skin lesions. Chronic effects may be due to acute damage to the brain, heart, and kidneys. Loss of appetite; dizziness, insomnia, tremors, malignant bladder growths; liver damage; and jaundice. Anemia has been reported. Has been linked to bladder cancer according to a NIOSH study. Signs and symptoms include: blood in the urine, other changes in the appearance of the urine; changes in urinary habits; lumps in the groin and lower abdomen; and pain in the lower abdomen or back. Aniline can cross the placental barrier. Because fetal hemoglobin is more easily oxidized to methemoglobin than is adult hemoglobin and is less easily reduced back to normal hemoglobin, methemoglobin theoretically may be at higher levels in fetuses than in exposed mothers.

Points of Attack: Blood, cardiovascular system, liver, kidneys.

Medical Surveillance: Preplacement and periodic physical examinations should be performed on all employees working in aniline exposure areas. These should include a work history to elicit information on all past exposures to aniline, other aromatic amines; and nitro compounds known to cause chemical cyanosis; the clinical history of any occurrence of chemical cyanosis; a personal history to elicit alcohol drinking habits; and general physical examination with particular reference to the cardiovascular system. Persons with impaired cardiovascular status may be at greater risk from the consequences of chemical cyanosis. A preplacement CBC and methemoglobin estimation should be performed as baseline levels, also follow-up studies including periodic blood counts and hematocrit. People at special risk include individuals with glucose-6-phosphate-dehydrogenase deficiency and those with liver and kidney disorders; blood diseases, or a history of alcoholism. This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to Physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Aniline, the simplest aromatic amine, is a prototypical inducer of methemoglobinemia and impaired oxygen transport to tissues. Chemical protective clothing is recommended because aniline vapor and liquid can be dermally absorbed and may contribute to systemic toxicity. Prevent skin contact. **8 hours** (more than 8 hours of resistance to breakthrough $>0.1\ \mu m > g/cm^2/min$): butyl rubber gloves, suits, boots; Polyvinyl alcohol gloves; 4H and Silver Shield gloves; Barricade coated suits; Responder suits, Trellchem HPS suits; **4 hours** (At least 4 but $<$ 8 hours of resistance to breakthrough $>0.1\ \mu m > g/cm^2/min$): Teflon gloves, suits, boots; Viton gloves, suits, Saranex coated suits. In areas of vapor concentration, the use of respirators alone is not sufficient; skin protection by protective clothing should be provided even though there is no skin contact with liquid aniline. Personal hygiene practices including prompt removal of clothing which has absorbed aniline, thorough showering after work and before changing to street clothes and clean working clothes daily are essential. Provide emergency showers and eyewash.

Respirator Selection: Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls, and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit.

NIOSH: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where aniline may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, dry, dark, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Where this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN1547 Aniline, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN1548 Aniline hydrochloride, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Stay upwind; keep out of low areas. Establish forced ventilation to keep levels below explosive limit. Wear positive-pressure breathing apparatus and special protective clothing. Remove all ignition sources: no flares, smoking or flames in hazard area. Do not touch material; stop leak if you can do it without risk. Use water spray to reduce vapors. *Small spills*: take up with vermiculite, dry sand; earth, or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: dike far ahead of spill for later disposal. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of nitrogen and carbon. Use alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Fight fire from maximum distance. Dike fire control water for later disposal and do not scatter material. If a leak or spill has not ignited, use water spray to control vapors. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant

(≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration with provision for nitrogen oxides removal from flue gases by scrubber, catalytic or thermal device[22].

References

(102); (31); (173); (101); (138); (2); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Aniline, Washington, DC (January 20, 1978).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 1, No. 3, 29−31 (1981) and 3, No. 5, 37−40 (1983) and 4, No. 4, 55−59 (1984) (Aniline hydrochloride).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Aniline, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

New York State Department of Health, Chemical Fact Sheet: Aniline," NY, Bureau of Toxic Substance Assessment (April 1986).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Aniline, Trenton, NJ (June 1998).

Anisidines A:1360

Formula: C_7H_9NO; $H_2NC_6H_4OCH_3$

Synonyms: *o-isomer*: Amine, *o*-methoxyphenylamine; *o*-Aminoanisole; 2-Aminoanisole; *o*-Anisidina (Spanish); 2-Anisidine; Anisidine-*o*; *o*-Anisylamine; *o*-Methoxyaniline; 2-Methoxyaniline; 2-Methoxybenzenamine; *o*-Methoxyphenylamine

p-isomer: *p*-Aminoanisole; 4-Aminoanisole; 1-Amino-4-methoxybenzene; *p*-Anisidina (Spanish); 4-Anisidine; Anisidine-*p*; *p*-Methoxyaniline; 4-Methoxyaniline; 4-Methoxybenzenamine; 4-Methoxybenzeneamine *Note*: for information on *o*-Anisidine, 5-methyl-120-71-8 see *p*-Cresidine record

CAS Registry Number: 536-90-3 (*m*-isomer); 90-04-0 (*o*-isomer); 104-94-9 (*p*-isomer); 29191-52-4 (mixed isomers); 134-29-2 (hydrochloride)

HSDB Number: 7816

RTECS Number: BZ5410000 (*o*-isomer); BZ5450000 (*p*-isomer)

UN/NA & ERG Number: UN2431/153

EC Number: 201-963-1 [*Annex I Index No*.: 612-035-00-4] (*o*-isomer); 203-254-2 [*Annex I Index No*.: 612-112-00-2] (*p*-isomer)

Regulatory Authority and Advisory Information *Note*: The *o*-and *p*-isomers are the primary concerns of federal, state, and local government regulators

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen: *o-Anisidine and its hydrochloride;* IARC: (*o*-) Animal Sufficient Evidence, Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B, 1999; (*p*-) IARC: Animal Limited Evidence, Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3; (hydrochloride, *o*-isomer). United States Environmental Protection Agency Gene-Tox Program (*m*-), Inconclusive: Histidine reversion-Ames test.

California Proposition 65 Chemical[102]: Cancer (includes hydrochloride) 1/1/1990.

Hazard Alert: all isomers: Poison, *m*-isomer): Suspected reprotoxic hazard; *o*-isomer: Combustible, Possible risk of forming tumors, Suspected reprotoxic hazard, Environmental hazard; *p-isomer*: Possible risk of forming tumors, Suspected reprotoxic hazard.

Clean Air Act 42USC7412; Title I, Part A, §112 Hazardous Pollutants (*o*-isomer)

Superfund/EPCRA 40CFR302.4, Appendix A, RQ: CERCLA 1 lb (0.454 kg) (*o*-isomer); 40CFR372.65: Form R *de minimis* Concentration Reporting Level: 0.1%. (*o*-isomer)

CERCLA/SARA 40CFR372.65: Form R *de minimis* Concentration Reporting Level: 1.0% (*p*-isomer)

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as *o*-aminoanisole

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%. (*o*-isomer, carconogen); 1% (*p*-isomer)

European/International Regulations (*90-04-0*): Hazard symbol: T; Risk phrases: R45; R23/24/25; R63; R68; Safety phrases: S53; S45; (*104-94-9*): Hazard symbol: T+, N; Risk phrases: R45; R26/27/28; R33; R50; R63; Safety phrases: S1/2; S28; S36/37; S41; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water (*m-isomer*); 3-Severe hazard to water (*o-isomer*); 2-Hazard to water (*p-isomer*)

Description: Anisidine exists as *ortho*-, *meta*-, and *para*-isomers. They have characteristic amine (fishy) odors.

o-isomer: A colorless to pink liquid. Solid below 5°C. Molecular weight = 123.17; boiling point = 224°C; melting/freezing point = 5°C; vapor pressure ≤ 0.1 mmHg @ 20°C; flash point = 118°C (oc); autoignition temperature = 415°C. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 1; reactivity 0. Practically insoluble in water; solubility = 1.5%.

m-isomer: Pale yellow liquid. Molecular weight = 123.2; boiling point = 251°C; freezing/melting point = 57.2°C; vapor pressure = 0.006 mmHg @ 20°C.

p-isomer: Reddish-brown solid. Molecular weight = 123.2; boiling point = 243°C; freezing/melting point = 57.2°C; vapor pressure = 0.4 mmHg @ 20°C; flash point = 122°C; autoignition temperature = 515°C. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 0; reactivity 0. Insoluble in water.

Potential Exposure: Anisidines are used in the manufacture of azo dyes; pharmaceuticals; textile-processing chemicals

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine,

bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Attacks some coatings and some forms of plastic and rubber.

Permissible Exposure Limits in Air

o- & p-isomers

NIOSH IDLH = 50 milligram per cubic meter

OSHA PEL: 0.5 milligram per cubic meter TWA [skin]

NIOSH REL: 0.5 milligram per cubic meter TWA [skin] Potential occupational carcinogen. Reduce exposures to the lowest feasible concentration.

ACGIH TLV[1]: 0.1ppm/0.5 milligram per cubic meter TWA [skin]; confirmed animal carcinogen with unknown relevance to humans; BEI established.

PAC Ver. 29[138]

90-04-0 (o-isomer); 104-94-9 (*p-isomer*)

PAC-1: 1.5 milligram per cubic meter

PAC-2: 8.3 milligram per cubic meter

PAC-3: 50 milligram per cubic meter

DFG MAK: [skin] Carcinogen Category 3B

Australia: TWA 0.1 ppm (0.5 milligram per cubic meter) [skin], 1993; Austria: MAK 0.1 ppm (0.5 milligram per cubic meter) [skin], 1993; Belgium: TWA 0.1 ppm (0.5 milligram per cubic meter) [skin], 1993; Denmark: TWA 0.1 ppm (0.5 milligram per cubic meter) [skin], 1999; Finland: TWA 0.5 milligram per cubic meter, STEL 1.5 milligram per cubic meter [skin], carcinogen, 1993; France: VME 0.1 ppm (0.5 milligram per cubic meter) [skin], carcinogen, 1999; India: TWA 0.1 ppm (0.5 milligram per cubic meter) [skin], 1993; Japan: [skin], 2B carcinogen, 1999; Norway: TWA 0.1 ppm (0.5 milligram per cubic meter), 1999; the Philippines: TWA 0.5 milligram per cubic meter [skin], 1993; Poland: MAC (time-weighted average) 0.5 milligram per cubic meter; MAC (STEL) 1 milligram per cubic meter, 1999; Russia: STEL 1 milligram per cubic meter [skin], 1993; Switzerland: MAK-week 0.1 ppm (0.5 milligram per cubic meter), KZG-week 0.2 ppm (1 milligram per cubic meter) [skin], 1999; United Kingdom: TWA 0.1 ppm (0.51 milligram per cubic meter), carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: confirmed animal carcinogen with unknown relevance to humans.

104-94-9 (p-isomer)

OSHA PEL: 0.5 milligram per cubic meter TWA

NIOSH REL: 0.5 milligram per cubic meter TWA

ACGIH TLV[1]: 0.1 ppm TWA [skin]; not classifiable as a human carcinogen

PAC Ver. 29[138]

PAC-1: 1.5 milligram per cubic meter

PAC-2: 8.3 milligram per cubic meter

PAC-3: 50 milligram per cubic meter

DFG MAK: [skin]; DFG Carcinogen Category 3B

Australia: TWA 0.1 ppm (0.5 milligram per cubic meter) [skin], 1993; Austria: MAK 0.1 ppm (0.5 milligram per cubic meter) [skin], 1999; Belgium: TWA 0.1 ppm (0.5 milligram per cubic meter) [skin], 1993; Denmark: TWA 0.1 ppm (0.5 milligram per cubic meter) [skin], 1999; Finland: TWA 0.5 milligram per cubic meter, STEL 1.5 milligram per cubic meter [skin], carcinogen, 1993; France: VME 0.1 ppm (0.5 milligram per cubic meter) [skin], 1999; India: TWA 0.1 ppm (0.5 milligram per cubic meter) [skin], 1993; Japan: [skin], 1999; the Netherlands: MAC-TGG 0.5 milligram per cubic meter [skin], 2003; the Philippines: TWA 0.5 milligram per cubic meter [skin], 1993; Poland: MAC (time-weighted average) 0.5 milligram per cubic meter; MAC (STEL) 1 milligram per cubic meter, 1999; Russia: STEL 1 milligram per cubic meter [skin], 1993; Switzerland: MAK-week 0.1 ppm (0.5 milligram per cubic meter), KZG-week 0.2 ppm (1 milligram per cubic meter) [skin], 1999; United Kingdom: TWA 0.1 ppm (0.53 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Several states have set guidelines or standards for anisidines in ambient air[60]: 0.02−1.0 μ/m^3 (Rhode Island), 5.0 μ/m^3 (Connecticut and North Dakota), 8.0 μ/m^3 (Virginia), 12.0 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method 2514, anisidine[18].

Permissible Concentration in Water: No criteria set.

Determination in Water: Octanol−water coefficient: Log $K_{ow} \leq 1$ (*o*-isomer); 1.18 (*m*-isomer); <1 (*p*-isomer). Unlikely to bioaccumulate in marine organisms. A listed United States DOT marine pollutant that may persist in the environment.

Routes of Entry: Inhalation, ingestion, skin, eye, mucous membrane absorption.

Harmful Effects and Symptoms

Short-Term Exposure: These chemicals can be absorbed through the skin, eyes, or mucous membranes; thereby increasing exposure. Contact with anisidines can irritate the eyes, skin and respiratory tract; can cause a burning sensation and skin rash. Inhalation of *p*-anisidine can cause shortness of breath and coughing. Exposure can interfere with the blood's ability to carry hemoglobin (methemaglobinemia). This can cause headache, dizziness, cyanosis of the skin and lips. Higher levels can cause difficult breathing; collapse and death.

Long-Term Exposure: *o*-anisidine is a probable carcinogen in humans (IARC: Group 2B, limited human evidence). Related aromatic amines are carcinogens, and *p*-anisidine may be carcinogenic as well. Repeated exposure to these isomers may cause anemia, skin allergy, lung irritation and bronchitis; nerve and kidney damage.

Points of Attack: Blood, kidneys, liver, cardiovascular system; CNS.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. *o-anisidine*: evaluation by a qualified allergist, test for blood hemoglobin, CBC and reticulocyte count. Consider nerve conduction studies. *p-Anisidine*: lung function tests, evaluation by a qualified allergist, kidney function tests, CBC, methemoglobin level.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to Physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof (*o*-anisidine) or dust-proof (*p*-anisidine) chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: At any detectable concentration: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv (APF = 500) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Green: General storage. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, dark, well-ventilated area. Protect against sunlight and strong oxidizers. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2431 Anisidines, Hazard Class: 6.1; Labels: 6.1-Poisonous materials

Spill Handling: *Liquid*: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Ventilate area of spill or leak. Cover with sand and soda ash (9:1). After mixing, collect material in the most convenient and safe manner and deposit in sealed containers. Keep *o*-anisidine out of confined spaces, such as a sewer, because of the potential for an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. *Solid*: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. It may be necessary to contain and dispose of this chemical as a hazardous waste. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve in combustible solvent (alcohols, benzene, etc.) and spray solution into furnace equipped with afterburner and scrubber, or burn spill residue on sand and soda ash absorbent in a furnace.

References

(109); (102); (31); (173); (101); (138); (2); (100).

National Cancer Institute, *Bioassay of o-Ansidine Hydrochloride for Possible Carcinogenicity*, Technical Report Series No. 89, Bethesda, MD (1978).

National Cancer Institute, *Biossay of p-Anisidine Hydrochloride for Possible Carcinogenicity*, Technical Report Series No. 116, Bethesda, MD (1978).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 1, No. 5, 34−36 (1981).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: *p*-Anisidine, Trenton, NJ (June 1998).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: *o*-Anisidine, Trenton, NJ (January 2001).

Anisole A:1370

Formula: C_7H_8O; $C_6H_5OCH_3$

Synonyms: Anisol (Spanish); Benzene, methoxy; Ether, methyl phenyl; Methoxybenzene; Methyl phenyl ether; Metil fenil eter (Spanish); Phenyl methyl ether

CAS Registry Number: 100-66-3

HSDB Number: 44

RTECS Number: BZ8050000

UN/NA & ERG Number: UN2222/128

EC Number: 202-876-1

Regulatory Authority and Advisory Information

Hazard Alert: Flammable, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction).

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xn, Xi; risk phrases: R10; R20/21/22; R36/37/38; R52/53; R61; R63; safety phrases: S16; S24/25; S26; 37/39 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Anisole is a colorless to yellowish liquid with an agreeable, aromatic, spicy-sweet odor. Molecular weight = 108.15; specific gravity (H_2O:1) = 1.7; boiling point = 154°C; freezing/melting point = −37.3°C; vapor pressure = 3.1 mmHg @ 25; flash point = 51.6°C (oc); explosive limits: LEL: 3400 ppm; autoignition temperature = 475°C. Hazard identification (based on NFPA-704M Rating System): Health 1; flammability 2; reactivity 0. Insoluble in water.

Potential Exposure: Anisole is used as a solvent; a flavoring, vermicide, making perfumes; and in organic synthesis.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

ACGIH TLV[1]: 0.1 ppm TWA (A4) [skin]

PAC Ver. 29[138]

PAC-1: 1.6 milligram per cubic meter

PAC-2: 18 milligram per cubic meter

PAC-3: 110 milligram per cubic meter

Permissible Concentration in Water: Harmful to aquatic organisms, may cause long-term adverse effects in the aquatic environment. Russia[43] set a MAC of 0.05 mg/L in water bodies used for domestic purposes.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 2.1$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, absorbed through the skin, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: A skin irritant since it degreases the skin; prolonged skin contact can cause drying and cracking. It irritates the eyes and respiratory tract if exposure occurs[57]. Exposure can cause dizziness, lightheadedness, and unconsciousness. It is moderately toxic by ingestion[44]. The oral LD_{50} for rat is 3700 mg/kg and for mouse is 2800 mg/kg[9].

Long-Term Exposure: Skin problems, dryness, cracking.

Points of Attack: Eyes, skin, respiratory system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear solvent-resistant gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Where there is no REL, at any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-

approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where anisole may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well ventilated, fireproof area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2222 Anisole, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate spill or leak area. Absorb spilled liquid in sand or inert absorbent and put in sealed containers and remove for disposal. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Anisole, Trenton, NJ (December 1998).

Anthracene A:1380

Formula: $C_{14}H_{10}$

Synonyms: Anthracen (German); Anthracene oil; Anthracene PAC; Anthracin; Antraceno (Spanish); Green oil; *p*-Naphthalene; Paranaphthalene; Sterilite hop defoliant; Tetra olive N2G

CAS Registry Number: 120-12-7; 90640-80-5 (anthracene oil)

HSDB Number: 702; 1178 as naphthenic acids

RTECS Number: CA9350000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 204-371-1

Regulatory Authority and Advisory Information

Carcinogenicty: Anthracene has not been identified as a carcinogen. Handle with caution as several related PAHs are known carcinogens. NIOSH has recommended that coal tar pitch volatiles, including PAHs be treated as potential human carcinogen.

California Proposition 65 Chemical[102]: (*coke oven emissions*) Cancer 2/27/1987.

Hazard Alert: Poison, Combustible, Lacrimator, Possible risk of forming tumors, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction), Environmental hazard.

Banned or Severely Restricted (UN) (in cosmetic products in the EU)[35]

United States DOT Regulated marine pollutant (49CFR172.101, Appendix B) as naphthalenes

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; Section 307(a)(1) Toxic pollutant designated, pursuant to of the and is subject to effluent limitations as PAHs.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed
RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.059; Nonwastewater (mg/kg), 3.4
RCRA 40CFR264, Appendix 9; Ground Water Monitoring List: Suggested methods (PQL μg/L): 8100 (200); 8270 (10)
Superfund/EPCRA 40CFR302.4, Appendix A, RQ: 5000 lb (2270 kg), 40CFR 372.65: Form R *de minimis* Concentration Reporting Level: 1.0%.
Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%; NPRI.
Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.
Hazard symbols, risk, & safety statements: Hazard symbol: Xn, N, F, T, Xi; risk phrases: R45; R11; R23/24/25; R36/37/38; R39; R51/53; R62; R65; R66; R67; safety phrases: S9; S16; S24/25; S26; S29; S36/37; S45; S60; S61; S62 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Anthracene is colorless, to pale yellow crystalline solid with a bluish fluorescence. PAHs are compounds containing multiple benzene rings and are also called polynuclear aromatic hydrocarbons. Molecular weight = 178.23; specific gravity (H_2O:1) = 1.28; boiling point = 340°C; freezing/melting point = 215.76−216.5°C; vapor pressure = 0.99 mmHg @ 145°C; flash point = 121°C; autoignition temperature = 540°C. Explosive limits: LEL: 0.6%[17]. NFPA 704M Hazard Identification (based on NFPA-704M Rating System): Health 0; flammability 1; reactivity 0. Insoluble in water.

Potential Exposure: It is used as an intermediate in dye stuffs (alizarin), insecticides, and wood preservatives; making synthetic fibers, anthraquinone, and other chemicals. May be present in coke oven emissions, diesel fuel, and coal tar pitch volitiles.

Incompatibilities: Finely dispersed powder may form explosive mixture in air. Contact with strong oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, chromic acid/or calcium hypochlorite.

Permissible Exposure Limits in Air
NIOSH IDLH = 80 milligram per cubic meter coal tar pitch volatiles
PAC Ver. 29[138]
120-12-7
PAC-1: 48 milligram per cubic meter
PAC-2: 530 milligram per cubic meter
PAC-3: 3200 milligram per cubic meter
No occupational limits have been established for anthracene. However this chemical may be present as *coke oven emissions* and *coal tar pitch volatiles*.
OSHA PEL: 0.2 milligram per cubic meter TWA [1910.1002] (benzene-soluble fraction). OSHA defines "coal tar pitch volatiles" in 29 CFR 1910.1002 as the fused polycyclic hydrocarbons that volatilize from the distillation residues of coal, petroleum (excluding asphalt), wood, and other organic matter.
NIOSH REL: 0.1 milligram per cubic meter (cyclohexane-extractable fraction). NIOSH considers coal tar products (i.e., coal tar, coal tar pitch, or creosote) to be potential occupational carcinogens
ACGIH TLV[1]: 0.2 milligram per cubic meter TWA (as benzene soluble aerosol); Confirmed Human Carcinogen
DFG MAK: Carcinogen Category 1
See also entry for coal tar pitch volatiles.

Determination in Air: Use NIOSH Analytical Method #5506 PAHs by HPLC; NIOSH Analytical Method #5515, PAHs by GC; OSHA Analytical Method ID-58.

Permissible Concentration in Water: For the maximum protection of human health from the potential carcinogenic effects due to exposure of polynuclear aromatic hydrocarbons through ingestion of contaminated water and contaminated aquatic organisms, therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 1×10^{-5}, 1×10^{-6}, and 1×10^{-7}. The corresponding criteria are 28.0, 2.8, and 0.28 ng/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 311.0, 31.1, and 3.11 ng/L, respectively.

Determination in Water: Octanol−water coefficient: Log $K_{ow} \geq$ 4.0. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood. Naphthalenes and naphthenic acids are listed as United States DOT marine pollutants and may persist in the environment.

Routes of Entry: Inhalation, skin, and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Anthracene can affect you when breathed in. Once inside your body, anthracene appears to target the skin, blood, stomach and intestines and the lymph system. Exposure to high doses of anthracene for a short time can cause damage to the skin. It can cause burning, itching and edema, a buildup of fluid in tissues. Humans exposed to anthracene experienced headaches, nausea, loss of appetite, inflammation or swelling of the stomach and intestines. In addition, their reaction time slowed and they felt weak. Skin contact can cause irritation or a skin allergy which is greatly aggravated by sunlight on contaminated skin. Breathing irritates the nose, throat and bronchial tubes. Eye contact or "fume" exposure can cause irritation and burns.

Long-Term Exposure: Repeated skin contact can cause thickening, pigment changes and growths. Anthracene may cause mutations. Handle with extreme caution. The carcinogenic status of anthracene is a bit confusing: Animal negative[9] compares with ACGIH[1] and DFG[3] categorization of coal tar volatiles as proven carcinogens. The

DFG[3] states that PAHs are present at particularly high levels in coal tar oils and related pyrolysis products of organic materials and are carcinogenic (category 1) in animal studies.

Points of Attack: Skin, lungs/respiratory system; bladder, liver, blood, kidneys.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Evaluation by a qualified allergist. NIOSH lists the following tests: CBC; chest X-ray; pulmonary function tests: Forced Vital Capacity; Forced Expiratory Volume (1 second); photopatch testing; sputum cytology; urinalysis (routine); cytology, hematuria[2].

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. If local exhaust ventilation or enclosure is not used, respirators should be worn. Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. *Antidotes and Special Procedures*: Sun screens for ultraviolet light may help prevent skin allergic reactions. These may need frequent reapplications if you are sweating. Ultraviolet-screening sunglasses can help with eye allergic reactions. Consult your doctor or pharmacist in selecting these.

Respirator Selection: Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls, and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit. *Where there is no REL, at any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Anthracene must be stored to avoid contact with strong oxidizers (such as chlorine, bromine and fluorine), chromic acid and calcium hypochlorite, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where Anthracene is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/ 75 ft.(NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Establish ventilation to keep levels below explosive limit. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Irritating and noxious gases, including oxides of carbon. This chemical is a combustible solid. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration[22].

References

(102); (31); (173); (101); (18); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 4, No. 6, 18−43 (1984)(2).

United States Environmental Protection Agency, "*Identification of Organic Compounds in Effluents from Industrial Sources*," EPA-560/3-75-002, April 1975.

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Anthracene, Trenton, NJ (June 2002).

United States Department of Health and Human Services, Agency for Toxic Substances and Disease Registry (ATSDR), *Public Health Statement, Polycyclic Aromatic Hydrocarbons*, Atlanta, GA, 1990.

Anthraquinone A:1390

Formula: $C_{14}H_8O_2$

Synonyms: 9,10-Anthracenedione; Anthracene-9,10-quinone; Anthradione; 9,10-Anthraquinone; Antraquinona (Spanish); Corbit; 9,10-Dihydro-9,10-dioxoanthracene; 9,10-Dioxoanthracene; Hoelite; Morkit

CAS Registry Number: 84-65-1

HSDB Number: 2074

RTECS Number: CB4725000

UN/NA & ERG Number: UN3143 (dyes, solid, toxic, n.o.s. [or] dye intermediates, solid, toxic, n.o.s.)/151

EC Number: 201-549-0

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human evidence: inadequate; animal evidence: sufficient, *possibly carcinogenic to humans*, Group 2B, 2007; NTP concluded that anthraquinone caused cancer of the kidney and urinary bladder in male and female rats and of the liver in female rats. Handle with caution as several related polynuclear aromatic hydrocarbons (PAHs) are known carcinogens. NIOSH has recommended that PAHs be treated as potential human carcinogen.

California Proposition 65 Chemical[102]: Cancer 9/28/2007.

Hazard Alert: Poison, Combustible, Agricultural Chemical, Suspected of causing genetic defects, Possible risk of forming tumors; Possible sensitization hazard (skin).

TSCA 40CFR704.30; 40CFR716.120(a) List of substances; 40CFR712.30(m); 40CFR799.500 Testing Requirements. Export notification required by §12(b)

Hazard symbols, risk, & safety statements: Hazard symbol: T + , Xi; Risk phrases: R45; R27/28; R43; R62; Safety phrases: S13; S28; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Anthraquinone is a combustible, light yellow to green crystalline solid. Molecular weight = 208.23; specific gravity (H_2O:1) = 1.44; boiling point = 376.89°C; melting/freezing point = 286°C (sublimes); flash point = 185°C (cc). NFPA 704M Hazard Identification (based on NFPA-704M Rating System): Health 2; flammability 1; reactivity 0. Very slightly soluble in water; solubility ≤ 13 mg/L @ 22°C.

Potential Exposure: Anthraquinone is an important starting material for vat dye manufacture. Also used in making organics; and used as a bird repellent in seeds.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 12 milligram per cubic meter

PAC-2: 130 milligram per cubic meter

PAC-3: 790 milligram per cubic meter

Russia[43]: MAC 5 milligram per cubic meter work-place air.

Determination in Air: NIOSH Analytical Method #5013, Dyes

Permissible Concentration in Water: No criteria set.

Determination in Water: Octanol−water coefficient: Log $K_{ow} \geq 3$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Through the skin, inhalation.

Harmful Effects and Symptoms

Short-Term Exposure: Can be absorbed through the skin, thereby increasing exposure. Eye or skin contact can cause irritation. An allergen, may cause skin irritation and sensitization. Severe poisoning may cause seizures and coma.

Long-Term Exposure: May cause skin allergy, with itching and rash. It may be mutagenic.

Points of Attack: Skin, lungs.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Evaluation by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls, and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit. *Where there is no REL, at any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN3143 Dyes, solid, toxic, n.o.s. or Dye intermediates, solid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Dampen spilled material with toluene to avoid airborne dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, water spray; or alcohol foam extinguishers. Thermal decomposition products may include oxides of carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(102); (31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Anthraquinone, Trenton, NJ (January 1999).

Antimony A:1400

Formula: Sb

Synonyms: Amspec antimony; Antimonio (Spanish); Antimonio, en polvo (Spanish); Antimoine en poudre

(French); Antimony black; Antimony powder; Antimony, regulus; Atomergic antimony; C.I. 77050; Silver GLO 33BP; Silver GLO 3KBP; Silver GLO BP; Stibium; the rmoguard CPA

Other antimony compounds: antimony lactate ($C_9H_{15}O_9Sb$) see A:1410; antimony potassium tartrate ($C_4H_4KO_7Sb$) see A:1440; antimony pentachloride (Cl_5Sb) see A:1420; antimony pentafluoride (SbF_5) see A:1430; antimony tribromide ($SbBr_3$) see A:1450; antimony trichloride ($SbCl_3$) see A:1460; antimony trifluoride (F_3Sb) see A:1470; antimony trioxide (Sb_3O_3) see A:1480

CAS Registry Number: 7440-36-0 (elemental)

HSDB Number: 508

RTECS Number: CC4025000

UN/NA & ERG Number: UN2871/170 antimony powder

Other antimony compounds: UN1549/157 antimony compound, inorganic, n.o.s.; UN3141/157 antimony compound, inorganic, liquid, n.o.s.; UN1549/157 antimony compound, inorganic, solid, n.o.s.; UN1730/157 antimony pentachloride, liquid; UN1551/151 antimony potassium tartrate; UN1731/157 antimony pentachloride, solution; UN1732/157 antimony pentafluoride (water reactive); UN1733/157 antimony trichloride; UN1733/157 antimony trichloride, liquid; UN1733/157 antimony trichloride, solid; UN1733/157 antimony trichloride, solution; UN1550/151 antimony lactate

EC Number: 231-146-5

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Flammable, Pyrophoric (powder/dust), Possible risk of forming tumors.

Banned or Severely Restricted (New Zealand)[13] (many countries, especially in food) (UN)[35]

Clean Air Act, 42USC7412; Title I, Part A, §112 Hazardous Pollutants

United States National Primary Drinking Water Regulations: MCLG = 0.006 mg[Sb]/L; MCL = 0.006 mg [Sb]/L as Antimony

Clean Water Act 40CFR401.15 Section 307 Toxic Pollutants; 40CFR423, Priority Pollutants

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed

RCRA Land Ban Waste

RCRA 40CFR264, Appendix 9; Ground Water Monitoring List: Suggested methods (PQL μg/L): 6010 (300); 7040 (2000); 7041 (30)

Superfund/EPCRA 40CFR302.4, Appendix A, RQ: 5000 lb (2270 kg) *only if the diameter of pieces of solid metal has a diameter equal to or greater than 0.004 in.*, 40CFR372.65: Form R *de minimis* Concentration Reporting Level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. as antimony, elemental; NPRI.

Hazard symbols, risk, & safety statements: Hazard symbol: Xn, Xi; risk phrases: R17; R20/22; R34; R36/37/38; R39; R46; R51/53; safety phrases: S16; S26; S6/37/39 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [2-Hazard to water. (est.)]

Description: Antimony is a silvery-white, lustrous, hard, brittle metal; scale-like crystals, or dark gray lustrous powder. Molecular weight = 121.76; specific gravity (H_2O:1) = 6.68 @ 25°C; boiling point = 1635°C; freezing/melting point = 630.63°C. Hazard identification (based on NFPA-704 M Rating System): [powder]. Health 2; flammability 2; reactivity 0. Insoluble in water and organic solvents.

Potential Exposure: Exposure to antimony may occur during mining, smelting or refining; alloy and abrasive manufacture; and typesetting in printing. Antimony is widely used in the production of alloys, imparting increased hardness, mechanical strength, corrosion resistance, and a low coefficient of friction. Some of the important alloys are Babbitt, pewter, white metal, Britannia metal and bearing metal (which are used in bearing shells), printing-type, metal, storage battery plates, cable sheathing, solder, ornamental castings, and ammunition. Pure antimony compounds are used as abrasives, pigments, flame-proofing compounds, plasticizers, and catalysts in organic synthesis; they are also used in the manufacture of tartar emetic, paints, lacquers, glass, pottery, enamels, glazes, pharmaceuticals, pyrotechnics, matches, and explosives. In addition, they are used in dyeing, for blueing steel; and in coloring aluminum pewter; and zinc. A highly toxic gas, stibine, may be released from the metal under certain conditions.

Incompatibilities: Pyrophoric. Finely dispersed powder may form explosive mixture in air. Strong oxidizers; strong acids [especially halogenated acids], produce a violent reaction, and deadly stibine gas (antimony hydride). Heat forms stibine gas. Mixtures with nitrates or halogenated compounds may cause combustion. Forms an explosive mixture with chloric and perchloric acid. *Note*: Stibine is formed when antimony is exposed to nascent (freshly formed) hydrogen[77].

Permissible Exposure Limits in Air

NIOSH IDLH = 50 mg[Sb]/m^3

ACGIH TLV[1]: 0.5 mg[Sb]/m^3 TWA

OSHA PEL: 0.5 mg[Sb]/m^3 TWA

NIOSH REL: 0.5 mg[Sb]/m^3 TWA

PAC Ver. 29[138]

PAC-1: 1.5 milligram per cubic meter

PAC-2: 13 milligram per cubic meter

PAC-3: 80 milligram per cubic meter

antimony and inorganic compounds, excluding stibine

DFG MAK: Carcinogen Category 2; Germ Cell Mutagen Category 3B (2006)

Arab Republic of Egypt: TWA 0.5 milligram per cubic meter, 1993; Australia: TWA 0.5 milligram per cubic meter, 1993; Austria: MAK 0.5 milligram per cubic meter, 1999; Belgium: TWA 0.5 milligram per cubic meter, 1993; Denmark: TWA 0.5 milligram per cubic meter, 1999; Finland: TWA 0.5 milligram per cubic meter, 1993; France: VME 0.5 milligram per cubic meter, 1999; the

Netherlands: MAC-TGG 0.5 mg[Sb]/m^3; MAC-TGG 0.5 milligram per cubic meter, 2003; Japan: 0.1 milligram per cubic meter, 2B carcinogen, 1999; Norway: TWA 0.5 mg[Sb]/m^3, 1999; the Philippines: TWA 0.5 milligram per cubic meter, 1993; Poland: MAC (time-weighted average) 0.5 milligram per cubic meter; MAC (STEL) 1.5 milligram per cubic meter, 1999; Russia: TWA 0.2 milligram per cubic meter, STEL 0.5 milligram per cubic meter, 1993; Sweden: NGV 0.5 milligram per cubic meter, 1999; Switzerland: MAK-week 0.5 milligram per cubic meter, 1999; Turkey: TWA 0.5 milligram per cubic meter, 1993; United Nations: TWA 0.5 milligram per cubic meter, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 0.5 mg [Sb]/m^3. Several states have set guidelines or standards for antimony in ambient air[60] ranging from 0.67 μ/m^3 (New York) to 1.19 μ/m^3 (Kansas) to 1.2 μ/m^3 (Pennsylvania) to 5 μ/m^3 (North Dakota) to 8.0 μ/m^3 (Virginia) to 10 μ/m^3 (Connecticut) to 12 μ/m^3 (Nevada) to 40 μ/m^3 (Rhode Island).

Determination in Air: OSHA Analytical Methods ID-125G, ID121. See also NIOSH Analytical Method #8005 (elements in blood and tissue).

Permissible Concentration in Water: Safe Drinking Water Act, MCL, treatment technique; MCL, 0.006 mg/L; MCLG, 0.006 mg/L; Regulated Chemical (47FR9352).

Determination in Water: Digestion followed by atomic absorption. See EPA Methods 204.1 and 204.2.

Routes of Entry: Inhalation of dust or fume, skin, and/or eye contact.

Harmful Effects and Symptoms

Antimony and its compounds are generally regarded as primary skin irritants. Lesions generally appear on exposed, moist areas of the body, but rarely on the face. The dust and fumes are also irritants to the eyes, nose, and throat, and may be associated with gingivitis, anemia, and ulceration of the nasal septum and larynx. Antimony trioxide causes a dermatitis known as "antimony spots." This form of dermatitis results in intense itching followed by skin eruptions. A diffuse erythema may occur, but usually the early lesions are small erythematous papules. They may enlarge, however, and become pustular. Lesions occur in hot weather and are due to dust accumulating on exposed areas that are moist due to sweating. No evidence of eczematous reaction is present, nor an allergic mechanism. *Systemic*: Systemic intoxication is uncommon from occupational exposure. However, miners of antimony may encounter dust containing free silica; cases of pneumoconiosis in miners have been termed "silico-antimoniosis." Antimony pneumoconiosis, per se, appears to be a benign process. Antimony metal dust and fumes are absorbed from the lungs into the blood stream. Principal organs attacked include certain enzyme systems (protein and carbohydrate metabolism), heart, lungs; and the mucous membrane of the respiratory tract. Symptoms of acute oral poisoning include violent irritation of the nose, mouth, stomach, and intestines, vomiting, bloody stools, slow shallow respiration, pulmonary congestion, coma, and sometimes death due to circulatory or respiratory failure. Chronic oral poisoning presents symptoms of dry throat, nausea, headache, sleeplessness, loss of appetite; and dizziness. Liver and kidney degenerative changes are late manifestations. Antimony compounds are generally less toxic than antimony. Antimony trisulfide, however, has been reported to cause myocardial changes in humans and experimental animals. Antimony trichloride and pentachloride are highly toxic and can irritate and corrode the skin. Antimony fluoride is extremely toxic; particularly to pulmonary tissue and skin.

Short-Term Exposure: Eye and skin contact can cause irritation and itchy skin rash. Inhalation can cause respiratory tract irritation with wheezing, and shortness of breath. Exposure can cause headache, nausea, abdominal pain; and loss of sleep. Antimony poisoning can be delayed from one half to 2 hours following ingestion. Symptoms include nausea, vomiting, dehydration and thirst; difficulty in swallowing; rapid pulse; cyanosis, watery stool and cramps; collapse and shock. See also above.

Long-Term Exposure: Repeated exposure can cause ulcers and sores of the nose to develop, damage to the kidneys, liver, and heart, lung effects (abnormal chest X-ray). See also above. Antimony may cause an increase in blood cholesterol; a decrease in blood sugar. Decreases longevity, alters blood levels of glucose and cholesterol in laboratory animals exposed at high levels over their lifetime.

Points of Attack: Respiratory system, cardiovascular system, skin, eyes and lungs. Decreases longevity, alters blood levels of glucose and cholesterol in laboratory animals exposed at high levels over their lifetime[182].

Medical Surveillance: Antimony can be measured in the urine, feces, and blood[76]. NIOSH lists the following tests: chest X-ray, electrocardiogram, pulmonary function tests: forced vital capacity, forced expiratory volume (1 second); pelvic X-ray; sputum cytology; urine (chemical/metabolite); urine (chemical/metabolite) pre- and postshift; urinalysis (routine); CBC/differential.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: For severe poisoning BAL (British Anti-Lewisite), Dimercaprol, dithiopropanol ($C_3H_8OS_2$) has been used to treat toxic symptoms of certain heavy metals poisoning—including antimony. Although BAS is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: A combination of protective clothing, barrier creams, gloves, and personal hygiene will protect the skin. Prevent skin contact. Any barrier that will prevent contamination from the dry chemical. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide washing facilities, emergency showers and eyewash. Eating should not be permitted in exposed areas.

Respirator Selection: *5 milligram per cubic meter*: 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100; or Sa (APF = 10) (any supplied-air respirator). *12.5 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *25 milligram per cubic meter*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *50 milligram per cubic meter*: Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, halogens, strong acids; and heat. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Contact with acids forms deadly stibine gas. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist.

Shipping: UN2871 Antimony powder, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Antimony dust can present a moderate hazard when exposed to flame. SCBA may be required when antimony is exposed to extreme temperatures in a fire. Use dry chemical appropriate for metal fires, water spray, fog or standard foam extinguishers. Toxic fumes are produced in fire, including deadly stibine gas. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Recovery and recycling is an option to disposal which should be considered for scrap antimony and spent catalysts containing antimony. Dissolve spilled material in minimum amount of concentrated HCl. Add water, until white precipitate appears. Then acidify to dissolve again. Saturate with H_2S. Filter, wash and dry the precipitate and return to supplier[22]. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (173); (101); (138); (170); (100).

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Groundwater, http://water.usgs.gov/edu/groundwater-contaminants.html (2016).

United States Environmental Protection Agency, *Antimony*: *Ambient Water Quality criteria*, Washington, DC (1980).

United States Environmental Protection Agency, *Literature Study of Selected Potential Environmental Contaminants*: *Antimony and Its Compounds, Report No. EPA-560/2-76-002*, Washington, DC, Office of Toxic Substances (February 1976).

National institute for Occupational Safety and Health (NIOSH), *Environmental Exposure to Airborne Contaminants in the Antimony Industry, NIOSH Publ. No. 79-140*, Cincinnati, OH (August 1979).

United States Environmental Protection Agency, *Toxicology of Metals, Vol II*: *Antimony, Report EPA-600-/1-77-022*, Research Triangle Park, NC, pp 15−29 (May 1977).

United States Environmental Protection Agency, antimony, Health and Environmental Effects Profile No. 10, Washington, DC, Office of Solid Waste (April 30, 1980).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 2, No. 2, 68−69 (1982).

National institute for Occupational Safety and Health (NIOSH), "Criteria for a Recommended Standard: Occupational Exposure to Antimony, Cincinnati OH (September 28, 1978).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Antimony, Trenton, NJ (June 2004).

Antimony Lactate A:1410

Formula: $C_9H_{15}O_9Sb$; $Sb(OCOCHOHCH_3)_3$

Synonyms: Antimony (3 +) salt (3: 1); 2-Hydroxypropanoic acid trainhydride with antimonic acid; 2-Hydroxy-, trianhydride with antimonic acid; Lactic acid, antimony salt; Propanic acid, 2-hydroxy-

CAS Registry Number: 58164-88-8

RTECS Number: CC5455000

UN/NA & ERG Number: UN1550/151

EC Number: 261-148-1

Regulatory Authority and Advisory Information

Banned or Severely Restricted (New Zealand)[13] (Many countries, especially in food) (UN)[35]

Clean Air Act: 42USC7412; Title I, Part A, §112 Hazardous Pollutants

United States National Primary Drinking Water Regulations: MCLG = 0.006 mg[Sb]/L; MCL = 0.006 mg [Sb]/L as Antimony

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed (as antimony compounds, n.o.s.)

Safe Drinking Water Act, MCL, treatment technique; MCL, 0.006 mg/L; MCLG, 0.006 mg/L; Regulated Chemical (47FR9352)

EPCRA Section 313: Includes any unique chemical substance that contains antimony as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. as antimony compounds, n.o.s.; NPRI as antimony compounds.

Description: Antimony lactate is a noncombustible, tan solid. Molecular weight = 388.98. Soluble in water. Antimony lactate may be contaminated with arsenic or other toxic substances.

Potential Exposure: Antimony lactate is used in fabric dyeing.

Incompatibilities: Contact with strong oxidizers (chlorates, permanganates, peroxides and nitrates) may cause a violent reaction. Contact with acids can produce deadly stibine gas.

Permissible Exposure Limits in Air

Inorganic [Sb]

NIOSH IDLH = 50 mg[Sb]/m^3

ACGIH TLV[1]: 0.5 mg[Sb]/m^3 TWA

OSHA PEL: 0.5 mg[Sb]/m^3 TWA

NIOSH REL: 0.5 mg[Sb]/m^3 TWA

No PAC available.

DFG MAK: Carcinogen Category 2; Germ Cell Mutagen Category 3B (2006)

The above exposure limits are for air levels only. When skin contact also occurs, you may be overexposed, even though air levels are lower than the limits listed above. Russia[43] set a MAC of 0.3 milligram per cubic meter in work-place air.

Permissible Concentration in Water: As part of the priority toxic pollutant program, EPA[6] has set a limit of 146 μg/L of antimony to protect human health. EPA has also suggested[32] an ambient limit of 7 μg/L of antimony based on health effects.

Routes of Entry: Inhalation, passing through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Antimony lactate can affect you when breathed and by passing through skin. Exposure can irritate the eyes, nose, throat and skin. Very high levels could cause Antimony poisoning, with symptoms of nausea headaches, abdominal pain; trouble breathing and death. See also antimony [7440-36-0]. Antimony lactate may be contaminated with arsenic or other toxic substances.

Long-Term Exposure: Repeated exposure can cause abnormal chest X-ray and damage the heart and liver. Prolonged or repeated skin contact can cause sores and ulcers. Antimony may cause an increase in blood cholesterol; a decrease in blood sugar.

Points of Attack: Skin, lungs, heart, liver.

Medical Surveillance: Antimony can be measured in the urine, feces, and blood[76]. EKG, liver function tests; urine tests for antimony. Also test for arsenic if contamination is suspected. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least

15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Specific engineering controls are recommended for this chemical in the NIOSH criteria document Antimony Number 72-216. Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. If local exhaust ventilation or enclosure is not used, respirators should be worn. Wear protective work clothing. Wash thoroughly immediately after exposure and at the end of the work-shift. Post hazard and warning information in the work area. In addition, as part of an ongoing education and training effort, communicate all information on the health and safety hazards of this antimony compound to potentially exposed workers.

Respirator Selection: *5 milligram per cubic meter*: 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100; or Sa (APF = 10) (any supplied-air respirator). *12.5 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *25 milligram per cubic meter*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *50 milligram per cubic meter*: Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from heat, acids, and oxidizers.

Shipping: UN1550 Antimony lactate, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Antimony lactate itself does not burn. Thermal decomposition products may include deadly stibine gas. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (101); (138).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Antimony Lactate, Trenton, NJ (September 2000).

Antimony Pentachloride A:1420

Formula: Cl_5Sb; $SbCl_5$

Synonyms: Antimonic chloride; Antimonpentachlorid (German); Antimony(V) chloride; Antimony perchloride; Atomergic antimony pentachloride; Butter of antimony;

Pentachloroantimony; Pentacloruro de antimonio (Spanish); Perchlorure d'antimoine (French); Tentachlorure d'antimoine (French)

CAS Registry Number: 7647-18-9

HSDB Number: 444

RTECS Number: CC5075000

UN/NA & ERG Number: UN1730 (liquid)/157; UN1731 (antimony pentachloride, solution)/157; UN1732/157

EC Number: 231-601-8 [*Annex I Index No.*: 051-002-00-3]

Regulatory Authority and Advisory Information

Banned or Severely Restricted (New Zealand)[13] (Many countries, especially in food) (UN)[35]

Clean Air Act, 42USC7412; Title I, Part A, §112 Hazardous Pollutants

Clean Water Act: 40CFR401.15 Section 307, Toxic Pollutants; Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

Safe Drinking Water Act, MCL, treatment technique; MCL, 0.006 mg[Sb]/L; MCLG, 0.006 mg[Sb]/L; Regulated Chemical (47FR9352) as Antimony, SMCL = 250 mg[Cl-]/L as Chloride.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed (as antimony compounds, n.o.s.)

SUPERFUND/CERCLA 40CFR302.4, Appendix A, RQ: 1000 lb (454 kg); 40CFR372.65: Form R *de minimis* Concentration Reporting Level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%; NPRI as antimony compounds.

Hazard symbols, risk, & safety statements: Hazard symbol: C, N; risk phrases: R34-R51/53; safety phrases: S1/2; S26; S41; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [2-Hazard to waters (est.)]

Description: Antimony pentachloride is a noncombustible, colorless to reddish-yellow oily liquid with an offensive odor. Molecular weight = 299.05; boiling point = 77°C (decomposes); freezing/melting point = 3°C; specific gravity (H_2O:1) = 2.354 @ 20°C; liquid surface tension (est.) = 0.015 N/m @ 20°C; latent heat of vaporization = 1.60×10^5 J/kg; heat of solution = -4.925×10^5 J/kg; vapor pressure = 0.84 mmHg @ 20°C. Hazard identification (based on NFPA-704M Rating System): (*solid or liquid*). Health 3; flammability 0; reactivity 1. Decomposes on contact with water.

Potential Exposure: It is used in dyeing, coloring metals and in many organic chemical reactions as a catalyst.

Incompatibilities: Decomposes on contact with heat, acids, alkalis, ammonia, water or other forms of moisture producing fumes of hydrogen chloride and antimony. Decomposes above 77°C forming chlorine and antimony trichloride. Attacks many metals in the presence of moisture forming explosive hydrogen gas. Reacts with air forming corrosive vapors.

Permissible Exposure Limits in Air

NIOSH IDLH = 50 mg[Sb]/m^3

ACGIH TLV[1]: 0.5 mg[Sb]/m^3 TWA

OSHA PEL: 0.5 mg[Sb]/m^3 TWA

NIOSH REL: 0.5 mg[Sb]/m^3 TWA

PAC Ver. 29[138]

PAC-1: 3.7 milligram per cubic meter

PAC-2: 33 milligram per cubic meter

PAC-3: 200 milligram per cubic meter

DFG MAK: Carcinogen Category 2; Germ Cell Mutagen Category 3B (2006)

The above exposure limits are for air levels only. When skin contact also occurs, you may be overexposed, even though air levels are lower than the limits listed above. Russia[43] set a MAC of 0.3 milligram per cubic meter in work-place air.

Permissible Concentration in Water: As part of the priority toxic pollutant program, EPA[6] has set a limit of 146 μg/L of antimony to protect human health. EPA has also suggested[32] an ambient limit of 7 μg/L of antimony based on health effects.

Routes of Entry: skin absorption; inhalation.

Harmful Effects and Symptoms

Short-Term Exposure: Antimony pentachloride is a corrosive chemical; can affect you when breathed in and by passing through your skin. Exposure can cause sore throat, rash, poor appetite; abdominal pain; loss of sleep; and irritate the lungs. Higher levels can cause pulmonary edema, a medical emergency that can be delayed for several hours; irregular heartbeat which can cause death. High or repeated exposure may damage the liver, kidneys, and the heart muscle. If used near acid, a deadly stibine gas can be formed. Antimony may contain arsenic. It is a corrosive chemical. Contact can burn the skin or eyes. The oral LD_{50} for rat is 1115 mg/kg[9].

Long-Term Exposure: Repeated contact can cause ulcers or sores in the nose, kidney, liver, and heart damage. Antimony may cause an increase in blood cholesterol; a decrease in blood sugar.

Points of Attack: Kidneys, liver, heart, respiratory system.

Medical Surveillance: Antimony can be measured in the urine, feces, and blood[76]. EKG, liver and kidney function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Specific engineering controls are recommended for this chemical in the NIOSH criteria document Antimony Number 72-216. Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. If local exhaust ventilation or enclosure is not used, respirators should be worn. Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *5 milligram per cubic meter*: 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100; or Sa (APF = 10) (any supplied-air respirator). *12.5 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *25 milligram per cubic meter*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *50 milligram per cubic meter*: Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: (1) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. (2) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Antimony pentachloride must be stored to avoid contact with organic or combustible materials (such as wood, paper and oil), since violent reactions occur. See incompatibilities. Store in tightly closed containers in a cool, well-ventilated area away from water or moisture and heat. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN1730 (liquid) Antimony pentachloride, liquid, Hazard class: 8; Labels: 8-Corrosive material. UN1731 (solution) Antimony pentachloride, solutions, Hazard class: 8; Labels: 8-Corrosive material.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Ventilate the area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Antimony Pentachloride itself does not burn. Thermal decomposition products may include chlorine and hydrogen chloride. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Encapsulate and transfer to an approve landfill. If chemically treated and neutralized, the chemical is amenable to biological treatment at municipal sewage treatment plant. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Antimony Pentachloride, Trenton, NJ (June 2004).

Antimony Pentafluoride A:1430

Formula: F_5Sb; SbF_5
Synonyms: Antimony fluoride; Antimony(5 +) fluoride; Antimony(V) fluoride; Antimony(5 +) pentafluoride; Antimony(V) pentafluoride; Atochem antimony pentafluoride; Atomergic antimony pentafluoride; Pentafluoroantimony; Pentafluoruro de antimonio (Spanish)
CAS Registry Number: 7783-70-2
HSDB Number: 442
RTECS Number: CC5800000
UN/NA & ERG Number: UN1732/(antimony pentafluoride) water reactive/157
EC Number: 232-021-8
Regulatory Authority and Advisory Information
Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade).
Hazard Alert: Exposure can be lethal, Corrosive, Dangerously water reactive. Explosive hazard, Air reactive, Environmental hazard.
Banned or Severely Restricted (New Zealand)[13] (Many countries, especially in food) (UN)[35]
Clean Air Act, 42USC7412; Title I, Part A, §112 Hazardous Pollutants
Clean Water Act: 40CFR401.15 Section 307, Toxic Pollutants
RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed (as antimony compounds, n.o.s.)
United States National Primary Drinking Water Regulations: MCLG = 0.006 mg[Sb]/L; MCL = 0.006 mg [Sb]/L as Antimony; MCLG = 4 mg[F]/L; MCL = 4 mg[F]/L; SMCL = 2.0 mg[F]/L, as Fluoride.
CERCLA/SARA 40CFR302 Extremely Hazardous Substances: TPQ = 500 lb (227 kg)
CERCLA/SARA Section 304 RQ: 1 lb (0.454 kg)
EPCRA Section 313: Includes any unique chemical substance that contains antimony as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: 0.1%.
Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. as antimony(V)pentafluoride; NPRI, as antimony compounds.
Hazardous to aquatic life or environment, with possible long-lasting effects[293]. Toxic to aquatic life with long-lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.
Hazard symbols, risk, & safety statements: Hazard symbol: T + , C, N, Xn; risk phrases: R20; R22; R27/28; R29; R34; R51/53; safety phrases: S1; S13; S22; S26; S27; S28; S29/35; S36/37/39; S45; S61 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.
Description: Antimony pentafluoride is a noncombustible, oily, colorless liquid with a pungent odor. Molecular weight = 216.7; specific gravity (H_2O:1) = 2.340 @ 30°C; boiling point = 143°C; melting/freezing point = 8.3°C; liquid surface tension = (estimate) 0.020 N/m @ 20°C; latent heat of vaporization = (estimate) 1.8×10^5 J/kg; vapor pressure = 1.33 kPa @ 25°C. Hazard identification (based on NFPA-704M Rating System): Health 4; flammability 0; reactivity 1₩. Soluble in water. Dangerously reactive with water; violent, forming hydrogen fluoride.
Potential Exposure: It is used as a catalyst in chemical reactions or as a source of fluorine (fluorinating reagent) in fluorination reactions.
Incompatibilities: Water and other forms of moisture releases hydrofluoric acid, combustible organic and siliceous materials, phosphorus, and phosphate materials. Attacks glass, ceramic, lead, and metals, including copper in the presence of moisture. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Antimony pentafluoride, if confined and wet may cause explosion. Antimony pentafluoride appears to have oxidizing properties; may cause fire in contact with combustible or organic materials. May react with metals, including lead, releasing flammable hydrogen gas.
Permissible Exposure Limits in Air
NIOSH IDLH = 50 mg[Sb]/m^3 (use Sb value)
ACGIH TLV[1]: 0.5 mg[Sb]/m^3 TWA
OSHA PEL: 0.5 mg[Sb]/m^3 TWA
NIOSH REL: 0.5 mg[Sb]/m^3 TWA
PAC Ver. 29[138]
PAC-1: 2.7 milligram per cubic meter
PAC-2: 23 milligram per cubic meter
PAC-3: 140 milligram per cubic meter
DFG MAK: Carcinogen Category 2; Germ Cell Mutagen Category 3B (2006)
as fluorides
NIOSH IDLH = 30[F] ppm
Odor threshold = 0.03 milligram per cubic meter.
OSHA PEL: 3 ppm/2.5 mg[F]/m^3 TWA
NIOSH REL: 3 ppm/2.5 mg[F]/m^3 TWA; 6 ppm/5 mg[F]/m^3 [15-min.] Ceiling Concentration
ACGIH TLV[1]: 5 ppm/0.41 mg[F]/m^3 TWA; 2 ppm/1.64 mg [F]/m^3 Ceiling Concentration; [skin]; not classifiable as a human carcinogen; BEI: 3 mg[F]/g creatinine in urine *prior* to end-of-shift; 10 mg[F]/g creatinine in urine end-of-shift
PAC HF*
PAC-1: **1.0**$_{\mathbf{A}}$ ppm
PAC-2: **24**$_{\mathbf{A}}$ ppm
PAC-3: **44**$_{\mathbf{A}}$ ppm
*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.
Permissible Concentration in Water: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water

Guidelines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg [Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg[F]/L. SafeDrinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg [F]/L; SMCL = 2 mg/F/L, as Fluoride.

Routes of Entry: Inhalation, ingestion, skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Severe health hazard. May be fatal if inhaled or absorbed through the skin. The compound is corrosive and irritating to eyes, skin, and lungs. Contact with eyes or skin causes severe burns. Ingestion causes vomiting and severe burns of mouth and throat. Overexposure by any route can cause bloody stools; slow pulse; low blood pressure; coma, convulsions, and cardiac arrest. The probable oral lethal dose of 5−50 mg/kg or between 7 drops and a teaspoonful for a 150-pound person (antimony salts).

Long-Term Exposure: Can damage the kidneys, liver, and heart. Repeated exposure may affect the lungs and cause an abnormal chest X-ray to develop. Antimony may cause an increase in blood cholesterol; a decrease in blood sugar.

Points of Attack: Eyes, skin, respiratory system; cardiovascular system, liver, lungs, kidney, heart.

Medical Surveillance: Antimony can be measured in the urine, feces, and blood[76]. EKG, liver and kidney function tests. Consider lung function tests and chest X-ray.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. If local exhaust ventilation or enclosure is not used, respirators should be worn. Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *5 milligram per cubic meter*: 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100; or Sa (APF = 10) (any supplied-air respirator). *12.5 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *25 milligram per cubic meter*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *50 milligram per cubic meter*: Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

NIOSH: *(fluorides) 12.5 milligram per cubic meter*: Qm (APF = 25) (any quarter-mask respirator). *25* milligram per cubic meter: 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or SA* (any supplied-air respirator). *62.5 milligram per cubic meter*: Sa:Cf (APF = 25)* + (any supplied-air respirator operated in a continuous-flow mode); or P* + *if not present as a fume* (any powered, air-purifying respirator with a dust and mist filter). *125 milligram per cubic meter*: HieF^{+} (any air-purifying, full facepiece respirator with a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *250 milligram per cubic meter*: Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: HieF^+ (any air-purifying, full facepiece respirator with a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA). *Substance reported to cause eye irritation or damage; may require eye protection. *May need acid gas sorbent. Exposure to 500 milligram per cubic meter (IDLH) is immediately dangerous to life and health.

Storage: (1) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. (2) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Antimony pentafluoride must be stored to avoid contact with phosphorus, phosphates, siliceous, and combustible or organic materials; since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from water or moisture and heat. Outside or detached storage is preferred.

Shipping: UN1732 Antimony pentafluoride, Hazard class: 8; Labels: 8-Corrosive material, 6.1-Poisonous materials.

Spill Handling: UN1732 Antimony pentafluoride, when spilled in water.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (from a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.3/0.4

Large spills (from a large package or from many small packages)

First: Isolate in all directions (ft/m) 500/150
Then: Protect persons downwind (mi/km)
Day 0.7/1.1
Night 2.6/4.1

Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. For *large spills* dike far ahead. Absorb spills with noncombustible absorbent material, such as vermiculite, dry sand; earth, etc., and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include hydrogen fluoride, fumes of fluoride and oxides of metal. Approach fire from upwind; avoid hazardous vapors and toxic decomposition products. Do not use water or foam on fire or on adjacent fires; extinguish with dry chemicals or carbon dioxide. Water spray may be used to reduce vapors. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (173); (101); (138); (122); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Antimony Pentafluoride, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Antimony Pentafluoride, Trenton, NJ (June 2004).

Experimental details are in the following: "Development of the Table of Initial Isolation and Protective Distances for the 2008 Emergency Response Guidebook", ANL/DIS-09-2, D. F. Brown, H.M. Hartmann, W.A. Freeman, and W.D. Haney, Argonne National Laboratory, Argonne, Illinois, June 2009.

Antimony Potassium Tartrate A:1440

Formula: $C_4H_4KO_7Sb$

Synonyms: Antimonate (2-), bis μ-2,3-dihydroxybutanedioata(4-)-01,02: 03,04di-,dipotassium, trihydrate, stereoisomer; Antimonyl potassium tartrate; Emetique (French); ENT 50,434; Potassium antimonyl-δ-tartrate; Potassium antimonyl tartrate; Potassium antimony tartrate; Tartar emetic; Tartaric acid, antimony potassium salt; Tartarized antimony; Tartrated antimony; Tartrato de antimonio y potasio (Spanish); Tastox

CAS Registry Number: 28300-74-5

HSDB Number: 1428

RTECS Number: CC6825000

UN/NA & ERG Number: UN1551/(antimony potassium tartrate)151

Regulatory Authority and Advisory Information

Banned or Severely Restricted (New Zealand)[13] (Many countries, especially in food) (UN)[35]

Clean Air Act, 42USC7412; Title I, Part A, §112 Hazardous Pollutants (as antimony compounds)

United States National Primary Drinking Water Regulations: MCLG = 0.006 mg[Sb]/L; MCL = 0.006 mg [Sb]/L as Antimony

Clean Water Act: 40CFR116.4 Hazardous Substances; 40CFR117.3, RQ (same as CERCLA); 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/1992); Section 307 Toxic Pollutants, 40CFR401.15 (effluent limitations); as antimony compounds

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed (as antimony compounds, n.o.s.)

Safe Drinking Water Act, MCL, treatment technique; MCL, 0.006 mg/L; MCLG, 0.006 mg/L; Regulated Chemical (47FR9352)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)

EPCRA Section 313: Includes any unique chemical substance that contains antimony as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%; NPRI (as antimony compounds).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Antimony potassium tartrate is an odorless, colorless, crystalline material or white powder with a sweetish, metallic taste. Molecular weight = 667.87; specific gravity (H_2O:1) = 2.6. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 0; reactivity 0. Soluble in water; solution is slightly acidic.

Potential Exposure: It is used in medicine; textile and leather dyeing; as an insecticide.

Incompatibilities: Solution will react with alkaline materials.

Permissible Exposure Limits in Air

NIOSH IDLH = 50 mg[Sb]/m^3

ACGIH TLV[1]: 0.5 mg[Sb]/m^3 TWA

OSHA PEL: 0.5 mg[Sb]/m^3 TWA

NIOSH REL: 0.5 mg[Sb]/m^3 TWA

PAC Ver. 29[138]

PAC-1: 4.1 milligram per cubic meter

PAC-2: 37 milligram per cubic meter

PAC-3: 220 milligram per cubic meter

DFG MAK: Carcinogen Category 2; Germ Cell Mutagen Category 3B (2006)

The above exposure limits are for air levels only. When skin contact also occurs, you may be overexposed, even though air levels are lower than the limits listed above. Russia MAC value[43] is 0.3 milligram per cubic meter.

Permissible Concentration in Water: As part of the priority toxic pollutant program, EPA[6] has set a limit of 146 μg/L of antimony to protect human health. EPA has also suggested[32] an ambient limit of 7 μg/L of antimony based on health effects.

Routes of Entry: Skin absorption; inhalation.

Harmful Effects and Symptoms

Short-Term Exposure: Antimony potassium tartrate can affect you when breathed in and by passing through your skin. Eye and skin contact can cause irritation and skin rash. Exposure can cause poor appetite; abdominal pain; nausea, headaches, sore throat; and irritation of air passages, with cough. Higher levels can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Exposure may make the heart beat irregularly or stop. High or repeated exposure may damage the liver or heart muscle.

Long-Term Exposure: Prolonged or repeated contact can cause ulcers or sores in the nose, kidney, liver, and heart damage. Antimony may cause an increase in blood cholesterol; a decrease in blood sugar.

Points of Attack: Skin, eyes, respiratory system; cardiovascular system, kidneys, liver.

Medical Surveillance: Antimony can be measured in the urine, feces, and blood[76]. EKG. Liver and kidney function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Specific engineering controls are recommended for this chemical in the NIOSH criteria document Antimony Number 72-216. Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. If local exhaust ventilation or enclosure is not used, respirators should be worn. Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *5 milligram per cubic meter*: 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100; or Sa (APF = 10) (any supplied-air respirator). *12.5 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *25 milligram per cubic meter*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *50 milligram per cubic meter*: Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from heat.

Shipping: UN1549 Antimony potassium tartrate, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Antimony potassium tartrate itself does not burn. Thermal decomposition products may include potassium oxide and antimony. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (173); (101); (138); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 1, No. 8, 33–35 (1981).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Antimony Potassium Tartrate, Trenton, NJ (June 2004).

Antimony Tribromide A:1450

Formula: Br_3Sb; $SbBr_3$

Synonyms: Antimonous bromide; Antimony(3 +) bromide; Antimony(III) bromide; Stibine, tribromo-; Tribromo stibine; Tribromuro de antimonio (Spanish)

CAS Registry Number: 7789-61-9

HSDB Number: 441

RTECS Number: CC4400000

UN/NA & ERG Number: UN3141 (antimony compounds, inorganic, liquid, n.o.s)/157

EC Number: 232-179-8

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Strong oxidizer, Corrosive, Water reactive.

Banned or Severely Restricted (New Zealand)[13] (Many countries, especially in food) (UN)[35]

Clean Air Act, 42USC7412; Title I, Part A, §112 Hazardous Pollutants (as antimony compounds)

United States National Primary Drinking Water Regulations: MCLG = 0.006 mg[Sb]/L; MCL = 0.006 mg [Sb]/L as Antimony

Clean Water Act: 40CFR116.4 Hazardous Substances; 40CFR117.3, RQ (same as CERCLA); 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/1992); Section 307 Toxic Pollutants, 40CFR401.15 (effluent limitations); as antimony compounds.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed (as antimony compounds, n.o.s.)

Safe Drinking Water Act, MCL, treatment technique; MCL, 0.006 mg/L; MCLG, 0.006 mg/L; Regulated Chemical (47FR9352)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1000 lb (454 kg)

EPCRA Section 313: Includes any unique chemical substance that contains antimony as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%; NPRI (as antimony compounds).

Hazard symbols, risk, & safety statements: Hazard symbol: O, Xn, N: risk phrases: R8; R20/22; R51/53; safety phrases: S17; S29/35; S41; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Antimony tribromide is a nonflammable, colorless to yellow crystalline solid dissolved in hydrobromic acid. Molecular weight = 361.51. Boiling point = 288°C @ 749 mmHg; freezing/melting point = 96.6°C; specific gravity (H_2O:1) = 4.148 @ 23°C; critical temperature = 904.5°C; critical pressure = 5.67 MN/m^2; heat of vaporization = 53.2 kJ/mol @ 560°C; vapor pressure ≤ 0.075 mmHg @ 23°C. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 0; reactivity 1 ₩. Soluble in water; slow reaction, releasing antimony trioxide and hydrogen bromide.

Potential Exposure: Antimony tribromide is used to make antimony salts; in dyeing, and analytical chemistry.

Incompatibilities: Contact with water reacts, liberating antimony trioxide and hydrogen bromide. Dry trioxide material may explode if heated air. Heat forms toxic bromides. Antimony tribromide attacks various metals.

Permissible Exposure Limits in Air antimony trioxide and hydrogen bromide.

NIOSH IDLH = 50 mg[Sb]/m^3

ACGIH TLV[1]: 0.5 mg[Sb]/m^3 TWA

OSHA PEL: 0.5 mg[Sb]/m^3 TWA

NIOSH REL: 0.5 mg[Sb]/m^3 TWA

No PACavailable.

DFG MAK: Carcinogen Category 2; Germ Cell Mutagen Category 3B (2006)

The above exposure limits are for air levels only. When skin contact also occurs, you may be overexposed, even though air levels are lower than the limits listed above. Russia MAC value[43] is 0.3 milligram per cubic meter.

Permissible Concentration in Water: As part of the priority toxic pollutant program, EPA[6] has set a limit of 146 μg/L of antimony to protect human health. EPA has also suggested[32] an ambient limit of 7 μg/L of antimony based on health effects.

Harmful Effects and Symptoms

Short-Term Exposure: Antimony tribromide can affect you when breathed and by passing though skin. Exposure can cause sore throat; skin rash; poor appetite; irritation of the air passages with cough. Higher exposures can cause pulmonary edema, a medical emergency, which can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. This chemical can cause irregular heartbeat; this can cause death. The symptoms of pulmonary edema are aggravated by physical effort. High or repeated exposure may damage the liver and the heart muscle. Antimony tribromide is a corrosive chemical and contact can burn the skin and eyes, with burns and possible permanent damage. If used near acid, a deadly stibine gas can be released.

Long-Term Exposure: Antimony may cause an increase in blood cholesterol; a decrease in blood sugar. Repeated exposure can cause liver, heart muscle damage; headaches; loss of appetite; dry throat and sleep disturbance. Corrosive substances, such as antimony tribromide have the potential for causing lung damage.

Points of Attack: Skin, eyes, respiratory system; cardiovascular system.

Medical Surveillance: Antimony can be measured in the urine, feces, and blood[76]. EKG, liver function tests; urine tests for antimony. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Lung function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Specific engineering controls are recommended for this chemical in the NIOSH criteria document Antimony Number 72-216. Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. If local exhaust ventilation or enclosure is not used, respirators should be worn. Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *5 milligram per cubic meter*: 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100; or Sa (APF = 10) (any supplied-air respirator). *12.5 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *25 milligram per cubic meter*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *50* milligram per cubic meter: Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Antimony Tribromide must be stored to avoid contact with potassium, sodium, and bases (such as sodium hydroxide, potassium hydroxide and ammonium hydroxide), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from water or moisture and heat.

Shipping: UN3141 Antimony compounds, inorganic, liquid, n.o.s, Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include corrosive hydrogen bromide and oxides of metal. Extinguish fire using an agent suitable for type of surrounding fire. Antimony tribromide itself does not burn. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Encapsulate and bury at an approved chemical landfill. Unacceptable for disposal at sewage treatment plants. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (173); (101); (138); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 3, No. 5, 42−43 (1983) and 8, N0. 5, 56−59 (January 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Antimony Tribromide, Trenton, NJ (October 2000).

Antimony Trichloride A:1460

Formula: Cl_3Sb; $SbCl_3$

Synonyms: Antimoine (trichlorure d') (French); Antimonius chloride; Antimony butter; Antimony(III) chloride; Butter of antimony; Chlorid antimonity; C.I. 77056; Stibine, trichloro-; Trichloro stibine; Trichlorostibine; Trichlorure d' antimoine (French); Tricloruro de antimonio (Spanish)

CAS Registry Number: 10025-91-9

HSDB Number: 439

RTECS Number: CC4900000

UN/NA & ERG Number: UN1733/157

EC Number: 233-047-2 [*Annex I Index No.*: 051-001-00-8]

Regulatory Authority and Advisory Information

Hazard Alert: Corrosive, Suspected of causing genetic defects, Suspected reprotoxic hazard, Environmental hazard.

United States Environmental Protection Agency Gene-Tox Program, Positive: B *subtilis* rec assay

Banned or Severely Restricted (New Zealand)[13] (Many countries, especially in food) (UN)[35]

Clean Air Act, 42USC7412; Title I, Part A, §112 Hazardous Pollutants (as antimony compounds)

United States National Primary Drinking Water Regulations: MCLG = 0.006 mg[Sb]/L; MCL = 0.006 mg [Sb]/L as Antimony

Clean Water Act: 40CFR116.4 Hazardous Substances; 40CFR117.3, RQ (same as CERCLA); 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/1992); Section 307 Toxic Pollutants, 40CFR401.15 (effluent limitations); as antimony compounds

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed (as antimony compounds, n.o.s.)

Safe Drinking Water Act, MCL, treatment technique; MCL, 0.006 mg[Sb]/L; MCLG, 0.006 mg[Sb]/L; Regulated Chemical (47FR9352) as Antimony, SMCL = 250 mg[Cl-]/L as Chloride.

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1000 lb (454 kg)

EPCRA Section 313: Includes any unique chemical substance that contains antimony as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. as antimony(III) trichloride; NPRI (as antimony compounds).

Hazardous to aquatic life or environment, with possible long-lasting effects[293]. Toxic to aquatic life with long-lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: C, N; risk phrases: R34; R35; R37; R51; R62; R63; safety phrases: S1/2; S24/25; S26; S29/35; S36; S41; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Antimony trichloride is a noncombustible, clear, colorless, crystalline solid. Acrid, pungent odor. Molecular weight = 228.10; boiling point = 223.3°C; freezing/melting point = 73°C; specific gravity (H_2O:1) = 3.14 @ 20°C; heat of solution = -1.6×10^5 J/kg; heat of fusion = 13.3 cal/g; vapor pressure = 0.119 mmHg @ 20°C. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 0; reactivity 2. Soluble in water; solubility = 10%[d]; reaction.

Potential Exposure: It is used to make antimony salts and drugs; to fireproof textiles; and as a catalyst in many organic reactions; as a reagent for chloral, aromatic hydrocarbons, vitamin A, and for drug identification.

Incompatibilities: Decomposes in water, forming hydrochloric acid and antimony oxychloride. Reacts violently with strong bases; ammonia, alkali metals; aluminum, potassium, sodium. Forms explosive mixture with perchloric acid when hot. Reacts with air forming hydrochloric acid. Attacks metals in the presence of moisture, forming explosive hydrogen gas.

Permissible Exposure Limits in Air

NIOSH IDLH = 50 mg[Sb]/m^3

ACGIH TLV[1]: 0.5 mg[Sb]/m^3 TWA

OSHA PEL: 0.5 mg[Sb]/m^3 TWA

NIOSH REL: 0.5 mg[Sb]/m^3 TWA

PAC Ver. 29[138]

PAC-1: 2.8 milligram per cubic meter

PAC-2: 25 milligram per cubic meter

PAC-3: 150 milligram per cubic meter

DFG MAK: Carcinogen Category 2; Germ Cell Mutagen Category 3B (2006)

Arab Republic of Egypt: TWA 0.5 mg(Sb)/m^3, 1993; Australia: TWA 0.5 mg(Sb)/m^3, 1993; Austria: MAK 0.5 mg(Sb)/m^3, 1993; Belgium: TWA 0.5 mg(Sb)/m^3, 1993; Denmark: TWA 0.5 mg(Sb)/m^3, 1999; Finland: TWA 0.5 mg(Sb)/m^3, 1993; France: VME 0.5 mg(Sb)/m^3, 1999; the Netherlands: MAC-TGG 0.5 mg(Sb)/m^3, 2003; Japan: 0.1 mg(Sb)/m^3, 2B carcinogen, 1999; Norway: TWA 0.5 mg(Sb)/m^3, 1999; the Philippines: TWA 0.5 mg (Sb)/m^3, 1993; Poland: MAC (time-weighted average) 0.5 mg(Sb)/m^3; MAC (STEL) 1.5 mg(Sb)/m^3, 1999; Russia: STEL 0.3 milligram per cubic meter, 1993; Russia: TWA 0.2 mg(Sb)/m^3, STEL 0.5 mg(Sb)/m^3, 1993; Sweden: NGV 0.5 mg(Sb)/m^3, 1999; Switzerland: MAK-week 0.5 mg(Sb)/m^3, 1999; Turkey: TWA 0.5 mg(Sb)/m^3, 1993; United Kingdom: TWA 0.5 mg(Sb)/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 0.5 mg[Sb]/m^3

Permissible Concentration in Water: As part of the priority toxic pollutant program, EPA[6] has set a limit of 146 μg/L of antimony to protect human health. EPA has also suggested[32] an ambient limit of 7 μg/L of antimony based on health effects.

Determination in Water: Toxic to aquatic organisms.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short-Term Exposure: Antimony trichloride can affect you when inhaled. Exposure can cause sore throat; skin rash; poor appetite; and irritation of the air passages, with cough. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Higher exposures can also cause irregular heartbeat; This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. High or repeated exposure may damage the liver and the heart muscle. Antimony trichloride is a corrosive chemical and contact can burn the skin and eyes, with possible permanent damage. If used near acid, a deadly gas (stibine) can be released. The oral LD_{50} for rat is 525 mg/kg[9].

Long-Term Exposure: Antimony may cause an increase in blood cholesterol; a decrease in blood sugar. May cause mutations. May damage the developing fetus. Repeated exposure can cause liver, heart muscle damage; headaches; loss of appetite; dry throat and sleep disturbance. Corrosive substances, such as antimony trichloride have the potential for causing lung damage.

Points of Attack: Cardiovascular system, reproductive system, liver, heart, and lungs.

Medical Surveillance: Antimony can be measured in the urine, feces, and blood[76]. EKG, liver function tests; urine test for antimony, lung function tests including chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Specific engineering controls are recommended for this chemical in the NIOSH criteria document Antimony Number 72-216. Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. If local exhaust ventilation or enclosure is not used, respirators should be worn. Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *5 milligram per cubic meter*: 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100; or Sa (APF = 10) (any supplied-air respirator). *12.5 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *25 milligram per cubic meter*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *50 milligram per cubic meter*: Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: (1) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. (2) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers under nitrogen in a cool, well-ventilated area away from water or moisture, heat and incompatible substances, such as strong bases; aluminum, potassium, and sodium.

Shipping: UN1733 Antimony trichloride, Hazard class: 8; Labels: 8-Corrosive material.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Antimony trichloride itself does not burn. Thermal decomposition products may include hydrogen chloride oxides of metal (antimony). Extinguish fire using an agent suitable for type of surrounding fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (173); (101); (138); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 2, No. 1, 73–74, New York, Van Nostrand Reinhold Co. (1982).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Antimony Trichloride, Trenton, NJ (May 2003).

Antimony Trifluoride A:1470

Formula: F_3Sb

Synonyms: Antimoine fluorure (French); Antimonous fluoride; Antimony(III) fluoride (1:3); Stibine, trifluoro-; Trifluoroantimony; Trifluoroantimony, stibine, trifluoro-; Trifluorostibine; Trifluoruro de antimonio (Spanish)

CAS Registry Number: 7783-56-4

HSDB Number: 438

RTECS Number: CC5150000

UN/NA & ERG Number: UN1549/(antimony compound, inorganic, n.o.s.) 157

EC Number: 232-009-2 [*Annex I Index No.*: 051-004-00-4]

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Suspected of causing genetic defects. Banned or Severely Restricted (New Zealand)[13] (Many countries, especially in food) (UN)[35]

Clean Air Act, 42USC7412; Title I, Part A, §112 Hazardous Pollutants (as antimony compounds)

Clean Water Act: 40CFR116.4 Hazardous Substances; 40CFR117.3, RQ (same as CERCLA); 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/1992); Section 307 Toxic Pollutants, 40CFR401.15 (effluent limitations); as antimony compounds

United States National Primary Drinking Water Regulations: MCLG = 0.006 mg[Sb]/L; MCL = 0.006 mg [Sb]/L as Antimony; MCLG = 4 mg[F]/L; MCL = 4 mg[F]/L; SMCL = 2.0 mg[F]/L as Fluoride.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed (as antimony compounds, n.o.s.)

Safe Drinking Water Act, MCL, treatment technique; MCL, 0.006 mg/L; MCLG, 0.006 mg/L; Regulated Chemical (47FR9352)

CERCLA Section 304 RQ: 1000 lb (454 kg)

EPCRA Section 313: Includes any unique chemical substance that contains antimony as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%; NPRI (as antimony compounds).

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: S23/24/25; R51/53; R62; safety phrases: S1/2; S7; S26; S41; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [2-Hazard to waters (est.)]

Description: Antimony trifluoride is a noncombustible, odorless, white to gray crystalline solid. Molecular weight = 178.75; specific gravity (H_2O:1) = 4.38 @ 21°C (solid); boiling point = 376°C; freezing/melting point = 292°C; vapor pressure = 3 mmHg @ 17°C. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 0; reactivity 0. Soluble in water.

Potential Exposure: It is used in dyeing; to make porcelain and pottery; and as a fluorinating agent.

Incompatibilities: Hot perchloric acid.

Permissible Exposure Limits in Air

NIOSH IDLH = 50 mg[Sb]/m^3

OSHA PEL: 0.5 mg[Sb]/m^3 TWA

NIOSH REL: 0.5 mg[Sb]/m^3 TWA

ACGIH TLV[1]: 0.5 mg[Sb]/m^3 TWA

PAC Ver. 29[138]

PAC-1: 2.2 milligram per cubic meter

PAC-2: 20 milligram per cubic meter

PAC-3: 120 milligram per cubic meter

DFG MAK: Carcinogen Category 2; Germ Cell, Mutagenic, Category 3B (2006)

The above exposure limits are for air levels only. When skin contact also occurs, you may be overexposed, even though air levels are lower than the limits listed above. Russia MAC value[43] is 0.3 milligram per cubic meter.

Permissible Concentration in Water: As part of the priority toxic pollutant program, EPA[6] has set a limit of 146 μg/L of antimony to protect human health. EPA has also suggested[32] an ambient limit of 7 μg/L of antimony based on health effects. Fluoride ion: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guidelines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg[F]/L. SafeDrinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg [F]/L; SMCL = 2 mg/F/L, as Fluoride.

Harmful Effects and Symptoms

Short-Term Exposure: Antimony trifluoride can affect you when breathed in and by passing through your skin. Exposure can cause sore throat; skin rash; poor appetite; and irritate the lungs. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Antimony trifluoride can cause irregular heartbeat; this can cause death. The symptoms of pulmonary edema are aggravated by physical effort. High or repeated exposure may damage the liver and the heart muscle. Antimony Trifluoride is a corrosive chemical and contact can burn the skin and eyes, causing damage. If used near acid, a deadly gas (Stibine) can be released. The oral LD_{50} for mouse is 804 mg/kg[9].

Long-Term Exposure: Antimony may cause an increase in blood cholesterol; a decrease in blood sugar. Repeated contact can cause ulcers and sores of the nose. Can damage the kidneys, liver, and heart. Repeated exposure may affect the lungs and cause an abnormal chest X-ray to develop.

Points of Attack: Eyes, skin, respiratory system; cardiovascular system.

Medical Surveillance: Antimony can be measured in the urine, feces, and blood[76]. EKG, liver and kidney function tests. Consider lung function tests and chest X-ray.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Specific engineering controls are recommended for this chemical in the NIOSH criteria document Antimony Number 72-216. Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. If local exhaust ventilation or enclosure is not used, respirators should be worn. Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *5 milligram per cubic meter*: 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100; or Sa (APF = 10) (any supplied-air respirator). *12.5 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *25 milligram per cubic meter*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *50 milligram per cubic meter*: Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

NIOSH: *(fluorides) 12.5* milligram per cubic meter: Qm (APF = 25) (any quarter-mask respirator). *25 milligram per cubic meter*: 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or SA* (any supplied-air respirator). *62.5 milligram per cubic meter*: Sa:Cf (APF = 25)* + (any supplied-air respirator operated in a continuous-flow mode); or* + *if not present as a fume* PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *125 milligram per cubic meter*: HieF$^+$ (any air-purifying, full facepiece respirator with a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). 250 milligram per cubic meter: Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: HieF$^+$ (any air-purifying, full facepiece respirator with a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Notes: *Substance reported to cause eye irritation or damage; may require eye protection. $^+$May need acid gas sorbent. Exposure to 500 milligram per cubic meter (IDLH) is immediately dangerous to life and health.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from heat.

Shipping: UN1549 Antimony compounds, inorganic, solid, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Antimony Trifluoride itself does not burn. Thermal decomposition products may include fluorides and antimony. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (173); (101); (138); (122); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 2, No. 8, 34−36 (1981) and 3, No. 5, 40−42, New York, Van Nostrand Reinhold Co. (1983).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: *Antimony Trifluoride*, Trenton, NJ (June 2004).

Antimony Trioxide A:1480

Formula: Sb_3O_3

Synonyms: Antimonous oxide; Antimony peroxide; Antimony sesquioxide; Antimony, white; Cystic prefil F; Diantimony trioxide; Exitelite; Fireshield H; Fireshield HPM; Fireshield L; Flowers of antimony; NCI-C55152; Nihon kagaku sangyo antimony trifluoride; Octoguard FR-10; Octoguard FR-15; Petcat R-9; Senarmontite; STCC 4966905; Trioxido de antimonio (Spanish); Ultrafine II; Valentinite; Weisspiessglanz (German); White antimony

CAS Registry Number: 1309-64-4; 1327-33-9

HSDB Number: 436

RTECS Number: CC5650000

UN/NA & ERG Number: UN1549/(antimony compound, inorganic, n.o.s.) 157

EC Number: 215-175-0 [*Annex I Index No.*: 051-005-00-X] (*1309-64-4*); 215-474-6 (1327-33-9)

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Sufficient Evidence, Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B, 1989; ACGIH (A2) Suspected Human Carcinogen. United States Environmental Protection Agency Gene-Tox Program, Positive: B *subtilis* rec assay.

California Proposition 65 Chemical[102]: Cancer 10/1/1990.

Hazard Alert: Poison, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction).

Banned or Severely Restricted (New Zealand)[13] (Many countries, especially in food) (UN)[35]

Clean Air Act, 42USC7412; Title I, Part A, §112 Hazardous Pollutants (as antimony compounds)

United States National Primary Drinking Water Regulations: MCLG = 0.006 mg[Sb]/L; MCL = 0.006 mg [Sb]/L as Antimony

Clean Water Act: 40CFR116.4 Hazardous Substances; 40CFR117.3, RQ (same as CERCLA); 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/1992); Section 307 Toxic Pollutants, 40CFR401.15 (effluent limitations); as antimony compounds

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed, as antimony compounds, n.o.s

Safe Drinking Water Act, MCL, treatment technique; MCL, 0.006 mg/L; MCLG, 0.006 mg/L; Regulated Chemical (47FR9352)

CERCLA/SARA Section 304 RQ: 1000 lb (454 kg)

EPCRA Section 313: Includes any unique chemical substance that contains antimony as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. as antimony trioxide; NPRI (as antimony compounds).

European/International Regulations (*1309-64-4*): Hazard symbol: T, Xn; risk phrases: R45; R40; R61; R62; R63; safety phrases: S2; S22; S36/37; European/International Regulations (*1327-33-9*): not listed in Annex 1.

WGK[100] (German Aquatic Hazard Class): 2-Hazard to waters (*antimony(III) oxide*).

Description: Antimony trioxide is a noncombustible, odorless, white crystalline powder. Molecular weight = 291.52; specific gravity (H_2O:1) = 5.2 @ 25°C (solid); boiling point = (sublimes) 1550°C @ 760 mmHg; freezing/melting point = 655°C; heat of fusion = 46.3 cal/g; vapor pressure = 1 mmHg @ 574°C. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 0; reactivity 0. Practically insoluble in water; solubility = 1.4×10^{-4} g/100 mL @ 30°C.

Potential Exposure: It is used in flame-proofing, pigments and ceramics, to stain iron and copper; to decolorize glass; industrial chemical, dye, pigment, and printing ink.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, halogenated acids, chlorinated rubber, bromine trifluoride. Reduction with hydrogen forms toxic antimony hydride.

Permissible Exposure Limits in Air

OSHA PEL: 0.5 mg[Sb]/m^3 TWA

NIOSH REL: 0.5 mg[Sb]/m^3 TWA

ACGIH TLV[1]: 0.5 mg[Sb]/m^3 TWA; Suspected Human Carcinogen; (production) keep worker exposure to a minimum.

PAC Ver. 29[138]

1309-64-4

PAC-1: 1.8 milligram per cubic meter

PAC-2: 16 milligram per cubic meter

PAC-3: 96 milligram per cubic meter

DFG MAK: Carcinogen Category 2; Germ Cell, Mutagenic, Category 3 A (2005)

Arab Republic of Egypt: TWA 0.5 mg(Sb)/m^3, 1993; Australia: STEL 0.5 ppm; TWA 0.5 mg(Sb)/m^3, 1993; Austria: carcinogen, 1999; Belgium: STEL 0.5 ppm; TWA 0.5 mg(Sb)/m^3, 1993; Denmark: TWA 0.5 mg(Sb)/m^3, 1999; Finland: TWA 0.5 mg(Sb)/m^3, 1993; the Netherlands: MAC-TGG 0.5 mg(Sb)/m^3, 2003; Hungary: STEL 0.5 mg (Sb)/m^3, 1993; Japan: 0.1 mg(Sb)/m^3, 2B carcinogen, 1999; Norway: TWA 0.5 mg(Sb)/m^3, 1999; the Philippines: TWA 0.5 mg(Sb)/m^3, 1993; Poland: MAC (time-weighted average) 0.5 mg(Sb)/m^3, 1993; Russia: STEL 1 milligram per cubic meter, 1993; Russia: TWA 0.2 mg(Sb)/m^3, STEL 0.5 mg(Sb)/m^3, 1993; Sweden: NGV 0.5 mg(Sb)/m^3, 1999; Switzerland: TWA 0.1 milligram per cubic meter, Carcinogen 1993; Switzerland: MAK-week 0.1 mg(Sb)/m^3, carcinogen, 1999; Turkey: TWA 0.5 mg(Sb)/m^3, 1993; United Kingdom: TWA 0.5 mg(Sb)/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Suspected Human Carcinogen

Permissible Concentration in Water: As part of the priority toxic pollutant program, EPA[6] has set a limit of 146 μg/L of antimony to protect human health. EPA has also suggested[32] an ambient limit of 7 μg/L of antimony based on health effects.

Harmful Effects and Symptoms

Short-Term Exposure: Antimony trioxide can affect you when breathed in. Exposure can cause sore throat, rash, poor appetite; and irritation of the airways, with cough. High or repeated exposure may damage the liver and the heart muscle. If used near acid, a deadly stibine gas can be released.

Long-Term Exposure: Antimony may cause an increase in blood cholesterol; a decrease in blood sugar. There is an association between antimony trioxide in smelting processes and increased lung cancer. There is some evidence that this chemical nay damage the developing fetus and cause miscarriage. Can damage the kidneys, liver, and heart. Repeated exposure may affect the lungs and cause an abnormal chest X-ray to develop.

Points of Attack: Eyes, skin, respiratory system; cardiovascular system, kidneys, liver, reproductive system.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Antimony can be measured in the urine, feces, and blood[76]. CBC, urine test for antimony, EKG, liver and kidney function tests. Consider lung function tests and chest X-ray. Depending on the degree of exposure, periodic medical checkups are advisable.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek

medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Specific engineering controls are recommended for this chemical in the NIOSH criteria document Antimony Number 72-216. Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. If local exhaust ventilation or enclosure is not used, respirators should be worn. Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *5 milligram per cubic meter*: 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100; or Sa (APF = 10) (any supplied-air respirator). *12.5 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *25 milligram per cubic meter*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *50 milligram per cubic meter*: Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from heat, strong oxidizers; acids. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN1549 Antimony compounds, inorganic, solid, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use any agent suitable for surrounding fires. Thermal decomposition products may include toxic Sb fumes. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(102); (31); (173); (101); (138); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 2, No. 1, 74−76.

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Antimony Trioxide, Trenton, NJ (June 2004).

Antimycin A A:1490

Formula: $C_{28}H_4N_2O_9$ (Antimycin A); $C_{28}H_{40}N_2O_9$ (Antimycin A1); $C_{26}H_{36}N_2O_9$ (Antimycin A3); $C_{25}H_{34}N_2O_9$ (Antimycin A_4)

Synonyms: Antimicina A (Spanish); Antimycin A; Antipiricullin; Dihyrosamidin; Fintrol; Isovaleric acid 8-ester with 3-formamido-*N*-(7-hexyl-8-hydroxy-4,9-dimethyl-2,6-dioxo-1,5-dioxonan-3-yl)salicylamide isovaleric acid 8 ester; Virosin

CAS Registry Number: 1397-94-0 (A-); 11118-72-2 (Antimycin/Fintrol); 518-75-2 (Antimycin/Citrinin); 642-15-9 (A_1-Dimidin); 522-70-3 (A_3-); 27220-59-3 (A_4-) *Note*: Both A_1 CAS Numbers are found in RTECS, with the same chemical formula, although EPA regulates only CAS number 1397-94-0 (Antimycin A-)

HSDB Number: 6417 (A-)

RTECS Number: CD0350000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 208-257-2 (CAS 518-75-2)

Regulatory Authority and Advisory Information

518-75-2 *(Antimycin/Citrinin)*

IARC: Animal Inadequate Evidence; Human No Adequate Data, *not classifiable as carcinogenic to humans*, Group 3

CERCLA/SARA 40CFR302 Extremely Hazardous Substances: TPQ = 1000/10,000 lb (454/4540 kg)[72]

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water. (*Antimycin A-*)

Description: Antimycin ($A_3C_{26}H_{36}N_2O_9$) and (Antimycin A_1) $C_{28}H_{40}N_2O_9$ are crystalline solids. Molecular weight = 512.8 (A); 520.64 (A_3-); 506.6 (A_4-); freezing/melting point = 170–175°C; 149–150°C (A1); 174–175°C (A_3). They are complex 9-membered (2 oxygens and 7 carbons) ring derivatives with complex side chains. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 0; reactivity 0. Practically insoluble in water.

Potential Exposure: Specific uses for antimycin A were not found, however, antimycin A_1, and antimycin A_3 are reported to be antibiotic substances produced by streptomyces for use as a fungicide, possible insecticide and miticide. Registered as a pesticide in the U.S.

Permissible Exposure Limits in Air

1397-94-0, Antimycin A

PAC Ver. 29[138]

PAC-1: 0.16 milligram per cubic meter

PAC-2: 1.8 milligram per cubic meter

PAC-3: 5.5 milligram per cubic meter

Routes of Entry: Ingestion, intramuscular.

Harmful Effects and Symptoms

Short-Term Exposure: Subcutaneous, intravenous, and intraperitoneal route poisons. Moderately toxic by ingestion and intramuscular routes. The oral LD_{50} for rat is 28 mg/kg[9].

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft.(NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. (Nonspecific–Pesticide, solid, n.o.s.). Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Wear positive-pressure breathing apparatus and special protective clothing. Remove and isolate contaminated clothing at the site. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills*: with clean shovel place material into clean, dry container and cover; move containers from spill area. *Large spills*: dike far ahead of spill for later disposal. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: (Nonspecific, Pesticide, solid, n.o.s.). *Small fires*: dry chemical, carbon dioxide; water spray; or foam. *Large fires*: water spray, fog, or foam. Move container from fire area if you can do so without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Thermal decomposition products may include oxides of nitrogen and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Antimycin A, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Antimycin A, #2132, Trenton, NJ (December 2001).

ANTU A:1500

Formula: $C_{11}H_{10}N_2S$

Synonyms: α-Naphthyl thiourea; α-Naphtyl thiouree (French); Alrato; Anturat; Bantu; Chemical 109; Dirax; Kill kantz; Krysid; Krysid PI; α-Naftiltiourea (Spanish); α-Naphthothiourea; α-Naphthylthiocarbamide; 1-Naphthyl-thioharnstoff (German); α-Naphthylthiourea; *N*-(1-Naphthyl)-2-thiourea; 1-(1-Naphthyl)-2-thiourea; 1-Naphthylthiourea; 1-Naphthyl-thiouree (French); Naphtox; Rattrack; Rat-TU; Smeesana; Thiourea, 1-Naphthalenyl-; Urea,1-(1-naphthyl)-2-thio-

CAS Registry Number: 86-88-4

HSDB Number: 1512 as α-Naphthyl thiourea

RTECS Number: YT9275000

UN/NA & ERG Number: UN1651/153

EC Number: 201-706-3 [*Annex I Index No*. 006-008-00-0]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Inadequate Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1987. United States Environmental Protection Agency Gene-Tox Program, Positive: SHE-clonal assay; Inconclusive: Carcinogenicity-mouse/rat.

Hazard Alert: Exposure can be lethal, Combustible Agricultural chemical, Possible risk of forming tumors, Suspected of causing genetic defects.

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P072

RCRA 40CFR261, Appendix 8; 40CFR261.11 Hazardous Constituents

CERCLA/SARA 40CFR302 Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg)

CERCLA/SARA Section 304 RQ: 100 lb (45.4 kg)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. (as 1-naphthyl thiourea).

Hazard symbols, risk, & safety statements: Hazard symbol: T + ; risk phrases: R40; R51/53; R62; safety phrases: S23; S25; S28; S36/37; S40; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [2-Hazard to water. (est.)]

Description: ANTU is a noncombustible, white crystalline solid or gray powder. Odorless. Molecular weight = 202.29; boiling point = (decomposes) 457°C; freezing/melting point = 198°C. Hazard identification (based on NFPA-704 M Rating System): Health 4; flammability 1; reactivity 0. Slightly soluble in water.

Potential Exposure: ANTU or its formulations are used as a rodenticide.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, silver nitrate.

Permissible Exposure Limits in Air

NIOSH IDLH = 100 milligram per cubic meter

OSHA PEL: 0.3 milligram per cubic meter TWA

NIOSH REL: 0.3 milligram per cubic meter TWA

ACGIH TLV[1]: 0.03 milligram per cubic meter TWA [skin]; not classifiable as a human carcinogen

PAC Ver. 29[138]

PAC-1: 0.91 milligram per cubic meter

PAC-2: 10 milligram per cubic meter

PAC-3: 100 milligram per cubic meter

DFG MAK: 0.3 milligram per cubic meter inhalable aerosol; Peak Limitations Category 11(2)

Australia: TWA 0.3 milligram per cubic meter, 1993; Austria: MAK 0.3 milligram per cubic meter, 1999; Belgium: TWA 0.3 milligram per cubic meter, 1993; Denmark: TWA 0.3 milligram per cubic meter, 1999; Finland: TWA 0.3 milligram per cubic meter, STEL 0.9 milligram per cubic meter, 1999; France: VME 0.3 milligram per cubic meter, carcinogen, 1999; the Netherlands: MAC-TGG 0.3 milligram per cubic meter, 2003; the Philippines: TWA 0.3 milligram per cubic meter, 1993; Switzerland: MAK-week 0.3 milligram per cubic meter, KZG-week 1.5 milligram per cubic meter, 1999; Turkey: TWA 0.3 milligram per cubic meter, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea. New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Several states have set guidelines or standards for ANTU in ambient air[60] ranging from 3 μ/m^3 (North Dakota) to 5 μ/m^3 (Virginia) to 6 μ/m^3 (Connecticut) to 7 μ/m^3 (Nevada).

Determination in Air: Collection on a filter and analysis by gas−liquid chromatography. Use NIOSH Analytical Method 5276.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 1.66$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion and skin absorption.

Harmful Effects and Symptoms

Short-Term Exposure: Poisonous. Symptoms include seizures, and dermal irritation. High exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Ingestion may cause vomiting, shortness of breath; and bluish discoloration of the skin. ANTU is moderately toxic: probable oral lethal dose (human) 0.5−5 mg/kg, or between 1 ounce and 1 pint (or 1 lb) for 150 lb person. The LD_{50} for oral rat is 6 mg/kg[9]. Chronic sublethal exposure may cause antithyroid activity. Can produce hyperglycemia of three times normal in 3 hours.

Long-Term Exposure: May cause chronic dermatitis; increased production of white blood cells. A suspected carcinogen and a possible mutagen.

Group ***Points of Attack:*** Respiratory system.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. People with chronic respiratory disease or liver disease may be especially at risk. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Lung function tests. Consider chest X-ray following acute overexposure. Evaluation by a dermatologist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *3 milligram per cubic meter*: CcrOv95 (APF = 10) [any air-purifying half-mask respirator equipped with an organic vapor cartridge(s) in combination with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *7.5 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOvHie (APF = 25) (any powered air-purifying respirator with an organic vapor cartridge in combination with a high-efficiency particulate filter). *15 milligram per cubic meter*: CcrFOv100 (APF = 50) [any air-purifying full facepiece respirator equipped with organic vapor cartridge(s) in combination with an N100, R100, or P100 filter]; or PaprTOvHie (APF = 50) [any powered, air-purifying respirator with a tight fitting facepiece and organic vapor cartridge(s) in combination with a high-efficiency particulate filter]; or GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *100 milligram per cubic meter*: Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry in unknown* *concentration or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers and silver nitrate. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN1651 Naphthylthiourea, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Avoid inhalation and skin contact; wear proper respiratory protection and protective clothing. Do not touch spilled material, stay upwind, keep out of low areas. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: ANTU may burn but will not ignite readily. Extinguish with dry chemical, carbon dioxide; water spray, fog, or foam. Thermal decomposition products may include nitrogen and sulfur oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incinerate in a furnace equipped with an alkaline scrubber[22]. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (173); (101); (138); (2); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 4, No. 2, 83−86 (1984).

United States Environmental Protection Agency, Chemical Hazard Information Profile: ANTU, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: alpha-naphtha Thiourea, #0051, Trenton, NJ (February 2001).

Aramite A:1507

Formula: $C_{15}H_{23}ClO_4S$; $(CH_3)_3C\text{-}C_6H_4\text{-}OCH_2CH(CH_3)OSO_2\text{-}(CH_2)_2Cl$

Synonyms: 88-R; Acaracide; Aracide; Araramite-15W; Aratron; 2-(*p*-Butylphenoxy)isopropyl 2-chloroethyl sulfite; 2-(4-*tert*-Butylphenoxy)isopropyl-2-chloroethyl sulfite; Butylphenoxyisopropyl chloroethyl sulfite; 2-(*p*,*tert*-Butylphenoxy)isopropyl 2′-chloroethyl sulphite; 2-(*p*,*tert*-Butylphenoxy)-1-methylethyl 2-chloroethyl ester of sulfurous acid; 2-(*p*-Butylphenoxy)-1-methylethyl 2-chloroethyl sulfite; 2-(*p*,*tert*-Butylphenoxy)-1-methylethyl-2-chloroethyl sulfite ester; 2-(*p*,*tert*-Butylphenoxy)-1-methylethyl 2′-chloroethyl sulphite; 2-(*p*,*tert*-Butylphenoxy)-1-methylethyl sulphite of 2-chloroethanol; 1-(*p*,*tert*-Butylphenoxy)-2-propanol-2-chloroethyl sulfite; CES; 2-Chloroethanol-2-(*p*,*tert*-butylphenoxy)-1-methylethyl sulfite; 2-Chloroethanol ester with 2-(*p*,*tert*-butylphenoxy)-1-methylethyl sulfite; β-Chloroethyl-b′-(*p*,*tert*-butylphenoxy)-a′-methylethyl sulfite; β-Chloroethyl-β-(*p*,*tert*-butylphenoxy)-α-methylethyl sulphite; 2-Chloroethyl 1-methyl-2-(*p*,*tert*-butylphenoxy)ethyl sulphite; 2-Chloroethylsulfurous acid 2-[4-(1,1-dimethylethyl)phenoxy]-1-methylethyl ester; 2-Chloroethyl sulphite of 1-(*p*,*tert*-Butylphenoxy)-2-propanol; Compound 88 R; ENT 16,519; *o*-Mite; Niagaramite; Sulfurous acid 2-(*p*-tert-butylphenoxy)-1-methylethyl-2-chloroethyl ester

CAS Registry Number: 140-57-8

HSDB Number: 1329

RTECS Number: WT2975000

UN/NA & ERG Number: UN2902 (Pesticides, liquid, toxic, n.o.s.)/151

EC Number: None found

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human No Sufficient Data; Animal Sufficient Evidence, *possibly carcinogenic to humans*, Group 2B, 1987
California Proposition 65 Chemical[102]: Cancer 7/1/1987
California Proposition 65 Developmental/Reproductive toxin 3/3/99.
Hazard Alert: Poison, Reproductive toxin, Agricultural chemical.
Hazardous Waste Constituent (EPA/RCRA)[5].
Hazard symbols, risk, & safety statements: Hazard symbol: T, F, Xn, N; risk phrases: R45; R11; R36/37/38; R40; R48/20; R50; R62; R63; safety phrases: S7; S16; S23; S24/25; S29/35; S36/37/39; S45; S53 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)].

Description: Aramite is a heavy, dark-amber liquid. Molecular weight = 334.89; boiling point = 175°C @ 0.1 mmHg; freezing/melting point = −32°C; vapor pressure = 9 mmHg @ 25°C. Practically insoluble in water.

Potential Exposure: Aramite is an organochlorine miticide and antimicrobial agent. Aramite is regulated by EPA under the Federal Insecticide, Fungicide, and Rodenticide Act and the Resource Conservation and Recovery Act. The significant regulatory action was a voluntary cancellation of the active ingredient registration by the sole producer in 1975.

Incompatibilities: Incompatible with alkaline material, such as lime or Bordeaux mixture (slaked lime and copper sulfate solution).

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices. A limit on Aramite in ambient air has been set in Pennsylvania[60] @ 18.07 μ/m^3.

Routes of Entry: Inhalation, ingestion; skin, and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: This material is slightly toxic (LD$_{50}$ value for rats is 3900 mg/kg) but it is carcinogenic to animals.

Long-Term Exposure: Aramite is carcinogenic in the rat and dog following its oral administration. It produced liver tumors in the rat and carcinomas of the gall bladder and biliary ducts in the dog. Aramite was tested in two strains of mice by the oral route and produced a significant increase of hepatomas in males of one strain.

Points of Attack: See above.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved SCBA that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full-face-piece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from alkalis, nitrates and heat. This material may be thermally unstable (Verschueren). Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Always store pesticides in their original containers, complete with labels that list ingredients, directions for use, and first aid steps in case of accidental poisoning. Never store pesticides in cabinets with or near food, animal feed, or medical supplies. Do not store pesticides in places where flooding is possible or in places where they might spill or leak into wells, drains, ground water, or surface water[72]. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2902 Pesticides, liquid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include chlorine and sulfur oxide. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Acid or alkaline hydrolysis followed by flushing to sewer.

References

(102); (31); (173); (101); (138); (203); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 3, 79−80 (1981).

New Jersey Department of Health and Senior Services, Hazardous Substances Fact Sheet: Aramite, #0150, Trenton, NJ (May 2000).

Argon A:1510

Formula: Ar

Synonyms: Argon-40; Argon, cryogenic; Liquid argon; R-740

CAS Registry Number: 7440-37-1

HSDB Number:7902

RTECS Number: CF2300000

UN/NA & ERG Number: UN1006 (compressed gas)/121; UN1951 [argon, refrigerated liquid (cryogenic liquid)]/120

EC Number: 231-147-0

Regulatory Authority and Advisory Information

Hazard Alert: Frostbite/Cryogenic burn hazard, Asphyxiation hazard[1], Contains gas under pressure; may explode if heated.

Hazard symbols, risk, & safety statements: Hazard symbol: Risk phrases: R5; R21; safety phrases: S9; S33; 38 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): Non hazard to water.

Description: With the symbol A, argon is a nonflammable gas; one of the elements in the inert gas category. It is colorless. Molecular weight = 39.95; boiling point = −186°C; freezing/melting point = −192°C; vapor density (air = 1) = 1.66. Hazard identification (based on NFPA-704 M Rating System): Health 1; flammability 0; reactivity 0. Slightly soluble in water; solubility = 3.5% @ 20°C.

Potential Exposure: Argon is used in metal fabrication and steel making; as an inert gas shield in arc welding; as an inert atmosphere in electric lamps; as a blanketing agent in metals refining (especially titanium and zirconium).

Permissible Exposure Limits in Air

An asphyxiant at less than 18% oxygen by volume.

OSHA: (shipyards and construction) simple asphyxiant, inert gas, and vapor

ACGIH: simple asphyxiant with no specified numerical TLV. The limiting factor is the available oxygen.

PAC Ver. 29[138]

PAC-1: 65,000 ppm

PAC-2: 230,000 ppm

PAC-3: 400,000 ppm

Australia: asphyxiant, 1993; Belgium: asphyxiant, 1993; Hungary: asphyxiant, 1993; Switzerland: asphyxiant, 1999; United Kingdom: asphyxiant, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Simple asphyxiant.

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guidelines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[Fl]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg[F]/L. SafeDrinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg[F]/L; SMCL = 2 mg/F/L, as Fluoride.

Routes of Entry: Inhalation and possibly skin contact with liquid argon.

Harmful Effects and Symptoms

Short-Term Exposure: The gas is a simple asphyxiant as noted above. Contact with the liquid can cause frostbite. High levels or concentrations in the air can replace oxygen, resulting in headache, unconsciousness, or death.

First Aid: If contact with liquid argon occurs, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with warm water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility.

Personal Protective Methods: Where exposure to cold equipment, vapors, or liquids may occur, employees should be equipped with special clothing designed to prevent the freezing of body tissues. Avoid skin contact with liquid argon. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Wear splash-proof chemical goggles where exposure to liquid argon can occur.

Respirator Selection: Exposure to argon is dangerous because it can cause a deficiency of oxygen and lead to suffocation. Only NIOSH/MSHA or European Standard EN 149-approved SCBA with a full facepiece operated in positive-pressure mode should be used in oxygen deficient environments.

Storage: Check oxygen content prior to entering storage area. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Storage areas should be well-ventilated. Protect vessels which contain argon from physical damage. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169 with the recommendations of the Compressed Gas Association.

Shipping: UN1006 Argon, compressed, Hazard Class: 2.2; Labels: 2.2-Nonflammable compressed gas. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Ventilate area of leak to disperse the gas. Stop flow of gas. If sources of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air and allow cylinder to empty. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Argon is nonflammable and indeed can act as an extinguishing agent itself. Therefore, use extinguishing agents suited for surrounding fires. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Vent to atmosphere. Return refillable compressed gas cylinders to supplier.

References

(31); (173); (101); (138); (122); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 1, No. 5, 36−37 (1981).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Argon, Trenton, NJ (April 2001).

Aristolochic Acid and Salts A:1515

Formula: $C_{17}H_{11}NO_7$ (A-salt); $C_{16}H_9NO_6$ (B-salt); $C_{16}H_9NO_7$ (C-salt)

Synonyms: (A-): Aristolochic acid A; Aristolochic acid-I; Aristolochin; Birthwort; 8-Methoxy-6-nitrophenanthol(3,4-d)1,3-dioxole-5-carboxylic acid; 3,4-Methylenedioxy-8-methoxy-10-nitro-1-phenanthrenecarboxylic acid; NSC-50413; Phenanthro(3,4-d)-1,3-dioxole-5-carboxylic acid, 8-methoxy-6-nitro-; Tardolyt; TR 1736; (B-): Aristolochic acid II; Aristolochic acid B; B-Aristolochic acid; Phenanthro(3,4-d)-1,3-dioxole-5-carboxylic acid, 6-nitro-; (C-): Aristolochic acid C; Aristolochic acid IIIa;10-Hydroxy-6-nitrophenanthro(3,4-d)-1,3-dioxole-5-carboxylic acid; 10-Hydroxy-6-nitronaphtho(2,1-g)(1,3)benzodioxole-5-carboxylic acid; 6-Nitro-10-hydroxyphenanthro[3,4-*d*]-1,3-dioxole-5-carboxylic acid

CAS Registry Number: 313-67-7 (A-); (alt.) 61117-05-3 (A-); 475-80-9 (B-); 4849-90-5 (C-)

HSDB Number: 7179 (A-)

RTECS Number: CF3325000 (A-); SF8281600 (B-)

UN/NA & ERG Number: UN1544 (alkaloid, solid, n.o.s.)/151

EC Number: 206-238-3; 202-499-6

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Sufficient Evidence; Human Inadequate Evidence, *probably carcinogenic to humans*, Group 2A, 2002.

California Proposition 65 Chemical[102]: Cancer 7/9/2004

Hazard Alert: Poison, (A-) Possible risk of forming tumors, Suspected of causing genetic defects; (B-), Suspected reprotoxic hazard.

Hazard symbols, risk, & safety statements: Hazard symbol: T; risk phrases: R45; R22; R25; R34; R40; R51/53; R61; R62; safety phrases: S7; S22; S35; S36/37/39; S45; S53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [2-Hazard to waters (est.)]

Description: Shiny brown leaflets or a yellow or white powder. Molecular weight = 341.27 (A-); 311.26 (B-); 327.247 (C-); boiling point = 658°C; freezing/melting point = 260−265°C (A-); 287-292°C (C-); flash point = 352°C. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 0; reactivity 0. Low solubility in water.

Potential Exposure: Aristolochic acids are alkaloids used primarily as a chemical intermediate for pharmaceuticals, lab chemicals, herbal extract, drug.

Incompatibilities: Compounds of the carboxyl group react with all bases, both inorganic and organic (i.e., amines) releasing substantial heat, water and a salt that may be harmful. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air: No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Routes of Entry: Ingestion, inhalation, skin and eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Highly toxic, may be fatal if inhaled, swallowed or absorbed through skin. Avoid any skin contact. Effects of contact or inhalation may be delayed. LD_{50} = (oral-rat) <200 mg/kg. LD_{Lo} = (i.v.-man) 3 mg/kg (Bethesda)

Long-Term Exposure: May cause tumors and affect the unborn fetus. Pregnant women should avoid contact.

Points of Attack: Reproductive sysem.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Pregnant women should avoid contact. Employees should be notified by a physician that this chemical may affect the reproductive system. In addition to comprehensive initial medical and work histories emphasizing reproductive experience and menstrual history, patient should have physical examination and testing of genitourinary tract, sperm count, motility and morphology. If required, other tests, such as serum testosterone, serum FSH, and serum LH may be indicated.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method* if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed.

Personal Protective Methods: Wear chemical protective clothing that is specifically recommended by the manufacturer. It may provide little or no thermal protection. Structural firefighters' protective clothing provides limited protection in fire situations *only*; it is not effective in spill situations where direct contact with the substance is possible.

Respirator Selection: Wear positive-pressure SCBA (SCBA). *At any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, dry place or a refrigerator. Protect from exposure to light, and keep away from mineral acids and oxidizers.

Shipping: UN1544 Alkaloids, solid, n.o.s. or Alkaloid salts, solid, n.o.s. poisonous, Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. PG III.

Spill Handling: As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 m/150 ft for liquids and at least 25 m/75 ft for solids. Keep unauthorized personnel away. Stay upwind. Keep out of low areas. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Stop leak if you can do it without risk. Prevent entry into waterways, sewers, basements or confined areas. Cover with plastic sheet to prevent spreading. Absorb or cover with dry earth, sand or other noncombustible material and transfer to containers for disposal.

Fire Extinguishing: Noncombustible material. Thermal decomposition products in fire include toxic oxides of nitrogen and carbon. Containers may explode when heated.

Runoff may pollute waterways. If tank, rail car or tank truck is involved in a fire, isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. *Small Fire*: Use dry chemical, CO_2 or water spray. *Large Fire*: Water spray, fog or regular foam. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal; do not scatter the material. Use water spray or fog; do not use straight streams. *Fire involving Tanks or Car/Trailer Loads*: Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Do not get water inside containers. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. *Always* stay away from tanks engulfed in fire. For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn. *Do not* get water inside containers.

Disposal Method Suggested: It is inappropriate and possibly dangerous to the environment to dispose of expired or waste drugs and pharmaceuticals by flushing them down the toilet or discarding them to the trash. Household quantities of expired or waste pharmaceuticals may be mixed with wet cat litter or coffee grounds, double-bagged in plastic, discard in trash. Larger quantities shall carefully take into consideration applicable DEA, EPA, and FDA regulations. If possible return the pharmaceutical to the manufacturer for proper disposal being careful to properly label and securely package the material. Alternatively, the waste pharmaceutical shall be labeled, securely packaged and transported by a state licensed medical waste contractor to dispose by burial in a licensed hazardous or toxic waste landfill or incinerator. All federal, state, and local environmental regulations must be observed.

References

(102); (31); (173); (101); (138); (100).

Department of Health and Human Services (National Institute for Occupational Safety and Health), *NIOSH Pocket Guide to Chemical Hazards*. DHHS (NIOSH) Publication No. 2005-149, Cincinnati, OH (August, 2006).

Santa Cruz Biotechnology, Aristolochic acid, https://www.scbt.com/scbt/product/aristolochic-acid-313-67-7.

Arsenic (Inorganic Arsenic Compounds) A:1520

Formula: As

Synonyms: Accuspin ASX-10 Spin-On Dopant; Arsen (German); Arsenic-75; Arsenicals; Arsenic black; Arsenic, metallic; Arsenico (Spanish); Arsenic, solid; AS-120; AS-217; Butter of arsenic; Colloidal arsenic; Grey arsenic; Metallic arsenic; Realgar; Ruby arsenic *Note*: The above synonyms are for metallic arsenic. Other inorganic synonyms vary depending on the specific As compound. The term "inorganic arsenic" does not include arsine.

CAS Registry Number: 7440-38-2

HSDB Number: 509

RTECS Number: CG0525000

UN/NA & ERG Number: UN1558 (metal)/152; UN1562/152 (dust)

EC Number: 231-148-6 [*Annex I Index No*. 033-001-00-X]

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen: Arsenic and inorganic arsenic compounds; IARC: Human Sufficient Evidence, 1980; Animal Limited Evidence, *carcinogenic to humans*, Group 1, 1987; EPA: Human Carcinogen; OSHA: Carcinogen [CFR 1910.1018, inorganic compounds (except arsine)].

California Proposition 65 Chemical[102]: Cancer 2/27/1987.

Hazard Alert: Exposure can be lethal, Possible risk of forming tumors, Reproductive toxin: possible risk of gene damage/impaired fertility; Suspected reprotoxic hazard, Environmental hazard.

OSHA, 29CFR1910 Specifically Regulated Chemicals [See CFR1910.1018) Inorganic compounds (except arsine)]

Banned or Severely Restricted (In Agricultural, Pharmaceutical, and Industrial Chemicals) (many countries)[13,35]

Clean Air Act, 42USC7412; Title I, Part A, §112 Hazardous Pollutants

United States National Primary Drinking Water Regulations: zero.

Clean Water Act 40CFR401.15 Section 307, Toxic Pollutants; 40CFR423, Appendix A Priority Pollutants; §313 Priority Chemicals

RCRA 40CFR261.24 Toxicity Characteristics, Maximum Concentration of Contaminants (MCC), Regulatory level, 5.0 mg/L

RCRA "D Series Waste" Number, D004, Chronic Toxicity Reference Level, 0.05 mg/L

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 1.4; Nonwastewater (mg/L), 5.0 TCLP

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List Suggested Methods (PQL μg/L):, total dust 6010 (500), 7060 (10), 7061 (20)

United States National Primary Drinking Water Regulations: MCLG = 0 mg[As]/L; MCL = 0.010 mg[As]/L as Arsenic.

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg), no reporting required, if diameter of metal is equal to or exceeds 0.004 in

EPCRA Section 313: Form R *de minimis* concentration reporting level: 0.1% (inorganic arsenic compounds)

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Canada: Priority Substance List & Restricted Substances/ Ocean Dumping FORBIDDEN (CEPA), NPRI (arsenic compounds).

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T + , N; risk phrases: R45; R23/25; R53; R61; R62; R63; safety phrases: S1/2; S20/21; S28; S29; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Elemental arsenic, as, occurs to a limited extent in nature as a steel-gray, amorphous metalloid. Molecular weight = 74.9216; boiling point = 613°C (sublimes); freezing/melting point = 814°C @ 36 atm; 817°C @ 28 atm; critical temperature = 803°C; critical pressure = 34.6 MN/m^2; specific gravity (H_2O:1) = 5.727 @ 25°C. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 1; reactivity 0; (*arsenic compounds*) Health 4; flammability 0; reactivity 0. Insoluble in water. Arsenic in this entry includes the element and any of its inorganic compounds *excluding* arsine. Arsenic trioxide (As_2O_3), the principal form in which the element is used, is frequently designated as arsenic, white arsenic, or arsenous oxide. Arsenic is present as an impurity in many other metal ores and is generally produced as arsenic trioxide as a by-product in the smelting of these ores, particularly copper. Most other arsenic compounds are produced from the trioxide.

Potential Exposure: Arsenic compounds have a variety of uses. Arsenic and its compounds are used as an alloy additive, in electronic devices; in veterinary medicines; in agriculture as insecticides, herbicides, larvicides, and pesticides. Some arsenic compounds are used in pigment production; the manufacture of glass as a bronzing or decolorizing agent; the manufacture of opal glass and enamels, textile printing; tanning, taxidermy, antifouling paints; to control sludge formation in lubricating oils. Metallic arsenic is used as an alloying agent for heavy metals; and in solders, medicines, herbicides. EPA has estimated that more than 6 million people living within 12 mi of major sources of copper, zinc, and lead smelters-may be exposed to 10 times the average United States atmospheric levels of arsenic. The agency says that 40,000 people living near some copper smelters may be exposed to 100 times the national atmospheric average.

Incompatibilities: Incompatible with strong acids; strong oxidizers; peroxides, bromine azide, bromine pentafluoride, bromine trifluoride; cesium acetylene carbide, chromium trioxide; nitrogen trichloride, silver nitrate. Can react vigorously with strong oxidizers (chlorine, dichromate, permanganate). Forms highly toxic fumes on contact with acids or active metals (iron, aluminum, zinc). Hydrogen gas can react with inorganic arsenic to form highly toxic arsine gas.

Permissible Exposure Limits in Air

NIOSH IDLH = 5 mg[As]/m^3

Arsenic and inorganic compounds

OSHA PEL: 0.01 mg[As]/m^3 TWA; Cancer hazard that can be inhaled.

NIOSH REL: 0.002 mg[As]/m^3 15 min. Ceiling Concentration. Limit exposure to lowest feasible level

Arsenic, organic compounds

OSHA PEL: 0.5 mg[As]/m^3 TWA

Arsenic, inorganic, and organic compounds

ACGIH TLV[1]: 0.01 mg[As]/m^3 TWA; Confirmed Human Carcinogen; BEI established.

PAC Ver. 29[138]

PAC-1: 1.5 milligram per cubic meter

PAC-2: 17 milligram per cubic meter

PAC-3: 100 milligram per cubic meter

DFG MAK: Carcinogen Category 1; Germ Cell Mutagen Group 3A (2004); BAT: 50 μg[As]/L in urine/end of exposure or end-of-shift; for long-term exposures; after several shifts.

Arab Republic of Egypt: TWA 0.2 milligram per cubic meter, 1993; Australia: TWA 0.05 milligram per cubic meter, carcinogen, 1993; Belgium: TWA 0.2 milligram per cubic meter, 1993; Denmark: TWA 0.05 milligram per cubic meter, 1999; Finland: carcinogen, 1993; France: VME 0.2 milligram per cubic meter, 1993; Hungary: STEL 0.5 milligram per cubic meter, carcinogen, 1993; India: TWA 0.2 milligram per cubic meter, 1993; Norway: TWA 0.02 milligram per cubic meter, 1999; the Philippines: TWA 0.5 milligram per cubic meter, 1993; Poland: MAC (TWA) 0.01 milligram per cubic meter, 1999; Sweden: NGV 0.03 milligram per cubic meter, carcinogen, 1999; Switzerland: TWA 0.1 milligram per cubic meter, carcinogen, 1999; Thailand: TWA 0.5 milligram per cubic meter, 1993; Turkey: TWA 0.5 mg(As)/m^3, 1993; Turkey: TWA 0.5 milligram per cubic meter, 1993; United Kingdom: TWA 0.1 milligram per cubic meter, carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH: TLV: Confirmed Human Carcinogen. Russia[43] set a MAC of 0.003 milligram per cubic meter on an average daily basis for residential areas. Several states have set guidelines or standards for arsenic in ambient air[60]: 0.06 milligram per cubic meter (California Prop. 65), 0.0002 μ/m^3 (Rhode Island), 0.00023 μ/m^3 (North Carolina), 0.024 μ/m^3 (Pennsylvania), 0.05 μ/m^3 (Connecticut), 0.07−0.39 μ/m^3 (Montana), 0.67 μ/m^3 (New York), 1.0 μ/m^3 (South Carolina), 2.0 μ/m^3 (North Dakota), 3.3 μ/m^3 (Virginia), 5 μ/m^3 (Nevada).

Determination in Air: NIOSH Analytical Methods (inorganic arsenic): #7300, #7301,#7303, #7900, #9102; OSHA Analytical Methods ID-105. The American Conference of Government Industrial Hygienists (ACGIH) Method 803 measures total particulate arsenic in air.

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 10 μg[As]/L; State Drinking Water Guidelines: Arizona 10 μg[As]/L; Connecticut 10 μg[As]/L

EPA Maximum Contaminant Level (MCL): 0.010 mg[As]/L[40 CFR 141.62]. Canadian Drinking Water Standards: IMAC 0.025 [As] mg/L.

Determination in Water: *For arsenic*: The atomic absorption graphite furnace technique is often used for measurement of total arsenic in water. It also has been standardized by EPA. Total arsenic may be determined by digestion followed by silver diethyldithiocarbamate; an alternative is atomic absorption; another is ICP optical emission spectrometry. See OSHA Method #ID-105 for arsenic[58].

Determination in Water: See OSHA Analytical Method ID-105 for arsenic. The atomic absorption graphite furnace technique is often used for measurement of total arsenic in water. It also has been standardized by EPA. Total arsenic may be determined by digestion followed by silver diethyldithiocarbamate; an alternative is atomic absorption; another is ICP optical emission spectrometry.

Routes of Entry: Inhalation, through the skin, and ingestion of dust and fumes.

Harmful Effects and Symptoms

Local: Trivalent arsenic compounds are corrosive to the skin. Brief contact has no effect, but prolonged contact results in a local hyperemia and later vesicular or pustular eruption. The moist mucous membranes are most sensitive to the irritant action. Conjunctiva, moist and macerated areas of the skin, eyelids, the angles of the ears, nose, mouth, and respiratory mucosa are also vulnerable to the irritant effects. The wrists are common sites of dermatitis, as are the genitalia if personal hygiene is poor. Perforations of the nasal septum may occur. Arsenic trioxide and pentoxide are capable of producing skin sensitization and contact dermatitis. Arsenic is also capable of producing keratoses, especially of the palms and soles. Arsenic has been cited as a cause of skin cancer, but the incidence is low. *Systemic*: The acute toxic effects of arsenic are generally seen following ingestion of inorganic arsenical compounds. This rarely occurs in an industrial setting. Symptoms develop within 1/2 to 4 hours following ingestion and are usually characterized by constriction of the throat followed by dysphagia, epigastric pain, vomiting, and watery diarrhea. Blood may appear in vomitus and stools. If the amount ingested is sufficiently high, shock may develop due to severe fluid loss, and death may ensue in 24 hours. If the acute effects are survived, exfoliative dermatitis and peripheral neuritis may develop. Cases of acute arsenical poisoning due to inhalation are exceedingly rare in industry. When it does occur, respiratory tract symptoms—cough, chest pain; dyspnea-giddiness, headache, and extreme general weakness precede GI symptoms. The acute toxic symptoms of trivalent arsenical poisoning are due to severe inflammation of the mucous membranes and greatly increased permeability of the blood capillaries. Chronic arsenical poisoning due to ingestion is rare and generally confined to patients taking prescribed medications. However, it can be a concomitant of inhaled inorganic arsenic from swallowed sputum and improper eating habits. Symptoms are weight loss; nausea and diarrhea alternating with constipation, pigmentation and eruption of the skin, loss of hair, and peripheral neuritis. Chronic hepatitis and cirrhosis have been described. Polyneuritis may be the salient feature, but more frequently there are numbness and paresthesias of "glove and sticking" distribution. The skin lesions are usually melanotic and keratotic and may occasionally take the form of an intradermal cancer of the squamous cell type, but without infiltrative properties. Horizontal white lines (striations) on the fingernails and toenails are commonly seen in chronic arsenical poisoning and are considered to be a diagnostic accompaniment of arsenical polyneuritis. Inhalation of inorganic arsenic compounds is the most common cause of chronic poisoning in the industrial situation. This condition is divided into three phases based on signs and symptoms. *First Phase*: The worker complains of weakness, loss of appetite; some nausea, occasional vomiting, a sense of heaviness in the stomach, and some diarrhea. *Second Phase*: The worker complains of conjunctivitis, and a catarrhal state of the mucous membranes of the nose, larynx, and respiratory passages. Coryza, hoarseness, and mild tracheobronchitis may occur. Perforation of the nasal septum is common, and is probably the most typical lesion of the upper respiratory tract in occupational exposure to arsenical dust. Skin lesions, eczematoid and allergic in type, are common. *Third Phase*: The worker complains of symptoms of peripheral neuritis, initially of hands and feet, which is essentially sensory. In more severe cases, motor paralyses occur; the first muscles affected are usually the toe extensors and the peronei. In only the most severe cases will paralysis of flexor muscles of the feet or of the extensor muscles of hands occur. Liver damage from chronic arsenical poisoning is still debated, and as yet the question is unanswered. In cases of chronic and acute arsenical poisoning, toxic effects to the myocardium have been reported based on EKG changes. These finding, however, are now largely discounted and the EKG changes are ascribed to electrolyte disturbances concomitant with arsenicalism. Inhalation of arsenic trioxide and other inorganic arsenical dusts does not give rise to radiological evidence of pneumoconiosis. Arsenic does have a depressant effect upon the bone marrow, with disturbances of both erythropoiesis and myelopoiesis. Evidence is now available incriminating arsenic compounds as a cause of lung cancer as well as skin cancer. Skin cancer in humans is causally associated with exposure to inorganic arsenic compounds in drugs, drinking water and the occupational environment. The risk of lung cancer was increased 4—12 times in certain smelter workers who inhaled high levels of arsenic trioxide. However, the influence of other constituents of the working environment cannot be excluded in these studies. Case reports have suggested an association between exposure to arsenic compounds and blood dyscrasias and liver tumors.

Short-Term Exposure: Skin contact can cause irritation, itching, burning sensation; and rash. Eye contact can cause irritation and burns. Inhalation can cause irritation of the respiratory tract. High exposure can cause poor appetite; nausea, vomiting and muscle cramps. High exposure can cause nerve damage with numbness, "pins and needles" sensation; weakness of the arms and legs.

Long-Term Exposure: Arsenic can cause skin damage or problems with circulatory systems, and may have increased risk of cancer. Arsenic is a carcinogen; causes skin, lung, and lymphatic cancer, possible reproductive hazard (a teratogen in animals). Can cause an ulcer of the "bone" dividing the inner nose. It can cause hoarseness, sore eyes, nerve damage; thickening of the skin with patch areas of darkening and loss of pigment; liver damage and stomach problems. Small doses can accumulate in the body. Causes acute and chronic toxicity, liver and kidney damage; decreases blood hemoglobin. A carcinogen[182].

Points of Attack: Liver, kidneys, skin, lungs, lymphatic system.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Before first exposure and every 6–12 months thereafter, OSHA 1910.1018 requires employers to provide (for persons exposed to 0.005 milligram per cubic meter of arsenic); a medical history and exam which shall include: chest X-ray, exam of the nose, skin, and nails, sputum cytology examination, test for urine arsenic (may not be accurate within 2 days of eating shellfish or fish; most accurate at the end of a work-day. Levels should not be greater than 100 μg/g creatinine in the urine. Exam of the nervous system. After suspected overexposure, repeat these tests and consider CBC and liver function tests. Also examine skin periodically for abnormal growths. Skin cancer from arsenic can easily be cured when detected early. Employees have a legal right to testing information under OSHA 1910.20.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: For severe poisoning BAL (British Anti-Lewisite), Dimercaprol, dithiopropanol ($C_3H_8OS_2$) has been used to treat toxic symptoms of certain heavy metals poisoning—including arsenic. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5). Oral *penicillamine (not penicillin)* has been used as a follow up treatment; or, used instead of BAL for milder poisoning, with mixed success. Side effects may occur with such treatment and it is never a substitute for controlling exposure. Treatment can only be done under strict medical care.

Personal Protective Methods: Workers should be trained in personal hygiene and sanitation, the use of PPE, and early recognition of symptoms of absorption, skin contact irritation, and sensitivity. With the exception of arsine and arsenic trichloride, the compounds of arsenic do not have odor or warning qualities. Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Wear dust-proof chemical goggles and face shield when working with powder or dust, unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Specific engineering controls are required under OSHA 1910.1018, *Inorganic Arsenic*. See also NIOSH Criteria Document #75-149, "*Inorganic Arsenic*."

Respirator Selection:

Requirements for Respiratory Protection for Inorganic Arsenic Particulate Except for Those With Significant Vapor Pressure: $<$ or $= 100\ \mu g/m^3$ (micrograms per cubic meter) (1) Half-mask air-purifying respirator equipped with high-efficiency filter*; or (2) Any half-mask supplied air respirator. $<$ or $= 500\ \mu g/m^3$ (1) Full facepiece air-purifying respirator equipped with high-efficiency filter*; (2) Any full-facepiece supplied-air respirator; or (3) Any full-facepiece SCBA. $<$ or $= 10{,}000\ \mu g/m^3$ (1) Powered air-purifying respirators in all inlet face coverings with high-efficiency filters*; or (2) Half-mask supplied-air respirators operated in positive-pressure mode. $<$ or $= 20{,}000\ \mu g/m^3$ Supplied-air respirator with full facepiece, hood, or helmet or suit, operated in positive-pressure mode. $> 20{,}000\ \mu g/m^3$, unknown concentrations, or firefighting any full-facepiece SCBA operated in positive-pressure mode.

*A high-efficiency filter means a filter that is at least 99.97% efficient against mono-dispersed particles of 0.3 μm (micrometers) in diameter or higher.

Requirements for Respiratory Protection for Inorganic Arsenicals*With Significant Vapor Pressure*

$<$ or $= 100\ \mu g/m^3$ (micrograms per cubic meter) (1) Half-mask* air-purifying respirator equipped with high-efficiency filter** and acid gas cartridge; or (2) any half-mask* supplied-air respirator. $<$ or $= 500\ \mu g/m^3$ (1) Front- or back-mounted gas mask equipped with high-efficiency filter** and acid gas canister; (2) any full-facepiece supplied-air respirator; or (3) any full-facepiece SCBA. < or = 10,000 μg/m^3 half-mask* supplied-air respirator operated in positive-pressure mode. < or = 20,000 μg/m^3 supplied-air respirator with full facepiece, hood, or helmet or suit, operated in positive-pressure mode. >20,000 μg/m^3, unknown concentrations, or firefighting: Any full-facepiece SCBA operated in positive-pressure mode. * Half-mask respirators shall not be used for protection against arsenic trichloride, as it is rapidly absorbed through the skin. ** A high-efficiency filter means a filter that is at least 99.97% efficient against mono-dispersed particles of 0.3 μm (micrometers) in diameter or higher. *Note*: Workers should be permitted to leave the work area every 2 hours to wash their faces and obtain clean respirators.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Arsenic must be stored in a cool, dry place away from oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates) and strong acids (such as hydrochloric, sulfuric, and nitric); since violent reactions occur. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN1558 Arsenic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Stay upwind; keep out of low areas. Wear self-contained (positive pressure if available) breathing apparatus and full protective clothing. Do not touch spilled material; stop leak if you can do it without risk. *Small liquid spills*: take up with sand or other noncombustible absorbent material into clean, dry container and cover; move containers from spill area. *Large spills*: dike far ahead of spill for later disposal. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. *Note*: see Initial isolation and protective action distances for organoarsenic compound, solid or liquid (e.g., UN3280).

Fire Extinguishing: Arsenic metal is noncombustible; however, arsenic dust can be flammable when exposed to heat or flame. Thermal decomposition products may include arsine and oxides of metal. Use dry chemical, CO_2, water spray; or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Elemental arsenic wastes should be placed in long-term storage or returned to suppliers or manufacturers for reprocessing. Arsenic pentaselenide-wastes should be placed in long-term storage or returned to suppliers or manufacturers for reprocessing. Arsenic trichloride: hydrolyze to arsenic trioxide utilizing scrubbers for hydrogen chloride abatement. The trioxide may then be placed in long-term storage. Arsenic trioxide: long-term storage in large shiftproof and weatherproof silos. This compound may also be dissolved, precipitated as the sulfide and returned to the suppliers. Arsenic-containing sewage may be decontaminated by pyrolusite treatment[22]. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(109); (102); (31); (173); (101); (138); (100).

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New York State Department of Health, Chemical Fact Sheet: Arsenic, Bureau of Toxic Substance Assessment, Albany, NY (May 1986).

United States Public Health Service, "Toxicological Profile for Arsenic," Atlanta, GA, agency for Toxic Substances and Disease Registry (November 1987).

United States Department of the Interior, United States Geological Survey, USGS *Contaminants Found in Groundwater*, http://water.usgs.gov/edu/groundwater-contaminants.html.

Arsenic Acid A:1530

Formula: AsH_3O_4 (*ortho*-); AsHO3 (*meta*-)
Synonyms: Acido arsenico (Spanish); Arsenate; *o*-Arsenic acid; Arsenic pentoxide; Orthoarsenic acid (*o*-isomer); Scorch; Zotox
CAS Registry Number: 7778-39-4 (*ortho*-); 1327-52-2; (These two CAS number are specifically regulated by the United States Environmental Protection Agency, United States DOT, New Jersey, California, and others); 10102-53-1 (*meta*-)
HSDB Number: 431
RTECS Number: CG0700000
UN/NA & ERG Number: UN1554 (solid)/154; UN1553 (liquid)/154
EC Number: 231-901-9 (*ortho*-)
Regulatory Authority and Advisory Information
Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen: Arsenic and inorganic arsenic compounds; IARC: Human Sufficient Evidence, 1980; Animal Limited Evidence, *carcinogenic to humans*, Group 1, 1987
California Proposition 65 Chemical[102]: Cancer 2/27/1987
Hazard Alert: Poison, Oxidizer (weak), Environmental hazard.
OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR1910.1018, inorganic compounds)
Banned or Severely Restricted (In Agricultural, Pharmaceutical and Industrial Chemicals) (many countries)[13,35]
Clean Air Act, 42USC7412; Title I, Part A, §112 Hazardous Pollutants
United States National Primary Drinking Water Regulations: MCLG = 0 mg[As]/L; MCL = 0.010 mg[As]/L as Arsenic.
Clean Water Act 40CFR401.15 Section 307 Toxic Pollutants; 40CFR423, Appendix A Priority Pollutants; §313 Priority Chemicals
RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number P010
Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg)
EPCRA Section 313: Form R *de minimis* concentration reporting level: 0.1% (inorganic arsenic compounds)
United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as orthoarsenic acid
Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%. as arsenic acid [CAS 7778-39-4]
Canada: Priority Substance List & Restricted Substances/Ocean Dumping FORBIDDEN (CEPA), NPRI (arsenic compounds).
Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.
Hazard symbols, risk, & safety statements: Hazard symbol: T+, N, O (liquid); risk phrases: R45; R8; R17; R23/25; R28; R40; R53; safety phrases: S1/2; S17; S25; S29; S36/37; S45, S60, S61 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.
Description: Arsenic acid is an odorless, noncombustible, white semitransparent crystalline material or in a commercial grade that is a pale yellow syrup-like liquid. Molecular weight = 141.95; specific gravity (H_2O:1) = 2.2 @ 20°C; boiling point = (loses water) 160°C; melting/freezing point = 36°C. Hazard identification (based on NFPA-704 M Rating System): Health 4; flammability 0; reactivity 0. It converts to As_2O_5 (arsenic pentoxide) when heated above 300°C. See also arsenic pentoxide.
Potential Exposure: It is used as a wood treatment, drying agent, soil sterilant and to make other arsenates. It has been used as a cotton defoliant.
Incompatibilities: Incompatible with sulfuric acid, caustics, ammonia, amines, isocyanates, alkylene oxides; oxidizers, epichlorohydrin, vinyl acetate; amides. Avoid contact with chemically active metals. Corrodes brass, mild steel and galvanized steel. Contact with acids or acid mists releases deadly arsine gas. The solution is weakly acidic and a weak oxidizing agent. Reacts with alkalis to generate some heat and precipitate arsenates[101].
Permissible Exposure Limits in Air
NIOSH IDLH = 5 mg[As]/m^3
arsenic, and inorganic compounds
OSHA PEL: 0.01 mg[As]/m^3 TWA; Cancer hazard that can be inhaled.

NIOSH REL: 0.002 mg[As]/m^3 15 min. Ceiling Concentration. Limit exposure to lowest feasible level
ACGIH TLV[1]: 0.01 mg[As]/m^3 TWA; Confirmed Human Carcinogen; BEI established.
7778-39-4
PAC Ver. 29[138]
PAC-1: 2.9 milligram per cubic meter
PAC-2: 32 milligram per cubic meter
PAC-3: 190 milligram per cubic meter
DFG MAK: Carcinogen Category 1; Germ Cell Mutagen Group 3A (2004); BAT: 50 μg[As]/L in urine/end of exposure or end-of-shift; for long-term exposures; after several shifts.

Arab Republic of Egypt: TWA 0.2 milligram per cubic meter, 1993; Australia: TWA 0.05 milligram per cubic meter, carcinogen, 1993; Belgium: TWA 0.2 milligram per cubic meter, 1993; Denmark: TWA 0.05 milligram per cubic meter, 1999; Finland: carcinogen, 1993; France: VME 0.2 milligram per cubic meter, 1993; Hungary: STEL 0.5 milligram per cubic meter, carcinogen, 1993; India: TWA 0.2 milligram per cubic meter, 1993; Norway: TWA 0.02 milligram per cubic meter, 1999; the Philippines: TWA 0.5 milligram per cubic meter, 1993; Poland: MAC (TWA) 0.01 milligram per cubic meter, 1999; Sweden: NGV 0.03 milligram per cubic meter, carcinogen, 1999; Switzerland: TWA 0.1 milligram per cubic meter, carcinogen, 1999; Thailand: TWA 0.5 milligram per cubic meter, 1993; Turkey: TWA 0.5 mg(As)/m^3, 1993; Turkey: TWA 0.5 milligram per cubic meter, 1993; United Kingdom: TWA 0.1 milligram per cubic meter, carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH: TLV: Confirmed Human Carcinogen. Russia[43] set a MAC of 0.003 milligram per cubic meter on an average daily basis for residential areas. Several states have set guidelines or standards for arsenic in ambient air[60]: 0.06 milligram per cubic meter (California Prop. 65), 0.0002 μ/m^3 (Rhode Island), 0.00023 μ/m^3 (North Carolina), 0.024 μ/m^3 (Pennsylvania), 0.05 μ/m^3 (Connecticut), 0.07−0.39 μ/m^3 (Montana), 0.67 μ/m^3 (New York), 1.0 μ/m^3 (South Carolina), 2.0 μ/m^3 (North Dakota), 3.3 μ/m^3 (Virginia), 5 μ/m^3 (Nevada).

Determination in Air: NIOSH Analytical Methods (inorganic arsenic): #7300, #7301,#7303, #7900, #9102; OSHA Analytical Methods ID-105. The American Conference of Government Industrial Hygienists (ACGIH) Method 803 measures total particulate arsenic in air.

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 10 μg[As]/L; State Drinking Water Guidelines: Arizona 10 μg[As]/L; Connecticut 10 μg[As]/L EPA Maximum Contaminant Level (MCL): 0.010 mg[As]/L[40 CFR 141.62]. Canadian Drinking Water Standards: IMAC 0.025 [As] mg/L.

Determination in Water: *For arsenic*: The atomic absorption graphite furnace technique is often used for measurement of total arsenic in water. It also has been standardized by EPA. Total arsenic may be determined by digestion followed by silver diethyldithiocarbamate; an alternative is atomic absorption; another is ICP optical emission spectrometry. See OSHA Method #ID-105 for arsenic[58]

Routes of Entry: Inhalation, ingestion, skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Skin contact can cause irritation, itching, burning sensation; and rash. Eye contact can cause irritation and burns. Inhalation can cause irritation of the respiratory tract. High exposure can cause poor appetite; nausea, vomiting and muscle cramps. High exposure can cause nerve damage with numbness, "pins and needles" sensation; weakness of the arms and legs. The oral LD_{50} for rat is 48 mg/kg[9]. Ingestion of 130 mg of arsenic may be fatal to humans. Smaller doses may become fatal since arsenic accumulates in the body.

Long-Term Exposure: Arsenic can cause skin damage or problems with circulatory systems, and may have increased risk of cancer. Arsenic acid is a mutagen that may cause changes to genetic material and an animal teratogen. Can cause an ulcer of the "bone" dividing the inner nose. It can cause disturbed sleep; thickening of the skin with patch areas of darkening and loss of pigment, or the development of white lines in the nails.

Points of Attack: Liver, kidneys, skin, lungs, nervous system; lymphatic system.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Examination of the nose, skin, eyes, nails, and nervous system. Test for urine arsenic. At NIOSH recommended exposure limits, urine arsenic should not be greater than 50−100 μg/L of urine. See also entry for "Arsenic."

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy. *Note to physician*: For severe poisoning BAL (British Anti-Lewisite), Dimercaprol, dithiopropanol ($C_3H_8OS_2$) has been used to treat toxic symptoms of certain heavy metals poisoning—including arsenic. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5). For milder poisoning *penicillamine (not penicillin)* has been used, both with mixed success. Side effects occur with such treatment and it is never a substitute for controlling exposure. It can only be done under strict medical care.

Personal Protective Methods: Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. If local exhaust ventilation or enclosure is not used, respirators should be worn. A regulated, marked area should be established where arsenic acid is handled, used, or stored. Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear full facepiece respiratory. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Specific engineering controls are required under OSHA 1910.1018, *Inorganic Arsenic*. See also NIOSH Criteria Document #75-149, "*Inorganic Arsenic*."

Respirator Selection: **Requirements for Respiratory Protection for Inorganic Arsenic Particulate** ***Except for Those With Significant Vapor Pressure:*** $<$ or $= 100\ \mu g/m^3$ (micrograms per cubic meter) (1) Half-mask air-purifying respirator equipped with high-efficiency filter*; or (2) any half-mask supplied air respirator. $<$ or $= 500\ \mu g/m^3$ (1) Full facepiece air-purifying respirator equipped with high-efficiency filter*; (2) Any full-facepiece supplied-air respirator; or (3) Any full-facepiece SCBA. $<$ or $= 10{,}000\ \mu g/m^3$ (1) Powered air-purifying respirators in all inlet face coverings with high-efficiency filters*; or (2) Half-mask supplied-air respirators operated in positive-pressure mode. $<$ or $= 20{,}000\ \mu g/m^3$ supplied-air respirator with full facepiece, hood, or helmet or suit, operated in positive-pressure mode. $>20{,}000\ \mu g/m^3$, unknown concentrations, or firefighting any full-facepiece SCBA operated in positive-pressure mode.

* A high-efficiency filter means a filter that is at least 99.97% efficient against mono-dispersed particles of 0.3 μm (micrometers) in diameter or higher.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Arsenic acid must be stored to avoid contact with heat and chemically active metals (such as potassium, sodium, magnesium and zinc), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN1554 (solid) or UN1553 (liquid) Arsenic acid, liquid or solid, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Neutralize spilled material with crushed limestone, soda ash or lime. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area and wash spill site after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Arsenic acid itself does not burn. Thermal decomposition products may include arsine and oxides of arsenic. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve in a minimum of concentrated hydrochloric acid. Dilute with water until white precipitate forms. Add HCl to dissolve. Saturate with H_2S; filter and wash precipitate and return to supplier. Alternatively, precipitate with heavy metals, such as lime or ferric hydroxide in lieu of H_2S[22]. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥ 100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(109); (102); (31); (173); (101); (138); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 2, No. 3, 56–59 (1982).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Arsenic acid, Trenton, NJ (April 1996).

Arsenic Pentoxide A:1540

Formula: As_2O_5
Synonyms: Anhydride arsenique (French); Arsenic acid anhydride; Arsenic anhydride; Arsenic oxide; Arsenic(V) oxide; Arsenic pentaoxide; Diarsenic pentoxide; Fotox; Peroxido de arsenico (Spanish)
CAS Registry Number: 1303-28-2; (*alt.*) 12044-50-7
HSDB Number: 429
RTECS Number: CG2275000
UN/NA & ERG Number: UN1559/151
EC Number: 215-116-9 [*Annex I Index No.* 033-004-00-6]
Regulatory Authority and Advisory Information
Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen: Arsenic and inorganic arsenic compounds; IARC: Human Sufficient Evidence, 1980; Animal Limited Evidence, *carcinogenic to humans*, Group 1, 1987. United States Environmental Protection Agency Gene-Tox Program, Positive: B *subtilis* rec assay.
California Proposition 65 Chemical[102]: Cancer 2/27/1987 (inorganic arsenic compounds); developmental 5/1/1997 (arsenic inorganic oxides).
Hazard Alert: Exposure can be lethal, Oxidizer, Systemic agent, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Environmental hazard.
OSHA, 29CFR1910 Specifically Regulated Chemicals [See CFR1910.1018, inorganic compounds)
United States Environmental Protection Agency, FIFRA 1998 Status of Pesticides: Supported
Banned or Severely Restricted (In Agricultural, Pharmaceutical and Industrial Chemicals) (many countries)[13,35]
Clean Air Act, 42USC7412; Title I, Part A, §112 Hazardous Pollutants
United States National Primary Drinking Water Regulations: MCLG = 0 mg[As]/L; MCL = 0.010 mg[As]/L as Arsenic.
Clean Water Act 40CFR401.15 Section 307, Toxic Pollutants; 40CFR423, Appendix A Priority Pollutants; §313 Priority Chemicals
RCRA 40CFR261.24 Toxicity Characteristics, Maximum Concentration of Contaminants (MCC), Regulatory level, 5.0 mg/L
RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number P011
CERCLA/SARA 40CFR302 Extremely Hazardous Substances: TPQ = 100/10,000 lb (454/4540 kg)
Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg)
EPCRA Section 313: Form R *de minimis* concentration reporting level: 0.1% (inorganic arsenic compounds)
United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)
Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.
Canada: Priority Substance List & Restricted Substances/Ocean Dumping FORBIDDEN (CEPA), NPRI (arsenic compounds).
Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.
Hazard symbols, risk, & safety statements: Hazard symbol: T + , O, N; risk phrases: R45; R8; R23/25; R50/53; R61; R62; R63; safety phrases: S17; S29/35; S53; S41; S45; S60; S61 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.
Description: Arsenic pentoxide is an odorless white lumpy solid or powder and nonflammable. It may be shipped as a concentrated water solution. Molecular weight = 229.84; specific gravity (H_2O:1) = 4.32 @ 25°C; 5.73[77]; boiling point = 499.8°C; freezing/melting point = (decomposes) 315°C. Hazard identification (based on NFPA-704 M Rating System): Health 4; flammability 0; reactivity 0. Highly soluble in water; solubility = 66 gm/100 mL.
Potential Exposure: Arsenic pentoxide is used in production of metal arsenates; as an herbicide, defoliant on cotton; as a chemical intermediate; as an ingredient in wood preservatives; and in glass. Other possible uses are as an insecticide and soil sterilant.
Incompatibilities: Decomposes above 315°C, forming oxygen and arsenic trioxide fumes. Arsenic pentoxide is an oxidizer; reacts violently with bromine pentafluoride and reducing agents. The solution in water is a weak acid. Incompatible with acids, strong alkalis; halogens, rubidium carbide, zinc. Corrosive to metals in the presence of moisture. Contact with acids or acid mists releases deadly arsine gas.
Permissible Exposure Limits in Air
NIOSH IDLH = 5 mg[As]/m^3
Arsenic and inorganic compounds
OSHA PEL: 0.01 mg[As]/m^3 TWA; Cancer hazard that can be inhaled.
NIOSH REL: 0.002 mg[As]/m^3 15 min. Ceiling Concentration. Limit exposure to lowest feasible level
ACGIH TLV[1]: 0.01 mg[As]/m^3 TWA; Confirmed Human Carcinogen; BEI established.
PAC Ver. 29[138]
PAC-1: 0.73 milligram per cubic meter
PAC-2: 8 milligram per cubic meter
PAC-3: 150 milligram per cubic meter
DFG TRK: DFG TRK: 0.10 mg[As]/m^3; BAT: 1.30 μg [As]/L in urine/end-of-shift; Carcinogen Category 1
Arab Republic of Egypt: TWA 0.2 milligram per cubic meter, 1993; Australia: TWA 0.05 milligram per cubic meter, carcinogen, 1993; Belgium: TWA 0.2 milligram per cubic meter, 1993; Denmark: TWA 0.05 milligram per cubic meter, 1999; Finland: carcinogen, 1993; France: VME 0.2 milligram per cubic meter, 1993; Hungary: STEL 0.5 milligram per cubic meter, carcinogen, 1993; India:

TWA 0.2 milligram per cubic meter, 1993; Norway: TWA 0.02 milligram per cubic meter, 1999; the Philippines: TWA 0.5 milligram per cubic meter, 1993; Poland: MAC (TWA) 0.01 milligram per cubic meter, 1999; Sweden: NGV 0.03 milligram per cubic meter, carcinogen, 1999; Switzerland: TWA 0.1 milligram per cubic meter, carcinogen, 1999; Thailand: TWA 0.5 milligram per cubic meter, 1993; Turkey: TWA 0.5 mg(As)/m^3, 1993; Turkey: TWA 0.5 milligram per cubic meter, 1993; United Kingdom: TWA 0.1 milligram per cubic meter, carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH: TLV: Confirmed Human Carcinogen. Russia[43] set a MAC of 0.003 milligram per cubic meter on an average daily basis for residential areas. Several states have set guidelines or standards for arsenic in ambient air[60]: 0.06 milligram per cubic meter (California Prop. 65), 0.0002 μ/m^3 (Rhode Island), 0.00023 μ/m^3 (North Carolina), 0.024 μ/m^3 (Pennsylvania), 0.05 μ/m^3 (Connecticut), 0.07–0.39 μ/m^3 (Montana), 0.67 μ/m^3 (New York), 1.0 μ/m^3 (South Carolina), 2.0 μ/m^3 (North Dakota), 3.3 μ/m^3 (Virginia), 5 μ/m^3 (Nevada).

Determination in Air: NIOSH Analytical Methods (inorganic arsenic): #7300, #7301,#7303, #7900, #9102; OSHA Analytical Methods ID-105. The American Conference of Government Industrial Hygienists (ACGIH) Method 803 measures total particulate arsenic in air.

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 10 μg[As]/L; State Drinking Water Guidelines: Arizona 10 μg[As]/L; Connecticut 10 μg[As]/L EPA Maximum Contaminant Level (MCL): 0.010 mg[As]/L[40 CFR 141.62]. Canadian Drinking Water Standards: IMAC 0.025 [As] mg/L.

Determination in Water: *For arsenic*: The atomic absorption graphite furnace technique is often used for measurement of total arsenic in water. It also has been standardized by EPA. Total arsenic may be determined by digestion followed by silver diethyldithiocarbamate; an alternative is atomic absorption; another is ICP optical emission spectrometry. See OSHA Method #ID-105 for arsenic[58]. Octanol–water coefficient: Log K_{ow} = (estimated) <0.7. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion, skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: It is irritating to eyes, nose, and respiratory system. This chemical can be absorbed through the skin, thereby increasing exposure. Skin contact can cause irritation, burning, itching, and a rash. Symptoms usually appear ½ to 1 hour after ingestion, but may be delayed. Symptoms include a sweetish, metallic taste and garlicky odor of breath; difficulty in swallowing; abdominal pain; vomiting and diarrhea; dehydration; feeble heart beat; dizziness and headache; and eventually coma, sometimes convulsions, general paralysis, and death. The oral LD$_{50}$ for rat is 8 mg/kg[9]. This material is extremely toxic; the probable oral lethal dose for humans is 5–50 mg/kg, or between 7 drops and 1 teaspoonful for a 150-lb person.

Long-Term Exposure: Arsenic can cause skin damage or problems with circulatory systems, and may have increased risk of cancer. Arsenic pentoxide is a carcinogen in humans. It has been shown to cause skin cancer. May damage the male reproductive glands. Chronic exposure may cause nerve damage to the extremities, alter cellular composition of the blood, and cause structural changes in blood components. Repeated exposure can cause an ulcer in the "bone" dividing the inner nose. Long-term skin contact can cause thickened skin and pigmentation changes. Some persons develop white lines in the finger nails.

Points of Attack: Liver, kidneys, skin, respiratory system; lymphatic system. Reproductive system.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Before first exposure and every 6–12 months thereafter, a medical history and exam are recommended, including: exam of the nose, skin eyes, nails and nervous system. Test for urine arsenic (may not be accurate within 2 days of eating shellfish or fish; most accurate at the end of a work-day). Levels should not be greater than 100 μg/ g of creatinine in the urine. Examine the skin for abnormal growths. Liver and kidney function tests. Pregnant women should avoid contact. Employees should be notified by a physician that this chemical may affect the reproductive system. In addition to comprehensive initial medical and work histories emphasizing reproductive experience and menstrual history, patient should have physical examination and testing of genito-urinary tract, sperm count, motility and morphology. If required, other tests, such as serum testosterone, serum FSH, and serum LH may be indicated.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: For severe poisoning BAL (British Anti-Lewisite), Dimercaprol, dithiopropanol ($C_3H_8OS_2$) has been used to treat toxic symptoms of certain heavy metals poisoning—including arsenic. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage.

Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5). For milder poisoning *penicillamine (not penicillin)* has been used, both with mixed success. Side effects occur with such treatment and it is never a substitute for controlling exposure. It can only be done under strict medical care.

Personal Protective Methods:

General information: First responders should use a NIOSH-certified CBRN SCBA with a level a protective suit when entering an area with an unknown contaminant or when entering an area where the concentration of the contaminant is unknown. Level a protection should be used until monitoring results confirm the contaminant and the concentration of the contaminant. *Note*: safe use of protective clothing and equipment requires specific skills developed through training and experience.

LEVEL A: (*RED ZONE)*: select when the greatest level of skin, respiratory, and eye protection is required. This is the maximum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than the AEGL-2. A NIOSH-certified CBRN full-face-piece SCBA operated in a pressure-demand mode or a pressure-demand supplied air-hose respirator with an auxiliary escape bottle. A TECP suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, and a hard hat worn under the TECP suit are optional items.

LEVEL B: (RED ZONE): Select when the highest level of respiratory protection is necessary but a lesser level of skin protection is required. This is the minimum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than AEGL-2. It differs from Level A in that it incorporates a nonencapsulating, splash-protective, chemical-resistant splash suit that provides Level A protection against liquids but is not airtight. A NIOSH-certified CBRN full-face-piece SCBA operated in a pressure-demand mode or a pressure-demand supplied air-hose respirator with an auxiliary escape bottle. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL C: (YELLOW ZONE): Select when the contaminant and concentration of the contaminant are known and the respiratory protection criteria factors for using APR or PAPR are met. This level is appropriate when decontaminating patient/victims. A NIOSH-certified CBRN tight-fitting APR with a canister-type gas mask or CBRN PAPR for air levels greater than AEGL-2. A NIOSH-certified CBRN PAPR with a loose-fitting face-piece, hood, or helmet and a filter or a combination organic vapor, acid gas, and particulate cartridge/filter combination or a continuous flow respirator for air levels greater than AEGL-1. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Escape mask, face shield, coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL D: (GREEN ZONE): Select when the contaminant and concentration of the contaminant are known and the concentration is below the appropriate occupational exposure limit or less than AEGL-1 for the stated duration times. Limited to coveralls or other work clothes, boots, and gloves.

Notes: Take all necessary precautions to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Eye protection is included in the recommended respiratory protection. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Specific engineering controls are required under OSHA 1910.1018, *Inorganic Arsenic*. See also NIOSH Criteria Document #75-149, *Inorganic Arsenic*. Protective Gloves: Wear Norton chemical protective glove set, Wear chemical goggles; wear a mask/respirator in open areas.

Respirator Selection: **Requirements for Respiratory Protection for Inorganic Arsenic Particulate** ***Except for Those With Significant Vapor Pressure:*** < or = 100 μg/m^3 (micrograms per cubic meter) (1) Half-mask air-purifying respirator equipped with high-efficiency filter*; or (2) Any half-mask supplied air respirator. < or = 500 μg/m^3 (1) Full facepiece air-purifying respirator equipped with high-efficiency filter*; (2) Any full-facepiece supplied-air respirator; or (3) Any full-facepiece SCBA. < or = 10,000 μg/m^3 (1) Powered air-purifying respirators in all inlet face coverings with high-efficiency filters*; or (2) Half-mask supplied-air respirators operated in positive-pressure mode. < or = 20,000 μg/m^3 Supplied-air respirator with full facepiece, hood, or helmet or suit, operated in positive-pressure mode. >20,000 μg/m^3, unknown concentrations, or firefighting Any full-facepiece SCBA operated in positive-pressure mode.

* A high-efficiency filter means a filter that is at least 99.97% efficient against mono-dispersed particles of 0.3 μm (micrometers) in diameter or higher.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, dry, well-ventilated area away from metals, acids and other incompatible materials. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN1559 Arsenic pentoxide, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Stay upwind; keep out of low areas. Wear self-contained (positive pressure if available) breathing apparatus and full protective clothing. Do not touch spilled material. Neutralize spilled material with crushed limestone, soda ash or lime. Absorb small liquid spills with sand or other noncombustible absorbent material and place into containers for later disposal. For *large spills*, dike far ahead of spill for later disposal. Ventilate area and wash spill site after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: As_2O_5 may burn but does not readily ignite. Thermal decomposition products may include arsenic trioxide fumes. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve in a minimum of concentrated hydrochloric acid. Dilute with water until white precipitate forms. Add HCl to dissolve. Saturate with H_2S; filter and wash precipitate and return to supplier. Alternatively, precipitate with heavy metals, such as lime or ferric hydroxide in lieu of H_2S[22]. If needed, seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line). Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(109); (102); (31); (173); (101); (138); (201); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 2, No. 3, 59−61 (1982) and 8, No. 3, 45−55 (1988).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Arsenic Pentoxide, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Arsenic Pentoxide, Trenton, NJ (April 2002).

Arsenic Trioxide A:1550

Formula: As_2O_3

Synonyms: Acide arsenieux (French); Anhydride arsenieux (French); Arsenic blanc (French); Arsenic(III) oxide; Arsenic sesquioxide; Arsenicum album; Arsenigen saure (German); Arsenious acid; Arsenious oxide; Arsenious trioxide; Arsenite; Arsenolite; Arsenous acid; Arsenous acid anhydride; Arsenous anhydride; Arsenous oxide; Arsenous oxide anhydride; Arsodent; Claudelite; Claudetite; Crude arsenic; Diarsenic trioxide; Spinrite arsenic; Trioxido de arsenico (Spanish); White arsenic

CAS Registry Number: 1327-53-3

HSDB Number: 419

RTECS Number: CG3325000

UN/NA & ERG Number: UN1561/151

EC Number: 215-481-4 [*Annex I Index No.* 033-003-00-0]

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen: Arsenic and inorganic arsenic compounds; IARC: Human Sufficient Evidence, 1980; Animal Limited Evidence, *carcinogenic to humans*, Group 1, 1987. United States Environmental Protection Agency Gene-Tox Program, Positive: B *subtilis* rec assay

California Proposition 65 Chemical[102]: Cancer 2/27/1987 (inorganic arsenic compounds); developmental 5/1/1997 (arsenic inorganic oxides).

Hazard Alert: Poison, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Environmental hazard.

OSHA, 29CFR1910 Specifically Regulated Chemicals [See CFR1910.1018, inorganic compounds)

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR1910.1018)

Banned or Severely Restricted (In Agricultural, Pharmaceutical and Industrial Chemicals) (many countries)[13,35]

Clean Air Act, 42USC7412; Title I, Part A, §112 Hazardous Pollutants

United States National Primary Drinking Water Regulations: MCLG = 0 mg[As]/L; MCL = 0.010 mg[As]/L as Arsenic.

Clean Water Act 40CFR401.15 Section 307 Toxic Pollutants; 40CFR423, Appendix A Priority Pollutants; §313 Priority Chemicals

RCRA 40CFR261.24 Toxicity Characteristics, Maximum Concentration of Contaminants (MCC), Regulatory level, 5.0 mg/L

RCRA, 40CFR261, Appendix 8, Hazardous Constituents, waste number P 012

RCRA Land Ban Waste

CERCLA/SARA 40CFR302 Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg)

EPCRA Section 313: Form R *de minimis* concentration reporting level: 0.1% (inorganic arsenic compounds)

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Canada: Priority Substance List & Restricted Substances/ Ocean Dumping FORBIDDEN (CEPA), NPRI (arsenic compounds).

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T + , N; risk phrases: R45; R28; R32; R34; R45; R50/53; R61; R62; R63; safety phrases: S29; S45; S53; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Arsenic trioxide is a noncombustible, odorless, white powder or colorless crystalline solid. Molecular weight = 197.84; boiling point = 460−465°C; freezing/melting point = 312°C (sublimes @ 193°C). Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 0; reactivity 0. Slightly soluble in water.

Potential Exposure: Arsenic trioxide, a primary raw material for other arsenic compounds, is used in manufacture of pesticides, glass, industrial chemicals, and drugs. It is an intermediate for insecticides, herbicides and fungicides. The material is used as a wood and tanning preservative and a decoloring and refining agent in glass manufacture. It is also used in pharmaceuticals and in the purification of synthetic gas.

Incompatibilities: Sodium chlorate; sodium hydroxide, sulfuric acid; fluorine; chlorine trifluoride; chromic oxide; aluminum chloride; phosphorus pentoxide; hydrogen fluoride; oxygen difluoride; tannic acid; infusion cinchona and other vegetable astringent infusions and decoctions; iron in solution. Contact with acids or acid mists releases deadly arsine gas.

Permissible Exposure Limits in Air

NIOSH IDLH = 5 mg[As]/m^3

Arsenic and inorganic compounds

OSHA PEL: 0.01 mg[As]/m^3 TWA; Cancer hazard that can be inhaled.

NIOSH REL: 0.002 mg[As]/m^3 15 min. Ceiling Concentration. Limit exposure to lowest feasible level

ACGIH TLV[1]: 0.01 mg[As]/m^3 TWA; Confirmed Human Carcinogen; BEI established.

PAC* Ver. 2.9

PAC-1: 0.27 milligram per cubic meter

PAC-2: **3.0**$_{\mathbf{A}}$ milligram per cubic meter

PAC-3: **9.1**$_{\mathbf{A}}$ milligram per cubic meter

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

DFG MAK: Carcinogen Category 1; Germ Cell Mutagen Group 3A (2004); BAT: 50 μg[As]/L in urine/end of exposure or end-of-shift; for long-term exposures; after several shifts.

Australia: carcinogen, 1993; Austria: carcinogen, 1999; Belgium: carcinogen, 1993; Denmark: TWA 0.05 mg(As)/m^3, 1999; Finland: carcinogen, 1993; France: VME 0.2 milligram per cubic meter, carcinogen, 1999; Japan carcinogen, 1999; Norway: TWA 0.01 mg(As)/m^3, 1999; the Philippines: TWA 0.1 milligram per cubic meter, carcinogen, 1993; Poland: TWA 0.01 mg(As)/m^3, 1999; Sweden: TWA 0.03 mg(As)/m^3, carcinogen, 1999; Switzerland: MAK-week 0.1 mg(As)/m^3, carcinogen, 1999; United Kingdom: TWA 0.1 mg(As)/m^3, carcinogen, SEP2000; United Kingdom: TWA 0.1 mg(Se)/m^3, SEP2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Confirmed human carcinogen. Russia[43] set a MAC of 0.003 milligram per cubic meter on an average daily basis for residential areas. Several states have set guidelines or standards for arsenic in ambient air[60]: 0.06 milligram per cubic meter (California Prop. 65), 0.0002 μ/m^3 (Rhode Island), 0.00023 μ/m^3 (North Carolina), 0.024 μ/m^3 (Pennsylvania), 0.05 μ/m^3 (Connecticut), 0.07−0.39 μ/m^3 (Montana), 0.67 μ/m^3 (New York), 1.0 μ/m^3 (South Carolina), 2.0 μ/m^3 (North Dakota), 3.3 μ/m^3 (Virginia), 5 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Methods (inorganic arsenic): #7300, #7301,#7303, #7900, #9102; OSHA Analytical Methods ID-105. The American Conference of Government Industrial Hygienists (ACGIH) Method 803 measures total particulate arsenic in air.

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 10 μg[As]/L; State Drinking Water Guidelines: Arizona 10 μg[As]/L; Connecticut 10 μg[As]/L EPA Maximum Contaminant Level (MCL): 0.010 mg[As]/L[40 CFR 141.62]. Canadian Drinking Water Standards: IMAC 0.025 [As] mg/L.

Determination in Water: *For arsenic*: The atomic absorption graphite furnace technique is often used for measurement of total arsenic in water. It also has been standardized by EPA. Total arsenic may be determined by digestion followed by silver diethyldithiocarbamate; an alternative is atomic absorption; another is ICP optical emission spectrometry. See OSHA Method #ID-105 for arsenic[58].

Routes of Entry: Inhalation, skin contact, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Skin contact can cause burning, itching, and rash. Inhalation can cause respiratory irritation. Eye contact can cause irritation and possible permanent damage. High exposures can cause an abnormal EKG. Symptoms of acute poisoning may take from ½ hour to several hours after ingestion to appear. They may include: sweetish metallic taste; garlicky odor of breath and feces; constriction in throat and difficulty in swallowing; burning and colicky pains in esophagus, stomach and bowel; vomiting and profuse painful diarrhea (stools are watery initially, later becoming bloody); dehydration with intense thirst and muscular cramps; bluing of skin; feeble pulse and cold extremities; vertigo, frontal headache; stupor, delirium and mania (these symptoms may occur without concurrent or preceding gastric symptoms); fainting, coma, convulsions, general paralysis; and then possible death. This material is considered super toxic; probable oral lethal dose (human) is less than 5 mg/kg, i.e., a taste (less than 7 drops) for a 70 kg (150 lb) person. Material causes acute GI and CNS symptoms.

Long-Term Exposure: Arsenic can cause skin damage or problems with circulatory systems, and may have increased risk of cancer. Arsenic trioxide is a human carcinogen; causes skin and liver cancer. Renal and hepatic damage have been observed. Chronic exposure to material has led to nasal septum perforation, dermatological symptoms (lesions, necrosis, etc.) and an increase in the incidence of lung and lymphatic cancers. Appreciable exposure to respiratory irritant promoters, such as metal oxide fumes elicits a carcinogenic response from arsenic trioxide. Repeated or high exposure can cause nerve damage with "pins and needles" sensation; burning, numbness, and weakness in the extremities. Exposure can cause skin allergy to develop.

Points of Attack: Skin, liver, kidneys, lungs, lymphatic system.

Medical Surveillance: Pregnant women should avoid contact. Employees should be notified by a physician that this chemical may affect the reproductive system. In addition to comprehensive initial medical and work histories emphasizing reproductive experience and menstrual history, patient should have physical examination and testing of genitourinary tract, sperm count, motility and morphology. If required, other tests, such as serum testosterone, serum FSH, and serum LH may be indicated. Before first exposure and every 6−12 months thereafter, a medical history and exam are recommended, including: exam of the nose, skin eyes, nails and nervous system. Test for urine arsenic (may not be accurate within 2 days of eating shellfish or fish; most accurate at the end of a work-day). Levels should not be greater than 100 μg/g of creatinine in the urine. Examine the skin for abnormal growths. Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with large amounts of soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention.

Note to physician: For severe poisoning BAL (British Anti-Lewisite), Dimercaprol, dithiopropanol ($C_3H_8OS_2$) has been used to treat toxic symptoms of certain heavy metals poisoning—including arsenic. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5). For milder poisoning *penicillamine (not penicillin)* has been used, both with mixed success. Side effects occur with such treatment and it is never a substitute for controlling exposure. It can only be done under strict medical care.

Personal Protective Methods: Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. If local exhaust ventilation or enclosure is not used, respirators should be worn. A regulated, marked area should be established where arsenic trioxide is handled, used, or stored. Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear full facepiece respiratory protection. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Wash thoroughly immediately after exposure to Arsenic Trioxide and at the end of the work-shift. Specific engineering controls are required under OSHA 1910.1018, *Inorganic Arsenic*. See also NIOSH Criteria Document #75-149, "*Inorganic Arsenic*."

Respirator Selection: **Requirements for Respiratory Protection for Inorganic Arsenic Particulate** ***Except for Those With Significant Vapor Pressure:*** < or = 100 μg/m^3 (micrograms per cubic meter) (1) Half-mask air-purifying respirator equipped with high-efficiency filter*; or (2) Any half-mask supplied air respirator. < or = 500 μg/m^3 (1) Full facepiece air-purifying respirator equipped with high-efficiency filter*; (2) Any full-facepiece supplied-air respirator; or (3) Any full-facepiece SCBA. < or = 10,000 μg/m^3 (1) Powered air-purifying respirators in all inlet face coverings with high-efficiency filters*; or (2)

Half-mask supplied-air respirators operated in positive-pressure mode. < or = 20,000 μg/m^3 Supplied-air respirator with full facepiece, hood, or helmet or suit, operated in positive-pressure mode. > 20,000 μg/m^3, unknown concentrations, or firefighting Any full-facepiece SCBA operated in positive-pressure mode.

* A high-efficiency filter means a filter that is at least 99.97% efficient against mono-dispersed particles of 0.3 μm (micrometers) in diameter or higher.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage Store in tightly closed containers in a cool, dry well-ventilated area away from contact with incompatible materials. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN1561 Arsenic trioxide, Hazard Class: 6.1; Labels: 6.1-Poisonous materials

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Avoid bodily contact with the material. Do not handle broken packages without protective equipment. Wash away any material which may have contacted the body with copious amounts of water or soap and water. Wear full protective clothing including gloves and eye protection. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include arsine and oxides of arsenic metal. Avoid breathing dusts and fumes from burning materials. Keep upwind. Wear SCBA. Extinguish fire using agent suitable for type of surrounding fire (material itself does not burn or burns with difficulty). Use water in flooding quantities as fog. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Dissolve in a minimum of concentrated hydrochloric acid. Dilute with water until white precipitate forms. Add HCl to dissolve. Saturate with H_2S; filter and wash precipitate and return to supplier. Alternatively, precipitate with heavy metals, such as lime or ferric hydroxide in lieu of H_2S[22]. If needed, seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

References

(109); (102); (31); (173); (101); (138); (2); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 3, No. 5, 50−58 (1983).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Arsenous Oxide, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Arsenic Trioxide, Trenton, NJ (July 2001).

Arsenic Trisulfide A:1560

Formula: As_2S_3

Synonyms: Arsenic sesquisulfide; Arsenic sulfide; Arsenic sulfide yellow; Arsenic tersulfide; Arsenic yellow; Arsenous sulfide; Auripigment; C.I. 77086; C.I. Pigment yellow; Diarsenic trisulfide; King's gold; King's yellow; Orpiment; STCC 4923222; Trisulfuro de arsenico (Spanish); Yellow arsenic sulfide

CAS Registry Number: 1303-33-9

HSDB Number: 428

RTECS Number: CG2638000

UN/NA & ERG Number: UN1557/152

EC Number: 215-117-4

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen: Arsenic and inorganic arsenic compounds; IARC: Human Sufficient Evidence, 1980; Animal Limited Evidence, *carcinogenic to humans*, Group 1, 1987

California Proposition 65 Chemical[102]: Cancer 2/27/1987

Hazard Alert: Poison, Combustible, Poison, Strong reducing agent, Environmental hazard.

OSHA, 29CFR1910 Specifically Regulated Chemicals (CFR1910.1018)

Banned or Severely Restricted (In Agricultural, Pharmaceutical and Industrial Chemicals) (many countries)[13,35]

Clean Air Act, 42USC7412; Title I, Part A, §112 Hazardous Pollutants

Clean Water Act 40CFR401.15 Section 307 Toxic Pollutants; 40CFR423, Appendix A Priority Pollutants; §313 Priority Chemicals

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, D004 (arsenic compounds)

United States National Primary Drinking Water Regulations: MCLG = 0 mg[As]/L; MCL = 0.010 mg[As]/L as Arsenic.

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg)

EPCRA Section 313: Form R *de minimis* concentration reporting level: 0.1% (inorganic arsenic compounds)

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Canada: Priority Substance List & Restricted Substances/ Ocean Dumping FORBIDDEN (CEPA), NPRI (arsenic compounds).

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R45; R10; R16; R23/25; R32; R50/53; safety phrases: S20/21; S28; S29; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water [lit.].

Description: Arsenic trisulfide is a noncombustible, odorless, yellow or orange powder or red needles (changes to a different "red" form @ 170°C). Molecular weight = 246.04; specific gravity (H_2O:1) = 3.43 @ 20°C; boiling point = 707°C; freezing/melting point = 300−327°C. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 1; reactivity 0. Insoluble in water.

Potential Exposure: Arsenic trisulfide is used in the manufacture of glass, oil cloth, linoleum, electrical semiconductors, fireworks and used as a pigment.

Incompatibilities: A strong reducing agent; avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates) and potassium nitrate mixed with sulfur, since violent reactions occur. Water contact forms hydrogen sulfide. Incompatible with acids, halogens. Contact with acids or acid mists releases deadly arsine gas.

Permissible Exposure Limits in Air

NIOSH IDLH = 5 mg[As]/m^3

Arsenic and inorganic compounds

OSHA PEL: 0.01 mg[As]/m^3 TWA; Cancer hazard that can be inhaled.

NIOSH REL: 0.002 mg[As]/m^3 15 min. Ceiling Concentration. Limit exposure to lowest feasible level

ACGIH TLV[1]: 0.01 mg[As]/m^3 TWA; Confirmed Human Carcinogen; BEI established.

No PAC available.

DFG MAK: Carcinogen Category 1; Germ Cell Mutagen Group 3 A (2004); BAT: 50 μg[As]/L in urine/end of exposure or end-of-shift; for long-term exposures; after several shifts.

Arab Republic of Egypt: TWA 0.2 milligram per cubic meter, 1993; Australia: TWA 0.05 milligram per cubic meter, carcinogen, 1993; Belgium: TWA 0.2 milligram per cubic meter, 1993; Denmark: TWA 0.05 milligram per cubic meter, 1999; Finland: carcinogen, 1993; France: VME 0.2 milligram per cubic meter, 1993; Hungary: STEL 0.5 milligram per cubic meter, carcinogen, 1993; India: TWA 0.2 milligram per cubic meter, 1993; Norway: TWA 0.02 milligram per cubic meter, 1999; the Philippines: TWA 0.5 milligram per cubic meter, 1993; Poland: MAC (TWA) 0.01 milligram per cubic meter, 1999; Sweden: NGV 0.03 milligram per cubic meter, carcinogen, 1999; Switzerland: TWA 0.1 milligram per cubic meter, carcinogen, 1999; Thailand: TWA 0.5 milligram per cubic meter, 1993; Turkey: TWA 0.5 mg(As)/m^3, 1993; Turkey: TWA 0.5 milligram per cubic meter, 1993; United Kingdom: TWA 0.1 milligram per cubic meter, carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH: TLV: Confirmed Human Carcinogen. Russia[43] set a MAC of 0.003 milligram per cubic meter on an average daily basis for residential areas. Several states have set guidelines or standards for arsenic in ambient air[60]: 0.06 milligram per cubic meter (California Prop. 65), 0.0002 μ/m^3 (Rhode Island), 0.00023 μ/m^3 (North Carolina), 0.024 μ/m^3 (Pennsylvania), 0.05 μ/m^3 (Connecticut), 0.07−0.39 μ/m^3 (Montana), 0.67 μ/m^3 (New York), 1.0 μ/m^3 (South Carolina), 2.0 μ/m^3 (North Dakota), 3.3 μ/m^3 (Virginia), 5 μ/m^3 (Nevada).

Determination in Air: NIOSH Analytical Methods (inorganic arsenic): #7300, #7301,#7303, #7900, #9102; OSHA Analytical Methods ID-105. The American Conference of Government Industrial Hygienists (ACGIH) Method 803 measures total particulate arsenic in air.

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 10 μg[As]/L; State Drinking Water Guidelines: Arizona 10 μg[As]/L; Connecticut 10 μg[As]/L EPA Maximum Contaminant Level (MCL): 0.010 mg[As]/ L[40 CFR 141.62]. Canadian Drinking Water Standards: IMAC 0.025 [As] mg/L.

Determination in Water: *For arsenic*: The atomic absorption graphite furnace technique is often used for measurement of total arsenic in water. It also has been standardized by EPA. Total arsenic may be determined by digestion followed by silver diethyldithiocarbamate; an alternative is atomic absorption; another is ICP optical emission spectrometry. See OSHA Method #ID-105 for arsenic[58].

Routes of Entry: Inhalation of dust, skin contact, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Arsenic trisulfide can affect you when breathed in and may enter the body thought the skin. Arsenic trisulfide is a carcinogen; handle with extreme caution. Contact can cause burning, itching, thickened skin; rash and color changes. Exposure can irritate the nose and throat; and may cause an ulcer or hole in the inner nose. High or repeated exposures can cause disturbed sleep; "pins and needles," numbness and weakness of arms and legs. High or repeated exposure can cause poor appetite; nausea, vomiting, diarrhea and death.

Long-Term Exposure: Arsenic can cause skin damage or problems with circulatory systems, and may have increased risk of cancer. Arsenic trisulfide is a carcinogen in humans; it has been shown to cause skin, liver and lung cancer. It may be a teratogen, causing reproductive damage, such as reduced fertility and interference with the menstrual cycle. May cause liver damage and lower the red blood cell count. Repeated skin contact can cause thickened skin and pigmentation changes. Some persons develop white lines on the fingernails. High or repeated exposure can cause nerve damage with burning, "pins and needles" sensation and weakness of the extremities.

Points of Attack: Skin, respiratory system; nervous system.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Before beginning employment and at regular times after that, the following are recommended: exam of the nose, skin, eyes, nails and nervous system. CBC. Examination of the nervous system. Test for urine arsenic (may not be accurate within 2 days of eating shellfish or fish; most accurate at the end of a work-day). At NIOSH recommended exposure levels, urine arsenic should not be greater than 50−100 μg/L of urine. After suspected overexposure, repeat these tests. Also examine your skin periodically for abnormal growths. Skin cancer from arsenic is easily cured with early detection.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: For severe poisoning BAL (British Anti-Lewisite), Dimercaprol, dithiopropanol ($C_3H_8OS_2$) has been used to treat toxic symptoms of certain heavy metals poisoning—including arsenic. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5). For milder poisoning *penicillamine (not penicillin)* has been used, both with mixed success. Side effects occur with such treatment and it is never a substitute for controlling exposure. It can only be done under strict medical care.

Personal Protective Methods: Avoid skin contact with arsenic trisulfide. Wear protective gloves and clothing. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operations. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Eye protection is included in the recommended respiratory protection. Specific engineering controls are required under OSHA 1910.1018, *Inorganic Arsenic*. See also NIOSH Criteria Document #75-149, "*Inorganic Arsenic*."

Respirator Selection: **Requirements for Respiratory Protection for Inorganic Arsenic Particulate** ***Except for Those With Significant Vapor Pressure:*** $<$ or $= 100\ \mu g/m^3$ (micrograms per cubic meter) (1) Half-mask air-purifying respirator equipped with high-efficiency filter*; or (2) Any half-mask supplied air respirator. $<$ or $= 500\ \mu g/m^3$ (1) Full facepiece air-purifying respirator equipped with high-efficiency filter*; (2) Any full-facepiece supplied-air respirator; or (3) Any full-facepiece SCBA. $<$ or $= 10{,}000\ \mu g/m^3$ (1) Powered air-purifying respirators in all inlet face coverings with high-efficiency filters*; or (2) Half-mask supplied-air respirators operated in positive-pressure mode. $<$ or $= 20{,}000\ \mu g/m^3$ Supplied-air respirator with full facepiece, hood, or helmet or suit, operated in positive-pressure mode. $> 20{,}000\ \mu g/m^3$, unknown concentrations, or firefighting Any full-facepiece SCBA operated in positive-pressure mode.

* A high-efficiency filter means a filter that is at least 99.97% efficient against mono-dispersed particles of 0.3 μm (micrometers) in diameter or higher.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Avoid contact with the incompatible materials cited above. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN1557 Arsenic compounds, solid, n.o.s. inorganic, including arsenates, n.o.s.; arsenites, n.o.s.; arsenic sulfides, n.o.s.; and organic compounds of arsenic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Keep water and acids away from spilled Arsenic Trisulfide. Collect powdered materials using a vacuum equipped with a high efficiency particulate filter (do not use a standard shop vacuum) or wet cleaning methods and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Arsenic trisulfide may burn, but does not readily ignite. Use dry chemical, CO_2, water spray; or foam extinguishers. Thermal decomposition products may include hydrogen sulfide, arsine, sulfur oxides and arsenic fumes. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(109); (102); (31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Arsenic Trisulfide, Trenton, NJ (December 1998).

Arsenous Trichloride A:1570

Formula: $AsCl_3$

Synonyms: Arsenic butter; Arsenic chloride; Arsenic(III) chloride; Arsenic trichloride; Arsenous chloride; Arsenous trichloride; Butter of arsenic; Caustic arsenic chloride; Chlorure d'arsenic (French); Fuming liquid arsenic; Trichloroarsine; Trichlorure d'arsenic (French); Tricloruro de arsenico (Spanish)

CAS Registry Number: 7784-34-1

HSDB Number: 422

RTECS Number: CG1750000

UN/NA & ERG Number: UN1560/157

EC Number: 232-059-5

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 15,000 (≥1.00% concentration); *Theft hazard* 2.2 (≥30% concentration)

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen: Arsenic and inorganic arsenic compounds; IARC: Human Sufficient Evidence, 1980; Animal Limited Evidence, *carcinogenic to humans*, Group 1, 1987

California Proposition 65 Chemical[102]: Cancer 2/27/1987.

Hazard Alert: Poisonous Inhalation hazard, Suspected reprotoxic hazard, Water reactive, air reactive, Environmental hazard.

OSHA, 29CFR1910 Specifically Regulated Chemicals [See CFR1910.1018, inorganic compounds)

Banned or Severely Restricted (In Agricultural, Pharmaceutical and Industrial Chemicals) (many countries)[13,35]

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR1910.1018)

Clean Air Act, 42USC7412; Title I, Part A, §112 Hazardous Pollutants; Section 112(r), accidental Release Prevention/Flammable Substances (Section 68.130), TQ = 15,000 lb (5825 kg)

United States National Primary Drinking Water Regulations: MCLG = 0 mg[As]/L; MCL = 0.010 mg[As]/L as Arsenic; SMCL = 250 mg[Cl^-]/L as Chloride

Clean Water Act 40CFR401.15 Section 307 Toxic Pollutants; 40CFR423, Appendix A Priority Pollutants; §313 Priority Chemicals

RCRA 40CFR261.24 Toxicity Characteristics, Maximum Concentration of Contaminants (MCC), Regulatory level, 5.0 mg/L

RCRA, 40CFR261, Appendix 8, Hazardous Constituents, D004 (arsenic compounds)

CERCLA/SARA 40CFR302 Extremely Hazardous Substances: TPQ = 500 lb (228 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: EHS 1 lb (0.454 kg)

EPCRA Section 313: Form R *de minimis* concentration reporting level: 0.1% (inorganic arsenic compounds)

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Canada: Priority Substance List & Restricted Substances/Ocean Dumping FORBIDDEN (CEPA), NPRI (arsenic compounds).

Hazardous to aquatic life or environment, with possible long-lasting effects[191,192]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T; N; risk phrases: R45; R20/21/22; R27/28; R46; R50/53; R61; R63; safety phrases: S1; S13; S22; S29/35; S36/37/39; S41; S45; S53; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Arsenous trichloride is a noncombustible, colorless or pale yellow oily, fuming liquid. The odor is described as pungent and acrid. Molecular weight = 181.27; specific gravity (H_2O:1) = 2.156 @ 25°C; boiling point = 130.2°C; freezing/melting point = −16°C; vapor pressure = 8.4 mmHg @ 23.5°C; Latent heat of vaporization = 49.06 cal/g; heat of solution = (estimate) -0.42×10^5 J/kg. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 0; reactivity 0₩. Decomposes in water, forming hydrogen chloride.

Potential Exposure: Arsenic chloride is used in the ceramics industry; in the synthesis of chlorine-containing arsenicals; as a chemical intermediate for arsenic insecticides, pharmaceuticals; and has been used in chemical warfare agents.

Incompatibilities: Contact with sodium, potassium, or powdered aluminum may cause a violent reaction. It is decomposed in water, forming arsenic hydroxide and hydrogen chloride. Exposure to light forms toxic gas. Violent reaction with anhydrous ammonia, strong acids; strong oxidizers and halogens. Incompatible with alkali metals; active metals, such as arsenic, iron, aluminum, zinc. Corrodes metals in the presence of moisture and forms flammable and explosive hydrogen gas.

Permissible Exposure Limits in Air

NIOSH IDLH = 5 mg[As]/m^3

Arsenic and inorganic compounds

OSHA PEL: 0.01 mg[As]/m^3 TWA; Cancer hazard that can be inhaled.

NIOSH REL: 0.002 mg[As]/m^3 15 min. Ceiling Concentration. Limit exposure to lowest feasible level

ACGIH TLV[1]: 0.01 mg[As]/m^3 TWA; Confirmed Human Carcinogen; BEI established.

7784-34-1

PAC Ver. 29[138]

PAC-1: 0.91 ppm

PAC-2: 10 ppm

PAC-3: 240 ppm

DFG MAK: Carcinogen Category 1; Germ Cell Mutagen Group 3A (2004); BAT: 50 μg[As]/L in urine/end of exposure or end-of-shift; for long-term exposures; after several shifts.

Arab Republic of Egypt: TWA 0.2 milligram per cubic meter, 1993; Australia: TWA 0.05 milligram per cubic meter, carcinogen, 1993; Belgium: TWA 0.2 milligram per cubic meter, 1993; Denmark: TWA 0.05 milligram per cubic meter, 1999; Finland: carcinogen, 1993; France: VME 0.2 milligram per cubic meter, 1993; Hungary: STEL 0.5 milligram per cubic meter, carcinogen, 1993; India: TWA 0.2 milligram per cubic meter, 1993; Norway: TWA 0.02 milligram per cubic meter, 1999; the Philippines: TWA 0.5 milligram per cubic meter, 1993; Poland: MAC (TWA) 0.01 milligram per cubic meter, 1999; Sweden: NGV 0.03 milligram per cubic meter, carcinogen, 1999; Switzerland: TWA 0.1 milligram per cubic meter, carcinogen, 1999; Thailand: TWA 0.5 milligram per cubic meter, 1993; Turkey: TWA 0.5 mg(As)/m^3, 1993; Turkey: TWA 0.5 milligram per cubic meter, 1993; United Kingdom: TWA 0.1 milligram per cubic meter, carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH: TLV: Confirmed Human Carcinogen. Russia[43] set a MAC of 0.003 milligram per cubic meter on an average daily basis for residential areas. Several states have set guidelines or standards for arsenic in ambient air[60]: 0.06 milligram per cubic meter (California Prop. 65), 0.0002 μ/m^3 (Rhode Island), 0.00023 μ/m^3 (North Carolina), 0.024 μ/m^3 (Pennsylvania), 0.05 μ/m^3 (Connecticut), 0.07−0.39 μ/m^3 (Montana), 0.67 μ/m^3 (New York), 1.0 μ/m^3 (South Carolina), 2.0 μ/m^3 (North Dakota), 3.3 μ/m^3 (Virginia), 5 μ/m^3 (Nevada).

Determination in Air: NIOSH Analytical Methods (inorganic arsenic): #7300, #7301,#7303, #7900, #9102; OSHA Analytical Methods ID-105. The American Conference of Government Industrial Hygienists (ACGIH) Method 803 measures total particulate arsenic in air.

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 10 μg[As]/L; State Drinking Water Guidelines: Arizona 10 μg[As]/L; Connecticut 10 μg[As]/L EPA Maximum Contaminant Level (MCL): 0.010 mg[As]/L[40 CFR 141.62]. Canadian Drinking Water Standards: IMAC 0.025 [As] mg/L.

Determination in Water: *For arsenic*: The atomic absorption graphite furnace technique is often used for measurement of total arsenic in water. It also has been standardized by EPA. Total arsenic may be determined by digestion followed by silver diethyldithiocarbamate; an alternative is atomic absorption; another is ICP optical emission spectrometry. See OSHA Method #ID-105 for arsenic[58]

Routes of Entry: Inhalation, ingestion, skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin and respiratory tract. Eye contact can cause burns, possibly causing permanent damage. Exposure to vapors causes spasm of eyelids, tearing, pain, and reddening. Exposure above the occupational exposure limits can cause death. In acute exposures, it is extremely toxic and caustic, owing not only to the poisonous nature of arsenic, but also to the release of hydrochloric acid in the presence of water. Exposure to the skin causes local irritation and blisters. Inhalation or ingestion causes hemorrhagic gastroenteritis resulting in loss of fluids and electrolytes, collapse, shock and death. The fatal human dose is 70−180 mg depending on the weight of the victim. Symptoms usually appear one-half to one hour after ingestion. Symptoms include a sweetish metallic taste; garlicky odor on the breath and stools; constriction in throat; difficulty in swallowing; abdominal pain; vomiting, diarrhea, bluing of the skin; weak pulse; dizziness, headaches, coma, and convulsions.

Long-Term Exposure: Arsenic can cause skin damage or problems with circulatory systems, and may have increased risk of cancer. Chronic poisoning can lead to peripheral disturbed sleep; skin conditions; liver damage. Arsenic and certain arsenic compounds have been implicated in the induction of skin and lung cancer. Based on several related arsenic compounds, arsenic trichloride may be a mutagen and teratogen.

Points of Attack: Liver, kidneys, skin, lungs, reproductive system.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Before first exposure and every 6–12 months thereafter, a medical history and exam are recommended, including: exam of the nose, skin eyes, nails and nervous system. Test for urine arsenic (may not be accurate within 2 days of eating shellfish or fish; most accurate at the end of a work-day). Levels should not be greater than 100 μg/g of creatinine in the urine. Examine the skin for abnormal growths. Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention.

Note to physician: For severe poisoning BAL (British Anti-Lewisite), Dimercaprol, dithiopropanol ($C_3H_8OS_2$) has been used to treat toxic symptoms of certain heavy metals poisoning—including arsenic. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5). For milder poisoning *penicillamine (not penicillin)* has been used, both with mixed success. Side effects occur with such treatment and it is never a substitute for controlling exposure. It can only be done under strict medical care.

Personal Protective Methods: Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. If local exhaust ventilation or enclosure is not used, respirators should be worn. A regulated, marked area should be established where arsenous trichloride is handled, used, or stored. Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear full facepiece respiratory protection. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Specific engineering controls are required under OSHA 1910.1018, *Inorganic Arsenic*. See also NIOSH Criteria Document #75-149, "*Inorganic Arsenic*."

Respirator Selection: **Requirements for Respiratory Protection for Inorganic Arsenicals*With Significant Vapor Pressure:*** < or = 100 μg/m^3 (micrograms per cubic meter) (1) Half-mask* air-purifying respirator equipped with high-efficiency filter** and acid gas cartridge; or (2) Any half-mask* supplied-air respirator. < or = 500 μg/m^3 (1) Front- or back-mounted gas mask equipped with high-efficiency filter** and acid gas canister; (2) Any full-facepiece supplied-air respirator; or (3) Any full-facepiece SCBA. < or = 10,000 μg/m^3 Half-mask* supplied-air respirator operated in positive-pressure mode. < or = 20,000 μg/m^3 Supplied-air respirator with full facepiece, hood, or helmet or suit, operated in positive-pressure mode. > 20,000 μg/m^3, unknown concentrations, or firefighting: Any full-facepiece SCBA operated in positive-pressure mode. * Half-mask respirators shall not be used for protection against arsenic trichloride, as it is rapidly absorbed through the skin. ** A high-efficiency filter means a filter that is at least 99.97% efficient against mono-dispersed particles of 0.3 μm (micrometers) in diameter or higher.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Arsenous trichloride, AsCl3, should be stored in tightly closed containers in a cool, well-ventilated area away from heat, water and any possible contact with active metals or other incompatible materials. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN1560 Arsenic trichloride, Hazard class 6.1; Labels: 6.1-Poison Inhalation Hazard, Inhalation Hazard Zone B.

Spill Handling:

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (from a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30

Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.2/0.3

Large spills (from a large package or from many small packages)
First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.6/0.9
Night 1.0/1.5

Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Wear positive-pressure breathing apparatus and special protective clothing. Remove and isolate contaminated clothing at the site. Do not touch-spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: absorb with sand or other noncombustible absorbent material and place into sealed containers for later disposal. *Large spills*: dike far ahead of spill for later disposal. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Arsenous trichloride is not flammable so agents must be used which are suitable for surrounding fire. Thermal decomposition products may include hydrogen chloride, arsine, chlorine and oxides of metal (arsenic). If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Dissolve in a minimum of concentrated hydrochloric acid. Dilute with water until white precipitate forms. Add HCl to dissolve. Saturate with H_2S; filter and wash precipitate and return to supplier. Alternatively, precipitate with heavy metals, such as lime or ferric hydroxide in lieu of H_2S[22]. If needed, seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line). In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(109); (102); (31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Arsenous Trichloride, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Arsenic Trichloride, Trenton, NJ (May 2003).

Arsine (Agent SA) A:1580

Formula: AsH_3

Synonyms: Arsenic anhydride; Arsenic trihydride; Arseniuretted hydrogen; Arsenous hydride; Arsenwasserstoff (German); Arsina (Spanish); Hydrogen arsenide; SA (military designation)

CAS Registry Number: 7784-42-1

HSDB Number: 510

RTECS Number: CG6475000

UN/NA & ERG Number: (PIH) UN2188/119

EC Number: 232-066-3 [*Annex I Index No*. 033-006-00-7]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): Release hazard 1000 ($\geq$1.00% concentration); *Theft hazard* 15 ($\geq$0.67% concentration)

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen: Arsenic and inorganic arsenic compounds; IARC: Human Sufficient Evidence, 1980; Animal Limited Evidence, *carcinogenic to humans*, Group 1, 1987

California Proposition 65 Chemical[102]: Cancer 2/27/1987.

Hazard Alert: Poison inhalation hazard: exposure can be lethal, Systemic agent, Extremely flammable and highly toxic gas, Thermally unstable, Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated, Possible risk of forming tumors, Suspected of causing genetic defects, Environmental hazard.

OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 100 lb (45.4 kg)

Clean Air Act, 42USC7412; Title I, Part A, §112 Hazardous Pollutants; 42USC7412; Title I, Part A, §112(r), accidental Release Prevention/Flammable Substances (Section 68.130) TQ = 1000 lb (454 kg)

United States National Primary Drinking Water Regulations: MCLG = 0 mg[As]/L; MCL = 0.010 mg[As]/L as Arsenic.

Clean Water Act: 40CFR401.15 Toxic Pollutant

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, D004 (arsenic compounds)

Superfund/EPCRA 40CFR302.4, Appendix A, RQ: 1 lb (0.454 kg)

CERCLA/SARA 40CFR302, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg)

EPCRA Section 313: Form R *de minimis* concentration reporting level: 0.1% (inorganic arsenic compounds)

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

United States DOT 49CFR172.101, Inhalation Hazardous Chemical (PIH).

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%. (carcinogen)

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T + , F + , N; risk phrases: R45; R2; R3; R5; R12; R20/21/22; R26; R27/28; R46; R48/20; R50/53; R61; R62; safety phrases: S1; S9; S13; S16; S22; S28; S33; S36/37/39; S41; S45; S53; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Arsine (SA) is an extremely flammable and poisonous, colorless, liquefied compressed gas. Slight garlic-like odor. SA is nonirritating, produces no immediate symptoms, and odor is not an adequate indicator of arsine's (SA) presence, so persons exposed to hazardous levels may be unaware of its presence. The established PEL is 10 times lower than the concentration at which people begin to smell SA (odor threshold of 0.5 ppm and above)[77]. Molecular weight = 77.95. Specific gravity (H_2O:1) = 3.19; boiling point = −63°C; freezing/melting point = −117.2°C; Relative vapor density (air = 1) = 2.69; vapor pressure = 14.9 atm @ 21.1°C; >760 mmHg @ 20°C[77]; flash point = flammable gas. Explosive Limits: LEL: 5.1%; 5100 ppm; UEL: 78%. NFPA 704M Hazard Identification (based on NFPA-704M Rating System): Health 4; flammability 4; reactivity 2. Decomposes @ 300°C. Solubility in water = 20% @ 20°C.

Potential Exposure: Arsine is used in making electronic, semiconductor components; in organic syntheses; and in making lead-acid storage batteries. Arsine may be generated by side reactions or unexpectedly; e.g., it may be generated in metal pickling operations; metal drossing operations; or when inorganic arsenic compounds contact sources of nascent hydrogen. It has been known to occur as an impurity in acetylene. Most occupational exposure occurs in chemical, smelting, and refining industries. It has been used as a poison gas. Cases of exposure have come from workers dealing with zinc, tin, cadmium, galvanized coated aluminum; and silicon and steel metals. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. SA is used as a military poison gas (blood agent). It forms cyanide in the body.

Incompatibilities: Arsine forms explosive mixture with air. SA reacts with strong oxidizers, nitric acid, causing an explosion hazard. Thermally unstable; shock, friction, and concussion sensitive; can explosively decompose. Can explode on contact with warm, dry air. Violent reaction with acids, halogens, mixtures of potassium and ammonia. Decomposes to metallic arsenic (fumes) on exposure to light, moisture or upon decomposition from heat or ignition.

Permissible Exposure Limits in Air

NIOSH IDLH = 3 ppm

odor threshold ≤ 1.0 ppm. The odor is an *unreliable* indicator.

Conversion factor: 1 ppm = 3.19 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 0.05 ppm/0.2 milligram per cubic meter TWA

NIOSH REL: 0.002 milligram per cubic meter [15 min.] Ceiling level, See *NIOSH Pocket Guide*, Appendix A

ACGIH TLV[1]: 0.005 ppm/0.01 milligram per cubic meter TWA

PAC SA* Ver. 29[138]

PAC-1: 0.015 ppm

PAC-2: $\mathbf{0.17_A}$ ppm

PAC-3: $\mathbf{0.50_A}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

Emergency Response Planning Guidelines (DOE)

ERPG-1: Inappropriate

ERPG-2: 0.5 ppm

ERPG-3: 1.5 ppm

Arab Republic of Egypt: TWA 0.05 ppm (0.2 milligram per cubic meter), 1993; Australia: TWA 0.05 ppm (0.2 milligram per cubic meter), 1993; Austria: MAK 0.05 ppm (0.2 milligram per cubic meter), 1999; Denmark: TWA 0.01 ppm (0.03 milligram per cubic meter), 1999; France: VME 0.05 ppm (0.2 milligram per cubic meter), VLE 0.2 ppm (0.8 milligram per cubic meter), 1999; Hungary: TWA 0.05 milligram per cubic meter, STEL 0.1 milligram per cubic meter [skin], 1993; Japan: 0.01 ppm (0.032 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 0.2 milligram per cubic meter, 2003; Norway: TWA 0.003 ppm (0.01 milligram per cubic meter), 1999; the Philippines: TWA 0.05 ppm (0.5 milligram per cubic meter), 1993; Poland: MAC (time-weighted average) 0.2 milligram per cubic meter; MAC (STEL) 0.6 milligram per cubic meter, 1999; Russia: TWA 0.05 ppm, STEL 0.1 milligram per cubic meter, 1993; Sweden: NGV 0.02 ppm (0.05 milligram per cubic meter), 1999; Switzerland: MAK-week 0.05 ppm (0.16 milligram per cubic meter), KZG-week 0.25 ppm, 1999; Thailand: TWA 0.05 ppm (0.2 milligram per cubic meter), 1993; Turkey: TWA 0.05 ppm (0.2 milligram per cubic meter), 1993; United Kingdom: TWA 0.05 ppm (0.16 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South

Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 0.05 ppm. Several states have set guidelines or standards for arsine in ambient air[60] ranging from 0.67 μ/m^3 (New York) to 1.0 μ/m^3 (Connecticut) to 2.0 μ/m^3 (Florida and North Dakota) to 3.3. μ/m^3 (Virginia) to 5.0 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method 6001, OSHA Analytical Method ID-105, ID-125G.

Permissible Concentration in Water: EPA[6] recommends a zero concentration of arsenic for human health reasons. Federal Drinking Water Guidelines: EPA 10 μg/L; State Drinking Water Guidelines: Arizona 10 μg/L; Connecticut 10 μg/L. Toxic pollutant designated pursuant to section 307 (a) (1) of the Clean Water Act and is subject to effluent limitations (arsenic and inorganic and organic arsenic) [40 CFR 401.15 (7/1/1987)]. Canadian Drinking Water Standards: IMAC 0.025 [As] mg/L. Runoff from spills or fire control may cause water pollution.

Determination in Water: See OSHA Analytical Method ID-105 for arsenic. The atomic absorption graphite furnace technique is often used for measurement of total arsenic in water. It also has been standardized by EPA. Total arsenic may be determined by digestion followed by silver diethyldithiocarbamate; an alternative is atomic absorption; another is ICP optical emission spectrometry. Octanol−water coefficient: Log K_{ow} = (estimated) 0.68. Unlikely to bioaccumulate in marine organisms. Very toxic to aquatic life with long-lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Routes of Entry: Inhalation of gas, ingestion, skin contact.

Harmful Effects and Symptoms

Arsine is an extremely toxic gas that can be fatal if inhaled in sufficient quantities. Acute poisoning is marked by a triad of main effects caused by massive intravascular homolysis of the circulating red cells. Early effects may occur within an hour or two and are commonly characterized by general malaise, apprehension, giddiness, headache, shivering, thirst; and abdominal pain with vomiting. In severe acute cases the vomitus may be blood stained and diarrhea ensues as with inorganic arsenical poisoning. Pulmonary edema has occurred in severe acute poisoning. Invariably, the first sign observed in arsine poisoning is hemoglobinuria, appearing with discoloration of the urine up to port wine hue (first to the triad). Jaundice (second of triad) sets in on the second or third day and may be intense, coloring the entire body surface a deep bronze hue. Coincident with these effects is a severe hemolytic-type anemia. Severe renal damage may occur with oliguria or complete suppression of urinary function (third of triad), leading to uremia and death. Severe hepatic damage may also occur, along with cardiac damage and EKG changes. Where death does not occur, recovery is prolonged. In cases where the amount of inhaled arsine is insufficient to produce acute effects, or where small quantities are inhaled over prolonged periods, the hemoglobin liberated by the destruction of red cells may be degraded by the reticuloendothelial system and the iron moiety taken up by the liver, without producing permanent damage. Some hemoglobin may be excreted unchanged by the kidneys. The only symptoms noted may be general tiredness; pallor, breathlessness on exertion; and palpitations as would be expected with severe secondary anemia.

Short-Term Exposure: Inhaling arsine can irritate the lungs, causing shortness of breath and coughing. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. High exposure can cause hemolysis (destruction of red blood cells), causing anemia with headache, weakness, nausea, vomiting and abdominal pain. Acute kidney failure may follow; this can cause death. The symptoms of pulmonary edema are aggravated by physical effort. High concentrations of arsine gas will cause damage to the eyes; however, many experts agree that before this occurs systemic effects can be expected. Skin or eye contact with compressed gas can cause frostbite.

Long-Term Exposure: Arsenic can cause skin damage or problems with circulatory systems, and may have increased risk of cancer. Arsine is carcinogenic to humans. Also, it should be treated as a teratogen. Repeated exposure may damage the nerves, causing weakness, "pins and needles" sensation; weakness in the limbs with loss of coordination. May cause kidney, liver, and heart damage.

Points of Attack: Blood, kidneys, liver, lungs.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. NIOSH lists the following tests: liver function tests; pulmonary function tests; reticulocyte count; urine (chemical/metabolite), hemoglobin; urinalysis (routine); white blood cell count/differential. In preemployment physical examinations, special attention should be given to past or present kidney disease, liver disease, and anemia. Periodic physical examinations should include tests to determine arsenic levels in the blood and urine, CBC with reticulocyte count, kidney and liver function tests; urine hemoglobin, examination of the nervous system; and chest X-ray (following acute exposure). Since arsine gas is a by-product of certain production processes, workers should be trained to recognize the symptoms of exposure and to use appropriate PPE.

First Aid: If a person breathes in large amounts of this chemical, move the exposed person to fresh air at once and perform artificial respiration. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. *Dimercaprol* treatment is indicated and blood transfusions may be necessary. If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water. Seek medical attention immediately. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Note to physician: For severe poisoning BAL (British Anti-Lewisite), Dimercaprol, dithiopropanol ($C_3H_8OS_2$) has been used to treat toxic symptoms of certain heavy metals poisoning—including arsenic. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5). For milder poisoning *penicillamine (not penicillin)* has been used, both with mixed success. Side effects occur with such treatment and it is never a substitute for controlling exposure. It can only be done under strict medical care.

Decontamination: Since arsine is a gas, you don't have to decontaminate victims or yourself. If you don't have the equipment and training, don't enter the hot zone to rescue and treat victims. And, be aware that arsine may be trapped in the victim's clothing.

Personal Protective Methods:

General information: first responders should use a NIOSH-certified CBRN SCBA with a level a protective suit when entering an area with an unknown contaminant or when entering an area where the concentration of the contaminant is unknown. Level a protection should be used until monitoring results confirm the contaminant and the concentration of the contaminant. *Note*: safe use of protective clothing and equipment requires specific skills developed through training and experience.

LEVEL A: (*RED ZONE*): select when the greatest level of skin, respiratory, and eye protection is required. This is the maximum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than the AEGL-2. A NIOSH-certified CBRN full-face-piece SCBA operated in a pressure-demand mode or a pressure-demand supplied air-hose respirator with an auxiliary escape bottle. A TECP suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, and a hard hat worn under the TECP suit are optional items.

LEVEL B: (RED ZONE): Select when the highest level of respiratory protection is necessary but a lesser level of skin protection is required. This is the minimum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than AEGL-2. It differs from Level A in that it incorporates a nonencapsulating, splash-protective, chemical-resistant splash suit that provides Level A protection against liquids but is not airtight. A NIOSH-certified CBRN full-face-piece SCBA operated in a pressure-demand mode or a pressure-demand supplied air-hose respirator with an auxiliary escape bottle. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL C: (YELLOW ZONE): Select when the contaminant and concentration of the contaminant are known and the respiratory protection criteria factors for using APR or PAPR are met. This level is appropriate when decontaminating patient/victims. A NIOSH-certified CBRN tight-fitting APR with a canister-type gas mask or CBRN PAPR for air levels greater than AEGL-2. A NIOSH-certified CBRN PAPR with a loose-fitting face-piece, hood, or helmet and a filter or a combination organic vapor, acid gas, and particulate cartridge/filter combination or a continuous flow respirator for air levels greater than AEGL-1. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Escape mask, face shield, coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL D: (GREEN ZONE): Select when the contaminant and concentration of the contaminant are known and the concentration is below the appropriate occupational exposure limit or less than AEGL-1 for the stated duration times. Limited to coveralls or other work clothes, boots, and gloves.

Notes: Take all necessary precautions to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Eye protection is included in the recommended respiratory protection. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Specific engineering controls are required under OSHA 1910.1018, *Inorganic Arsenic*. See also NIOSH Criteria Document #75-149, *Inorganic Arsenic*. Protective Gloves: Wear Norton chemical protective glove set, Wear chemical goggles; wear a mask/respirator in open areas.

Respirator Selection: **Requirements for Respiratory Protection for Inorganic Arsenicals *With Significant Vapor Pressure*** $<$ or $= 100\ \mu g/m^3$ (micrograms per cubic meter) (1) Half-mask* air-purifying respirator equipped with high-efficiency filter** and acid gas cartridge; or (2) Any half-mask* supplied-air respirator. $<$ or $= 500\ \mu g/m^3$ (1) Front- or back-mounted gas mask equipped with high-efficiency filter** and acid gas canister; (2) Any full-facepiece supplied-air respirator; or (3) Any full-facepiece SCBA. $<$ or $= 10{,}000\ \mu g/m^3$ Half-mask* supplied-air respirator operated in positive-pressure mode. $<$ or $= 20{,}000\ \mu g/m^3$ Supplied-air respirator with full facepiece, hood, or helmet or suit, operated in positive-pressure mode. $> 20{,}000\ \mu g/m^3$, unknown concentrations, or firefighting: Any full-facepiece SCBA operated in positive-pressure mode.

* Half-mask respirators shall not be used for protection against arsenic trichloride, as it is rapidly absorbed through the skin.

** A high-efficiency filter means a filter that is at least 99.97% efficient against mono-dispersed particles of 0.3 μm (micrometers) in diameter or higher.

When used as a weapon, use SCBA Respirator Certified By NIOSH For CBRN Environments. *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFS* [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern]; or SCBAE (any appropriate escape-type, SCBA). *Note*: *Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Check oxygen content prior to entering storage area. Poison gas. (1) Color code—Blue: Health Hazard/ Poison: Store in a secure poison location. This gas is highly toxic. Even slight exposure to these gasses can cause death. Store outdoors in a secure, restricted area that containing warning signs. This area must be roofed and shaded with the cylinders stored off the ground and away from radiant heat sources on nonwooden floors. If indoors, store in a well-ventilated areas in temperatures not to exceed 50°C. (2) Color code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Arsine must be stored to avoid contact with incompatible materials including oxidizers (such as perchlorates, peroxides, permanganates, chlorates and nitrates), since violent reactions occur. Outside, detached storage is preferred. Arsine decomposes and deposits Arsenic on exposure to light and moisture. Sources of ignition, such as smoking and open flames, are prohibited where arsine is handled, used, or stored. Metal containers involving the transfer of arsine should be grounded and bonded. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169 with the recommendations of the Compressed Gas Association. The storage area for flammable toxic gases should have electrical equipment conforming to Article 500 of the National Electrical Code.

Shipping: UN2188 Arsine, Hazard class: 2.3; Labels: 2.3-Poisonous gas, 2.1-Flammable gas, Inhalation Hazard Zone A. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner. Military driver shall be given full and complete information regarding shipment and conditions in case of emergency. AR 50-6 deals specifically with the shipment of chemical agents. Shipments of agent will be escorted in accordance with AR 740-32.

Spill Handling:

Arsine (for SA see below)

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (from a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 500/150
Then: Protect persons downwind (mi/km)
Day 0.6/0.9
Night 2.5/4.1

Large Spills (from a large package or from many small packages)

First: Isolate in all directions(ft/m) 3000/1000
Then: Protect persons downwind (mi/km)
Day 3.6/5.8
Night 7.0 + /11.0 + *

* + means distance can be larger in certain atmospheric conditions.

SA, when used as a weapon

Small spills (from a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 1250/400

Then: Protect persons downwind (mi/km)

Day 1.2/1.9

Night 3.6/5.8

Large Spills (from a large package or from many small packages)

First: Isolate in all directions(ft/m) 3000/1000

Then: Protect persons downwind (mi/km)

Day 5.6/9.0

Night 7.0 + /11.0 + *

* + means distance can be larger in certain atmospheric conditions.

No flares, smoking, or flames in area. Use water spray to reduce vapors. Isolate area until arsine gas has dispersed. Stay upwind; keep out of low areas. Ventilate area of leak to disperse the gas if it can be done without placing personnel at risk. Wear positive-pressure breathing apparatus and full protective clothing. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Stop the flow of gas if it can be done safely, with undue risk. If the source of the leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. Use large amounts of water to disperse vapors; contain runoff. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This gas is under pressure; containers may rupture and explode when heated. Containers may rocket. In case of fire, *do not put out the fire*. Arsine is so bad that the fire is safer than the unburned arsine. If you can shut off the flow of gas don't do anything else—let the fire burn out. Thermal decomposition products may include arsenic and nitrogen oxides. In the unlikely situation where there is a tank of arsine adjacent to a fire, cool the tank with large amounts of water, but first evacuate the area—if the tank ruptures from heating, arsine could kill. Again, arsine gives off toxic gases in a fire or when heated, but these are not as bad as the arsine itself. You can use a water spray to "knock down" the toxic gases coming from an arsine fire. This chemical is a highly flammable gas. Firefighting gear (including SCBA) does not provide adequate protection. If exposure occurs, remove and isolate gear immediately and thoroughly decontaminate personnel. Approach fire from upwind. Fight fire from protected location or maximum possible distance. Let small fires burn out, if possible. Use water spray or foam extinguishers. For massive fire in cargo area use unmanned hose holder or monitor nozzles; if this is impossible, withdraw from area and let fire burn. Cool containers that are exposed to flames with water from the side until well after fire is out. See isolation distances above if tank car or truck is involved in fire. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Arsine may be disposed of by controlled burning. When possible, cylinders should be sealed and returned to suppliers[22]. Seek guidance from regulatory agencies as to proper disposal. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(109); (102); (31); (173); (101); (138); (2); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Arsine, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

New York State Department of Health, Chemical Fact Sheet: Arsine, Albany, NU, Bureau of Toxic Substance Assessment (March 1986).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Arsine, Trenton, NJ (June 1998).

Asbestos A:1590

Formula: $ONa_2Fe_2O_{33}FeO_8SiO_2H_2O$ (Crocidolite); $H_4O_4Si \cdot 1/2H_2O \cdot 3/2Mg$ (Chrysotile)

Synonyms: Amianthus; Amosite; Amphibole; Asbest (German); Asbesto (Spanish); Asbestose (German); Asbestos fiber; Ascarite; Chrysotile (AKA white asbestos); Crocidolite (AKA brown asbestos, Blue asbestos); Fiberous grunerite; Krokydolith (German); Mysorite; NCI-C08991; Serpentine; Tremolite Note: asbestos is a generic name for various hydrated mineral silicates.

CAS Registry Number: 1332-21-4 (no specified type); 77536-66-4 (Actinolite); 12172-73-5 (Amosite); 77536-67-

5 (Anthophyllite); 17068-78-9 (OSHA); 12001-29-5; *(alt.)* 12426-98-1; 61076-97-9 (Chrysotile); 12001-28-4; *(alt.)*: 132207-33-1 (Crocidolite); 77536-68-6 *(alt.)* 14567-73-8 (Tremolite); 81133-20-2 (Ascarite)

HSDB Number: 511

RTECS Number: CI6475000 (No Spec type); CI6476000 (Actinolite); CI6477000 (Amosite); CI6478000 (Anthophyllite); CI6478500 (Chrysotile); CI6479000 (Crocidolite); CI6560000 (Tremolite)

UN/NA & ERG Number: UN2212 [blue asbestos (crocidolite) or brown asbestos (amosite, mysorite)]/171; UN2590 [white asbestos (chrysotile, actinolite,anthophyllite, tremolite)]/171

EC Number: 650-013-00-6

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen; IARC: Human Sufficient Evidence, 1980; Animal Sufficient Evidence, *carcinogenic to humans*, Group 1, 1987. United States Environmental Protection Agency Gene-Tox Program, Positive: Carcinogenicity-mouse/rat; TRP reversion; NCI: Carcinogenesis Studies (Chrysotile) (feed); equivocal evidence: rat NCI: Carcinogenesis Studies (feed); no evidence: hamster; NTP: Carcinogenesis Studies (Chrysotile) (feed): some evidence: rat; NCI: Carcinogenesis Studies (Crocidolite) (feed); no evidence: rat.

California Proposition 65 Chemical[102]: Cancer 2/27/1987.

Hazard Alert: Possible risk of forming tumors, Suspected of causing genetic defects.

Banned or Severely Restricted (several countries) (UN)[13,35]

United States National Primary Drinking Water Regulations: MCGL = 7 MFL; MCL = 7 MFL.

OSHA 29CFR1910 OSHA Specifically Regulated Substances. (See CFR1910.1001)

Clean Air Act, 42USC7412; Title I, Part A, §112 Hazardous Pollutants; § 63.74 List of high risk pollutants, weighting factor: 100

Clean Water Act 40CFR401.15 Section 307 Toxic Pollutants; §307 Priority Pollutants; §313 Priority Chemicals Superfund/EPCRA 40CFR302.4, Appendix A, RQ: 1 lb (0.454 kg), 40CFR372.65: Form R *de minimis* Concentration Reporting Level: 0.1%.

Canada, WHMIS Ingredients Disclosure List Concentration Reporting Level: 0.1%. (carcinogen); NPRI; CEPA Schedule I, Toxic Substances (atmospheric releases from mines and mills) (Amosite asbestos 12172-73-5, carcinogen)

TSCA 40CFR716.120.c6 (asbestiform minerals).

Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)] (as Asbestos: Actinolite 77536-66-4; Anthophyllite 77536-67-5; amosite 12172-73-5; Crocidolite 12001-28-4; Tremolite 77536-68-6).

Hazard symbols, risk, & safety statements: Hazard symbol: T; risk phrases: R45; R48/23; R20/21/22; R27/28; R46; R50/53; R61; R62; safety phrases: S13; S22; S36/37/39; S45; S53 (see Appendix 4)

Description: White or greenish (chrysotile), Blue (crocidolite), or gray-green (amosite) fibrous, odorless solids; freezing/melting point = 600°C (Decomposes). Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 0; reactivity 0. Insoluble in water. Asbestos is a generic term that applies to a number of naturally occurring, hydrated mineral silicates incombustible in air and separable into filaments. The most widely used in industry in the United States is chrysotile, a fibrous form of serpentine. Other types include amosite, crocidolite, tremolite, anthophyllite, and actinolite.

Potential Exposure: Most asbestos is used in the construction industry. Much of it is firmly bonded, i.e., the asbestos is "locked in" in such products as floor tiles, asbestos cements, and roofing felts, and shingles; while the remaining 8% is friable or in powder forms present in insulation materials, asbestos cement powders, and acoustical products. As expected, these latter materials generate more airborne fibers than the firmly bonded products. The asbestos used in nonconstruction industries is utilized in such products as textiles; friction material including brake linings and clutch facings; paper, paints, plastics, roof coatings; floor tiles, and miscellaneous other products. Significant quantities of asbestos fibers appear in rivers and streams draining from areas where asbestos-rock outcroppings are found. Some of these outcroppings are being mined. Asbestos fibers have been found in a number of drinking water supplies, but the health implications of ingesting asbestos are not fully documented. Emissions of asbestos fibers into water and air are known to result from mining and processing of some minerals. Exposure to asbestos fibers may occur throughout urban environments perhaps resulting from asbestos from brake linings and the flaking of sprayed asbestos insulation material. In recent years, much effort has been put into removal of asbestos insulation, particularly from schools and other public buildings where worn or exposed asbestos causes public exposure.

Incompatibilities: None

Permissible Exposure Limits in Air

OSHA PEL: 0.1 asbestos fiber (> 5 μm long)/cc; 1f/cc/30 minutes excursion; carcinogen. [0.1 fiber (longer than 5 μm and having a length-to-diameter ratio of at least 3 to 1) per cubic centimeter of air (0.1 fiber/cm^3), as determined by the membrane filter method at approximately 400X magnification with phase contrast illumination. No worker should be exposed in excess of 1 fiber/cm^3 (excursion limit) as averaged over a sampling period of 30 minutes; Cancer and Lung Disease Hazard]

NIOSH REL: 0.1f/cc (fibers > 5 μm long)/400L; carcinogen. [NIOSH considers asbestos to be a potential occupational carcinogen and recommends that exposures be reduced to the lowest feasible concentration. For asbestos fibers >5 μm in length: 1×10^5 fibers/m^3/0.1 fiber/cm^3 as determined by a 400-liter air sample collected over 100 minutes (see NIOSH Analytical Method #7400)]

ACGIH TLV[1]: (all forms) 0.1f/cc TWA; Confirmed Human Carcinogen

European OEL: 0.1 asbestos fibers/cc (2003)
PAC Ver. 29[138]
asbestos (includes amosite 12172-73-5; ascarite 81133-20-2; chrysotile 1332-21-4)
PAC-1: 0.05 milligram per cubic meter
PAC-2: 0.55 milligram per cubic meter
PAC-3: 3.3 milligram per cubic meter
DFG MAK: Carcinogen Category 1, Confirmed Human carcinogen, (2004)
Austria: carcinogen, 1999; France: VME 0.3 fiber/ml, carcinogen, 1999; Norway: TWA 0.1 fiber/cm^3, 1999; Switzerland: MAK-week 0.25 fiber/ml, carcinogen, 1999; United Kingdom: carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Confirmed Human Carcinogen. Several states have set guidelines or standards for asbestos in ambient air[60] ranging from zero (Massachusetts, Nevada, North Carolina, North Dakota, South Carolina) to 0.001 μ/m^3 (Connecticut) to 0.005 μ/m^3 (Pennsylvania) to 0.005 μ/m^3 (Nevada) to 2.0 μ/m^3 (Virginia) to 5.0 μ/m^3 (New York).

Determination in Air: NIOSH Analytical Method #9002, asbestos (bulk) by PLM, #7402, by PCM #7402, by TEM (Transmission Electron Microscopy), OSHA Analytical Methods ID-160, asbestos in Air, and ID-191, Polarized Light Microscopy of asbestos. NIOSH Analytical Method #9000, asbestos, chrysotile by XRD

Permissible Concentration in Water: Safe Drinking Water Act (47FR 9352): 40CFR141.62, MCL, 7 million fibers/l (longer than 10 μm); 40CFR141.51, MCLG, 7 million fibers/l ($>$ 10 μm); 47FR9352 regulated chemical; 40CFR141.23, inorganic chemical sampling and analytical requirements; 40CFR141.32, public notification requirements To protect freshwater and saltwater aquatic life: no criteria have been established due to insufficient data. *To protect human health*: preferably zero. A lifetime cancer risk of 1 in 100,000 corresponds to concentrations of 300,000 fibers/L[6].

Routes of Entry: Inhalation, ingestion; skin, and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: There is no known acute health effects. Persons who develop serious and fatal diseases later in life may feel fine at the time of exposure.

Long-Term Exposure: Asbestosis (chronic exposure): dyspnea (breathing difficulty), interstitial fibrosis; restricted pulmonary function; finger clubbing; irritation of eyes; (Potential occupational carcinogen). Available studies provided conclusive evidence that exposure to asbestos fibers causes cancer and asbestosis in humans. Lung cancers and asbestosis have occurred following exposure to chrysotile, crocidolite, amosite, and anthophyllite. Mesotheliomas, lung and GI cancers have been shown to be excessive in occupationally exposed persons, while mesotheliomas have developed also in individuals living in the neighborhood of asbestos factories and near crocidolite deposits; and in persons living with asbestos workers. Asbestosis has been identified among persons living near anthophyllite deposits. Likewise, all commercial forms of asbestos are carcinogenic in rats, producing lung carcinomas and mesotheliomas following their inhalation; and mesotheliomas after intrapleural (i.p.) injection. Mesotheliomas and lung cancers were induced following even 1 day's exposure by inhalation. The size and shape of the fibers are important factors; fibers less than 0.5 μm in diameter are most active in producing tumors. Other fibers of a similar size including glass fibers can also produce mesotheliomas following intrapleural or i.p. injection. There are data that show that the lower the exposure, the lower the risk of developing cancer. Excessive cancer risks have been demonstrated at all fiber concentrations studied to date. Evaluation of all available human data provides no evidence for a threshold or for a "safe" level of asbestos exposure.

Points of Attack: Respiratory system, eyes, lungs [cancer site].

Medical Surveillance: OSHA mandates the following: chest X-ray; pulmonary function tests: forced vital capacity, forced expiratory volume (1 sec); NIOSH lists the following tests: chest X-ray; pulmonary function tests: forced vital capacity, forced expiratory volume (1 sec); radiography; sputum cytology; tuberculin skin test. Medical surveillance is required, except where a variance from the medical requirements of this proposed standard have been granted, for all workers who are exposed to asbestos as part of their work environment. For the purposes of this requirement the term "exposed to asbestos" will be interpreted as referring to TWA exposures above 1 fiber/c or peak exposures above 5 fibers/c. The major objective of such surveillance will be to ensure proper medical management of individuals who show evidence of reaction to past dust exposures, either due to excessive exposures or unusual susceptibility. Medical management may range from recommendations as to job placement, improved work practices, cessation of smoking, to specific therapy for asbestos-related disease or its complications. Medical surveillance cannot be a guide to adequacy of current controls when environmental data and medical examinations only cover recent work experience because of the prolonged latent period required for the development of asbestosis and neoplasms. Required components of a medical surveillance program include periodic measurements of pulmonary function [forced vital capacity (FVC) and forced expiratory volume for one second (FEV_1)], and periodic chest roentgenograms (postero-anterior 14 × 17 inches). Additional medical requirement components include a history to describe smoking habits and details on past exposures to asbestos and other dusts and to determine presence or absence of pulmonary, cardiovascular, and GI symptoms, and a physical examination, with special attention to pulmonary rales, clubbing of fingers and other signs related to cardiopulmonary systems. Chest roentgenograms and pulmonary function tests should be performed at least every two years on all employees exposed to asbestos. Such tests should be made annually on individuals: (1) who have a history of 10 or more years of employment involving exposure to asbestos or (2) who show roentgenographic findings (such as small opacities, pleural plaques, pleural thickening or pleural calcification) which suggest or indicate pneumoconiosis or other reactions to asbestos or (3) who have changes in pulmonary function which indicate restrictive or obstructive lung disease. Preplacement medical examinations and medical examinations on the termination of employment of asbestos-exposed workers are also required.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water.

Personal Protective Methods: Prevent skin contact; Any barrier that will prevent contamination from the fiber. Use of respirators can be decided on the basis of TWA or peak concentration. When the limits of exposure to asbestos dust cannot be met by limiting the concentration in the workplace, the employer must utilize a program of respiratory protection and furnishing of protective clothing to protect every worker exposed. *Protective Clothing*: (1) The employer shall provide each employee subject to exposure in a variance area with coveralls or similar full body protective clothing and hat, which shall be worn during the working hours in areas where there is exposure to asbestos dust. Nondisposable clothing should be placed in plastic bags for laundering or decontamination. (2) The employer shall provide for maintenance and laundering of the solid protective clothing, which shall be stored, transported and disposed of in sealed nonreusable containers marked "Asbestos-Contaminated Clothing" in easy-to-read letters. (3) Protective clothing shall be vacuumed before removal. Clothes shall not be cleaned by blowing dust from the clothing or shaking. (4) If laundering is to be done by a private contractor, the employer shall inform the contractor of the potentially harmful effects of exposure to asbestos dust and of safe practices required in the laundering of the asbestos-soiled work clothes. (5) Resin-impregnated paper or similar protective clothing can be substituted for fabric-type of clothing. (6) It is recommended that in tightly contaminated operations (such as insulation and textiles) provisions be made for separate change rooms.

Respirator Selection: $<$ or $= 1 f/cm^3$: (fibers per cubic centimeter) ($10 \times$ PEL): Half-mask air-purifying respirator other than a disposable respirator, equipped with high-efficiency filters*. $<$ or $= 5 f/cm^3$ ($50 \times$ PEL): Full-facepiece air-purifying respirator equipped with high-efficiency filters*. $<$ or $= 10 f/cm^3$ ($100 \times$ PEL) Any powered air-purifying respirator equipped with high-efficiency filters* or any supplied-air respirator operated in continuous-flow mode. $<$ or $= 100 f/cm^3$ ($1{,}000 \times$ PEL): Full-facepiece supplied air respirator operated in pressure-demand mode. $> 100 f/cm^3$ ($1{,}000 \times$ PEL), or unknown concentrations Full-facepiece supplied-air respirator operated in pressure-demand mode, equipped with an auxiliary positive-pressure SCBA.

* A high-efficiency filter means a filter that is at least 99.97% efficient against mono-dispersed particles of 0.3 μm (micrometers) in diameter or higher.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with asbestos workers must be, by law, trained in its proper handling and storage. Asbestos should be stored wet with special surfactants and water. Keep asbestos in closed, impermeable, sealed containers. Protect against physical damage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2212 Blue asbestos (Crocidolite) or Brown asbestos (amosite, mysorite), Hazard class: 9; Labels: 9-Miscellaneous hazardous material. UN2590 White asbestos (chrysotile, actinolite, anthophyllite, tremolite), Hazard class: 9; Labels: 9-Miscellaneous hazardous material.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Proper procedures for repair or removal of the material must be followed by trained personnel. Strict hygiene is required; keep dust under control. Wearing protective equipment, use a wet mop or special high efficiency HEPA vacuum to clean area. Do not use common shop vacuum cleaner. *Note*: Avoid blowing, sweeping or dry brushing, and dry mopping; all of which may raise dust levels. Do not shovel. For storing asbestos wastes, use heavy-gauge impervious plastic bags. For final disposal contact your local environmental authority. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Asbestos itself does not burn. Care should be taken to contain asbestos materials disturbed in a fire. Becomes powder-like and loses its hazardous properties when heated above 1,200°C. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Asbestos may be recovered from waste asbestos slurries as an alternative to disposal. Landfilling is an option[22] for disposal if carefully controlled.

References

(109); (102); (31); (101); (138).

National institute for Occupational Safety and Health (NIOSH), "Criteria for a Recommended Standard:

Occupational Exposure to Asbestos", NIOSH Document Number HSV 72-1-267, Cincinnati, OH (1972).

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United States Environmental Protection Agency, Status Assessment of Toxic chemicals: Asbestos, Report No. EPA-600/2-79-210C, Washington, DC (December 1979).

National Academy of Sciences, Medical and Biologic Effects of Environmental Pollutants: Asbestos, Washington, DC (1971).

National Cancer Institute, asbestos: An Information Resource, DHEW Publication No. (NIH)-79-1681, Bethesda, MD (May 1978).

United States Environmental Protection Agency, asbestos, Health and Environmental Effects Profile No. 12, Washington, DC, Office of Solid Waste (April 30, 1980).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 1, No. 1, 29−31 (1981).

New York State Department of Health, Chemical Fact Sheet: Asbestos, Bureau of Toxic Substance Assessment, Albany, NY (January 1986).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Asbestos, Trenton, NJ (January 2001).

Asphalt and Fumes A:1600

Synonyms: Asphalt and Bitumen fume; Asfalto (Spanish); Asphaltum; Bitumen fume; Judean pitch; Mineral pitch; Petroleum asphalt; Petroleum bitumen; Pitch; Road asphalt; Road tar; Roofing asphalt

CAS Registry Number: 8052-42-4

HSDB Number: 5075

RTECS Number: CI9900000

UN/NA & ERG Number: UN1999 [tars, liquid (including road asphalt and oils, bitumen and cut backs)]/130

EC Number: 232-490-9

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 2B (*extracts of steam and air refined*); Group 3 *(steam refined, cracking residue, and air-refined*) 1987; NTP: Carcinogenesis studies; selected, October 2000; NIOSH has recommended that coal tar pitch volatiles, including PAHs be treated as potential human carcinogen.

California Proposition 65 Chemical[102]: (*if present as coke oven emissions*) Cancer 2/27/1987.

Hazard Alert: Combustible, Possible risk of forming tumors, Suspected reprotoxic hazard.

EPCRA Section 313 Form R *de minimus* concentration reporting level: 0.1%. Form R Toxic Chemical Category Code: N590 as PACs.

Hazard symbols, risk, & safety statements: Hazard symbol: risk phrases: R40; R61; safety phrases: S41; (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): Non hazard to water.

Description: Asphalt fumes are flammable when hot and may contain hydrogen sulfide and human carcinogen, such as benzo(*a*)pyrene and dibenz(*a*,*h*)anthracene. Fumes generated during the production or application of asphalt (a dark-brown to black cement-like substance manufactured by the vacuum distillation of crude petroleum oil). Molecular weight = variable 1000 to 2600; specific gravity (H_2O:1) = 1.0 to 1.8 (no temperature given); boiling point ≥ 300°C; freezing/melting point = 55−175°C; flash point ≤ 10−225°C (as a general rule, the more liquid the type of asphalt, the lower the flashpoint; cutback <10°C; typical asphalt 225°C); Autoignition ≥ 400°C. Hazard identification (based on NFPA-704 M Rating System) (typical asphalt): Health 0; flammability 1; reactivity 0. However, *asphalt cutback* has a flammability rating of 3. Insoluble in water. Hazard identification (based on NFPA-704 M Rating System): *roofer's flux and straight run residue*: Health 0; flammability 1; reactivity 0.

Asphalt fumes have been defined by NIOSH as the nimbose effusion of small, solid particles created by condensation from the vapor state after volatilization of asphalt. In additional to particles, a cloud of fume may contain materials still in the vapor state. The major constituent groups of asphalt are asphaltenes, resins, and oils made up of saturated and unsaturated hydrocarbons. The asphaltenes have molecular weights in the range of 1000−2600, those of the resins fall in the range of 370−500, and those of the oils is the range of 290−630. Asphalt has often been confused with tar because the two are similar in appearance and have sometimes been used interchangeably as construction materials. Tars are, however, produced by destructive distillation of coal, oil or wood, whereas asphalt is a residue from fractional distillation or crude oil. The amounts of benzo(*a*)pyrene found in fumes collected from two different plants that prepared hot mix asphalt ranged from 3 to 22 ng/m^3; this is approximately 0.03% of the amount in coke oven emissions and 0.01% of that emitted from coal-burning home furnaces.

Potential Exposure: Occupational exposure to asphalt fumes can occur during the transport, storage, production, handling, or use of asphalt. The composition of the asphalt that is produced is dependent on the refining process applied to the crude oil, the source of the crude oil and the penetration grade (viscosity) and other physical characteristics of the asphalt required by the consumer. The process for production of asphalt is essentially a closed-system distillation. Refinery workers are therefore potentially exposed to the fumes during loading of the asphalt for transport from the refinery during routine maintenance, such as leaning of the asphalt storage tanks, or during accidental spills. Most asphalt is used out of doors, in paving and roofing. The workers' exposure to the fumes is dependent on environmental conditions, work practices, and other factors. These exposures are stated to be generally intermittent and at low concentrations. Workers are potentially exposed also to skin and eye contacts with hot, cut-back, or emulsified asphalts. Spray application of cut-back, or emulsified asphalts may involve respiratory exposure also.

Incompatibilities: Asphalt and bitumen dust may form explosive mixture with air. *Note*: Asphalt becomes molten at about 93°C. Asphalt burns readily when heated or ignited in the presence of air or oxygen. May be incompatible with strong oxidizing agents like nitric acid. Charring may occur followed by ignition. If heated sufficiently or ignited in the presence of air, oxygen or strong oxidizing agents, can burn exothermically. May be ignited by strong oxidizing agents. Mostly unreactive in other settings. Not affected by aqueous solutions of acids, alkalis, most oxidizing agents, and most reducing agents[101].

Permissible Exposure Limits in Air

OSHA PEL: None

NIOSH REL: 5 milligram per cubic meter 15-minute Ceiling concentration; NIOSH considers asphalt fumes to be a potential occupational carcinogen and recommends that exposures be reduced to the lowest feasible concentration. See Pocket guide, Appendix A.

ACGIH TLV[1]: 0.5 milligram per cubic meter not to be exceeded at any time; not classifiable as a human carcinogen [asphalt (bitumen) fume (8052-42-)] *as benzene-soluble aerosol*; BEI issued (1999)

Asphalt (bitumen) and petroleum asphalt

PAC Ver 29

PAC-1: 30 milligram per cubic meter

PAC-2: 330 milligram per cubic meter

PAC-3: 2000 milligram per cubic meter

DFG MAK: [skin] Carcinogen Category 2, *as bitumen, vapor and aerosol*

Arab Republic of Egypt: TWA 5 milligram per cubic meter, 1993; Australia: TWA 5 milligram per cubic meter, 1993; Belgium: TWA 5 milligram per cubic meter, 1993; Norway: TWA 5 milligram per cubic meter, 1999; Poland: TWA 5 milligram per cubic meter (fume), STEL 15 milligram per cubic meter (fume), 1999; United Kingdom LTEL 5 milligram per cubic meter, STEL 10 milligram per cubic meter, 1993; the Netherlands: MAC-TGG 5 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Not classifiable as a human carcinogen

Occupational exposure to asphalt fumes is defined as exposure in the work-place at a concentration of one-half or more of the recommended occupational exposure limit. If exposure to other chemicals also occurs, as is the case when asphalt is mixed with a solvent, emulsified, or used concurrently with other materials, such as tar or pitch, provisions of any applicable standard for the other chemicals shall also be followed. Occupational exposure to asphalt fumes shall be controlled so that employees are not exposed to the airborne particulates at a concentration greater than 5 milligram per cubic meter (measured as total particulates) of air, determined during any 15-minute period (NIOSH Ceiling Concentration). Several states have set guidelines or standards for asphalt fumes in ambient air[60]: 50 μ/m^3 (North Dakota), 80 μ/m^3 (Virginia), 100 μ/m^3 (Connecticut), 119 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method 5042 "Benzene-soluble fraction and total particulate (asphalt fume)." The total particulate portion of this method is based on NIOSH Analytical Method 0500. Other methods applicable to asphalt fume are NIOSH Analytical Method #5800, PACs, and NIOSH Analytical Method #2550, Benzothiazole in Asphalt Fume.

Routes of Entry: Inhalation of dusts and fumes. Skin exposure can cause thermal burns from hot asphalt.

Harmful Effects and Symptoms

Short-Term Exposure: The principal adverse effects on health from exposure to asphalt fumes are irritation of the serous membranes of the conjunctivae and the mucous membranes of the respiratory tract. Hot asphalt can cause burns of the skin; and release vapors that irritate the eyes, throat, and possible bronchial tubes and lungs.

Long-Term Exposure: In animals, there is evidence that asphalt left on the skin for long periods of time may result in local carcinomas, but there have been no reports of such effects of human skin that can be attributed to asphalt alone.

Points of Attack: Skin, respiratory system. Cancer site in animals: skin tumors. Reproductive system

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Lung function tests, Details of recommended preplacement and periodic physical examinations and record keeping have been set forth by NIOSH in the Criteria Document cited below. Pregnant women should avoid contact. Employees should be notified by a physician that this chemical may affect the reproductive system. In addition to comprehensive initial medical and work histories emphasizing reproductive experience and menstrual history, patient should have physical examination and testing of genito-urinary tract, sperm count, motility and morphology. If required, other tests, such as serum testosterone, serum FSH, and serum LH may be indicated.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if

heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Employees shall wear appropriate protective clothing, including gloves, suits, boots; face shields (8-inch minimum), or other clothing as needed, to prevent eye and/or skin contact with asphalt. NIOSH recommends thermally insulated gloves if working with hot asphalt, long sleeve shirts, long cuffless trousers, and metal-toed shoes. All protective clothing should be clean and available each day, and put on prior to the work-shift.

Respirator Selection: *At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA). Engineering controls shall be used when needed to keep concentrations of asphalt fumes below the recommended exposure limit. The only conditions under which compliance with the recommended exposure limit may be achieved by the use of respirators are: (1) During the time required to install or test the necessary engineering controls. (2) For operations, such as nonroutine maintenance or repair activities, causing brief exposure at concentrations above the environmental limit. (3) During emergencies when concentrations of asphalt fumes may exceed the environmental limit. When a respirator is permitted above, it shall be selected from a list of respirators approved by NIOSH. See the Criteria Document cited below.

Storage: Color code—Red: Flammability Hazard: Store in a flammable materials storage area. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Asphalt is normally shipped solid in steel drums. Fumes are encountered only in asphalt melting operations. Wherever lighter or liquid forms of asphalt are used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN1999 Tars, liquid including road oils and cutback bitumens, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Spilled asphalt is allowed to cool and solidify whereupon it is recovered, melted and used if clean. Ventilate area of spill or leak. Absorb liquid asphalt with sand or other noncombustible absorbent material and place in containers for disposal. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: The lighter, more liquid forms are flammable (especially cutback). The heavier, more solid forms may give off flammable gas when heated. Thermal decomposition products may include hydrogen sulfide. For heavy forms of asphalt, use dry chemical, carbon dioxide; or foam extinguishers. For light forms, use dry chemical, fog, or water mist. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed. Asphalt solids may be landfilled[22].

References

(102); (31); (173); (101); (138); (2); (18); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 2, No. 1, 76–77 (1982).

National institute for Occupational Safety and Health (NIOSH), "Criteria for a Recommended Standard: Occupational Exposure to Asphalt Fumes", NIOSH Document Number 78-106, Cincinnati, OH (September 1977).

New York State Department of Health, Chemical Fact Sheet: Asphalt, Bureau of Toxic Substance Assessment, Albany, NY (March 1986).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Asphalt Fumes, Trenton, NJ (January 2001).

Atrazine A:1610

Formula: $C_8H_{14}ClN_5$

Synonyms: A361; Aatram; Aatrex; Aatrex 4L; Aatrex 80W; Aatrex herbicide; Aatrex Nine-O; Actinite PK; 2-Aethylamino-4-chlor-6-isopropylamino-1,3,5-triazin (German); AI3-28244; Aktikon; Aktikon PK; Aktinit A; Aktinit PK; Argezin; Atazinax; Atranex; Atrasine; Atratol; Atratol A; Atrazin; Atrazin 80; Atrazina (Spanish); Atred;

Atrex; Candex; Cekuzina-T; 2-Chloro-4-ethylamineisopropylamine-*s*-triazine; 1-Chloro-3-ethylamino-5-isopropylamino-*s*-triazine; 1-Chloro-3-ethylamino-5-isopropylamino-2,4,6-triazine; 2-Chloro-4-ethylamino-6-isopropylamino-*s*-triazine; 2-Chloro-4-ethylamino-6-isopropylamino-1,3,5-triazine; 2-Chloro-4-ethylamono-6-isopropylamino-; 6-Chloro-*N*-ethyl-*N*-isopropyl-1,3,5-triazinediyl-2,4-diamine; 6-Chloro-*N*-ethyl-*N′*-(1-methylethyl)-1,3,5-triazine-2,4-diamine; 2-Chloro-4-(2-propylamino)-6-ethylamino-*s*-triazine; Chromozin; Crisatrina; Crisazine; Cyazin; EPA pesticide chemical code 080803; 2-Ethylamino-4-isopropylamino-6-chloro-*s*-triazine; Farmco atrizine; Fenamin; Fenamine; Fenatrol; G30027; Geigy 30,027; Gesaprim; Gesaprim 50; Gesaprim 500 L; Gesoprim; Griffex; Hungazin; Hungazin PK; Inakor; New chlorea; NSC 163046; Oleogesaprim; Penatrol; Plant extract, Corn grown in atrizine-treated soil; Primatol; Primatol A; Primaze; Radazin; Radizine; Residox; Shell Atrazine herbicide; Strazine; Triazine A 1294; *s*-Triazine, 2-chloro-4-(ethylamino)-6-(isopropylamino)-; 1,3,5-Triazine-2,4-diamine,6-chloro-*N*-ethyl-*N′*-(1-methylethyl)-; Tripart Atrazine 50 SC; Vectal; Vectal SC; Weedex; Weedex A; Wonuk; Zeapos; Zeazin; Zeazin 50; Zeazine

CAS Registry Number: 1912-24-9; *(alt.)* 11121-31-6; *(alt.)* 12040-45-8; *(alt.)* 12797-72-7; *(alt.)* 39400-72-1; *(alt.)* 69771-31-9; (alt.) 93616-39-8

HSDB Number: 413

RTECS Number: XY5600000

UN/NA & ERG Number: UN2763 (triazine pesticide, solid, toxic)/151

EC Number: 217-617-8 [*Annex I Index No.*: 613-068-00-7]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Sufficient Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1999. United States Environmental Protection Agency Gene-Tox Program, Positive: Aspergillus-reversion; S *cerevisiae* gene conversion; Negative: *N crassa-aneuploidy*; Inconclusive: D *melanogaster*-whole sex chrom. loss; Inconclusive: D *melanogaster-nondisjunction*; Inconclusive: D *melanogaster* sex-linked lethal.

Hazard Alert: Poison, Endocrine disruptor (high), Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction), Possible sensitization hazard, Environmental hazard.

United States Environmental Protection Agency TSCA Section 8(e) Risk Notification, 8EHQ-0892-8894

United States Environmental Protection Agency, FIFRA 1998 Status of Pesticides: Supported

Water Pollution Standard Set (EPA) (Canada)

United States National Primary Drinking Water Regulations: MCLG = 0.003 mg/L

Safe Drinking Water Act (47FR 9352): 40CFR141.61(c)5, MCL, 0.003 mg/L; 40CFR141.50(b)7, MCGL 0.003 mg/L; 40CFR142.62, Variances and Exceptions from the MCLs; 40CFR9352 Regulated Chemical; 40CFR141.24, Requirements for Sampling and Analytical Testing; 40CFR 141.32 Public Notification Requirements

CERCLA/SARA 40CFR372.65: Form R *de minimis* Concentration Reporting Level: 0.1%.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xn, N, Xi; risk phrases R43; R48/22; R50/53; R62; R63; safety phrases: S2; S29; S36/37; S41; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Atrazine is a white, odorless, crystalline solid or powder which is often mixed with a flammable liquid. Molecular weight = 215.72; boiling point = decomposes; freezing/melting point = 175-177°C; specific gravity (H_2O:1) = 1.19; vapor pressure = 2.9×10^{-7}. Hazard identification (based on NFPA-704 M Rating System): Health 1; flammability 0; reactivity 0. Slightly soluble in water; solubility 0.003%.

Potential Exposure: Atrazine is an herbicide and plant growth regulator used for season-long weed control in corn, sorghum, and certain other crops. Banned for use as a pesticide in the EU. US annual use > 75 millon pounds.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

OSHA PEL: None

NIOSH REL: 5 milligram per cubic meter TWA

ACGIH TLV[1]: 5 milligram per cubic meter TWA; not classifiable as a human carcinogen

No PAC available.

DFG MAK: 2 milligram per cubic meter, inhalable fraction TWA; Peak Limitation Category II(8) (2004)

Australia: TWA 5 milligram per cubic meter, 1993; Austria: MAK 2 milligram per cubic meter, 1999; Belgium: TWA 5 milligram per cubic meter, 1993; Denmark: TWA 0.2 milligram per cubic meter, 1999; France: VME 5 milligram per cubic meter, 1999; Norway: TWA 5 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 5 milligram per cubic meter, 2003; Switzerland: MAK-week 2 milligram per cubic meter, 1999; United Kingdom LTEL 10 milligram per cubic meter, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Several states have set guidelines or standards[60] for atrazine in ambient air ranging from 50 μ/m^3 (North Dakota) to 80 μ/m^3 (Virginia) to 100 μ/m^3 (Connecticut) to 119 μ/m^3 (Nevada).

Determination in Air: Use OSHA versatile sampler-2; Reagent; GC/Electron capture detection; NIOSH #5602.

Permissible Concentration in Water: A maximum level (MCL and MCGL) in drinking water of 0.003 mg/L has been set by EPA[62]. The Canadian Drinking Water IMAC is 0.06 mg/L. A suggested no-adverse-effect-level in drinking water has been calculated by NAS/NRC as 0.15 mg/L. An acceptable daily intake (ADI) of 0.0215 mg/kg/day has been calculated for atrazine[46]. A limit of 0.5 mg/L of atrazine has been specified by Russia[43] in water bodies used for domestic purposes. Also, several states have set guidelines for atrazine in drinking water[61] ranging from 0.093 μg/L (Massachusetts) to 15 μg/L (California) to 25 μg/L (New York) to 43 μg/L (Maine) to 150 μg/L (Kansas).

Determination in Water: Analysis of atrazine is by a gas chromatographic (GC) method applicable to the determination of certain nitrogen-phosphorus containing pesticides in water samples. In this method, approximately 1:1 sample is extracted with methylene chloride. The extract is concentrated, and the compounds are separated using capillary column GC. Measurement is made using a nitrogen phosphorus detector. The method detection limit has not been determined for this compound, but it is estimated that the detection limits for the method analytes are in the range of 0.1−2 μg/L. Fish Tox: 88.31816000 ppb MATC (INTERMEDIATE). Octanol−water coefficient: Log $K_{ow} = 2.3$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, passing through the skin.

Harmful Effects and Symptoms

Atrazine is possibly carcinogenic to humans (IARC: 2B). There is inadequate evidence to confirm carcinogenicity of atrazine in humans. However, there is the increased risk for tumors known to be associated with hormonal factors. These have been observed in both animals and human beings, and are consistent with the known effects of atrazine on the hypothalamic pituitary gonadal axis.

Short-Term Exposure: Contact may cause skin and severe eye irritation.

Long-Term Exposure: Atrazine may be a carcinogen in humans since it has been shown to cause mammary and uterine cancers in animals. There is limited evidence that atrazine may damage the developing fetus. Atrazine may cause skin allergy. Human Tox: 3.00000 ppb (HIGH). Human Tox Type: MCL

Points of Attack: Eyes, skin, respiratory system; CNS; liver.

Medical Surveillance: Evaluation by a qualified allergist. Examination of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water or milk and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof (for liquid) or dust-proof (for powders or dust) chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Should be stored in tightly closed containers away from strong acids.

Shipping: UN2763 Triazine pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Collect spilled dry material in the most convenient and safe manner and deposit in sealed containers for reclamation or for disposal in an approved facility. Absorb liquid containing atrazine in vermiculite, dry sand; earth, or similar material. Treatment technologies which will remove atrazine from water include activated carbon adsorption, ion exchange, reverse osmosis, ozone oxidation and ultraviolet irradiation. Conventional treatment methods have been found to be ineffective for the removal of atrazine from drinking water. Limited data suggest that aeration would not be effective in atrazine removal. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Soil Adsorption Index $K_{oc} = 100$.

Fire Extinguishing: Extinguish fire using an agent suitable for the type of surrounding fire; atrazine itself does not burn. Thermal decomposition products may include hydrogen chloride and nitrogen oxide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Atrazine is hydrolyzed by either acid or base[22]. The hydroxy compounds are generally herbicidally inactive, but their complete environmental effects are uncertain. However, the method appears suitable for limited use and quantities of triazine. Atrazine underwent >99% decomposition when burned in a polyethylene bag, and combustion with a hydrocarbon fuel would appear to be a generally suitable method for small quantities. Combustion of larger quantities would probably require the use of a caustic wet scrubber to remove nitrogen oxides and HCl from the product gases[22].

References

(31); (173); (101); (138); (201); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Atrazine, Trenton, NJ (June 1998).

United States Environmental Protection Agency, “Health advisory: Atrazine, Washington, DC, Office of Drinking Water (September 1987).

Auramine A:1620

Formula: $C_{17}H_{21}N_3$;$(CH_3)_2N\text{-}C_6H_4CNH\text{-}C_6H_4\text{-}N(CH_3)_2$; $(CH_3)_2\text{—}N\text{—}C_6H_4\text{—}(C == NH)\text{—}C_6H_4\text{—}N\text{—}(CH_3)_2 \cdot H_2O$

Synonyms: Apyonine auramarine base; Auramina (Spanish); Auramine; Auramine base; Auramine N base; Auramine OAF; Auramine O base; Auramine SS; Basic yellow 2; Baso yellow 124; Benzeneamine, 4,4′-cabonimidoyl-bis(*N*-dimethyl-); Brilliant oil yellow; 4,4′-Carbonimidoylbis(*N*,*N*-dimethylbenzenamine); C.I. 41000B; C.I. basic yellow 2, free base; C.I. Solvent yellow 34; 4,4′-Dimethylaminobenzophenonimide; Fat Yellow A; Glauramine; 4,4-(Imidocarbonyl)bis (*N*,*N*-dimethylaniline); Tetramethyldiaminodiphenylacetimine; Waxoline yellow O; Yellow pyoctanine

CAS Registry Number: 492-80-8 (technical grade); 2465-27-2 (hydrochloride)

HSDB Number: 2935; 5532 (*hydrochloride*)

RTECS Number: BY3500000; BY3675000 (hydrochloride salt)

UN/NA & ERG Number: UN3143 (dyes, solid, toxic, n.o.s. [or] dye intermediates, solid, toxic, n.o.s.)/151; UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 207-762-5 [*Annex I Index No*.: 612-096-00-7]; 219-567-2 (*hydrochloride*)

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Sufficient Evidence, Human Sufficient Evidence, *carcinogenic to humans*, Group 1; *Technical grade*: Human Possibly Carcinogenic, *possibly carcinogenic to humans*, Group 2B, 1998

California Proposition 65 Chemical[102]: Cancer 7/1/1987

Hazard Alert: Poison, Combustible, Suspected of causing genetic defects, Possible risk of forming tumors.

Banned or Severely Restricted (Italy, Sweden) (UN)[13]

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U014 (as C.I. Solvent Yellow 34)

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 40CFR302.4, Appendix A, RQ: 100 lb (45.4 kg)

CERCLA/SARA 40CFR372.65: Form R *de minimis* Concentration Reporting Level: 0.1%.

Hazardous to aquatic life or environment, with possible long-lasting effects[293]. Toxic to aquatic life with long-lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

European/International Regulations (*492-80-8 and salts*): Hazard symbol: Xn, N; Risk phrases: R45; R22; R36; R40; R51/53; R62; Safety phrases: S2; S36/37; S41; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [2-Hazard to waters (est.)].

Description: Auramine is a yellow crystalline powder or flaky material. Molecular weight = 267.4; freezing/melting point = 136°C. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 1; reactivity 0; (*hydrochloride*) Health 3; flammability 0; reactivity 0. Insoluble in water.

Potential Exposure: Auramine is used industrially as a dye or dye intermediate for coloring textiles; paper, and leather. Also used as an antiseptic (a powerful antiseptic in ear and nose surgery, and treatment of gonorrhea) and fungicide. Human exposure to auramine occurs principally through skin absorption or inhalation of vapors. Low-level dermal exposure to the consumer may occur but would be limited to any migration of auramine from fabric, leather, or paper goods.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air
PAC Ver. 29[138]
2465-27-2, hydrochloride
PAC-1: 0.81 milligram per cubic meter
PAC-2: 8.9 milligram per cubic meter
PAC-3: 53 milligram per cubic meter
technical grade and hydrochloride
DFG MAK: [skin] Carcinogen Category 2
No numerical occupational exposure limits (OELs) have been established. However auramine may be a carcinogen; there may be no safe level of exposure. This chemical can be absorbed through the skin, thereby increasing the potential for exposure. Zero in New York, North Dakota[60] in ambient air.

Determination in Air: NIOSH Analytical Method #5013, Dyes

Routes of Entry: Inhalation, ingestion, skin absorption.

Harmful Effects and Symptoms

Short-Term Exposure: Contact can irritate the eyes, and may cause damage. Skin absorption may result in dermatitis and burns, nausea and vomiting. May cause tumors. May be mutagenic.

Long-Term Exposure: Commercial auramine is carcinogenic in mice and rats after oral administration, producing liver tumors; after subcutaneous injection in rats, producing local sarcomas. The manufacture of auramine (which also involves exposure to other chemicals) has been shown in one study to be causally associated with an increase in bladder cancer. The actual carcinogenic compound(s) has not been specified precisely.

Points of Attack: Liver, bladder.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Monthly urinalysis. Physical exam every 6 months focused on bladder.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls, and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit. *Where there is no REL, at any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with auramine all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN3143 Dyes, solid, toxic, n.o.s. or Dye intermediates, solid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft.(NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Cover with sand and soda ash. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen and carbon. Use water, carbon dioxide; powdered agents or alcohol foam on auramine fires. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Incinerate in furnace with afterburner and scrubber[24].

References

(102); (31); (173); (101); (138); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 1, No. 5, 37−38 (1981).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Auramine, Trenton, NJ (February 2004).

Azacitidine A:1623

Formula: $C_8H_{12}N_4O5$

Synonyms: 5-AC; 4-Amino-1-β-D-ribofuranosyl-1,3,5-triazin-2(1*h*)-one; 4-Amino-1-β-D-ribofuranosyl-D-triazin-2(1*h*)-one; 4-Amino-1-β-D-ribofuranosyl-*S*-triazin-2(1*h*)-one; Antibiotic U-18496; 5′-Azacytidine; 5-Azacytidine; 5 AZC; 5-AZCR; Ladakamycin; MTase inhibitor; Mylosar; NCI-C01569; NSC 102816; NSC 103627; S-Triazin-2(1*H*)-one, 4-amino-1-β-D-ribofuranosyl-; 1,3,5-Triazin-2(1*H*)-one, 4-amino-1-β-D-ribofuranosyl-; U 18496; Vidaza

CAS Registry Number: 320-67-2

HSDB Number: 6879

RTECS Number: XZ3017500

UN/NA & ERG Number: UN3249 (medicine, solid, toxic, n.o.s.)/151

EC Number: 206-280-2

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: probably carcinogenic to humans, *probably carcinogenic to humans*, Group 2A.

California Proposition 65 Chemical[102]: Cancer 1/1/1992

Hazard Alert: Poison, Azicitidine is a regulated prescription drug and subject to labeling and other requirements. Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction).

Hazard symbols, risk, & safety statements: Hazard symbol: T; risk phrases: R45; R34; R36/37/38; R41; R50/53; R61; R62; R63; safety phrases: S1/2; S20/21; S28; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)]

Description: White crystalline solid or powder. Molecular weight = 244.2; freezing/melting point = 228-230°C; vapor pressure = 4×10^{-12} mmHg @ 25°C. Low solubility in water; solubility ≤ 100 g/L @ 25°C.

Potential Exposure: A growth inhibitor (DNA methyltransferase inhibitor). A cytotoxic agent and chemotherapeutic agent used to treat *angina pectoris*, an ischemic heart disease symptom. Occupational exposure to azacitidine could occur among health professionals and support staff (including custodians) by dermal contact, inhalation, or accidental ingestion during drug preparation or administration or cleanup of medical waste, including disposal of excretions from treated patients (Zimmerman *et al*. 1981, NIOSH 2004). The National Occupational Exposure Survey (conducted from 1981 to 1983) estimated that 1069 health-services workers, including 698 women, potentially were exposed to azacitidine[77]. Azacitidine may be produced synthetically or isolated from the bacterium *Streptoverticillium ladakanus* [IARC 1990].

Incompatibilities: Azacitidine is Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Contact with alkali metals, nitrides, and strong reducing agents such as hydrides may form flammable and/or toxic gases. May react with anhydrides forming acids and esters, generating noticeable heat, and also with oxoacids and carboxylic acids to form esters plus water, but the heat of reaction in the latter case typically is low. Keep away from isocyanates and epoxides; may initiate their polymerization. Azacitidine is sensitive to light and oxidation and unstable in solution. It undergoes hydrolysis in aqueous buffers.

Permissible Exposure Limits in Air: No standards or PAC available.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = -3.5$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Dermal contact, inhalation, or accidental ingestion during drug preparation The primary route of human exposure to azacitidine is intravenous or intramuscular injection in patients receiving anticancer therapy.

Harmful Effects and Symptoms

Short-Term Exposure: Symptoms of exposure via intravenous route include nausea, vomiting, diarrhea, reduction in white cell count, leukopenia and agranulocytosis. Other symptoms via intravenous route include dose-related leukemia, thrombocytopenia, myelosuppression, GI upset, alterations in hepatic function tests, fatal hepatic coma, myalgia, rhabdomyolysis, rash, stomatitis, fever, hypotension and reversible renal impairment. Symptoms of exposure to this type of compound include anorexia, local irritant effects, allergic reactions including pruritus and erythema, headache, malaise, weakness, anaphylaxis, vesicant or irritant effect on skin and mucous membranes, thrombophlebitis, anemia, bleeding, immunosuppressant effect, mouth ulcers, esophagitis, abdominal pain, hemorrhage, perforation of the stomach, alopecia, delayed wound healing, amenorrhea, inhibition of spermatogenesis, gynecomastia, hyperuricemia, acute renal failure due to uric acid nephropathy, hyperphosphatemia, disturbances of electrolyte balance, pigmentation of the skin and nails, jaundice and abnormal liver function tests [NCI].

Long-Term Exposure: May cause tumors. Suspected of causing genetic defects. May cause cancer.

Medical Surveillance: This chemical is a known or suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Pregnant women should avoid contact. Employees should be notified by a physician that this chemical may affect the reproductive system. In addition to comprehensive initial medical and work histories emphasizing reproductive experience and menstrual history, patient should have physical examination and testing of genito-urinary tract, sperm count, motility and morphology. If required, other tests, such as serum testosterone, serum FSH, and serum LH may be indicated.

First Aid: *Eyes*: First check the victim for contact lenses and remove if present. Flush victim's eyes with water or normal saline solution for 20 to 30 minutes while simultaneously calling a hospital or poison control center. Do not put any ointments, oils, or medication in the victim's eyes without specific instructions from a physician. Immediately transport the victim after flushing eyes to a hospital even if no symptoms (such as redness or irritation) develop. *Skin*: *Immediately* flood affected skin with water while removing and isolating all contaminated clothing. Gently wash all affected skin areas thoroughly with soap and water. If symptoms such as redness or irritation develop, *immediately* call a physician and be prepared to transport the victim to a hospital for treatment. *Inhalation*: *Immediately* leave the contaminated area; take deep breaths of fresh air. IMMEDIATELY call a physician and be prepared to transport the victim to a hospital even if no symptoms (such as wheezing, coughing, shortness of breath, or burning in the mouth, throat, or chest) develop. Provide proper respiratory protection to rescuers entering an unknown atmosphere. Whenever possible, SCBA (SCBA) should be used; if not available, use a level of protection greater than or equal to that advised under Protective Clothing. INGESTION: *Do not induce vomiting*. If the victim is conscious and not convulsing, give 1 or 2 glasses of water to dilute the chemical and *immediately* call a hospital or poison control center. Be prepared to transport the victim to a hospital if advised by a physician. If the victim is convulsing or unconscious, do not give anything by mouth, ensure that the victim's airway is open and lay the victim on his/her side with the head lower than the body. *Do not induce vomiting*. Immediately transport the victim to a hospital.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Respirator Selection: *At any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA). Where the neat test chemical is weighed and diluted, wear a NIOSH-approved half face respirator equipped with a combination filter cartridge, i.e. organic vapor/acid gas/HEPA (specific for organic vapors, HCl, acid gas, SO_2 and a high efficiency particulate filter)[193].

Storage: Color code—Blue: Health Hazard/Poison (Toxic): Store in a secure, locked and cool, ventilated area. Protect this chemical from exposure to light. Keep the container tightly closed under an inert atmosphere, and store under refrigerated temperatures[193].

Shipping: UN3249 Medicine, solid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: If you spill this chemical, you should dampen the solid spill material with water, then transfer the dampened material to a suitable container. Use absorbent paper dampened with water to pick up any remaining material. Seal your contaminated clothing and the absorbent paper in a vapor-tight plastic bag for eventual disposal. Wash all contaminated surfaces with a soap and water solution. Do not reenter the contaminated area until the Safety Officer (or other responsible person) has verified that the area has been properly cleaned[72].

Fire Extinguishing: Thermal decomposition oxides of nitrogen carbon. Fires involving this material can be controlled with a dry chemical, carbon dioxide or Halon extinguisher. A water spray may also be used[193].

Disposal Method Suggested: It is inappropriate and possibly dangerous to the environment to dispose of expired or waste drugs and pharmaceuticals by flushing them down the toilet or discarding them to the trash. Household quantities of expired or waste pharmaceuticals may be mixed with wet cat litter or coffee grounds, double-bagged in plastic, discard in trash. Larger quantities shall carefully take into consideration applicable DEA, EPA, and FDA regulations. If possible return the pharmaceutical to the manufacturer for proper disposal being careful to properly label and securely package the material. Alternatively, the waste pharmaceutical shall be labeled, securely packaged and transported by a state licensed medical waste contractor to dispose by burial in a licensed hazardous or toxic waste landfill or incinerator.

References

(109); (102); (31); (173); (101); (138); (100).

Azadirachtin A:1624

Formula: $C_{35}H_{44}O_{16}$

Synonyms: AZATIN-O; Dimethyl (2aR,3S,4S,4aR,5S,7aS,8S,10R,10aS,10bR)-10-acetoxy-3,5-dihydroxy-4-[(1aR,S,3aS,6aS,7S,7aS)-6a-hydroxy-7a-methyl-3a,6a,7,7a-tetrahydro-2,7-methanofuro[2,3-b]oxireno[e]oxepin-1a(2*H*)-yl]-4-methyl-8-[[(2E)-2-methylbut-2-enoyl]oxy}octahydro-1*H*-naphtho[1,8a-c:4,5-b′c′]difuran-5,10a(8*H*)-dicarboxylate Dimethyl (2aR,3S,4S,R,S,7aS,8S,10R,10aS,10bR)-10-(acetyloxy)-3,5-dihydroxy-4-[(1S,2S,6S,8S,9R,11S)-2-hydroxy-11-methyl-5,7,10-trioxatetracyclo[6.3.1.02,6.09,11]dodec-3-en-9-yl]-4-methyl-8-[[(2E)-2-methylbut-2-enoyl]oxy] octahydro-1*H*-furo[3′,4′:4,4a]naphtho[1,8-bc]furan-5,10a (8*H*)-dicarboxylate; EPA Reg. No. 70051-9-59807

CAS Registry Number: 11141-17-6 (A-); 95507-03-2 (B-); 118855-02-0 (F-); 134788-15-1 (H-); 134788-16-2 (I-)

HSDB Number: 7372

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

Regulatory Authority and Advisory Information

Hazard Alert: Combustible, Sensitization hazard (skin); Agricultural chemical.

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xi, Xn; risk phrases: R22; R36/37; R43; R50/53; safety phrases: S1; S24/25; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Off-white, yellowish powder or dark brown emulsifiable concentrate. Molecular weight = 720.7 (A-); 662 (B-); freezing/melting point = 159°C; flash point ≥ 100°C. Hazard identification (based on NFPA-704 M Rating System): Health 1; flammability 2; reactivity 0. Insoluble in water. Carrier solvents used in commercial formulations may change physical and toxicological properties.

Potential Exposure: Biological tetranortriterpinoid insecticide; insect growth regulator. A natural product extracted from seeds of the Neem tree (*Azadirachta indica*).

Incompatibilities: Powder or liquid may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, reducing agents and metals, acid chlorides, alkalis, alkali metals, high heat, including sunlight.

Permissible Exposure Limits in Air:

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Routes of Entry: Skin, eyes, inhalation, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Eye and skin contact may cause mild to severe irritation or other temporary injury. Toxic if swallowed. LD_{50} = (oral-rat) 5 g/kg; LD_{50} = (dermal-rat) >2 g/kg

Long-Term Exposure: Constant exposure may cause skin sensitization.

Points of Attack: Skin.

Medical Surveillance: Evaluation by a qualified allergist.

First Aid: Eyes: First check the victim for contact lenses and remove if present. Flush victim's eyes with water or normal saline solution for 20 to 30 minutes while simultaneously calling a hospital or poison control center. Do not put any ointments, oils, or medication in the victim's eyes without specific instructions from a physician. Immediately transport the victim after flushing eyes to a hospital even if no symptoms (such as redness or irritation) develop. *Skin*: Immediately flood affected skin with water while removing and isolating all contaminated clothing. Gently wash all affected skin areas thoroughly with soap and water. If symptoms such as redness or irritation develop, immediately call a physician and be prepared to transport the victim to a hospital for treatment. *Inhalation*: Immediately leave the contaminated area; take deep breaths of fresh air. If symptoms (such as wheezing, coughing, shortness of breath, or burning in the mouth, throat, or chest) develop, call a physician and be prepared to transport the victim to a hospital. Provide proper respiratory protection to rescuers entering an unknown atmosphere. Whenever possible, SCBA (SCBA) should be used; if not available, use a level of protection greater than or equal to that advised under Protective Clothing. *Ingestion*: *Do Not induce vomiting*. If the victim is conscious and not convulsing, give 1 or 2 glasses of water to dilute the chemical and immediately call a hospital or poison control center. Be prepared to transport the victim to a hospital if advised by a physician. If the victim is convulsing or unconscious, do not give anything by mouth, ensure that the victim's airway is open and lay the victim on his/her side with the head lower than the body. Do Not induce vomiting. Immediately transport the victim to a hospital.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where risk assessment shows air-purifying respirators are appropriate, use a full-face respirator type (N100) United States or Type P3 (EN-143) respirators as backup to engineering controls. If the respirator is the sole means of protection, use a full-face supplied respirator. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

Storage: Keep locked up in a cool, dark place or refrigerator. Safe Storage of Pesticides: Always store pesticides in their original containers, complete with labels that list ingredients, directions for use, and first aid steps in case of accidental poisoning. Never store pesticides in cabinets with or near food, animal feed, or medical supplies. Do not store pesticides in places where flooding is possible or in places where they might spill or leak into wells, drains, ground water, or surface water[72].

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Stay upwind and uphill. Isolate the area of release or fire and deny entry. Remove all ignition sources. All equipment used to handle this material must be grounded. If material or contaminated runoff from fire control enters waterways, notify downstream users of potentially contaminated water. Wear positive-pressure, SCBA (SCBA). Wear chemical protective clothing which is specifically recommended by the manufacturer. Structural firefighter's protective clothing provides only limited protection. *Release, no fire*. Prevent dust cloud. Small spill: Cover with sand or other noncombustible material and place in a container for later disposal. Cover powder spills with plastic sheet or tarp to minimize spreading and protect from wind, rain, or spray. Large spill: Stop the release if it can be done safely from a distance. Prevent material and runoff from entering sewers and waterways if it can be done safely well ahead of the release. Use large amounts of water well away from release to disperse vapors—contain runoff. Ventilate confined area if it can be done without placing personnel at risk.

Fire Extinguishing: Liquid may be flammable. *Small fire*: Use dry chemical, CO_2, water spray, or polymer foam. *Large fire*: Use water spray, fog, or regular foam. Do not scatter spilled material with high pressure water streams. Dike fire-control water for later disposal. IF material is not leaking, cool exposed containers with large quantities of water from unattended equipment until fire is well out, or remove intact containers if it can be done safely. If cooling streams are ineffective (*venting sound increases in volume and pitch, tank discolors or shows signs of deforming*), withdraw immediately to a secure location. Always stay away from ends of tanks, especially when engulfed in flames. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156.

Disposal Method Suggested: Waste product may be disposed of onsite (open dumping may be prohibited) or at an approved waste disposal facility. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (178)(100).

Azathioprine A:1630

Formula: $C_9H_7N_2O_2S$

Synonyms: Azanin azatioprin; Azothioprine; BW 57-322; Ccucol; Imuran; Imurek; Imurel; 6-(1′-Methyl-4′-nitro-5′-imidazolyl)-mercaptopurine; Methylnitroimidazolylmercaptopurine; 6-(1-Methyl-*p*-nitro-5-imidazolyl)-thiopurine; 6-(1-Methyl-4-nitroimidazol-5-ylthio)purine; 6-(Methyl-*p*-nitro-5-imidazolyl)-thiopurine; 6-[(1-Methyl-4-nitro-1*H*-imidazol-5-yl)thio]-1*H*-purine; 6-[(1-Methyl-4-nitroimidazol-5-yl)thio]purine; NCI-C03474; NSC-39084; Rorasul

CAS Registry Number: 446-86-6

HSDB Number: 7084

RTECS Number: UO8925000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 207-175-4

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen; IARC: Human

Sufficient Evidence, 1980; Animal Limited Evidence, *carcinogenic to humans*, Group 1, 1998

California Proposition 65 Chemical[102]: Cancer; Developmental/Reproductive toxin.

Hazard Alert: Poison, Immunosuppressant, Antineoplastic, Antirheumatic drug; Reproductive toxin.

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xi, Xn; risk phrases: R45; R20/21/22; R36/37/38; R61; R62; safety phrases: S22; S26; S36/37; S41; S45; S53 (see Appendix 4).

Description: Azathioprine is a complex heterocyclic compound which forms pale yellow crystals. Molecular weight = 277.3; freezing/melting point = 243−244°C (decomposes). Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 0; reactivity 0.

Potential Exposure: Azathioprine is an immunosuppressive agent, generally used in combination with a corticosteroid to prevent rejection following renal homotransplantations. It also is used following transplantation of other organs. Other uses of azathioprine include the treatment of a variety of presumed autoimmune diseases, including rheumatoid arthritis; ankylosing spondylitis; systemic lupus erythematosus; dermatonyositis, periarteritis nodosa, scleroderma, refractory thombocytopenic purpura; autoimmune hemolytic anemia; chronic active liver disease; regional enteritis; ulcerative colitis; various autoimmune diseases of the eye; acute and chronic glomerulonephritis; the nephritic syndrome; Wegener's granulomatosis; and multiple sclerosis.

Incompatibilities: Incompatible with reducing agents, such as hydrides (may cause the release of explosive gases), oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong acids (violent exothermic reaction), strong bases.

Permissible Exposure Limits in Air

No standards or PAC available.

Permissible Concentration in Water: Octanol−water coefficient: Log $K_{ow} = 0.1$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Human exposure to azathioprine occurs because of its widespread use, since the 1970s, to prevent rejection following organ transplantation and to treat a variety of autoimmune diseases. Azathioprine is readily absorbed from the gut and is known to cross the human placenta.

Harmful Effects and Symptoms

There is sufficient evidence that azathioprine is carcinogenic in humans. Two large prospective studies of kidney transplant patients (receiving azathioprine and prednisone almost routinely) showed that these patients experienced increased incidences of nonHodgkin's lymphomas, cancer of the skin, hepatobiliary carcinoma and other tumors. Patients treated with azathioprine, but not transplant recipients, showed an increased incidence of the same cancers as patients with transplants, but to a lesser extent. Mice receiving azathioprine by intraperitoneal, subcutaneous or intramuscular injection had suggestive evidence of induced lymph system neoplasms. Rats given azathioprine orally had suggestive evidence of induced ear cancers. Results of the animal studies provide limited evidence of carcinogenicity. Among reported symptoms of azathioprine exposure are bone-marrow depression, especially leukopenia[52]; toxic hepatitis and jaundice, stomatitis, dermatitis, hair loss; fever; anorexia, vomiting and diarrhea. It is a developmental toxicant and suspected toxicant of the following systems: cardiovascular or blood-, respiratory, GI, liver, kidney, musculo-skeletal, respiratory.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Pregnant women should avoid contact. Employees should be notified by a physician that this chemical may affect the reproductive system. In addition to comprehensive initial medical and work histories emphasizing reproductive experience and menstrual history, patient should have physical examination and testing of genitourinary tract, sperm count, motility and morphology. If required, other tests, such as serum testosterone, serum FSH, and serum LH may be indicated.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Respirator Selection: *At any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved SCBA that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full-face-piece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in a refrigerator under an inert atmosphere[52]. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft.(NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Remove all ignition sources. Dampen spilled material with toluene to avoid airborne dust. Seal the accumulated wastes in vapor-tight plastic bags for eventual disposal. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include nitrogen and sulfur oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(109); (102); (31); (173); (101); (138).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 1, No. 4, 36−37 (1981).

Azobenzene A:1660

Formula: $C_{12}H_{10}N_2$; $C_6H_5N=NC_6H_5$

Synonyms: Azobenzide; Azobenzol; Azobisbenzene; Azodibenzene; Azodibenzeneazofume; Benzeneazobenzene; Diazobenzene; 1,2-Diphenyldiazene; Diphenyldiazene; Diphenyldiimide; NCI-C02926

CAS Registry Number: 103-33-3

HSDB Number: 1513

RTECS Number: CN1400000

UN/NA & ERG Number: UN2811 (Toxic solids, organic, n.o.s.)/154

EC Number: 203-102-5 [*Annex I Index No.*: 611-001-00-6]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Limited Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1987; NCI: Carcinogenesis Bioassay (feed); clear evidence: rat; no evidence: mouse; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies.

California Proposition 65 Chemical[102]: Cancer 1/1/1990

Hazard Alert: Poison, Combustible, Chemically unstable, Possible risk of forming tumors, Suspected of causing genetic defects, Explosion hazard, Environmental hazard.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R45; R20/22; R48/22; R68; R50/53; R62 safety phrases: S29; S53; S41; S46; S60; S61; S62 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Azobenzene is a combustible, orange-red crystalline solid. Molecular weight = 182.2; boiling point = 293°C (decomposes); freezing/melting point = 68°C; vapor pressure = 7.6×10^{-5}. Hazard identification (based on NFPA-704 M Rating System): Health 1; flammability 1; reactivity 0. Insoluble in water.

Potential Exposure: An azo compound. Those engaged in azobenzene use in dye, rubber, chemical, and pesticide manufacturing.

Incompatibilities: Azo compounds can detonate. This applies in particular to organic azides that have been sensitized by the addition of metal salts or strong acids. Toxic gases are formed by mixing materials of this class with acids, aldehydes, amides, carbamates, cyanides, inorganic fluorides, halogenated organics, isocyanates, ketones, metals, nitrides, peroxides, phenols, epoxides, acyl halides, and strong oxidizing or reducing agents. Flammable gases are formed by mixing materials in this group with alkali metals. Explosive combination can occur with strong oxidizing agents, metal salts, peroxides, and sulfides. This chemical is sensitive to prolonged exposure to heat. This chemical is incompatible with strong oxidizing agents[101].

Permissible Exposure Limits in Air

No standards or PAC available.

Determination in Water: Octanol−water coefficient: Log $K_{ow} \geq 3.5$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, ingestion, skin absorption.

Harmful Effects and Symptoms

Short-Term Exposure: Azobenzene irritates the eyes, skin and respiratory tract. In serious cases there is a risk of unconsciousness and death. The consumption of alcohol may exacerbate toxic effects. The oral LD_{50} for rat is 1000 mg/kg.

Long-Term Exposure: A potential carcinogen. Can affect the blood and cause liver disorders.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Liver function tests. CBC.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Specific respirator(s) have not been recommended by NIOSH. However, based on potential carcinogenicity, and where the potential exists for exposure, the following might be considered:

At any detectable concentration: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air-purifying, full facepiece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store under an inert atmosphere in a freezer or refrigerator. Protect from air and light[52]. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft.(NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Dampen spilled material with alcohol to avoid dust. Transfer to vapor-tight plastic bags for eventual disposal. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include oxides of nitrogen and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(102); (31); (173); (101); (138); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 1, No. 3, 35–36 (1981) and 7, No. 1, 38–47 (1987).

Azodiisobutyronitrile A:1670

Formula: $C_8H_{12}N_4$; $NCC(CH_3)_2N = NC(CH_3)_2CN$
Synonyms: Aceto azib; AIBN; 2,2′-Azobis(2-cyanopropane); Azodiisobutironitrilo (Spanish); α,α′-Azobisisobutylonitrile; α,α′-Azodiisobutyric acid dinitrile; 2,2′-Azobis(isobutyronitrile); α,α′-Azodiisobutyric acid dinitrile; *N*,*N*′-Azobis(isobutyronitrile); Azobis (isobutyronitrile) (French); Azobisisobutyronitrile; 2,2′-Azobis(2-methylpropionitrile); α,α′-Azodiisobutyronitrile; 2,2′-Azodiisobutyronitrile; α,α′-Azodiisobutyronitrile; Azodiisobutyronitrile; AZDH; CHKHE 57; CHKHZ 57; 2,2′-Dimethyl-2,2′-azodipropionitrile; *N*,*N*′-Bis(2-cyano-2-propyl)diazene; 2,2′-Dicyano-2,2′-azopropane; Genetron AZDN; Genetron AZDN-FF; KB-P 13; KE-P 13; Perkadox aibn; Pianofor AN; Porofor CHKHZ 57; Porofor N; Propionitrile, 2,2′-azobis[2-methyl-; POLY-ZOLE AZDN; POROFOR 57; V-60 (polymerization catalyst); VAZO 64
CAS Registry Number: 78-67-1
HSDB Number: 5220
RTECS Number: UG0800000
UN/NA & ERG Number: UN3234/150 (P)
EC Number: 201-132-3 [*Annex I Index No.*: 608-019-00-1]
Regulatory Authority and Advisory Information

Hazard Alert: Highly flammable solid, Polymerization hazard.

United States Environmental Protection Agency TSCA Section 8(e) Risk Notification, 8EHQ-0892-8909.

Hazardous to aquatic life or environment, with possible long-lasting effects[194]. Harmful to aquatic life with long-lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & safety statements: Hazard symbol: E, Xn, N; risk phrases: R2; R11; R19; R20/22; R52/53; safety phrases: S2; S39; S41; S47; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Azobisisobutylonitrile is a white crystalline compound. Molecular weight = 164.23; specific gravity (H_2O:1) = 1.11 @ 25°C; boiling point = decomposes; freezing/melting point = (decomposes) 99–103°C; Autoignition temperature = 63°C. NFPA 704M Hazard Identification (based on NFPA-704M Rating System): Health 3; flammability 3; reactivity 3. Insoluble in water.

Potential Exposure: Azobisisobutylonitrile is both a nitrile and azo compound. Used as a polymerization initiator, free radical generator (or initiator); as a catalyst in vinyl polymerizations; as a blowing agent for elastomers and plastics.

Incompatibilities: Flammable; dust may form explosive mixture with air. Unstable and easily oxidized material; keep away from oxidizers, strong acids. Keep at temperature not $\geq 30°C$ (this may vary by manufacturer). Risk of explosion from heat, shock, friction. Warming causes production of tetramethylsuccinonitrile and cyanide fumes. Keep away from acetone and other ketones, alcohols, lithium, aluminum, aldehydes, and hydrocarbons, such as heptane. Azo compounds can detonate. This applies in particular to organic azides that have been sensitized by the addition of metal salts or strong acids. Toxic gases are formed by mixing materials of this class with acids, aldehydes, amides, carbamates, cyanides, inorganic fluorides, halogenated organics, isocyanates, ketones, metals, nitrides, peroxides, phenols, epoxides, acyl halides, and strong oxidizing or reducing agents. Flammable gases are formed by mixing materials in this group with alkali metals. Explosive combination can occur with strong oxidizing agents, metal salts, peroxides, and sulfides. This chemical is sensitive to prolonged exposure to heat. This chemical is incompatible with strong oxidizing agents[101].

Permissible Exposure Limits in Air

PAC Ver. 29[138]
PAC-1: 4.1 milligram per cubic meter
PAC-2: 45 milligram per cubic meter
PAC-3: 130 milligram per cubic meter
NIOSH REL: (nitriles) 2 ppm, Ceiling Concentration, not to be exceeded in any 15-minute work period.

Determination in Air: NIOSH Analytical Method #7904 (Cyanides). See also NIOSH Criteria Document 212 *Nitriles*

Permissible Concentration in Water: No criteria set. May be harmful to aquatic organisms.

Determination in Water: Octanol–water coefficient: Log $K_{ow} = 1.1$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, skin contact, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Azodiisobutyronitrile can affect you by passing through your skin. Contact can cause irritation to the eyes and skin. Inhalation can irritate the nose and throat, causing wheezing and coughing. High exposure can cause dizziness, vomiting, abdominal pain; flushing, headache, shortness of breath; and coma. Convulsions and death may follow.

Long-Term Exposure: Azodiisobutyronitrile may cause liver and kidney damage. See NIOSH Criteria Document 212 *Nitriles*.

Points of Attack: Respiratory system, liver.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: blood cyanide level. Liver and kidney function tests. Consider thyroid evaluation and CBC.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek

medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. *Note*: Use amyl nitrate capsules if symptoms develop. All area employees should be trained regularly in emergency measures for cyanide poisoning and in CPR. A cyanide antidote kit should be kept in the immediate work area and must be rapidly available. Kit ingredients should be replaced every 1-2 years to ensure freshness. Persons trained in the use of this kit; oxygen use, and CPR must be quickly available.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See NIOSH Criteria Document 212 *Nitriles*.

Respirator Selection: Where there is potential exists for exposures to azodiisobutyronitrile, use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

NIOSH (*as cyanides*): *25 milligram per cubic meter*: Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFS100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern and having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Red Stripe: Flammability Hazard: Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Azodiisobutyronitrile must be stored to avoid contact with acetone, lithium, aluminum hydride, and water, since violent reactions occur. Azodiisobutyronitrile is self-reactive and will explode at elevated temperatures. It should be stored under nitrogen, dry ice or ice. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN3234 Self-reactive solid type C, temperature controlled materials, Hazard Class: 4.1; Labels: 4.1-Flammable solid, Technical Name Required.

Spill Handling:

Nitriles

Initial isolation and protective action distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.1/0.2

Large spills (from a large package or from many small packages)

First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.3/0.5
Night 0.5/0.8

Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Do not sweep or raise dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. *Do not use water or wet method*. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Azodiisobutyronitrile may self-ignite at elevated temperatures. Use dry chemical, CO_2, water spray; or foam extinguishers. Use water spray to keep fire-exposed containers cool. Thermal decomposition products may include oxides of nitrogen, tetramethylsuccinonitrile, and cyanide fumes. Containers may explode in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Azodiisobutyronitrile, Trenton, NJ (November 1998).

Azoxystrobin A:1680

Formula: $C_{22}H_{17}N_3O_5$

Synonyms: Amistar fungicide; (αE)-2-[[6-(2-Cyanophenoxy)-4-pyrimidinyl]oxy]-α-(methoxymethylene) benzeneacetic acid methyl ester; Heritage Fungicide; ICIA5504; Methyl (E)-2-[2-(6-(2-cyanophenoxy)pyrimidin-4-yloxy)phenyl]-3-methoxyacrylate

CAS Registry Number: 131860-33-8

HSDB Number: 7017

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154; UN3082/177

EC Number: 607-256-00-8

Regulatory Authority and Advisory Information

Carcinogenicity: EPA, Not Likely to be Carcinogenic to Humans

Hazard Alert: Poison, Combustible, Agricultural chemical, Environmental hazard.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & safety statements: Hazard symbol: T, N; risk phrases: R23; R50/53; safety phrases: S22; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)]

Description: White to beige crystalline solid or powder. Molecular weight = 403.4; specific gravity = 1.33; freezing/melting point = 116°C[72]; vapor pressure = 3 to 8.25×10^{-13} mmHg @ 20°C; Henry's Law constant = 7×10^{-14} atm m^3/mol @ 25°C (est)[72]; hazard identification (based on NFPA-704 M Rating System): Health 1; flammability 2; reactivity 0. Soluble in water; solubility = 6−10 mg/L @ 20°C. Physical and toxicological properties may be affected by the carrier solvents used in commercial formulations.

Potential Exposure: A β-methyoxyacrylate, Strobilurin is an agricultural fungicide.

Incompatibilities: Combustible; dust may form explosive with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air:

2 milligram per cubic meter TWA (recommended by Syngenta, makers of Amistar fungicide)

Determination in Water: Octanol−water coefficient: Log $K_{ow} \leq 2.5$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, absorption through the unbroken skin.

Harmful Effects and Symptoms

Short-Term Exposure: Slightly to moderately toxic by ingestion, inhalation and skin absorption. May cause skin, eye and respiratory system irritation. LD_{50} = (oral-rat) >2 g/kg; LD_{50} = (dermal-rat) >5 g/kg.

Long-Term Exposure: Possible mutagen; in vitro test were positive for the induction of chromosomal aberrations in human lymphocytes assay[72]. May cause DNA damage. May cause liver damage.

Points of Attack: Liver and possibly the reproductive system.

Medical Surveillance: In addition to comprehensive initial medical and work histories emphasizing reproductive experience and menstrual history, patient should have physical examination and testing of genito-urinary tract, sperm count, motility and morphology. If required, other tests, such as serum testosterone, serum FSH, and serum LH may be indicated.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear positive-pressure, SCBA (SCBA). Wear chemical protective clothing which is specifically recommended by the manufacturer. Structural firefighter's protective clothing provides only limited protection.

Respirator Selection: Where there is potential exists for exposure to azoxystrobin, use respirators and components tested and approved under appropriate government standards: NIOSH/MSHA or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full-face-piece, hood, or helmet in the continuous flow mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Store in a cool, dry place away from oxidizers. Always store pesticides in their original containers, complete with labels that list ingredients, directions for use, and first aid steps in case of accidental poisoning. Never store pesticides in cabinets with or near food, animal feed, or medical supplies. Do not store pesticides in places where flooding is possible or in places where they might spill or leak into wells, drains, ground water, or surface water.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN3082 Environmentally hazardous substances, liquid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft.(NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Stay upwind and uphill. Isolate the area of release or fire and deny entry. Remove all ignition sources. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Cover with plastic sheet to prevent spreading and to protect it from wind, rain or spray. Absorb or cover with *dry* sand, sand or other noncombustible material and transfer to containers clean up spill promptly. Don't wash it away. Instead, sprinkle the spill with sawdust, vermiculite, or kitty litter. Sweep it into a plastic garbage bag, and dispose of it as directed on the pesticide product label[72]. Stop the release if it can be done safely from a distance. Prevent material and runoff from entering sewers and waterways if it can be done safely well ahead of the release. Use large amounts of water well away from release to disperse vapors—contain runoff. Water spray may reduce vapor, but may not prevent ignition in enclosed spaces. Ventilate confined area if it can be done without placing personnel at risk. If in a building, evacuate the building and confine vapors by closing doors and shutting down HVAC system.

Fire Extinguishing: Thermal decomposition products may include toxic oxides of nitrogen and carbon. Small fire: Use dry chemical, CO_2, or water spray. Large fire: Use *dry* chemical, CO_2, alcohol-resistant foam, or water spray. Keep exposures cool to protect against reignition. Do not direct straight streams into the liquid. Cool exposed containers with large quantities of water from unattended equipment or remove intact containers if it can be done safely. *Do not allow water to get inside containers.* If cooling streams are ineffective (*venting sound increases in volume and pitch, tank discolors or shows signs of deforming*), withdraw immediately to a secure location. Always stay away from ends of tanks, especially when engulfed in flames. If material or contaminated runoff from fire control enters waterways, notify downstream users of potentially contaminated water. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156.

Disposal Method Suggested: Recycle any unused portion of the material for its approved use or return it to the manufacturer or supplier. Dispose of contents and container to an approved waste disposal plant. Use a licensed professional waste disposal service to dispose of this material. Ultimate disposal of the chemical, product, and waste containers must consider: the material's impact on air quality; potential migration in soil or water; effects on animal and plant life; and conformance with public health, local, state, and federal health and environmental regulations. Never reuse or recycle used product containers unless the recycling program specifically accepts pesticide containers and you follow the program's instructions for preparing the empty containers for collection

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency Office of Prevention, Pesticides & Toxic Substances (7501C), Pesticide Fact Sheet: Azoxystrobin. Conditional Registration. August 22, 2000. Washington, DC.

United States Environmental Protection Agency/Prevention, Pesticides, and Toxic Substances; Citizen's Guide to Pest Control and Pesticide Safety p. 20 (March 2005) EPA 730-K-04-002].

Syngenta Crop Protection, Inc, Amistar fungicide MSDS, RSVP#: SCP-955-00434C, Greensboro, NC, 3/21/2005.

B

Bacitracin B:0050

Formula: $C_{66}H_{103}N_{17}O_{16}S$
Synonyms: Ayfivin; Baciguent; Baci-Jel; Baciliquin; Bacitek ointment; Fortracin; Parentracin; Penitracin; Topitracin; Zutracin
CAS Registry Number: 1405-87-4
HSDB Number: 6418
RTECS Number: CP0175000
UN/NA & ERG Number: UN3249 (medicine, solid, toxic, n.o.s.)/151
EC Number: 215-786-2
Regulatory Authority and Advisory Information
Hazard Alert: Poison, Combustible, Sensitization hazard.
Listed on the TSCA inventory.
List of Acutely Toxic Chemicals, Chemical Emergency Preparedness Program (EPA) and formerly on CERCLA/SARA 40CFR302, Table 302.4 Extremely Hazardous Substances List. *Removed from listing in 1988*
Listed on Canada's DSL List.
Hazard symbols, risk, & safety statements: Hazard symbol: Xn; risk phrases: R20/21/22; R43; safety phrases: S22; 36/37/39; S41; S45 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): No value found. [2-Hazard to waters (est.)].
Description: Bacitracin is a white to light tan powder which is odorless or having a slight odor and very bitter taste. Molecular weight = 1422.69; freezing/melting point: 221−224°C. Hazard identification (based on NFPA-704 M Rating System): Health 1; flammability 1; reactivity 0. Highly soluble in water.
Potential Exposure: Bacitracin is used as an ingredient in antibiotic ointments to treat or prevent topical or eye infections. Commercial Bacitracin is a mixture of at least 9 bacitracins. Also used as a feed and drinking water additive for animals; as a food additive for human consumption.
Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.
Permissible Exposure Limits in Air
No standards or Protective Action Criteria (PAC) available.
Routes of Entry: Skin contact, inhalation, ingestion.
Harmful Effects and Symptoms
This data has been questioned, however, and it has been stated that as a result of a mathematical miscalculation, bacitracin was wrongly included on a list of hazardous chemicals drafted several years ago by the National Institute of Occupational Safety and Health. The mistake was remedied in 1988 when the substance was removed from the EHS list as noted above.
Short-Term Exposure: Bacitracin may be absorbed through the skin, thereby increasing exposure. May cause eye and/or skin irritation. Hypersensitivity reactions may result from application of this compound to the skin, but this may not be common. Ingestion may cause gastrointestinal upset with nausea, vomiting and diarrhea. LD_{50} = (oral-mouse) 25 mg/kg (highly toxic).
Long-Term Exposure: May cause liver damage. Exposure may cause hypersensitivity; allergic reaction to bacitracin through inhalations, ingestion and dermal contact.
Points of Attack: Liver, skin.
Medical Surveillance: Evaluation by a qualified allergist. Kidney function tests.
First Aid: In case of large-scale exposure, the directions for medicines (nonspecific, n.o.s.) would be applied as follows: Move victim to fresh air; call emergency medical care. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. In case of contact with material, immediately flush skin or eyes with running water for at least 15 minutes. Speed in removing material from skin is of extreme importance. Remove and isolate contaminated clothing and shoes at the site. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.
Storage: Color code—Blue: Health Hazard/Poison (Toxic): Store in a secure, locked and cool, ventilated area.
Shipping: UN 3249 Medicine, solid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1—Poisonous materials.
Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.
Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen, sulfur and carbon. Use dry chemical, carbon dioxide; water spray; or polymer foam extinguishers. *Small fires:* dry chemical, carbon dioxide; water spray; or foam. *Large fires:* water spray, fog, or foam. Move container from fire area if you can do so without risk. Fight fire from maximum distance. Save fire control water for later disposal, do not scatter the material. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control

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Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens.

agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses (SCBAs) that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: It is inappropriate and possibly dangerous to the environment to dispose of expired or waste pharmaceuticals by flushing them down the toilet or discarding them to the trash. Household quantities of expired or waste pharmaceuticals may be mixed with wet cat litter or coffee grounds, double-bagged in plastic, discard in trash. Larger quantities shall carefully take into consideration applicable DEA, EPA, and FDA regulations. If possible return the pharmaceutical to the manufacturer for proper disposal being careful to properly label and securely package the material. Alternatively, the waste pharmaceutical shall be labeled, securely packaged and transported by a state licensed medical waste contractor to dispose by burial in a licensed hazardous or toxic waste landfill or incinerator.

References

(31); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Bacitracin, Washington, DC, Chemical Emergency Preparedness Program (October 31, 1985).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Bacitracin, Trenton, NJ (March, 1999).

X-Gen Pharmaceuticals, *Bacitracin MSDS*, Big Flats, NY, 2003.

Barium B:0100

Formula: Ba

Synonyms: Bario (Spanish); Barium, elemental; Barium metal; Baryum (French)

CAS Registry Number: 7440-39-3

HSDB Number: 4481

RTECS Number: CQ8370000

UN/NA & ERG Number: UN1400/138; UN1854 (Barium alloys, pyrophoric)/135; UN1564/154 Barium compound, n.o.s.

Other barium compounds: UN1445/151 Barium chlorate, solid; UN1446/141 Barium nitrate; UN1447/141 Barium perchlorate, solid; UN1448/141 Barium permanganate; UN1449/141 Barium peroxide; UN1565/157 Barium cyanide; UN1571/113 Barium azide, wetted with not less than 50% water; UN1884/157 Barium oxide; UN2719/141 Barium bromate; UN2741/141 Barium hypochlorite, with more than 22% available chlorine; UN3405/141 Barium chlorate, solution; UN3406/141 Barium perchlorate, solution

EC Number: 231-149-1

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Combustible solid, Pyrophoric hazard, Dangerously water reactive.

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): D005

RCRA Toxicity Characteristic (Section 261.24), Maximum Concentration of Contaminants, regulatory level, 100.0 mg/L

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed

RCRA Maximum Concentration Limit for Ground Water Protection (40CFR264.94), 1.0 mg/L

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 1.2; Nonwastewater (mg/L), 7.6 TCLP

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List, Suggested methods (PQL μg/L): 6010 (20); 7080 (1000)

United States National Primary Drinking Water Regulations: MCLG = 2 mg[Ba]/L; Maximum Contaminant Level (MCL) = 2 mg[Ba]/L, as Barium.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%. Form R, Toxic Chemical Category Code: N040.

Canada MAC for drinking water quality: 1.0 mg/L

Hazard symbols, risk, & safety statements: Hazard symbol: C, Xi; risk phrases: R14/15; R17; R25; R26; R34; R36/37/38; R50; safety phrases: S16; S23; S26; S36/37/39; S43; S45.

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Barium is a flammable, silver white or yellowish metal in various forms including powder. Barium may ignite spontaneously in air in the presence of moisture, evolving hydrogen. Molecular weight = 137.34; boiling point = 1640°C; freezing/melting point = 725°C; vapor pressure = 10 mmHg @ 1049°C. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 1; reactivity 2 ₩ (dangerously water reactive).

Potential Exposure: Metallic barium is used for removal of residual gas in vacuum tubes and in alloys with nickel, lead, calcium, magnesium, sodium, and lithium. Barium compounds are used in the manufacture of lithopone (a white pigment in paints), chlorine, sodium hydroxide, valves, and green flares; in synthetic rubber vulcanization; X-ray diagnostic work, glassmaking, papermaking, beet-sugar purification; animal and vegetable oil refining. They are used in the brick and tile, pyrotechnics, and electronics industries. They are found in lubricants, pesticides, glazes, textile dyes and finishes; pharmaceuticals; in cements which will be exposed to saltwater; and barium is used as a rodenticide, a flux for magnesium alloys, a stabilizer and mold lubricant in the rubber and plastics industries, an extender in paints; a loader for paper, soap, rubber, and linoleum; and as a fire extinguisher for uranium or plutonium fires.

Incompatibilities: Barium powder may spontaneously ignite on contact with air. It is a strong reducing agent and reacts violently with oxidizers and acids. Reacts with water, forming combustible hydrogen gas and barium hydroxide. Reacts violently with halogenated hydrocarbon solvents, causing a fire and explosion hazard.

Permissible Exposure Limits in Air

NIOSH IDLH = 50 mg[Ba]/m^3

OSHA PEL: 0.5 mg[Ba]/m^3 TWA

NIOSH REL: 0.5 mg[Ba]/m^3 TWA

ACGIH TLV[1]: 0.5 mg[Ba]/m^3 TWA; not classifiable as a human carcinogen

PAC Ver. 29[138]

PAC-1: 1.5 milligram per cubic meter

PAC-2: 180 milligram per cubic meter

PAC-3: 1100 milligram per cubic meter

DFG MAK: 0.5 mg[Ba]/m^3, inhalable fraction TWA; Peak limitation II(2); Pregnancy Risk Group D.

Australia: TWA 0.5 milligram per cubic meter, 1993; Austria: MAK 0.5 milligram per cubic meter, 1993; Belgium: TWA 0.5 milligram per cubic meter, 1993; Denmark: TWA 0.5 milligram per cubic meter, 1999; Finland: TWA 0.5 milligram per cubic meter, 1999; Hungary STEL 0.5 milligram per cubic meter, 1993; the Netherlands: MAC-TGG 0.5 milligram per cubic meter, 2003; the Philippines: TWA 0.5 milligram per cubic meter, 1993; Poland: MAC (time-weighted average) 0.5 milligram per cubic meter; MAC (STEL) 1.5 milligram per cubic meter, 1999; Sweden: TWA 0.5 milligram per cubic meter, 1999; Switzerland: MAK-week 0.5 milligram per cubic meter, 1999; Turkey: TWA 0.5 milligram per cubic meter, 1993; United Kingdom LTEL 0.5 milligram per cubic meter, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Several states have set guidelines or standards for barium in ambient air[60] ranging from 0.67 μ/m^3 (New York) to 5.0 μ/m^3 (Florida and North Dakota) to 8.0 μ/m^3 (Virginia) to 10.0 μ/m^3 (Connecticut) to 12.0 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Methods (IV) #7056, Barium, soluble compounds. Collection on a cellulose membrane filter, workup with hot water, analysis by atomic absorption. Use NIOSH Analytical Method #8310, Metals in urine. OSHA ANALYTICAL METHOD ID-121.

Permissible Concentration in Water: Safe Drinking Water act: MCLG = 2 mg[Ba]/L; MCL = 2 mg[Ba]/L as Barium. Federal Drinking Water Guidelines: EPA 2000 μg[Ba]/L; State Drinking Water Standards: California 1000 μg[Ba]/L; State Drinking Water Guidelines: Arizona 1500 μg[Ba]/L; Minnesota 2000 μg[Ba]/L.

Determination in Water: Conventional flame atomization does not have sufficient sensitivity to determine barium in most water samples; however, a barium detection limit of 10 μg/L can be achieved if a nitrous oxide flame is used. A concentration procedure for barium uses thenoyltrifluoro-acetone-methylisobutylketone extraction at a pH of 6.8. With a tantalum liner insert, the barium detection limit of the flameless atomic absorption procedure can be improved to 0.1 μg/L according to NAS/NRC[46].

Routes of Entry: Ingestion or inhalation of dust or fume, skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Alkaline barium compounds, such as the hydroxide and carbonate, may cause local irritation to the eyes, nose, throat, and skin. Exposure to either form can affect the nervous system and cause hypokalemia, which can cause heart disorders.

Long-Term Exposure: Can cause a variety of cardiac, gastrointestinal, and neuromuscular effects. Associated with hypertension and cardio toxicity in animals[182]. Barium can cause an increase in blood pressure. Barium poisoning is virtually unknown in industry, although the potential exists when the soluble forms are used. When ingested or given orally, the soluble, ionized barium compounds exert a profound effect on all muscles and especially smooth muscles, markedly increasing their contractility. The heart rate is slowed and may stop in systole. Other effects are increased intestinal peristalsis; vascular constriction; bladder contraction, and increased voluntary muscle tension. The inhalation of the dust of barium sulfate may lead to deposition in the lungs in sufficient quantities to produce "baritosis" (a benign pneumoconiosis). This produces a radiologic picture in the absence of symptoms and abnormal physical signs. X-rays, however, will show disseminated nodular opacities throughout the lung fields, which are discrete, but sometimes overlap. Animal studies have found increased blood pressure and changes in the heart from ingesting barium over a long time.

Points of Attack: Heart, lungs, central nervous system; skin, respiratory system; eyes.

Medical Surveillance: Consideration should be given to the skin, eye, heart, and lung in any placement or periodic examination.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration With the aid of a pocket mask equipped with a one-way valve or other proper respiratory Medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Note to physician (poisoning from barium compounds): If ingested, there is are treatment considerations available including the following: Gastric emptying, a warm aqueous solution of 1% to 3% soluble sulfates of magnesium sulfate or sodium sulfate administered orally as a gastric lavage (forms insoluble barium sulfate). Atropine sulfate, 0.5 to 1.0 mg, to decrease colic. Small doses of morphine may be necessary to control abdominal pain. IV of potassium if hypokalemia is present [Cain].

Personal Protective Methods: Employees should receive instruction in personal hygiene and the importance of not eating in work areas. Good housekeeping and adequate ventilation are essential. Dust masks, respirators, or goggles may be needed where amounts of significant soluble or alkaline forms are encountered, as well as protective clothing.

Respirator Selection: *5 mg^3:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *12.5 milligram per cubic meter:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25) (any powered, air-purifying respirator (PAPR) with a high-efficiency particulate filter). *25 milligram per cubic meter:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTHie (APF = 50) (any PAPR with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *50 milligram per cubic meter:* SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd, Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination With an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: UN1400l Color code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Barium metal should be stored in a dry area, separated from halogenated solvents, strong oxidants, acids, in tightly closed containers under an inert gas blanket, petroleum or oxygen-free liquid. UN1564 Color code—Blue: Health Hazard/Poison (Toxic): Store in a secure, locked and cool, ventilated area. UN1854 Color code—Red Stripe: Dangerous when wet materials release flammable gases on contact with water. Do not store this material in a room protected by water sprinkler systems. Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Do not store in a basement. Rubber gloves, rubber protective clothing and apron, goggles, and gas-filter mask should be worn when working in a barium storage area.

Shipping: UN1400 Barium, Hazard Class: 4.3; Labels: 4.3—Dangerous when wet material. UN1854 Barium alloys, pyrophoric, Hazard Class: 4.2; Labels: 4.2—Spontaneously combustible material. UN1564 Barium compound, n.o.s., Hazard Class: 6.1; Labels: 6.1—Poisonous materials.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Small quantities of barium metal may be dissolved in large quantities of water. Soda ash is added and the solution then neutralized with HCl. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: May decompose explosively in fire. Barium powder is a flammable solid. Containers may explode when heated. Reacts violently with fire extinguishing agents, such as water, bicarbonate, powder, foam, and carbon dioxide. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Barium in solution (see spill handling) may be precipitated with soda ash and the sludge may be landfilled.

References

(31); (173); (101); (138); (2); (170); (100).

United States Environmental Protection Agency, *Toxicology of Metals, Vol. 2: Barium, pp. 71−84, Report EPA-600/1-77-022*, Research Triangle Park, NC (May 1977).

United States Environmental Protection Agency, *Barium, Health and Environmental Effects Profile No. 13*, Washington, DC, Office of Solid Waste (April 30, 1980).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 1, No. 7, 35−40 (1981) and 3, No. 4, 29−30 (1983).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Barium, Trenton, NJ (January, 1996).

United States Department of the Interior, United States Geological Survey, *The USGS Water Science School, USGS Contaminants Found in Groundwater*, http://water.usgs.gov/edu/groundwater-contaminants.html.

Barium Azide B:0110

Formula: BaN_6; $Ba(N_3)_2$

Synonyms: Azida de bario (Spanish)

CAS Registry Number: 18810-58-7

RTECS Number: CQ8500000 (dry); CQ8510000 (wet)

UN/NA & ERG Number: UN1571 (Barium azide, wetted with not less than 50% water)/113; UN/NA0224 (Barium Azide dry or wetted with <50% water, by mass)/112 Explosive.

EC Number: 242-594-6

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (TQ) (pounds): *Release hazard* 5000 (commercial grade); *Theft hazard* 400 (commercial grade).

Hazard Alert: Poison, Highly flammable, Explosive Substance (World Bank)[15], Environmental hazard.

RCRA 40CFR261, Appendix 8; 40CFR261.11 Hazardous Constituents

United States National Primary Drinking Water Regulations: MCLG = 2 mg[Ba]/L; MCL = 2 mg[Ba]/L, as Barium.

EPCRA Section 313: Includes any unique chemical substance that contains barium as part of that chemical's infrastructure. This category does not include barium sulfate (7727-43-7). Form R *de minimis* concentration reporting level: 0.1%. Form R, Toxic Chemical Category Code: N040.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. As Barium, water-soluble compounds, n.o.s.

WGK[100] (German Aquatic Hazard Class): No value found. [1-Low hazard to water. (est.)]

Description: Barium azide is a flammable, crystalline solid which can be used or transported in solution. Molecular weight = 221.4; boiling point = explodes; freezing/melting point = 120°C (decomposes, losing nitrogen). Highly soluble in water.

Potential Exposure: Barium Azide is used in high explosives.

Incompatibilities: Carbon disulfide. It can explode when heated or shocked.

Permissible Exposure Limits in Air

NIOSH IDLH = 50 mg[Ba]/m^3

ACGIH TLV[1]: 0.5 mg[Ba]/m^3 TWA; not classifiable as a human carcinogen

OSHA PEL: 0.5 mg[Ba]/m^3 TWA

NIOSH REL: 0.5 mg[Ba]/m^3 TWA

DFG MAK: 0.5 mg[Ba]/m^3, inhalable fraction TWA; Peak limitation II(2)

No PAC available.

Several states have set guidelines or standards for barium in ambient air[60] ranging from 0.67 μ/m^3 (New York) to 5.0 μ/m^3 (Florida and North Dakota) to 8.0 μ/m^3 (Virginia) to 10.0 μ/m^3 (Connecticut) to 12.0 μ/m^3 (Nevada).

Determination in Air: No criteria set for barium azide. Use NIOSH Analytical Methods (IV) #7056, Barium, soluble compounds. Collection on a cellulose membrane filter, workup with hot water, analysis by atomic absorption. Use NIOSH Analytical Method #8310, Metals in urine. OSHA ANALYTICAL METHOD ID-121.

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 2000 μg[Ba]/L; State Drinking Water Standards: California 1000 μg[Ba]/L; State Drinking Water Guidelines: Arizona 1500 μg[Ba]/L; Minnesota 2000 μg[Ba]/L.

Routes of Entry: Inhalation, skin and/or eyes.

Harmful Effects and Symptoms

Short-Term Exposure: Barium azide irritates the eyes, nose, and respiratory tract; with coughing. Overexposure can cause a drop in blood pressure, with dizziness; blurred vision; headaches; and unconsciousness. Exposure to either form can affect the nervous system and cause hypokalemia, which can cause heart disorders.

Long-Term Exposure: Barium can cause an increase in blood pressure. Repeated exposure to the dust can cause spots on chest X-ray without lung scarring. Animal studies have found increased blood pressure and changes in the heart from ingesting barium over a long time.

Points of Attack: Lungs.

Medical Surveillance: Consideration should be given to the skin, eye, heart, and lung in any placement or periodic examination. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a Medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce

vomiting. Do not make an unconscious person vomit. If weakness or fainting is present, lay the person down flat with feet elevated. See also First Aid section in "Barium" entry.

Personal Protective Methods: Wear protective eye Protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash- (for liquid) or dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: (as soluble barium compounds) *5 mg/m^3:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *12.5 milligram per cubic meter:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25) (any PAPR with a high-efficiency particulate filter). *25 milligram per cubic meter:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTHie (APF = 50) (any PAPR with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *50 milligram per cubic meter:* SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd, Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: UN0224 Explosive. UN1571 Color code—Red Stripe: Flammability Hazard: Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Barium azide must be stored to avoid contact with carbon disulfide, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area from anything which could disturb or shock barium azide. Sources of ignition, such as smoking and open flames are prohibited where barium azide is handled, used, or stored. Keeping barium azide wet greatly reduces its fire and explosion hazard. Wherever barium azide is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1571 Barium azide wetted with not <50% water, by mass, Hazard Class: 4.1; Labels: 4.1—Flammable solid, 6.1—Poisonous materials. UN0224 Barium Azide dry or wetted with <50% water, by mass, Hazard Class: 1.1A; Labels: 1.1A—Explosive (with a mass explosion hazard); A—Substances which are expected to mass detonate very soon after fire reaches them. Packing Group 1.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Barium Azide will explode when heated or when shocked. Thermal decomposition products may include oxides of nitrogen and metal (barium). If fire or explosion occurs, evacuate the area. Fight the fire from an explosion-resistant location as containers may explode in fire. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Barium Azide, Trenton, NJ (June 2005).

Barium Bromate B:0120

Formula: $BaBr_2O_6$; $Ba(BrO_3)_2$
Synonyms: Bromato barico (Spanish); Bromic acid, barium salt
CAS Registry Number: 13967-90-3
RTECS Number: EF8715000
UN/NA & ERG Number: UN2719/141
EC Number: 237-750-5

Regulatory Authority and Advisory Information

Carcinogenicity: EPA: Likely to produce cancer in humans (inhalation, as bromates); Available data are inadequate for an assessment of human carcinogenic potential (oral route, as bromates); Limited evidence of carcinogenicity based on epidemiologic studies.

Hazard Alert: Poison, Strong oxidizer, Environmental hazard.

United States National Primary Drinking Water Regulations: MCLG = 2 mg[Ba]/L; MCL = 2 mg[Ba]/L; 0 mg[BrO_3^-]/L as barium; MCL = 0.010 mg[BrO_3^-]/L, as Bromates.

RCRA 40CFR261, Appendix 8; 40CFR261.11 Hazardous Constituents

EPCRA Section 313: Includes any unique chemical substance that contains barium as part of that chemical's infrastructure. This category does not include barium sulfate (7727-43-7). Form R *de minimis* concentration reporting level: 0.1%. Form R, Toxic Chemical Category Code: N040.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) (Ba compounds, soluble, n.o.s.)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. As Barium, water-soluble compounds, n.o.s.

Hazard symbols, risk, & safety statements: Hazard symbol: O, Xn; risk phrases: R8; R20/22; safety phrases: S1; S17; S28; S41; (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Barium bromate is a white crystalline powder. Molecular weight = 411.2; Boiling point: explodes @ 300°C; freezing/melting point = 260°C (decomposes). Slightly soluble in water.

Potential Exposure: This material is used as an analytical reagent, oxidizer and corrosion inhibitor.

Incompatibilities: A strong oxidizer; keep away from reducing agents. Keep away from oxidizable materials; aluminum, arsenic, carbon, copper, metal sulfides; phosphorus, sulfur, organic, and combustible materials (such as wood, paper, oil, fuels), since violent reactions occur.

Permissible Exposure Limits in Air

NIOSH IDLH = 50 mg[Ba]/m^3
ACGIH TLV[1]: 0.5 mg[Ba]/m^3 TWA; not classifiable as a human carcinogen
OSHA PEL: 0.5 mg[Ba]/m^3 TWA
NIOSH REL: 0.5 mg[Ba]/m^3 TWA
DFG MAK: 0.5 mg[Ba]/m^3, inhalable fraction TWA; Peak limitation II(2)
No PAC available.

Several states have set guidelines or standards for barium in ambient air[60] ranging from 0.67 μ/m^3 (New York) to 5.0 μ/m^3 (Florida and North Dakota) to 8.0 μ/m^3 (Virginia) to 10.0 μ/m^3 (Connecticut) to 12.0 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Methods (IV) # 7056, Barium, soluble compounds. Collection on a cellulose membrane filter, workup with hot water, analysis by atomic absorption. Use NIOSH Analytical Method #8310, Metals in urine. OSHA analytical method ID-121.

Permissible Concentration in Water: United States Safe Drinking Water Act (47FR 9352): MCLG = 0 mg/L; MCL = 0.010 mg/L, as bromates. Federal Drinking Water Guidelines: EPA 2000 μg[Ba]/L; State Drinking Water Standards: California 1000 μg[Ba]/L; State Drinking Water Guidelines: Arizona 1500 μg[Ba]/L; Minnesota 2000 μg [Ba]/L.

Routes of Entry: Inhalation, ingestion, skin and eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Barium bromate can affect you when breathed in or swallowed. Contact can irritate and even burn the eyes and skin. Breathing the dust or mist can irritate the nose, throat, and bronchial tubes, causing cough and phlegm. Exposure to either form can affect the nervous system and cause hypokalemia, which can cause heart disorders.

Long-Term Exposure: Barium can cause an increase in blood pressure. After repeated exposure, barium may show up as spots on chest X-ray. Some barium chemicals are contaminated with silica, which scars the lungs. Repeated exposure to Barium Bromate can cause bromine to build up in the body. Consult the sheet on "Bromine" entry. Animal studies have found increased blood pressure and changes in the heart from ingesting barium over a long time. Repeated skin contact can cause chronic dryness and cracking.

Points of Attack: Lungs, skin.

Medical Surveillance: serum bromide levels. Consideration should be given to the skin, eye, heart, and lung in any placement or periodic examination.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. See also First Aid section in "Barium" entry.

Personal Protective Methods: Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. If local exhaust ventilation or enclosure is not used, respirators should be worn. Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *5 milligram per cubic meter:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *12.5 milligram per cubic meter:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25) (any PAPR with a high-efficiency particulate filter). *25 milligram per cubic meter:* 100 F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTHie (APF = 50) (any PAPR with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *50 milligram per cubic meter:* SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd, Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Oxidizers should be isolated from acids, metals, organic materials, and ammonium nitrate. (1) Color code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially organic materials, flammables and combustibles, and other incompatible materials. Oxidizers, including oxidizing gases, should have a boundary separation of 8–10 m or a 1-hour fire wall from flammable or reactive materials. (2) Color code—Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where barium bromate is handled, used, or stored. Avoid any possible contact with incompatible materials. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: UN2719 Barium bromate, Hazard Class: 5.1; Labels: 5.1—Oxidizer, 6.1—Poisonous materials.

Spill Handling: *Caution:* Incompatible absorbents: Cellulose-Based Absorbents, Expanded Polymeric Absorbents[101]. Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Barium bromate explodes @ 275–300°C. Thermal decomposition products may include hydrogen bromide and oxygen which can increase the activity of fire. Extinguish fire using an agent suitable for type of surrounding fire. Barium bromate itself does not burn. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (101); (138); (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Barium Bromate, Trenton, NJ (June 2005).

Barium Chlorate B:0130

Formula: $BaCl_2O_6$; $Ba(ClO_3)_2$
Synonyms: Barium chlorate (monohydrate); Chloric acid, barium salt; Clorato barico (Spanish)
CAS Registry Number: 13477-00-4 (monohydrate); 10326-27-7 (dihydrate)
HSDB Number: 405
RTECS Number: FN9770000; CQ 8751000 (dihydrate)
UN/NA & ERG Number: UN1445/151
EC Number: 236-760-7 [*Annex I Index No.:* 017-003-00-8] (monohydrate); dihydrate not found.

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Strong oxidizer, Environmental hazard, Hematological changes.

United States National Primary Drinking Water Regulations: MCLG = 2 mg[Ba]/L; MCL = 2 mg[Ba]/L as Barium.

RCRA 40CFR261, Appendix 8; 40CFR261.11 Hazardous Constituents

EPCRA Section 313: Includes any unique chemical substance that contains barium as part of that chemical's infrastructure. This category does not include barium sulfate (7727-43-7). Form R *de minimis* concentration reporting level: 0.1%. Form R, Toxic Chemical Category Code: N040.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) (Ba compounds, soluble, n.o.s.)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. As Barium, water-soluble compounds, n.o.s.

Hazardous to aquatic life or environment, with possible long-lasting effects[293]. Toxic to aquatic life with long-lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

European/International Regulations (*monohydrate*): Hazard symbol: O, Xn, N; risk phrases: R8; R9; R20/22; R51/53; safety phrases: S2; S13; S27; S61.

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Barium chlorate is a combustible, colorless to white crystalline solid or powder. Molecular weight = 304.24; 244.3 (dihydrate); freezing/melting point = monohydrate decomposes below 250°C; dihydrate @ 120°C (loss of water of crystallization). Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 0; reactivity 1 ₩, Oxidizer. Soluble in water; solubility = 27 g/100 mL.

Potential Exposure: It is used in fireworks and explosives manufacture; in textile dyeing and in the manufacture of other perchlorates.

Incompatibilities: A strong oxidizer. When heated above 250°C, it begins to give off oxygen and will increase risk of fire. Barium chlorate is a reactive chemical and is an explosion hazard. Violent reaction may occur with reducing materials; strong acids; powdered metals. Contact with combustible materials will increase activity in fire.

Permissible Exposure Limits in Air

NIOSH IDLH = 50 mg[Ba]/m^3

ACGIH TLV[1]: 0.5 mg[Ba]/m^3 TWA; not classifiable as a human carcinogen

OSHA PEL: 0.5 mg[Ba]/m^3 TWA

NIOSH REL: 0.5 mg[Ba]/m^3 TWA

DFG MAK: 0.5 mg[Ba]/m^3, inhalable fraction TWA; Peak limitation II(2)

No PAC available.

Australia: TWA 0.5 milligram per cubic meter, 1993; Austria: MAK 0.5 milligram per cubic meter, 1993; Belgium: TWA 0.5 milligram per cubic meter, 1993; Denmark: TWA 0.5 milligram per cubic meter, 1999; Finland: TWA 0.5 milligram per cubic meter, 1999; Hungary STEL 0.5 milligram per cubic meter, 1993; the Netherlands: MAC-TGG 0.5 milligram per cubic meter, 2003; the Philippines: TWA 0.5 milligram per cubic meter, 1993; Poland: MAC (time-weighted average) 0.5 milligram per cubic meter; MAC (STEL) 1.5 milligram per cubic meter, 1999; Sweden: TWA 0.5 milligram per cubic meter, 1999; Switzerland: MAK-week 0.5 milligram per cubic meter, 1999; Turkey: TWA 0.5 milligram per cubic meter, 1993; United Kingdom LTEL 0.5 milligram per cubic meter, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Several states have set guidelines or standards for barium in ambient air[60] ranging from 0.67 μ/m^3 (New York) to 5.0 μ/m^3 (Florida and North Dakota) to 8.0 μ/m^3 (Virginia) to 10.0 μ/m^3 (Connecticut) to 12.0 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Methods (IV) #7056, Barium, soluble compounds. Collection on a cellulose membrane filter, workup with hot water, analysis by atomic absorption. Use NIOSH Analytical Method #8310, Metals in urine. OSHA analytical method ID-121.

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 2000 μg[Ba]/L; State Drinking Water Standards: California 1000 μg[Ba]/L; State Drinking Water Guidelines: Arizona 1500 μg[Ba]/L; Minnesota 2000 μg[Ba]/L.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Contact may burn the eyes and skin. Breathing the dust or mist can irritate the nose, throat, and bronchial tubes. Higher exposures can damage red blood cells. Symptoms include headache, weakness, abdominal pain, dark urine, and jaundice. The symptoms of paralysis may be delayed for several hours. Exposure to either form can affect the nervous system and cause hypokalemia, which can cause heart disorders.

Long-Term Exposure: Barium can cause an increase in blood pressure. After repeated exposure, barium may show up as spots in the lungs on chest X-ray. Some barium chemicals are contaminated with silica, which scars the lungs. See entry for "Silica quartz." Chlorates can damage red blood cells, leading to kidney damage, or cause methemoglobin to form in the blood, reducing oxygen supply to body organs. Animal studies have found increased blood pressure and changes in the heart from ingesting barium over a long time. Repeated skin contact can cause chronic dryness and skin cracking.

Points of Attack: Lungs, blood cells, skin.

Medical Surveillance: Lung function tests, complete blood count (CBC), test for methemoglobin. Consideration should be given to the skin, eye, heart, and lung in any placement or periodic examination.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. The symptoms of paralysis do not become obvious until some hours have passed. Keep under medical observation for 24 to 48 hours. See also First Aid Section in "Barium" entry.

Note to Physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. If local exhaust ventilation or enclosure is not used, respirators should be worn. Wear protective work clothing. Wash thoroughly immediately after exposure to barium chlorate. Post hazard and warning information in the work area. In addition, as part of an ongoing education and training effort, communicate all information on the health and safety hazards of barium chlorate to potentially exposed workers.

Respirator Selection: (Ba soluble compounds) *5 milligram per cubic meter:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *12.5 milligram per cubic meter:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25) (any PAPR with a high-efficiency particulate filter). *25 milligram per cubic meter:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTHie (APF = 50) (any PAPR with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *50 milligram per cubic meter:* SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Check oxygen content prior to entering storage area. Oxidizers should be isolated from acids, metals, organic materials, and ammonium nitrate. (1) Color code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially organic materials, flammables and combustibles, and other incompatible materials. Oxidizers, including oxidizing gases, should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. (2) Color code—Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. Barium chlorate must be stored to avoid contact with organic or combustible materials (such as wood, paper, oil, fuels, and starch) and other easily oxidizable materials (such as sulfur, aluminum, copper, metal sulfides; ammonium salts, etc.), since violent reactions occur. Store in tightly closed containers on nonwood floors in a cool, well-ventilated area. Wherever barium chlorate is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Store in a cool, well-ventilated area away from incompatible materials listed above. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage.

Shipping: UN1445 Barium chlorate, Hazard Class: 5.1; Labels: 5.1—Oxidizer, 6.1—Poisonous materials.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Absorb liquids in vermiculite, dry sand; earth, or a similar nonorganic material and deposit in sealed containers. May also be covered with weak reducing agents; resulting sludge neutralized and flushed to sewer. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental

protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include chlorides and oxides of metal. May explode when heated. Contact with combustible, organic, or other easily oxidizable materials, such as paper, oil, fuels or sawdust can cause fires. Rubbing of these mixtures can cause explosions. Use water to extinguish the fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Use large volumes of reducing agent (bisulfite or ferrous salt) solutions. Neutralize and flush to sewer with large volumes of water[24].

References

(31); (173); (101); (138); (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Barium Chlorate, Trenton, NJ (August 2001).

Barium Cyanide B:0140

Formula: BaC_2N_2; $Ba(CN)_2$

Synonyms: Barium cyanide, solid; Barium dicyanide; Cianuro de bario (Spanish); Cianuro barico (Spanish); Cyanure de baryum (French)

CAS Registry Number: 542-62-1

HSDB Number: 403

RTECS Number: CQ8785000

UN/NA & ERG Number: UN1565/157

EC Number: 208-822-3

Regulatory Authority and Advisory Information

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

Hazard Alert: Poison, Pyrophoric hazard, Environmental hazard.

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P013

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV.D.3.b, Reportable Quantity (RQ): 10 lb (4.54 kg)

RCRA Land Ban Waste Restrictions

EPCRA Section 313: Includes any unique chemical substance that contains barium as part of that chemical's infrastructure. This category does not include barium sulfate (7727-43-7). Form R *de minimis* concentration reporting level: 0.1%. Form R, Toxic Chemical Category Code: N040.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as cyanide compounds

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

United States National Primary Drinking Water Regulations: MCLG = 2 mg[Ba]/L; MCL = 2 mg[Ba]/L, as Barium; MCLG = 0.2 mg[CN^-]/L; MCL = 0.2 mg [CN^-]/L as cyanide.

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants as cyanide, total

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P030 as cyanides soluble salts and complexes, n.o.s.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents. As cyanides, soluble salts and complexes, n.o.s.

EPCRA (Section 313): X + CN-where X = H+ or any other group where a formal dissociation may occur. For example, KCN or Ca(CN)2; Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as cyanide mixtures, cyanide solutions or cyanides, inorganic, n.o.s.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. As Barium, water-soluble compounds, n.o.s. and Cyanide compounds, inorganic, n.o.s.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R17; R28; R32; R50/53; safety phrases: S1/2; S7/8; S23; S29; S36/37; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Barium cyanide is a white crystalline powder. Often used in solution. Molecular weight = 189.4; heat of combustion = -60.5×10^5 J/kg; heat of solution = (exothermic) = -6.19×10^5 J/kg. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 0; reactivity 0 ₩. Soluble in water; solubility = 80 g/100 cc @ 14°C. Slow reaction with water releases cyanide gas.

Potential Exposure: Barium cyanide is used in electroplating and in metallurgy.

Incompatibilities: Solution is basic. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong acids, & acid salts (release toxic hydrogen cyanide gas), strong bases.

Permissible Exposure Limits in Air

NIOSH IDLH = 50 mg[Ba]/m^3; 25 mg[CN]/m^3

ACGIH TLV[1]: 0.5 mg[Ba]/m^3 TWA; not classifiable as a human carcinogen
OSHA PEL: 0.5 mg[Ba]/m^3 TWA
NIOSH REL: 0.5 mg[Ba]/m^3 TWA
PAC Ver. 29[138]
PAC-1: 44 milligram per cubic meter
PAC-2: 60 milligram per cubic meter
PAC-3: 360 milligram per cubic meter
DFG MAK: 0.5 mg[Ba]/m^3, inhalable fraction TWA; Peak limitation II(2)
Australia: TWA 5 milligram per cubic meter, [skin], 1993; Austria: MAK 5 mg[CN]/m^3, [skin], 1999; Denmark: TWA 5 milligram per cubic meter, [skin], 1999; France: VME 5 mg[CN]/m^3, [skin], 1999; Poland: TWA 0.3 mg[CN]/m^3, ceiling 10 mg[CN]/m^3, 1999; Switzerland: MAK-W 5 milligram per cubic meter, KZG-W 10 milligram per cubic meter, [skin], 1999; United Kingdom: TWA 5 mg[CN]/m^3, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: ceiling concentration 5 milligram per cubic meter [skin]. Several states have set guidelines or standards for barium in ambient air[60] ranging from 0.67 μ/m^3 (New York) to 5.0 μ/m^3 (Florida and North Dakota) to 8.0 μ/m^3 (Virginia) to 10.0 μ/m^3 (Connecticut) to 12.0 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method #7904; #6010, cyanides.

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 200 μg[CN]/L; State Drinking Water Standards: California 150 μg[CN]/L; State Drinking Water Guidelines: Arizona 220 μg[CN]/L; Maine. 140 μg [CN]/L; Minnesota 100 μg[CN]/L. United States Army field drinking-water standards for cyanide: 2 mg[CN]/L assuming a water consumption of 15 L/day and 6 mg[CN]/L assuming a water consumption of 5 L/day. United States Army field drinking-water standards for cyanide, long-term consumption 0.5 mg[CN]/L; Short-term consumption; Raw water constituents (maximum) 20 mg[CN]/L.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact. Passes through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: This chemical can be absorbed through the skin, thereby increasing exposure. Barium cyanide is a deadly poison; can affect you when breathed and by passing through skin. Exposure can cause confusion, weakness, headaches, nausea, vomiting, gasping for air; collapse and even death from cyanide poisoning. On contact with acids, acid mists, or acid salts; flammable hydrogen cyanide gas is formed which can cause rapid poisoning. Exposure to either form can affect the nervous system and cause hypokalemia, which can cause heart disorders.

Long-Term Exposure: Barium can cause an increase in blood pressure. Animal studies have found increased blood pressure and changes in the heart from ingesting barium over a long time. Can interfere with the normal functioning of the thyroid gland, causing goiter (enlarged thyroid).

Points of Attack: Thyroid, heart.

Medical Surveillance: Blood cyanide level. Thyroid function tests. Consideration should be given to the skin, eye, heart, and lung in any placement or periodic examination.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. *If cyanide poisoning is confirmed*, use amyl nitrate capsules if symptoms develop. All area employees should be trained regularly in emergency measures for cyanide poisoning and in CPR. A cyanide antidote kit should be kept in the immediate work area and must be rapidly available. Kit ingredients should be replaced every 1–2 years to ensure freshness. Persons trained in the use of this kit; oxygen use, and CPR must be quickly available. See also First Aid section in "Barium" entry.

Personal Protective Methods: Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. If local exhaust ventilation or enclosure is not used, respirators should be worn. Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-(for liquid) or dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: (***as Ba soluble compounds***) *5 milligram per cubic meter:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *12.5 milligram per cubic meter:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25) (any PAPR with a high-efficiency particulate filter). *25 milligram per cubic meter:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTHie (APF = 50) (any PAPR with a tight-fitting facepiece and a high-efficiency particulate filter); or

SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *50 milligram per cubic meter:* SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd, Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

NIOSH (***as cyanides***): *25 milligram per cubic meter*: Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted canister providing protection against the compound of concern and having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Barium cyanide must be stored to avoid contact with acids; acid salt (such as potassium bisulfate, calcium biphosphate and calcium nitrate); carbon dioxide and strong oxidizers (such as nitrates, chlorates and chlorine), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: UN1565 Barium cyanide, Hazard Class: 6.1; Labels: 6.1—Poisonous materials.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Restrict persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Ventilate the area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers.

Fire Extinguishing: Barium cyanide does not burn, but contact with acids, acid salts; or carbon dioxide in air may produce highly flammable hydrogen cyanide gas. Extinguish fire using an agent suitable for type of surrounding fire. Thermal decomposition products may include hydrogen cyanide and oxides of nitrogen. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Precipitate barium with sulfate. Then add with stirring to alkaline calcium hypochlorite solution. Let stand 24 hours, then flush to sewer.

References

(31); (173); (101); (138); (2); (170); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 1, No. 6, 33–35 (1981) and 3, No. 4, 31–32 (1983).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Barium Cyanide*, Trenton, NJ (June 2005).

Barium Nitrate B:0160

Formula: BaN_2O_6; $Ba(NO_3)_2$

Synonyms: Barium dinitrate; Nitrate de baryum (French); Nitrato barico (Spanish); Nitrato de bario (Spanish); Nitric acid, Barium salt

CAS Registry Number: 10022-31-8

HSDB Number: 401

RTECS Number: CQ9625000

UN/NA & ERG Number: UN1446/141

EC Number: 233-020-5

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Strong oxidizer, Corrosive, Primary irritant (w/o allergic reaction), Environmental hazard.

United States National Primary Drinking Water Regulations: MCLG = 2 mg[Ba]/L; MCL = 2 mg[Ba]/L as Barium; MCLG = 10 mg[N]/L; MCL = 10 mg/L as Nitrates

RCRA 40CFR261, Appendix 8; 40CFR261.11 Hazardous Constituents

EPCRA Section 313: Includes any unique chemical substance that contains barium as part of that chemical's infrastructure. This category does not include barium sulfate (7727-43-7). Form R *de minimis* concentration reporting level: 0.1%. Form R, Toxic Chemical Category Code: N040.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) (Ba compounds, soluble, n.o.s.)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: O, C, Xi, Xn risk phrases: R8; R20/21/22; R25; R26; R34; R36/38; safety phrases: S17; S23; S26; S28; 36/37/39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Barium Nitrate is a shiny, white crystalline solid. Molecular weight = 261.35; Specific gravity water = 1) = 3.24 @ 23°C; boiling point = 210°C (decomposes); freezing/melting point = 590°C. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 0; reactivity 2 ₩, Oxidizer. Soluble in water.

Potential Exposure: Barium nitrate is used in making fireworks (in green fire pyrotechnics), signal lights, ceramics; and in the electronics industry; to make BaO_2. Once used in the vacuum tube industry.

Incompatibilities: A strong oxidizer. Decomposes in heat; may detonate if confined in elevating temperatures. Keep away from strong acids; reducing agents. Contact with organic and combustible materials (such as wood, paper, oil and fuels); and aluminum−magnesium alloys, since violent reactions occur. Contact with sulfur powder and finely divided metals can form shock-sensitive compounds.

Permissible Exposure Limits in Air

NIOSH IDLH = 50 mg[Ba]/m^3

ACGIH TLV[1]: 0.5 mg[Ba]/m^3 TWA; not classifiable as a human carcinogen

OSHA PEL: 0.5 mg[Ba]/m^3 TWA

NIOSH REL: 0.5 mg[Ba]/m^3 TWA

PAC Ver. 29[138]

PAC-1: 2.9 milligram per cubic meter

PAC-2: 350 milligram per cubic meter

PAC-3: 2100 milligram per cubic meter

DFG MAK: 0.5 mg[Ba]/m^3, inhalable fraction TWA; Peak limitation II(2)

Several states have set guidelines or standards for barium in ambient air[60] ranging from 0.67 μ/m^3 (New York) to 5.0 μ/m^3 (Florida and North Dakota) to 8.0 μ/m^3 (Virginia) to 10.0 μ/m^3 (Connecticut) to 12.0 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Methods (IV) #7056, Barium, soluble compounds. Collection on a cellulose membrane filter, workup with hot water, analysis by atomic absorption. Use NIOSH Analytical Method #8310, Metals in urine. OSHA ANALYTICAL METHOD ID-121.

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 2000 μg[Ba]/L; State Drinking Water Standards: California 1000 μg[Ba]/L; State Drinking Water Guidelines: Arizona 1500 μg[Ba]/L; Minnesota 2000 μg[Ba]/L.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short-Term Exposure: Barium nitrate can affect you when breathed in. Inhaling dust or mist can cause irritation of the respiratory system, causing cough and phlegm. Contact can irritate and even burn the eyes and skin. Exposure can irritate the eyes, nose, and throat. Very high exposure (such as swallowing or extremely high dust exposure) can cause barium poisoning with symptoms of vomiting and diarrhea; irregular heartbeat; paralysis, and death. Exposure to either form can affect the nervous system and cause hypokalemia, which can cause heart disorders. LD_{50} = (oral-rat) 355 mg/kg.

Long-Term Exposure: Barium can cause an increase in blood pressure. Repeated high exposure can irritate the lungs, causing cough and phlegm and may cause an abnormal chest X-ray. Animal studies have found increased blood pressure and changes in the heart from ingesting barium over a long time.

Points of Attack: Lungs, nervous system; heart.

Medical Surveillance: Consideration should be given to the skin, eye, heart, and lung in any placement or periodic examination.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and Wash immediately with soap and Water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. See also First Aid section in "Barium" entry.

Personal Protective Methods: Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. If local exhaust ventilation or enclosure is not used, respirators should be worn. Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash or dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: (Ba soluble compounds) *5 milligram per cubic meter:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *12.5 milligram per cubic meter:* Sa: Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25) (any PAPR with a high-efficiency particulate filter). *25 milligram per cubic meter:* 100 F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTHie (APF = 50) (any PAPR with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *50 milligram per cubic meter:* Sa:Pd,Pp (APF = 1000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100 F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Oxidizer. Potentially explosive. Oxidizers should be isolated from acids, metals, organic materials, and ammonium nitrate. (1) Color code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially organic materials, flammables and combustibles, and other incompatible materials. Oxidizers, including oxidizing gases, should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Store in tightly closed containers in a cool, well-ventilated area. (2) Color code—Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: UN1446 Barium nitrate, Hazard Class: 5.1; Labels: 5.1—Oxidizer, 6.1—Poisonous materials.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120 (q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen and metal. Extinguish fire using an agent suitable for type of surrounding fire. Barium nitrate itself does not burn but heating causes decomposition and gives off oxygen, thereby increasing the intensity of an existing fire. Use flooding amounts of water in early stages of fire[17]; in large fires, the material may melt and water could scatter the molten material. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve waste in 6-MHCl. Neutralize with NH_4OH. Precipitate with excess sodium carbonate. Filter, wash and dry precipitate and return to supplier.

References

(31); (173); (101); (138); (2); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 1, No. 6, 36−37 (1981).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Barium Nitrate, Trenton, NJ (June 2001).

Barium Oxide B:0170

Formula: BaO

Synonyms: Barium monoxide; Barium protoxide; Baryta; Calcined baryta; Monoxido barico (Spanish); Oxido de bario (Spanish); Oxyde de baryum (French)

CAS Registry Number: 1304-28-5

RTECS Number: CQ9800000

UN/NA & ERG Number: UN1884/157

EC Number: 215-127-9

Regulatory Authority and Advisory Information

Hazard Alert: poison, Corrosive, Dangerously water reactive, Environmental hazard.

RCRA 40CFR261, Appendix 8; 40CFR261.11 Hazardous Constituents

United States National Primary Drinking Water Regulations: MCLG = 2 mg[Ba]/L; MCL = 2 mg[Ba]/L as Barium.

EPCRA Section 313: Includes any unique chemical substance that contains barium as part of that chemical's infrastructure. This category does not include barium sulfate (7727-43-7). Form R *de minimis* concentration reporting level: 0.1%. Form R, Toxic Chemical Category Code: N040.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) (Ba compounds, soluble, n.o.s.)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. As Barium, water-soluble compounds, n.o.s.

Hazard symbols, risk, & safety statements: Hazard symbol: T; risk phrases: R20; R25; R34; safety phrases: S26; S36/37/39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Barium oxide is a white to yellowish-white, odorless powder. Molecular weight = 153.33; specific gravity (H_2O:1) = 5.7; freezing/melting point = 1973°C. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 0; reactivity 2 ₩. Reacts violently with water, releasing heat, and highly basic solution of barium hydroxide.

Potential Exposure: It is used to dry gases and solvents and in producing detergents for lubricating oils.

Incompatibilities: Reacts with water, forming the strong base, barium hydroxide. Keep away from acids, hydrogen sulfide, carbon dioxide; hydroxylamine, nitrogen tetroxide; sulfur trioxide; since violent reactions occur. Reacts with triuranium. Never pour water into this chemical.

Permissible Exposure Limits in Air

NIOSH IDLH = 50 mg[Ba]/m^3

ACGIH TLV[1]: 0.5 mg[Ba]/m^3 TWA; not classifiable as a human carcinogen

OSHA PEL: 0.5 mg[Ba]/m^3 TWA

NIOSH REL: 0.5 mg[Ba]/m^3 TWA

PAC Ver. 29[138]

PAC-1: 1.7 milligram per cubic meter

PAC-2: 200 milligram per cubic meter

PAC-3: 1200 milligram per cubic meter

DFG MAK: 0.5 mg[Ba]/m^3, inhalable fraction TWA; Peak limitation II(2)

Several states have set guidelines or standards for barium in ambient air[60] ranging from 0.67 μ/m^3 (New York) to 5.0 μ/m^3 (Florida and North Dakota) to 8.0 μ/m^3 (Virginia) to 10.0 μ/m^3 (Connecticut) to 12.0 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Methods (IV) #7056, Barium, soluble compounds. Collection on a cellulose membrane filter, workup with hot water, analysis by atomic absorption. Use NIOSH Analytical Method #8310, Metals in urine. OSHA ANALYTICAL METHOD ID-121.

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 2000 μg[Ba]/L; State Drinking Water Standards: California 1000 μg[Ba]/L; State Drinking Water Guidelines: Arizona 1500 μg[Ba]/L; Minnesota 2000 μg[Ba]/L.

Determination in Water: Harmful to the environment: aquatic organisms [NIOSH, ICSC:0778]

Routes of Entry: Inhalation, ingestion, skin or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Barium oxide can affect you when breathed in. Contact can irritate the skin and burn the eyes, causing loss of vision. Breathing the dust or mist can irritate the nose, throat and bronchial tubes, causing cough and phlegm. High exposure may cause pulmonary edema, a medical emergency, which can be delayed for several hours. The symptoms of pulmonary edema are aggravated by physical effort. This can cause death. Exposure to this chemical can affect the nervous system and cause hypokalemia, which can cause heart disorders.

Long-Term Exposure: Barium can cause an increase in blood pressure. May cause lung irritation and bronchitis. After repeated exposure, barium may show up as spots in the lungs on chest X-ray. Some barium chemicals are contaminated with silica, which scars the lungs. Animal studies have found increased blood pressure and changes in the heart from ingesting barium over a long time.

Points of Attack: Lungs, nervous system, heart.

Medical Surveillance: Consideration should be given to the skin, eye, heart, and lung in any placement or periodic examination.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy. See also First Aid section in "Barium" entry.

Personal Protective Methods: Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. If local exhaust ventilation or enclosure is not used, respirators should be worn. Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: (Ba soluble compounds) *5 milligram per cubic meter:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *12.5 milligram per cubic meter:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25) (any PAPR with a high-efficiency particulate filter). *25 milligram per cubic meter:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTHie (APF = 50) (any PAPR with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *50 milligram per cubic meter:* SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Store in tightly closed containers in a dry, cool, well-ventilated area away from water and the incompatible substances cited above.

Shipping: UN1884 Barium oxide, Hazard Class: 6.1; Labels: 6.1—Poisonous materials.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. NEVER pour water into this substance; when dissolving or diluting always add it slowly to the water. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Barium oxide itself does not burn. Thermal decomposition products may include oxides of metal (barium). Do not use water. Extinguish fire using an agent suitable for type of surrounding fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Barium Oxide, Trenton, NJ (June 2002).

NIOSH, ICSC:0778

Barium Permanganate B:0190

Formula: $BaMn_2O_8$; $Ba(MnO_4)_2$

Synonyms: Barium manganate(VIII); Permanganate de barium (French); Permanganato de bario (Spanish); Permanganato barico (Spanish); Permanganic acid, barium salt

CAS Registry Number: 7787-36-2

HSDB Number: 397

RTECS Number: SD6405000

UN/NA & ERG Number: UN1448/141

EC Number: 232-110-1

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Neurotoxic (cumulative) as Mn, Strong oxidizer, Environmental hazard.

OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 7500 lb

RCRA 40CFR261, Appendix 8; 40CFR261.11 Hazardous Constituents

United States National Primary Drinking Water Regulations: MCLG = 2 mg[Ba]/L; MCL = 2 mg[Ba]/L as Barium.

EPCRA Section 313: Includes any unique chemical substance that contains barium as part of that chemical's infrastructure. This category does not include barium sulfate (7727-43-7). Form R *de minimis* concentration reporting level: 0.1%. Form R, Toxic Chemical Category Code: N040; Section 313 Form R *de minimis* concentration reporting level: 1.0%, manganese compounds, Form R Toxic Chemical Category Code: N450.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. As Barium, water-soluble compounds, n.o.s.

Hazard symbols, risk, & safety statements: Hazard symbol: O, T; risk phrases: R8, R9, R20/22; R23/24/25; R26; R36/37/38; safety phrases: S8; S28; 36/37/39; S41; S45 (see Appendix 4)

Description: Barium permananganate is a brownish-violet, dark purple to black crystalline solid. Molecular weight = 375.2; specific gravity (H$_2$O:1) = 3.77 @ 20°C. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 0; reactivity 0 ₩. Soluble in water.

Potential Exposure: It is used to make dry cells and other permanganates, and as a disinfectant.

Incompatibilities: A strong oxidizer. May be explosive on contact with combustible and finely divided materials/metals. Keep away from sulfuric acid; possibly explosive. Explosions can occur when permanganates that have been treated with sulfuric acid come in contact with benzene, carbon disulfide, diethyl ether, ethyl alcohol, petroleum, or organic matter. Contact with acetic acid or acetic anhydride can cause explosion. if not kept cold [Von Schwartz 1918 p. 34][101]. Incompatible with acetic acid, acetic anhydride, and organic or combustible materials (such as wood, paper, oil, and fuels), since violent reactions can occur. When mixed with combustible materials, this material can ignite by friction or acids; may be spontaneously combustible.

Permissible Exposure Limits in Air

Manganese, inorganic compound

NIOSH IDLH = 500 mg[Mn]/m^3

OSHA PEL: 5 mg[Mn]/m^3 Ceiling Concentration (inorganic compounds and fume)

NIOSH REL: 1 mg[Mn]/m^3 TWA; 3 mg[Mn]/m^3 STEL

ACGIH TLV[1] 0.02 mg[Mn]/m^3, respirable fraction; 0.1 mg[Mn]/m^3, inhalable fraction; not classifiable as a human carcinogen.

DFG MAK (*inorganic compounds and fume*): 0.5 mg[Mn]/m^3 inhalable fraction (Mn and its inorganic compounds); Pregnancy Risk Group C

Barium permananganate

PAC Ver. 29[138]

PAC-1: 20 milligram per cubic meter

PAC-2: 34 milligram per cubic meter

PAC-3: 200 milligram per cubic meter

Determination in Air: *Barium:* Use NIOSH Analytical Methods (IV) #7056, Barium, soluble compounds. Collection on a cellulose membrane filter, workup with hot water, analysis by atomic absorption. Use NIOSH Analytical Method #8310, Metals in urine. OSHA ANALYTICAL METHOD ID; *Manganese:* Use NIOSH Analytical Method, Elements by ICP, #7300; #7301; #7303; #9102; Elements in blood or tissue, #8005; Metals in urine, #8310; OSHA Analytical Method, ID-125G or ID121.

Permissible Concentration in Water: *Manganese:* Federal Drinking Water Guidelines: EPA 50 µg[Mn]/L; State Drinking Water Standards: New York: 300 µg[Mn]/L; State Drinking Water Guidelines: California 500 µg[Mn]/L; Connecticut: 500 µg[Mn]/L; Maine: 500 µg[Mn]/L; Minnesota: 300 µg[Mn]/L; New Hampshire: 100 µg[Mn]/L World Health Organization (WHO) limit: 400 µg(Mn)/L

Barium: Federal Drinking Water Guidelines: EPA 2000 µg [Ba]/L; State Drin king Water Standards: California 1000 µg[Ba]/L; State Drinking Water Guidelines: Arizona 1500 µg[Ba]/L; Minnesota 2000 µg[Ba]/L.

Routes of Entry: Inhalation.

Short-Term Exposure: Skin and eye contact can cause severe irritation and burns. Barium permanganate can affect you when breathed in. Breathing the dust or mist can irritate the nose, throat and bronchial tubes, causing cough and phlegm. Exposure to either form can affect the nervous system and cause hypokalemia, which can cause heart disorders.

Long-Term Exposure: Barium can cause an increase in blood pressure. After repeated exposure, Barium may show up as spots in the lungs on chest X-ray. Some barium chemicals are contaminated with Silica, which scars the lungs. Animal studies have found increased blood pressure and changes in the heart from ingesting barium over a long time. Repeated contact may cause chronic drying and cracking skin.

Points of Attack: Lungs, skin.

Medical Surveillance: Consideration should be given to the skin, eye, heart, and lung in any placement or periodic examination.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. See also First Aid section in "Barium" entry.

Personal Protective Methods: Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. If local exhaust ventilation or enclosure is not used, respirators should be worn. Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles an d face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Post hazard and warning information in the work area. In addition, as part of an ongoing education and training effort, communicate all information on the health and safety hazards of Barium permanganate to potentially exposed workers.

Respirator Selection: (Ba soluble compounds) *5 milligram per cubic meter:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *12.5 milligram per cubic meter:* Sa: Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25) (any PAPR with a high-efficiency particulate filter). *25 milligram per cubic meter:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTHie (APF = 50) (any PAPR with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *50 milligram per cubic meter:* Sa:Pd,Pp (APF = 1000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Oxidizers should be isolated from acids, metals, organic materials, and ammonium nitrate. (1) Color code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially organic materials, flammables and combustibles, and other incompatible materials. Oxidizers, including oxidizing gases, should have a boundary separation of 8–10 m or a 1-hour fire wall from flammable or reactive materials. Store in tightly closed containers is a cool, well-ventilated area. (2) Color code—Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: UN1448 Barium permanganate, Hazard Class: 5.1; Labels: 5.1—Oxidizer, 6.1—Poisonous materials.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: A strong oxidizing agent; my increase intensity of fire. Thermal decomposition products may include oxides of metal. Barium permanganate does not burn, but contact with organic and combustible materials may cause fires or explosions. In case of fire, evacuate the area and fight the fire from a safe, protected location. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Generators of waste (equal to or greater than 100 kg/mo) containing this contaminant, EPA hazardous waste number N450, must conform with USEP A regulations for storage, transportation, treatment, and disposal of waste. Dispose of waste material as hazardous waste using a licensed disposal contractor to an approved landfill. Dispose of contents and container to an approved waste disposal plant. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office. All federal, state, and local environmental regulations must be observed. Do not discharge into drains or sewers.

References

(31); (173); (101); (138); (2).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Barium permanganate, Trenton, NJ (August 2001).

Barium Peroxide B:0200

Formula: BaO_2

Synonyms: Barium binoxide; Barium dioxide; Bariumperoxid (German); Barium superoxide; Dioxyde de baryum (French); Peroxido barico (Spanish); Peroxyde de baryum (French)

CAS Registry Number: 1304-29-6

HSDB Number: 396

RTECS Number: CR0175000

UN/NA & ERG Number: UN1449/141

EC Number: 215-128-4 [*Annex I Index No.:* 056-001-00-1]

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Oxidizer, Environmental hazard.

RCRA 40CFR261, Appendix 8; 40CFR261.11 Hazardous Constituents

EPCRA Section 313: Includes any unique chemical substance that contains barium as part of that chemical's infrastructure. This category does not include barium sulfate (7727-43-7). Form R *de minimis* concentration reporting level: 0.1%. Form R, Toxic Chemical Category Code: N040.

United States National Primary Drinking Water Regulations: MCLG = 2 mg[Ba]/L; MCL = 2 mg[Ba]/L, as Barium.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. As Barium, water-soluble compounds, n.o.s.

Hazard symbols, risk, & safety statements: Hazard symbol: O, Xn; risk phrases: R8; R20/22; safety phrases: S2; S13; S27; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Barium peroxide is a grayish-white powder. Molecular weight = 169.34; specific gravity (H_2O:1) = 4.97; boiling point = 800°C (decomposes below this point); freezing/melting point = 450°C. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 0; reactivity 2 ₩, Oxidizer. Very slightly soluble in water.

Potential Exposure: Is used as a bleaching agent; in making hydrogen peroxide, oxygen; in aluminum welding; in textile dyeing and for bleaching fibers; animal substances.

Incompatibilities: A strong oxidizer. Keep away from organic and combustible materials (such as wood, paper, oil, fuels, and other easily oxidized materials) and peroxyformic acid, hydrogen sulfide and hydroxylamine solutions, since violent reactions occur.

Permissible Exposure Limits in Air

NIOSH IDLH = 50 mg[Ba]/m^3

ACGIH TLV[1]: 0.5 mg[Ba]/m^3 TWA; not classifiable as a human carcinogen

OSHA PEL: 0.5 mg[Ba]/m^3 TWA

NIOSH REL: 0.5 mg[Ba]/m^3 TWA

PAC Ver. 29[138]

PAC-1: 1.8 milligram per cubic meter

PAC-2: 230 milligram per cubic meter

PAC-3: 1400 milligram per cubic meter

DFG MAK: 0.5 mg[Ba]/m^3, inhalable fraction TWA; Peak limitation II(2)

Australia: TWA 0.5 milligram per cubic meter, 1993; Austria: MAK 0.5 milligram per cubic meter, 1993; Belgium: TWA 0.5 milligram per cubic meter, 1993; Denmark: TWA 0.5 milligram per cubic meter, 1999; Finland: TWA 0.5 milligram per cubic meter, 1999; Hungary STEL 0.5 milligram per cubic meter, 1993; the Netherlands: MAC-TGG 0.5 milligram per cubic meter, 2003; the Philippines: TWA 0.5 milligram per cubic meter, 1993; Poland: MAC (time-weighted average) 0.5 milligram per cubic meter; MAC (STEL) 1.5 milligram per cubic meter, 1999; Sweden: TWA 0.5 milligram per cubic meter, 1999; Switzerland: MAK-week 0.5 milligram per cubic meter, 1999; Turkey: TWA 0.5 milligram per cubic meter, 1993; United Kingdom LTEL 0.5 milligram per cubic meter, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Several states have set guidelines or standards for barium in ambient air[60] ranging from 0.67 μ/m^3 (New York) to 5.0 μ/m^3 (Florida and North Dakota) to 8.0 μ/m^3 (Virginia) to 10.0 μ/m^3 (Connecticut) to 12.0 μ/m^3 (Nevada).

Determination in Air: See entry under "Barium."

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 2000 μg[Ba]/L; State Drinking Water Standards: California 1000 μg[Ba]/L; State Drinking Water Guidelines: Arizona 1500 μg[Ba]/L; Minnesota 2000 μg[Ba]/L.

Determination in Water: Environmental hazard for aquatic organisms.

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Barium peroxide can affect you when breathed in. Contact can irritate and burn the eyes and skin. Breathing the dust or mist can irritate the nose, throat and bronchial tubes, causing cough and phlegm. Exposure to this chemical can affect the nervous system and cause hypokalemia, which can cause heart disorders.

Long-Term Exposure: Barium can cause an increase in blood pressure. After repeated exposure, Barium may show up as spots in the lungs on chest X-ray. Some barium chemicals are contaminated with silica, which scars the lungs. Repeated contact may cause chronic drying and cracking skin. Animal studies have found increased blood pressure and changes in the heart from ingesting barium over a long time.

Points of Attack: Lungs, skin.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Where possible, enclose operational and use local exhaust ventilation at the site of chemical release. If local exhaust ventilation or enclosure is not used, respirators should be worn. Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: (Ba soluble compounds) *5 milligram per cubic meter:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *12.5 milligram per cubic meter:* Sa: Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25) (any PAPR with a high-efficiency particulate filter). *25 milligram per cubic meter:* 100 F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTHie (APF = 50) (any PAPR with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *50 milligram per cubic meter:* Sa:Pd,Pp (APF = 1000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Oxidizers should be isolated from acids, metals, organic materials, and ammonium nitrate. (1) Color code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially organic materials, flammables and combustibles, and other incompatible materials. Oxidizers, including oxidizing gases, should have a boundary separation of 8–10 m or a 1-hour fire wall from flammable or reactive materials. (2) Color code—Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. Store in tightly closed containers in a cool, well-ventilated area away from water or moisture, and away from contact with the incompatible materials cited above. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: UN1449 Barium peroxide, Hazard Class: 5.1; Labels: 5.1—Oxidizer, 6.1—Poisonous materials.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Cover material with sand/soda ash 9:1 mixture. Mix thoroughly and while stirring, add slowly to sodium bisulfite solution with plastic implements. Neutralize with dilute H_2SO_4. After setting, decant the solution with flushing water and transport the sand to a sanitary landfill[22]. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include barium oxide and pure oxygen. Barium peroxide does not burn, but mixtures of barium peroxide and combustible, organic, or easily oxidized materials, such as wood, fuels, paper, and charcoal will burn or explode if rubbed or contact a small amount of water. Use large amounts of water to extinguish the fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dispose of contents and container to an approved waste disposal plant. All federal, state, and local environmental regulations must be observed. Contact your local or federal environmental protection agency for specific recommendations.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Barium peroxide, Trenton, NJ (August 2001).

Barium Sulfate B:0210

Formula: BaO_4S; $BaSO_4$

Synonyms: Actybaryte; Artificial brite; Artificial heavy spar; Bakontal; Baridol; Barite; Baritop; Barosperse;

Barotrast; Baryta white; Barytes; Bayrites; Blanc fixe (French); C.I. 77120C.I.; Citobaryum; Colonatrast; Enamel white; Esophotrast; Eweisse-Z-paque; E-Z-paque; Finemeal; Lactobaryt; Liquibarine; Macropaque; Neobar; Oratrast; Permanent white; Pigment white 21; Polybar; Precipitated barium sulfate; Radiobaryt; Raybar; Redi-Flow; Solbar; Sulfato barico (Spanish); Sulfuric acid, barium salt (1:1); Supramike; Travad; Unibaryt

CAS Registry Number: 7727-43-7

HSDB Number: 5041

RTECS Number: CR0600000

UN/NA & ERG Number: UN1564/154

EC Number: 231-784-4

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Environmental hazard.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, as barium compounds, n.o.s., waste number not listed

EPCRA Section 313: This does *not* cover barium sulfate (7727-43-7).

United States National Primary Drinking Water Regulations: MCLG = 2 mg[Ba]/L; MCL = 2 mg[Ba]/L, as Barium.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

United States National Primary Drinking Water Regulations: SMCL = 250 $\mathrm{mg[SO_4^{2-}]}/L$ as sulfate

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. As Barium, water-soluble compounds, n.o.s.

Hazard symbols, risk, & safety statements: Hazard symbol: Xn risk phrases: R20/21/22; R36/37/38; R62; safety phrases: S22; S24/25/26; 36/37/39; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): Non hazard to water.

Description: Barium sulfate is a white crystalline solid. Molecular weight = 233.39; specific gravity (H_2O:1) = 4.49 (no temperature given); freezing/melting point = 1580°C. Hazard identification (based on NFPA-704 M Rating System): Health 1; flammability 1; reactivity 0 ₩. Slightly soluble in water.

Potential Exposure: Barium sulfate is used as an opaque medium in radiography; as a mud weighting material in oil well drilling; in paper coating; as a paint pigment.

Incompatibilities: May act as an oxidizer. Reacts with reducing agents such as hydrides, potassium, phosphorus or aluminum. Aluminum powder + heat may be violent; possibly explosive.

Permissible Exposure Limits in Air

OSHA PEL: 15 milligram per cubic meter, total dust TWA; 5 milligram per cubic meter, respirable fraction TWA

NIOSH REL: 10 milligram per cubic meter, total dust TWA; 5 milligram per cubic meter, respirable fraction TWA

ACGIH TLV[1]: 10 milligram per cubic meter TWA

PAC Ver. 29[138]

PAC-1: 15 milligram per cubic meter

PAC-2: 170 milligram per cubic meter

PAC-3: 990 milligram per cubic meter

DFG MAK: 1.5 milligram per cubic meter respirable fraction (previously “fine dust”); 4 milligram per cubic meter inhalable fraction (previously “total dust”).

Pregnancy Risk group C.

Australia: TWA 10 milligram per cubic meter, 1993; Austria: MAK 0.5 mg(Ba)/m^3, 1999; Belgium: TWA 10 milligram per cubic meter (resp. dust), 1993; Denmark: TWA 0.5 mg(Ba)/m^3, 1999; Finland: TWA 0.5 mg(Ba)/m^3, 1999; Norway: TWA 0.5 mg(Ba)/m^3, 1999; Sweden: TWA 0.5 mg(Ba)/m^3, 1999; the Netherlands: MAC-TGG 0.5 mg (Ba)/m^3; MAC-TGG 1.5 milligram per cubic meter (respirable dust), 2003; MAC-TGG 4 milligram per cubic meter (total dust), 2003; United Kingdom: TWA (Respirable dust) 4 mg(Ba)/m^3, 2000; United Kingdom: TWA 10 mg(Ba)/m^3 (total dust), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV; TWA 10 milligram per cubic meter

Determination in Air: Barium sulfate may be determined by filtration and gravimetric measurement.

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 2000 μg[Ba]/L; State Drinking Water Standards: California 1000 μg[Ba]/L; State Drinking Water Guidelines: Arizona 1500 μg[Ba]/L; Minnesota 2000 μg[Ba]/L.

Routes of Entry: Inhalation of dust; ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates eyes and respiratory tract. Exposure to either form can affect the nervous system and cause hypokalemia, which can cause heart disorders.

Long-Term Exposure: Barium can cause an increase in blood pressure. Lungs may be affected by repeated or prolonged exposure to dust particles, resulting in baritosis (a form of benign pneumoconiosis) (WHO). Animal studies have found increased blood pressure and changes in the heart from ingesting barium over a long time.

Points of Attack: Lungs, nervous system; heart.

Medical Surveillance: Consideration should be given to the skin, eyes, heart, and lung in any placement or periodic examination.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *5 milligram per cubic meter:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *12.5 milligram per cubic meter:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25) (any PAPR with a high-efficiency particulate filter). *25 milligram per cubic meter:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTHie (APF = 50) (any PAPR with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *50 milligram per cubic meter:* SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd, Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Store in tightly closed containers in a cool, well-ventilated area away from incompatible materials listed above. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN1564 Barium compounds, n.o.s., Hazard Class: 6.1; Labels: 6.1—Poisonous materials.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include sulfur oxides. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 1, No. 1, 31 (1980),

Basic Red 9 Monohydrochloride B:0216

Formula: $C_{19}H_{17}N_3 \cdot ClH$

Synonyms: 4-[(4-Aminophenyl)(4-imino-2,5-cyclohexadien-1-ylidene)methyl]benzenamine monohydrochloride; Basic parafuchsine; Basic red 9; Benzenamine, 4-[(4-aminophenyl)(4-imino-2,5-cyclohexadien-1-ylidene)methyl]; C.I. 42,500; C.I. Basic red 9; C.I. Basic red 9, monohydrochloride; Calcozine magenta N; *p*-Fuchsin; Fuchsine DR 001; Fuchsine SP; Fuchsine SPC; 4,4′-[(4-Imino-2,5-cyclohexadien-1-ylidene)methylene]dianiline monohydrochloride; NCI-C54739; Orient para magenta base; *p*-Magenta; Magenta-O; Parafuchsin; Parafuchsine; Pararosaniline; Pararosaniline chloride; Pararosaniline hydrochloride; *p*-Rosaniline HCL; *p*-Rosaniline hydrochloride; 4,4′4″-Triaminotriphenylmethan-hydrochlorid (German)

CAS Registry Number: 569-61-9; 70426-60-7; 131883-55-1

HSDB Number: 2952

RTECS Number: CX9850100
UN/NA & ERG Number: UN3143/151; UN2924/132
EC Number: 209-321-2 [*Annex I Index No.:* 611-031-00-X)
Regulatory Authority and Advisory Information
Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Human evidence: inadequate; animal evidence: sufficient, possibly carcinogenic to humans, Group 2B, 1993
California Proposition 65 Chemical[102]: Cancer 6/1/1989.
Hazard Alert: Poison, Combustible Corrosive, Possible risk of forming tumors, Suspected reprotoxic hazard.
Hazard symbols, risk, & safety statements: Hazard symbol: F, T, Xn; risk phrases: R45; R40; R50/53; R61; R63; safety phrases: S16; 36/37/39; S41; S45; S53 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: C.I. Basic red 9 is a colorless to red crystalline solid or green powder. Molecular weight = 323.85; freezing/melting point = (decomposes) 268−270°C. Practically insoluble in water; solubility ≤ 0.1 mg/mL @ 20°C. Physical and toxicological properties may be affected by the carrier solvents used in commercial formulations.

Potential Exposure: Used as a dye for textiles, paper; printing, computer and photo imaging inks, leather, and many consumer products; as a microbiological/microscopy stain for bacilli, including tubercle and influenza.

Incompatibilities: May be combustible; powder or liquid may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air:
No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Determination in Water: Octanol−water coefficient: Log $K_{ow} \leq -0.1$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Ingestion, dermal contact

Harmful Effects and Symptoms

Short-Term Exposure: LD_{50} = (oral-mouse) 5 g/kg.

Long-Term Exposure: May cause tumors, cancer. May affect DNA of fetus.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure.

First Aid: Eyes: first check the victim for contact lenses and remove if present. Flush victim's eyes with water or normal saline solution for 20 to 30 minutes while simultaneously calling a hospital or poison control center. Do not put any ointments, oils, or medication in the victim's eyes without specific instructions from a physician. Immediately transport the victim after flushing eyes to a hospital even if no symptoms (such as redness or irritation) develop. *Skin*: immediately flood affected skin with water while removing and isolating all contaminated clothing. Gently wash all affected skin areas thoroughly with soap and water. If symptoms such as redness or irritation develop, immediately call a physician and be prepared to transport the victim to a hospital for treatment. *Inhalation:* immediately leave the contaminated area; take deep breaths of fresh air. Immediately call a physician and be prepared to transport the victim to a hospital even if no symptoms (such as wheezing, coughing, shortness of breath, or burning in the mouth, throat, or chest) develop. Provide proper respiratory protection to rescuers entering an unknown atmosphere. Whenever possible, SCBA should be used; if not available, use a level of protection greater than or equal to that advised under protective clothing. Ingestion: do not induce vomiting. If the victim is conscious and not convulsing, give 1 or 2 glasses of water to dilute the chemical and immediately call a hospital or poison control center. Be prepared to transport the victim to a hospital if advised by a physician. If the victim is convulsing or unconscious, do not give anything by mouth, ensure that the victim's airway is open and lay the victim on his/her side with the head lower than the body. *Do not induce vomiting*. Immediately transport the victim to a hospital. *Other:* since this chemical is a known or suspected carcinogen you should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician will depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure.

Personal Protective Methods: Wear positive-pressure, SCBA. Wear chemical protective clothing which is specifically recommended by the manufacturer. Structural firefighter's protective clothing provides only limited protection.

Respirator Selection: *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA-or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a tightly closed container in a dry, well-ventilated and secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Where possible, automatically transfer material from other storage containers to process containers.

Shipping: UN 3143 Dyes, solid, toxic, n.o.s., or dye intermediates, solid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1—Poisonous materials, Technical Name Required.

Spill Handling: Stay upwind and uphill. Isolate the area of release or fire and deny entry. Remove all ignition sources. All equipment used to handle this material must be grounded. IF material or contaminated runoff from fire control enters waterways, notify downstream users of potentially contaminated water. Wear positive-pressure, SCBA. Wear chemical protective clothing which is specifically recommended by the manufacturer. Structural firefighter's protective clothing provides only limited protection. *Release, no fire.* Prevent dust cloud. Small spill: Cover with sand or other noncombustible material and place in a container for later disposal. Cover powder spills with plastic sheet or tarp to minimize spreading and protect from wind, rain, or spray. Large spill: Stop the release if it can be done safely from a distance. Prevent material and runoff from entering sewers and waterways if it can be done safely well ahead of the release. Use large amounts of water well away from release to disperse vapors−contain runoff. Ventilate confined area if it can be done without placing personnel at risk.

Fire Extinguishing: Thermal decomposition products may include poisonous and toxic hydrogen chloride gas, and oxides of nitrogen and carbon. *Small fire*: Use *dry* chemical, CO$_2$, water spray, or regular foam. Large fire: Use water spray, fog, or regular foam. Do not scatter spilled material with high pressure water streams. Dike fire-control water for later disposal. If material is not leaking, cool exposed containers with large quantities of water from unattended equipment until fire is well out, or remove intact containers if it can be done safely. If cooling streams are ineffective (*venting sound increases in volume and pitch, tank discolors or shows signs of deforming*), withdraw immediately to a secure location. Always stay away from ends of tanks, especially when engulfed in flames. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156.

Disposal Method Suggested: Use a licensed professional waste disposal service to dispose of this material. Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(109); (102); (31); (173); (101); (138); (100).

Bendiocarb B:0220

Formula: $C_{11}H_{13}NO_4$

Synonyms: AI3-27695; Bencarbate; Bendiocarbe; 1,3-Benzodioxole, 2,2-dimethyl-1,3-benzodioxol-4-ol methylcarbamate; 1,3-Benzodioxole, 2,2-dimethyl-4-(*N*-methylcarbamato)-; 1,3-Benzodioxol-4-ol, 2,2-dimethyl-, methylcrbamate; Bicam ULV; Carbamic acid, methyl-, 2,3-(dimethylmethylenedioxy)phenyl ester; Carbamic acid, methyl-, 2,3-(isopropylidenedioxy)phenyl ester; 2,2-Dimethylbenzo-1,3-benzodioxol-4-yl *N*-methylcarbamate; 2,2-Dimethyl-1,3-benzodioxol-4-yl *N*-methylcarbamate; 2,2-Dimethylbenzo-1,3-dioxol-4-yl methylcarbamate; 2,2-Dimethyl-4-(*N*-methylaminocarboxylato)-; 2,2-Dimethyl-4-(*N*-methylaminocarboxylato)-1,3-benxodioxole; Dycarb; Ficam; Ficam 80W; Ficam D; Ficam ULV; Ficam W; Fuam; Garvox; Garvox 3G; 2,3-Isopropylidenedioxyphenyl methylcarbamate; MC 6897; Methylcarbamic acid 2,3-(isopropylidenedioxy)phenyl ester; Multamat; Multimet; NC 6897; Niomil; OMS-1394; Rotate; Seedox; Seedox SC; Tattoo; Turcam

CAS Registry Number: 22781-23-3

HSDB Number: 3919

RTECS Number: FC1140000

UN/NA & ERG Number: UN2757 (carbamate pesticides, solid, toxic)/151; UN2811 (toxic solid, organic, n.o.s.)/153

EC Number: 245-216-8 [*Annex I Index No.:* 006-046-00-8]

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Possible neurotoxic effects (methyl carbamate), Environmental hazard, Agricultural chemical.

FAO/WHO Acceptable Daily Intake (ADI): 0.004 mg/kg

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U278

Superfund/EPCRA [40CFR 302 and 355, FR: 8/16/06, Vol. 71, No. 158] RQ: 100 lb (45.4 kg)

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.056; Nonwastewater (mg/kg), 1.4

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R21; R23/24/25; R50/55; safety phrases: S1/2; S22; S29; S36/37; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)]

Description: Bendiocarb is a white odorless crystalline powder. Molecular weight = 223.3; freezing/melting point = 129−130°C. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 0; reactivity 0 ₩. Soluble in water.

Potential Exposure: A potential danger to those involved in the manufacture, formulation and application of this carbamate insecticide which is used against household pests, in agriculture in seed treatment, and as a foliar spray.

Incompatibilities: Carbamates are incompatible with reducing agents, strong acids, oxidizing acids, peroxides, and bases. Contact with active metals or nitrides cause the release of flammable, and potentially explosive, hydrogen gas. May react violently with bromine, ketones. Incompatible with azo dyes, caustics, ammonia, amines, boranes, hydrazines, strong oxidizers. Keep away from flammable materials and sources of heat and flame.

Permissible Exposure Limits in Air
No standards or PAC available.

Permissible Concentration in Water: Canada's Drinking Water Quality is 0.04 mg/L MAC.

Determination in Water: Fish Tox = 379.47332000 ppb MATC (LOW).

Routes of Entry: Inhalation, skin, contact, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Bendiocarb is a toxic carbamate chemical. Bendiocarb can affect you when inhaled. Exposure can cause rapid poisoning, with headaches, sweating, nausea and vomiting; diarrhea, loss of concentration and death. Eye contact can cause irritation and blurred vision.

Long-Term Exposure: Similar carbamates can affect the central nervous system. Human Tox: 35.00000 ppb Health advisory: (INTERMEDIATE).

Medical Surveillance: Within a few hours of exposure determine erythrocyte cholinesterase and/or the presence of metabolites of bendiocarb in urine. Before starting work, at regular times after that, and if symptoms develop or over exposure occurs, the following is recommended: Serum and RBC cholinesterase levels (a test for the body substance affected by bendiocarb). For this substance, these tests are accurate only if done within about two hours of exposure, and can return to normal before the person feels well.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Shampoo hair. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: *Clothing:* Avoid skin contact with Bendiocarb. Wear protective gloves and clothing. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. The Farm Chemicals Handbook recommends polyvinyl chloride or rubber as a protective material.

Eye Protection: Wear dust-proof goggles when working with powders or dust, unless full facepiece respiratory protection is worn.

Respirator Selection: Where there is potential exists for exposures to bendiocarb, use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece respirator with a pesticide cartridge. Increased protection is obtained from full facepiece air purifying respirators (APR). *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator for pesticides with a full facepiece operated in the positive pressure mode, or with a full facepiece hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with Bendiocarb all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from food, fertilizers, other pesticides, flammable materials and sources of heat and flame.

Shipping: UN2757 Carbamate pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1—Poisonous materials. UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1—Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft. (NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Soil Adsorption Index (K_{oc}) = 570.

Fire Extinguishing: Bendiocarb may burn, but does not readily ignite. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide, halon, water spray; or standard foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office. Dispose in accordance with 40CFR165 recommendations for the disposal of pesticides and pesticide containers.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Bendiocarb, Trenton, NJ (January 2004).

Benfluralin B:0224

Formula: $C_{13}H_{16}F_3N_3O_4$

Synonyms: Balan; Balfin; Benefex; Benefin; Benfluraline; Benzenamine, *N*-butyl-*N*-ethyl-2,6-dinitro-4-(trifluoro methyl)-; Bethrodine; Bhulan; Binnell; Bonalan; *N*-Butyl-2,6-dinitro-*N*-ethyl-4-trifluoromethylaniline; *N*-Butyl-*N*-ethyl-2,6-dinitro-4-trifluoromethylbenzenamine; *N*-Butyl-*N*-ethyl-2,6-dinitro-4-(trifluromethyl)benzeneamine; *N*-Butyl-*N*-ethyl-2,6-dinitro-4-trifluoromethylaniline; *N*-Butyl-*N*-ethyl-α,α,α-trifluoro-2,6-dinitro-*p*-toluidine; Carpidor; Caswell No. 130; EL-110; Emblem; Flubalex; Pel-tech; Quilan; Team; *p*-Toluidine, *N*-butyl-*N*-ethyl-α,α,α-trifluoro-2,6-dinitro-; α,α,α-Trifluoro-2,6-dinitro-*N,N*-ethylbutyl-*p*-toluidine; XL 2G

CAS Registry Number: 1861-40-1

HSDB Number: 407

RTECS Number: XU4550000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171; UN1596 (Dinitroanilines)/153

EC Number: 217-465-2

Regulatory Authority and Advisory Information

Carcinogenicity[83]: EPA, Group E Evidence of Noncarcinogenicity for humans

Hazard Alert: Poison, Combustible, Sensitization hazard (skin), Environmental hazard, Agricultural chemical.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R21; R23/25; R50/53; safety phrases: S1/2; S22; S24/25; S29; S36/37; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)]

Description: Yellowish-orange crystalline solid. Commercial product is available as an emulsifiable concentrate. Molecular weight = 335.31; Specific gravity (H_2O:1) = 1.278 @ 20°C; freezing/melting point = 66°C; vapor pressure = 1×10^{-5} mmHg @ 20°C; flash point =< 190°C. Slightly soluble in water: solubility = 70 mg/L @ 25°C; <1 mg/L @ 25°C. Physical and toxicological properties may be affected by carrier solvents in commercial formulations.

Potential Exposure: Selective preemergence herbicide used to control of annual grasses and broad-leaf weeds. Used on alfalfa, red clover, seeded lettuce, trefoil; peanuts, certain tobaccos, vegetables such as endive, field and French beans, and lentils. A dinitroaniline derivative.

Permissible Concentration in Water: Runoff from spills or fire control may cause water pollution.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Moderate heat causes decomposition that produces toxic vapors that can form an explosive mixture with air.

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guidelines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg [F]/L. Safe Drinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg[F]/L; SMCL = 2 mg[F]/L, as Fluoride.

Determination in Water: Octanol−water coefficient: Log K_{ow} => 5. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood. Fish toxicity (threshold)[101]: High—3.08219 ppb, MATC (Maximum Acceptable Toxicant Concentration).

Routes of Entry: Ingestion, dermal contact, absorbed through the skin, inhalation of the dust, or vapor when these materials are heated

Harmful Effects and Symptoms

Short-Term Exposure: Severely irritates eyes, skin and respiratory tract, with burning sensation, pain, redness and swelling. Metabolic stimulant. If inhaled, causes coughing, dilated pupils, headache, profuse perspiration, intense thirst, extreme fatigue, rapid pulse, high fever, clammy, flushed skin, rapid breathing, nausea, vomiting, yellowish tint to skin and lips, anxiety and confusion, convulsions, risk of lung edema. If swallowed, face and lips turn bluish. Liver injury with associated jaundice, kidney failure, and cardiac arrhythmia is commonly noted. Because this material has a low vapor pressure, significant inhalation of vapors is unlikely at ordinary temperatures. Severe exposure can cause death from heart failure Dinitrobenzene materials are toxic to the blood; prevents hemoglobin from carrying oxygen. May be more toxic than aniline. LD_{50} (oral, rat) => 5 g/kg; LD_{50} (dermal, rat) => 5 g/kg.

Long-Term Exposure: Fluorides may cause bone disease (pain and tenderness of the bones); mottled teeth in children. May damage the liver, kidneys, and blood cells. This chemical may stain yellow the skin, eyes, and fingernails. Repeated exposure may cause anxiety, fatigue, insomnia, excessive perspiration, unusual thirst, weight loss and cataracts in the eyes. May affect the thyroid gland. May cause skin sensitization in some persons. Human toxicity (long-term)[101]: Very low—2100.00 ppb, Health advisory.

Points of Attack: Skin, bones, liver, kidneys, lungs, peripheral nervous system, eyes, thyroid gland, blood. May cause reproductive and fetal effects.

Medical Surveillance: Before beginning employment, at regular times after that and if symptoms develop or overexposure has occurred, the following may be useful: Exam of eyes for cataracts. Exam of skin and nails for staining. Liver and kidney function tests. CBC. Blood methemoglobin levels. Evaluation by a qualified allergist, including exposure history and testing, may help diagnose allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. *Do not induce vomiting when formulations containing petroleum solvents are ingested*. Otherwise, give large quantities of water and induce vomiting. Do not make an unconscious person vomit. *Note to Physician:* Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Dinitroanilines react with cellulose-based and expanded polymeric absorbents[88]. Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of dermal and/or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a tightly closed container in a dry, well-ventilated and secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Where possible, automatically transfer material from other storage containers to process containers. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9—Miscellaneous hazardous material, Technical Name Required. UN1596 Dinotoanilines, Hazard Class: 6.1; Labels: 6.1—Poisonous materials.

Spill Handling: First, remove all sources of ignition. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition product includes hydrogen fluoride fumes and oxides of nitrogen and carbon. This chemical is a combustible solid but does not readily ignite. Moderate heat causes decomposition that produces toxic vapors that form an explosive mixture with air. As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 m/150 ft for liquids and at least 25 m/75 ft for solids. *Fire involving storage or vehicular tanks:* Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. *On a small fire:* use dry chemical, CO_2, water spray or regular *foam. On a large fire:* use water spray, fog or regular foam. Do not scatter spilled material with high pressure streams of water. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal. *Fire involving tanks:* From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. Always stay away from tanks engulfed in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Do not discharge into drains or sewers. Dispose of waste material as hazardous waste using a licensed disposal contractor to an approved landfill. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. If allowed, Incineration with effluent gas scrubbing is recommended. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office. Ultraviolet-radiation: This liquid herbicide is reported to be susceptible to decomposition by UV radiation[UN].

References

(31); (173); (101); (138); (122); (100).

United States Environmental Protection Agency, Office of Pesticide Programs, *Pesticide Residue Limits, Benfluralin*, 40 CFR 180.208 (2008). http://www.epa.gov/pesticides/food/viewtols.htm.

United States Environmental Protection Agency, *R.E.D. FACTS, Benfluralin*, EPA 738-F-04-007, Washington, DC (July 31, 2004).

Benfuracarb B:0227

Formula: $C_{20}H_{30}N_2O_5S$

Synonyms: β-Alanine, *N*-[((((2,3-dihydro-2,2-dimethyl-7-benzofuranyl)oxy)carbonyl)methylamino)thio]-*N*-(1-methylethyl)-, ethyl ester; Aminofuracarb; Aminosulfulan; 2,3-Dihydro-2,2-dimethyl-7-benzofuranyl *N*-(*N*-2-(ethoxycarbonyl)ethyl-*N*-isopropylaminosulfenyl)-*N*-methylcarbamate; Ethyl*N*-(2,3-dihydro-2,2-dimethylbenzofuran-7-yloxycarbonyl(methyl)aminothio)-*N*-isopropyl-β-alaninate; Ethyl [((((2,3-dihydro-2,2-dimethyl-7-benzofuranyl)oxy)carbonyl)methylamino)thio]-*N*-(1-methylethyl)-β-alanine; furacon; OC-11588; OK 174; Oncol

CAS Registry Number: 82560-54-1

HSDB Number: 6664 accesses Furathiocarb (65907-30-4)

RTECS Number: AY5088000

UN/NA & ERG Number: UN2992 (Carbamate pesticides, liquid, toxic)/151

EC Number: Not available [*Annex I Index No.:* 006-088-007]

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Possible neurotoxic effects (methylcarbamate), Combustible, Environmental hazard, Agricultural chemical.

Hazardous substance: OSHA29CFR1910.1200.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xn, N; risk phrases: R22; R23; R33; R50/53; R62; safety phrases: S1/2; S29; S36/37; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)]

Description: Benfuracarb is a thick liquid. Molecular weight = 410.55; specific gravity (H_2O:1) = 1.172; boiling point = 110°C; freezing/melting point = < 25°C; flash point = 114°C. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 1; reactivity 0 ₩. Partly soluble in water; solubility = 7.8 mg/L @ 20°C. Physical and toxicological properties may be affected by the carrier solvents used in commercial formulations.

Potential Exposure: A benzofuranyl methylcarbamate insecticide, nematicide. Not registered for use in the United States.

Incompatibilities: Carbamates are incompatible with reducing agents, strong acids, oxidizing acids, peroxides, and bases. Contact with active metals or nitrides cause the release of flammable, and potentially explosive, hydrogen gas. May react violently with bromine, ketones. Incompatible with azo dyes, caustics, ammonia, amines, boranes, hydrazines, strong oxidizers.

Permissible Concentration in Water: No criteria set. Runoff from spills or fire control may cause water pollution.

Determination in Water: Octanol−water coefficient: Log K_{ow} => 4. Values above 3.0 are likely to bioaccumulate in aquatic organisms.

Routes of Entry: Inhalation, ingestion and skin absorption

Harmful Effects and Symptoms

The signs and symptoms (of carbamate intoxication) can be categorized into the following three groups: (1) Muscarinic manifestations: increased bronchial secretion, excessive sweating, salivation, and lachrymation; pinpoint pupils, bronchoconstriction, abdominal cramps (vomiting and diarrhea); and bradycardia. (2) Nicotinic manifestations-fasciculation of fine muscles (in severe cases, diaphragm and respiratory muscles also involved); and tachycardia. (3) Central nervous system manifestations, including headache, dizziness, anxiety, mental confusion, convulsions, and coma; and depression of respiratory center. All these signs and symptoms can occur in different combinations and can vary in onset and sequence, depending on the chemical, dose, and route of exposure. Mild poisoning might include muscarinic and nicotinic signs only. Severe cases always show central nervous system (CNS) involvement; the clinical picture is dominated by the respiratory failure sometimes leading to pulmonary edema due to the combination of the above mentioned symptoms [WHO].

Short-Term Exposure: Eye pupils are small; blurred vision; eye watering; runny nose; cough; shortness of breath; salivation; nausea, stomach cramps, diarrhea, and vomiting; increased blood pressure; profuse sweating; hypermotility, hallucinations; agitation; tingling of the skin; slow heartbeat; convulsions; fluid in lungs; loss of consciousness; incontinence; breathing stops; death. Carbamate insecticides inhibit the cholinesterase activity of enzymes, causing accumulation of acetylcholine at synapses and altering the way in which nervous impulses are transmitted. However, within several hours carbamates spontaneously detach from the enzymes. LD_{50} (oral, rat) = 200 mg/kg; LD_{50} (dermal, rat) = 2 g/kg.

Long-Term Exposure: A potent acetylcholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, central nervous system, cardiovascular system, skin, eyes, plasma and red blood cell cholinesterase. Suspected of causing genetic defects.

Medical Surveillance: Comprehensive physical examination with emphasis on the genito-urinary tract analysis to include sperm count, motility and morphology. Other tests, such as serum testosterone, serum follicle stimulating hormone (FSH), and serum lutenizing hormone (LH) may be carried out if, in the opinion of the responsible physician, they are indicated. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a drug or other inhalation therapy. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. Before employment and at regular times after that, the following are recommended: Plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When acetylcholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider CBC. Consider chest X-ray following acute overexposure

First Aid: Speed in removing material from eyes and skin is of extreme importance. *Eyes:* Eye contact can cause dangerous amounts of these chemicals to be quickly absorbed through the mucous membrane into the bloodstream. Immediately and gently flush eyes with plenty of warm or cold water (NO hot water) for at least 15 minutes, occasionally lifting the upper and lower eyelids. Get medical aid immediately. *Skin:* Get medical aid. Dermal contact can cause dangerous amounts of these chemicals to be absorbed into the bloodstream. Wearing the appropriate PPE equipment and respirator for carbamate pesticides, immediately flush skin with plenty of soap and water for at least 15 minutes while removing contaminated clothing and shoes. Shampoo hair promptly if contaminated; protect eyes. *Ingestion:* Call poison control. Loosen all clothing. Never give anything by mouth to an unconscious person. Get medical aid. Do NOT induce vomiting.* If conscious, alert, and able to swallow, rinse mouth and have victim drink 4 to 8 ounces of water. Check to see if poison control instructs you to use ipecac syrup, otherwise administer slurry of activated charcoal (2 oz in 8 oz of water). If victim is *UNCONSCIO United States OR HAVING CONVULSIONS*, do nothing except keep victim warm. **In some cases you may be specifically instructed by poison control to induce vomiting by way of 2 tablespoons of syrup of ipecac (adult) washed down with a cup of water.* Do NOT give activated charcoal before or with ipecac syrup. *Inhalation:* Get medical aid. Do not contaminate yourself. Wearing the appropriate PPE equipment and respirator for carbamate pesticides, immediately remove the victim from the contaminated area to fresh air. If the victim is not breathing, administer artificial respiration. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. If breathing is difficult, administer oxygen through bag/mask apparatus until medical help arrives. Do not leave victim unattended. *Note to physician or authorized medical personnel.* Administer atropine, 2 mg (1/30 g) intramuscularly or intravenously as soon as any local or systemic signs or symptoms of an intoxication are noted; repeat the administration of atropine every 3 to 8 minutes until signs of atropinization (mydriasis, dry mouth, rapid pulse, hot and dry skin) occur; initiate treatment in children with 0.05 mg mg/kg of atropine; repeat at 5 to 10 minute intervals. Watch respiration, and remove bronchial secretions if they appear to be obstructing the airway; intubate if necessary. *Medical note:* 2-PAMCI may be contraindicated in the case of some carbamate poisonings.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of dermal contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. DuPont Tychem suit fabrics[101] All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin

is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000): (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus). *Escape*: GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison. Store in a secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong alkalis (such as sodium hydroxide, sodium bicarbonate, etc.).

Shipping: UN 2992 Carbamate pesticides, liquid, toxic, Hazard Class: 6.1; Labels: 6.1—Poisonous materials.

Spill Handling: For liquids, isolate spill or leak area in all directions for at least 50 m/150 ft. Increase, in the downwind direction, as necessary. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Stop leak if you can do it without risk. Prevent entry into waterways, sewers, basements, or confined areas. Cover with plastic sheet to prevent spreading. Absorb or cover with dry earth, sand or other noncombustible material and transfer to containers. Do not allow water to get inside containers.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen, sulfur, and carbon. *On small fire*, use dry chemical powder, carbon dioxide, water spray, or foam. *On large fire*, use water spray, fog or regular alcohol-resistant foam. Do not scatter material using straight water jet streams. Dike fire control water for later disposal; do not scatter the material. Move containers from fire area if you can do it without risk. *If tank, rail car or tank truck is involved in a fire*, *isolate* for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Do not allow water to get inside containers. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. *Always* stay away from tanks engulfed in fire. For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn.

Disposal Method Suggested: Do not discharge into drains or sewers. Dispose of waste material as hazardous waste using a licensed disposal contractor to an approved landfill. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Incineration with effluent gas scrubbing is recommended. Containers must be disposed of properly by following package lab el directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (204); (100).

Benomyl B:0230

Formula: $C_{14}H_{18}N_4O_3$

Synonyms: Abortrine; Agrocite; Arilate; BBC; BBC6597; Benex; Benlat; Benlate; Benlate 40W; Benlate 50W; Benlate 50; Benomilo (Spanish); Benomyl 50W; 2-Benzimidazolecarbamic acid, 1-(butylcarbamoyl)-, methyl ester; BNM; 1-(Butylamino)carbonyl-1*H*-benzimidazol-2-yl-, methyl ester; 1-(Butylcarbamoyl)-2-benzimidazole carbamic acid, methyl ester; 1-(*N*-Butylcarbamoyl)-2-(methoxy-carboxamido)-benzamidazol (German); 1-(*N*-Butylcarbamoyl)-2-(methoxy-carboxamido)-benzimidazol (German); Carbamic acid, 1-(butylamino)carbonyl-1*H*-benzimidazol-2yl, methyl ester; D1991; Dupont 1991; F1991; Fundazol; Fungacide D-1991; Fungicide 1991; Fungochrom; MBC; Methyl 1-(butylcarbamoyl)-2-benzimidazolyl carbamate; Tarsan; Tersan 1991; UZGN

CAS Registry Number: 17804-35-2

HSDB Number: 16555

RTECS Number: DD6475000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 241-775-7 [*Annex I Index No.:* 613-049-00-3]

Regulatory Authority and Advisory Information

United States Environmental Protection Agency Gene-Tox Program, Positive: Aspergillus-aneuploidy; TRP reversion; Negative: *Aspergillus*-recombination; Host-mediated assay; Negative: *S. cerevisiae* gene conversion; Inconclusive: TRP reversion.

California Proposition 65 Chemical[102]: Developmental/Reproductive toxin (male) 7/1/1991.

Hazard Alert: Flammable, Neurotoxin (cumulative), Reproductive toxin: possible risk of gene damage/impaired fertility; Suspected reprotoxic hazard, Sensitization hazard (skin), Environmental hazard.

United States Environmental Protection Agency, FIFRA 1998 Status of Pesticides: Supported

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U271

Superfund/EPCRA [40CFR 302 and 355, F R: 8/16/06, Vol 71, No. 158] RQ: 10 lb (4.54 kg)

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.056; Nonwastewater (mg/kg), 1.4

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)] (adjustable powder formulations containing a combination of: Benomyl @ or $>7\%$; carbofuran @ or $>10\%$; thiram @ or $>15\%$).

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N, Xi; risk phrases: R33; R46; R60; R61; R37/38; R43; R50/53; R61; R62; R63; safety phrases: S29; S41; S45; S53; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [2-Hazard to waters (est.)].

Description: Benomyl is a white crystalline solid. Faint acrid odor. Molecular weight = 290.36. Boiling point = decomposes without melting; freezing/melting point = (decomposes) $\geq 300°C$; vapor pressure = 1×10^{-5} mmHg @ 20°C. Autoignition temperature = 220°C; explosive limits: LEL: 0.05 g/L[101]; UEL: unknown; Hazard identification (based on NFPA-704 M Rating System): Health 1; flammability 2; reactivity 0 ₩. Slightly soluble in water; solubility = 0.002 g/L @ 25°C; decomposition Physical and toxicological properties may be affected by the carrier solvents used in commercial formulations.

Potential Exposure: Benomyl is used as an agricultural chemical and pesticide, pharmaceutical, and veterinary drug.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides (forms toxic oxides of nitrogen). Decomposed in water or otherwise moist conditions.

Permissible Exposure Limits in Air

OS HA PE L: 15 milligram per cubic meter total dust, TWA; 5 milligram per cubic meter respirable fraction, TWA

NIOSH REL: None established. See Appendix D of the *NIOSH Pocket Guide*

ACGIH TLV[1]: 10 milligram per cubic meter TWA; not classifiable as a human carcinogen

No PAC available.

DFG MAK: [skin] possible sensitization of skin; Germ Cell Mutagen Group: 3A (2005).

Australia: TWA 0.8 ppm (10 milligram per cubic meter), 1993; Belgium: TWA 0.84 ppm (10 milligram per cubic meter), 1993; Denmark: TWA 5 milligram per cubic meter, 1999; Finland: TWA 0.8 ppm (10 milligram per cubic meter), STEL 2.4 ppm (30 milligram per cubic meter), [skin], 1993; France: VME 0.8 ppm (10 milligram per cubic meter), 1999; Switzerland: MAK-week 0.8 ppm (10 milligram per cubic meter), 1999; United Kingdom: TWA 10 milligram per cubic meter, STEL 15 milligram per cubic meter, 2000; the Netherlands: MAC-TGG 10 milligram per cubic meter, 2003; Argentina, Bulgaria, Colombia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Russia[43] has set a limit in ambient air of 0.35 milligram per cubic meter on a once-a-day basis and 0.05 milligram per cubic meter on an average daily basis. Several states have set guidelines or standards for benomyl in ambient air[60] ranging from $100\ \mu/m^3$ (North Dakota and Virginia) to $200\ \mu/m^3$ (Connecticut) to $238\ \mu/m^3$ (Nevada).

Determination in Air: Determination in Air: Organonitrogen pesticides. OSHA versatile sampler-2; Reagent; High-pressure liquid chromatography/Ultraviolet detection; NIOSH Analytical Method (IV) #5601. Filter; none; Gravimetric; NIOSH IV [Particulates NOR; #0500, total dust, #0600 (respirable)]

Permissible Concentration in Water: Russia set a MAC in surface water of 0.5 mg/L of benomyl[35].

Determination in Air: Fish Tox: 2.19089000 ppb MATC (HIGH)

Routes of Entry: Inhalation, dermal contact.

Harmful Effects and Symptoms

Benomyl is generally felt to have a low order of acute and chronic toxicity[53]. However, a rebuttable presumption against registration for benomyl was issued on December 6, 1978 by United States Environmental Protection Agency on the basis of reduction in nontarget species, mutagenicity, teratogenicity, reproductive effects, and hazard to wildlife. The ADI for man is 0.02 mg/kg[23].

***Short-Term Exposure*:** The substance irritates the skin, eyes, and upper respiratory system. Exposure could cause depression of the CNS and lack of muscular coordination. LD_{50} = 9590 mg/kg[77].

Long-Term Exposure: Repeated or prolonged contact may cause skin sensitization and allergy. Human mutation data reported. Also experimental and reproductive effect. May damage the male reproductive system; cause heritable genetic damage in humans. Animal tests show that this substance possibly causes birth defects in human babies, miscarriage, or cancer.

Points of Attack: Eyes, skin, respiratory system, reproductive system.

Medical Surveillance: Pregnant women should avoid contact. Employees should be notified by a physician that this chemical may affect the reproductive system. In addition to comprehensive initial medical and work histories emphasizing reproductive experience and menstrual history, patient should have physical examination and testing of genitourinary tract, sperm count, motility and morphology. If required, other tests, such as serum testosterone, serum FSH, and serum LH. Evaluation by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the

skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive pressure mode).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Store in a cool, dry place or in a refrigerator[52] away from strong bases; strong acids, heat.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9—Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen spilled material with toluene to avoid dust, then transfer material to a suitable container. Use absorbent paper dampened with toluene to pick up remaining material. Wash surfaces well with soap and water. Seal all wastes in vapor-tight plastic bags for eventual disposal[52]. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Soil Adsorption Index (K_{oc}) = 1900.

Fire Extinguishing: Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include oxides of nitrogen and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode. Extinguish fires using an agent suitable for the type of surrounding fire; benomyl itself does not burn.

Disposal Method Suggested: In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(102); (31); (173); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 4, No. 1, 20−21 (1984).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Benomyl, Trenton, NJ (April 2004).

NIOSH Manual of Analytical Methods, 4th Edition, Issue 1, *Organonitrogen pesticides*, page 7 of 21, Cincinnati, OH, 1/15/1998.

Bensulide B:0238

Formula: $C_{14}H_{24}NO_4PS_3$

Synonyms: Bensumec; Benzulfide; Betamec; Betasan; Betasan-e; Betasan-g; *O,O*-Bis(1-methylethyl)-*S*-[2-((phenylsulfonyl) amino)ethyl]pheosphorodithioate; *N*-[2-(*O,O*-Diisopropyldithiophosphoryl)ethyl] benzenesulfonamide; *N*-(β-*O,O*-Diisopropyl dithiophosphorylethyl)bezenesulfonamide; *S*-(*O,O*-Diisopropyl phosphorodithioate) ester of *N*-(2-mercaptoethyl)benzenesulfonamide; Disan; Exporsan; Kayaphenone; *N*-(2-Mercaptoethyl benzenesulfonamide)-*S*-(*O,O*-diisopropyl phosphorodithioate); Prefar; Prefar-E; Phosphorodithioic acid-*O,O*-bis(1-methylethyl)-*S*-[2-((phenylsulfonyl)amino)ethyl]ester; Pre-San; Proturf; R-4461; SAP

CAS Registry Number: 741-58-2

HSDB Number: 393

RTECS Number: TE0250000

UN/NA & ERG Number: (PIH) UN3077 (environmentally hazardous substances, solid, n.o.s.)/171; UN3018 (organophosphorus pesticide, liquid, toxic)/152;

EC Number: 212-010-4 [*Annex I Index No.:* 015-083-00-9]

Regulatory Authority and Advisory Information

Carcinogenicity[83]: EPA, Not likely to be carcinogenic in humans.

Hazard Alert: Poison inhalation hazard, Combustible, Neurotoxin (cumulative), Environmental hazard. Listed for Tier 1 screening as an endocrine disruptor[88].

Potential Ground water Pollutant [California FAC Section 13145(d)/12811, active]

United States DOT 49CFR172.101, Inhalation Hazard Chemical as organophosphates

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xn, N; risk phrases: R22; R33; R50/R53; safety phrases: S2; S24; S36; S41; S60; S61 (see Appendix 4).

Description: Bensulide is and amber, viscous liquid, or forms colorless or white crystalline solid below 34.4°C. Combustible. Commercial product is available as an emulsifiable concentrate. Molecular weight = 397.49; specific gravity (H_2O:1) = 1.25 @ 22°C; molecular weight = 397.54; freezing/melting point = 34°C; vapor pressure = 8×10^{-7} mmHg; 0.53 mmHg @ 20°C. Flash point = 160°C. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 2; reactivity 1 ₩. Practically insoluble in water; solubility = 0.0025 g/mL @ 20°C. Physical and toxicological properties may be affected by carrier solvents in commercial formulations.

Potential Exposure: A selective preemergence organophosphate herbicide used to control bluegrass, crabgrass and other annual grasses and broadleaf weed s in agriculture crops, cotton and turf. It is widely used on golf courses and home lawns. Target weeds also include barnyard grass, burning nettle, and canary grass.

Incompatibilities: Incompatible with oxidizers; chlorates nitrates, peroxides. Decomposes slowly in light and strong UV. Corrosive to copper, aluminum, magnesium, zinc. Slowly hydrolyzes in water, releasing ammonia gas and forming acetate salts. In the presence of strong reducing agents such as hydrides, organophosphates form highly toxic and flammable phosphine gas. Contact with oxidizers can cause the release of toxic oxides of phosphorus. Stable @ 80°C for 50 hours; decomposes @ 200°C in 18−40 hours.

Determination in Air: OSHA versatile sampler-2; Toluene/Acetone; Gas chromatography/Flame ionization detection; NIOSH IV[18], Method #5600, Organophosphorus Pesticides

Permissible Concentration in Water: Runoff from spills or fire control may cause water pollution.

Determination in Water: NIOSH Method 1657. The determination of organophosphorus pesticides in municipal and industrial wastewater by gas chromatography (GC). Detection limit = 6.0 ηg/L. Octanol−water coefficient: Log K_{ow} => 4.0. Values above 3.0 are likely to bioaccumulate in aqua tic organisms and possibly in the food chain, especially seafood. Fish toxicity (threshold)[101]: Intermediate—43.42721 ppb, MATC.

Routes of Entry: Inhalation, ingestion, dermal contact, passes through the skin

Harmful Effects and Symptoms

Organophosphates are highly toxic. Symptoms may develop rapidly, or there may be a delay of several hours following exposure before they become noticeable. The delay tends to be longer in the case of some compounds that dissolve fats, lipids, oils, and nonpolar solvents such as toluene. Symptoms may increase in severity for more than a single day and last for several days. In severe cases of organophosphate intoxication, respiratory failure may occur.

Short-Term Exposure: Eye pupils are small; blurred vision; eye watering; runny nose; cough; shortness of breath; salivation; dizziness; nausea, stomach cramps, diarrhea, and vomiting; increased blood pressure; profuse sweating; hypermotility, hallucinations; irritability; tingling of the skin; drowsiness; slow heartbeat; convulsions; fluid in lungs; loss of consciousness; incontinence; breathing stops; death. Organophosphates inhibit the action of acetylcholinesterase enzymes, and alter the way in which nervous impulses are transmitted. The effects can last for hours, days, or much longer. The action of the enzymes is reestablished after new enzymes are formed. LD_{50} (oral, rat) = 270−360 mg/kg; LD_{50} (dermal, rat) = 3500−4000 mg/kg.

Long-Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. May be a neurotoxin; may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver and/or kidney damage. May be a skin sensitizer. Human toxicity (long-term)[101]: Intermediate—46.20 ppb, Health advisory.

Points of Attack: Respiratory system, central nervous system, cardiovascular system, blood cholinesterase. Liver, kidneys, skin.

Medical Surveillance: Medical observation is recommended for 24 to 48 hours following breathing overexposure, as pulmonary edema may be delayed. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. Routine biological monitoring of pesticide applicators and field workers includes testing of plasma and red blood cell acetylcholinesterase levels (for enzyme poisoned by this chemical). These tests are normally accurate only if done within about 2 hours of exposure. If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When acetylcholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate pesticides is recommended until enzyme levels recover. Do not drink any alcoholic beverages before or during use as it promotes absorption of organophosphates. Evaluation by a qualified allergist, including exposure history and testing, may help diagnose allergy.

First Aid: **Treatment for organophosphate poisoning consists of thorough decontamination, cardiorespiratory support, and administration of the antidotes atropine and pralidoxime. In cases of severe poisoning, diazepam, an anticonvulsant, should also be administered. Antidotes should be administered as prevention even if the diagnosis is in doubt.** Speed in removing material from eyes and skin is of extreme importance. *Eyes:* Eye contact can cause dangerous amounts of these chemicals to be quickly absorbed through the mucous membrane into the bloodstream. Immediately and gently flush eyes with plenty of warm or cold water (NO hot water) for at least 15 minutes, occasionally lifting the upper and lower eyelids. Get medical aid immediately. *Skin:* Get medical aid. Dermal contact can cause dangerous amounts of these chemicals to be absorbed into the bloodstream. Wearing the appropriate PPE equipment and respirator for organophosphate/carbamate pesticides, immediately flush skin with plenty of soap and water for at least 15 minutes while removing contaminated clothing and shoes. Shampoo hair promptly if contaminated. The removed, contaminated clothing and shoes should be double-bagged and left in Hot Zone for later disposal by hazardous materials experts. Skin may also be decontaminated with diluted hypochlorite solution. *Inhalation:* Get medical aid. Do not contaminate yourself. Wearing the appropriate PPE equipment and respirator for organophosphate pesticides, immediately remove the victim from the contaminated area to fresh air. If the victim is not breathing, administer artificial respiration. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. If breathing is difficult, administer oxygen through bag/mask apparatus until medical help arrives. Do not leave victim unattended. *Ingestion:* Call poison control. Loosen all clothing. Never give anything by mouth to an unconscious person. If victim is *unconscious or having convulsions,* do nothing except keep victim warm. Get medical aid. Transfer promptly to a medical facility. In cases of ingestion, **do not induce vomiting**. If the victim is alert and asymptomatic, administer a slurry of activated charcoal at a dose of 1 g/kg (infant, child, and adult dose). A soda can and straw may be of assistance when offering charcoal to a child. *In some cases you may be specifically instructed by poison control to induce vomiting by way of 2 tablespoons of syrup of ipecac (adult) washed down with a cup of water*. Do NOT give activated charcoal before or with ipecac syrup.

Note to physician or authorized medical personnel: Treat cases of respiratory compromise, coma, or excessive pulmonary secretions with respiratory support using protocols and techniques available and within the scope of training. Some cases may necessitate procedures such as endotracheal intubation or cricothyrotomy by properly trained and equipped personnel. When possible, atropine (see *Antidotes*, below) should be given under medical supervision. Patients who are comatose, hypotensive, or having seizures or cardiac arrhythmias should be treated according to advanced life support protocols. *Antidotes:* Two antidotes are administered to treat organophosphate poisoning. Artropine is a competitive antagonist of acetylcholine at muscarinic receptors and is used to control the excessive bronchial secretions which are often responsible for death. Pralidoxime relieves both the nicotinic and muscarine effects of organophosphate poisoning by regenerating acetylcholinesterase and can reduce both the bronchial secretions and the muscle weakness associated with poisoning. The initial intravenous dose of atropine in adults should be determined by the severity of symptoms: An initial adult dose of 1.0 to 2.0 mg or pediatric dose of 0.01 mg/kg (minimum 0.01 mg) should be administered intravenously. If intravenous access cannot be established, atropine may also be given intramuscularly, subcutaneously or via endotracheal tube. Doses should be repeated every 15 minutes until excessive secretions and sweating have been controlled. Once bronchial secretion has been controlled, atropine administration should be repeated whenever the secretions begin to recur. In seriously poisoned patients, very large doses may be required. Alterations of pulse rate and pupillary size should not be used as indicators of treatment adequacy. Pralidoxime should be administered as early in poisoning as possible as its efficacy may diminish when given more than 24 to 36 hours after exposure. Doses are as follows: adult 1.0 g; pediatric 25 to 50 mg/kg. The drug should be administered intravenously over 30 to 60 minutes, but in a life-threatening situation, one-half of the total dose can be given per minute for a total administration time of 2 minutes. Treatment should begin to take effect within 40 minutes with a reduction in symptoms and the amount of atropine necessary to control bronchial secretion. The initial dose can be repeated in 1 hour and then every 8 to 12 hours until the patient is clinically well and no longer requires atropine. If intravenous access cannot be established, pralidoxime may also be given intramuscularly. Early administration of diazepam in addition to the combined atropine and pralidoxime treatment may help prevent the onset of seizures and potential brain and cardiac morphologic damage following high-level organophosphate poisoning.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of dermal and/or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. One recommendation is the use of DuPont Tychem suit fabrics[88] All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit. *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive pressure mode).

Storage: Color code—Blue: Health Hazard/Poison. Store in a secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Where possible, automatically transfer material from other storage containers to process containers. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN3018 Organophosphorus pesticides, liquid, toxic, Hazard Class: 6.1; Labels: 6.1—Poisonous materials. UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9—Miscellaneous hazardous material, Technical Name Required.

Spill Handling: First, remove all sources of ignition. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Stay upwind; keep out of low areas. Ventilate area of spill or leak. Remove and isolate contaminated clothing at the site. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills:* absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills:* dike far ahead of spill for later disposal. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen, phosphorus, sulfur and carbon. May be fatal if inhaled, ingested or absorbed through skin. Inhalation or contact with some of these materials will irritate or burn skin and eyes. Vapors may cause dizziness or suffocation. *Small fires:* dry chemical, carbon dioxide; water spray; or foam. *Large fires:* water spray, fog, or foam. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Firefighting gear (including SCBA) may not provide adequate protection. If exposure occurs, remove and isolate gear immediately and thoroughly decontaminate personnel. Wear positive pressure breathing apparatus and special protective clothing. Remove and isolate contaminated clothing at the site. Move container from fire area if you can do so without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Destruction by alkali hydrolysis or incineration. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138).

EXTOXNET, Extension Toxicology Network, "Pesticide Information Profile, Bensulide," Oregon State University, Corvallis, OR. (June 1996). http://extoxnet.orst.edu/pips/bensulid.htm.

United States Environmental Protection Agency, "Interim Reregistration Eligibility Decision (IRED), Bensulide", Office of Prevention, Pesticides and Toxic Substances, Washington, DC (June 2000). http://www.epa.gov/REDs/2035ired.pdf.

United States Environmental Protection Agency, Office of Pesticide Programs, Pesticide Residue Limits, "Bensulide",

40CFR180.242 (1977). http://www.epa.gov/pesticides/food/viewtols.htm.

United States Environmental Protection Agency, *R.E.D. FACTS, Bensulide*, EPA 738-F-01-001, Washington, DC (June 2000).

Bentazon B:0240

Formula: $C_{10}H_{12}N_2O_3S$

Synonyms: Asagio; BAS351-H; Basagran; Bendioxide; Bentazone; 1*H*-2,1,3-Benzothiadiazin-4(3*H*)-one, 3-(1-methylethyl)-, 2,2-dioxide; 3-Isopropyl-2,1,3-benzothiadiazinon-(4)-2,2-dioxid (German); 3-Isopropyl-1*H*-2,1,3-benzothiadiazin-4(3*H*)-one-2,2-dioxide; 3-(1-Methylethyl)-1*H*-2,1,3-benzothiazain-4(3*H*)-one-2,2-dioxide; Pledge

CAS Registry Number: 25057-89-0; 50723-80-3 (sodium bentazon)

HSDB Number: 3430

RTECS Number: DK9900000

UN/NA & ERG Number: UN2588 (Pesticides, solid, toxic, n.o.s.)/151

EC Number: 246-585-8 [*Annex I Index No.:* 613-012-00-1]; 256-735-4 (sodium bentazon)

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Combustible, Possible sensitization hazard (skin)

Safe Drinking Water Act, 55FR1470 Priority List

Hazardous to aquatic life or environment, with possible long-lasting effects[194]. Do not allow release to the environment unless proper permits are obtained from the federal government.

European/International Regulations (*25057-89-0*): Hazard symbol: Xn, N, Xi; risk phrases: R22; R36; R43; R51/53; safety phrases: S2; S24; S37; S41; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Bentazon is a colorless to white crystalline powder. Molecular weight = 240.3; boiling point = 200°C (decomposes); freezing/melting point = 137−139°C; vapor pressure = 10^{-3} @ 20°C. Hazard identification (based on NFP A-704 M Rating System): Health 2; flammability 2; reactivity 0 ₩. Very slightly soluble in water; solubility = 490 mg/L @ 20°C.

Potential Exposure: A potential danger to those involved in the manufacture, formulation or application of this selective postemergent thiadiazine herbicide.

Incompatibilities: Keep away from flammable materials, heat and flame. Risk of fire and explosion if formulations contain flammable/explosive solvents.

Permissible Exposure Limits in Air

No standards or PAC available.

Permissible Concentration in Water: A no-observed adverse-effect-level (NOAEL) of 2.5 mg/kg/day has been determined by EPA based on the absence of prostatic effects in dogs. This led to the determination of a longer-term.

Health advisory: of 0.875 mg/L for a 70-kg adult. It also led to the establishment of a lifetime Health advisory: of 0.0175 mg/L. In addition, California[61] has set a guideline in drinking water of 8.0 μg/L.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = -0.48$. Unlikely to bioaccumulate in marine organisms. Fish Tox (sodium bentazon): 40423.03894000 (VERY LOW). Fish Tox Type: MATC

Routes of Entry: Ingestion, inhalation.

Harmful Effects and Symptoms

Short-Term Exposure: LD_{50} = (oral-rat) 1100 mg/kg (slightly toxic). Avoid eye contact; may cause severe irritation or injury. May cause skin burns.

Long-Term Exposure: May be a reproductive hazard. May cause skin sensitization; Human Tox (sodium bentazon): 200.00000 Health advisory: (VERY LOW).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit. *Where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved [for pesticides] SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:

Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive pressure mode).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Store in tightly closed containers in a cool, well-ventilated area away from flammable materials, sources of heat and fire.

Shipping: UN2588 Pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1—Poisonous materials, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Soil Adsorption Index (sodium bentazon) $K_{oc} = 34$.

Fire Extinguishing: Bentazon is not combustible, but may support combustion under fire conditions. Risk of fire and explosion if formulations contain flammable/explosive solvents. Stay upwind of fire. Use dry chemical, carbon dioxide, water spray, or standard foam extinguishers. Thermal decomposition products may include oxides of nitrogen and sulfur. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, "Health advisory: Bentazon, Washington, DC, Office of Drinking Water (August 1987).

Bentonite B:0250

Formula: $Al_2H_2O_{12}Si_4$; $Al_2O_3A4SiO_2 \cdot AH_2O$

Synonyms: Albagel premium USP 4444; Bentonite clay absorbent; Bentonite magma; Entonite 2073; Hi-Jel; Imvite I.G.B.A; Magbond; Montmorillonite; Panther Creek bentonite; Southern bentonite; Tixoton; Volclay; Volclay bentonie BC; Wilkinite

CAS Registry Number: 1302-78-9

HSDB Number: 392

RTECS Number: CT9450000

UN/NA & ERG Number: Not a regulated substance.

EC Number: 215-108-5

Regulatory Authority and Advisory Information

Carcinogenicity: NTP: Carcinogenesis studies; selected, October 2000

Hazard Alert: Combustible, Possible risk of forming tumors, FDA-proprietary drug.

United States National Primary Drinking Water Regulations: SMCL = 0.05 to 0.2 mg[Al]/L as aluminum.

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Bentonite is a light yellow, creamy, pale brown or gray to black powder or granules. These chemicals contain 1% to 24% crystalline silica (O_2Si). Specific gravity (H_2O:1) = 2.5. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 1; reactivity 0 ₩. Insoluble in water.

Potential Exposure: This material is used as Fuller's earth; as a mineral, natural, or synthetic fiber; as an emulsifier for oils; as a base for plasters; in cosmetics, in polishes and abrasives; as a food additive and others. Bentonites are aluminate silicate and can contain crystalline silica. The content varies widely from less than 1% to about 24% [WHO].

Incompatibilities: Substance is a weak acid in water; avoid contact with strong alkaline material. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

PAC Ver. 27; No values found in Ver. 29[138]

PAC-1: 0.21 milligram per cubic meter

PAC-2: 2.3 milligram per cubic meter

PAC-3: 14 milligram per cubic meter

Inasmuch as this material can contain up to 24% crystalline silica, the OSHA PEL is listed for reference: crystalline silica (as respirable quartz): either 250 mppcf/%SiO_2 + 5 or 10 milligram per cubic meter/[%SiO_2 + 2] TWA. Also under study by ACGIH[1].

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Dust may cause irritation to nose, throat and lungs. Dust may cause eye irritation. The intravenous LD_{50} (inh, rat) = 35 mg/kg[9]

Long-Term Exposure: Repeated inhalation of dust can cause irritation and bronchial asthma. Bentonite contains crystalline silica and may cause silicosis.

Points of Attack: Lungs.

Medical Surveillance: Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Lung function tests.

First Aid: *Inhalation:* Move person to fresh air. Seek medical attention if necessary. *Skin:* Wash with water. *Eyes:* Wash with water as needed. Seek medical attention if necessary. *Ingestion:* Seek medical attention if necessary.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Wear dust mask.

Storage: Color code—Green: General storage may be used. Store in tightly closed containers in a cool, well-ventilated area

Shipping: Bentonite is not cited in the DOT Performance-Oriented Packaging Standards.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen dry material. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after clean-up is complete. Dispose with normal trash. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Not combustible. Use extinguishers suitable for surrounding fires. Thermal decomposition products may include metallic oxides of aluminum and silicon. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Land fill disposal.

References

(31); (173); (101); (138); (100).

New York State Department of Health, Chemical Fact Sheet: Bentonite, Bureau of Toxic Substance Assessment, Albany, NY (March 1986).

N-Benzaldenine B:0255

Formula: $C_{12}H_{11}N_5$

Synonyms: Adenine, *N*-benzyl-; 6-BAP; BAP; 6-Benzyladenine; Benzyladenine; *N*-Benzylad enine; N^6-Benzyladenine; Benzylaminopurine; N^6-(Benzylamino) purine; 6-(Benzylamino)purine; 6-(*N*-Benzylamino)purine; *N*-(Phenylmethyl)-1*H*-purin-6-amine; 1*H*-Purin-6-amine, *N*-(phenylmethyl)-; Promalin, component of (with Gibberellin D); Verdan senescence inhibitor; ABG 3034; ACCEL; AGTROL; 6-BA; BA (growth stimulant); CHRYSAL BVB; EXILIS; PERLAN; PROMALIN; SD 4901; SQ 4609

CAS Registry Number: 1214-39-7

HSDB Number: 7667

RTECS Number: AU6252200

UN/NA & ERG Number: UN3259/154

EC Number: 214-927-5

Regulatory Authority and Advisory Information

Hazard Alert: Suspected reprotoxic hazard

Description: Colorless to off-white or yellow powder. Corrosive. Molecular weight = 225.27; freezing/melting point = 233°C; vapor pressure = 2×10^{-11} mmHg @ 25°C. Henry's Law constant = 9×10^{-14} atm m^3/mol @ 25°C (est). Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 0; reactivity 0 ₩. Low solubility in water.

Potential Exposure: A polyamine plant growth regulator used to lengthen and enhance the shape of apples and to increase the fruit set in pears. It increases the yield of pistachios and tomatoes. Not listed for use in the EU countries.

Incompatibilities: May react with strong oxidizers such as chlorates, peroxides, nitrates, etc. May release heat on contact with water. Solid and corrosive amines are chemical bases. Neutralize acids to form salts plus water in exothermic reactions. May be incompatible with isocyanates, halogenated organics, peroxides, phenols (acidic), epoxides, anhydrides, and acid halides. May generate flammable gaseous hydrogen in combination with strong reducing agents, such as hydrides[88].

Permissible Concentration in Water: Runoff from fire control or dilution water may be corrosive and/or toxic and cause pollution.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = < 2.0$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation of dust, dermal and/or eye contact.

Harmful Effects and Symptoms

Toxic; inhalation, ingestion, or dermal contact with material may cause severe injury or death. Contact with molten substance may cause severe burns to skin and eyes. Avoid any dermal and/or eye contact. Effects of contact or inhalation may be delayed.

Short-Term Exposure: Corrosive to the eyes, skin, and respiratory tract. Contact can cause burns and permanent damage. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. May be harmful if swallowed. LD_{50} (oral, rat) = 1300 mg/kg[83]; LD_{50} (dermal, rabbit) = 5 mg/kg[83]. LD_{50} (inhalation, rabbit) = 5 mg/L/1-hour[83]

Long-Term Exposure: NIOSH warns this may be mutagenic.

Points of Attack: Lungs, eyes, Reproductive material/DNA.

Medical Surveillance: In addition to comprehensive initial medical and work histories emphasizing reproductive experience and menstrual history, patient should have physical examination and testing of genito-urinary tract, sperm count, motility, and morphology. If required, other tests, such as serum testosterone, serum FSH, and serum LH may be indicated.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. *Eyes*: Check the victim for contact lenses and remove if present. Flush victim's eyes with water or normal saline solution for 20 to 30 minutes. Do not put any ointments, oils, or medication in the victim's eyes without specific instructions from a physician. Transport the victim after flushing eyes to a hospital even if no symptoms (such as redness or irritation) develop. *Skin*: Flood affected skin with water while removing and isolating all contaminated clothing. Gently wash all affected skin areas thoroughly with soap and water. If symptoms such as red ness or irritation develop, call a physician and be prepared to transport the victim to a hospital for treatment. *Inhalation:* Leave the contaminated area; take deep breaths of fresh air. If symptoms (such as wheezing, coughing, shortness of breath, or burning in the mouth, throat, or chest) develop, call a physician and be prepared to transport the victim to a hospital. Provide proper respiratory protection to rescuers entering an unknown atmosphere. Whenever possible, SCBA should be used; if not available, use a level of protection greater than or equal to that advised under Protective Clothing. *Ingestion*: *Do not induce vomiting.* If the victim is conscious and not convulsing, give 1 or 2 glasses of water to dilute the chemical and call a hospital or poison control center. Be prepared to transport the victim to a hospital if advised by a physician. If the victim is convulsing or unconscious, do not give anything by mouth, ensure that the victim's airway is open and lay the victim on his/her side with the head lower than the body. *Do not induce vomiting.* Immediately transport the victim to a hospital.

Personal Protective Methods: Reacts with the following kinds of absorbents: Mineral- and Clay Based[88]. Applicators and other handlers must wear: Coveralls worn over long-sleeved shirt and long pants; Chemical-resistant gloves such as DuPont Tychem suit fabrics, barrier laminate, or Viton; Chemical-resistant footwear plus socks; Protective eye wear; Chemical-resistant headgear for overhead exposure; Chemical-resistant apron when cleaning equipment, mixing, or loading[83]. *Agricultural Use/Engineering Controls:* When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the Worker Protection Standard (WPS) for agricultural pesticides, 40CFR170.240(d)(4-6), the handler PPE requirements may be reduced or modified as specified in the WPS. Firefighters should wear NIOSH approved SCBA and full protective clothing.

Respirator Selection: Wherever and whenever workplace conditions warrant respirator use, a respiratory protection program must be followed that meets one or more of the following government standards: OSHA's 29 CFR 1910.134, ANSI Z88.2, or European Standard EN 149.

Storage: Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: UN3259 Amines, solid, corrosive, n.o.s, or Polyamines, solid, corrosive, n.o.s., Hazard class: 8; Labels: 8—Corrosive material, Technical Name Required.

Spill Handling: Spill Handling: As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 m/150 ft for liquids and at least 25 m/75 ft for solids. Stay upwind. Keep out of low areas. Ventilate enclosed areas. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Stop leak if you can do it without risk. Wear positive pressure SCBA. Wear chemical protective clothing that is specifically recommended by the manufacturer. It may provide little or no thermal protection. Structural firefighters' protective clothing provides limited protection in fire situations ONLY; it is not effective in spill situations where direct contact with the substance is possible. Remove all sources of ignition. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Prevent entry into waterways, sewers, basements or confined areas. Sweep up or vacuum powdered material being careful not to raise dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. *Do not get water inside containers*. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Fire Extinguishing: Thermal decomposition products may include poisonous oxides of nitrogen and carbon. *Fire involving storage or vehicular tanks:* Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. *Small fire:* Dry chemical, carbon dioxide or water spray. *Large fire:* dry chemical, carbon dioxide, alcohol-resistant foam or water spray. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal; do not scatter the material. *Fire involving tanks or car/trailer loads:* Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Do not get water inside containers. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. Always stay away from tanks engulfed in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138).

United States National Library of Medicine, ChemIDplus Advanced, Bethesda, MD (2017), http://chem.sis.nlm.nih.gov/chemidplus/rn/1214-39-7.

Benz[*a*]anthracene B:0260

Formula: $C_{18}H_{12}$

Synonyms: BA; B(*a*)A; A13-50599; 1,2-Benzanthracene; Benzanthracene; 1,2-Benzanthrazen (German); 1,2-Benzanthrene; Benzanthrene; 1,2-Benz(*a*)anthracene; 1,2-Benzo(*a*)anthracene; Benzo(*a*)anthracene; Benzo(*a*) anthrene; 2,3-Benzophenanthrene; Benzo(*b*)phenanthrene; 2,3-Benzphenanthrene; Naphthaanthracene; NSC 30970; Tetraphene

CAS Registry Number: 56-55-3

HSDB Number: 4003

RTECS Number: CV9275000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 200-280-6 [*Annex I Index No.*: 601-033-00-9]

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Animal Sufficient Evidence; Human Possibly Carcinogenic, *possibly carcinogenic to humans*, Group 2B; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies. NIOSH has recommended that coal tar pitch volatiles, including polycyclic aromatic hydrocarbons (PAHs) be treated as potential human carcinogen. United States Environmental Protection Agency Gene-Tox Program, Positive: Carcinogenicity-mouse/rat; SHE-clonal assay; Positive: Cell transformation-mouse prostate; Positive: Cell transformation-RLV F344 rat embryo; Host-mediated assay; Positive: Histidine reversion-Ames test; Positive: V79 cell culture-gene mutation; Negative: Cell transformation-BALB/c-3T3; In vitro UDS in rat liver; Negative: *S. cerevisiae-homozygosis*; Inconclusive: *E. coli polA* without S9; In vivo SCE-nonhuman; Inconclusive: *D. melanogaster* sex-linked lethal; Inconclusive: In vitro UDS-human fibroblast.

California Proposition 65 Chemical[102]: Carcinogen (7/1/1987).

Hazard Alert: Poison, Combustible, Possible risk of forming tumors, Suspected reprotoxic hazard, Environmental hazard.

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR1910.1002) as coal tar pitch volatiles

United States National Primary Drinking Water Regulations: MCLG = 0 mg/L; MCL = 0.0001 mg/L as PAHs.

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; Section 307(a)(1) Toxic pollutant designated, pursuant to of the and is subject to effluent limitations as PAHs.

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV.D.3.b, RQ: 10 lb (4.54 kg)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U018

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.059; Nonwastewater (mg/kg), 3.4

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8100 (200); 8270 (10)

EPCRA Section 313 Form R *de inimus* concentration reporting level: 0.1%. Form R Toxic Chemical Category Code: N590 as polycyclic aromatic compounds

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R45; R50/53; R61; R62; safety phrases: S29; S45; S53; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. 1-Low hazard to waters.

Description: Benz(*a*)anthracene is a colorless plate-like material which is recrystallized from glacial acetic acid or a light yellow to tan powder. PAHs are compounds containing multiple benzene rings and are also called polynuclear aromatic hydro carbons. Molecular weight = 228.29; boiling point = (sublimates) 437.6°C; freezing/melting point = 158−162°C; vapor pressure = 4.9×10^{-9} mmHg @ 20. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 1; reactivity 0 ₩. Practically insoluble in water.

Potential Exposure: Benz(*a*)anthracene is a contaminant and does not have any reported commercial use or application, although one producer did report the substance for the Toxic Substances Control Act Inventory. Benz(*a*)anthracene has been reported present in cigarette smoke condensate, automobile exhaust gas; soot; and the emissions from coal and gas works and electric plants. Benz(*a*)anthracene also occurs in the aromatic fraction of mineral oil, commercial solvents, waxes, petrolatum, creosote, coal tar; petroleum asphalt; and coal tar pitch. Microgram quantities of benz(*a*)anthracene can be found in various foods, such as charcoal broiled, barbecued, or smoked meats and fish; certain vegetables and vegetable oils, roasted coffee, and coffee powders. Human subjects are exposed to benz(*a*) anthracene through either inhalation or ingestion. Workers at facilities with likely exposure to fumes from burning or heating of organic materials have a potential for exposure to benz(*a*)anthracene. Consumers can be exposed to this chemical through ingestion of various foods, with concentrations of 100 μg/kg in some instances. Cigarette smoke condensate has quantities of benz(*a*)anthracene that range from 0.03 to 4.6 μg/g. Benz(*a*)anthracene is found in the atmosphere at levels that vary with geography and climatology. These values can range from up to 136 μg/1000 m^3 in summer to 361 μg/1000 m^3 in winter. Drinking water samples may contain up to 0.023 μg/L benz(*a*)anthracene, and surface waters have been found to contain 0.004−0.185 μg/L. The soil near industrial centers has been shown to contain as much as 390 μg/kg of Benz(*a*)anthracene, whereas soil near highways can have levels of up to 1500 μg/kg, and areas polluted with coal tar pitch can reach levels of 2500 mg/kg.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Powder can form an explosive mixture with air.

Permissible Exposure Limits in Air

NIOSH IDLH = 80 milligram per cubic meter, *coal tar pitch volatiles*

OSHA PEL: 0.2 milligram per cubic meter TWA [1910.1002] (benzene-soluble fraction). OSHA defines “coal tar pitch volatiles” in 29 CFR 1910.1002 as the fused polycyclic hydrocarbons that volatilize from the distillation residues of coal, petroleum (excluding asphalt), wood, and other organic matter.

NIOSH REL: 0.1 milligram per cubic meter (cyclohexane-extractable fraction). NIOSH considers coal tar products (i.e., coal tar, coal tar pitch, or creosote) to be potential occupational carcinogens

ACGIH TLV[1]: 0.2 milligram per cubic meter TWA (as benzene soluble aerosol); Confirmed Human Carcinogen; BEIp assigned *as Polycyclic Aromatic Compounds (PAHs)*

PAC Ver. 29[138]

PAC-1: 0.6 milligram per cubic meter

PAC-2: 120 milligram per cubic meter

PAC-3: 700 milligram per cubic meter

DFG MAK: [skin] Carcinogen Category 2; Pregnancy Risk Group 3A

France: carcinogen, 1993; Norway: TWA 0.04 milligram per cubic meter, 1999

Determination in Air: Use NIOSH Analytical Method #5506 PAHs by HPLC; NIOSH Analytical Method #5515, PAHs by GC; OSHA Analytical Method ID-58.

Permissible Concentration in Water: For the maximum protection of human health from the potential carcinogenic effects due to exposure of polynuclear aromatic hydrocarbons through ingestion of contaminated water and contaminated aquatic organisms; therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 1×10^{-5}, 1×10^{-6}, and 1×10^{-7}. The corresponding criteria are 28.0, 2.8, and 0.28 ng/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 311.0, 31.1, and 3.11 ng/L, respectively.

Determination in Water: Octanol−water coefficient: Log $K_{ow} \geq 5$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood. Bioaccumulation can take place in the food chain, especially seafood. Extraction with methylene chloride followed by GC/mass spectrometry (EPA Methods 625 and 1625) are summarized in the EPA Toxicological Profile cited below.

Routes of Entry: Inhalation, dermal contact.

Harmful Effects and Symptoms

Benz(*a*)anthracene is absorbed by the oral and dermal routes of exposure; no direct evidence is available for absorption of B(*a*)A via the lungs. Following oral absorption, B(*a*)A is distributed to several tissues and accumulates preferentially in the adipose and mammary tissues. It is metabolized to conjugated derivatives and eliminated. It is expected that absorbed B(*a*)A will be excreted predominantly in the feces, as is true for other PAHs. B(*a*)A is metabolized to reactive derivatives that are thought to be responsible for its mutagenic activity in experimental systems. B(*a*)A is a weak experimental carcinogen by the dermal route of exposure. There is some evidence that it is carcinogenic by the oral route as well. Its carcinogenicity by the inhalation route has not been studied. Mutation is thought to be a necessary (although insufficient) step for the carcinogenic activity of B(*a*)A.

Short-Term Exposure: No acute health effects known at this time.

Long-Term Exposure: May be a carcinogen in humans. Has shown to cause bladder and skin cancer in animals. The DFG[3] states that PAHs are present at particularly high levels in coal tar oils and related pyrolysis products of organic materials and are carcinogenic (category 1) in animal studies.

Points of Attack: Skin, respiratory system; bladder, liver, kidneys as PAH.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure preplacement and regular physical examinations are indicated for workers having contact with acenaphthene in the work-place. CBC, chest X-ray, pulmonary function tests, photopatch testing; sputum cytology, urinalysis (routine) [cytology, hematuria], liver, kidney, and bladder function tests are recommended for coal tar pitch volatiles[2].

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Store in a cool, dry place away from oxidizers. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1—Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft (NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Atomize into incinerator with a flammable liquid[22].

References

(109); (102); (31); (173); (101); (138); (2); (100).

Agency for Toxic Substance and Disease Registry, United States Public Health Service, "Toxicological Profile for Benz [*a*]Anthracene," Atlanta, Georgia, ATSDR October (1987).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 5, No. 1, 32−37 (1985).

United States Environmental Protection Agency, "*Identification of Organic Compounds in Effluents from Industrial Sources*," EPA-560/3-75-002, April (1975).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Benz[*a*]anthracene, Trenton, NJ (September 1998).

Benzal Chloride B:0270

Formula: $C_7H_6Cl_2$; $C_6H_5CHCl_2$

Synonyms: Benzene, dichloromethyl-; Benzyl dichloride; Benzylene chloride; Benzylidene chloride; Chlorbenzal; Chlorobenzal; Chlorure de benzylidene (French); Cloruro de bencilideno (Spanish); Cloruro de benzal (Spanish); (Dichloro methyl)benzene; Dichlorophenylmethane; α,α-Dichlorotoluene; Toluene, α,α-dichloro-

CAS Registry Number: 98-87-3

HSD B Number: 5322

RTECS Number: CZ5075000

UN/NA & ERG Number: UN1886/156

EC Number: 202-709-2 [*Annex I Index No.:* 602-058-00-8]

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Flammable, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard.

List II, DEA chemical code 8570 (Title 21 CFR1310.02)

United States Environmental Protection Agency Gene-Tox Program, Positive: *B. subtilis* rec assay; Histidine reversion-Ames test

Banned or Severely Restricted (Sweden) (UN)[13]

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U017

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.055; Nonwastewater (mg/kg), 6.0

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500 lb (227 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV.D.3.b, RQ: 5000 lb (2270 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, F; risk phrases: R10; R22; R23; R37/38; R40; R41; R61; R62; R63; safety phrases: S1/2; S36/37; S38; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Benzal chloride is a combustible, fuming, colorless, oily liquid; fumes on exposure to air. Faint, pungent odor. Molecular weight = 161.03; Specific gravity (H_2O:1) = 1.2557 @ 14°C; boiling point = 205−207°C; freezing/melting point = −16.8°C; relative vapor density (air = 1) = 5.6; latent heat of vaporization = 2.9×10^5 J/kg; vapor pressure = 0.30 mmHg @ 20°C; 0.75 mmHg @ 31°C; flash point = 93°C; autoignition temperature = 585°C. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 2; reactivity 1 ₩. Insoluble in water; biodegrades.

Potential Exposure: Benzal chloride is used almost exclusively for the manufacture of benzaldehyde. It can also be used to prepare cinnamic acid and benzoyl chloride.

Incompatibilities: May form explosive mixture with air. Reacts with water, air, or heat, forming fumes of hydrochloric acid. Reacts (possibly violently) with acids, bases, strong oxidizers; many metals; potassium, sodium, aluminum. Attacks plastics and coatings.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 0.21 milligram per cubic meter

PAC-2: 2.3 milligram per cubic meter

PAC-3: 14 milligram per cubic meter

DFG MAK: [skin] Carcinogen Category 2 *as benzyl dichloride Note:* DFG MAK: [skin] Carcinogen Category 1, Confirmed Human Carcinogen (α-chlorinated toluenes, mixtures of Benzoyl and various Benzyl chlorides)

Austria: carcinogen, 1999; Finland: carcinogen, 1993; Russia: STEL 0.5 milligram per cubic meter, 1993; Sweden: carcinogen, 1999

Permissible Concentration in Water: No criteria set. Benzal chloride hydrolyzes to benzaldehyde and HCl on contact with water.

Determination in Water: Octanol−water coefficient: Log K_{ow} => 3. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood. Biodegrades in water.

Routes of Entry: Inhalation, ingestion, passing through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Benzal chloride can affect the nervous system; and may be fatal if inhaled, swallowed or absorbed through the skin. Benzal chloride is irritating to the skin and eyes, causing excessive tearing. Irritates the respiratory tract causing shortness of breath and cough. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: Benzal chloride may cause skin cancer. This chemical was found to induce carcinomas, leukemia, and papillomas in mice. Benzal chloride was shown to possess a longer latency period than benzotrichloride before the onset of harmful effects. May affect the CNS.

Points of Attack: Central nervous system; skin.

Medical Surveillance: Lung function and nervous system tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Specific respirator(s) have not been recommended by NIOSH. However, based on potential carcinogenicity, and where the potential exists for exposure, the following might be considered:

At any detectable concentration: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full facepiece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, strong acids, flammable materials, sources fire as this material is combustible. Sources of ignition, such as smoking and openflames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN1886 Benzylidene chloride, Hazard class 6.1; Label 6.1—Poisonous materials.

Spill Handling: Stay upwind and uphill. Isolate the area of release or fire and deny entry. Remove all ignition sources. Stop the release if it can be done safely from a distance. All equipment used to handle this material must be grounded. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. *Small spill*: Cover with *dry* earth, *dry* sand, or other noncombustible material followed with plastic sheet to minimize spreading or contact with water or rain. Use clean nonsparking tools to collect material and place material into loosely covered plastic containers for later disposal. Prevent material and runoff from entering sewers and waterways if it can be done safely well ahead of the release. Use vapor suppressing foam to disperse vapors−contain runoff. Water spray may reduce vapor, but may not prevent ignition in enclosed spaces. Ventilate confined area if it can be done without placing personnel at risk. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include hydrogen chloride. *Small fire*: use *dry* chemical, CO_2, *dry* sand, or alcohol-resistant foam. May react with foams releasing corrosive/toxic gases. *Large fire*: use water spray or alcohol-resistant foam if it is available in sufficient amounts. Under favorable conditions, experienced crews can use coordinated fog streams to sweep the flames off the surface of the burning liquid. Combustible material: may burn but does not ignite readily. Most vapors are heavier than air. They will spread along ground and collect in low or confined areas (sewers, basements, tanks). Vapors may travel to source of ignition and flashback. Containers may explode when heated or if contaminated with water.

Keep exposures cool long after fire is out to protect against reignition. Do not direct straight streams into the liquid. Cool exposed containers with large quantities of water from unattended equipment or remove intact containers if it can be done safely. *Do not get water on spilled substance or inside containers.* If cooling streams are ineffective (*venting sound increases in volume and pitch, tank discolors or shows signs of deforming*), withdraw immediately to a secure location. Always stay away from ends of tanks, especially when engulfed in flames. If material or contaminated runoff from fire control enters waterways, notify downstream users of potentially contaminated water. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156.

Disposal Method Suggested: Incineration @ 816°C, 0.5 second minimum for primary combustion; 1204°C, 1.0 second for secondary combustion; elemental chlorine formation may be alleviated through injection of steam or methane into the combustion process.

References

(31); (173); (100).

United States Environmental Protection Agency, Benzal Chloride, Health and Environmental Effects Profile No. 14, Washington, DC, Office of Solid Waste (April 30, 1980).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Benzal Chloride, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Benzal Chloride, Trenton, NJ (May 2003).

Benzaldehyde B:0280

Formula: C_7H_6O; C_6H_5CHO

Synonyms: Almond artificial essential oil; Artificial almond oil; Benzaldehído (Spanish); Benzaldéhyde (French); Benzene carbaldehyde; Benzenecarbonal; Benzene carcaboxaldehyde; Benzenemethylal; Benzoic aldehyde; NCI-C56133; Oil of bitter almond; Phenylformaldehyde; Phenylmethanal

CAS Registry Number: 100-52-7

HSDB Number: 388

RTECS Number: CU4375000

UN/NA & ERG Number: UN1990/129

EC Number: 202-860-4 [*Annex I Index No.:* 605-012-00-5]

Regulatory Authority and Advisory Information

Carcinogenicity: NTP: Carcinogenesis Studies (gavage); some evidence: mouse; NCI: Carcinogenesis Studies (gavage); equivocal evidence: mouse; (gavage); no evidence: rat. United States Environmental Protection Agency Gene-Tox Program, Positive: *N. crassa*-reversion

List 1, DEA chemical code 8256 (Title 21 CFR1310.02).

Hazard Alert: Flammable, Possible risk of forming tumors, May cause harm to the unborn child, Primary irritant (w/o allergic reaction), Environmental hazard.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

TSCA 40CFR712.30.(e)1 (aldehydes)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xn; risk phrases: R10; R21/22/23; R51; R61; safety phrases: S2; S24; R45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Benzaldehyde is a clear to yellowish liquid with an almond odor. The Odor Threshold is 0.042 ppm. Molecular weight = 106.13; specific gravity (H_2O:1) = 1.04; boiling point = 198°C @ 19.5 mmHg; freezing/melting point = -26°C; flash point = 63°C (cc); vapor pressure = 1 mmHg @ 26°C; 5 mmHg @ 50°C; autoignition temperature = 190°C. Explosive limits: LEL: 1.4%, UEL: 13.5%. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 2; reactivity 1 ₩. Practically insoluble in water; solubility =< 1 mg/mL 0.3 g/100 mL.

Potential Exposure: In manufacture of perfumes, dyes, and cinnamic acid; as solvent; in flavors.

Incompatibilities: The substance reacts with air, forming explosive peroxides. Reacts violently with performic acid, oxidants, aluminum, iron, bases, and phenol, causing fire and explosion hazard. May self-ignite if absorbed in combustible material with large surface area, or otherwise dispersed over large areas. Reacts with rust, amines, alkalies, strong bases, reducing agents such as hydrideds and active metals.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 4 ppm

PAC-2: 9.9 ppm

PAC-3: 59 ppm

DFG MAK: [skin] May cause dermal sensitization.

Hungary: TWA 5 milligram per cubic meter, STEL 10 milligram per cubic meter, 1993; Poland: TWA 10 milligram per cubic meter, STEL 40 milligram per cubic meter, 1999; Russia: STEL 5 milligram per cubic meter, 1993; United Kingdom: carcinogen, 2000.

Permissible Concentration in Water: No criteria set. Toxic to aquatic organisms.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 1.5$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion and skin absorption.

Harmful Effects and Symptoms

Short-Term Exposure: Anyone with a history of asthma must avoid all contact with this chemical. Absorbed through the skin, thereby increasing exposure. The substance irritates the eyes, skin, and the respiratory tract, causing coughing and shortness of breath. May cause asthma symptoms; this may take hours to develop; physical activity and/or alcohol consumption can aggravate the symptoms. May cause contact dermatitis. Acts as a narcotic in high concentrations; exposure can cause dizziness; and, at higher levels, unconsciousness. LD_{50} = (oral-rat) 1300 mg/kg.

Long-Term Exposure: Repeated or prolonged contact may cause skin sensitization, rashes, and kidney damage. Causes mutations; may cause cancer or reproductive risks.

Points of Attack: Skin, central nervous system; kidneys.

Medical Surveillance: Examination by a qualified dermatologist and allergist. Kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers recommend polyvinyl alcohol gloves; styrene-butadiene rubber, butyl rubber; and polyethylene-coated materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls, and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit. Specific respirator(s) have not been recommended by NIOSH. However, based on potential carcinogenicity, and where the potential exists for exposure, the following might be considered:

At any detectable concentration: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full facepiece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Store under nitrogen in an area away from steam or water, See also, incompatibilities section. Keep away from strong acids and oxidizers.

Shipping: UN1990 Benzaldehyde, Hazard class: 9; Labels: 9—Miscellaneous hazardous material.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Benzaldehyde is a combustible liquid. Thermal decomposition products may include acrid smoke, irritating fumes, and oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration; add combustible solvent and spray into incinerator with afterburner[22].

References

(31); (173); (101); (138); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 1, No. 8, 36−38 (1981).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Benzaldehyde, Trenton, NJ (July 2002).

Benzamide B:0290

Formula: C_7H_7NO; $C_6H_5CONH_2$
Synonyms: Benzamida (Spanish); Benzoic acid amide; Benzoylamide; Phenylcarboxyamide
CAS Registry Number: 55-21-0
HSDB Number: 6360
RTECS Number: CU8700000
EC Number: 200-227-7
Regulatory Authority and Advisory Information
Hazard Alert: Combustible, Suspected of causing genetic defects
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
Hazard symbols, risk, & safety statements: Hazard symbol: Xn; risk phrases: R22; R36/37/38; R50/53; R62; safety phrases: S16; S26; S36/37; S41; S45 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.
Description: Benzamide is a combustible, colorless to beige, off-white, crystalline solid; freezing/melting point = 132−133°C. Molecular weight = 121.15; specific gravity (H_2O:1) = 1.34; boiling point = 288°C; freezing/melting point = 130°C; vapor pressure = (est) 1.65×10^{-4} mmHg. Water solubility = 1.34 g in 100 mL; flash point = 180°C. Hazard identification (based on NFPA-704 M Rating System): Health 1; flammability 1; reactivity 0 ₩. Soluble in water; solubility = 13 g/L.
Potential Exposure: Benzamide is used in organic synthesis.
Permissible Exposure Limits in Air
PAC Ver. 29[138]
PAC-1: 4.7 milligram per cubic meter
PAC-2: 52 milligram per cubic meter
PAC-3: 310 milligram per cubic meter
Determination in Water: Octanol−water coefficient: Log K_{ow} = 0.6. Unlikely to bioaccumulate in marine organisms. Fish Tox (benzamide) LC_{50} (fathead minnow, 96 hours) = 661 mg/L.
Routes of Entry: Inhalation, passing through the skin.
Harmful Effects and Symptoms
Short-Term Exposure: Irritates the eyes, nose, and throat. May produce gastric pain, nausea and vomiting[52]. The oral LD_{50} (mouse) = 1160 mg/kg (slightly toxic).
Long-Term Exposure: Similar chemicals cause methemoglobinemia and liver damage, but it is not known if benzamide has these effects.
Medical Surveillance: CBC, liver function tests.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.
Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls, and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit. *Where there is no REL, at any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive pressure mode).
Storage: Combustible solid. Store in a refrigerator or a cool, dry place.
Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen spilled material with 60%−70% ethanol to avoid dust and transfer to vapor-tight plastic bags for eventual disposal. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.
Fire Extinguishing: A combustible solid. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. Thermal decomposition products may include oxides of nitrogen and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially

contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References:
(31); (173); (101); (138); (100).

Benzenamine, 3-(Trifluoromethyl)- B:0300

Formula: $C_7H_6F_3N$; $H_2NC_6H_4CF_3$
Synonyms: *m*-Aminobenzal fluoride; *m*-Aminobenzaltrifluoride; *m*-Aminobenzotrifluoride; 3-Amino-benzotrifluoride; 3-Amino-benzo-trifluoride; 1-Amino-3-(trifluoromethyl)benzene; *m*-Amino-α,α,α-trifluorotoluene; Toluene, 3-amino-α,α,α-trifluoro-; *m*-Toluidine, α,α,α-trifluoro-; 3-Trifluorometilanilina (Spanish); *m*-(Trifluoromethyl)aniline; 3-Trifluoromethylaniline; 3-(Trifluoromethyl)aniline; *m*-(Trifluoromethyl)benzenamine; 3-(Trifluoromethyl)benzenamine; α, α, α-Trifluoro-*m*-toluidine
CAS Registry Number: 98-16-8
HSDB Number: 4249
RTECS Number: XU9180000
UN/NA & ERG Number: UN2948/153
EC Number: 202-643-4
Regulatory Authority and Advisory Information
Hazard Alert: Poison, Combustible, Highly toxic (inhalation)
Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500 pounds
Superfund/EPCRA 40CFR302.4, Appendix A and Section IV.D.3.b, RQ: 500 lb
Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%
Hazardous to aquatic life or environment, with possible long-lasting effects[293]. Toxic to aquatic life with long-lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.
Hazard symbols, risk, & safety statements: Hazard symbol: T+, Xi, Xn, N: risk phrases: R20/21/22; R23/24/25; R26; R33; R36/37/38; R51/53; safety phrases: S36/37/39; S41; S45 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.
Description: Benzenamine, 3-(trifluoromethyl)-is a combustible, colorless to yellow oily liquid. Unpleasant amine odor. Molecular weight = 161.13; Specific gravity (H_2O:1) = 1.3 @ 15°C; vapor density = 5.6; boiling point = 187.5; freezing/melting point = 2.8°C; flash point = 85°C[52]. Hazard identification (based on NFP A-704 M Rating System): Health 3; flammability 1; reactivity 0 ₩
Potential Exposure: This material is used as a chemical intermediate for herbicides, antihypertensives, and diuretics.
Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Light and air sensitive.
Permissible Exposure Limits in Air
NIOSH IDLH = 250 milligram per cubic meter
OSHA PEL: 3 ppm/2.5 mg[F]/m^3 TWA
NIOSH REL: 3 ppm/2.5 mg[F]/m^3 TWA; 6 ppm/5 mg[F]/m^3, 15 minutes. Ceiling Concentration
ACGIH TLV[1]: 2.5 mg[F]/m^3 TWA; not classifiable as a hum an carcinogen; BEI: 3 mg[F]/g creatinine in urine *prior* to end-of-shift; 10 mg[F]/g creatinine in urine end-of-shift
PAC Ver. 29[138]
PAC-1: 0.4 milligram per cubic meter
PAC-2: 4.4 milligram per cubic meter
PAC-3: 19 milligram per cubic meter
DFG MAK: 1 mg[F]/m^3, inhalable fraction [skin]; Peak Limitation Category II(4); Pregnancy Risk Group C; BAT: 7.0 mg[F]/g creatinine in urine at end-of-shift; 4.0 mg[F]/g creatinine in urine at the beginning of the next shift
Permissible Concentration in Water: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guidelines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg[F]/L. SafeDrinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg [F]/L; SMCL = 2 mg[F]/L, as Fluoride.
Routes of Entry: Inhalation, ingestion, skin contact.
Harmful Effects and Symptoms
Short-Term Exposure: Contact may cause burns to skin and eyes. May be poisonous if inhaled, swallowed or absorbed through the skin. LD_{50} = (oral-rat) 480 mg/kg; the oral LD_{50} mouse is 220 mg/kg.
Long-Term Exposure: Repeated exposure to fluoride chemicals may cause stiffness in muscles or ligaments and even crippling. Fluoride may increase bone density, stimulate new bone growth or cause calcium deposits in ligaments. This may become a problem at levels of 20−50 milligram per cubic meter or higher. Mottling of the teeth may occur at this level.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately.

If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls, and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit.

NIOSH: (*fluorides*) *12.5 milligram per cubic meter*: Qm (APF = 25) (any quarter-mask respirator). *25 milligram per cubic meter:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or SA* (any supplied-air respirator). *62.5 milligram per cubic meter:* Sa:Cf (APF = 25)*+ (any supplied-air respirator operated in a continuous-flow mode); or * ** *if not present as a fume* PaprHie (APF = 25) (any PAPR with a high-efficiency particulate filter). *125 milligram per cubic meter:* HieF** (any air-purifying, full facepiece respirator with a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *250 milligram per cubic meter:* Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* HieF** (any air-purifying, full facepiece respirator with a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA). *Substance reported to cause eye irritation or damage; may require eye protection.

**May need acid gas sorbent.

Storage: Color code—Blue: Health Hazard/Poison (Toxic): Store in a secure, locked and cool, ventilated area. Store in tightly closed, light-resistant containers in a cool, well-ventilated area away from oxidizers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN29483-Trifluoromethylaniline, Hazard Class: 6.1; Labels: 6.1—Poisonous materials.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills:* absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills:* dike far ahead of spill for later disposal. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Wear positive pressure breathing apparatus and special protective clothing. Move container from fire area if you can do so without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References
(31); (173); (101); (138); (122); (100).
United States Environmental Protection Agency, Chemical Hazard Information Profile: Benzenamine, 3-Trifluoromethyl), Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

Benzene B:0310

Formula: C_6H_6
Synonyms: (6) Annulene; Benceno (Spanish); Benzelene; Benzol; Benzole; Bicarburet of hydrogen; Carbon naphtha; Carbon oil; Coal naphtha; Coal naphtha, Phenyl hydride; Coal tar naphtha; Cyclohexatriene; Mineral naphtha; Motor benzol; NCI-C55276; Nitration benzene; Phene; Phenyl hydride; Pyrobenzol; Pyrobenzole
CAS Registry Number: 71-43-2
HSDB Number: 35
RTECS Number: CY1400000
UN/NA & ERG Number: UN1114/130
EC Number: 200-753-7 [*Annex I Index No.:* 601-020-00-8]
Regulatory Authority and Advisory Information
Carcinogenicity: IARC: Human Sufficient Evidence, 1982; Animal Sufficient Evidence, 1982*, carcinogenic to humans*, Group 1, 1987 NCI: Carcinogenesis Studies (gavage); clear evidence: mouse, rat; NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen. United States Environmental Protection Agency Gene-Tox Program, Positive: Carcinogenicity-mouse/rat; Positive: In vitro cytogenetics-human lymphocyte; Positive: In vivo cytogenetics-human lymphocyte; Positive: Mammalian micronucleus; Sperm morphology-mouse; Negative: Cell transformation-SA7/SHE; In vitro SCE-human lymphocytes; Negative: In vitro SCE-human.
California Proposition 65 Chemical[102]: Cancer 1/27/87; Developmental/Reproductive toxin (male) 12/26/1997.
Hazard Alert: Highly flammable, Systemic agent, Possible risk of forming tumors, Reproductive toxin: possible risk of gene damage/impaired fertility; Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction), Environmental hazard. Listed for Tier 1 screening as an endocrine disruptor[88].
OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR1910.1028); (CFR 29,1926.1128)
United States National Primary Drinking Water Regulations: MCLG = 0 mg/L; MCL = 0.005 mg/L.
Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112). *Note:* Including benzene from gasoline
Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/1992); 40CFR401.15 Section 307 Toxic Pollutants
United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U019
RCRA Toxicity Characteristic (Section 261.24), Maximum Concentration of Contaminants, regulatory level, 0.5 mg/L
RCRA, 40CFR261, Appendix 8 Hazardous Constituents
RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.14; Nonwastewater (mg/kg), 10
RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8020 (2); 8240 (5)
Superfund/EPCRA 40CFR302.4, Appendix A and Section IV.D.3.b, RQ: 10 lb (4.54 kg)
EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.
United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)
Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%. (carcinogen); National Pollutant Release Inventory (NPRI); Priority Substance List (CEPA).
Hazard symbols, risk, & safety statements: Hazard symbol: F+, T; risk phrases: R45; R46; R11; R36/38; R45/23/24/25; R61; R62; R63; safety phrases: S21; S41; S45; S53; S65 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.
Description: Benzene is a clear, volatile, colorless, highly flammable liquid with a pleasant, characteristic odor. Molecular weight = 78.112; boiling point @ 1 atm = 80.1°C; melting/freezing point = 5.5°C; critical temperature = 288.9°C; critical pressure = 710 psia; specific gravity (H_2O:1) = 0.879 @ 20°C; liquid surface tension = 0.0289 N/m @ 20°C; liquid water interfacial tension = 0.035 N/m @ 20°C; relative vapor density (air = 1) = 2.7; latent heat of vaporization = 3.94×10^5 J/kg; heat of combustion = -406.0×10^5 J/kg; vapor pressure = 75 mmHg @ 20; electrical conductivity = 3.8 pS/m; flash point = −11°C; autoignition temperature = 498°C. Explosive limits: LEL: 1.2%, UEL: 7.8%. Hazard identification (based on NFPA-704 M Rating System): Health 1; flammability 3; reactivity 0 ₩. The Odor Threshold in air is 4.9 milligram per cubic meter; the Odor Threshold in water is 2.0 mg/L. Very slightly soluble in water; solubility = 0.18 g/100 mL.
Potential Exposure: Benzene is used as a constituent in motor fuels; as a solvent for fats; inks, oils, paints, plastics, and rubber, in the extraction of oils from seeds and nuts; in photogravure printing. It is also used as a chemical intermediate. By alkylation, chlorination, nitration, and sulfonation, chemicals, such as styrene, phenols, and malefic anhydride are produced. Benzene is also used in the manufacture of detergents, explosives, pharmaceuticals; in the manufacture of cyclohexane and ethylbenzene; and dye-stuffs. Increased concern for benzene as a significant environmental pollutant arises from public exposure to the presence of benzene in gasoline and the increased content in gasoline due to requirements for unleaded fuels for automobiles equipped with catalytic exhaust converters.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, many fluorides and perchlorates, nitric acid.

Permissible Exposure Limits in Air

NIOSH IDLH = 500 ppm

Conversion factor: 1 ppm = 3.19 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 1 ppm TWA; 5 ppm STEL, cancer hazard. See Appendix F of the *NIOSH Pocket Guide*

NIOSH REL: 0.1 ppm TWA; 1 ppm STEL, potential carcinogen. Limit exposure to lowest feasible level. See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV[1]: 0.5 ppm TWA; 2.5 ppm [skin] STEL, Confirmed Human Carcinogen; BEI: 25 μg[*S*-Phenylmercapturic acid]/g creatinine in urine/end-of-shift; 500 μg[*t,t*-Muconic acid]/g creatinine in urine/end-of-shift

PAC* Ver. 29[138]

PAC-1: **52**$_{\mathbf{A}}$ ppm

PAC-2: **800**$_{\mathbf{A}}$ ppm

PAC-3: **4000**$_{\mathbf{A}}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

Emergency Response Planning Guidelines (ERPG) (DOE)

ERPG-1: 50 ppm

ERPG-2: 150 ppm

ERPG-3: 1000 ppm

DFG MAK: [skin], Carcinogen Category 1; Germ Cell Mutagen Group: 3A; TRK: 1 mL/m^3/3.3 milligram per cubic meter; 5 μg[Benzene]/L in whole blood/end-of-shift; 0.045 mg[*S*-Phenylmercapturic acid]/g creatinine in urine/end-of-shift; 2 mg[*trans,trans*-Muconic acid]/L in urune/end-of-shift, Class 1, human carcinogen

Australia: TWA 5 ppm (16 milligram per cubic meter), carcinogen, 1993; Austria [skin], carcinogen, 1999; Belgium: TWA 10 ppm (32 milligram per cubic meter), carcinogen, 1993; Denmark: TWA 5 ppm (16 milligram per cubic meter), [skin], 1999; Finland: TWA 5 ppm (15 milligram per cubic meter), STEL 10 ppm (30 milligram per cubic meter), [skin], carcinogen, 1993; United Kingdom: TWA 3 ppm (9.6 milligram per cubic meter), carcinogen, 2000; Hungary STEL 5 milligram per cubic meter, [skin], carcinogen, 1993; the Netherlands: MAC-TGG 3.25 milligram per cubic meter, [skin], 2003; Japan: 10 ppm (32 milligram per cubic meter), Group 1 carcinogen, 1999; Norway: TWA 1 ppm (3 milligram per cubic meter), 1999; the Philippines: TWA 25 ppm (80 milligram per cubic meter), [skin], 1993; Poland: MAC (time-weighted average) 10 milligram per cubic meter; MAC (STEL) 40 milligram per cubic meter, 1999; Russia: TWA 10 ppm (5 milligram per cubic meter), STEL 25 ppm (15 milligram per cubic meter), [skin], carcinogen, 1993; Sweden: NGV 0.5 ppm (1.5 milligram per cubic meter), KTV 3 ppm (9 milligram per cubic meter), [skin], carcinogen, 1999; Switzerland: MAK-week 1 ppm (3.2 milligram per cubic meter), [skin], carcinogen, 1999; Thailand: TWA 10 ppm (30 milligram per cubic meter), STEL 25 ppm (75 milligram per cubic meter), 1993; Turkey: TWA 20 ppm (64 milligram per cubic meter), [skin], 1993; United Kingdom LTEL 10 ppm (30 milligram per cubic meter), 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 2.5 ppm [skin]. Russia[43] set a MAC in ambient air in residential areas on a momentary basis and 0.8 milligram per cubic meter in residential air on a daily average basis. Several states have set guidelines or standards for benzene in ambient air[60] ranging from zero (North Dakota) to 0.12 μ/m^3 (North Carolina) to 0.14 μ/m^3 (Michigan) to 1.2 μ/m^3 (Massachusetts) to 72 μ/m^3 (Pennsylvania) to 100 μ/m^3 (New York and Rhode Island) to 150 μ/m^3 (Connecticut and South Carolina) to 300 μ/m^3 (Virginia).

The final OSHA benzene standard in 1910.1028 applies to all occupational exposures to benzene except some subsegments of industry where exposures are consistently under the action level (i.e., distribution and sales of fuels, sealed containers and pipelines, coke production, oil and gas drilling and production, natural gas processing; and the percentage exclusion for liquid mixtures); *for the excepted subsegments, the benzene limits in Table Z-2 apply* (i.e., an 8-hour TWA of 10 ppm, an acceptable ceiling of 25 ppm, and 50 ppm for a maximum duration of 10 minutes as an acceptable maximum peak above the acceptable ceiling).

Determination in Air: NIOSH Analytical Method #1500, Hydrocarbons, BP = 36−126°C, #1501, Hydrocarbons, aromatic; #3700, Benzene, by portable GC, #3800, OSHA Analytical Method 12.

Permissible Concentration in Water: Safe Drinking Water Act (47FR 9352): MCLG, zero; MCL, 0.005 mg/L. Regulated chemical (47FR9352) Federal Drinking Water Guidelines: EPA 5 μg/L; State Drinking Water Standards: California 1 μg/L; Florida 1 μg/L; New Jersey 1 μg/L; State Drinking Water Guidelines: Arizona 1.3 μg/L; Connecticut 1 μg/L; Maine 6 μg/L; Minnesota 3 μg/L.

Determination in Water: Gas chromatography (EPA Method 602) or GC plus mass spectrometry (EPA Method 624). Octanol−water coefficient: Log $K_{\text{ow}} =< 2.1$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, skin absorption, ingestion, skin, and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Inhalation of Benzene may produce both nerve and blood effects. Irritation of the nose, throat and lungs may occur (3000 ppm may be tolerated for only 30−60 minutes). Lung congestion may occur. Nerve effects may include an exaggerated feeling of well-being, excitement, headache, dizziness, and slurred speech. At high levels, slowed breathing and death may result. Death has occurred @ 20,000 ppm for 5−10 minutes, or 7500 ppm for 30 minutes. Skin contact: Irritation may occur, with redness and blistering if not promptly removed. Benzene is poorly absorbed. Whole body exposure for 30 minutes has been reported with no health effects. Eye contact may cause severe irritation. Ingestion may cause irritation of mouth, throat and stomach. Symptoms are similar to those listed under inhalation. One tablespoon may cause collapse, bronchitis, pneumonia and death. Use of alcoholic beverages enhances the harmful effect.

Long-Term Exposure: Benzene is a known human carcinogen. Exposure has been linked to increased risk of several forms of leukemia. The liquid defats the skin. The substance may have effects on the blood forming organs, liver and immune system. May cause loss of appetite; nausea, weight loss; fatigue, muscle weakness; headache, dizziness, nervousness and irritability. Mild anemia has been reported from exposures of 25 ppm for several years and 100 ppm for 3 months. At levels between 100 and 200 ppm for periods of 6 months, or more, severe irreversible blood changes and damage to liver and heart may occur. Temporary partial paralysis has been reported.

Points of Attack: Eyes, skin, respiratory system; blood, central nervous system; bone marrow. *Cancer site:* leukemia.

Medical Surveillance: OSHA mandates the following: CBC: leulocyte count, thrombocyte count, hematocrit, hemoglobin, erythrocyte count; pulmonary function tests. NIOSH lists the following tests: CBC including leucocyte count, thrombocyte count, hematocrit, hemoglobin, erythrocyte count; white blood cell count/differential; whole blood (chemical/metabolite)*; whole blood (chemical/metabolite), prior to next shift; expired air, next shift, prior to next shift; urine (chemical/metabolite)*; urine (chemical/metabolite), during exposure, end-of-shift, end-of-work-week, pre- & postshift. **no time specified*

Preplacement and periodic examinations should be concerned especially with effects on the blood and bone marrow and with a history of exposure to other myelotoxic agents or drugs or of other diseases of the blood. Preplacement laboratory exams should include: (1) CBC (hematocrit, hemoglobin, mean corpuscular volume, white blood count, differential count, and platelet estimation); (2) reticulocyte count; (3) serum bilirubin; and (4) urinary phenol. The type and frequency of periodic hematologic studies should be related to the data obtained from biologic monitoring and industrial hygiene studies, as well as any symptoms or signs of hematologic effects. Recommendations for proposed examinations have been made in the "Criteria for a recommended standard. Examinations should also be concerned with other possible effects, such as those on the skin, CNS; and liver and kidney functions. Biologic monitoring should be provided to all workers subject to benzene exposure. It consists of sampling and analysis of urine for total phenol content. The objective of such monitoring is to be certain that no worker absorbs an unacceptable amount of benzene. Unacceptable absorption of benzene, posing a risk of benzene poisoning, is considered to occur at levels of 75 mg phenol per liter of urine (with urine specific gravity, corrected to 1.024), when determined by methods specified in the NIOSH "Criteria for Recommended Standard-Benzene." Alternative methods shown to be equivalent in accuracy and precision may also be useful. Biological monitoring should be done at quarterly intervals. If environmental sampling and analysis are equal to or exceed accepted safe limits, the urinary phenol analysis should be conducted every 2 weeks. This increased monitoring frequency should continue for at least 2 months after the high environmental level has been demonstrated. Two follow-up urines should be obtained within 1 week after receipt of the original results, one at the beginning and the other at the end of the work week. If original elevated findings are confirmed, immediate steps should be taken to reduce the worker's absorption of benzene by improvement in environment control, personal protection, personal hygiene, and administrative control.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, rinse mouth, get medical attention. Do not induce vomiting.

Personal Protective Methods:

General information: First responders should use a NIOSH-certified chemical, biological, radiological, nuclear (CBRN) SCBA with a level a protective suit when entering an area with an unknown contaminant or when entering an area where the concentration of the contaminant is unknown. Level a protection should be used until monitoring results confirm the contaminant and the concentration of the contaminant. *Note:* safe use of protective clothing and equipment requires specific skills developed through training and experience.

LEVEL A: (*RED ZONE*): Select when the greatest level of skin, respiratory, and eye protection is required. This is the maximum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than the AEGL-2. A NIOSH-certified CBRN full-face-piece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle. A totally encapsulating chemical protective (TECP) suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, and a hard hat worn under the TECP suit are optional items.

LEVEL B: (RED ZONE): Select when the highest level of respiratory protection is necessary but a lesser level of skin protection is required. This is the minimum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than AEGL-2.

It differs from Level A in that it incorporates a nonencapsulating, splash-protective, chemical-resistant splash suit that provides Level A protection against liquids but is not airtight. A NIOSH-certified CBRN full-face-piece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL C: (YELLOW ZONE): Select when the contaminant and concentration of the contaminant are known and the respiratory protection criteria factors for using APR or Powered APR (PAPR) are met. This level is appropriate when decontaminating patient/victims. A NIOSH-certified CBRN tight-fitting APR with a canister-type gas mask or CBRN PAPR for air levels greater than AEGL-2. A NIOSH-certified CBRN PAPR with a loose-fitting facepiece, hood, or helmet and a filter or a combination organic vapor, acid gas, and particulate cartridge/filter combination or a continuous flow respirator for air levels greater than AEGL-1. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Escape mask, face shield, coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL D: (GREEN ZONE): Select when the contaminant and concentration of the contaminant are known and the concentration is below the appropriate occupational exposure limit or less than AEGL-1 for the stated duration times. Limited to coveralls or other work clothes, boots, and gloves.

Notes: Take all necessary precautions to prevent any reasonable probability of skin or eye contact. **8 hours** (more than 8 hours of resistance to breakthrough $>0.1\ \mu g/cm^2/min$): polyvinyl alcohol gloves; 4H and Silver Shield gloves; Barricade-coated suits; CPF3 suits; Responder suits; Trychem 1000 suits; **4 hours:** (At least 4 but <8 hours of resistance to breakthrough $>0.1\ \mu g/cm^2/min$): Teflon gloves, suits, boots; Viton gloves, suits. Also, safety equipment suppliers/manufacturers can also provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: < or = 10 ppm (parts per million) Half-mask air-purifying respirator with organic vapor cartridge. < or = 50 ppm (1) full-facepiece respirator with organic vapor cartridges; or (2) full-facepiece gas mask with chin-style canisters*. < or = 100 ppm Full-facepiece PAPR with organic vapor canister*. < or = 1000 ppm Supplied-air respirator with full facepiece in positive-pressure mode. >1000 ppm or unknown concentration (1) SCBA with full facepiece in positive-pressure mode; or (2) full-facepiece positive-pressure supplied-air respirator with auxiliary self-contained air supply. Escape (1) Any organic vapor gas mask; or (2) any SCBA with full facepiece. Firefighting full-facepiece SCBA in positive-pressure mode.

* Canisters must have a minimum service life of 4 hours when tested at 150 ppm benzene, at a flow rate of 64 liters per minute (LPM), 25°C, and 85% relative humidity for non-PAPRs. The flow rate shall be 115 and 170 LPM, respectively, for tight-fitting and loose-fitting PAPRs.

Storage: (1) Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. (2) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Before entering confined space where benzene may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area. Protect containers against physical damage. Storage preferred in an outdoor or detached building. If storage is indoor, use a standard flammable liquid storage room. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN1114 Benzene, Hazard Class: 3; Labels: 3—Flammable liquid

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. Keep benzene out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is highly flammable. Thermal decomposition products may include acrid smoke, irritating fumes, and oxides of carbon. Use dry chemical, carbon dioxide; or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed. Dilution with alcohol or acetone to minimize smoke is recommended[22]. Bacterial degradation is also possible.

References

(109); (102); (31); (173); (100).

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Sax, N. I., E d., "*Dangerous Properties of Industrial Materials Report*" 1, No. 4, 38–41 (1981); 2, No. 4, 33–38 (1982); and 3, No. 3, 53–59 (1983) and 4, No. 1, 21–22 (1984); and 4, No. 6, 55 (1984).

Occupational Safety and Health Administration "Occupational Exposure to Benzene; Final Rule," Federal Register, 52, No. 176, 34460–34578 incl. (September 11, 1987).

New York State Department of Health, Chemical Fact Sheet: Benzene, Bureau of Toxic Substance Assessment, Albany, NY (Version 2) (1995).

Mehlman, M. A., Ed., Carcinogenicity and Toxicity of Benzene, Princeton, NJ, Princeton Scientific Publishers (1983).

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Benzenearsonic Acid B:0320

Formula: $C_6H_7AsO_3$; $C_6H_5AsO(OH)_2$

Synonyms: Acido fenilarsonico (Spanish); Phenyl arsenic acid; Phenylarsonic acid

CAS Registry Number: 98-05-5

HSDB Number: 6381

RTECS Number: CY3150000

UN/NA & ERG Number: UN3280 (organoarsenic compounds, liquid, n.o.s.)/151

EC Number: 202-631-9

Regulatory Authority and Advisory Information

Hazard Alert: Exposure can be lethal, Combustible, Drug, Environmental hazard.

Banned or Severely Restricted

Air Pollutant Standard Set

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); List of high risk pollutants (Section 63.74) as arsenic compounds

Clean Water Act: Section 307 Toxic Pollutants, 40CFR401.15 (effluent limitations); as arsenic and compounds

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 10/10,000 lb (4.54/4540 kg)

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, D004 (arsenic compounds)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV.D.3.b, RQ: 1 lb (0.454 kg)

EPCRA (Section 313): as an arsenic organic compound. Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as arsenates, liquid, n.o.s.; arsenates, solid, n.o.s.; arsenical pesticides liquid, Toxic, flammable, n.o.s.

This compound is not specifically cited but falls in these categories since it is an arsenic compound. See entry on "Arsenic."

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, N; risk phrases: R45; R23/25; R50/53; safety phrases: S29; S53; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Benzenearsonic acid is a colorless, crystalline powder. Molecular weight = 202.05; specific gravity (H_2O:1) = 1.76; freezing/melting point = 160°C (decomposes). Hazard identification (based on NFPA-704 M Rating System):

Health 4; flammability 1; reactivity 0 ₩. Soluble in water.

Potential Exposure: This material is used as an analytical reagent for tin.

Permissible Exposure Limits in Air

NIOSH IDLH = 5 mg[As]/m^3

Arsenic, organic compounds

OSHA PEL: 0.5 mg[As]/m^3 TWA

NIOSH REL: Not established. See NIOSH Pocket Guide, Appendix A

ACGIH TLV[1]: 0.01 mg[As]/m^3 TWA; Confirmed Human Carcinogen; BEI established.

PAC Ver. 29[138]

PAC-1: 0.025 milligram per cubic meter

PAC-2: 0.27 milligram per cubic meter

PAC-3: 13 milligram per cubic meter

DFG MAK: Carcinogen Category 1; Germ Cell Mutagen Group 3A (2004); BAT: 50 μg[As]/L in urine/end of exposure or end-of-shift; for long-term exposures; after several shifts.

Arab Republic of Egypt: TWA 0.2 mg(As)/m^3, 1993; Australia: TWA 0.05 mg(As)/m^3, carcinogen, 1993; Belgium: TWA 0.2 mg(As)/m^3, 1993; Finland: carcinogen, 1999; France: VME 0.2 mg(As)/m^3, 1993; Hungary STEL 0.5 mg(As)/m^3, carcinogen, 1993; India: TWA 0.2 mg (As)/m^3, 1993; the Philippines: TWA 0.5 mg(As)/m^3, 1993; Poland: MAC (time-weighted average) 0.3 mg(As)/m^3, 1993; Sweden: NGV 0.03 mg(As)/m^3, carcinogen, 1999; Switzerland: MAK-week 0.1 mg(As)/m^3, carcinogen, 1999; Thailand: TWA 0.5 mg(As)/m^3, 1993; Turkey: TWA 0.5 mg(As)/m^3, 1993; United Kingdom LTEL 0.2 mg(As)/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Confirmed Human Carcinogen

Determination in Air: Use NIOSH Analytical Method #5022, arsenic, organic compounds.

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 10 μg[As]/L; State Drinking Water Guidelines: Arizona 10 μg[As]/L; Connecticut 10 μg[As]/L EPA MCL: 0.010 mg[As]/L [40 CFR 141.62]. Canadian Drinking Water Standards: IMAC 0.025 [As]mg/L.

Determination in Water: *For arsenic:* The atomic absorption graphite furnace technique is often used for measurement of total arsenic in water. It also has been standardized by EPA. Total arsenic may be determined by digestion followed by silver diethyldithiocarbamate; an alternative is atomic absorption; another is inductively coupled plasma optical emission spectrometry. See OSHA Method #ID-105 for arsenic[58]

Routes of Entry: Ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Symptoms of arsenic poisoning usually appear one-half to one hour after ingestion, but may be delayed many hours. Symptoms include a sweetish metallic taste and garlicky odor; difficulty in swallowing; abdominal pain; vomiting and painful diarrhea; dehydration, thirst, and cramps; dizziness, stupor, delirium, rapid heartbeat; headache, skin disorders; and coma. Benzenearsonic acid is a deadly poison. The LD_{low} oral (rat) is 50 mg/kg; the oral LD_{50} mouse is 270 μg/kg.

Long-Term Exposure: Chronic exposure to arsenic compounds can cause dermatitis and digestive disorders. Renal damage may develop.

Points of Attack: Skin, kidneys.

Medical Surveillance: Kidney function tests. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: For severe poisoning BAL (British Anti-Lewisite), Dimercaprol, dithiopropanol ($C_3H_8OS_2$) has been used to treat toxic symptoms of certain heavy metals poisoning—including arsenic. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5). For milder poisoning *penicillamine (not penicillin)* has been used, both with mixed success. Side effects occur with such treatment and it is never a substitute for controlling exposure. It can only be done under strict medical care.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Specific respirator(s) have not been recommended by NIOSH; however, where the potential exists for exposure, the following might be considered: *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full facepiece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: UN3280 Organoarsenic compound, liquid, n.o.s., Hazard Class: 6.1; Labels: 6.1—Poisonous materials, Technical Name Required. Potential Inhalation Hazard (Special Provision 5).

Spill Handling:

Organoarsenic compound, solid or liquid

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.5/0.8

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 500/60
Then: Protect persons downwind (mi/km)
Day 1.1/1.8
Night 2.8/4.5

Evacuate and restrict Persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Stay upwind; keep out of low areas. Wear self-contained (positive pressure if available) breathing apparatus and full protective clothing. Do not touch spilled material; stop leak if you can do it without risk. *Small liquid spills:* take up with sand or other noncombustible absorbent material into clean, dry container and cover; move containers from spill area. *Large spills:* dike far ahead of spill for later disposal. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of carbon and arsenic metal. This material does not burn or burns with difficulty. Extinguish fire using agent suitable for surrounding fire. Use water in flooding quantities as fog. Avoid breathing dusts and fumes; keep upwind; wear SCBA. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Benzenearsonic Acid (2). Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

(173); (101); (138).

Benzene, 1-(Chloromethyl)-4-Nitro- B:0330

Formula: $C_7H_6ClNO_2$: $ClCH_2C_6H_4NO_2$

Synonyms: Benzene, 1-(Chloromethyl)-4-nitro-; *p*-(Chloromethyl)nitrobenzene; 1-(Chloromethyl)-4-nitrobenzene; 4-(Chloromethyl)nitrobenzene; α-Chloro-nitrotoluene;

α-Chloro-*p*-nitrotoluene; *p*-Nitrobenzyl chloride; 4-Nitro phenylmethyl chloride; Toluene, α-chloro-*p*-nitro-

CAS Registry Number: 100-14-1

HSDB Number: 6323

RTECS Number: XS9093000

UN/NA & ERG Number: UN3261/154; UN1578 (Chloronitrobenzenes, *meta*-or *para*-, solid)/152

EC Number: 202-822-7

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: (chloronitrobenzenes); Human Inadequate Evidence; Animals Inadequate Evidence*, not classifiable as carcinogenic to humans*, Group 3

Listed in the TSCA inventory.

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV.D.3.b, RQ: 500 lb (227 kg).

Hazard symbols, risk, & safety statements: Hazard symbol: C; risk phrases: R22; R34; R36/37/38; R50/53; safety phrases: S26; S27; S36/37/39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Benzene, 1-(chloromethyl)-4-nitro-, is a crystalline solid. Molecular weight = 171.59; Specific gravity = 1.57; boiling point = 229.8°C; freezing/melting point = 71°C; vapor pressure = 0.05 @ 25°C. Very slightly soluble in water; slow reaction.

Potential Exposure: A chloronitrobenzene compound, used in organic synthesis.

Incompatibilities: Can react with sulfuric acid[52]. Keep away from oxidizers, amines, bases: sodium hydroxide, and potassium hydroxide; may cause fire and explosions. Incompatible with strong oxidizing and reducing agents such as hydrides, certain amines, nitrides, azo/diazo compounds, alkali metals (potassium), and epoxides. Corrodes steel, some plastics and human tissue.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 2.5 milligram per cubic meter

PAC-2: 28 milligram per cubic meter

PAC-3: 360 milligram per cubic meter

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: This chemical is a lachrymator[52]. Poisonous if swallowed or dust is inhaled. Can cause headaches, vomiting, cyanosis, difficulty in breathing. May cause skin irritation and sensitization.

Long-Term Exposure: Prolonged chronic exposure to nitro compounds of aromatic hydrocarbons may cause liver and kidney damage.

Points of Attack: Liver, kidneys.

Medical Surveillance: Kidney and liver function tests.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Safety equipment suppliers/ manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where risk assessment shows APRs are appropriate, use a full-face respirator type (N100) United States or Type P3 (EN-143) respirators as backup to engineering controls. If the respirator is the sole means of protection, use a full-face supplied respirator. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

Storage: (1) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. (2) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Before entering confined space where benzotrichloride may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a dark, cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN3261 Corrosive solid, acidic, organic, n.o.s., Hazard class: 8; Labels: 8—Corrosive material, Technical Name Required. UN1578 Chloronitrobenzenes, solid or liquid, Hazard Class: 6.1; Labels: 6.1—Poisonous materials.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Do not touch spilled material; stop leak if you can do so without risk.

Small liquid spills: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills:* with clean shovel, place material into clean, dry container and cover; move containers from spill area. *Large spills:* dike far ahead of spill for later disposal. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a Hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide; water spray; or foam extinguishers. Thermal decomposition products may include oxides of nitrogen and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Benzene, 1-(Chloromethyl)-4-nitro, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Chloronitrobenzenes (mixed isomers), Trenton, NJ (January 2007).

Benzenesulfonyl Chloride B:0340

Formula: $C_6H_5ClO_2S$; $C_6H_5SO_2Cl$

Synonyms: Benzene sulfochloride; Benzene sulfonechloride; Benzene sulfone-chloride; Benzenesulfonic (acid) chloride; Benzenesulfonic acid chloride; Benzenesulfonyl chloride; Benzenosulphochloride; BSC-refined D

CAS Registry Number: 98-09-9

HSDB Number: 6004

RTECS Number: DB8750000

UN/NA & ERG Number: UN2225/156

EC Number: 202-636-6

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Combustible, Corrosive liquid.

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U020

RCRA Land Ban Waste Restrictions

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV.D.3.b, RQ: 100 lb (45.4 kg)

TSCA 40CFR716.120(a)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: risk phrases: C; R20/22; R29; R34; R35; R37; 42/43; safety phrases: S23; S24/25; S26; S36/37/39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Benzenesulfonyl chloride is a colorless oily liquid with a pungent odor. Molecular weight = 176.6; specific gravity (H_2O:1) = 1.3842 @ 15°C; boiling point = 251−252°C (decomposes); freezing/melting point = 14.6°C; vapor pressure = 0.68 mmHg @ 25°C; relative vapor density (air = 1) = 6.12; flash point = 130°C; autoignition point = 460°C. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 1; reactivity 1 ₩. Moderately soluble in water.

Potential Exposure: It is used as a chemical intermediate for benzenesulfonamides, thiophenol, glybuzole (hypoglycemic agent), *N*-2-chloroehtylamides, benzonitrile; for its esters-useful as insecticides, and miticides.

Incompatibilities: Violent reaction with strong oxidizers, dimethyl sulfoxide, and methyl formamide. It is very reactive with bases and many organic compounds. Incompatible with ammonia, aliphatic amines. Water contact forms hydrochloric and chlorosulfonic acids. Aqueous solutions of this chemical are strong acids that react violently with bases. Attacks metals in presence of moisture.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 0.77 milligram per cubic meter

PAC-2: 8.4 milligram per cubic meter

PAC-3: 51 milligram per cubic meter

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Contact may cause severe irritation and burns to skin and eyes. Breathing this chemical may cause liver damage. Symptoms may include allergic reactions, and severe shock. Benzene sulfonyl chloride is poisonous; may be fatal if inhaled, swallowed or absorbed through the skin. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Reversible toxic damage to the liver is possible after dermal exposure. LD_{50} = (oral-rat) 1960 mg/kg[9].

Long-Term Exposure: May cause chronic irritation of the air passages and lungs, bronchitis with cough and phlegm. Repeated exposure may cause liver damage. Repeated skin contact may cause dry skin, redness, rash, and sores.

Points of Attack: Liver, lungs.

Medical Surveillance: lung function tests, liver function tests. Consider X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Do not induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear solvent-resistant gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Where there is no REL, at any detectable concentration:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOv (APF = 25) [any PAPR with organic vapor cartridge(s)]; CcrFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full face piece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd, Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, SCBA).

Storage: (1) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. (2) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Before entering confined space where benzotrichloride may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a dark, cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2225 Benzene sulfonyl chloride, Hazard class: 8; Labels: 8—Corrosive material.

Spill Handling: Stay upwind and uphill. Isolate the area of release or fire and deny entry. Remove all ignition sources. Stop the release if it can be done safely from a distance. All equipment used to handle this material must be grounded. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. *Small spill*: Cover with *dry* earth, *dry* sand, or other noncombustible material followed with plastic sheet to minimize spreading or contact with water or rain. Use clean nonsparking tools to collect material and place material into loosely covered plastic containers for later disposal. Prevent material and runoff from entering sewers and waterways if it can be done safely well ahead of the release. Use vapor suppressing foam to disperse vapors−contain runoff. Water spray may reduce vapor, but may not prevent ignition in enclosed spaces. Ventilate confined area if it can be done without placing personnel at risk. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical may burn but does not easily ignite. *Do not use water*. Thermal decomposition products may include hydrogen chloride and sulfur dioxide. *Small fire*: use *dry* chemical, CO_2, *dry* sand, or alcohol-resistant foam. May react with foams releasing corrosive/toxic gases. *Large fire*: use water spray or alcohol-resistant foam if it is available in sufficient amounts. Under favorable conditions, experienced crews can use coordinated fog streams to sweep the flames off the surface of the burning liquid. Combustible material: may burn but does not ignite readily. Most vapors are heavier than air. They will spread along ground and collect in low or confined areas (sewers, basements, tanks). Vapors may travel to source of ignition and flashback. Containers may explode when heated or if contaminated with water. Keep exposures cool long after fire is out to protect against reignition. Do not direct straight streams into the liquid. Cool exposed containers with large quantities of water from unattended equipment or remove intact containers if it can be done safely. *Do not get water on spilled substance or inside containers.* If cooling streams are ineffective (*venting sound increases in volume and pitch, tank discolors or shows signs of deforming*), withdraw immediately to a secure location. Always stay away from ends of tanks, especially when engulfed in flames. If material or contaminated runoff from fire control enters waterways, notify downstream users of potentially contaminated water. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Benzene Sulfonyl Chloride, Washington, DC, Chemical Emergency Preparedness Program (October 31, 1985).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Benzene Sulfonyl Chloride, Trenton, NJ (August 2000).

Benzidine B:0350

Formula: $C_{12}H_{12}N_2$; $NH_2C_6H_4C_6H_4NH_2$

Synonyms: Bencidina (Spanish); *p,p*-Bianiline; 4,4′-Bianiline; (1,1′-Bifenyl)-4,4′-diamine; (1,1′-Biphenyl)-4,4′diamine; (1,1′-Biphenyl)-4,4′-diamine; 4,4′-Biphenyldiamine; Biphenyl, 4,4′-diamino-; 4,4′-Biphenyl-enediamine; C.I. 37,225; C.I. azoic diazo; C.I. azoic diazo component 112; Component 112; *p,p*′-Diaminobiphenyl; 4,4′-Diamino-1,1′-biphenyl; 4,4′-Diaminobiphenyl; *p*-Diaminodiphenyl; 4,4′-Diaminodiphenyl; *p,p*′-Dianiline; 4,4′-Diphenylenediamine; Fast corinth base B; NCI-C03361

CAS Registry Number: 92-87-5

HSDB Number: 948

RTECS Number: DC9625000

UN/NA & ERG Number: UN1885/153

EC Number: 202-199-1 [*Annex I Index No.:* 612-042-00-2]

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen; Benzidine and dyes metabolized to benzidine; IARC: Human Sufficient Evidence, 1982; Animal Sufficient Evidence, 1982, *carcinogenic to humans*, Group 1, 1998. United States Environmental Protection Agency Gene-Tox Program, Positive: Carcinogenicity-mouse/rat; SHE-clonal assay; Positive: Cell transformation-mouse embryo; Positive: Cell transformation-RLV F344 rat embryo; Positive: Mammalian micronucleus; Histidine reversion-Ames test; Positive: In vitro UDS in rat liver; Negative: Sperm morphology-mouse; Inconclusive: *E coli polA* without S9; In vitro UDS-human fibroblast; Positive: CHO gene mutation

Banned or Severely Restricted (many countries)[13,35]

California Proposition 65 Chemical[102]: Cancer (benzidine and its salts) 2/27/1987; (benzidine-based dyes) 10/1/1992.

Hazard Alert: Poison, Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Environmental hazard.

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR1910.1010)

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; 40CFR401.15 Section 307 Toxic Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U021

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV.D.3.b, RQ: 1 lb (0.45 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R45; R22; R50/53; R60; R62; safety phrases: S29; S41; S45; S53; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Benzidine is a white, grayish-yellow crystalline solid or powder. Turns brownish-red on exposure to air and light; molecular weight = 184.24; specific gravity (H_2O:1) = 1.25 @ 20°C; freezing/melting point = 127°C.

Molecular weight = 184.2; boiling point = 400.7°C; freezing/melting point = 128°C (anhydrous, rapid heat); 115−120°C (slow heat). Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 1; reactivity 0 ₩. Slightly soluble in water; solubility = 0.04% @ 12°C.

Potential Exposure: Benzidine is used primarily in the manufacture of azo dyestuffs; there are over 250 of these produced. Other uses, including some which may have been discontinued, are in the rubber industry as a hardener; in the manufacture of plastic films; for detection of occult blood in feces, urine, and body fluids; in the detection of H_2O_2 in milk; in the production of security paper; and as a laboratory reagent in determining HCN, sulfate, nicotine, and certain sugars. No substitute has been found for its use in dyes. Free benzidine is present in the benzidine-derived azo dyes. According to industry, quality control specifications require that the level not exceed 20 ppm and in practice the level is usually below 10 ppm. Regulations in the USA concerning this chemical define strict procedures to avoid worker contact: mixture containing 0.1% or more must be maintained in isolated or closed systems; employees must observe special personal hygiene rules, and certain procedures must be followed in case of emergencies. Some *p*-phenylenediamine compounds have been used as rubber components, and DFG warns of danger of skin sensitization. Benzidine and dyes metabolized to benzidine: The following three benzidine-based dyes have been tested and found to cause cancer in rodents after oral exposure for 13 weeks (NCI 1978, IARC 1982): C.I. direct black 38 (CAS 1937-37-7) caused liver cancer in rats and mice, mammary-gland cancer in mice, and colon and urinary-bladder cancer in rats. C.I. direct Blue 6 (CAS 2602-46-2) caused liver cancer in rats. C.I. direct brown 95 (CAS 16071-86-6) caused hepatocellular adenoma in the liver and one malignant liver tumor in rats.

Incompatibilities: Dust may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. On contact with strong reducing agents, such as hydrides may form flammable gases. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Contact with red fuming nitric acid may cause fire. Oxidizes in air. Neutralizes acids in exothermic reactions to form salts plus water. May be incompatible with isocyanates, halogenated organics, peroxides, phenols (acidic), epoxides, anhydrides, and acid halides.

Permissible Exposure Limits in Air

NIOSH IDLH = Not determined. Potential occupational carcinogen

OSHA PEL: Cancer suspect agent. Exposures of workers to this chemical is to be controlled through the required use of engineering controls, work practices; and personal protective equipment, including respirators. See 29 CFR 1910.1003-1910.1016 for specific details of these requirements.

PAC Ver. 29[138]

PAC-1: 0.93 milligram per cubic meter

PAC-2: 10 milligram per cubic meter

PAC-3: 61 milligram per cubic meter

Note: OSHA and NIOSH concluded that benzidine and benzidine-based dyes were potential occupational carcinogens and recommended that worker exposure be reduced to the lowest feasible level. OSHA and NIOSH further concluded that *o*-tolidine and *o*-dianisidine (and dyes based on them) may present a cancer risk to workers and should be handled with caution and exposure minimized.

DFG MAK: [skin] Carcinogen Category 1. Some *p*-phenylenediamine compounds have been used as rubber components, and DFG warns of danger of skin sensitization.

Australia: (prohibited) [skin], carcinogen, 1993; Austria: [skin], carcinogen, 1999; Finland: carcinogen, 1999; France: VME 0.001 ppm (0.008 milligram per cubic meter), carcinogen, 1999; Poland: MAC (time-weighted average) 0 milligram per cubic meter; MAC (STEL) 0 milligram per cubic meter, 1999; Sweden: carcinogen, 1999; Switzerland: carcinogen, 1999; United Kingdom: carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Confirmed Human Carcinogen. Several states have set guidelines or standards for benzidine in ambient air[60] ranging from zero (New York, North Dakota, South Carolina, Virginia) to 0.014 ng/m^3 (North Carolina) to 0.02 ng/m^3 (Rhode Island) to 30 μ/m^3 (30,000 ng/m^3) (Pennsylvania).

Determination in Air: Use NIOSH Analytical Method #5509, Benzidine, #8306, in urine, OSHA Analytical Method ID-65.

Permissible Concentration in Water: Federal Drinking Water Guidelines: State Drinking Water Guidelines: Arizona 0.0001 μg/L; Florida 250 μg/L; New Hampshire 0.0002 μg/L.

Determination in Water: High performance liquid chromatography (EPA Method 605) or an oxidation/colorimetric method using Chloramine T (available from EPA) or a GC/mass spectrometric method (EPA Method 625). Octanol−water coefficient: Log K_{ow} =< 1.5. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, percutaneous absorption, and ingestion of dust.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes. Corrosive to the skin and respiratory tract. Easily absorbed thought the skin. Inhalation can irritate the lungs, causing coughing and/or shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Ingestion: animal studies suggest 0.01%−0.08% in food may cause a decrease in liver, kidney and body weight; an increase in spleen weight; swelling of the liver and blood in the urine.

Long-Term Exposure: May cause skin allergy. Benzidine is a human carcinogen. Exposure may cause an increase in urination, blood in the urinary tract tumors. Can affect the blood and cause bladder tumors; liver and kidney damage.

Points of Attack: Skin, bladder, kidney, liver.

Medical Surveillance: OSHA mandates the following be investigated: reduced immunologic competence; steroid treatment; pregnancy; cigarette smoking; NIOSH lists the following tests: cystoscopy; pulmonary function tests; urine (chemical/metabolite); urinalysis (routine); urinalysis (routine), cytology every six months, hematuria every month; urinalysis (routine), every month. Placement and periodic examinations should include an evaluation of exposure to other carcinogens; use of alcohol, smoking, medications: and family history. Special attention should be given on a regular basis to urine sediment and cytology. If red cells or positive smears are seen, cystoscopy should be done at once. The general health of exposed persons should also be evaluated in periodic examinations. Urine cytology. Evaluation by a certified allergist. This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Use gastric lavage if ingested followed by saline catharsis. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: These are designed to supplement engineering controls (such as a prohibition on open-vessel operation) and to prevent all skin or respiratory contact. Full body protective plastic clothing and butyl rubber gloves should also be used. On exit from a regulated area employees should shower and change into street clothes, leaving their protective clothing and equipment at the point of exit to be placed in impervious containers at the end of the work shift for decontamination or disposal. Effective methods should be used to clean and decontaminate gloves and clothing.

Respirator Selection: NIOSH: *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCB A (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full facepiece respirator with an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard: Store in a secure poison location. Store in a dark, cool, well-ventilated area in closed, sealed containers. Keep out of sunlight and away from heat. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN1885 Benzidine, Hazard Class: 6.1; Labels: 6.1—Poisonous materials. PGII.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Cover the spill with a mixture of 9 parts sand to 1 part soda ash. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Benzidine may burn, but does not readily ignite. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; or foam extinguishers. Use water spray in flooding quantities as fog. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration; oxides of nitrogen are removed from the effluent gas by scrubber, catalytic or thermal device[22]. Package spill residues and sorbent media in 17 hour epoxy-lined drums and move to an EPA-approved disposal site. Treatment may include destruction by potassium permanganate oxidation, high-temperature incineration, or microwave plasma methods.

Encapsulation by organic polyester resin or silicate fixation. These disposal procedures should be confirmed with responsible environmental engineering and regulatory officials.

References

(109); (102); (31); (173); (101); (138); (2); (100).

United States Environmental Protection Agency, Benzidine: Ambient Water Quality Criteria, Washington, DC (1980).

United States Environmental Protection Agency, Status Assessment of Toxic Chemicals: Benzidine, Report, EPA-600/2-79-210E, Washington, DC (December 1979).

United States Environmental Protection Agency, Reviews of the Environmental Effects of Pollutants: II, Benzidine, Cincinnati, Ohio, Health Effects Research Laboratory, Report No. EPA-600/1-78-024 (1978).

United States Environmental Protection Agency, Benzidine, Health and Environmental Effects Profile No. 16, Washington, DC, Office of Solid Waste (April 30, 1980).

United States Environmental Protection Agency, Benzidine, Its Congeners and Their Derivative Dyes and Pigments, TSCA Chemical Assessment Series; Preliminary Risk Assessment Phase I, Report EPA-560/11-80-019, Washington, DC (June 1980).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 1, No. 5, 38−39 (1981) and 2, No. 4, 38−43, and 3, No. 4, 32−37 (1983).

New York State Department of Health, Chemical Fact Sheet: Benzidine, Bureau of Toxic Substance Assessment, Albany, NY (January 1988).

United States Public Health Service, "Toxicological Profile for Benzidine," Atlanta, Georgia, agency for Toxic Substances and Disease Registry (December 1988).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Benzidine, Trenton, NJ (July 1998).

United States Department of Health and Human Services, Agency for Toxic Substances and Disease Registry (ATSDR), *Toxicological Profile for Benzidine*, Atlanta, GA, 2001. http://www.atsdr.cdc.gov/toxprofiles/tp62.pdf.

Benzo[*b*]fluoranthene B:0360

Formula: $C_{20}H_{12}$

Synonyms: B(b)F; 2,3-Benzfluoranthene; 3,4-Benz-fluoranthene; 2,3-Benzfluoranthrene; 3,4-Benzfluoranthrene; Benzo[*b*]fluoranthene; 2,3-Benzofluoranthene; 3,4-Benzofluoranthene; 4,5-Benzofluoranthene; NSC 89265

CAS Registry Number: 205-99-2

HSDB Number: 4035

RTECS Number: CU1400000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 205-911-9 [*Annex I Index No.:* 601-034-00-4]

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen: Benz[*a*] anthracene; Benzo[*b*]fluoranthene; Benzo[*j*]fluoranthene; Benzo[*k*]fluoranthene; IARC: Animal Sufficient Evidence, Human No Adequate Data, *possibly carcinogenic to humans*, Group 2B, 1987. United States Environmental Protection Agency Gene-Tox Program, Positive: Carcinogenicity-mouse/rat; Inconclusive: In vivo SCE-nonhuman

California Proposition 65 Chemical[102]: Cancer 7/1/1987.

Hazard Alert: Poison, Combustible, Possible risk of forming tumors, Suspected reprotoxic hazard, Environmental hazard.

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR1910.1002) as coal tar pitch volatiles

Water Pollutant Standard Set (EPA) (Mexico)

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; Section 307(a)(1) Toxic pollutant designated, pursuant to of the and is subject to effluent limitations as PAHs.

United States National Primary Drinking Water Regulations: MCLG = 0 mg/L; MCL = 0.0002 mg/L as PAHs.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater. *Note*: Difficult to distinguish from benzo(*k*)fluoranthene (mg/L), 0.11; Nonwastewater (mg/kg), 6.8

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL:g/L): 8100 (200); 8270 (10)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV.D.3.b, RQ: 1 lb (0.454 kg)

EPCRA Section 313 Form R *de minimus* concentration reporting level: 0.1%. Form R Toxic Chemical Category Code: N590 as polycyclic aromatic compounds

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R45; R50/53; R62; safety phrases: S29; S53; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Benzo(*b*)fluoranthene is a colorless, needle-shaped solid. Molecular weight = 252.32; boiling point = 480 °C; freezing/melting point = 168°C; vapor pressure = 5.0×10^{-7} mmHg. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 1; reactivity 0 ₩. Practically insoluble in water; solubility =< 1 mg/mL @ 19°C.

Potential Exposure: There is no commercial production of this compound. Benzo(*b*)fluoranthene is a chemical substance formed during the incomplete burning of fossil fuel, garbage, in cigarette smoke, or any organic matter and is found in smoke in general; it is carried into the air, where it condenses onto dust particles and is distributed into water and soil and on crops. B(*b*)F is a PAH and a component of coal tar pitch used in industry as a binder for electrodes. It is also a component of creosote, which is used to preserve wood. PAHs are also found in limited a mounts in bituminous materials and asphalt used for paving, roofing, and insulation. B(*b*)F has some use as a research chemical. It is available from some specialty chemical firms in low quantities (25−100 mg).

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

NIOSH IDLH = 80 milligram per cubic meter as coal tar pitch volatiles

OSHA PEL: 0.2 milligram per cubic meter TWA [1910.1002] (benzene-soluble fraction). OSHA defines "coal tar pitch volatiles" in 29 CFR 1910.1002 as the fused polycyclic hydrocarbons that volatilize from the distillation residues of coal, petroleum (excluding asphalt), wood, and other organic matter.

NIOSH REL: 0.1 milligram per cubic meter (cyclohexane-extractable fraction). NIOSH considers coal tar products (i.e., coal tar, coal tar pitch, or creosote) to be potential occupational carcinogens

ACGIH TLV[1]: Exposure by all routes should be carefully controlled to levels as low as possible; Suspected Human Carcinogen

PAC Ver. 29[138]

PAC-1: 0.12 milligram per cubic meter

PAC-2: 1.3 milligram per cubic meter

PAC-3: 7.9 milligram per cubic meter

DFG MAK: Carcinogen Category 2; Germ Cell Mutagen Group 2

Austria: carcinogen, 1999; France: carcinogen, 1993; Norway: TWA 0.04 milligram per cubic meter, 1999

Determination in Air: Use NIOSH Analytical Method #5506 PAHs by HPLC; NIOSH Analytical Method #5515, PAHs by GC; OSHA Analytical Method ID-58.

Permissible Concentration in Water: For the maximum protection of human health from the potential carcinogenic effects due to exposure of polynuclear aromatic hydrocarbons through ingestion of contaminated water and contaminated aqua tic organisms; therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 1×10^{-5}, 1×10^{-6}, and 1×10^{-7}. The corresponding criteria are 28.0, 2.8, and 0.28 ng/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 311.0, 31.1, and 3.11 ng/L, respectively.

Determination in Water: The analytical methods required by EPA for the analysis of B(b)F in water are procedures 610 (HPLC/FS), 625 (GC/MS), and 1625 (GC/MS). These are required test procedures under the Clean Water Act for municipal and industrial wastewater-discharging sites. GC/MS is also the method recommended be the EPA Contract Laboratory Program for analysis of B(*b*)F and other PAHs in water and soil. Octanol/water partition coefficient as Octanol−water coefficient: Log $K_{\text{ow}} = 6.1$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, passing through the skin. B(*b*)F enters the body primarily through breathing polluted air containing the compound or from inhaling tobacco smoke. Drinking contaminated water or accidentally swallowing soil or dust particles containing B(*b*)F can also result in B(*b*)F entering the body. Smoking or charcoal-broiling food can cause B(*b*)F to be formed. B(*b*)F can then enter the body through consumption of the contaminated food. Under normal conditions of environmental exposure, B(*b*)F does not usually enter the body through the skin; however, small amounts could enter the body if contact occurs with soil that contains high levels of B(*b*)F (e.g., near a hazardous waste site) or if contact occurs with heavy oils containing B(*b*)F.

Harmful Effects and Symptoms

B(*b*)F is a toxic chemical that causes cancer in laboratory animals when it is applied to their skin. B(*b*)F has not been studied adequately, and, consequently, it is not known whether it causes cancer if it is breathed or ingested, or if it causes harmful effects other than cancer. Because B(*b*)F causes skin cancer in animals, it is possible that humans exposed in the same manner or by other routes could develop cancer as well.

Short-Term Exposure: The substance can be absorbed into the by inhalation of its aerosol skin absorption. Skin contact may cause irritation or skin allergy, which is greatly aggravated by sunlight on contaminated skin. Eye contact or "fume" exposure may cause irritation and a reaction greatly aggravated by sunlight during or shortly following exposure. Direct contact or "fumes" can cause irritation of the nose, throat, and bronchial tubes; skin irritation, redness, and possible swelling.

Long-Term Exposure: Repeated skin contact may cause thickening, pigment changes and skin growths, including warts, pimples and skin cancer. B(*b*)F is a probable carcinogen in humans. May cause eye allergy. Repeated inhalation of fumes, especially with heating may cause chronic bronchitis with cough and phlegm.

Points of Attack: Skin, eyes.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure. Periodic skin examination.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Sun screen lotion or creams with a high ability to screen out ultraviolet light can help prevent skin allergic reactions. These may need frequent reapplication if the user is sweating. Ultraviolet-screening sunglasses can help with eye allergic reactions. Consult your doctor or pharmacist in selecting these. Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Store in a cool, dry place. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1—Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft.(NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include acrid smoke, irritating fumes, and oxides of carbon. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Residues and sorbent media may be packaged in 17H epoxy-lined drums and disposed of at an EPA-approved site. Destroy by permanganate oxidation, high-temperature incineration with scrubbing equipment, or microwave plasma treatment, if available. Confirm disposal procedures with responsible environmental engineer and regulatory officials.

References

(109); (102); (31); (173); (101); (138); (2); (18); (100).

Agency for Toxic Substance and Disease Registry, United States Public Health Service, *Toxicological Profile for Benzo[b]fluoranthene*, Atlanta, Georgia, ATSDR (November 1987).

Sax, N. I., Ed., “*Dangerous Properties of Industrial Materials Report*” 5, No. 1, 37−39 (1985).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Benzo[*b*]fluoroanthene, Trenton, NJ (July 2001).

Benzoic Acid B:0370

Formula: $C_7H_6O_2$: C_6H_5COOH

Synonyms: Acide benzoique (French); Acido benzoico (Spanish); Benzenecarboxylic acid; Benzeneformic acid; Benzenemethanoic acid; Benzoate; Benzoesaeure (German); Carboxybenzene; Carboxylbenzene; Dracyclic acid; Phenyl carboxylic acid; Phenylformic acid; Retarder BA; Retarder Bax; Salvo; Tennplas

CAS Registry Number: 65-85-0

HSDB Number: 704

RTECS Number: DG0875000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 200-618-2

Regulatory Authority and Advisory Information

United States Environmental Protection Agency Gene-Tox Program, Negative: Histidine reversion-Ames test; *S. cerevisiae-homozygosis*.

Hazard Alert: Combustible, Suspected of causing genetic defects, Possible sensitization hazard, Primary irritant (w/o allergic reaction), FDA-over the counter drug.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV.D.3.b, RQ: 5000 lb (2270 kg)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xn, Xi; risk phrases: R45; R20/21/22; R23/24/25; R36/37/38; R40; R41; R42/43; R48/23; R62; R63; R67; safety phrases: S22; S23; S2425; S26; S36/37/39; S45; S53; S63 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Benzoic acid is a white crystalline or flaky solid with a faint, pleasant odor. Molecular weight = 122.13; boiling point = 249°C; freezing/melting point = 122.4°C (sublimes); specific gravity (H_2O:1) = 1.27 @ 28°C; relative vapor density (air = 1) = 4.21; vapor pressure =< 0.076 mmHg @20°C; Flash point = 121°C; autoignition temperature = 570°C. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 1; reactivity 0 ₩. Soluble in water; solubility 0.3% @ 20°C.

Potential Exposure: Benzoic acid is used in production of plasticizers, benzoyl chloride, sodium benzoate and alkyl resins; in the manufacture of benzoates; in the manufacture of food preservatives; as a dye binder in calico printing; in curing of tobacco, flavors, perfumes, dentifrices; standard in analytical chemistry; antifungal agent.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, caustics, ammonia, amines, isocyanates. Dust forms an explosive mixture with air.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 13 milligram per cubic meter

PAC-2: 140 milligram per cubic meter

PAC-3: 830 milligram per cubic meter

Permissible Concentration in Water: Russia has proposed a MAC of 0.6 mg/L in surface water[35].

Determination in Water: Octanol−water coefficient: Log K_{ow} =< 2. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation and ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Irritating to skin, eyes (possibly severe), and mucous membranes. Skin contact may cause irritation, skin rash, or burning feeling on contact. Ingestion causes nausea and G.I. troubles. For most people, ingestion of 1/10−2/10 ounce will have no effect although some sensitive people may experience allergic reactions. Larger amounts may cause stomach upset. Information from animal studies show that about 6 ounces may be lethal to a 150 pound person. LD_{50} (oral, rat) = 1700 mg/kg.

Long-Term Exposure: Repeated or prolonged contact may cause skin sensitization. Mutation data reported.

Points of Attack: Skin, eyes, and mucous membranes.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Cannister mask recommended.

Storage: Color code—Blue: Health Hazard/Poison (Toxic): Store in a secure, locked and cool, ventilated area. Store away from excessive heat. Benzoic acid must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine), since violent reactions occur.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9—Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Vapor may explode if ignited in an enclosed area. Solutions should be neutralized with soda ash. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Then flush the area with water. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of carbon. Benzoic acid is a combustible solid. Benzoic acid may burn, but does not readily ignite. High levels of dust may form an explosive concentration in air. Use dry chemical, CO_2, or water spray extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed[22].

References

(31); (173); (101); (138); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 1, No. 8, 38−40 (1981) and 3, No. 4, 37−40 (1983).

New York State Department of Health, Chemical Fact Sheet: Benzoic Acid, Bureau of Toxic Substance Assessment, Albany, NY (January 1986).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Benzoic Acid, Trenton, NJ (October 2000).

Benzonitrile B:0380

Formula: C_7H_5N; C_6H_5CN

Synonyms: Benzene, cyano-; Benzenenitrile; Benzoic acid nitrile; Benzonitrilo (Spanish); Cyanobenzene; Fenylkyanid; Phenyl cyanide

CAS Registry Number: 100-47-0

HSDB Number: 45

RTECS Number: DI2450000

UN/NA & ERG Number: UN2224/152

EC Number: 202-855-7 [*Annex I Index No.:* 608-012-00-3]

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Flammable, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction), Environmental hazard.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV.D.3.b, RQ: 5000 lb (2270 kg)

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as cyanide mixtures, cyanide solutions, or cyanides, inorganic, n.o.s.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xn; risk phrases: R10; R21/22; R51/53; R62; safety phrases: S2; S23; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Bezonitrile is a colorless, oily liquid. It has an almond odor. Molecular weight = 103.13; Specific gravity (H_2O:1) = 1.01 @ 25°C; boiling point = 191°C; freezing/melting point = −12.8°C; critical temperature = 426°C; critical pressure = 611 psia; relative vapor density (air = 1) = 3.6; electrical conductivity = 2×10^6 pS/m; ratio of specific heats of vapor (gas) = 1.091; latent heat of vaporization = 3.67×10^5 J/kg; heat of combustion = -351×10^5 J/kg. flash point = 71°C; explosive limits in air: lower = 1.4%; upper = 7.2%; autoignition temperature = 550°C. Hazard identification (based on NF PA-704 M Rating System): Health 2; flammability 2; reactivity 0 ₩. Poor solubility in water.

Potential Exposure: Bezonitrile is used as an electroplating agent; in organic synthesis of pharmaceuticals; dyestuffs; rubber chemicals; as a solvent and chemical intermediate.

Incompatibilities: May form explosive mixture with air. Strong acids which can release hydrogen cyanide. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Nitriles may polymerize in the presence of metals and some metal compounds. They are incompatible with acids; mixing nitriles with strong oxidizing acids can lead to extremely violent reactions. Nitriles are generally incompatible with other oxidizing agents such as peroxides and epoxides. The combination of bases and nitriles can produce hydrogen cyanide. Nitriles are hydrolyzed in both aqueous acid and base to give carboxylic acids (or salts of carboxylic acids). These reactions generate heat. Peroxides convert nitriles to amides. Nitriles can react vigorously with reducing agents. Acetonitrile and propionitrile are soluble in water, but nitriles higher than propionitrile have low aqueous solubility. They are also insoluble in aqueous acids[101].

Permissible Exposure Limits in Air

NIOSH REL: (nitriles) 2 ppm, Ceiling Concentration, not to be exceeded in any 15-minute work period.

PAC* Ver. 29[138]

PAC-1: 0.56 ppm

PAC-2: $\mathbf{6.2}_{\mathbf{A}}$ ppm

PAC-3: $\mathbf{19}_{\mathbf{A}}$ ppm

*AEGLs are marked with a subscript "**A**" and correspond to 60 minute values.

Russia[43] set a MAC in work-place air of 1.0 milligram per cubic meter.

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 200 μg[CN]/L; State Drinking Water Standards: California 150 μg[CN]/L; State Drinking Water Guidelines: Arizona 220 μg[CN]/L; Maine. 140 μg [CN]/L; Minnesota 100 μg[CN]/L. United States Army field drinking-water standards for cyanide: 2 mg[CN]/L assuming a water consumption of 15 L/day and 6 mg[CN]/L assuming a water consumption of 5 L/day. United States Army field drinking-water standards for cyanide, long-term consumption 0.5 mg[CN]/L; Short-term consumption; Raw water constituents (maximum) 20 mg[CN]/L.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 1.6$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion, skin absorption.

Harmful Effects and Symptoms

Short-Term Exposure: Benzonitrile can affect you when breathed in by passing through your skin. Lower exposures can cause you to feel dizzy and lightheaded. Exposure to high levels, by breathing or skin contact, can cause trouble breathing, convulsions, coma and death. Exposure may impede cellular or tissue respiration causing cyanosis and unconsciousness. Contact can irritate the eyes and skin. Prolonged contact can cause skin burns. The oral LD_{50} cat and rabbit is 800 mg/kg.

Long-Term Exposure: Repeated exposure may damage the liver and nervous system. See NIOSH Criteria Document 212 *Nitriles*.

Points of Attack: Liver, nervous system.

Medical Surveillance: Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once, and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, rinse mouth and get medical attention. If cyanide poisoning is suspected use amyl nitrate capsules if symptoms develop. All area employees should be trained regularly in emergency measures for cyanide poisoning and in CPR. A cyanide antidote kit should be kept in the immediate work area and must be rapidly available. Kit ingredients should be replaced every 1−2 years to ensure freshness. Persons trained in the use of this kit; oxygen use, and CPR must be quickly available.

Personal Protective Methods: Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. If local exhaust ventilation or enclosure is not used, respirators should be worn. Wear protective work clothing. Butyl rubber and polyvinyl alcohol gloves have been tested and found to be resistant to permeation by benzonitrile. Wash thoroughly immediately after exposure to benzonitrile and at the end of the work-shift. Post hazard and warning information in the work area. In addition, as part of an ongoing education and training effort, communicate all information on the health and safety hazards of benzonitrile to potentially exposed workers. See NIOSH Criteria Document 212 *Nitriles*.

Respirator Selection: W*here there is a potential for overexposure:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive pressure mode).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Store in tightly closed containers in a cool, well-ventilated area. Away from strong acids. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2224 Benzonitrile, Hazard Class: 6.1; Labels: 6.1—Poisonous materials.

Spill Handling:

Nitriles spill

Initial isolation and protective action distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.3/0.5
Night 0.5/0.8

Before entering confined space where benzonitrile may be present, check to make sure that an explosive concentration does not exist. Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Benzonitrile is a combustible liquid. Thermal decomposition products may include hydrogen cyanide and oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. Water may ineffective in controlling fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: (1) Mix with calcium hypochlorite and flush to sewer with water or (2) incinerate.

References

(31); (173); (101); (138); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 1, No. 8, 40−42 (1981); and 3, No. 4, 40−42 (1983).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Benzonitrile, Trenton, NJ (December 2000).

Benzophenone B:0390

Formula: $C_{13}H_{10}O$; $C_6H_5COC_6H_5$

Synonyms: Benzofenona (Spanish); Benzoyl benzene; Diphenyl ketone; Diphenyl methanone; α-Oxodiphenylmethane; alpha-oxoditane; Phenyl ketone

CAS Registry Number: 119-61-9

HSDB Number: 6809

RTECS Number: DI9950000

UN/NA & ERG Number: UN1224/127; UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 204-337-6

Regulatory Authority and Advisory Information

United States Environmental Protection Agency Gene-Tox Program, Negative: *E. coli polA* without S9 (see Appendix 4).

Hazard Alert: Combustible, Possible risk of forming tumors, Suspected reprotoxic hazard.

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xi, Xn, N: risk phrases: R11; R36/37/38; R40; R48/20; R48/20; R50/51/52/53; R65; R67; R62; safety phrases: S9; S16; S26; S33; S36/37/39; S45; S61; S62 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Benzophenone is a combustible, white, crystalline solid with a rose-like odor. Molecular weight = 182.23; specific gravity (H_2O:1) = 1.085 @ 50°C; boiling point = 305°C; freezing/melting point = 48.5°C; latent heat of vaporization = 2.93×10^5 J/kg; heat of combustion = -358×10^5 J/kg. Autoignition temperature => 500°C; Hazard identification (based on NFPA-704 M Rating System): Health 1; flammability 1; reactivity 0 ₩. Insoluble in water.

Potential Exposure: Benzophenone is used in UV curing of inks and coatings; as an intermediate; as an odor fixative in fragrances, flavoring, soaps; in the manufacture of pharmaceuticals and insecticides; in organic syntheses.

Incompatibilities: Oxidizing materials, such as dichromates and permanganates.

Permissible Exposure Limits in Air

PAC Ver. 29[138]
PAC-1: 1.5 milligram per cubic meter
PAC-2: 90 milligram per cubic meter
PAC-3: 310 milligram per cubic meter

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 3.4$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, through the skin, and by ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Skin and eye contact can cause irritation. Ingestion can cause nausea, vomiting and stomach pain. Estimated lethal dose is 8 oz.

Medical Surveillance: See NIOSH Criteria Document: 78-173 *Ketones*

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, rinse mouth and get medical attention.

Personal Protective Methods: Adequate ventilation; sinks, showers and eyewash stations should be available. Goggles or face shields and rubber gloves should be worn if contact is likely.

Respirator Selection: Local exhaust or breathing protection.

Storage: Color code—Red: Flammability Hazard: Store in a flammable (liquid or solid materials) storage area or approved cabinet away from sources if ignition. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN1224 Ketones, liquid, n.o.s., Hazard Class: 3; Labels: 3—Flammable liquid, Technical Name Required. UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9—Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen spilled material with alcohol to avoid dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Use dry chemical, alcohol foam, or CO_2.

References

(31); (173); (101); (138); (100).

National Institute for Occupational Safety and Health (NIOSH), "Criteria for a Recommended Standard. Occupational Exposure to Ketones, NIOSH Pub. No. 78−173, Cincinnati, OH (1978).

New York State Department of Health, Chemical Fact Sheet: Benzophenone, Bureau of Toxic Substance Assessment, Albany, NY (March 1986).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 1, No. 1, 77−78 (1982).

Benzo[*a*]pyrene B:0400

Formula: $C_{20}H_{12}$

Synonyms: B(*a*)P; BAP; Benzo(*d*,*e*,*f*)chrysene; Benzopireno (Spanish); 3,4-Benzopyrene; 6,7-Benzopyrene; Benzopyrene; 3,4-Benzpyren (German); 6,7-Benzpyren (German); 3,4-Benz (*a*)pyrene; 3,4-Benzypyrene; 3,4-BP; BP; NSC21914

CAS Registry Number: 50-32-8

HSDB Number: 2554

RTECS Number: DJ3675000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 200-028-5 [*Annex I Index No.:* 601-032-00-3]

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Animal Sufficient Evidence; Human Sufficient Evidence, *carcinogenic to humans*, Group 1; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies. NIOSH has recommended that coal tar pitch volatiles, including PAHs be treated as potential human carcinogen.

California Proposition 65 Chemical[102]: Cancer 7/1/1987.

Hazard Alert: Exposure can be lethal, Combustible, Possible risk of forming tumors, Reproductive toxin: possible risk of gene damage/impaired fertility; Suspected reprotoxic hazard, Sensitization hazard (skin), Primary irritant (w/o allergic reaction), Environmental hazard. Listed for Tier 1 screening as an endocrine disruptor[88]. Listed for Tier 1 screening as an endocrine disruptor[88].

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR1910.1001) as coal tar pitch volatiles

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; Section 307(a)(1) Toxic pollutant designated, pursuant to of the and is subject to effluent limitations as PAHs

United States National Primary Drinking Water Regulations: MCLG = 0 mg/L; MCL = 0.0002 mg/L as PAHs.

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U022

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.061; Nonwastewater (mg/kg), 3.4

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8100 (200); 8270 (10)

Safe Drinking Water Act (47FR 9352): MCL, 0.0002 mg/L; MCLG, zero

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV.D.3.b, RQ: 1 lb (0.454 kg)

EPCRA Section 313 Form R *de minimus* concentration reporting level: 0.1%. Form R Toxic Chemical Category Code: N590 as polycyclic aromatic compounds

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%. (carcinogen)

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, N, Xi; risk phrases: R45; R46; R60; R61; R43; R50/53; R62; R63; safety phrases: S29; S53; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: B(*a*)P, is yellowish needles[2], crystals or powder. Odorless. PAHs are compounds containing multiple benzene rings and are also called polynuclear aromatic hydrocarbons. Molecular weight = 252.32; freezing/melting point = 179°C[2]; boiling point = 311°C @ 10 mmHg[2]. Hazard identification (based on NFPA-704 M Rating System): Health 4; flammability 1; reactivity 0 ₩. Insoluble in water.

Potential Exposure: Benzo[*a*]pyrene (B[*a*]P) is a PAH that has no commercial-scale production. B(*a*)P is produced in the United States by one chemical company and distributed by several specialty chemical companies in quantities from 100 mg to 5 g for research purposes. Although not manufactured in great quantity, B(*a*)P is a by-product of combustion. It is estimated that 1.8 million pounds per year are released from stationary sources, with 96% coming from: (1) coal refuse piles, outcrops, and abandoned coal mines; (2) residential external combustion of bituminous coal; (3) coke manufacture; and (4) residential external combustion of anthracite coal. Human exposure to B(*a*)P can occur from its presence as a by-product of chemical production. The number of persons exposed is not known. Persons working at airports in tarring operations; refuse incinerator operations; power plants, and coke manufacturers, may be exposed to higher B(*a*)P levels than the general population. Scientists involved in cancer research or in sampling toxic materials may also be occupationally exposed. The general population may be exposed to B(*a*)P from air pollution, cigarette smoke, and food sources. B(*a*)P has been detected in cigarette smoke at levels ranging from 0.2 to 12.2:g per 100 cigarettes. B(*a*)P has been detected at low levels in foods ranging from 0.1 to 50 ppb.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, nitrogen dioxide and ozone.

Permissible Exposure Limits in Air

PAHs

NIOSH IDLH = 80 milligram per cubic meter as coal tar pitch volatiles

OSHA PEL: 0.2 milligram per cubic meter TWA [1910.1002] (benzene-soluble fraction). OSHA defines "coal tar pitch volatiles" in 29 CFR 1910.1002 as the fused polycyclic hydrocarbons that volatilize from the distillation residues of coal, petroleum (excluding asphalt), wood, and other organic matter.

NIOSH REL: 0.1 milligram per cubic meter (cyclohexane-extractable fraction). NIOSH considers coal tar products (i.e., coal tar, coal tar pitch, or creosote) to be potential occupational carcinogens; See NIOSH Pocket Guide, Appendix C.

ACGIH TLV[1]: 0.2 milligram per cubic meter TWA (as benzene soluble aerosol); Confirmed Human Carcinogen; Suspected Human Carcinogen; BEIp assigned *as Polycyclic Aromatic Compounds (PAHs)*

PAC Ver. 29[138]

PAC-1: 0.6 milligram per cubic meter

PAC-2: 120 milligram per cubic meter

PAC-3: 700 milligram per cubic meter

DFG MAK: [skin] Carcinogen Category 2; Germ Cell Mutagen Group 2

Australia: carcinogen, 1993; Belgium: carcinogen, 1993; Finland: TWA 0.01 milligram per cubic meter, [skin], carcinogen, 1999; France: carcinogen, 1993; Norway: TWA 0.04 milligram per cubic meter, 1999; Poland: TWA 0.003 milligram per cubic meter, 1999; Russia: STEL 0.00015 milligram per cubic meter, carcinogen, 1993; Sweden: NGV 0.002 milligram per cubic meter, KTV 0.02 milligram per cubic meter, [skin], carcinogen, 1999; Switzerland: MAK-week 0.0002 ppm

(0.002 milligram per cubic meter), carcinogen, 1999; United Kingdom: carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Suspected Human Carcinogen. Russia[43] set a MAC of 0.001 μ/m^3 in ambient residential air. In addition, several states have set guidelines or standards for benzo[*a*]pyrene in ambient air[60] ranging from zero (New York and Virginia) to 0.0007 μ/m^3 (Pennsylvania) to 0.10 μ/m^3 (Connecticut).

Determination in Air: Use NIOSH Analytical Method #5506 PAHs by HPLC; NIOSH Analytical Method #5515, PAHs by GC; OSHA Analytical Method ID-58.

Permissible Concentration in Water: For the maximum protection of human health from the potential carcinogenic effects due to exposure of polynuclear aromatic hydrocarbons through ingestion of contaminated water and contaminated aquatic organisms; therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 1×10^{-5}, 1×10^{-6}, and 1×10^{-7}. The corresponding criteria are 28.0, 2.8, and 0.28 ng/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 311.0, 31.1, and 3.11 ng/L, respectively.

Determination in water: Octanol−water coefficient: Log $K_{ow} = 6.0$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation skin absorption.

Harmful Effects and Symptoms

B(*a*)P has produced tumors in all of the nine species for which data are reported following different administrations including oral, skin and intratracheal routes. It has both a local and a systemic carcinogenic effect. In subhuman primates, there is convincing evidence of the ability of B(*a*)P to produce local sarcomas following repeated subcutaneous injections and lung carcinomas following intratracheal instillation. It is also an initiator of skin carcinogenesis in mice, and it is carcinogenic in single-dose experiments and following prenatal exposure. In skin carcinogenesis studies in mice, B(*a*)P was consistently found to produce more tumors in a shorter period of time than did other polycyclic aromatic hydrocarbons (PAH), with the possible exception of DB(*a,h*)A. In a dose−response study involving subcutaneous injection in mice, the minimal dose at which carcinogenicity was detected was higher for B(*a*)P than for DB(*a,h*)A and for MC. However, the latent periods were shorter for B(*a*)P than for DB(*a,h*)A. In studies using intratracheal administration, B(*a*)P appeared to be less effective than 7*H*-dibenzo(*c,g*)carbazole in the hamster[1]. No epidemiological studies on the significance of B(*a*)P exposure to humans are available, and studies are insufficient to prove that B(*a*)P is carcinogenic for man. However, coal-tar and other materials which are known to be carcinogenic to humans may contain B(*a*)P. The substance has also been detected in other environmental situations. A 1% solution applied to the skin caused skin irritation, swelling, flaking, coloration of skin, and formation of warts.

Short-Term Exposure: B(*a*)P can cause exposure by inhalation and passing through the unbroken skin. Can cause skin irritation with rash and/or burning sensations. Exposure to sunlight can increase these effects. Eye contact can cause irritations and burns.

Long-Term Exposure: B(*a*)P is a probable carcinogenic in humans. The DFG[3] states that PAHs are present at particularly high levels in coal tar oils and related pyrolysis products of organic materials and are carcinogenic (category 1) in animal studies. May damage the developing fetus. May affect male reproductive glands and cause genetic damage. May be transferred to nursing infants through exposed mother's milk. Repeated exposure can cause skin changes, such as thickening; darkening, and pimples. Later skin changes include loss of color, reddish areas, thinning of the skin, and warts. Sunlight may cause rash to develop, and increased risk of skin cancer. Skin cancer is very often easily cured when detected early.

Points of Attack: Skin, respiratory system; bladder, liver, kidneys as PAH.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. CBC, chest X-ray, pulmonary function tests, photopatch testing; sputum cytology, urinalysis (routine) [cytology, hematuria], liver, kidney, and bladder function tests recommended for coal tar pitch volatiles[2].

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: *Avoid exposure of (pregnant) women*! Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when

skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister having an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Store in tightly closed containers in a cool, well-ventilated area away from oxidizing chemicals (such as chlorates, perchlorates, permanganates, and nitrates). A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Flammable, but generally found in such low quantities it is not considered a fire hazard. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Thermal decomposition products may include oxides of carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration in admixture with a flammable solvent[22].

References

(109); (102); (31); (173); (101); (138); (2); (18); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 5, No. 1, 42–49 (1985).

New York State Department of Health, *Chemical Fact Sheet: Benzo[a]pyrene*, Bureau of Toxic Substance Assessment, Albany, NY (January 1986).

Agency for Toxic Substance and Disease Registry, United States Public Health Service, *Toxicological Profile for Benzo[a] pyrene*, Atlanta, Georgia, ATSDR (October 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Benzo[a]Pyrene*, Trenton, NJ (July 1998).

United States Environmental Protection Agency, "*Identification of Organic Compounds in Effluents from Industrial Sources*," EPA-560/3-75-002, April (1975).

Benzotrichloride B:0410

Formula: $C_7H_5Cl_3$; $C_6H_5CCl_3$

Synonyms: Benzene, trichloromethyl-; Benzenyl chloride; Benzenyl trichloride; Benzotrichloride; Benzotricloruro (Spanish); Benzylidynechloride; Benzyl trichloride; Chlorure de benzenyle (French); Phenyl chloroform; Phenylchloroform; Phenyltrichloro methane; Toluene trichloride; Trichlormethylbenzol (German); 1-(Trichloromethyl)benzene; Trichloromethylbenzene; Trichloro-phenylmethane; α,α,α-Trichlorotoluene; *O*,*O*,*O*-Trichloro-toluene; Triclorotoluene

CAS Registry Number: 98-07-7

HSDB Number: 2076

RTECS Number: XT9275000

UN/NA & ERG Number: UN2226/156

EC Number: 202-634-5 [*Annex I Index No.:* 602-038-00-9]

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Cancer Review Animal Sufficient Evidence; Human Limited Evidence, *probably carcinogenic to humans*, Group 2A, 1999; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies. United States Environmental Protection Agency Gene-Tox Program, Positive: Carcinogenicity-mouse/rat; B *subtilis* rec assay; Positive: Histidine reversion-Ames test.

California Proposition 65 Chemical[102]: Cancer 1/1/1987.

Hazard Alert: Combustible, Possible risk of forming tumors, Suspected reprotoxic hazard, Sensitization hazard (skin).

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U023

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV.D.3.b, RQ: 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N, Xi; risk phrases: R45; R24; R26/28; R43; R50/53; safety phrases: S41; S53; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Benzotrichloride is a combustible, colorless to yellow-brown, oily liquid that fumes on contact with air. It has a penetrating odor. Molecular weight = 195.47; specific gravity (H_2O:1) = 1.38; boiling point = 220.7°C; freezing/melting point = −4.4°C; flash point = 127°C (cc); autoignition temperature = 211°C. Explosive limits in air: LEL 2.1%; UEL 6.5% @ 160°C. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 1; reactivity 0 ₩. Slowly reacts in water.

Potential Exposure: Benzotrichloride is used as a chemical and dye intermediate; extensively used in the dye industry for the production of Malachite green, Rosamine, Quinoline red, and Alizarin yellow A. It can also be used to produce ethyl benzoate. Commercial grades may contain hydrochloric acid, benzylidene chloride, or benzyl chloride.

Incompatibilities: Benzotrichloride decomposes on heating, on contact with acids and/or water, producing toxic and corrosive hydrogen chloride and benzoic acid. Reacts violently with strong oxidizers, iron and other metals, alkali and earth alkali metals; bases and organic substances, and may cause fire and explosions. On contact with air it emits toxic and corrosive hydrogen chloride. Attacks many metals in presence of water. Attacks many plastics.

Permissible Exposure Limits in Air

ACGIH TLV[1]: 0.1 ppm/0.8 milligram per cubic meter TWA [skin]; Ceiling; Suspected Human Carcinogen

PAC Ver. 29[138]

PAC-1: 0.064 milligram per cubic meter

PAC-2: 0.7 milligram per cubic meter

PAC-3: 5.3 milligram per cubic meter

DFG MAK: [skin] Carcinogen Category 2

Austria: carcinogen, 1999; Finland: carcinogen, 1999; Russia: STEL 0.2 milligram per cubic meter, 1993; Sweden: carcinogen, 1999; Switzerland: carcinogen, 1999; United Kingdom: carcinogen, 2000. Several states have set guidelines or standards for benzotrichloride in ambient air ranging from zero in North Dakota to 0.0007 μ/m^3 in Rhode Island.

Determination in Air: NIOSH Analytical Method #5013, Dyes.

Permissible Concentration in Water: No criteria set. (Benzotrichloride decomposes in the presence of water to benzoic acid and hydrogen chloride).

Determination in Water: Octanol−water coefficient: Log K_{ow} = ~3. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, ingestion, skin absorption.

Harmful Effects and Symptoms

Short-Term Exposure: Inhalation may cause irritation and chemical burns to the nose, throat and lungs. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Based on animal study information, permanent injury or death may occur from exposure to 125 ppm for 4 hours. Skin contact may cause irritation and chemical burns. Eye contact can cause severe irritation and chemical burns. Ingestion may cause severe irritation and chemical burns to the mouth, throat and stomach. Additionally, it may be aspirated into the lungs with the risk of chemical pneumonitis. The damage may be permanent. LD_{50} = (oral-rat) 6 mg/kg.

Long-Term Exposure: Benzotrichloride may affect the liver, kidneys, thyroid, CNS, and hematopoetic system, causing impaired functions and anemia. Probable carcinogen in humans.

Points of Attack: Lungs, liver, kidneys, thyroid glands, blood.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Liver function tests; examination of the nervous system; thyroid function, CBC.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full facepiece respirator with an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: (1) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. (2) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Before entering confined space where benzotrichloride may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a dark, cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2226 Benzotrichloride, Hazard class: 8; Labels: 8—Corrosive material.

Spill Handling: Material is extremely hazardous to health but areas may be entered with extreme care. Full protective clothing including SCBA should be provided. No skin surface should be exposed. Spilled material should not be touched. Stay upwind and uphill. Isolate the area of release or fire and deny entry. Remove all ignition sources. Stop the release if it can be done safely from a distance. All equipment used to handle this material must be grounded. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. *Small spill*: Cover with *dry* earth, *dry* sand, or other noncombustible material followed with plastic sheet to minimize spreading or contact with water or rain. Use clean nonsparking tools to collect material and place material into loosely covered plastic containers for later disposal. Prevent material and runoff from entering sewers and waterways if it can be done safely well ahead of the release. Use vapor suppressing foam to disperse vapors−contain runoff. Water spray may reduce vapor, but may not prevent ignition in enclosed spaces. Ventilate confined area if it can be done without placing personnel at risk. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material may react violently with water. Fire may produce irritating and/or Thermal decomposition products may include hydrogen chloride and oxides of carbon. *Small fire*: use *dry* chemical, CO_2, *dry* sand, or alcohol-resistant foam. May react with foams releasing corrosive/toxic gases. *Large fire*: use water spray or alcohol-resistant foam if it is available in sufficient amounts. Under favorable conditions, experienced crews can use coordinated fog streams to sweep the flames off the surface of the burning liquid. Combustible material: may burn but does not ignite readily. Most vapors are heavier than air. They will spread along ground and collect in low or confined areas (sewers, basements, tanks). Vapors may travel to source of ignition and flashback. Containers may explode when heated or if contaminated with water. Keep exposures cool long after fire is out to protect against reignition. Do not direct straight streams into the liquid. Cool exposed containers with large quantities of water from unattended equipment or remove intact containers if it can be done safely. *Do not get water on spilled substance or inside containers*. If cooling streams are ineffective (*venting sound increases in volume and pitch, tank discolors or shows signs of deforming*), withdraw immediately to a secure location. Always stay away from ends of tanks, especially when engulfed in flames. If material or contaminated runoff from fire control enters waterways, notify downstream users of potentially contaminated water. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156.

Disposal Method Suggested: Incineration with flammable solvent added in incinerator with afterburner and alkaline scrubber.

References

(109); (102); (31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Benzotrichloride, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

United States Environmental Protection Agency, Benzotrichloride, Health and Environmental Effects Profile No. 20, Washington, DC, Office of Solid Waste (April 30, 1980).

New York State Department of Health, Chemical Fact Sheet: Benzotrichloride, Bureau of Toxic Substance Assessment, Albany, NY (April 1997).

Benzoyl Chloride B:0420

Formula: C_7H_5ClO; C_6H_5COCl
Synonyms: Benzaldehyde, α-chloro-; Benzenecarbonyl chloride; Benzoic acid, chloride; α-Chlorobenzaldehyde; Clorurode benzoilo (Spanish)
CAS Registry Number: 98-88-4
HSDB Number: 383
RTECS Number: DM6600000
UN/NA & ERG Number: UN1736/137
EC Number: 202-327-6 [*Annex I Index No.:* 607-012-00-0]
Regulatory Authority and Advisory Information
Carcinogenicity: IARC: Human Limited Evidence; Animals Inadequate Evidence, *probably carcinogenic to humans*, Group 2A, 1999. United States Environmental Protection Agency Gene-Tox Program, Inconclusive: *B. subtilisrec* assay.
Hazard Alert: Combustible, Corrosive, Lacrymator, Water reactive, Possible sensitization hazard (skin).
CleanWater Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)
Superfund/EPCRA 40CFR302.4, Appendix A and Section IV.D.3.b, RQ: 1000 lb (454 kg)
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.
Hazard symbols, risk, & safety statements: Hazard symbol: F, C, Xi; risk phrases: R10; R20/21/22; R34; R43; safety phrases: S1/2; S26; S36/37/39; S45 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.
Description: Benzoyl chloride is a colorless to slight brown liquid with a strong, penetrating odor. Molecular weight = 140.57; specific gravity (H_2O:1) = 1.22 @ 15°C; boiling point = 197.2°C @ 760 mmHg; freezing/melting point = −0.5°C; flash point = 72°C; vapor pressure = 0.38 mmHg @ 20°C; autoignition temperature = 19°C. Explosive limits in air: Lower = 2.5%; Upper = 27%. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 2; reactivity 2 ₩ (water reactive). Decomposes in water forming hydrogen chloride.
Potential Exposure: Benzoyl chloride is used as a chemical intermediate; in organic synthesis; to produce other chemicals, dyes, perfumes, herbicides, and medicines.
Incompatibilities: May form explosive mixture with air. Contact with heat, hot surfaces, and flames causes decomposition, forming phosgene and hydrogen chloride. Water contact may be violent; forms hydrochloric acid. Reactions with amines, alcohols, alkali metals, dimethyl sulfoxide, strong oxidizers, and metal salts may be violent, causing fire and explosions. Attacks metals in the presence of moisture, forming explosive hydrogen gas. Attacks some plastics, rubber or coatings.
Permissible Exposure Limits in Air
ACGIH TLV[1]: 0.5 ppm/0.8 milligram per cubic meter Ceiling Concentration; not classified as a human carcinogen
PAC* Ver. 29[138]
PAC-1: $\mathbf{0.3_E}$ ppm
PAC-2: $\mathbf{5_E}$ ppm
PAC-3: $\mathbf{20_E}$ ppm
*ERPG are marked with a subscript "**E.**"
DFG MAK: Carcinogen Category 3B
Hungary: TWA 5 milligram per cubic meter, STEL 10 milligram per cubic meter, 1993; Russia: STEL 5 milligram per cubic meter, 1993
Determination in Air: By photometry[11].
Permissible Concentration in Water: EPA has suggested a limit of 69 μg/L[52].
Routes of Entry: Inhalation, ingestion.
Harmful Effects and Symptoms
Short-Term Exposure: Corrosive to the eyes, skin, and respiratory tract. Corrosive if ingested. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.
Long-Term Exposure: Can cause chronic rash, warts, sore throat, and reduced sense of smell. Can cause bronchitis with cough and phlegm, and/or shortness of breath. May cause skin sensitization and allergic reaction.
Points of Attack: Eyes, skin, and mucous membranes.
Medical Surveillance: Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Lung function tests. Consider chest X-ray following acute exposure. Examination by a qualified allergist.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical

facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Use in a well-ventilated area. Showers, sinks, and eyewash stations should be readily available. Wear an apron, gauntlets, rubber gloves, boots and any additional protective clothing to prevent skin contact. Wear safety goggles.

Respirator Selection: *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive pressure mode). *Escape:* 100 F (APF = 50) (any air-purifying, full facepiece respirator with an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: (1) Corrosive or Contact Hazard; Store separately in a corrosion resistant location. (2) Color code—Red Stripe: Flammability Hazard: Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Color code—White: Store in a cool, dry, well-ventilated area preferably in a detached warehouse. Keep away from sources of ignition. Avoid physical damage to the container.

Shipping: UN 1736 Benzoylchloride, Hazard class: 8; Labels: 8—Corrosive material.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. *Do not use water or wet method.* Absorb liquid in vermiculite, dry sand; earth, or similar material and deposit in sealed containers; or cover any spills with sodium bicarbonate. Remove the resulting mixture to a fiber container or plastic bag for disposal by incineration[22].Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Benzoyl chloride is a combustible liquid. Thermal decomposition products may include deadly phosgene gas, hydrogen chloride fumes and oxides of carbon. *Do not use water.* Reacts violently with water or steam releasing heat, phosgene and hydrogen chloride fumes. Use dry chemical, carbon dioxide, or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Pour into sodium bicarbonate solution and flush to sewer.

References

(31); (173); (101); (138); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 2, No. 1, 78−80 (1982).

New York State Department of Health, Chemical Fact Sheet: Benzoyl Chloride, Bureau of Toxic Substance Assessment, Albany, NY (February 1986).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Benzoyl Chloride, Trenton, NJ (July 2002).

Benzoyl Peroxide B:0430

Formula: $C_{14}H_{10}O_4$; $C_6H_5CO\text{-}O\text{-}O\text{-}COC_6H_5$

Synonyms: Abcure S-40-25; Acetoxyl; Acnegel; Aztec benzoyl peroxide 70; Aztec benzoyl peroxide 77; Aztec BPO; Aztec BPO-Dry; Benox L-40V; Benoxyl; Benzac; Benzaknew; Benzoic acid; Benzoic acid benzoperoxide; Benzoic acid peroxide; Benzoperoxide; Benzoylperoxid (German); Benzoyl superoxide; BPO-W40; BPZ-250; BZF-60; Cadet; Cadet BPO-70W; Cadox; Cadox 40E; Cadox benzoyl peroxide-W 40; Cadox BTW-50; Clearasil acne treatment cream; Clearasil antibacterial acne lotion; Clearasil benzoyl peroxide lotion; Clearasil super strength; Cuticura acne cream; Debroxide; Dermoxyl; Dibenzoylperoxid (German); Dibenzoyl peroxide; Diphenylglyoxal peroxide; Eloxyl; Epiclear; Florox; Fostex; Garox; Incido l; Loroxide-HC lotion; Lucidol; Lucidol 75-FP; Lucidol-78; Lucidol GS; Lucipal; LupercoAFR-250; Luperco A; Luperco AA; Luperco AC; Luperco AFR; Lupercol; Luperox FL; Nericur Gel 5; Norox; Novadelox; Oxy-10; Oxy-5 acne pimple medication; Oxylite; Oxy wash antibacterial skin wash; Panoxyl; Panoxyl; Panoxyl aquagel; Panoxyl wash; Perlygel; Peroxide, dibenzoyl; Peroxido de benzoilo (Spanish); Peroxyde de benzoyle (French); Persadox; Persadox cream lotion; Persadox HP cream lotion; Persa-gel; Quinolor compound; Sulfoxyl lotion; the raderm; Topex; Vanoxide-HC lotion; XERAC

CAS Registry Number: 94-36-0

HSDB Number: 372

RTECS Number: DM8575000; DM8576000 (≥30% <52% with inert solid); DM8576200 (>52% with inert solid);

DM8577000 (≤72% as a paste); DM8578000 (≤77% with water); DM8579000 (>72% <95%); DM8579000 (>77% <95% with water)

UN/NA & ERG Number: UN3104/ (organic peroxide type C, solid)/146; UN3108/(organic peroxide type E, solid)/145

EC Number: 202-327-6 [*Annex I Index No.:* 617-008-00-0]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Limited Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1999. United States Environmental Protection Agency Gene-Tox Program, Inconclusive: *E. coli polA* without S9.

Hazard Alert: Organic peroxide, Extremely flammable, Strong oxidizer, Possible risk of forming tumors, Suspected of causing genetic defects, Sensitization hazard (skin), Primary irritant (w/o allergic reaction), FDA-over the counter drug.

Banned or Severely Restricted (in consumer products) (Sweden)[13]

OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 7500 lb (3504 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: E, O, F+, Xi; risk phrases: R2; R3; R7; R8; R12; R36/37/38; R43; R61; R62; safety phrases: S3/7; S14; S17; S36/37/39; S41; (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Benzoyl peroxide is an odorless, white or colorless crystalline powder. Molecular weight = 242.23; specific gravity (H_2O:1) = 1.33 @ 15°C; boiling point = explosive decomposition; freezing/melting point = (possible explosive decomposition heated) 103−105°C; vapor pressure =< 1 mmHg @ 20°C; flash point = 80°C; autoignition temperature = 80°C. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 4; reactivity 3−4 OX. Poor solubility in water; solubility =< 1 mg/mL @ 25°C. Commercial formulations use carrier solvents that may alter the physical properties shown.

Potential Exposure: Used as polymerization initiator, curing agent, and cross-linking agent.

Incompatibilities: May explode when heated above melting point, 103°C. A strong oxidizer. Extremely explosion-sensitive to heat, shock, friction, and concussion. May explode or cause fire on contact with reducing agents; combustible substances, organic substances, wood, paper, metal powders, lithium aluminum hydride. Violent reaction with alcohols, organic and inorganic acids, and amines.

Permissible Exposure Limits in Air

NIOSH IDLH = 1500 milligram per cubic meter

OSHA PEL: 5 milligram per cubic meter TWA

NIOSH REL: 5 milligram per cubic meter TWA

ACGIH TLV[1]: 5 milligram per cubic meter TWA, not classifiable as a human carcinogen

PAC Ver. 29[138]

PAC-1: 15 milligram per cubic meter

PAC-2: 1200 milligram per cubic meter

PAC-3: 7500 milligram per cubic meter

DFG MAK: 5 milligram per cubic meter, inhalable fraction TWA; Peak limitation Category I(1)

Austria: MAK 5 milligram per cubic meter, 1999; Belgium: TWA 5 milligram per cubic meter, 1993; Denmark: TWA 5 milligram per cubic meter, 1999; Finland: TWA 5 milligram per cubic meter; STEL 10 milligram per cubic meter [skin] 1999; France: VME 5 mg/m^3, 1999; Hungary: TWA 5 milligram per cubic meter; STEL 10 milligram per cubic meter [skin] 1993; the Netherlands: MAC-TGG 5 milligram per cubic meter, 2003; Norway: TWA 5 milligram per cubic meter, 1999; the Philippines: TWA 5 milligram per cubic meter, 1993; Poland: MAC (TWA) 5 milligram per cubic meter, MAC (STEL) 10 milligram per cubic meter, 1999; Switzerland: MAK-W 5 milligram per cubic meter, KZG-W 10 milligram per cubic meter, 1999; United Kingdom: TWA 5 milligram per cubic meter, 2000 Occupational Exposure Limit; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen. In addition, four states have set guidelines or standards for benzoyl peroxide in ambient air[60] ranging from 50 μ/m^3 (North Dakota) to 80 μ/m^3 (Virginia) to 100 μ/m^3 (Connecticut) to 119 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method #5009, Benzoyl peroxide[18]

Determination in Water: Octanol−water coefficient: Log K_{ow} => 3.4. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short-Term Exposure: Contact can irritate the eyes, skin and respiratory tract. *Inhalation:* 1.3 milligram per cubic meter may cause nose and throat irritation. 12 milligram per cubic meter may cause lung irritation, asthmatic wheezing, decreased pulse rate and temperature, difficult breathing and stupor. *Skin:* a 5% solution left on the skin for 12 hours has caused redness, swelling, and burning. A 5% solution left on the skin for 48 hours may cause severe irritation. Solutions greater than 20% left on for more than a few minutes caused severe irritation. *Eyes:* 2.6 milligram per cubic meter has caused irritation. *Ingestion:* there is little or no information available on human ingestion. However, results from animal studies suggest that the lethal dose for humans is about 3/4 pound. LD_{50} = (oral-rat) 7710 mg/kg[9].

Long-Term Exposure: May cause skin sensitization; allergic reaction may develop. May cause lung irritation and bronchitis with cough, phlegm, and/or shortness of breath.

Points of Attack: Skin, respiratory system, and eyes.

Medical Surveillance: Preplacement and periodic medical examinations should be conducted with particular attention to skin conditions. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Lung function tests. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Protective clothing and safety glasses with side shields or safety goggles should be worn by employees to reduce the possibility of skin contact and eye irritation. Such protection is especially important where benzoyl peroxide and other powder or granular benzoyl formulations may become airborne or where liquid or paste formulations of benzoyl peroxide might be spattered or spilled. Protective clothing should be fire resistant. Any fabric that generates static electricity is not recommended. To prevent the buildup of static electricity, appropriate conductive footwear should be worn. Gloves made of rubber, leather, or other appropriate material should be worn by employees pure benzoyl peroxide. Aprons made of rubber or another appropriate material are recommended for added protection when handling benzoyl peroxide and its formulations. Plastic aprons that may generate static electricity should not be used. Employees should wash promptly when skin is contaminated. Work clothing should be changed daily if it may be contaminated. Remove nonimpervious clothing promptly if contaminated.

Respirator Selection: Respiratory protection as follows must be used whenever airborne concentrations of benzoyl peroxide cannot be controlled to the recommended workplace environmental limit by either engineering or administrative controls. NIOSH: *50 milligram per cubic meter:* 95XQ* (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa* (APF = 10) (any supplied-air respirator). *125 milligram per cubic meter*: Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie* (APF = 25) (any PAPR with a high-efficiency particulate filter). *250 milligram per cubic meter:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or PaprTHie (APF = 50) (any PAPR with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *1500 milligram per cubic meter:* SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd, Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—Yellow Stripe: Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Protect containers against physical damage. Isolate in well-detached, fire-resistive, cool and well-ventilated building with no other materials stored therein; provide explosion venting in a safe direction and prohibit any electrical installation or heating facilities. Dibenzoyl peroxide should be stored in and used from original containers. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: UN3104 [Benzoyl peroxide ($\geq$77% but $<$95% with water)]: Organic peroxide type C, solid, Hazard Class: 5.2; Labels: 5.2—Organic peroxide, Technical Name Required. UN3108 [Benzoyl peroxide (with $\leq$77% water)]: Organic peroxide type E, solid, Hazard Class: 5.2; Labels: 5.2—Organic peroxide, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. *Mix spilled material with water-wetted vermiculite, and deposit in sealed containers. Do not use spark-generating materials or materials made of paper or wood for* *sweeping or handling spilled benzoyl peroxide*. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a highly flammable liquid. At high temperatures it may explode. Thermal decomposition products may include suffocating smoke and oxides of carbon. Use water only. Do not use chemical or carbon dioxide extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode. Clean-up and salvage operations after a fire should not be attempted until all of the peroxide has cooled completely.

Disposal Method Suggested: Pretreatment involves decomposition with sodium hydroxide. The final solution of sodium benzoate, which is very biodegradable, may be flushed into the drain. Disposal of large quantities of solution may require pH adjustment before release into the sewer or controlled incineration after mixing with a noncombustible material.

References

(31); (173); (101); (138); (2); (100).

National Institute for Occupational Safety and Health (NIOSH), "Criteria for a Recommended Standard: Occupational Exposure to Benzoyl Peroxide", NIOSH Document Number 77-166, Cincinnati, OH (1977).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 2, No. 1, 80−82 (1982).

New York State Department of Health, Chemical Fact Sheet: Benzoyl Peroxide, Bureau of Toxic Substance Assessment, Albany, NY (July 1998).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Benzoyl Peroxide, Trenton, NJ (July 1998).

Benzyl Bromide B:0440

Formula: C_7H_7Br; $C_6H_5CH_2Br$

Synonyms: (Bromomethyl)benzene; *p*-(Bromomethyl)nitrobenzene; Bromophenyl methane; α-Bromotoluene; ω-Bromotoluene; Bromuro de bencilo (Spanish); Toluene, α-bromo-

CAS Registry Number: 100-39-0

HSDB Number: 369

RTECS Number: XS7965000

UN/NA & ERG Number: UN1737/156

EC Number: 202-847-3 [*Annex I Index No.:* 602-057-00-2]

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Flammable, Dangerously water reactive, Suspected reprotoxic hazard.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xi; risk phrases: R10; R36/37/38; R51; safety phrases: S2; S39 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Benzylbromide is a combustible, colorless to yellow liquid with a pleasant odor. Molecular weight = 171.05; Specific gravity (H_2O:1) = 1.738; boiling point = 198−201°C; freezing/melting point = −4.0°C; vapor pressure = 0.45 mmHg @ 25°C; flash point = 79°C (cc). Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 2; reactivity 1 ₩ Insoluble in water; slowly decomposes, releasing dangerous chemicals.

Potential Exposure: It is used as a chemical intermediate; in organic syntheses; as a foaming and frothing agent.

Incompatibilities: May form explosive mixture with air. Contact with water forms hydrogen bromide and benzyl alcohol. Incompatible with strong oxidizers, bases, magnesium. Attacks metals, except nickel and lead, in the presence of moisture.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 0.41 milligram per cubic meter

PAC-2: 4.5 milligram per cubic meter

PAC-3: 27 milligram per cubic meter

Permissible Concentration in Water: No criteria set. Toxic to aquatic organisms.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = \sim 3$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact

Harmful Effects and Symptoms

Short-Term Exposure: Irritates eyes, skin, and respiratory system. Eye contact can cause severe irritation and burns. Skin contact can cause severe irritation, redness, swelling and sores. High levels can cause dizziness because it attacks the nervous system

Long-Term Exposure: Mutation data reported. Repeated skin contact can cause chronic irritation with dry skin, redness, rash, and sores. Similar very irritating substances can cause lung damage.

Points of Attack: Skin, lungs.

Medical Surveillance: Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Lung function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Store in tightly closed containers in a cool, well-ventilated area away from water and other incompatible materials listed above.

Shipping: UN1737 Benzyl Bromide, Hazard class: 6.1; Labels: 6.1—Poisonous materials, 8—Corrosive material.

Spill Handling: Stay upwind and uphill. Isolate the area of release or fire and deny entry. Remove all ignition sources. Stop the release if it can be done safely from a distance. All equipment used to handle this material must be grounded. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. *Small spill*: Cover with *dry* earth, *dry* sand, or other noncombustible material followed with plastic sheet to minimize spreading or contact with water or rain. Use clean nonsparking tools to collect material and place material into loosely covered plastic containers for later disposal. Prevent material and run off from entering sewers and waterways if it can be done safely well ahead of the release. Use vapor suppressing foam to disperse vapors—contain runoff. Water spray may reduce vapor, but may not prevent ignition in enclosed spaces. Ventilate confined area if it can be done without placing personnel at risk. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide; water spray; or foam extinguishers. Thermal decomposition products may include bromine gas. *Small fire*: use *dry* chemical, CO_2, *dry* sand, or alcohol-resistant foam. May react with foams releasing corrosive/toxic gases. *Large fire*: use water spray or alcohol-resistant foam if it is available in sufficient amounts. Under favorable conditions, experienced crews can use coordinated fog streams to sweep the flames off the surface of the burning liquid. Combustible material: may burn but does not ignite readily. Most vapors are heavier than air. They will spread along ground and collect in low or confined areas (sewers, basements, tanks). Vapors may travel to source of ignition and flashback. Containers may explode when heated or if contaminated with water. Keep exposures cool long after fire is out to protect against reignition. Do not direct straight streams into the liquid. Cool exposed containers with large quantities of water from unattended equipment or remove intact containers if it can be done safely. *Do not get water on spilled substance or inside containers*. If cooling streams are ineffective (*venting sound increases in volume and pitch, tank discolors or shows signs of deforming*), withdraw immediately to a secure location. Always stay away from ends of tanks, especially when engulfed in flames. If material or contaminated runoff from fire control enters waterways, notify downstream users of potentially contaminated water. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156.

Disposal Method Suggested: Pour into vermiculite, sodium bicarbonate, or a sand-soda ash mixture and transfer to paper boxes, then to an open incinerator. Alternatively, mix with flammable solvent and spray into incinerator equipped with after burner and alkali scrubber.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Benzyl Bromide, Trenton, NJ (February 1987).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 2, No. 3, 66–68 (1982).

Benzyl Chloride B:0450

Formula: C_7H_4Cl; $C_6H_2CH_2Cl$

Synonyms: Benzene, (chloromethyl)-; Benzylchlorid (German); Benzyle (chlorure de) (French); Chloromethylbenzene; Chlorophenylmethane; α-Chlorotoluene; ω-Chlorotoluene; α-Chlortoluol (German); Chlorure debenzyle (French); Cloruro debencilo (Spanish); NCI-C06360; Tolylchloride

CAS Registry Number: 100-44-7

HSDB Number: 368

RTECS Number: XS8925000

UN/NA & ERG Number: UN1738/156

EC Number: 202-853-6 [*Annex I Index No.:* 602-037-00-3]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Sufficient Evidence; Human Limited Evidence, *probably carcinogenic to humans*, Group 2A, 1999; NCI: Carcinogenesis Studies (feed); clear evidence: mouse; inadequate evidence, rat; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies.

United States Environmental Protection Agency Gene-Tox Program, Positive: SHE-clonal assay; *B. subtilis* rec assay; Positive: *E. coli polA* without S9; *E. coli polA* with S9; Positive: Histidine reversion-Ames test; Positive: In vitro UDS-human fibroblast; *S. cerevisiae-homozygosis*; Positive/limited: Carcinogenicity-mouse/rat; Negative: Host-mediated assay; Inconclusive: CHO gene mutation.

California Proposition 65 Chemical[102]: Cancer 1/1/1990

Hazard Alert: Poison, High acute toxicity, Flammable, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Clean Water Act: Section 311 Hazardous Substances/ RQ40CFR117.3 (same as CERCLA, see below); Section 313Water Priority Chemicals (57FR41331, 9/9/1992).

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P028

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500 lb (227 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV.D.3.b, RQ: 100 lb (45.4 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%; NPRI.

Hazard symbols, risk, & safety statements: Hazard symbol: F, T+; risk phrases: R10; R45; R22; R23; R37/38; R41; R48/22; R61; R62; R63; safety phrases: S53; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Benzyl chloride is a colorless to slightly yellow liquid with a strong, unpleasant, irritating odor. The Odor Threshold is 0.05 ppm[41]. Molecular weight = 126.6; specific gravity (H_2O:1) = 1.10; boiling point = 179.4°C; freezing/melting point = −45°C; vapor pressure = 1 mmHg @ 20°C; flash point = 67°C (cc); autoignition temperature = 585°C. Flammable Limits in Air: LEL: 1.1%; UEL: 14.0%[52]. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 2; reactivity 1 ₩. Practically insoluble in water; solubility = 0.05%.

Potential Exposure: Used as an intermediate and as an irritant gas in chemical warfare. In contrast to phenyl halides, benzyl halides are very reactive. Benzyl chloride is used in production of benzal chloride, benzyl alcohol, and benzaldehyde. Industrial usage includes the manufacture of plastics, dyes, synthetic tannins, perfumes and resins. It is used in the manufacture of many pharmaceuticals. Suggested uses of benzyl chloride include: the vulcanization of fluororubbers and the benzylation of phenol and its derivatives for the production of possible disinfectants.

Incompatibilities: May form explosive mixture with air. Contact with water forms hydrogen chloride fumes. Strong oxidizers may cause fire and explosions. Unstabilized benzyl chloride undergoes polymerization with copper, aluminum, iron, zinc, magnesium, tin, and other common metals except lead and nickel, with the liberation of heat and hydrogen chloride gas. May accumulate static electrical charges, and may cause ignition of its vapors. Attacks some plastics and rubber. Thermal decomposition and polymerization reactions are inhibited, to a limited extent, by addition of triethylamine, propylene oxide, or sodium carbonate[17].

Permissible Exposure Limits in Air

NIOSH IDLH = 10 ppm

OSHA PEL: 1 ppm/5 milligram per cubic meter TWA

NIOSH REL: 1 ppm/5 milligram per cubic meter [15 minutes] Ceiling Concentration

ACGIH TLV[1]: 1 ppm/5.2 milligram per cubic meter TWA; Confirmed Carcinogen with unknown relevance to humans

PAC* Ver. 29[138]

PAC-1: $\mathbf{1_E}$ ppm

PAC-2: $\mathbf{10_E}$ ppm

PAC-3: $\mathbf{50_E}$ ppm

*ERPG are marked with a subscript "**E.**"

DFG MAK: [skin] Carcinogen Category 2

Australia: TWA 1 ppm (5 milligram per cubic meter), 1993; Austria: carcinogen, 1999; Belgium: TWA 1 ppm (5.2 mg/

m^3), 1993; Denmark: TWA 1 ppm (5 milligram per cubic meter), 1999; Finland: TWA 1 ppm (5 milligram per cubic meter); STEL 3 ppm (15 milligram per cubic meter), 1999; France: VME 1 ppm (5 milligram per cubic meter), VLE 2 ppm (11 milligram per cubic meter); STEL 3 ppm (15 milligram per cubic meter), carcinogen, 1993; Hungary: STEL 0.5 milligram per cubic meter [skin] 1993; Norway: TWA 1 ppm (5 milligram per cubic meter), 1999; the Philippines: TWA 1 ppm (5 milligram per cubic meter), 1993; Poland: 3 milligram per cubic meter, ceiling 5 milligram per cubic meter, 1999; Russia: STEL 0.5 milligram per cubic meter, 1993; Sweden: NGV 1 ppm (5 milligram per cubic meter), KTV 2 ppm (11 milligram per cubic meter), carcinogen, 1999; Switzerland: MAK-W 1 ppm (5 milligram per cubic meter), carcinogen, 1999; Turkey: TWA 1 ppm (5 milligram per cubic meter), 1993; United Kingdom: TWA 0.5 ppm (2.6 milligram per cubic meter); STEL 1.5 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: confirmed animal carcinogen with unknown relevance to humans. Several States have set guidelines or standards for benzyl chloride in ambient air[60] ranging from $0.01\,\mu/m^3$ (Rhode Island) to $0.7\,\mu/m^3$ (Massachusetts) to $16.7\,\mu/m^3$ (New York) to $20.0\,\mu/m^3$ (Rhode Island) to $25\,\mu/m^3$ (South Carolina) to $50\,\mu/m^3$ (North Dakota) to $85\,\mu/m^3$ (Virginia) to $100\,\mu/m^3$ (Connecticut) to $119\,\mu/m^3$ (Nevada) to $500\,\mu/m^3$ (North Carolina).

Determination in Air: Use NIOSH Analytical Methods 1003, Hydrocarbons, halogenated[18].

Permissible Concentration in Water: No criteria set but EPA[32] has suggested an ambient limit of $69\,\mu g/L$ based on health effects.

Determination in Water: Octanol−water coefficient: $\log K_{ow} = 2.3$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation of vapor, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Inhalation exposure may result in severe irritation of upper respiratory tract with coughing, burning of the throat, headache, dizziness, and weakness. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Eye contact may result in immediate and severe eye irritation and prolonged exposure may cause permanent eye damage. Ingestion may cause severe burns of the mouth, throat; and gastrointestinal tract resulting in nausea, vomiting, cramps, and diarrhea. It is intensely irritating to skin, eyes, and mucous membranes. Highly toxic; may cause death or permanent injury after very short exposure to small quantities. Large doses cause CNS depression, with possible unconsciousness.

Long-Term Exposure: Causes thyroid cancer in animals. Has been listed as a direct-acting or primary carcinogen. May damage the developing fetus. May cause liver damage and affect the nervous system.

Points of Attack: Eyes, skin, and respiratory system.

Medical Surveillance: NIOSH recommends Pulmonary function tests; chest X-ray; Expired air test. Preplacement and periodic examinations should include the skin, eyes, and an evaluation of the liver, kidney, respiratory tract, blood, and nervous system. This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. **8 hours** (more than 8 hours of resistance to breakthrough $>0.1\,\mu g/cm^2/min$): 4H and Silver Shield gloves, CPF3 suits; Responder suits; Trychem 1000 suits; **4 hours:** (At least 4 but $<$ 8 hours of resistance to breakthrough $>0.1\,\mu g/cm^2/min$): Teflon gloves, suits, boots. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: 10 ppm: CcrOvAg* (APF = 10) [any chemical cartridge respirator with organic vapor and acid gas cartridge(s)]; or GmFOvAg (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor or acid gas canister]; or PaprOvAg* (APF = 25) [any PAPR with organic vapor and acid gas cartridge(s)]; or Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive pressure mode. *Escape:* GmFOvAg (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor or acid gas canister]; or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance causes eye irritation or damage; eye protection needed.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. This material should be stored in tightly closed containers in a cool, well-ventilated area away from sunlight, heat, moisture, active metals, oxidizers. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN1738 Benzyl chloride, Hazard class: 6.1; Labels: 6.1—Poisonous materials, 8—Corrosive material.

Spill Handling: Stay upwind and uphill. Isolate the area of release or fire and deny entry. Remove all ignition sources. Stop the release if it can be done safely from a distance. All equipment used to handle this material must be grounded. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. *Small spill*: Cover with *dry* earth, *dry* sand, or other noncombustible material followed with plastic sheet to minimize spreading or contact with water or rain. Use clean nonsparking tools to collect material and place material into loosely covered plastic containers for later disposal. Prevent material and runoff from entering sewers and waterways if it can be done safely well ahead of the release. Use vapor suppressing foam to disperse vapors–contain runoff. Water spray may reduce vapor, but may not prevent ignition in enclosed spaces. Ventilate confined area if it can be done without placing personnel at risk. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated run off enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Benzyl chloride is a combustible liquid. Thermal decomposition products may include hydrogen chloride and oxides of carbon. Use dry chemical, carbon dioxide; or foam extinguishers. *Do not use water. Small fire*: use d*ry* chemical, CO_2, *dry* sand, or alcohol-resistant foam. May react with foams releasing corrosive/toxic gases. *Large fire*: use water spray or alcohol-resistant foam if it is available in sufficient amounts. Under favorable conditions, experienced crews can use coordinated fog streams to sweep the flames off the surface of the burning liquid. Combustible material: may burn but does not ignite readily. Most vapors are heavier than air. They will spread along ground and collect in low or confined areas (sewers, basements, tanks). Vapors may travel to source of ignition and flashback. Containers may explode when heated or if contaminated with water. Keep exposures cool long after fire is out to protect against reignition. Do not direct straight streams into the liquid. Cool exposed containers with large quantities of water from unattended equipment or remove intact containers if it can be done safely. *Do not get water on spilled substance or inside containers*. If cooling streams are ineffective (*venting sound increases in volume and pitch, tank discolors or shows signs of deforming*), withdraw immediately to a secure location. Always stay away from ends of tanks, especially when engulfed in flames. If material or contaminated runoff from fire control enters waterways, notify downstream users of potentially contaminated water. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156.

Disposal Method Suggested: Incineration @ 816°C for 0.5 second minimum for primary combustion and 1204°C for 12.0 second for secondary combustion. Elemental chlorine formation may be alleviated by injection of steam or methane into the combustion process[24].

References

(102); (31); (173); (101); (138); (2); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Benzyl Chloride, Washington, DC (December 9, 1977).

National Institute for Occupational Safety and Health (NIOSH), Information Profiles on Potential Occupational Hazards, Benzyl Chloride, Report PB 276,678, Rockville, Maryland, pp. 2–7 (October 1977).

United States Environmental Protection Agency, Benzyl Chloride, Health and Environmental Effects Profile No. 21, Washington, DC, Office of Solid Waste (April 30, 1980).

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United States Environmental Protection Agency, Chemical Hazard Information Profile: Benzyl Chloride," Chemical Emergency Preparedness Program, Washington, DC, (November 30, 1987).

NIOSH/OSHA Occupational Health Guidelines for Chemical Hazards DH HS (NIOSH) Pub No. 81–123; 88–118; Suppls. I-IV. 1981–1995, Cincinnati, OH.

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Benzyl Chloride, Trenton, NJ (November 1998).

Benzyl Cyanide B:0460

Formula: C_8H_4N; $C_6H_2CH_2CN$
Synonyms: Acetic acid, phenyl-nitrile; Acetonitrile, phenyl-; Benzeneacetonitrile; Benzylkyanid; Benzylnitrile; Cianuro de bencilo (Spanish); (Cyanomethyl) benzene; α-Cyanotoluene; Fenilacetonitrilo, líquido (Spanish); 2-Phenylacetonitrile; α-Phenylacetonitrile; Phénylacétonitrile, liquide (French); Phenylacetonitrile; Phenyl acetyl nirtile; Toluene, α-cyano; α-Tolunitrile
CAS Registry Number: 140-29-4
HSDB Number: 2103 as phenylacetonitrile
RTECS Number: AM1400000
UN/NA & ERG Number: UN2470/152
EC Number: 205-410-5
Regulatory Authority and Advisory Information
Hazard Alert: Poison, Combustible, Primary irritant (w/o allergic reaction), Environmental hazard.
Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) as cyanide compound
Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500 lb (227 kg)
Superfund/EPCRA 40CFR302.4, Appendix A and Section IV.D.3.b, RQ: 500 lb (227 kg)
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
United States DOT Regulated Marine Pollutant (49CFR 172.101, Appendix B) as cyanide mixtures, cyanide solutions or cyanides, inorganic, n.o.s.
List 1, DEA chemical code 8735 (Title 21 CFR1310.02)
United States National Primary Drinking Water Regulations: MCLG = 0.2 mg[CN$^-$]/L; MCL = 0.2 mg[CN$^-$]/L as cyanide
Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.
Hazard symbols, risk, & safety statements: Hazard symbol: T+; risk phrases: R22; R 23/24/25; R26; R51/53; safety phrases: S23; S28; S36/37/39; S45 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.
Description: Benzyl cyanide is a colorless, oily liquid with an aromatic odor. Molecular weight = 117.2; specific gravity (H_2O:1) = 1.02; boiling point = 233.5°C; freezing/melting point = −24; vapor pressure = low <0.40 @ 20°C; Flash point = 113°C (oc),[17] also cited as 101°C[52]. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 1; reactivity 0 ₩. Insoluble in water.
Potential Exposure: (as CN): Benzyl cyanide is used in organic synthesis, especially of penicillin precursors. It is used as a chemical intermediate for amphetamines, phenobarbital; the stimulant, methyl phenidylacetate; esters as perfumes and flavors.
Incompatibilities: Violent reaction with strong oxidizers; sodium hypochlorite, lithium aluminum hydride. Nitriles may polymerize in the presence of metals and some metal compounds. They are incompatible with acids; mixing nitriles with strong oxidizing acids can lead to extremely violent reactions. Nitriles are generally incompatible with other oxidizing agents such as peroxides and epoxides. The combination of bases and nitriles can produce hydrogen cyanide. Nitriles are hydrolyzed in both aqueous acid and base to give carboxylic acids (or salts of carboxylic acids). These reactions generate heat. Peroxides convert nitriles to amides. Nitriles can react vigorously with reducing agents. Acetonitrile and propionitrile are soluble in water, but nitriles higher than propionitrile have low aqueous solubility. They are also insoluble in aqueous acids[101].
Permissible Exposure Limits in Air
NIOSH IDLH = 25 mg[CN]/m^3
OSHA PEL: 5 mg[CN]/m^3/4.7 ppm TWA
NIOSH REL: 5 mg[CN]/m^3/4; 7 ppm/10 minutes, Ceiling Concentration
ACGIH TLV[1]: 5 mg[CN]/m^3 [skin] Ceiling Concentration
PAC Ver. 29[138]
PAC-1: 0.39 milligram per cubic meter
PAC-2: 4.3 milligram per cubic meter
PAC-3: 15 milligram per cubic meter
DFG MAK: 2 mg[CN]/m^3, inhalable fraction TWA; Peak Limitation Category II(1) [skin]; Pregnancy Risk Group: C.
Australia: TWA 5 milligram per cubic meter, [skin], 1993; Austria: MAK 5 mg[CN]/m^3, [skin], 1999; Denmark: TWA 5 milligram per cubic meter, [skin], 1999; France: VME 5 mg[CN]/m^3, [skin], 1999; Poland: TWA 0.3 mg[CN]/m^3, ceiling 10 mg[CN]/m^3, 1999; Switzerland: MAK-W 5 milligram per cubic meter, KZG-W 10 milligram per cubic meter, [skin], 1999; United Kingdom: TWA 5 mg[CN]/m^3, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Ceiling Concentration 5 milligram per cubic meter [skin]. Russia[43] set a MAC of 0.8 milligram per cubic meter in work-place air.
Determination in Air: See NIOSH Criteria Document 212 *Nitriles*.
Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 200 μg[CN]/L; State Drinking Water Standards: California 150 μg[CN]/L; State Drinking Water Guidelines: Arizona 220 μg[CN]/L; Maine. 140 μg [CN]/L; Minnesota 100 μg[CN]/L. United States Army field drinking-water standards for cyanide: 2 mg[CN]/L assuming a water consumption of 15 L/day and 6 mg[CN]/L assuming a water consumption of 5 L/day. United States Army field drinking-water standards for cyanide, long-term consumption 0.5 mg[CN]/L; Short-term consumption; Raw water constituents (maximum) 20 mg[CN]/L.
Determination in Water: Octanol−water coefficient: Log K_{ow} = 1.6. Unlikely to bioaccumulate in marine organisms.
Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Poisonous. May be fatal if inhaled, swallowed, or absorbed through skin. Contact may cause burns to skin and eyes. LD_{50} = (oral-rat) 270 mg/kg[9].

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. For cyanide poisoning, use amyl nitrate capsules if symptoms develop. All area employees should be trained regularly in emergency measures for cyanide poisoning and in CPR. A cyanide antidote kit should be kept in the immediate work area and must be rapidly available. Kit ingredients should be replaced every 1−2 years to ensure freshness. Persons trained in the use of this kit; oxygen use, and CPR must be quickly available.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See NIOSH Criteria Document 212 *Nitriles*.

Respirator Selection: NIOSH/OSHA (as cyanides): *Up to 25 milligram per cubic meter:* Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd, Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive pressure mode. *Escape:* GmFS100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted canister providing protection against the compound of concern and having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard: Store in a secure poison location. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers and other incompatible materials listed above. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2470 Phenylacetonitrile, Hazard Class: 6.1; Labels: 6.1—Poisonous materials.

Spill Handling:

Nitriles spill

Initial isolation and protective action distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.3/0.5
Night 0.5/0.8

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Use water spray to reduce vapors. *Small spills:* take up with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills:* dike far ahead of spill for later disposal. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. *Small fires:* dry chemical, carbon dioxide; water spray; or foam. *Large fires:* water spray, fog, or foam. Move container from fire area if you can do it without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Wear positive pressure breathing apparatus and special protective clothing. Remove and isolate contaminated clothing at the site. Thermal decomposition products may include cyanide and oxides of nitrogen. Container may explode in heat of fire. Runoff from fire control water may give off poisonous gases. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Benzyl Cyanide, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

Beryllium and Compounds B:0470

Formula: Be

Synonyms: Berilio (Spanish); Beryllium-9; Béryllium en poudre (French); Beryllium dust; Beryllium metal powder; Glucinium; Glucinum

CAS Registry Number: 7440-41-7 (metal)

Other compounds as [Be]: 12770-50-2 (Beryllium-aluminum alloy); 11133-98-5 (Beryllium-copper alloy); 1302-52-9 (Beryl); 7787-47-5 (Beryllium chloride); 7787-49-7 (Beryllium fluoride); 13327-32-7 (Beryllium hydroxide); 13510-49-1 (Beryllium sulfate); 7787-56-6 (Beryllium sulfate tetrahydrate); 1304-56-9; (Beryllium oxide); 1319-43-3 (Beryllium carbonate basic); 13597-99-4 (Beryllium nitrate); 7787-55-5 (Beryllium nitrate trihydrate); 13510-48-0 (Beryllium nitrate tetrahydrate); 13598-15-7 (Beryllium phosphate); 13598-00-0 (Beryllium silicate); 39413-47-3 (Zinc beryllium silicate)

HSDB Number: 512

RTECS Number: DS1750000

UN/NA & ERG Number: UN1566/154 (compounds); UN1567 (powder)/134

EC Number: 231-150-7 [*Annex I Index No.:* 004-001-00-7], *as beryllium*

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen; IARC: (beryllium and beryllium compounds)[9] Animal Sufficient Evidence; Human Sufficient Evidence*, carcinogenic to humans*, Group 1, 1997; Cancer site: lung; EPA: Limited evidence of carcinogenicity based on epidemiologic studies; Likely to produce cancer in humans when inhaled; Cannot be determined-when ingested. United States Environmental Protection Agency Genetox Program, positive: carcinogenicity-mouse/rat

California Proposition 65 Chemical[102]: Cancer, as Beryllium and beryllium compounds 10/1/1987.

Hazard Alert: Combustible, Possible risk of forming tumors, Suspected reprotoxic hazard, Possible, sensitization hazard (skin).

Banned or Severely Restricted (UN)[35]

United States National Primary Drinking Water Regulations: MCLG = 0.004 mg[Be]/L; MCL = 0.004 mg [Be]/L, as Beryllium.

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; 40 CFR401.15 Section 307 Toxic Pollutants

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P015

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.82; Nonwastewater (mg/L), 0.014 TCLP

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL:g/L):, total dust 6010 (3); 7090 (50); 7091 (2)

Safe Drinking Water Act (47 FR 9352): MCL, 0.004 mg/L; MCLG, 0.004 mg/L

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV.D.3.b, RQ: 10 lb (4.54 kg). *Note:* No report required if the diameter of the pieces of solid metal is equal to or exceeds 0.004 in.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%. (carcinogen), beryllium and beryllium compounds; CEPA, Schedule 3, Part 2, Ocean Dumping Restriction.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, Xi; risk phrases: R45; R49; R25; R26; R36/37/38; R43; R48/23; R63; safety phrases: S41; S45; S53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to Waters (*Beryllium nitrate*)

Description: Beryllium is a gray shiny metal or powder, or fine granules which resemble powdered aluminum. Beryllium is slightly soluble in water. All beryllium compounds are soluble in water, to some degree. Berylore is the primary source of beryllium, although there are numerous other sources. Molecular weight = 9.01; specific gravity (H_2O:1) = 1.85; boiling point = 2471°C; freezing/melting point = 1287°C; vapor pressure = 10 mmHg @ 1860°C. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 1; reactivity 0 ₩.

Potential Exposure: Beryllium is used extensively in manufacturing electrical components, chemicals, ceramics, nuclear reactors; in the aerospace industry; and X-ray tubes.

A number of alloys are produced in which beryllium is added to yield greater tensile strength, electrical conductivity, and resistance to corrosion and fatigue. The metal is used as a neutron reflector in high-flux test reactors. Human exposure occurs mainly through inhalation of beryllium dust or fumes by beryllium ore miners, beryllium alloy makers and fabricators; phosphor manufacturers; ceramic workers; missile technicians; nuclear reactor workers; electric and electronic equipment workers; and jewelers. The major source of beryllium exposure of the general population is thought to be the burning of coal. Approximately 250,000 pounds of beryllium is released from coal and oil-fired burners. EPA estimates the total release of beryllium to the atmosphere from point sources is approximately 5500 pounds per year. The principal emissions are from beryllium−copper alloy production. Approximately 721,000 persons living within 12.5 mi (20 km) of point sources are exposed to small amounts of beryllium (median concentration 0.005 μ/m^3). Levels of beryllium have been reported in drinking water supplies and in small amounts in food.

Incompatibilities: Beryllium metal reacts with strong acids; alkalis (forming combustible hydrogen gas), oxidizable materials. Forms shock sensitive mixtures with some chlorinated solvents, such as carbon tetrachloride and trichloroethylene. Incompatible with caustics, chlorinated hydrocarbons, oxidizers, molten lithium[77].

Permissible Exposure Limits in Air

NIOSH IDLH = 4 mg[Be]/m^3

OSHA PEL: 0.002 mg[Be]/m^3 TWA; 0.005 mg[Be]/m^3 Ceiling Concentration; 0.025 mg[Be]/m^3/30 minute maximum peak-per 8 hour shift.

NIOSH REL: 0.0005 mg[Be]/m^3 STEL (do not exceed) Limit exposure to lowest feasible concentration.

ACGIH TLV[1]: 0.00005 mg[Be]/m^3 TWA, inhalable fraction; Confirmed Human Carcinogen

PAC* Ver. 29[138]

7440-41-7 metal

PAC-1: 0.0023 mg[Be]/m^3

PAC-2: **0.025**$_{\mathbf{E}}$ mg[Be]/m^3

PAC-3: **0.1**$_{\mathbf{E}}$ mg[Be]/m^3

*ERPG are marked with a subscript "**E.**"

7787-47-5 chloride

PAC-1: 0.02 milligram per cubic meter

PAC-2: 0.22 milligram per cubic meter

PAC-3: 0.89 milligram per cubic meter

7787-49-7 fluoride

PAC-1: 0.012 milligram per cubic meter

PAC-2: 0.13 milligram per cubic meter

PAC-3:0.52 milligram per cubic meter

13327-32-7 hydroxide

PAC-1: 0.011 milligram per cubic meter

PAC-2: 0.12 milligram per cubic meter

PAC-3: 0.48 milligram per cubic meter

13597-99-4 nitrate

PAC-1: 0.47 milligram per cubic meter

PAC-2: 0.52 milligram per cubic meter

PAC-3: 2.1 milligram per cubic meter

1304-56-9 oxide

PAC-1: 0.0063 milligram per cubic meter

PAC-2: 0.069 milligram per cubic meter

PAC-3: 0.28 milligram per cubic meter

DFG MAK: Danger of sensitization of the airways; Carcinogen Category 1, proven carcinogens in humans.

Arab Republic of Egypt: TWA 0.002 milligram per cubic meter, 1993; Australia: TWA 0.002 milligram per cubic meter, carcinogen, 1993; Austria: carcinogen, 1999; Belgium: TWA 0.002 milligram per cubic meter, Carcinogen 1993; Denmark: TWA 0.001 milligram per cubic meter, 1999; Finland: TWA 0.002 milligram per cubic meter; STEL 0.006 milligram per cubic meter, carcinogen, 1999; France: VME 0.002 milligram per cubic meter, continuous carcinogen, 1999; Hungary: STEL 0.001 milligram per cubic meter, carcinogen, 1993; India: TWA 0.002 milligram per cubic meter, carcinogen, 1993; Japan: TWA 0.002 milligram per cubic meter, 2 A carcinogen, 1999; Norway: TWA 0.001 milligram per cubic meter, 1999; the Philippines: TWA 0.002 milligram per cubic meter, 1993; Poland: MAC (TWA) 0.001 milligram per cubic meter, MAC STEL 0.003 milligram per cubic meter, 1999; Russia: STEL 0.001 milligram per cubic meter, carcinogen, 1993; Sweden: NGV 0.002 milligram per cubic meter, carcinogen, 1999; Switzerland: MAK-W 0.002 milligram per cubic meter, carcinogen, 1999; Thailand: TWA 0.002 milligram per cubic meter; STEL 0.005 milligram per cubic meter, 1993; Turkey: TWA 0.002 milligram per cubic meter, 1993; United Kingdom: TWA 0.002 milligram per cubic meter, carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Confirmed Human Carcinogen. Several states have set guidelines or standards for beryllium in ambient air[60] ranging from zero (North Dakota) to 0.0042 μ/m^3 (Massachusetts) to 0.01 μ/m^3 (Connecticut, Pennsylvania, South Carolina) to 0.02 μ/m^3 (South Dakota and Virginia) to 0.1 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method #7704[18]. Beryllium in Air by Field-Portable Fluorometry (4/6/2007); 9110[18] Beryllium in Surface Wipes by Field-Portable Fluorometry (4/6/2007). (See also the ATSDR profile cited below).

Permissible Concentration in Water: Federal Drinking Water Standards: MCL: 0.004 mg[Be]/L; Federal Drinking Water Guidelines: Maximum Contaminant Level Goal (MCGL) for inorganic contaminants: 0.004 mg[Be]/L. Runoff from spills or fire control may cause water pollution.

Routes of Entry: Inhalation of fume or dust.

Harmful Effects and Symptoms

Local: The soluble beryllium salts are cutaneous sensitizers as well as Primary irritant (w/o allergic reaction)s. Contact dermatitis of exposed parts of the body is caused by acid salts as well as Primary irritant (w/o allergic reaction)s. Contact dermatitis of exposed parts of the body is caused by acid salts of beryllium. Onset is generally delayed about 2 weeks from the time of first exposure. Complete recovery occurs following cessation of exposure. Eye irritation and conjunctivitis can occur. Accidental implantation of beryllium metal or crystals of soluble beryllium compound in areas of broken or abraded skin may cause granulomatous lesions. These are hard lesions with a central nonhealing area. Surgical excision of the lesion is necessary. Exposure to soluble beryllium compounds may cause nasopharynigitis, a condition characterized by swollen and edematous mucous membranes; bleeding points, and ulceration. These symptoms are reversible when exposure is terminated. *Systemic:* Beryllium and its compounds are highly toxic substances. Entrance to the body is almost entirely by inhalation. The acute systemic effects of exposure to beryllium primarily involve the respiratory tract and are manifest by a nonproductive cough, substernal pain; moderate shortness of breath; and some weight loss. The character and speed of onset of these symptoms, as well as their severity, are dependent on the type and extent of exposure. An intense exposure, although brief, may result in severe chemical pneumonitis with pulmonary edema. Chronic beryllium disease can be classified by its clinical variants according to the disability the disease process produces. (1) Asymptomatic nondisabling disease is usually diagnosed only by routine chest X-ray changes and supported by urinary or tissue assay. (2) In its mildly disabling form, the disease results in some nonproductive cough and dyspnea following unusual levels of exertion. Joint pain and weakness are common complaints. Diagnosis is by X-ray changes. Renal calculi containing beryllium may be a complication. Usually, the patient remains stable for years, but eventually shows evidence of pulmonary or myocardial failure. (3) In its moderately severe disabling form, the disease produces symptoms of distressing cough and shortness of breath; with marked X-ray changes. The liver and spleen are frequently affected, and spontaneous pneumothorax may occur. There is generally weight loss; bone and joint pain; oxygen desaturation; increase in hematocrit; disturbed liver function; hypercalciuria, and spontaneous skin lesions similar to those of Boeck's sarcoid. Lung function studies show measurable decreases in diffusing capacity. Many people in this group survive for years with proper therapy. Bouts of chills and fever carry a bad prognosis. (4) The severely disabling disease will show all of the above mentioned signs and symptoms in addition to severe physical wasting and negative nitrogen balance. Right heart failure may appear, causing a severe nonproductive cough which leads to vomiting after meals. Severe lack of oxygen is the predominant problem, and spontaneous pneumothorax can be a serious complication. Death is usually due to pulmonary insufficiency or right heart failure.

Short-Term Exposure: Eye or skin contact can cause irritation, itching, and burning. Sometimes an allergic eye problem develops, breaking out with future exposure. Inhalation overexposure can severely irritate the airways and lungs, causing nasal discharge; tightness of the chest; cough, shortness of breath; and/or fever. Death can occur in severe cases. Seek prompt medical attention. Future exposures can cause further attacks. Symptoms may be delayed for days following exposure. Some persons later develop lung scarring after such exposures.

Long-Term Exposure: Causes acute and chronic toxicity; can cause damage to lungs and bones. Known carcinogen[182]. Beryllium can cause intestinal lesions. There is some evidence that it causes lung and bone cancer in humans and animals. High or repeated exposure can permanently scar the lungs or other body organs. If be particles get under cuts in the skin, ulcers or lumps can develop; these must be surgically removed. Allergic skin rashes can occur. High or repeated exposure can cause kidney stones to develop. May cause intestinal lesions.

Points of Attack: Skin, eyes, respiratory system, lungs, liver, spleen, heart.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Preemployment history and physical examinations for worker applicants should include chest X-rays, baseline pulmonary function tests (FVC and FEV_1), and measurement of body weight. Beryllium workers should receive a periodic health evaluation that includes: spirometry (FVC and FEV_1), medical history questionnaire directed toward respiratory symptoms and a chest X-ray, blood/urine trace metals. General health, liver and kidney functions, and possible effects of the skin should be evaluated. See NIOSH Criteria Document 72-10268.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Work areas should be monitored to limit and control levels of exposure. Personnel samplers are recommended. Good housekeeping, proper maintenance, and engineering control of processing equipment and technology are essential. The importance of safe work practices and personal hygiene should be stressed. When beryllium levels exceed the accepted standards, the workers should be provided with respiratory protective devices of the appropriate class, as determined on the basis of the actual or projected atmospheric concentration of airborne beryllium at the worksite. Protective clothing should be provided all workers who are subject to exposure in excess of the standard. This should include shoes or protective shoe covers as well as other clothing. The clothing should be reissued clean on a daily basis. Workers should shower following each shift prior to change to street clothes.

Respirator Selection: NIOSH: *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full facepiece respirator with an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: (1) Color code—Red (powder): Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. (2) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Beryllium must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates and nitrates); and strong acids (such as hydrochloric, sulfuric, and nitric); since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Protect storage containers from physical damage. Use only non-sparking tools, and equipment, especially when opening and closing containers of beryllium. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN1567: Beryllium powder, Hazard class: 6.1; Labels: 6.1—Poisonous material, 4.1—Flammable solid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Be is a combustible solid. Smother fire with dry sand, dry clay, dry ground limestone, or use approved Class "D" extinguishers (NFPA). *Do not use carbon dioxide or halogenated extinguishing agents. Do not use water.* Thermal decomposition products may include beryllium oxide fume. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: For beryllium (powder), waste should be converted into chemically inert oxides using incineration and particulate collection techniques. These oxides should be returned to suppliers if possible. Recovery and recycling is an alternative to disposal for beryllium scrap and pickle liquors containing beryllium[22].

References

(109); (102); (31); (173); (101); (138); (2); (100).

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United States Environmental Protection Agency, Beryllium: Ambient Water Quality Criteria, Washington, DC (1979).

United States Environmental Protection Agency, Toxicology of Metals, Vol. 2: Beryllium, Report No. EPA-600/1-77-022, Research Triangle Park, pp. 85−109 (May 1977).

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Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 3, No. 5, 61−64 (1983). (Beryllium Fluoride).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Beryllium (Dust and Powder), Trenton, NJ (July 1998) *Note:* Beryllium Chloride (July 2004), Fluoride (July 2004), Nitrate (June 2005) and Oxide (July 2004) are the subject of fact sheets from the state of New Jersey, quite similar to one another. Also, the chloride, fluoride, nitrate and oxide are the topics of articles cited above. To avoid duplication, separate entries for those four compounds are therefore not included here.

United States Department of the Interior, United States Geological Survey, *The USGS Water Science School, USGS Contaminants Found in Groundwater* (2016), http://water.usgs.gov/edu/groundwater-contaminants.html.

Bifenthrin B:0474

Formula: $C_{23}H_{22}ClF_3O_2$

Synonyms: Biphenthrin; Biflex; Bistar; Brigade; Capture Bifenthrin; Caswell No. 463F; Cyclo propanecarboxylic acid, 3-(2-chloro-3,3,3-trifluoro-1-propenyl)-2,2-dimethyl-, [2-methyl(1,1′-biphenyl)3-yl]methyl ester,*(Z)*-; Discipline; Double threat; Empower; FMC, 54800; FMC 58000; Talstar; Talstar lawn & tree; Torant; Zipak

CAS Registry Number: 82657-04-3

HSDB Number: 6568

RTECS Number: GZ12278000

UN/NA & ERG Number: UN2588 (Pesticides, solid, toxic, n.o.s.)/151; UN3349 (pyrethroid pesticide, solid toxic)/151

Regulatory Authority and Advisory Information

Carcinogenicity[83]: EPA Group C, possible human carcinogen

Hazard Alert: Poison, Possible sensitization hazard (skin), Suspected reprotoxic hazard; Possible endocrine disruptor, Environmental hazard.

Permissible Exposure Limits for Chemical Contaminants (CAL/OSHA) as pyrethrum

Clean water act: Section 311 Hazardous Substances/RQ (same as CERCLA) as pyrethrins

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%

Hazardous to aquatic life or environment, with possible long-lasting effects[293]. Toxic to aquatic life with long-lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xi, N; risk phrases: R40; R11; R20/21/22; R23/25; R36/37/38; R43; R48/22; R50/53; R63; safety phrases: S13; S16; S23; S24; S26; S29/35; S36; S36/37; S38; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Off white to pale tan waxy substance. Faint, sweet odor. Molecular weight = 422.9; specific gravity (H_2O:1) = 1.2125 @ 20°C; boiling point = (decomposes); freezing/melting point = 51°C; 57−63°C; vapor pressure = 1.8×10^{-7} mmHg; flash point = 165°C (oc). Practically insoluble in water; solubility =< 0.1 mg/L

Potential Exposure: A broad spectrum pyrethroid secticide/acaricide used to control cone worms, seed bugs, seed worms and other insects and mites in forests, on rangeland, and right-of-ways. It is also used to control household and lawn pests. A United States Environmental Protection Agency Restricted Use Pesticide (RUP).

Incompatibilities: May react violently with strong oxidizers, bromine, 90% hydrogen peroxide, phosphorus trichloride, silver powders or dust. Incompatible with silver compounds, lime, and ordinary soaps. Mixture with some silver compounds forms explosive salts of silver oxalate.

Permissible Exposure Limits in Air:

NIOSH[2] IDLH = 5000 ppm

OSHA PEL: 5 milligram per cubic meter TWA

NIOSH REL: 5 milligram per cubic meter TWA

ACGIH TLV[1]: 5 milligram per cubic meter TWA

STEL set by HSE[33] = 10 milligram per cubic meter.

Determination in Air: Collection by impinger or fritted bubbler, analysis by gas liquid chromatography/ultraviolet. See NIOSH IV, Method #5008[18], pyrethrum.

Permissible Concentration in Water: ADI = 0.02 mg/kg as pyrethroid. *Fluoride ion*: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guidelines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg [F]/L; Maine 1680 μg[F]/L. Safe Drinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg[F]/L; SMCL = 2 mg/F/L, as Fluoride.

Determination in Water: Octanol−water coefficient: Log K_{ow} => 6.0. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood. Fish toxicity (threshold)[101]: Extra high—0.06197 ppb, MATC.

Routes of Entry: Inhalation, ingestion, dermal and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: May cause irritation of the skin, eyes, and respiratory tract. Skin sensitizer. Overexposure may cause tremors and staggered gait. LD_{50} (oral, rat) = 53−210 mg/kg; LD_{50} (dermal, rat) => 2 g/kg.

Long-Term Exposure: Fluorides may cause bone disease (pain and tenderness of the bones); mottled teeth in children. May be a nerve poison. A suspected carcinogen and endocrine disputer. Human toxicity (long-term)[101]: Intermediate—10.50 ppb, Health advisory.

Points of Attack: Bones, central nervous system; endocrine system (suspected).

Medical Surveillance: This chemical is a suspected or known human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and advice for medical monitoring. Before beginning employment and at regular times after that, the following are recommended: Employees should be screened for history of certain medical conditions which might place the employee at increased risk from pyrethroid exposure. Chronic respiratory disease: In persons with chronic respiratory disease, especially asthma, the inhalation of pyrethroids might cause exacerbation of symptoms due to its sensitizing properties. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. These may be normal if the person is not having an attack at the time of the test. Consider chest X-ray if lung symptoms are present. Skin disease: Pyrethroids can cause dermatitis which may be allergic in nature. Persons with preexisting skin disorders may be more susceptible to the effects of this agent. Evaluation by a qualified allergist, including exposure history and testing, may help diagnose allergy. Any employee developing the above-listed conditions should be referred for further medical examination[9].

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. Give artificial respiration if victim is not breathing. *Do not* use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. *Do not induce vomiting when formulations containing petroleum solvents are ingested.* Otherwise, give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Applicators and other handlers must wear: Coveralls worn over long-sleeved shirt and long pants; Chemical-resistant gloves such as DuPont Tychem suit fabrics, barrier laminate, or Viton; Chemical-resistant footwear plus socks; Protective eye wear; Chemical-resistant headgear for overhead exposure; Chemical-resistant apron when cleaning equipment, mixing, or loading[83]. Agricultural Use/Engineering Controls: When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the WPS for agricultural pesticides, 40 CFR 170.240(d)(4-6), the handler PPE requirements may be reduced or modified as specified in the WPS. Firefighters should wear NIOSH approved SCBA and full protective clothing.

Respirator Selection: NIOSH/OSHA *for pyrethrum*: *50 mg/m^3:* CcrOv95 (APF = 10) [any air-purifying half-mask respirator equipped with an organic vapor cartridge(s) in combination with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator).*125 milligram per cubic meter:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOvHie (APF = 25) (any air-purifying full facepiece respirator equipped with an organic vapor cartridge in combination with a high-efficiency particulate filter). *250 milligram per cubic meter:* CcrFOv100 (APF = 50) [any air-purifying full facepiece respirator equipped with organic vapor cartridge(s) in combination with an N100, R100, or P100 filter]; or PaprTOvHie (APF = 50) [any PAPR with a tight-fitting facepiece and organic vapor cartridge(s) in combination with a high-efficiency particulate filter]; or SCBAF (APF = 50) (any SCBA with full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *5000 milligram per cubic meter:* SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—Blue: Health Hazard/Poison. Store in a secure poison location at temperature <35°C and away from alkaline materials. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN2588 Pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1—Poisonous materials, Technical Name Required. UN3349 Pyrethroid pesticide, solid toxic, Hazard Class: 6.1; Labels: 6.1—Poisonous material.

Spill Handling: First, remove all sources of ignition. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Ventilate area of spill or leak. Use water spray to reduce vapor. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include hydrogen fluoride, hydrogen chloride and oxides of carbon. *On a small fire:* use dry chemical, CO_2 or water spray. On a large fire, use water spray, fog or regular foam. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal; do not scatter the material. Use water spray or fog; do not use straight streams. Fire involving tanks or car/trailer loads: *Fire involving storage or vehicular tanks:* Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Do not get water inside containers. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. ALWAYS stay away from tanks engulfed in fire.

For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies.

Disposal Method Suggested: Incineration would be an effective disposal procedure where permitted. If an efficient incinerator is not available, the product should be mixed with large amounts of combustible material and contact with the smoke should be avoided. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers.

References

(173); (31); (101); (138); (122); (100).

EXTOXNET, Extension Toxicology Network, "Pesticide Information Profile, Bifenthrin," Oregon State University, Corvallis, OR (September 1995). http://extoxnet.orst.edu/pips/bifenthr.htm.

United States Environmental Protection Agency, Office of Pesticide Programs, Pesticide Residue Limits, "Bifenthrin," 40CFR180.442 (2008). http://www.epa.gov/cgi-bin/oppsrch.

Johnson, M., Luukinen, B., Gervais, J., Buhl, K., Stone, D., *Bifenthrin Technical Fact Sheet*; National Pesticide Information Center, Oregon State University Extension Services, Corvallis, OR (2010)

Biphenyl B:0480

Formula: $C_{12}H_{10}$; $C_6H_5C_6H_5$

Synonyms: Bibenzene; 1,1′-Biphenyl; Dibenzene; 1,1′-Diphenyl; Diphenyl; Dowtherm A; Lemonene; Phenador-X; Phenylbenzene; PHPH; Xenene

CAS Registry Number: 92-52-4

HSDB Number: 530

RTECS Number: DU8050000

UN/NA & ERG Number: UN2811 Toxic solids, organic, n.o.s./154

EC Number: 202-163-5 [*Annex I Index No.:* 601-042-00-8]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human Limited Evidence, *probably carcinogenic to humans*, Group 2A (PCBs). United States Environmental Protection Agency Gene-Tox Program, Positive/dose response: In vitro SCE-nonhuman; Negative: In vitro UDS-human fibroblast; In vitro UDS in rat liver; Negative: *S. cerevisiae-homozygosis*.

Hazard Alert: Poison, Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction), Environmental hazard.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV.D.3.b, RQ: 1 lb (0.454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%; NPRI.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: Xi, N; risk phrases: R36/37/38; R51/53; R62; safety phrases: S2; S23; S29; S60; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Biphenyl is a combustible, white flakes or crystalline solid. Pleasant, characteristic odor. Molecular weight = 154.2; specific gravity (H_2O:1) = 1.04; boiling point = 256°C; freezing/melting point = 69−70°C; vapor pressure = 0.005 mmHg @ 20°C; flash point = 113°C; autoignition temperature = 540°C. Explosive limits in air: LEL: 0.6% @ 111°C, UEL: 5.8% @ 166°C[17]. Hazard identification (based on NFPA-704 M Rating System): Health 2, Flammability 1; reactivity 1 ₩. Insoluble in water.

Potential Exposure: Biphenyl is a fungicide (pesticide). It is also used as a heat transfer agent, dye carrier, and as an intermediate in organic synthesis.

Incompatibilities: Mist may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

NIOSH IDLH = 100 milligram per cubic meter

Conversion factor: 1 ppm = 6.31 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 0.2 ppm/1 milligram per cubic meter TWA

NIOSH REL: 0.2 ppm/1 milligram per cubic meter TWA

ACGIH TLV[1]: 0.2 ppm/1.3 milligram per cubic meter TWA

PAC* Ver. 29[138]

PAC-1: 0.87 ppm

PA C-2: $\mathbf{9.6}_{\mathbf{A}}$ ppm

PAC-3: 300 ppm

*AEGLs are marked with a subscript "**A**" and correspond to 60 minute values.

DFG MAK: [skin] Carcinogen Category 3B

Arab Republic of Egypt: TWA 0.2 ppm (1 milligram per cubic meter), 1993; Australia: TWA 0.2 ppm (1.5 milligram per cubic meter), 1999; Austria: MAK 0.2 ppm (1 milligram per cubic meter), 1993; Belgium: TWA 0.2 ppm (1.3 milligram per cubic meter), 1993; Denmark: TWA 0.2 ppm (1 milligram per cubic meter), 1999; Finland: TWA 0.2 ppm (1 milligram per cubic meter); STEL 0.6 ppm (3 milligram per cubic meter) [skin] 1993; France: VME 0.2 ppm (1.5 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 1 milligram per cubic meter, 2003; India: TWA 0.2 ppm (1.5 milligram per cubic meter), 1993; Norway: TWA 0.2 ppm (1 milligram per cubic meter), 1999; Poland: TWA 1 milligram per cubic meter; STEL 2 milligram per cubic meter, 1999; Sweden: NGV 0.2 ppm (1.3 milligram per cubic meter), KTV 0.4 ppm (2.5 milligram per cubic meter), 1999; Switzerland: MAK-W 0.2 ppm (1.3 mg/m^3), 1999; Thailand: TWA 0.2 ppm (1 milligram per cubic meter), 1993; United Kingdom: TWA 0.2 ppm (1.3 milligram per cubic meter); STEL 0.6 ppm (3.8 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV TWA 0.2 ppm. Several states have set guidelines or standards for biphenyl in ambient air[60] ranging from 0.086 μ/m^3 (Massachusetts) to 0.4 μ/m^3 (Rhode Island) to 5.0 μ/m^3 (New York) to 15.0 μ/m^3 (Florida and North Dakota) to 20.0 μ/m^3 (Connecticut) to 25 μ/m^3 (Virginia) to 36 μ/m^3 (Nevada) to 40 μ/m^3 (North Dakota).

Determination in Air: Tenax Gas chromatography; CCl_4; Gas chromatography/Flame ionization detection; NIOSH (IV) Method #2530.

Permissible Concentration in Water: Federal Drinking Water Guidelines: State Drinking Water Guidelines: Florid a 0.5 μg/L, Minnesota 300 μg/L.

Determination in Water: No tests listed. Octanol–water coefficient: Log K_{ow} => 3.2. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation of vapor or dust, percutaneous absorption, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Skin contact contributes significantly to overall exposure. Repeated exposure to dust may result in irritation of skin and respiratory tract. The vapor may cause moderate eye irritation. Repeated skin contact may produce a sensitization dermatitis. In acute exposure, biphenyl exerts a toxic action on the CNS; on the peripheral nervous system (PNS); and on the liver. Symptoms of poisoning are headache; diffuse, gastrointestinal pain; nausea, indigestion; numbness and aching of limbs; and general fatigue. LD_{50} = (oral-rat) 3280 mg/kg[9].

Long-Term Exposure: Chronic exposure is characterized mostly be CNS symptoms, fatigue, headache, tremor, insomnia, sensory impairment; and mood changes. However, such symptoms may be rare. May cause lung irritation and bronchitis. Liver and kidney damage. May cause skin allergy with itching and rash.

Points of Attack: Liver, skin, central nervous system, upper respiratory system, eyes.

Medical Surveillance: Consider skin, eye, liver function, and respiratory tract irritation in any preplacement or periodic examination. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Examination of the nervous system.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Because of its low vapor pressure and low order of toxicity, it does not usually present a major problem in industry. a major problem in industry. Protective creams, gloves, and masks with organic vapor canisters for use in areas of elevated vapor concentrations should suffice. Elevated temperature may increase the requirement for protective methods or ventilation. Wear appropriate clothing to prevent repeated or prolonged skin contact. Wear eye protection to prevent any possibility of eye contact with molten biphenyl. Employees should wash promptly when skin is contaminated. Work clothing should be changed daily as it may be contaminated. Remove nonimpervious clothing immediately if wet or contaminated.

Respirator Selection: *Up to 10 milligram per cubic meter:* CcrOv95 (APF = 10) [any air-purifying half-mask respirator with organic vapor cartridge(s) in combination with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *Up to 25 milligram per cubic meter:* Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOvHie* (APF = 25) (any PAPR with an organic vapor cartridge in combination with a high-efficiency particulate filter). *Up to 50 milligram per cubic meter:* CcrFOv100 (APF = 50) [any air-purifying full facepiece respirator equipped with organic vapor cartridge (s) in combination with an N100, R100, or P100 filter]; or GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or PaprTOvHie* (APF = 50) [any PAPR with a tight-fitting facepiece and organic vapor cartridge(s) in combination with a high-efficiency particulate filter]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) Any supplied-air respirator with a full facepiece. *Up to 100 milligram per cubic meter:* SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (any SCBA that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp:ASCBA (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard: Store in a secure poison location. Before entering confined space where biphenyl may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1—Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/ 75 ft. (NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish ventilation to keep levels below explosive limit. Spill material should be dampened with alcohol to avoid dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak following clean-up. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include oxides of carbon and acrid smoke. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed[22].

References

(31); (173); (101); (138); (80); (100).

National Institute for Occupational Safety and Health (NIOSH), Profiles on Occupational Hazards for Criteria Document Priorities: Diphenyl, Report PB 274,073, Cincinnati, OH pp. 274–276 (1977).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 1, No. 5, 42–43 (1981).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Diphenyl*, Trenton, NJ (December 1998).

Bis(2-Chloroethoxy)-Methane B:0490

Formula: $C_5H_{10}C_{12}O_2$; $ClCH_2CH_2OCH_2OCH_2CH_2Cl$
Synonyms: A13-01455; Bis(β-chlorethyl)formal; Bis(chlorethyl)formal; Bis(2-cloroetoxi)metano (Spanish); β-chloroethyl acetal of form aldehyde; β,β-Dichlorodiethyl formal; Dichlorodiethyl formal; Dichlorodiethyl methylal; 2,2-Dichloroethyl formal; Di-2-chloroethyl formal; Dichloroethyl formal; Dichloromethoxy ethane; Ethane, 1,1′-[methylenebis(oxy)]bis(2-chloro-); Formaldehyde bis (β-chloroethyl) acetal; Formaldehyde bis(2-chloroethyl) acetal; Methane, bis(2-chloroethoxy)-; 1,1-[Methylenebis(oxy)] bis(2-chloroethane)
CAS Registry Number: 111-91-1
HSDB Number: 1333
RTECS Number: PA3675000
UN/NA & ERG Number: UN2810 (toxic liquid, organic, n.o.s.)/153
EC Number: 203-920-2
Regulatory Authority and Advisory Information
Carcinogenicity: EPA: Not Classifiable as to human carcinogenicity.
Hazard Alert: Poison, Combustible, Highly toxic, Primary irritant (w/o allergic reaction), Inhalation hazard
Clean Water Act: 40CFR423, Appendix A, Priority Pollutants
United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U024
RCRA, 40CFR261, Appendix 8 Hazardous Constituents
RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.036; Nonwastewater (mg/kg), 7.2
RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10)
Superfund/EPCRA 40CFR302.4, Appendix A and Section IV.D.3.b, RQ: 1000 lb (454 kg)
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
Hazard symbols, risk, & safety statements: Hazard symbol: T, Xi; risk phrases: R25; R26/28; R36/37/38; safety phrases: S23; S26; S36/37; S45; S53 S41; S45 (see Appendix 4)
Description: Bis(2-chloroethoxy)methane is a colorless liquid. Molecular weight = 173.05; specific gravity (H_2O:1) = 1.24 @ 20°C; boiling point = 218°C; freezing/melting point = −32.8°C; vapor pressure = 0.1 mmHg @ 20°C; flash point = 110°C (oc). Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 1; reactivity 0 ₩. Slight solubility in water; solubility = 0.8%. The aqueous solution is a strong acid.
Potential Exposure: The chloroalkyl ethers have a wide variety of industrial uses in organic synthesis, treatment of textiles; the manufacture of polymers; polysulfide rubbers, and insecticides; as degreasing agents and solvents; and in the preparation of ion exchange resins.
Incompatibilities: The aqueous solution is a strong acid; keep away from bases and alkaline material. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Contact with mineral acids causes decomposition.
Permissible Exposure Limits in Air
PAC Ver. 29[138]
PAC-1: 0.04 ppm
PAC-2: 0.44 ppm
PAC-3: 2.7 ppm
Permissible Concentration in Water: No criteria set because of inadequate data according to EPA.
Determination in Water: Octanol−water coefficient: $\log K_{ow} = < 1$. Unlikely to bioaccumulate in marine organisms.
Harmful Effects and Symptoms
Specific data on this chemical is sparse. The reader is referred to the sections on other chloroalkyl ethers: Chloromethyl methyl ether, CMME: Bis(chloromethyl) ether (B:0510) or BCME: Bis(2-chloroethyl) ether (D:0550). BCIE LD_{50} = (oral-rat) 65 mg/kg[9]. This material is toxic by inhalation and ingestion and is a strong irritant.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.
Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a

pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive pressure mode)

Storage: Color code—Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2810 Toxic liquids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1—Poisonous materials, Technical Name Required.

Spill Handling:

Toxic liquids, organic, n.o.s.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 0.7/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 1000/300
Then: Protect persons downwind (mi/km)
Day 1.1/1.8
Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of carbon. This chemical is a combustible liquid. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥ 100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Destroy by high-temperature incineration with HCl scrubber.

References

(31); (173); (101); (138).

United States Environmental Protection Agency, Haloethers: Ambient Water Quality Criteria, Washington, DC (1980).

United States Environmental Protection Agency, Chloroalkyl Ethers: Ambient Water Quality Criteria, Washington, DC (1980).

United States Environmental Protection Agency, Bis(2-Chloroethoxy)Methane, Health and Environmental Effects Profile No. 23, Washington, DC, Office of Solid Waste (April 30, 1980).

Sax, N.I., Ed., "*Dangerous Properties of Industrial Materials Report*" 7, No. 4, 39–42 (1987).

Bis(2-Chloroisopropyl)ether B:0500

Formula: $C_6H_{12}Cl_2O$; $[ClCH_2CH(CH_3)]_2O$

Synonyms: BCIE; BCMEE; Bis(β-chloroisopropyl) ether; Bis(2-chloro-1-methylethyl) ether; Bis(1-chloro-2-propyl) ether; Bis(2-clorometil)eter (Spanish); (2-Chloro-1-methylethyl) ether; DCIP (nematocide); β,β′-Dichlorodiisopropyl ether; Dichlorodiisopropyl ether; 2,2′-Dichloroisopropyl ether; Dichloroisopropyl ether; Ether, bis(2-chloro-1-methylethyl); NCI-C50044; Nemamort; 2,2′-Oxybis(1-chloropropane); Propane, 2,2′-oxybis(1-chloro-); Propane,2,2′-oxybis (1-chloro)

CAS Registry Number: 108-60-1; (alt.) 52438-91-2

HSDB Number: 503

RTECS Number: KN1750000

UN/NA & ERG Number: UN2490/153

EC Number: 203-598-3

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Limited Evidence; Human No Adequate Data, *not classifiable as carcinogenic to humans*, Group 3, 1999

Hazard Alert: Poison, Flammable, Possible risk of forming tumors, Suspected reprotoxic hazard.

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U027

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.055; Nonwastewater (mg/kg), 7.2

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8010 (100); 8270 (10)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV.D.3.b, RQ: 1000 lb (454 kg)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, F, Xi, Xn; risk phrases: R10; R22; R23/24/25; R36/37/38; R39; R61; safety phrases: S7; S16; S26; S36/37; S41; S45 (see Appendix 4)

Description: Dichloroisopropyl ether is a colorless liquid. Molecular weight = 171.1; specific gravity (H_2O:1) = 1.11 @ 25°C; boiling point = 187−189°C; freezing/melting point = −101°C; vapor pressure = 0.75 @ 27.3°C; flash point = 85°C (oc)[17]. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 2; reactivity 0 ₩. Slightly soluble in water.

Potential Exposure: BCIE was previously used as a solvent and as an extractant. It may be formed as a by-product of propylene oxide production. It has been found in industrial waste water and in natural water.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. It may form dangerous peroxides upon standing; may explode when heated.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 0.15 ppm

PAC-2: 0.1.6 ppm

PAC-3: 22 ppm

Russia: MAC: 5 milligram per cubic meter.

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 300 μg/L; State Drinking Water Guidelines: New Hampshire 300 μg/L.

Determination in Water: Gas chromatography (EPA Method 611) or GC plus mass spectrometry (EPA Method 625). Octanol−water coefficient: Log $K_{ow} = 2.5$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, passing through the skin.

Harmful Effects and Symptoms

There is no empirical evidence that BClE is carcinogenic; however, some chronic toxic effects of the compound have been noted.

Short-Term Exposure: Can cause irritation and burns on contact with eyes, nose and skin. Very high levels of BCIE may cause loss of appetite; fatigue, irritability, and even death. LD_{50} = (oral-rat) 240 mg/kg (moderately toxic)[9].

Long-Term Exposure: There is limited evidence that this chemical may cause cancer in animals; lung adenomas. Many similar solvents can cause brain or disturbed sleep; this chemical has not been fully evaluated for these effects. May cause liver and kidney damage.

Medical Surveillance: Pregnant women should avoid contact. Employees should be notified by a physician that this chemical may affect the reproductive system. In addition to comprehensive initial medical and work histories emphasizing reproductive experience and menstrual history, patient should have physical examination and testing of genitourinary tract, sperm count, motility and morphology. If required, other tests, such as serum testosterone, serum FSH, and serum LH may be indicated. Kidney and liver function tests. Evaluate for brain effects.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 20 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full facepiece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Ethers tend to form unstable peroxides. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area separated from strong oxidants, strong bases; strong acids. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2490 Dichloroisopropyl ether, Hazard Class: 6.1; Labels: 6.1—Poisonous materials.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide; or foam extinguishers. Thermal decomposition products may include hydrogen chloride. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Use special incinerator due to high HCl content, such as seagoing incinerator ships[22].

References

(31); (173); (101); (138).

United States Environmental Protection Agency, Chloroalkyl Ethers: Ambient Water Quality Criteria, Washington, DC (1980).

United States Environmental Protection Agency, Bis(2-Chloroisopropyl) Ether, Health and Environmental Effects Profile No. 25, Washington, DC, Office of Solid Waste (April 30, 1980).

United States Environmental Protection Agency, Chemical Hazard Information Profile Draft Report: Bis(2-Chloro-1-Methylethyl) Ester (BCMEE); Washington, DC (July 29, 1983).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 6, No. 3, 47−49 (1986).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Bis(2-chloro-1-methylethyl)ether, Trenton, NJ (May 1998).

Bis(chloromethyl)ether B:0510

Formula: $C_2H_4Cl_2O$; $ClCH_2OCH_2Cl$

Synonyms: BCME; Bis-chloromethyl ether; Bis(2-chloromethyl) ether; Bis(clorometil)eter (Spanish); Bis-CME; Chloro(chloromethoxy)methane; Chloromethyl ether; Dichlordimethylaether (German); α,α'-Dichlorodimethyl ether; *sym*-Dichlorodimethyl ether; Dichlorodimethyl ether; Dichlorodimethyl ether, *symmetrical*; *sym*-Dichloromethyl ether; Dichloromethyl ether; Dimethyl-1,1′-dichloroether; Ether, bis(chloromethyl); Methane oxybis(chloro-); Monochloromethyl ether; Oxybis(chloromethane)

CAS Registry Number: 542-88-1

HSDB Number: 501

RTECS Number: KN1575000

UN/NA & ERG Number: UN2249/131

EC Number: 208-832-8 [*Annex I Index No.:* 603-046-00-5]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening TQ (pounds): *Release hazard* 1000 (≥1.00% concentration).

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen; Bis(chloromethyl) ether and technical-grade chloromethyl methyl ether; IARC: Human Sufficient Evidence; Animal Sufficient Evidence, *carcinogenic to humans*, Group 1, 1987; EPA: Human Carcinogen. United States Environmental Protection Agency Gene-Tox Program, Positive: Carcinogenicity-mouse/rat

California Proposition 65 Chemical[102]: Cancer 2/27/1987.

Hazard Alert: Exposure can be lethal, Highly flammable, Water reactive, Possible risk of forming tumors, Suspected of causing genetic defects.

OSHA, 29CFR1910 Specifically Regulated Chemicals (CFR1910.1008)

Occupational Safety and Health Administration (OSHA): Highly hazardous chemical: TQ: 500 lb for CMME Bis (chloromethyl)ether

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 1000 lb (454 kg)

Clean Water Act: Section 311 Hazardous Substances/RQ (same as CERCLA); Section 307 Toxic Pollutants. Water Quality Criteria: Based on fish or shellfish and water consumption = 0.00010 μg/L for BCME; based on fish or shellfish consumption only = 0.00029 μg/L for BCME.

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P016

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) RQ = 10 lb for BCME

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA Land Ban Waste

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV.D.3.b, RQ: EHS = 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%. NPRI.

Hazard symbols, risk, & safety statements: Hazard symbol: F, T+; risk phrases: R45; R11; R22; R24; R26; R62; safety phrases: S1; S21; S41; S45; S53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Bis(chloromethyl)ether is a colorless, volatile liquid with a suffocating odor. Molecular weight = 115.0. Specific gravity (H_2O:1) = 1.32 @ 25°C; boiling point = 106.1°C; freezing/melting point = −42°C; vapor pressure = 30 mmHg @ 25°C; flash point = ≤18.8°C. Class IB Flammable Liquid: Flash point <23°C/73°F and Boiling point ≥37.8°C/100°F. Hazard identification (based on NFPA-704 M Rating System): Health 4; flammability 3; reactivity 1 ₩. Insoluble in water; decomposes, releasing hydrogen chloride.

Potential Exposure: Exposure to bis(chloromethyl)ether may occur in industry and in the laboratory. This substance can form spontaneously in warm moist air by the combination of formaldehyde and hydrogen chloride. This compound is used as an alkylating agent in the manufacture of polymers; as a solvent for polymerization reactions; in the preparation of ion exchange resins; and as an intermediate for organic synthesis. Haloethers, primarily α-chloromethyl ethers, represent a category of alkylating agents of increasing concern due to the establishment of a causal relationship between occupational exposure to two agents of this class and lung cancer in the United States and abroad. The cancers are mainly oat cell carcinomas. Potential sources of human exposure to BCME appear to exist primarily in areas including: (1) its use in chloromethylating (crosslinking) reaction mixtures in anion-exchange resin production; (2) segments of the textile industry using formaldehyde-containing reactants and resins in the finishing of fabric and as adhesive in the laminating and flocking of fabrics; and (3) the nonwoven industry which uses as binders, thermosetting acrylic emulsion polymers comprising methylol acrylamide, since a finite amount of formaldehyde is liberated on the drying and curing of these bonding agents. NIOSH has confirmed the spontaneous formation of BCME from the reaction of formaldehyde and hydrochloric acid in some textile plants and is now investigating the extent of possible worker exposure to the carcinogen. However, this finding has been disputed by industrial tests in which BCME was not formed in air by the reaction of textile systems employing hydrochloric acid and formaldehyde.

Incompatibilities: May form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Decomposes on contact with water, moist air, and heat, forming corrosive hydrochloric acid, hydrogen chloride, and formaldehyde vapors. May form shock-sensitive compounds on contact with oxidizers, peroxides, and sunlight. Attacks many plastics.

Permissible Exposure Limits in Air

NIOSH IDLH = Not determined. Potential occupational carcinogen

OSHA PEL: Cancer suspect agent. Exposures of workers to this chemical is to be controlled through the required use of engineering controls, work practices; and personal protective equipment, including respirators. See 29 CFR 1910.1003-1910.1016 for specific details of these requirements. See Appendix B of the *NIOSH Pocket Guide*.

NIOSH REL: Limit exposure to lowest feasible concentration. NIOSH considers this chemical to be a potential occupational carcinogen as defined by the OSHA carcinogen policy [29 CFR 1990]. See *NIOSH Pocket Guide*, Appendix A

ACGIH TLV[1]: 0.001 ppm/0.0047 milligram per cubic meter TWA, Confirmed Human Carcinogen

PAC* Ver. 29[138]

PAC-1: 0.004 ppm

PAC-2: **0.044**$_{\mathbf{A}}$ ppm

PAC-3: **0.18**$_{\mathbf{A}}$ ppm

*AEGLs are marked with a subscript "**A**" and correspond to 60 minute values.

DFG MAK: Carcinogen Category 1

Australia: TWA 0.001 ppm (0.006 milligram per cubic meter), carcinogen, 1993; Austria: carcinogen, 1999; Belgium: TWA 0.001 ppm (0.0047 milligram per cubic meter), carcinogen, 1993; Denmark: TWA 0.001 ppm (0.005 milligram per cubic meter), 1999; Finland: TWA 0.001 ppm (0.004 milligram per cubic meter); STEL 0.003 ppm, carcinogen, 1999; France: VME 0.001 ppm (0.006 milligram per cubic meter), carcinogen, 1999; India: TWA 0.001 ppm (0.005 milligram per cubic meter), carcinogen, 1993; Norway: TWA 0.001 ppm (0.005 milligram per cubic meter), 1999; Sweden: carcinogen, 1999; Switzerland: MAK−W 0.001 ppm (0.005 milligram per cubic meter), carcinogen, 1999; United Kingdom: TWA 0.001 ppm (0.005 milligram per cubic meter), carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New

Zealand, Singapore, Vietnam: ACGIH TLV: Confirmed Human Carcinogen. The Czech Republic[35] has set a TWA of 0.00025 milligram per cubic meter and a ceiling value of 0.005 milligram per cubic meter.

Determination in Air: Collection by charcoal tube, analysis by gas liquid chromatography.

Permissible Concentration in Water: For maximum protection of human health from potential carcinogenic effects of exposure to BCME through ingestion of water and contaminated aquatic organisms, the ambient water concentration is zero. Concentrations of BCME estimated to result in additional lifetime cancer risks of 1 in 100,000 are presented by a concentration of 0.038 ng/l (3.8×10^{-5} μg/L)[6]. Kansas has set a guideline for drinking water also[61].

Determination in Water: Gas chromatography (EPA Method 611) or GC plus mass spectrometry (EPA Method 625). Octanol−water coefficient: Log $K_{ow} =< 1.5$. Unlikely to bioaccumulate in marine organisms. Clean Water Act, Water Quality Criteria: Based on fish or shellfish and water consumption = 0.00010 μg/L; based on fish or shellfish Consumption only = 0.00029 μg/L.

Routes of Entry: Inhalation of vapor and percutaneous absorption.

Harmful Effects and Symptoms

Bis(chloromethyl) ether has an extremely suffocating odor even in minimal concentration so that experience with acute poisoning is not available. It is not considered a respiratory irritant at concentrations of 10 ppm. Bis(chloromethyl) ether is a known human carcinogen. Animal experiments have shown increases in lung adenoma incidence; olfactory esthesioneuroepitheliomas which invaded the sinuses, cranial vault, and brain; skin papillomas and carcinomas; and subcutaneous fibrosarcomas. There have been several reports of increased incidence of human lung carcinomas (primarily small cell undifferentiated) among ether workers exposed to bis(chloromethyl) ether as an impurity. The latency period is relatively short-10−15 years. Smokers as well as nonsmokers may be affected.

Short-Term Exposure: This chemical is corrosive to the eyes, skin, and respiratory tract. Inhalation can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Affects the nervous system. Symptoms can be loss of appetite; nausea, and fatigue; higher exposures can cause irritability, anxiety, and weakness.

Long-Term Exposure: Can cause liver and kidney damage. Lungs may be affected by repeated or prolonged exposure. This substance is carcinogenic to humans and has caused lung cancer in humans. May cause genetic damage in humans.

Points of Attack: Skin, respiratory tract, eyes, lungs.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Pregnant women should avoid contact. Employees should be notified by a physician that this chemical may affect the reproductive system. In addition to comprehensive initial medical and work histories emphasizing reproductive experience and menstrual history, patient should have physical examination and testing of genitourinary tract, sperm count, motility and morphology. If required, other tests, such as serum testosterone, serum FSH, and serum LH may be indicated. Preplacement and periodic medical examinations should include an examination of the skin and respiratory tract, including chest X-ray. Sputum cytology has been suggested as helpful in detecting early malignant changes; and in this connection, a smoking history is of importance. Possible effects on the fetus should be considered. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: These are designed to supplement engineering controls and should be appropriate for protection of all skin or respiratory contact. Full body protective clothing and gloves should be used on entering areas of potential exposure. Those employed in handling operations should be provided with full face, supplied air respirators of continuous flow or pressure demand type. Wash thoroughly *immediately* following exposure to this chemical. On exit from a regulated area, employees should remove and leave protective clothing and equipment at the point of exit, to be placed in impervious containers at the end of the work shift for decontamination or disposal. Showers should be taken before dressing in street clothes.

Respirator Selection: NIOSH: *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

Storage: (1) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. (2) Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in airtight containers in a cool, dry, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Mine Safety and Health Administration: To control airborne exposure, BCME shall be used or stored except by competent persons under laboratory conditions approved by a nationally recognized agency acceptable to the Secretary.

Shipping: UN2249 Dichlorodimethyl ether, symmetrical, Hazard class: 6.1; Labels: 6.1—Poisonous materials, 3—Flammable liquid.

Spill Handling: Evacuate area. Seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line). Full body protective clothing and gloves should be used on entering areas of potential exposure. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Wear positive pressure breathing apparatus and special protective clothing. Remove and isolate contaminated clothing at the site. *Spill or leak:* do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills:* absorb with sand or other noncombustible material and place into containers for later disposal. *Large spills:* dike far ahead of spills for later disposal. Do NOT let this chemical enter the environment (extra personal protection: complete protective clothing including SCBA). Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include hydrogen chloride. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced[22].

References

(109); (102); (31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chloroalkyl Ethers: Ambient Water Quality Criteria, Washington, DC (1980).

United States Environmental Protection Agency, Haloethers: Ambient Water Quality Criteria, Washington, DC (1980).

United States Environmental Protection Agency, Bis (Chloromethyl) Ether, Health and Environmental Effects Profile No. 26, Washington, DC, Office of Solid Waste (April 30, 1980).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 6, No. 3, 49−52 (1986).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Chloromethyl Ether, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

United States Public Health Service, "Toxicological Profile for Bis(Chloromethyl) Ether," Atlanta, Georgia, agency for Toxic Substances and Disease Registry (December 1988).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Bis(2-chloromethyl) ether, Trenton, NJ (June 2003).

Bis(chloromethyl)ketone B:0520

Formula: $C_3H_4Cl_2O$; $ClCH_2COCH_2Cl$
Synonyms: Bis(chloromethyl) ketone; *sym*-Dichloroacetone; α,α′-Dichloroacetone; α,γ′-Dichloroacetone; 1,3-Dichloroacetone; 1,3-Dichloro-2-propanone
CAS Registry Number: 534-07-6
HSDB Number: 6391
RTECS Number: UC1430000
UN/NA & ERG Number: UN2649/153
EC Number: 208-585-6

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction).

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 10/10,000 lb (4.54/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV.D.3.b, RQ: EHS = 10 lb (4.54 kg)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, F, Xn, Xi; risk phrases: R11; R22; R23/24/25; R36/37/38; R39; R51; R62; safety phrases: S7; S16; S26; S36/37; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [2-Hazard to water. (est.)].

Description: Bis(chhloromethyl)ketone is a crystalline solid. Molecular weight = 126.97; freezing/melting point = 45°C; specific gravity (H_2O:1) = 1.38 @ 46°C; boiling point = 173°C. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 1; reactivity 0 ₩. Soluble in water.

Potential Exposure: Formerly extensively used in textiles (especially polyester fabrics) and still employed in polyurethane foams, textile backcoating and adhesives.

Permissible Exposure Limits in Air

PAC Ver. 29[138]
PAC-1: 0.025 milligram per cubic meter
PAC-2: 0.27 milligram per cubic meter
PAC-3: 1 milligram per cubic meter

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: It causes tearing and blistering. It may be fatal if inhaled, swallowed or absorbed through skin. Contact may cause burns to skin and eyes.

Long-Term Exposure: Due to the availability of insufficient data on short-term effects, caution should be exercised.

Medical Surveillance: See: NIOSH Criteria Document: *78-173 Ketones*.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Keep away from sources of ignition. Store in a refrigerator, in a tightly closed container. Store below 4°C. Keep away from oxidizers, heat, flame, and sparks.

Shipping: UN2649 1,3-Dichloroacetone, Hazard class: 6.1; Labels: 6.1—Poisonous materials.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Avoid inhalation; wear respiratory protection, eye protection and protective clothing. In case of contact, immediately flush skin or eyes with water. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. For small spills, absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills:* with clean shovel place material into clean, dry container and cover; move containers from spill area. *For Large spills:* dike far ahead of spill for later disposal. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: For small fires, use dry chemical, carbon dioxide; water spray; or foam. For large fires, use water spray, fog, or foam. Thermal decomposition products may include chlorine. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Bis(chloromethyl)ketone,

Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Bis(chloro methyl) ketone, #2170, Trenton, NJ (April, 2000).

Bismuth B:0530

Formula: Bi

Synonyms: Bismuth-209; Bismuto (Spanish)

Bismuth compounds: Bismuth acetate 22306-37-2; Bismuth germanate 12233-73-7; Bismuth hydroxide 10361-43-0; Bismuth hydroxide nitrate oxide 1304-85-4; Bismuth iodide 7787-64-6; Bismuth nitrate 10361-44-1; Bismuth oxide 1304-76-3; Bismuth oxychloride (Bismuth chloride oxide) 7787-59-9; Bismuth(III) nitrate, pentahydrate 10035-06-0; Potassium bismuthate 12589-75-2; Sodium bismuthate 12232-99-4

CAS Registry Number: 7440-69-9

HSDB Number: 2078

RTECS Number: EB2600000

UN/NA & ERG Number: UN3089 (metal powder, flammable, n.o.s.)/170

EC Number: 231-177-4

Regulatory Authority and Advisory Information

7440-69-9 (bismuth, elemental)

CERCLA/SARA Section 302, Extremely Hazardous Substances: TPQ = 10 lb/10,000 lb (4.54/4540 kg)

Banned or Severely Restricted (In medicine) (UN)[13]

Mexico, wastewater as heavy metals.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%. (carcinogen)

Hazard symbols, risk, & safety statements: Hazard symbol: F, C, Xi, O; Risk Statements: R8; R11; R34; R36/37/38; Safety Statements: S16; S26; S36/37/39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Bismuth is a pinkish-silver, hard, brittle metal. It is found as the free metal in ores, such as bismutite and bismuthinite and in lead ores. Molecular weight = 209.0; specific gravity (H_2O:1) = 9.8, no temperature cited; boiling point = 1420−1560°C; freezing/melting point = 271°C. Hazard identification (based on NFPA-704 M Rating System): (bismuth) Health 2; flammability 0; reactivity 0 ₩. Insoluble in water.

Bismuth acetate: Molecular weight = 386.1; Bismuth germanate: 297.6; Bismuth hydroxide: 260.

Potential Exposure: Bismuth is used as a constituent of tempering baths for steel alloys; in low Freezing/Melting point alloys which expand on cooling; in aluminum and steel alloys to increase machinability; and in printing type metal. Bismuth compounds are found primarily in pharmaceuticals as antiseptics, antacids, antiluetics, and as a medicament in the treatment of acute angina. They are also used as a contrast medium in roentgenoscopy and in cosmetics. For the general population the total intake from food is 5−20 μg with much smaller amounts contributed by air and water.

Incompatibilities: Finely divided powder is highly flammable. Reacts with strong acids and strong oxidizers, chlorine, fused ammonium nitrates, iodine pentafluoride, and nitrosyl fluoride.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

7440-69-9, bismuth

PAC-1: 15 milligram per cubic meter

PAC-2: 170 milligram per cubic meter

PAC-3: 990 milligram per cubic meter

22306-37-2, bismuth acetate

PAC-1: 30 milligram per cubic meter

PAC-2: 330 milligram per cubic meter

PAC-3: 2000 milligram per cubic meter

10361-43-0, bismuth hydroxide

PAC-1: 19 milligram per cubic meter

PAC-2: 210 milligram per cubic meter

PAC-3: 1200 milligram per cubic meter

10361-44-1 bismuth nitrate

PAC-1: 12 milligram per cubic meter

PAC-2: 139 milligram per cubic meter

PAC-3: 790 milligram per cubic meter

There is no Federal standard for bismuth metal. ACGIH has set TWA values for bismuth telluride only (see B:0540). Tellurium compounds are both an oral and dermal toxic hazard. The material is toxic by ingestion. Oral ingestion of tellurium compounds is generally regarded as extremely toxic. The probable oral lethal dose is 5−50 mg/kg or between 7 drops and 1 teaspoonful for a 70-kg (150 pound) person. Tellurium compounds are regarded as super toxic for skin exposures.

Permissible Concentration in Water: No criteria set but EPA[32] has suggested an ambient limit of 3.5 μg/L based on health effects. Russia[43] set a MAC of 0.5 mg/L of trivalent bismuth and 0.1 mg/L of pentavalent bismuth.

Determination in Water: Atomic absorption spectrophotometry may be used[1]. Spark source mass spectrometry may also be used.

Routes of Entry: Ingestion of powder or inhalation of dust.

Harmful Effects and Symptoms

Most accounts of bismuth poisoning are from the soluble compounds used previously in therapeutics. Bismuth compounds have been withdrawn from pharmaceuticals because of reports of encephalopathy[13]. Fatalities and near fatalities have been reported chiefly as a result of intravenous or intramuscular injection of soluble salts.

Short-Term Exposure: Bismuth and bismuth compounds have slight effect on intact skin and mucous membrane. Absorption occurs only minimally through broken skin.

Long-Term Exposure: All bismuth compounds do not have equal toxicity. Although considered less hazardous than most heavy metals, can cause kidney and possible liver damage. Chronic intoxication from repeated oral or parenteral doses causes "bismuth line," a gum condition with black spots of buccal and colonic mucosa, superficial stomatitis; foul breath; and salivation.

Points of Attack: Kidneys, liver.

Medical Surveillance: No special considerations are necessary other than following good general health practices. Liver and kidney function should be followed if large amounts of soluble salts are ingested.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. *Note:* Dimercaptol (BAL) brings good results in the treatment of bismuth poisoning if given early. Other measures include atropine and meperidine to relieve gastrointestinal discomfort. *Note to physician:* For severe poisoning BAL, dimercaprol, dithiopropanol ($C_3H_8OS_2$) has been used to treat toxic symptoms of certain heavy metals poisoning. In the case of bismuth poisoning it may have *some* value. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Personal hygiene should be stressed, and eating should not be permitted in work areas. Dust masks should be worn in dusty areas to prevent inadvertent ingestion of the soluble bismuth compounds.

Storage: Color code—Red Stripe (*bismuth powder*) Flammability Hazard: Do not store in the same area as other flammable materials. Prior to working with bismuth all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from acetylene gas, oxidizers, and other incompatible materials listed above. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where bismuth powder is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Store to avoid conditions which create fumes or fine dusts.

Shipping: UN3089 Metal powders, flammable, n.o.s., Hazard Class: 4.1; Labels: 4.1—Flammable solid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of metal. Use extinguishers suitable for surrounding fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve in a minimum amount of concentrated HCl. Dilute with water until precipitate is formed. Redissolve in HCl. Then saturate with H_2S. Filter, wash, dry and return to supplier.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Toxicology of Metals, Vol. II: Bismuth, Report EPA-600/1-77-022. Research Triangle Park, NC, pp. 110–123 (May 1977).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 1, No. 5, 43–45 (1981) and 3, No. 5, 64–65 (1983).

Bismuth Telluride B:0540

Formula: Bi_2Te_3

Synonyms: Bismuth telluride, undoped; Bismuth sesquitelluride; Dibismuth telluride

Doped: Doped bismuth sesquitelluride; Doped bismuth telluride; Doped tellurobismuthite; Doped bismuth tritelluride (*Note*: Doped with selenium sulfide (SeS). Commercial mix may contain 80% Bi_2Te_3, 20% stannous telluride, plus some tellurium[77].)

Undoped: Bismuth sesquitelluride, Bismuth telluride, Bismuth tritelluride, Tellurobismuthite

CAS Registry Number: 1304-82-1; 37293-14-4 (doped and undoped)

HSDB Number: 7904

RTECS Number: EB311000 (undoped)

UN/NA & ERG Number: UN3284 (tellurium compound, n.o.s.)/151

EC Number: 215-135-2

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Combustible, Slowly reacts with moisture; may be explosive.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. (1304-82-1).

Hazard symbols, risk, & safety statements: Hazard symbol: Xn; risk phrases: R20/21/22; R36/R37; R38; safety phrases: S26; S36; S41; S45 (see Appendix 4)

Description: Bismuth telluride is a gray or black crystalline solid or gray powder. Molecular weight = 800.83; Specific gravity (H_2O:1) = 7.8 g/cm^3; freezing/melting point = 586°C; vapor pressure = 0 mmHg @ 20°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 2; reactivity 2 ₩. *Note:* Commercial mix of doped bismuth tritelluride may contain 80% Bi_2Te_3, 20% stannous telluride, plus some tellurium. Insoluble in water. Doped and undoped have similar physical properties.

Potential Exposure: Bismuth telluride is used in thermoelectric cooling, power generation, semiconductor manufacture; pharmaceuticals; medical therapy; cosmetics. Exposure involves those working in "Silicon Valley" and similar locations around the world. An alloy of two metallic elements that are sometimes doped with SeS. The SeS dopant alters the electrical properties, but has too low a concentration to affect the chemical properties[101].

Incompatibilities: Reacts with acids forming toxic gases. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Toxic and flammable gas may slowly evolve from contact with moisture.

Permissible Exposure Limits in Air

Undoped

OSHA PEL: 15 milligram per cubic meter TWA, total dust; 5 milligram per cubic meter TWA, respirable fraction (undoped); None (doped with Se)

NIOSH REL: 10 milligram per cubic meter TWA, total dust; 5 milligram per cubic meter TWA, respirable fraction; 5 milligram per cubic meter TWA (doped with Se)

ACGIH TLV[1]: 10 milligram per cubic meter (undoped) TWA; 5 milligram per cubic meter TWA (doped with Se); not classifiable as a human carcinogen

No PAC available.

Australia: TWA 10 milligram per cubic meter, 1993; Australia: TWA 5 milligram per cubic meter, 1993; Austria: MAK 0.1 mg(Te)/m^3, 1999; Belgium: TWA 10 milligram per cubic meter, 1993; Belgium: TWA 5 milligram per cubic meter, 1993; Denmark: TWA 10 milligram per cubic meter, 1999; France: VME 10 milligram per cubic meter, 1999; France: VME 5 milligram per cubic meter, 1993; the Netherlands: MAC-TGG 10 milligram per cubic meter, 2003; Norway: TWA 10 milligram per cubic meter, 1999; Switzerland: MAK-W 0.1 milligram per cubic meter, KZG-W 0.5 milligram per cubic meter, 1999; United Kingdom: TWA 10 milligram per cubic meter; STEL 20 milligram per cubic meter, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Several states have set guidelines or standards for bismuth telluride in ambient air [60] ranging from 0.05 milligram per cubic meter (North Dakota) to 0.08 milligram per cubic meter (Virginia) to 0.2 milligram per cubic meter (Connecticut) to 0.238 milligram per cubic meter (Nevada).

Determination in Air: Use NIOSH Analytical Methods #0500, #0600, or OSHA Analytical Method ID-121 Metal & Metalloid Particulates in work-place Atmospheres (Atomic Absorption).

Routes of Entry: Inhalation/ingestion of dust, eye/skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Tellurium compounds are both an oral and dermal toxic hazard. Tellurium compounds are regarded as super toxic for skin exposures. Oral ingestion of tellurium compounds is generally regarded as extremely toxic. The probable oral lethal dose is 5−50 mg/kg or between 7 drops and 1 teaspoonful for a 70-kg (150 pound) person. Bismuth telluride is harmful if inhaled; may cause respiratory tract irritation. Harmful if absorbed through skin. Eye contact causes irritation and redness. The material is toxic by ingestion. May cause nausea, headache, and vomiting.

Long-Term Exposure: Lung changes may occur. It is unknown at this time whether these can be permanent. Can affect the kidneys and possibly the liver; bismuth nephropathy (with proteinuria) may occur. Bismuth may affect the amniotic fluid and fetus. in animals: pulmonary lesions (nonfibrotic)[77].

Points of Attack: Kidneys, liver.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: For severe poisoning BAL, dimercaprol, dithiopropanol ($C_3H_8OS_2$) has been used to treat toxic symptoms of certain heavy metals poisoning. In the case of bismuth poisoning it may have SOME value. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: *Clothing:* Avoid skin contact with Bismuth Telluride. Wear protective gloves and clothing. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. *Eye Protection:* Wear dust-proof goggles when working with powders or dust, unless full facepiece respiratory protection is worn.

Respirator Selection: Where there is potential exists for Exposures over *10 mg/m*^{3}, use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure demand or other positive pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Bismuth telluride must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluoride), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from moisture.

Shipping: UN3284 Tellurium compound, n.o.s., Hazard Class: 6.1; Labels: 6.1—Poisonous materials, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Absorb liquid containing Bismuth telluride in vermiculite, dry sand; earth, or similar material. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: For small fires, use dry chemical, carbon dioxide; water spray; or foam. Extinguish fire using an agent suitable for the type of surrounding fire; Bismuth telluride itself does not burn. Thermal decomposition products may include bismuth oxides and tellurium oxide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (2).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Bismuth Telluride*, Trenton, NJ (November 2001).

Bisphenol A B:0550

Formula: $C_{15}H_{16}O_2$; $HOC_6H_4C(CH_3)_2{-}C_6H_4OH$

Synonyms: Bisfenol A (Spanish); Bisferol A (German); Bis(4-hydroxyphenyl)dimethylmethane; β,β′-Bis(*p*-hydroxyphenyl) propane; 2,2-Bis(*p*-hydroxyphenyl)propane; 2,2-Bis(4-hydroxyphenyl)propane; Bis(*p*-hydroxyphenyl)propane; *p,p*′-Bisphenol A; Dian; Diano; *p,p*′-Dihydroxydiphenyldimethylmetane; 4,4′-Dihydroxydiphenyldimethylmetane; *p,p*′-Dihydroxydiphenylpropane; 2,2-(4,4′-Dihydroxydiphenyl)propane; 4,4′-Dihydroxy-2,2-diphenylpropane; 4,4′-Dihydroxy-diphenyl-2,2-propane; 4,4′-Dihydroxydiphenylpropane; β-Di-*p*-hydroxyphenylpropane; 2,2-Di(4-hydroxyphenyl)propane; Dimethyl bis(*p*-hydroxyphenyl)methane; Di-methylmethylene *p,p*′-diphenol; 2,2-Di(4-phenylol)propane; Diphenylolpropane; Ipognox 88; *p,p*′-Isopropilidendifenol (Spanish); Isopropylidenebis(4-hydroxybenzene); *p,p*′-Isopropyl-idenebisphenol; 4,4′-Isopropylidenebis(phenol); *p,p*′-Isopropylidenediphenol; 4,4′-Isopropyl-idenediphenol; 4,4′-(1-Methylethylidene)bisphenol; NCI-C50635; Parabis A; Phenol, 4,4′-isopropylidenedi-; Phenol, 4,4′-(1-methylethylidene)bis-; Pluracol 245; Rikabanol; UCAR Bisphenol HP

CAS Registry Number: 80-05-7

HSDB Number: 513

RTECS Number: SL6300000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 201-245-8 [*Annex I Index No.:* 604-030-00-0]

Regulatory Authority and Advisory Information

Carcinogenicity: NCI: Carcinogenesis: Studies (feed); equivocal evidence: mouse, rat; Bioassay (feed); inadequate studies: mouse, rat

California Proposition 65 Chemical[102]: *delisted developmental, female 4/11/2013.*

Hazard Alert: Combustible, Endocrine disruptor (high), Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxichazard, Sensitization hazard, Primary irritant (w/o allergic reaction), Environmental hazard.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%; NPRI.

Hazardous to aquatic life or environment, with possible long-lasting effects[293]. Toxic to aquatic life with long-lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xn, N, Xi; risk phrases: R36/37/38; R41; R43; R51; R52; R62; R63; safety phrases: S2; S24; S26; S29/35; S36/37; S39; S41; S46; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Bisphenol A is a white or tan crystals or flakes with a mild phenolic odor. Molecular weight = 228.29; Specific gravity (H_2O:1) = 1.2; boiling point = 220°C @ 4 mmHg; freezing/melting point = 153°C; Flash point = 207°C (oc); Autoignition temperature = 600°C. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 1; reactivity 0 ₩. Practically insoluble in water; solubility = 120 mg/L.

Potential Exposure: Workers engaged in the manufacture of epoxy, polysulfone, polycarbonate and certain polyester resins. It is also used in flame retardants, rubber chemicals, and as a fungicide. Bisphenol A (BP A), an environmental estrogen, is found in a wide variety of products, including polycarbonate bottles food and drink containers. According to 2008 research conducted at University of Cincinnati, when it comes to BPA, it's not whether polycarbonate bottles are new or old but the liquid's temperature that has the greatest impact on how much BPA is released. When exposed to boiling hot water, BPA was released 55 times more rapidly than exposure to cold water.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, acid chlorides and acid anhydrides.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 15 milligram per cubic meter

PAC-2: 110 milligram per cubic meter

PAC-3: 650 milligram per cubic meter

DFG MAK: 5 mg/m^3, inhalable fraction TWA; Peak Limitation Category I(1); photosensitization; Pregnancy Risk Group C

Russia: STEL 5 milligram per cubic meter, 993; the Netherlands: MAC-TGG 5 milligram per cubic meter (respirable dust); 10 milligram per cubic meter (total dust), 2003.

It should be recognized that bisphenol-A can be absorbed through the skin, thereby increasing exposure.

Determination in Air: OSHA Method 1018 (December 2013). Bisphenol A and Diglycidyl Ether of Bisphenol A.

Determination in Water: Octanol−water coefficient: Log K_{ow} => 3.3. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood. Fish Tox (benzamide) LC_{50} (fathead minnow, 96 h.) = 4.6 mg/L.

Routes of Entry: Passes through the unbroken skin; inhalation; ingestion.

Harmful Effects and Symptoms

Bisphenol-A and its resins produce a typical contact dermatitis; redness and edema with weeping, followed by crusting and scaling, usually confined to the area of contact. Since the face is frequently affected, this may indicate that vapors are the cause, although contact with contaminated clothing can also be a factor. Areas other than the face and neck, back of hands, and forearms are seldom involved. LD_{50} = (oral-rat) 3250 mg/kg[9] which is slightly toxic. Dusts may cause irritation to mouth, nose or throat and can cause eye irritation. As regards ingestion, comparison with phenol suggests probable symptoms would include nausea, burning of mouth, throat and stomach; severe stomach pain; stomach ulcers; vision disturbances; irregular breathing and pulse, dizziness, fainting, coma and possible death. Animal studies suggest that death may occur from ingestion of about 1/3 pound (6 ounces) for a 15-lb person. On long-term exposure, susceptible individuals may become sensitized after repeated or prolonged contact and thereafter exhibit an allergic response. Allergy may include reaction to many epoxy resins containing bisphenol A.

Short-Term Exposure: Eye and skin contact can cause irritation and burns. May irritate the respiratory tract.

Long-Term Exposure: May cause skin sensitization and allergy. There is limited evidence that this chemical may damage the developing fetus.

Points of Attack: Skin.

Medical Surveillance: Evaluation by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is

worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Dust mask should be worn to protect against inhaled dust. Fire fighters should wear SCBA to protect against noxious fumes.

Storage: Color code—Green: General storage may be used. Store away from heat and strong oxidizers and the incompatible materials listed above.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9—Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Vacuum cleaning is preferable to sweeping to keep dust levels down. Use special HEPA vacuum; not a shop vacuum. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Bisphenol A is a combustible solid. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. Thermal decomposition products may include oxides of carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(102); (31); (173); (101); (138); (100).

National Institute for Occupational Safety and Health (NIOSH), Information Profiles on Potential Occupational Hazards (Bisphenol-A), Rockville, Maryland (March 29, 1978).

New York State Department of Health, Chemical Fact Sheet: Bisphenol-A, Albany, New York, Bureau of Toxic Substance Assessment (October 1984).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Bisphenol A.*, Trenton, NJ (May 1998).

Bithionol B:0560

Formula: $C_{12}H_6Cl_4O_2S$

Synonyms: Actamer; Bidiphenbis(2-hydroxy-3,5-dichlorophenyl) sulfide; Bithinol sulfide; Bitin; CP3438; 2,2′-Dihydroxy-3,3′,5,5′-tetrachlorodiphenyl sulfide; 2-Hydroxy-3,5-dichlorophenyl sulphide; Lorothidol; NCI-C60628; Neopellis; TBP; 2,2′-Thiobis(4,6-dichlorophenol); Vancide BL; XL 7

CAS Registry Number: 97-18-7

HSDB Number: 6380

RTECS Number: SN0525000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 202-565-0

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Combustible, Environmental hazard.

Banned or Severely Restricted (USA, Japan) (UN)[13]

TSCA 40CFR716.120(a)

CLEAN WATER ACT: Toxic Pollutant (Section 401.15) as chlorinated phenols

EPCRA Section 313 Form R *de minimus* concentration reporting level: 0.1%, as chlorophenols

United States DOT Regulated marine pollutant (49CFR 172.101, Appendix B) as chlorophenols.

Hazard symbols, risk, & safety statements: Hazard symbol: T; risk phrases: R27/28; R50/53; safety phrases: S13; S28; S41; S45 (see Appendix 4)

Description: Bithionol is a white or grayish powder with a slight phenolic odor. Molecular weight = 365.03; freezing/melting point = 188°C; vapor pressure = very low. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 1; reactivity 0 ₩.

Potential Exposure: It is used as a surfactant-formulated antimicrobial against bacteria, molds and yeast. It is proposed as an agricultural fungicide. Other uses include deodorant, germicide, fungistat, and in the manufacture of pharmaceuticals. It is no longer allowed to be used in cosmetics. A food additive in feed and drinking water of animals. Also a food additive permitted in food for human consumption.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

DFG MAK: Danger of photosensitization.

Routes of Entry: Ingestion, skin and/or eye contact

Harmful Effects and Symptoms

Probable oral lethal dose for humans is 5−15 g/kg for a 70-kg (150 lb) person. The toxicity of this compound is similar to that of phenol. Major hazard of phenol poisoning stems from its systemic effects which include CNS depression with coma, hypothermia, loss of vasoconstrictor tone, cardiac depression, and respiratory arrest. Symptoms of exposure include burning pain in mouth and throat; white necrotic lesions in mouth, esophagus and stomach; abdominal pain; vomiting, bloody diarrhea; paleness; sweating; weakness; headache; dizziness; tinnitus; scanty, dark-colored urine; weak irregular pulse, and shallow respiration.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/ manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: For emergency situations, wear a positive pressure, pressure-demand, full facepiece SCBA or pressure-demand supplied air respirator with escape SCBA.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Store in a refrigerator or a cool dry place.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1—Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/ 75 ft(NJ). Isolation Distance, Fire: 800 m/0.5 miles[70]. Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen spilled material with 60%−70% acetone to avoid airborne dust. Stay upwind. Do not touch spilled material. Use water spray to reduce vapors. Absorb spills with noncombustible absorbent material. For *large spills* dike far ahead for later disposal. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include sulfur oxides and chlorine. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138).

United States Environmental Protection Agency, Chemical Hazard Information Profile: 2,2′-Thiobis (4,6-Dichlorophenol), Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

Bitoscanate B:0570

Formula: $C_8H_4N_2S_2$

Synonyms: Biscomate; Bitoscanat; 1,4-Diisothiocyanatobenzene; Isothiocyanic acid, 1,4-phenylenedi-; Isothiocyanic acid *p*-phenylene ester; JONIT; *p*-Phenylene bisisothiocyanate; 1,4-Phenylene diisosthiocyanic acid; *p*-Phenylene diisothiocyanate; Phenylene 1,4-diisothiocyanate; Phenylene thiocyanate; WM 842

CAS Registry Number: 4044-65-9

HSDB Number: 6435

RTECS Number: NX9150000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 223-741-3

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Combustible, Environmental hazard.

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV.D.3.b, RQ: 500 lb (227 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%, as cyanide compounds

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) as cyanide compound

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants as cyanide, total

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P030 as cyanides soluble salts and complexes, n.o.s.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents as cyanides, soluble salts and complexes, n.o.s.

EPCRA (Section 313): Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR 172.101, Appendix B) as cyanide mixtures, cyanide solutions, or cyanides, inorganic, n.o.s.

Hazard symbols, risk, & safety statements: Hazard symbol: Xi, Xn; risk phrases: R20; R22; R36/37/38; R41; R51/53; R65 safety phrases: S7; S23; S26; S36; S39; S45; S61; S41 (see Appendix 4)

Description: Bitoscanate is a colorless to beige, odorless, crystalline compound. Molecular weight = 192.265; freezing/melting point = 129−131°C. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 1; reactivity 0 ₩.

Potential Exposure: Those engaged in the manufacture, formulation and application of this anthelmintic compound.

Incompatibilities: In general, keep away from strong oxidizers, moisture, strong acids, strong bases. This is a thiocyanate compound. Violent reactions may occur upon contact with chlorates (potassium chlorate, sodium chlorate), nitrates, nitric acid; organic peroxides.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

NIOSH IDLH = 25 mg[CN]/m^3

PAC Ver. 29[138]

PAC-1: 1.8 milligram per cubic meter

PAC-2: 20 milligram per cubic meter

PAC-3: 25 milligram per cubic meter

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 200 μg[CN]/L; State Drinking Water Standards: California 150 μg[CN]/L; State Drinking Water Guidelines: Arizona 220 μg[CN]/L; Maine. 140 μg [CN]/L; Minnesota 100 μg[CN]/L. United States Army field drinking-water standards for cyanide: 2 mg[CN]/L assuming a water consumption of 15 L/day and 6 mg[CN]/L assuming a water consumption of 5 L/day. United States Army field drinking-water standards for cyanide, long-term consumption 0.5 mg[CN]/L; Short-term consumption; Raw water constituents (maximum) 20 mg[CN]/L.

Routes of Entry: Ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: This material is highly toxic if ingested. It is a CNS and gastrointestinal toxin in humans. May cause nausea, headache, and vomiting. LD_{50} = (oral-rat) 2 mg/kg (highly toxic)[9]. Harmful if inhaled; may cause respiratory tract irritation. Harmful if absorbed through skin. Causes skin irritation. Eye contact causes irritation and redness.

Long-Term Exposure: Inhalation may result in respiratory tract sensitization.

Medical Surveillance: Blood cyanide level.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye Contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and

face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA (as cyanides): *Up to 25 milligram per cubic meter:* Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd, Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive pressure mode. *Escape:* GmFS100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted canister providing protection against the compound of concern and having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. Store in tightly closed containers in a cool, well-ventilated area. Store under inert gas; moisture sensitive.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1—Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/ 75 ft(NJ). Isolation Distance, Fire: 800 m/0.5 miles[70]. Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include cyanide and oxides of nitrogen, sulfur and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Bitoscanate, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Bitoscanate*, #2172, Trenton, NJ (May 2000).

Blister Agents/Vesicants

Blister Agents or vesicants are chemicals which have severely irritating properties and can produce irritated and reddened skin with progression to blisters, swelling, and inflammation of tissues surrounding the eyes with progression to light sensitivity and lacrimation. They can damage the skin, eyes, and airways. They have the ability to form widespread vesicular lesions, causing blistering and peeling of the skin. High concentrations of vapor or direct liquid exposures to the eye can cause damage to the eye surface. Warm, moist tissues are most susceptible to damage and the tissues of the upper respiratory tract can also be affected. Symptoms of exposure may be delayed until hours or days after exposure depending on the magnitude of the absorbed dose. The major chemical warfare agents in this category are listed below along with their record number for quick access.

Sulfur Mustard, agents H and HD see M:1460
Sulfur Mustard, agent T or HT see M:1460
Nitrogen Mustard, agent HN-1 see E:0400
Nitrogen Mustard, agent HN-2 see M:0300
Nitrogen Mustard, agent HN-3 see T: 0960
Lewisite, agents L-1 and L-2 see HL L: 0250
Mustard-Lewisite, agent HL see L: 0250
Phosgene oxime, agent CX see P:0555

Blood Agents

Blood agents, among the most lethal chemical weapons agents, disrupt the normal biochemical processes required by your cells to use oxygen. The major chemical warfare agents in this category are listed below along with their record number for quick access.

Arsine, agent SA see A:1580
Cyanogen chloride, agent CK see C:1620
Hydrogen cyanide, agent AC 74-90-8 see H:0440
Potassium cyanide (KCN) see P:0910
Sodium cyanide (NaCN) S:0450
Sodium monofluoroacetate see S:0480

Borax B:0573

Formula: $B_4H_2Na_2O_8$ (borax); $Na_2B_4O_7 \cdot AH_2O$ (borax); $Na_2B_4O_7 \cdot 5H_2O$ (borax pentahydrate)

Synonyms: *Borax:* Borato sodico (Spanish); Borato sodico, anhidro (Spanish); Disodium tetraborate; Sodium borate; Sodium borate decahydrate; Sodium tetraborate

Borax pentahydrate: Borate pentahydrate sodium; tetraborate pentahydrate

Sodium borate: Disodium tetraborate

CAS Registry Number: 1303-96-4 (borax); *(alt.) borax*: *(alt.)* 1344-90-7; *(alt.)* 12447-40-4; *(alt.)* 61028-24-8; 1330-43-4 (disodium tetraborate, anhydrous); 12179-04-3 (borax pentahydrate)

HSDB Number: 328

RTECS Number: VZ2275000 (borax)

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 215-540-4 [*Annex I Index No.:* 005-011-01-1] (*disodium tetraborate, anhydrous*)

Regulatory Authority and Advisory Information

Carcinogenicity: NCI: Carcinogenesis Studies (feed); no evidence: mouse; EPA: Available data are inadequate for an assessment of human carcinogenic potential.

Hazard Alert: Suspected of causing genetic defects, Suspected reprotoxic hazard.

Safe Drinking Water Act, 55FR1470 Priority List

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. [sodium tetraborate (borax)]

Canada Drinking Water Quality: 5.0 mg/L IMAC

Mexico Drinking Water Criteria: 1.0 mg/L.

Hazard symbols, risk, & safety statements: (*disodium tetraborate, anhydrous*) Hazard symbol: T; risk phrases: R60; R61; R62; R63; safety phrases: S53; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Nonhazard to water. (*borax, decahydrate*)

Description: Borax is a noncombustible (an inherent fire retardant), bluish-gray or green, odorless crystalline powder or granules. Molecular weight = 301.37; boiling point = 320°C; freezing/melting point = 75°C (rapid heating). Borax is soluble in water; solubility = 6% @ 20°C. Borax pentahydrate is a white crystalline solid or free-flowing powder. Odorless. Molecular weight = 291.4; Specific gravity (H_2O:1) = 1.82; Melting Point: 200°C; Density: 1.82 g cm^{-3}. Soluble in water; solubility = 3%.

Potential Exposure: Borax is used as a soldering flux, preservative against wood fungus; and as an antiseptic. Used in ant poisons, for fly control around refuse and manure piles, as a larvicide. It is used in the manufacture of enamels and glazes, fiberglass insulation; sodium perborate bleach; in tanning, cleaning compounds; for fire-proofing fabrics and wood; and in artificial aging of wood.

Incompatibilities: Dissolves in water forming a basic solution. Boron dust may form explosive mixture with air. Contact with strong oxidizers may be violent. Boron is incompatible with ammonia, bromine tetrafluoride, cesium carbide, chlorine, fluorine, interhalogens, iodic acid, lead dioxide, nitric acid, nitric oxide, nitrosyl fluoride, nitrous oxide, potassium nitrite, rubidium carbide, silver fluoride.

Permissible Exposure Limits in Air

Borate compounds, inorganic (including borax)

OSHA PEL: None

NIOSH REL: None

ACGIH TLV: 2 milligram per cubic meter TWA (inhalable fraction); 6 milligram per cubic meter (inhalable fraction) not classifiable as a human carcinogen.

For particulates not otherwise classified (PNOC)

OSHA: 15 milligram per cubic meter TWA (Total dust); 5 milligram per cubic meter TWA (Respirable fraction)

DFG MAK: 4 milligram per cubic meter TWA (Inhalable fraction); 1.5 milligram per cubic meter TWA (Respirable fraction)

PAC Ver. 29[138]

1303-96-4, Borax

PAC-1: 6 milligram per cubic meter

PAC-2: 190 milligram per cubic meter

PAC-3: 1100 milligram per cubic meter

16940-66-2, borax (fused, sodium borohydrate)

PAC-1: 0.49 milligram per cubic meter

PAC-2: 5.3 milligram per cubic meter

PAC-3: 32 milligram per cubic meter

1330-43-4, disodium tetraborate

PAC-1: 6 milligram per cubic meter

PAC-2: 88 milligram per cubic meter

PAC-3: 530 milligram per cubic meter

12179-04-3, borax pentahydrate

OSHA PEL: None

NIOSH REL: 1 milligram per cubic meter TWA

ACGIH TLV: 2 milligram per cubic meter TWA inhalable fraction; 6 milligram per cubic meter TWA inhalable fraction; not classifiable as a human carcinogen (2004).

Determination in Air: Use NIOSH Analytical Method #0500 or OSHA Analytical Method ID-125G, Metal and Metalloid Particulates in work-place Atmospheres (ICP analysis).

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 600 μg[B]/L; State Drinking Water Guidelines: California 1000 μg[B]/L; Maine 1400 μg[B]/L; New Hampshire 630 μg[B]/L; Minnesota 1000 μg[B]/L; Wisconsin 960 μg[B]/L. Runoff from spills or fire control may cause water pollution. EPA in July 1976 established a criterion for boron of 750 μg/L for long-term irrigation on sensitive crops. More recently[32] EPA has suggested an ambient water limit of 43 μg/L based on health effects. Octanol−water coefficient: Log K_{ow} =< 0.2. Unlikely to bioaccumulate in marine organisms.

Determination in Water: Fish Tox: LC_{50} (goldfish, 72 h) = 178 mg/L; EC_{50} [daphnia magna (water flea), 48 h] = 1.085−1.402 mg/L.

Routes of Entry: Inhalation of dust, fumes, and aerosols; ingestion.

Harmful Effects and Symptoms

These effects vary greatly with the type of borax compound. Acute poisoning in humans from boric acid or borax is usually the result of application of dressings, powders, or ointment to large areas of burned or abraded skin, or accidental ingestion. The signs are: nausea, abdominal pain; diarrhea and violent vomiting, sometimes bloody, which may be accompanied by headache and weakness. There is a characteristic erythematous rash followed by peeling. In severe cases, shock with fall in arterial pressure, tachycardia, and cyanosis occur. Marked CNS irritation, oliguria, and anuria may be present. The oral lethal dose in adults is over 30 g. Little information is available on chronic oral poisoning, although it is reported to be characterized by mild Gl irritation, loss of appetite; disturbed digestion; nausea; possibly vomiting; and erythematous rash. The rash may be "hard" with a tendency to become purpuric. Dryness of skin and mucous membranes; reddening of tongue; cracking of lips; loss of hair; conjunctivitis; palpebral edema; gastro-intestinal disturbances; and kidney injury have also been observed. Workers manufacturing boric acid had some atrophic changes in respiratory mucous membranes; weakness; joint pains, and other vague symptoms. The biochemical mechanism of boron toxicity is not clear but seems to involve action on the nervous system; enzyme activity; carbohydrate metabolism; hormone function; and oxidation processes coupled with allergic effects. Borates are excreted principally by the kidneys.

Short-Term Exposure: Borax may affect the nervous system. Serious overexposure to borates can cause seizures, unconsciousness and death.

Long-Term Exposure: May cause brain, kidney and liver damage. Repeated exposure may cause boric acid to accumulate in the brain, bone, and other body parts. Repeated skin contact may cause dermatitis, borism (boron poisoning), dry skin, skin eruptions, and gastric disturbances. Animal tests show that this substance possibly causes toxic effects upon human reproduction (WHO).

Medical Surveillance: No specific considerations are needed for boric acid or borates except for general health and liver and kidney function. In the case of boron trifluoride; the skin, eyes, and respiratory tract should receive special attention. In the case of the boranes, CNS and lung function will also be of special concern.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Exposed workers should be educated in the proper use of protective equipment and there should be strict adherence to ventilating provisions in work areas. Workers involved with the manufacture of boric acid should be provided with masks to prevent inhalation of dust and fumes.

Storage: Color Code—Green: General storage may be used; Store in a cool, dry place away from incompatible materials listed above.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9—Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. The material may be dampened with water to avoid dust and then transferred to a sealed container for disposal. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide; water, or foam extinguishers. Irritation and toxic fumes. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Borax, dehydrated: The material is diluted to the recommended provisional limit (0.10 mg/L) in water. The pH is adjusted to between 6.5 and 9.1 and then the material can be discharged into sewers or natural streams.

References

(31); (173); (101); (138); (2); (100).

Environmental Protection Agency, Preliminary Investigation of Effects on the Environment of Boron, Indium, Nickel, Selenium, Tin, Vanadium and Their Compounds, Volume 1: Boron, Report EPA-560/2-75-005A, Washington, DC, Office of Toxic Substances (August 1975).

National Institute for Occupational Safety and Health (NIOSH), Information Profiles on Potential Occupational Hazards: Boron and Its Compounds, Report PB 276,678, Rockville, Maryland, pp. 63–75 (October 1977).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 1, No. 8, 42−45 (1981) (Boron and Boric acid) and 3, No. 5, 65−67, New York, Van Nostrand Reinhold Co. (1983).
Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 2, No. 6, 76−78 (1982) (Sodium Borate).
New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Sodium Borates*, Trenton, NJ (November 2001).

Boric Acid B:0576

Formula: BH_3O_3; H_3BO_3
Synonyms: Boracic acid; Basilit B; Borofax; Boron trihydroxide; Hydrogen orthoborate; Orthoboric acid
CAS Registry Number: 10043-35-3; *(alt)* 11113-50-1
HSDB Number: 1432
RTECS Number: ED4550000
UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171
EC Number: 233-139-2 [*Annex I Index No.:* 005-007-00-2] (boric acid)
Regulatory Authority and Advisory Information
Carcinogenicity: NCI: Carcinogenesis Studies (feed); no evidence: mouse; EPA: Available data are inadequate for an assessment of human carcinogenic potential.
Hazard Alert: (*Boric acid*): Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction).
Listed in TSCA inventory.
Safe Drinking Water Act, 55FR1470 Priority List
Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%; Category D-2A.
Hazard symbols, risk, & safety statements: Hazard symbol: T; risk phrases: R60; R61; R62; R63; safety phrases: S53; S41; S45 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 1-Non hazard to water.
Description: Boric acid is a white, amorphous powder or colorless, crystalline solid. Molecular weight = 61.8; Specific gravity (H_2O:1) = 1.44 @ 20°C; boiling point = 300°C (decomposes: loses ½ its H_2O); freezing/melting point = 171°C (decomposes above 100°C). Saturated solutions: @ 0°C, 2.6% acid; @ 100°C, 28% acid. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 0; reactivity 1 ₩. Boric acid is soluble in water; solubility = ~4.5 g/100 mL @ 20°C.
Potential Exposure: Boric acid is a fireproofing agent for wood; a preservative, and an antiseptic. It is used in the manufacture of glass, pottery, enamels, glazes, cosmetics, cements, porcelain, borates, leather, carpets, hats, soaps; artificial gems; in tanning leather; printing, dyeing, painting, and photography.
Incompatibilities: Boric acid decomposes in heat above 100°C, forming boric anhydride and water. Boric acid is hygroscopic; it will absorb moisture from the air. Boric acid aqueous solution is a weak acid; incompatible with strong reducing agents including alkali metals and metal hydrides (may generate explosive hydrogen gas); acetic anhydride, alkali carbonates, and hydroxides. Violent reaction with powdered potassium metal, especially if impacted. Attacks iron in the presence of moisture.
Permissible Exposure Limits in Air
Borate compounds, inorganic (including boric acid)
OSHA PEL: None
NIOSH REL: None
ACGIH TLV: 2 milligram per cubic meter TWA (inhalable fraction); 6 milligram per cubic meter (inhalable fraction) not classifiable as a human carcinogen.
For particulates not otherwise classified (PNOC)
OSHA: 15 milligram per cubic meter TWA (Total dust); 5 milligram per cubic meter TWA (Respirable fraction)
DFG MAK: 4 milligram per cubic meter TWA (Inhalable fraction); 1.5 milligram per cubic meter TWA (Respirable fraction)
PAC Ver. 29[138]
PAC-1: 6 milligram per cubic meter
PAC-2: 23 milligram per cubic meter
PAC-3: 830 milligram per cubic meter
Determination in Air: Use NIOSH Analytical Method #0500 or OSHA Analytical Method ID-125G, Metal and Metalloid Particulates in work-place Atmospheres (ICP analysis).
Determination in Water: Fish Tox: LC_{50} (goldfish, 72 h) = 178 mg/L; EC_{50} [daphnia magna (water flea), 48 h] = 1.085−1.402 mg/L.
Permissible Concentration in Water: EPA in July 1976 established a criterion for boron of 750 μg/L for long-term irrigation on sensitive crops. More recently[32], EPA has suggested an ambient water limit of 43 μg/L based on health effects.
Routes of Entry: Inhalation of dust, fumes, and aerosols; ingestion.
Harmful Effects and Symptoms
Workers manufacturing boric acid had some atrophic changes in respiratory mucous membranes; weakness; joint pains, and other vague symptoms. The biochemical mechanism of boron toxicity is not clear but seems to involve action on the nervous system; enzyme activity; carbohydrate metabolism; hormone function; and oxidation processes coupled with allergic effects. Borates are excreted principally by the kidneys. Based on animal studies, may be fetotoxic, affect reproductive material and fertility; teratogenic effects.
Short-Term Exposure: Boric acid dust or aqueous solutions cause irritation of the eyes, skin, and the respiratory tract. Boric acid dust is absorbed through mucous membranes but not through the unbroken skin. Solutions and dust can be absorbed in harmful amounts through abraded skin, burns, and open wounds. Prolonged skin contact may

cause dermatitis. If absorbed through the broken skin, boron may affect behavior, metabolism, sense organs, the gastrointestinal tract, and respiratory tract (respiratory depression). Ingestion can cause digestive/gastrointestinal tract irritation with symptoms of nausea, vomiting and diarrhea. Prolonged or high levels of exposure may cause effects on the gastrointestinal tract; liver and kidneys. Prolonged exposure to boric acid may affect the nervous system. Serious overexposure can cause seizures, unconsciousness and death. Ingestion of 5 g or more may irritate gastrointestinal tract and affect CNS; may be fatal to some adults. LD_{50} = (rat-oral) 2660 mg/kg; 3450 (mouse-oral) mg/kg (slightly toxic).

Long-Term Exposure: Repeated exposure may cause boric acid to accumulate in the brain, bone, and other body parts. Repeated skin contact may cause dermatitis, borism (boron poisoning), dry skin, skin eruptions, and gastric disturbances. May affect behavior, cause damage to the brain, kidneys, liver, cardiovascular system, CNS, PNS, cardiovascular system, blood, liver, urinary system (kidney, ureter, bladder), and endocrine system. Animal tests show that this substance possibly causes toxic effects upon human reproduction[WHO].

Medical Surveillance: Check for eye and skin disorder problems. Tests for liver, kidney, or respiratory function.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Exposed workers should be educated in the proper use of protective equipment and there should be strict adherence to ventilating provisions in work areas. Workers involved with the manufacture of boric acid should be provided with masks to prevent inhalation of dust and fumes. Wear impervious gloves: recommended gloves include Butyl rubber, Neoprene, Viton.

Respirator Selection: A respiratory protection program that meets OSHA's Respiratory Protection Standard 29 CFR 1910.134 requirements or European Standard EN 149 must be followed whenever workplace conditions warrant a respirator's use. Oxygen levels below 19.5% are considered IDLH by NIOSH/OSHA and require use of a full facepiece pressure/demand SCBA; or, a full facepiece, supplied air respirator with auxiliary self-contained air supply is required under 1910.134-1998.

Storage: Color code—Green: General storage may be used. Store in a cool, dry place away from incompatible materials listed above.

Shipping: UN 3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9—Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. The material may be dampened with water to avoid dust and then transferred to a sealed container for disposal. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide; water, or foam extinguishers. Irritation and toxic fumes. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Boric acids may be recovered from organic process wastes as an alternative to disposal.

References

(31); (173); (101); (138); (2); (100).

Environmental Protection Agency, Preliminary Investigation of Effects on the Environment of Boron, Indium, Nickel, Selenium, Tin, Vanadium and Their Compounds, Volume 1: Boron, Report EPA-560/2-75-005A, Washington, DC, Office of Toxic Substances (August 1975).

National Institute for Occupational Safety and Health (NIOSH), Information Profiles on Potential Occupational Hazards: Boron and Its Compounds, Report PB 276,678, Rockville, Maryland, pp. 63−75 (October 1977).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 1, No. 8, 42−45 (1981) (Boron and Boric acid) and 3, No. 5, 65−67, New York, Van Nostrand Reinhold Co. (1983).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 2, No. 6, 76−78 (1982) (Sodium Borate).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Sodium Borates*, Trenton, NJ (November 2001).

Boron and Compounds B:0580

Formula: B
Synonyms: There are no common synonyms for elemental boron. Boron compounds: Boron trifluoride dihydrate
CAS Registry Number: 7440-42-8
HSDB Number: 4482
RTECS Number: ED7350000
UN/NA & ERG Number: UN3178 (Flammable solid, inorganic, n.o.s.)/133
EC Number: 231-151-2
Regulatory Authority and Advisory Information
Carcinogenicity: NCI: Carcinogenesis Studies (feed); no evidence: mouse; EPA: Available data are inadequate for an assessment of human carcinogenic potential.
Hazard Alert: Combustible, Pyrophoric (dust); Agricultural chemical, Suspected of causing genetic defects, Suspected reprotoxic hazard.
Safe Drinking Water Act, 55FR1470 Priority List
Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. [boric acid, sodium tetraborate (borax)]
Canada Drinking Water Quality: 5.0 mg/L IMAC
Mexico Drinking Water Criteria: 1.0 mg/L.
Hazard symbols, risk, & safety statements: Hazard symbol: T, Xn; risk phrases: R17; R22; R62; R63; R63; safety phrases: S16; S24/25; S26; S27; S36/37/39; S41; S45 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 1-Non hazard to water. (*boron, borax*)
Description: Boron is a yellow or brownish-black powder and may be either crystalline or amorphous. It does not occur free in nature and is found in the minerals borax, colemanite, boronatrocalcite, and boracite. Molecular weight = 10.81; Specific gravity (H_2O:1) = 2.45; boiling point = 3660°C; 2550°C (highly purified); freezing/melting point = 2190°C; 2079°C (highly purified); Autoignition temperature = 580°C. Hazard identification (based on NFP A-704 M Rating System) (*boron, 1000 μg/mL*) Health 1; flammability 1; reactivity 0 ₩; (*Boron, 10,000 μg/mL)*: Health 2; flammability 1; reactivity 2 ₩. Practically insoluble in water.
Boron carbide: Molecular weight = 55.26; Specific gravity (H_2O:1) = 2.95; freezing/melting point = 2350°C.
Boron nitride: Molecular weight = 24.82; Specific gravity (H_2O:1) = 22; freezing/melting point = 2966°C.
Potential Exposure: Boron is used in metallurgy as a degasifying agent and is alloyed with aluminum, iron, and steel to increase hardness. It is also a neutron absorber in nuclear reactors. Boron is frequently encountered in a variety of chemical formulations including boric acid, various borate salts, borax, and boron soil supplements.
Incompatibilities: Boron dust may form explosive mixture in air. Contact with strong oxidizers may cause explosions. Violent reaction (possible explosion) with concentrated nitric acid, hydrogen iodide; silver fluoride. Boron is incompatible with ammonia, bromine tetrafluoride, cesium carbide, chlorine, fluorine, interhalogens, iodic acid, lead dioxide, nitric acid, nitrosyl fluoride, nitrous oxide, potassium nitrite, rubidium carbide. Reacts exothermically with metals at high temperature above 900°C.
Permissible Exposure Limits in Air
For particulates not otherwise classified (PNOC)
OSHA: 15 milligram per cubic meter TWA (Total dust); 5 milligram per cubic meter TWA (Respirable fraction)
DF G M AK: 4 milligram per cubic meter TWA (Inhalable fraction); 1.5 milligram per cubic meter TWA (Respirable fraction)
Borate compounds, inorganic (including 1330-43-4; 1303-96-4; 10043-35-3; 12179-04-3)
OSHA PEL: None
NIOSH REL: None
ACGIH TLV: 2 milligram per cubic meter TWA (inhalable fraction); 6 milligram per cubic meter (inhalable fraction) not classifiable as a human carcinogen
PAC Ver. 29[138]
7440-42-8, boron (elemental)
PAC-1: 1.9 milligram per cubic meter
PAC-2: 21 milligram per cubic meter
PAC-3: 130 milligram per cubic meter
12069-32-8, boron carbide
PAC-1: 2.4 milligram per cubic meter
PAC-2: 27 milligram per cubic meter
PAC-3: 170 milligram per cubic meter
Determination in Air: Use NIOSH Analytical Method #0500 or OSHA Analytical Method ID-125G, Metal and Metalloid Particulates in work-place Atmospheres (ICP analysis).
Determination in Water: Fish Tox: LC_{50} (goldfish, 72 h) = 178 mg/L; EC_{50} [daphnia magna (water flea), 48 h] = 1.085−1.402 mg/L.
Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 600 μg[B]/L; State Drinking Water Guidelines: California 1000 μg[B]/L; Maine 1400 μg[B]/L; New Hampshire 630 μg[B]/L; Minnesota 1000 μg[B]/L; Wisconsin 960 μg[B]/L. Runoff from spills or fire control may cause water pollution.
Routes of Entry: Inhalation of dust, fumes, and aerosols; ingestion; skin absorption.
Harmful Effects and Symptoms
Boron compounds may produce irritation of the nasal mucous membranes; the respiratory tract, and eyes. *Systemic:* These effects vary greatly with the type of compound. Acute poisoning in humans from boric acid or borax is usually the result of application of dressings, powders, or ointment to large areas of burned or abraded skin, or accidental ingestion. The signs are: nausea, abdominal pain; diarrhea and violent vomiting, sometimes bloody, which may be accompanied by headache and weakness. There is a characteristic erythematous rash followed by peeling. In severe cases, shock with fall in arterial pressure, tachycardia, and cyanosis occur. Marked CNS irritation, oliguria, and anuria may be present. The oral lethal dose in adults is over 30 g. Little information is available on chronic oral

poisoning, although it is reported to be characterized by mild Gl irritation, loss of appetite; disturbed digestion; nausea; possibly vomiting; and erythematous rash. The rash may be "hard" with a tendency to become purpuric. Dryness of skin and mucous membranes; reddening of tongue; cracking of lips; loss of hair; conjunctivitis; palpebral edema; gastro-intestinal disturbances; and kidney injury have also been observed. Workers manufacturing boric acid had some atrophic changes in respiratory mucous membranes; weakness; joint pains, and other vague symptoms. The biochemical mechanism of boron toxicity is not clear but seems to involve action on the nervous system; enzyme activity; carbohydrate metabolism; hormone function; and oxidation processes coupled with allergic effects. Borates are excreted principally by the kidneys. No toxic effects have been attributed to elemental boron.

Short-Term Exposure: Irritating by skin and eye contact. Can be absorbed through the skin. Harmful by inhalation and ingestion. LD_{50} = (mouse-oral) 560 mg/kg; (oral-rat) 650 mg/kg. High exposure may cause CNS disturbances.

Long-Term Exposure: May cause brain, kidney and liver damage. Repeated exposure may cause boric acid to accumulate in the brain, bone, and other body parts. Repeated skin contact may cause dermatitis, borism (boron poisoning), dry skin, skin eruptions, and gastric disturbances. Animal tests show that this substance possibly causes toxic effects upon human reproduction (WHO). Repeated exposure may cause CNS effects.

Medical Surveillance: No specific considerations are needed for boric acid or borates except for general health and liver and kidney function. In the case of boron trifluoride; the skin, eyes, and respiratory tract should receive special attention. In the case of the boranes, CNS and lung function will also be of special concern.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Exposed workers should be educated in the proper use of protective equipment and there should be strict adherence to ventilating provisions in work areas. Safety glasses, respirator, adequate ventilation.

Respirator Selection: A respiratory protection program that meets OSHA's 29 CFR 1910.134 requirements or European Standard EN 149 must be followed whenever workplace conditions warrant a respirator's use. In many cases, a dust respirator meeting these standards may suffice.

Storage: Color code—Red Stripe: Flammability Hazard: Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Store flammable solids up to maximum allowable quantity per control area in an approved flammable storage area. Do not store in a basement. Store in a cool, dry place away from incompatible material, sources of heat and ignition. Boron powder may decompose on exposure to air and may have to be stored under a nitrogen blanket.

Shipping: Boron powder or dust: UN3178 Flammable solid, inorganic, Hazard Class: 4.1; Labels: 4.1—Flammable solid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. The material may be dampened with water to avoid dust and then transferred to a sealed container for disposal. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products include boron oxide. Use dry chemical, carbon dioxide; water, or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dispose of contents and container to an approved waste disposal plant. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (2); (170); (100).

Environmental Protection Agency, *Preliminary Investigation of Effects on the Environment of Boron, Indium, Nickel, Selenium, Tin, Vanadium and Their Compounds, Volume 1: Boron, Report EPA-560/2-75-005A*, Washington, DC, Office of Toxic Substances (August 1975).

National Institute for Occupational Safety and Health (NIOSH), Information Profiles on Potential Occupational Hazards: Boron and Its Compounds, Report PB 276,678, Rockville, Maryland, pp. 63−75 (October 1977).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 1, No. 8, 42−45 (1981) (Boron and Boric acid) and 3, No. 5, 65−67, New York, Van Nostrand Reinhold Co. (1983).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 2, No. 6, 76−78 (1982) (Sodium Borate).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Sodium Borates*, Trenton, NJ (November 2001).

Oregon Department of Human Services, Environmental Toxicology Section, Drinking Water Section, *Technical Bulletin, Health Effects Information, Boron*, Portland, OR (January 1996).

Boron Oxide B:0590

Formula: B_2O_3

Synonyms: Anhydrous boric acid; Boric anhydride; Boron sesquioxide; Boron trioxide; Diboron trioxide; Fused boric acid; Oxido de boro (Spanish)

CAS Registry Number: 1303-86-2

HSDB Number: 1609

RTECS Number: ED7900000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 215-125-8 [*Annex I Index No.:* 005-008-00-8]

Regulatory Authority and Advisory Information

Hazard Alert: Primary irritant (w/o allergic reaction), Suspected of causing genetic defects.

Canada, WHM IS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. As boric anhydride.

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xi; risk phrases: R36/37/38; R60; R61; R62; safety phrases: S53; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Boron oxide is a noncombustible, colorless, semitransparent lumps or hard, white, odorless crystals, with slightly bitter taste. Molecular weight = 69.62; Specific gravity (H_2O:1) = 2.46; boiling point = 2250°C; freezing/melting point = 450°C. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 0; reactivity 0 ₩. Moderately soluble in water; solubility = (moderate) 3%; slow reaction forming boric acid.

Potential Exposure: Boron oxide is used in glass manufacture and the production of other boron compounds. It is used in fluxes, enamels, drying agents, and as a catalyst.

Incompatibilities: Incompatible with bromine pentafluoride, calcium oxide. Reacts slowly with water, forming boric acid. Reacts exothermically with alkaline material and strong bases. May react with strong reducing agents such as metal hydrides, metal alkyls to generate flammable or explosive gases. May react violently on contact with bromine pentafluoride. Corrosive to metals in the presence of air[101].

Permissible Exposure Limits in Air

NIOSH IDLH = 2000 milligram per cubic meter

OSHA PEL: 15 milligram per cubic meter TWA (total dust)

NIOSH REL: 10 milligram per cubic meter TWA

ACGIH TLV[1]: 10 milligram per cubic meter TWA

PAC Ver. 29[138]

PAC-1: 30 milligram per cubic meter

PAC-2: 100 milligram per cubic meter

PAC-3: 620 milligram per cubic meter

Austria: MAK 15 milligram per cubic meter, 1993; Denmark: TWA 10 milligram per cubic meter, 1999; France: VME 10 milligram per cubic meter, 1999; Norway: TWA 10 milligram per cubic meter, 1999; the Philippines: TWA 15 milligram per cubic meter, 1993; Poland: MAC (TWA) 10 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 10 milligram per cubic meter, 2003; United Kingdom: TWA 10 milligram per cubic meter; STEL 20 milligram per cubic meter, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 10 milligram per cubic meter. Several states have set guidelines or standards for Boron oxide in ambient air[60] ranging from 10 μ/m^3 (North Dakota) to 160 μ/m^3 (Virginia) to 200 μ/m^3 (Connecticut) to 238 μ/m^3 (Nevada).

Determination in Air: Collection on a filter and gravimetric analysis. Use NIOSH Analytical Method #0500 Particulates NOR, total dust[18].

Determination in Water: Fish Tox: LC50 (goldfish, 72 h) = 570 mg/L; EC_{50} [daphnia magna (water flea), 48 h] = 370 to 490 mg/L.

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 600 μg[B]/L; State Drinking Water Guidelines: California 1000 μg[B]/L; Maine 1400 μg[B]/L; New Hampshire 630 μg[B]/L; Minnesota 1000 μg[B]/L; Wisconsin 960 μg[B]/L. Runoff from spills or fire control may cause water pollution.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: May irritate the skin, causing a rash or burning feeling on contact. May cause nasal irritation, conjunctivitis, erythema. Ingestion causes abdominal pain; diarrhea, nausea, vomiting. Low toxicity. The oral LD_{50} mouse is 3163 mg/kg[9].

Long-Term Exposure: Unknown at this time.

Points of Attack: Skin, eyes, respiratory system.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention.

Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *50 milligram per cubic meter*: Qm (APF = 25) (any quarter-mask respirator). *100 milligram per cubic meter:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *250 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25) (any PAPR with a high-efficiency particulate filter). *500 milligram per cubic meter*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or PaprTHie (APF = 50) (any PAPR with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *2000 milligram per cubic meter*: SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive pressure mode. *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Green: General storage may be used. Store in tightly closed containers in a dry, well-ventilated area away from incompatible materials listed above and water.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9—Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Moisten dry material to prevent dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental Protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Boron oxide is a noncombustible solid. Extinguish fire using an agent suitable for type of surrounding fire. Boron oxide itself does not burn. Thermal decomposition products may include oxides of boron and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling stream s are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Boron Oxide*, Trenton, NJ (September 2000).

Boron Tribromide B:0600

Formula: BBr_3

Synonyms: Borane, tribromo-; Boron bromide; Boron tribromide 6; Tribromoborand; Tribromuro de boro (Spanish); Trona

CAS Registry Number: 10294-33-4

HSDB Number: 327

RTECS Number: ED7400000

UN/NA & ERG Number: UN2692/157

EC Number: 233-657-9 [*Annex I Index No.:* 005-003-00-0]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening TQ (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade); *Theft hazard* 45 ($\geq$12.67% concentration)

Hazard Alert: Poison inhalation hazard (highly toxic gas).

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, C; risk phrases: R14; R26/28; R35; safety phrases: S1; S26; S28; S36/37/39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Boron tribromide is a colorless, fuming liquid. Molecular weight = 250.54. Specific gravity (H_2O:1) = 2.65; boiling point = 91°C; freezing/melting point = −46°C; vapor pressure = 40 mmHg @14°C. Hazard identification (based on NFP A-704 M Rating System): Health 3; flammability 0; reactivity 2 ₩. Soluble in water; dangerous reaction.

Potential Exposure: Boron tribromide is highly toxic and corrosive, it is used as a catalyst in organic synthesis, making diborane, high purity boron, and semiconductors.

Incompatibilities: Reacts violently and explosively with water, steam, or alcohols, forming toxic, corrosive, and potentially explosive hydrogen bromide gas. Mixtures with potassium or sodium can explode on impact. Incompatible with oxidizers, strong bases. Attacks some metals, rubbers, and plastics.

Permissible Exposure Limits in Air

NIOSH IDLH = 50 ppm.

Conversion factor: 1 ppm = 10.25 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: None

NIOSH REL: 1 ppm/10 milligram per cubic meter Ceiling Concentration

ACGIH TLV[1]: 0.7 ppm, Ceiling Concentration

PAC* Ver. 29[138]

PAC-1: **0.33**$_{\mathbf{A}}$ ppm

PAC-2: **13**$_{\mathbf{A}}$ ppm

PAC-3: **40**$_{\mathbf{A}}$ ppm

*AEGLs are marked with a subscript "**A**" and correspond to 60 minute values.

Australia: TWA 1 ppm (10 milligram per cubic meter), 1993; Austria: MAK 1 ppm (10 milligram per cubic meter), 1999; Belgium: STEL 1 ppm (10 milligram per cubic meter), 1993; Denmark: TWA 1 ppm (10 milligram per cubic meter), 1999; Finland: TWA 1 ppm (10 milligram per cubic meter); STEL 3 ppm (30 milligram per cubic meter), 1999; Norway: TWA 1 ppm (10 milligram per cubic meter), 1999; Switzerland: MAK-W 1 ppm (10 milligram per cubic meter), 1999; the Netherlands: MAC 10 milligram per cubic meter (total dust), 2003; Argentina, Bulgaria, Columbia, Israel, Jordan, South Korea, New Zealand, Singapore, Vietnam: use ACGIH TLV Ceiling Concentration 1 ppm. Several states have set guidelines or standards for boron tribromide in ambient air[60] ranging from 80 μ/m^3 (Virginia) to 100 μ/m^3 (Connecticut) to 238 μ/m^3 (Nevada).

Determination in Water: No method established. Reaction.

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 600 μg[B]/L; State Drinking Water Guidelines: California 1000 μg[B]/L; Maine 1400 μg[B]/L; New Hampshire 630 μg[B]/L; Minnesota 1000 μg[B]/L; Wisconsin 960 μg[B]/L. Runoff from spills or fire control may cause water pollution.

Routes of Entry: Eyes, skin, respiratory system.

Harmful Effects and Symptoms

Short-Term Exposure: Boron tribromide is highly toxic and can affect you when inhaled, on skin contact and by eye contact. Boron tribromide is a corrosive liquid and exposure can cause severe burns of the eyes, nose, throat, lungs, and skin. Boron tribromide may cause cough, headaches, nose bleeds, and shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. LD50 = (rat, inhal.) =< 400 ppm.

Long-Term Exposure: Repeated exposure may cause a brownish color of the tongue and/or runny nose. May cause irritation of the lungs and bronchitis to develop. May cause kidney damage and affect the nervous system.

Points of Attack: Kidneys, nervous system; lungs.

Medical Surveillance: Before beginning employment and at regular times after that, the following is recommended: lung function tests, kidney function tests, examination of the nervous system. If symptoms develop or overexposure is suspected the following may be useful: consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear acid resistant gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Gloves made of chlorinated polyethylene are considered fair to good protection for boron tribromide. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash or dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures *over* 1 ppm; Use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece respirator with an acid gas canister. Increased protection is obtained from full facepiece PAPR. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/M SHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive pressure mode.

Storage: Poison inhalation chemical (PIH); check oxygen content prior to entering storage area. (1) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. (2) Color Code—Blue: Health Hazard/Poison: Store in a secure poison location. Before entering confined space where boron tribromide may be present, check to make sure that an explosive concentration does not exist. Store in airtight, unbreakable containers in a cool well-ventilated area away from water, steam, potassium, sodium, alcohol, and other incompatible materials. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2692 Boron tribromide, Hazard class: 8; Labels: 8—Corrosive materials, 6.1—Poison Inhalation Hazard, Inhalation Hazard Zone B.

Spill Handling:

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

When spilled on land

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.2/0.3

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 0.4/0.6

when spilled in water

Day 0.3/0.5
Night 0.6/1.0
First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.3/0.5

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 200/100
Then: Protect persons downwind (mi/km)
Day 0.5/0.8
Night 1.6/2.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Stop discharge if possible. Avoid contact with liquid or vapor[41]. Remove all ignition sources. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. Ventilate area of leak or spill after clean-up is complete. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical decomposes in heat and may explode. Use dry chemical or carbon dioxide. Do not use foam. Do not use water on material itself. Water can be used to cool intact containers and to absorb vapors. Thermal decomposition products may include hydrogen bromide and boron oxides. Vapors are heavier than air and will collect in low areas. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Boron Tribromide*, Trenton, NJ (July 1998).

Boron Trichloride B:0610

Formula: BCl_3

Synonyms: Borane, trichloro-; Boron chloride; Chlorure de bore (French); Trichloroborane; Trichloroboron; Tricloruro de boro (Spanish); Trona

CAS Registry Number: 10294-34-5; *(alt.)* 31012-04-1
HSDB Number: 326
RTECS Number: ED1925000
UN/NA & ERG Number: UN1741 (poison gas, corrosive)/125
EC Number: 233-658-4 [*Annex I Index No.:* 005-002-00-5]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening TQ (pounds): *Release hazard* 5000 (≥1.00% concentration); *Theft hazard* 45 (≥84.70% concentration)

Hazard Alert: Poison inhalation hazard (extremely toxic gas), water reactive, corrosive, frostbite/cryogenic burn hazard, asphyxiation hazard, contains gas under pressure; may explode if heated.

United States National Primary Drinking Water Regulations: SMCL = 250 mg[Cl^-]/L as Chloride

OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 2500 lb (1135 kg)

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 5000 lb (2270 kg)

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500 lb (227 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV.D.3.b, RQ: 500 lb (227 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T+; risk phrases: R5; R14; R21; R26/28; R34; safety phrases: S1/2; S9; S26; S28; S33; S36/37/39; S38; S41; S45 (see Appendix 4).

Description: Boron trichloride is a colorless liquid or liquefied gas with a pungent, irritating odor. Molecular weight = 117.2; Specific gravity (H_2O:1) = 1.35 @ 12.7°C; boiling point = 12.5°C; freezing/melting point = −107°C; vapor pressure = 985 mmHg @ 20°C; Relative vapor density (air = 1) = 4.02. Hazard identification (based on NFPA-704 M Rating System): Health 4; flammability 0; reactivity 2 ₩. Insoluble in water, releasing hydrogen chloride and boric acid.

Potential Exposure: Used in refining of aluminum, magnesium, copper alloys, and in polymerization of styrene. Manufacture and purification of boron; catalyst in organic reactions; semiconductors; bonding of iron or steel; purification of metal alloys to remove oxides, nitrides, and carbides; chemical intermediate for boron filaments; soldering flux; electrical resistors; and extinguishing magnesium fires in heat treating furnaces.

Incompatibilities: Incompatible with lead, graphite-impregnated asbestos, potassium, sodium. Vigorously attacks elastomers, packing materials, natural and synthetic rubber; viton, tygon, saran, silastic elastomers. Avoid aniline, hexafluorisopropylidene amino lithium, nitrogen dioxide, phosphine, grease, organic matter; and oxygen. Nitrogen peroxide, phosphine. Fat or grease react vigorously with boron trichloride. It reacts with water or steam to produce heat, boric acid, and corrosive hydrochloric acid fumes. Oxygen and boron trichloride react vigorously on sparking. Attacks most metals in the presence of moisture.

Permissible Exposure Limits in Air

NIOSH IDLH = 25 ppm
PAC Ver. 29[138]
PAC-1: 0.19 ppm
PAC-2: 2.1 ppm
PAC-3: 71 ppm

Boron trichloride is a poisonous, corrosive gas. Other than PAC, shown above, no other numerical standards have been established. Since the hydrolysis product, HCl, tends to govern the effect in moist air, reference should be made to the limit for hydrogen chloride as follows:

OSHA PEL: 5 ppm/7 milligram per cubic meter Ceiling Concentration

NIOSH REL: 5 ppm/7 milligram per cubic meter Ceiling Concentration

ACGIH TLV[1]: 5 ppm/7.5 milligram per cubic meter Ceiling Concentration; not classifiable as a human carcinogen

DFG MAK: 5 ppm/7.6 milligram per cubic meter, Pregnancy Risk Group C

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 600 μg[B]/L; State Drinking Water Guidelines: California 1000 μg[B]/L; Maine 1400 μg[B]/L; New Hampshire 630 μg[B]/L; Minnesota 1000 μg[B]/L; Wisconsin 960 μg[B]/L. Runoff from spills or fire control may cause water pollution.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Extremely corrosive to the eyes, skin and respiratory tract. Contact with eyes produces severe pain, swelling, corneal erosions and blindness. Viscid white or blood-stained foamy mucus and threads of tissue may appear in mouth. Inhalation can cause low blood oxygen, difficulty in breathing; chest pain and pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Symptoms of overexposure include depression of circulation, persistent vomiting and diarrhea, profound shock and coma. Temperature becomes subnormal and rash may cover entire body. Boron affects the CNS causing depression of circulation as well as shock and coma. May result in marked fluid and electrolyte loss and shock. LD50 (rat, inhal.) =< 1300 ppm/4 h.

Long-Term Exposure: Can cause liver, kidney and brain damage.

Medical Surveillance: Consider X-ray following acute overexposure. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Lung function tests. Liver kidney.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention immediately. Do not induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Person al Protective Methods: Wear acid-resistant gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Where there is no REL, at any detectable concentration:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOv (APF = 25) [any PAPR with organic vapor cartridge (s)]; CcrFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted acid gas canister]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, SCBA).

Storage: PIH; check oxygen content prior to entering storage area. (1) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. (2) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. This gas is toxic and/or corrosive, nonflammable. Outside or detached storage is preferred in an area that is roofed, shaded with the cylinders stored off the ground on nonwooden floors, and away from radiant heat sources and all possible sources of ignition. If indoors or outdoors, store in a well-ventilated noncombustible location temperatures not to exceed 50°C. Automatic monitoring systems are also preferred. Before entering confined space where boron trichloride may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well ventilated, fireproof place. Metal containers involving the transfer of this chemical should be grounded and bonded. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169 with the recommendations of the Compressed Gas Association.

Shipping: UN1741 Boron trichloride, Hazard class: 2.3; Labels: 2.3—Poisonous gas, 8—Corrosive material, Inhalation Hazard Zone C. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: Seek expert help. Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

when spilled on land

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)

Day 0.1/0.2
Night 0.2/0.3
Large spills (From a large package or from many small packages)
First: Isolate in all directions (ft/m) 300/100
Then: Protect persons downwind (mi/km)
Day 0.4/0.6
Night 1.0/1.5
when spilled in water
First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.3/0.5
Large spills (From a large package or from many small packages)
First: Isolate in all directions (ft/m) 300/100
Then: Protect persons downwind (mi/km)
Day 0.8/1.2
Night 2.4/3.8

Avoid breathing vapors. Keep up wind. Remove all ignition sources. Ventilate area of leak or spill. Isolate area until gas has dispersed. Stop leak if you can do so without risk. Keep material out of water sources and sewers. Use water spray to knock down vapors. Do not use water on material itself. Neutralize spilled material with crushed limestone, soda ash, or lime. Collect neutralized material in the most convenient and safe manner and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Boron trichloride is not combustible. Thermal decomposition products may include hydrogen chloride gas. This gas is under pressure; containers may rupture and explode when heated. Reacts with water forming boric acid and hydrochloric acid fumes. Use dry chemical, carbon dioxide; or dry sand to extinguish. If large quantities of combustibles are involved, use water in flooding quantities as spray and fog. Use water spray to absorb vapors. For large fires use water spray, fog, or foam. *Do not get water on material itself.* Thermal decomposition products may include hydrogen chloride. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed, undamaged containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Nonrefillable cylinders should be disposed of in accordance with local, state, and federal regulations. Allow remaining gas to vent slowly into atmosphere in an unconfined area or exhaust hood. Refillable-type cylinders should be returned to original supplier with any valve caps and outlet plugs secured and valve protection caps in place.

References

(31); (173); (101); (138).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Boron Trichloride, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Boron Trichloride*, #0245, Trenton, NJ (April 2001).

Boron Trifluoride B:0620

Formula: BF_3
Synonyms: Borane, trifluoro-; Boron fluoride; Fluorure de bore (French); Leecure B; Leecure, B series; Trifluoroborane; Trifluoroboron; Trifluoruro de boro (Spanish)
CAS Registry Number: 7637-07-2; 13319-75-0 (dihydrate)
HSDB Number: 325
RTECS Number: ED2275000
UN/NA & ERG Number: UN1008/125
EC Number: 231-569-5 [*Annex I Index No.:* 005-001-00-X]
Regulatory Authority and Advisory Information

Department of Homeland Security Screening TQ (pounds): *Release hazard* 5000 (≥1.00% concentration); *Theft hazard* 45 (≥26.87% concentration).

Hazard Alert: Poison inhalation hazard (extremely toxic gas), Corrosive, Lacrimator, frostbite/Cryogenic burn hazard, asphyxiation hazard, Contains gas under pressure; may explode if heated.

Listed in the TSCA inventory.

OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 250 lb

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 5000 lb (2270 kg)

United States National Primary Drinking Water Regulations: MCLG = 4 mg[F]/L; MCL = 4 mg[F]/L; SMCL = 2.0 mg [F]/L, as Fluoride.

Superfund/EPCRA 302, extremely hazardous substances: TPQ = 500 lb (227 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV.D.3.b, RQ: 500 lb (227 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard Symbol (7637-07-2): T+, C; risk phrases: R5; R14; R21; R26; R35; safety phrases: S1/2; S9; S26; S28; S33; S36/37/39; S38; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Boron trifluoride is a nonflammable, colorless gas. Pungent, suffocating odor. Forms dense white fumes in moist air. Shipped as a nonliquefied compressed gas. Molecular weight = 67.8; Relative vapor density (air = 1) = 2.38; boiling point = −100°C; freezing/melting point = −127°C. Hazard identification (based on NFPA-704 M Rating System): Health 4; flammability 0; reactivity 1 ₩. Reacts with water; solubility in cold water = 106%.

Potential Exposure: Boron trifluoride is a highly reactive chemical used primarily as a catalyst in chemical synthesis. It is stored and transported as a gas, but can be reacted with a variety of materials to form both liquid and solid compounds. The magnesium industry utilizes the fire-retardant and antioxidant properties of boron trifluoride in casing and heat treating. Nuclear applications of boron trifluoride include neutron detector instruments; boron-10 enrichment and the production of neutroabsorbing salts for molten-salt breeder reactors.

Incompatibilities: Boron trifluoride reacts with polymerized unsaturated compounds. Decomposes on contact with water, moist air, and other forms of moisture, forming toxic and corrosive hydrogen fluoride, fluoroboric acid, and boric acid. Reacts violently with alkali and alkaline earth metals (except magnesium); metals, such as sodium, potassium, and calcium oxide, and with alkyl nitrates. Attacks many metals in presence of water.

Permissible Exposure Limits in Air

NIOSH IDLH = 25 ppm

Conversion factor: 1 ppm = 2.77 milligram per cubic meter

OSHA PEL: 1 ppm/3 milligram per cubic meter Ceiling Concentration

NIOSH REL: 1 ppm/3 milligram per cubic meter Ceiling Concentration

ACGIH TLV[1]: 1 ppm/2.8 milligram per cubic meter Ceiling Concentration

PAC* Ver. 29[138]

7637-07-2

PAC-1: $\mathbf{2.5_A}$ milligram per cubic meter

PAC-2: $\mathbf{29_A}$ milligram per cubic meter

PAC-3: $\mathbf{88_A}$ milligram per cubic meter

13319-75-0, dihydrate

PAC-1: 3.8 milligram per cubic meter

PAC-2: 44 milligram per cubic meter

PAC-3: 140 milligram per cubic meter

*AEGLs are marked with a subscript "**A**" and correspond to 60 minute values.

Arab Republic of Egypt: TWA 1 ppm (3 milligram per cubic meter), 1993; Australia: TWA 1 ppm (3 milligram per cubic meter), 1993; Austria: MAK 1 ppm (3 milligram per cubic meter), 1999; Belgium: STEL 1 ppm (2.8 milligram per cubic meter), 1993; Denmark: TWA 1 ppm (3 milligram per cubic meter), 1999; Finland: TWA 1 ppm (3 milligram per cubic meter); STEL 3 ppm (8.3 milligram per cubic meter), 1999; France: VLE 1 ppm (3 milligram per cubic meter), 1999; the Netherlands: MAC 3 milligram per cubic meter, 2003; Japan: 0.3 ppm (0.83 milligram per cubic meter), 1999; Norway: TWA 1 ppm (3 milligram per cubic meter), 1999; the Philippines: STEL 1 ppm (3 milligram per cubic meter), 1993; Russia: TWA 0.3 ppm; STEL 1 milligram per cubic meter, 1993; Switzerland: MAK-W 1 ppm (3 milligram per cubic meter), KZG-W 2 ppm (6 milligram per cubic meter), 1999; Thailand: TWA 1 ppm (3 milligram per cubic meter), 1993; Turkey: TWA 1 ppm (3 milligram per cubic meter), 1993; United Kingdom: STEL 1 ppm (2.8 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Ceiling Concentration 1 ppm. Several states have set guidelines or standards for boron trifluoride in ambient air[60] ranging from zero (Connecticut) to 25 μ/m^3 (Virginia) to 30 μ/m^3 (North Dakota) to 71 μ/m^3 (Nevada).

Determination in Air: Collection by an impinger preceded by a filter followed by colorimetric analysis.

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 600 μg[B]/L; State Drinking Water Guidelines: California 1000 μg[B]/L; Maine 1400 μg[B]/L; New Hampshire 630 μg[B]/L; Minnesota 1000 μg[B]/L; Wisconsin 960 μg[B]/L. Runoff from spills or fire control may cause water pollution. *Fluoride ion*: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guidelines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg[F]/L. SafeDrinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg [F]/L; SMCL = 2 mg/[F]/L, as Fluoride.

Routes of Entry: Inhalation, skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Boron trifluoride gas, upon contact with air, immediately reacts with water vapor to form a mist; which, if at a high enough concentration, provides a visible warning of its presence. The gas or mist is severely irritating and corrosive to the skin, eyes, and respiratory system. Inhalation causes coughing and breathing difficulties. Boron trifluoride is highly toxic; may cause death, by inflammation, lung congestion, or pulmonary edema, a medical emergency that can be delayed for several hours. Death or permanent injury can result from very short exposure to small quantities (an estimated 40−60 ppm for 30−60 minutes). Contact with the skin and eyes can cause redness, pain, and serious burns. May cause depression of the CNS. Rapid evaporation of the liquid may cause frostbite. The toxic action of the halogenated borons (boron trifluoride and trichloride) is considerably influenced by their halogenated decomposition products. They are Primary irritant (w/o allergic reaction)s of the nasal passages, respiratory tract, and eyes in man. Animal experiments showed a fall in inorganic phosphorus level in blood and on auropsy, pneumonia, and degenerative changes in renal tubules.

Long-Term Exposure: May cause liver and kidney damage. Long-term exposure leads to irrigation of the respiratory tract, dysporteinemia, reduction in cholinesterase activity; increased nervous system liability.

Points of Attack: Respiratory system; kidneys, eyes, skin.

Medical Surveillance: In the absence of a suitable monitoring method, NIOSH recommends that medical surveillance, including comprehensive preplacement and annual periodic examinations be made available to all workers employed in areas where boron trifluoride is manufactured, used, handled, or is evolved as a result of chemical processes.

First Aid: If contact with liquid, treat for frostbite. If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Engineering controls should be used to maintain boron trifluoride concentrations at the lowest feasible level. Prevent skin contact. **8 hours** (more than 8 hours of resistance to breakthrough $>0.1\ \mu g/cm^2/min$): Teflon gloves, suits, boots; Responder suits. Wear corrosive-resistant gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *10 ppm:* SA* (any supplied-air respirator). *25 ppm*: Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode. *Escape:* GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted canister providing protection against the compound of concern]; or SCBAE (any appropriate escape-type, SCBA). *Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Check oxygen content prior to entering storage area. Poison gas. Color code—Blue: Health Hazard/Poison: Store in a secure poison location. This gas is highly toxic. Even slight exposure to these gasses can cause death. Store outdoors in a secure, restricted area that containing warning signs. This area must be roofed and shaded with the cylinders stored off the ground and separated from all other products assigned to other hazard categories and radiant heat sources on nonwooden floors. If indoors, store in a well-ventilated areas in temperatures not to exceed below −28.9°C or above 54.4°C. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169 with the recommendations of the Compressed Gas Association.

Shipping: UN1008 Boron trifluoride, Hazard class: 2.3; Labels: 2.3—Poisonous gas, 8—Corrosive material, Inhalation Hazard Zone B. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling:

Boron trifluoride

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

Liquid or Compressed

First: Isolate in all directions (ft/m) 100/30

Then: Protect persons downwind (mi/km)

Day 0.1/0.2

Night 0.4/0.6

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 1000/300

Then: Protect persons downwind (mi/km)

Day 1.1/1.8

Night 3.0/4.8

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak to disperse gas. Stop leak if you can do it without risk. Use water spray to reduce vapor but do not put water on leak or spill area. *Small spills:* flush area with flooding amounts of water. *Large spills:* dike far ahead of spill for later disposal. Do not get water inside container. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Decomposes upon heating or on contact with moist air, releasing toxic and corrosive fumes of boric acid, hydrofluoric acid, and oxides of carbon. This gas is under pressure; containers may rupture and explode when heated. Do not use water. For small fire use dry chemical or carbon dioxide. On larger fires use any agent suitable for surrounding fire. Vapors are heavier than air and will collect in low areas. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies.

From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. Chemical reaction with water to form boric acid, and fluoroboric acid. The fluoroboric acid is reacted with limestone, forming boric acid and calcium fluoride. The boric acid may be discharged into a sanitary sewer system while the calcium fluoride may be recovered or landfilled. Protect cylinder and labels from physical damage.

References

(31); (173); (101); (138); (122); (100).

National Institute for Occupational Safety and Health (NIOSH), *Criteria for a Recommended Standard: Occupational Exposure to Boron Trifluoride*, NIOSH Document Number 77-122, Cincinnati, OH (1977).

United States Environmental Protection Agency, Chemical Hazard Information Profile: *Boron Trifluoride*, Washington, DC, Chemical Emergency Preparedness Program (2016).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Boron Trifluoride*, #0246, Trenton, NJ (February 2012).

Boron Trifluoride Etherates B:0630

Formula: $C_2H_6BF_3O$ (*with methyl ether*); $C_4H_{10}BF_3O$ (*with ethyl ether*); $CH_3OCH_3ABF_3$ (*with methyl ether*)

Synonyms: Boron trifluoride diethyl etherate; Boron trifluoride-dimethyl ether; Boron trifluoride dimethyl etherate; Boron trifluoride etherate; Fluorid bority dimethyl ether

CAS Registry Number: 353-42-4 (*compounded with methyl ether*); 109-63-7 (*compounded with ethyl ether*); 373-57-9 (*methanol complex in excess methanol*)

HSDB Number: 6326

RTECS Number: ED8400000 (*with methyl ether*); KX7375000 (*with ethyl ether*)

UN/NA & ERG Number: UN2965 (dimethyl etherate)/139; UN2604 (diethyl etherate)/132

EC Number: 206-532-1 (*with dimethyl ether*); 203-689-8 (*with diethyl ether*)

Regulatory Authority and Advisory Information

The following is for 353-42-4 (with methyl ether), except as noted.

Department of Homeland Security Screening TQ (pounds): *Release hazard* 15,000 (≥1.00% concentration). [Boron triflouride compound with methyl ether (1:1)]

Hazard Alert: Exposure can be lethal, Highly flammable, Highly reactive, Corrosive, Dangerously water reactive (spontaneously explosive).

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 15,000 lb (6810 kg)

United States National Primary Drinking Water Regulations: MCLG = 4 mg[F]/L; MCL = 4 mg[F]/L; SMCL = 2.0 mg [F]/L, as Fluoride.

Safe Drinking Water Act: Priority List (55FR1470), as boron

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV.D.3.b, RQ: 1000 lb (454 kg) (with methyl ether)

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg) (with methyl ether)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. [109-63-7 (*boron trifluoride diethyletherate*)].

Hazard symbols, risk, & safety statements: Hazard symbol: T+, F+, C; risk phrases: R12; R14/15; R20/22; R34; R48/23; safety phrases: S1; S8; S16; S21; S23; S26; S28; 36/37/39; S43; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [1-Low hazard to water. (est.)]

Description: Boron trifluoride etherates: (*compounded with methyl ether*) is moisture-sensitive, corrosive, flammable liquid. Molecular weight = 113.9; boiling point = 126−127°C; freezing/melting point = −14°C. Hazard identification (based on NFPA −704 M Rating System): (*dimethyl etherate/ UN2965*) Health 4; flammability 4; reactivity 1 ₩.

(*compounded with ethyl ether*) is a moisture-sensitive, corrosive, flammable liquid. Molecular weight = 141.9; boiling point = 126°C; freezing/melting point = −58°C; flash point = 64°C (oc). Hazard identification (based on NFPA-704 M Rating System) (*methyl ether*): Health 3; flammability 3−4; reactivity 1 ₩. Decomposes in water.

(*methanol complex in excess methanol*)

Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 4; reactivity 1 ₩.

Potential Exposure: Used as a catalyst.

Incompatibilities: Reacts with air forming corrosive hydrogen fluoride vapors. Incompatible with oxidizers (may cause fire and explosion), water, steam or heat, forming corrosive and flammable vapors. Peroxide containing etherate reacts explosively with aluminum lithium hydride, magnesium tetrahydroaluminate. Mixtures with phenol react explosively with 1,3-butadiene. Presumed to form explosive peroxides.

Permissible Exposure Limits in Air

NIOSH IDLH = 25 ppm

There are no airborne exposure limits for the etherates. Exposure limits for boron trifluoride may be applicable in most cases as follows:

OSHA PEL: 1 ppm/3 milligram per cubic meter Ceiling Concentration

NIOSH REL: 1 ppm/3 milligram per cubic meter Ceiling Concentration

ACGIH TLV[1]: 1 ppm/2.8 milligram per cubic meter Ceiling Concentration

PAC* Ver. 29[138]

353-42-4 compounded with methyl ether

PAC-1: 2.5 milligram per cubic meter

PAC-2: 29 milligram per cubic meter

PAC-3: 88 milligram per cubic meter

109-63-7 compounded with ethyl ether

PAC-1: 2.5 milligram per cubic meter

PAC-2: 29 milligram per cubic meter

PAC-3: 88 milligram per cubic meter

Arab Republic of Egypt: TWA 1 ppm (3 milligram per cubic meter), 1993; Australia: TWA 1 ppm (3 milligram per cubic meter), 1993; Austria: MAK 1 ppm (3 milligram per cubic meter), 1999; Belgium: STEL 1 ppm (2.8 milligram per cubic meter), 1993; Denmark: TWA 1 ppm (3 milligram per cubic meter), 1999; Finland: TWA 1 ppm (3 milligram per cubic meter); STEL 3 ppm (8.3 milligram per cubic meter), 1999; France: VLE 1 ppm (3 milligram per cubic meter), 1999; the Netherlands: MAC 3 milligram per cubic meter, 2003; Japan: 0.3 ppm (0.83 milligram per cubic meter), 1999; Norway: TWA 1 ppm (3 milligram per cubic meter), 1999; the Philippines: STEL 1 ppm (3 milligram per cubic meter), 1993; Russia: TWA 0.3 ppm; STEL 1 milligram per cubic meter, 1993; Switzerland: MAK-W 1 ppm (3 milligram per cubic meter), KZG-W 2 ppm (6 milligram per cubic meter), 1999; Thailand: TWA 1 ppm (3 milligram per cubic meter), 1993; Turkey: TWA 1 ppm (3 milligram per cubic meter), 1993; United Kingdom: STEL 1 ppm (2.8 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Ceiling Concentration 1 ppm. Several states have set guidelines or standards for boron trifluoride in ambient air[60] ranging from zero.

(Connecticut) to 25 μ/m^3 (Virginia) to 30 μ/m^3 (North Dakota) to 71 μ/m^3 (Nevada).

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 600 μg[B]/L; State Drinking Water Guidelines: California 1000 μg[B]/L; Maine 1400 μg[B]/L; New Hampshire 630 μg[B]/L; Minnesota 1000 μg[B]/L; Wisconsin 960 μg[B]/L. Runoff from spills or fire control may cause water pollution. *Fluorideion*: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guidelines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg[F]/L. SafeDrinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg [F]/L; SMCL = 2 mg/F/L, as Fluoride.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: These compounds are corrosive. Contact may cause severe burns to skin and eyes. The boron fluoride etherates are highly toxic by inhalation. Inhalation may cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: Can cause kidney damage.

Points of Attack: Kidneys.

Medical Surveillance: Consider chest X-ray following acute overexposure. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Lung function tests. Kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately.

If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: (as boron trifluoride) *10 ppm:* SA* (any supplied-air respirator). *25 ppm:* Sa:Cf (APF = 25)* (any supplied-air respirator operated in a continuous-flow mode); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode. *Escape:* GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted canister providing protection against the compound of concern]; or SCBAE (any appropriate escape-type, SCBA). *Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Un2604 Corrosive or Contact Hazard; Store separately in a corrosion resistant location.UN2965 Color code—Red Stripe: Dangerous when wet materials release flammable gases on contact with water. Do not store this material in a room protected by water sprinkler systems. Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Do not store in a basement. Before entering confined space where these chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: *Diethyl*: UN2604 Boron trifluoride diethyl etherate, Hazard class: 8; Labels: 8—Corrosive material, 3—Flammable liquid. *Dimethyl*: UN2965 Boron trifluoride dimethyl etherate, Hazard class: 4.3; Labels: 4.3—Dangerous when wet, 8—Corrosive material, 3—Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Do not touch spill material. Use water spray to reduce vapors, but do not get water inside containers. For *small spills*, absorb with sand or other non-combustible absorbent material and place into containers. For *large spills*, dike far ahead of spill for later disposal. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include fluoride compounds, boric acid and oxides of carbon. For small fires use dry chemical, carbon dioxide; water spray; or foam extinguishers. For large fires, use water spray, fog, or foam. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (122); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: *Boron Trifluoride Compound with Methyl Ether (1:1),* Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Boron Trifluoride Dimethyl Etherate,* #0250, Trenton, NJ (September 2002).

Bromacil B:0640

Formula: $C_9H_{13}BrN_2O_2$
Synonyms: Borea; Borocil extra; Bromacil 1.5; alpha-Bromacil 80 WP; Bromax; Bromazil; 5-Bromo-3-*sec*-butyl-6-methyluracil; 5-Bromo-6-methyl-3-(1-methylpropyl)-2,4-(1*H*,3*H*)-pyrimidinedione; 5-Bromo-6-methyl-3-(1-methylpropyl)-2,4(1*H*,3*H*)-pyrimidinedione; 3-*sek*-Butyl-5-brom-6-methyluracil (German); Croptex onyx; Cynogan; Dupont herbicide 976; Eerex; Eerex granular weed killer; Eerex water soluble granular weed killer; Fenocil; Herbicide 976; Hydon; Hyvar; Hyvarex; Hyvar-EX; Hyvar X; Hyvar X-7; Hyvar X Bromacil; Hyvar X weed killer; Hyvar X-WS; Krovar II; Nalkil; 2,4(1*H*,3*H*)-Pyrimidinedione, 5-bromo-6-methyl-3-(1-methylpropyl)-; Uracil, 5-Bromo-3-*sec*-butyl-6-methyl; Uragan; Uragon; Urox; Urox B; Urox B water soluble concentrate weed killer; Urox-HX; Urox HX granular weed killer
CAS Registry Number: 314-40-9; *(alt.)* 154670-12-9
HSDB Number: 1522
RTECS Number: YQ9100000
UN/NA & ERG Number: NA1993 [For Domestic Bulk Shipments: Proper shipping name: Combustible liquid, n.o.s., (Ethanol, Methanol)]/128
EC Number: 206-245-1
Regulatory Authority and Advisory Information
Hazard Alert: Poison, Flammable, Suspected of causing genetic defects, Suspected reprotoxic hazard.
Safe Drinking Water Act (47FR 9352): Priority List (55FR1470)
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
Hazard symbols, risk, & safety statements: Hazard symbol: F, N, Xn; risk phrases: R10; R22; R36/37/38; R51; R61; R62; R63; safety phrases: S16; S26; S45; S61 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): No value found. [2-Hazard to water. (est.)]
Description: Bromacil is a noncombustible colorless, crystalline solid, which may be dissolved in a flammable liquid. Molecular weight = 261.2; Specific gravity (H_2O:1) = 1.55 @ 25°C; boiling point = (sublimes); freezing/melting point = 158.3°C (sublimes); vapor pressure = 0.0008 mmHg @ 25°C (NIOSH); 3.1×10^{-7} mmHg (EPA); Flash point (*in ethanol or methanol*) = ~44°C. Hazard identification (based on NFP A-704 M Rating System): Health 1; flammability 1; reactivity 0 ₩; (*in ethanol or methanol*): Health 1; flammability 2; reactivity 0 ₩. Slightly soluble in water; 0.08% @ 77°F/25°C. Commercial formulations use carrier solvents that may alter the physical properties shown.
Potential Exposure: Used for general weed or brush control in noncrop areas and primarily for the control of annual and perennial grasses and broadleaf weeds, both nonselectively on noncrop lands and selectively for weed-control in a few crops (citrus and pineapple). A limit of 0.1 mg/kg of agricultural products is set in several countries[35]. Those exposed will be those involved in manufacture, formulation, and application.
Incompatibilities: Incompatible with strong acids; oxidizers, heat. Decomposes slowly in strong acids.
Permissible Exposure Limits in Air
Conversion factor: 1 ppm = 10.68 milligram per cubic meter @ 25°C & 1 atm
OSHA PEL: None
NIOSH REL: 1 ppm/10 milligram per cubic meter TWA
ACGIH 10 milligram per cubic meter TWA, confirmed animal carcinogen with unknown relevance to humans.
No PAC available.
Australia: TWA 1 ppm (10 milligram per cubic meter), 1993; Belgium: TWA 1 ppm (11 milligram per cubic meter), 1993; Denmark: TWA 5 milligram per cubic meter, 1999; Finland: TWA 1 ppm (10 milligram per cubic meter); STEL 3 ppm (30 milligram per cubic meter), 1999; France: VME 1 ppm (10 milligram per cubic meter), 1999; Switzerland: MAK-W 1 ppm (10 milligram per cubic meter), 1999; United Kingdom: TWA 1 ppm (11 milligram per cubic meter), STE; 2 ppm (22 milligram per cubic meter), 2000; the Netherlands: MAC-TGG 10 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea: ACGIH TLV: confirmed animal carcinogen with unknown relevance to humans. Some states have set guidelines or standards for bromacil in ambient air[60] ranging from 100 μ/m^3 (North Dakota) to 160 μ/m^3 (Virginia) to 200 μ/m^3 (Connecticut) to 238 μ/m^3 (Nevada).
Determination in Air: Use NIOSH Analytical Methods (IV) #0500, Particulates NOR, total dust.
Permissible Concentration in Water: A no-adverse-effects-level in drinking water has been calculated by NAS/NRC as 0.086 mg/L[46]. Some states have set guidelines for Bromacil in drinking water[61] including Maine @ 25 μg/L, and Kansas @ 87.5 μg/L.
Determination in Water: Octanol–water coefficient: Log K_{ow} = 2.1. Unlikely to bioaccumulate in marine organisms. Fish Tox: 6485.34001000 ppb MATC (VERY LOW).
Routes of Entry: Inhalation, ingestion, skin and/or eye contact.
Harmful Effects and Symptoms
Short-Term Exposure: Irritates the eyes, skin, upper respiratory system; lungs. Inhalation can cause irritation, coughing, and wheezing.
Long-Term Exposure: Has cause thyroid affects in animals. Human Tox: 90.00000 ppb Health advisory: (LOW).
Points of Attack: Eyes, skin, respiratory system; thyroid.
Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following is recommended: Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours

following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Lung function tests. Thyroid function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing, and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-or dust-proof chemical goggles (depending on physical state of material) and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures *over* 1 ppm; Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure demand or other positive pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with bromacil all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong acids; oxidizers, heat and open flame.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1—Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft (NJ). Isolation Distance, Fire: 800 m/0.5 miles[70]. Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Absorb liquid containing bromacil in vermiculite, dry sand; earth, or similar material. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Soil Adsorption Index $K_{oc} = 32$.

Fire Extinguishing: Bromacil may burn, but does not readily ignite. Bromacil may be ignited by heat or open flame. Dust may cause an explosion. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. Thermal decomposition products may include bromine and nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Bromacil should be incinerated in a unit operating @ 850°C equipped with gas scrubbing equipment[22].

References

(31); (173); (101); (138); (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Bromacil*, Trenton, NJ (October 2007).

Bromadiolone B:0650

Formula: $C_{30}H_{23}BrO_4$

Synonyms: 2H-1-Benzopyran-2-one, 3-(3-[4′-Bromo(1,1′-biphenyl)-4-yl]-3-hydroxy-1-phenylpropyl)-4-hydroxy-; Bromadialone; 3-(3-[4′-Bromo(1,1′-biphenyl)-4-yl]3-hydroxy-1-phenylpropyl)-4-hydroxy-2H-1-benzopyran-2-one; 3-[3-(4′-Bromobiphenyl)-4-yl]3-hydroxy-1-phenylpropyl)-4-hydroxy-coumarin; 3-(α-[*p*-(*p*-Bromophenyl)-β-hydroxyphenethyl] benzyl)-4-hydroxy-coumarin; Canadien2000; Contrac; Coumarin, 3-(3-(4′-bromo-1,1′-biphenyl-4-yl)-3-hydroxy-1-phenylpropyl)-4-hydroxy-; Coumarin, 3-(α-[*p*-(*p*-bromophenyl)-β-hydroxyphenethyl)benzyl]-4-hydroxy-; (Hydroxy-4-coumarinyl 3)-3 phenyl-3(bromo-4 biphenyl-4)-1 propanol-1 (French); LM-637; MAKI; Ratimus; Rentokil Deadline; Slaymor; Supercaid; Super-Caid; Super-Rozol; Sup'orats; Temus.

CAS Registry Number: 28772-56-7
HSDB Number: 6458
RTECS Number: GN4934700
UN/NA & ERG Number: UN3026 (liquid)/151; UN3027 (solid)/151
EC Number: 249-205-9

Regulatory Authority and Advisory Information

Hazard Alert: Exposure can be lethal, Highly toxic(ingestion), Combustible, Environmental hazard, Agricultural chemical.

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV.D.3.b, RQ: 100 lb (45.4 kg).

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T+; risk phrases: R27/28; R50/53; safety phrases: S13; S28; S29/35; S45; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Bromadiolone is white to off-white (yellowish) powder. Molecular weight = 527.41; freezing/melting point = 200−210°C. Hazard identification (based on NFPA-704 M Rating System): Health 4; flammability 1; reactivity 0 ₩. Very low solubility in water.

Potential Exposure: Bromadiolone is used as an anticoagulant rodenticide. It is bait for rodent control used against house mice, roof rats, warfarin-resistant Norway rats. It is also authorized by USDA for use in official establishments operating under the federal meat, poultry, shell egg grading, and egg products inspection program. May be used as a drug.

Permissible Exposure Limits in Air

PAC Ver. 29[138]
PAC-1: 0.091 milligram per cubic meter
PAC-2: 1 milligram per cubic meter
PAC-3: 3.4 milligram per cubic meter

Routes of Entry: Ingestion, inhalation, skin and/or eye contact.

Harmful Effects and Symptoms

The compound is toxic by oral exposure, the oral LD_{50} rabbit is 1.0 mg/kg and LD_{50} = (oral-rat) 1.125 mg/kg (Extremely toxic)[9].

Short-Term Exposure: Very toxic if ingested; by skin and eye contact. May cause eye irritation. Bro madiolone has an acute oral toxicity LD_{50} = 1−3 mg/kg, rodents/nonrodents (HIGH). Dermal toxicity LD_{50} = 9.4 mg/kg, rabbits (HIGH).

Long-Term Exposure: Studies of mutagenicity and teratogenicity have not shown any mutagenic, embryotoxic, or teratogenic effects. Coumarin and its derivatives may be carcinogenic to humans.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full face piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full face piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive pressure mode).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with bromadiolone all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: UN3027 Coumarin derivative pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1—Poisonous materials. UN3026 Coumarin derivative pesticides, liquid, toxic, Hazard Class: 6.1; Labels: 6.1—Poisonous materials.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills:* absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills:* with clean shovel place material into clean, dry container and cover; move containers from spill area. *Large spills:* dike far ahead of spill for later disposal.

Fire Extinguishing: Thermal decomposition products may include toxic hydrogen bromide and oxides of carbon. This material may burn but does not ignite readily. *Small fires:* dry chemicals, carbon dioxide; water spray or foam. *Large fires:* water spray, fog or foam. Move container from fire area if you can do so without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: *Bromadiolone*, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Bromadiolone*, #2179, Trenton, NJ (July 2000).

Bromoxynil

Formula: $C_7H_3Br_2NO$; $C_{15}H_{17}Br_2NO$ (octanoate)

Synonyms: Bensonitrile, 3,5-dibromo-4-hydroxy-; Benzonitrile, 3,5-dibromo-4-hydroxy-; Butilchlorofos; Caswell No. 119; Briotril; Brucil; Brittox; Brominal; Brominex; Brominal; Brominal me-4; Brominil; Bromilil plus; Bromox 2e; Bromotril; Bromoxynil nitrile herbicide; Bronate; Broxynil; Buctril bromoxynil; Buctril gel herbicide (octanoate); Buctril 4ec gel (mixture of bromoxynil octanoate + bromoxynil heptanoate); Buctril industrial; Chipco buctril; Chipco crab-kleen; 2,6-Dibromo-4-cyanophenol; 2,6-Dibromo-4-hydroxybenzonitrile; 2,6-Dibromo-4-phenylcyanide; 3,5-Dibromo-4-hydroxybenzonitrile; 3,5-Dibromo-4-hydroxyphenyl cyanide; ENT 20,852; Flagon, 400ec; Hobane; 4-Hydroxy-3,5-dibromobenzonitrile; Labuctril; Litarol; M&B 10064; MB 10064; MB 10731 (octanoate); M&B 10731; ME4 brominal; Merit; Mextrol-biox; Moxy 2e; NCR CE EE DOV7 (octanoate); NU-lawn weeder; Oxytrilm; Pardner; Sabre; Torch

CAS Registry Number: 1689-84-5; 1689-99-2 (octanoate)

HSDB Number: 1523

RTECS Number: DI3150000

UN/NA & ERG Number: UN2588 (pesticide, solid, poisonous, n.o.s.)/151

EC Number: 216-882-7 [*Annex I Index No.:* 608-006-00-0]

Regulatory Authority and Advisory Information

Carcinogenicity[83]: EPA Group C, possible human carcinogen

California Proposition 65 Chemical[102]: Developmental toxin (10/1/1990)

Hazard Alert: Poison, Sensitization hazard (skin), Environmental hazard, Agricultural chemical.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0% (also, octanoate)

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, N, Xi; risk phrases: R25; R26; R43; R50/53; R63; safety phrases: S1/2; S27/28; S29; S36/37; S41; S45; S63; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): [3-Severe hazard to waters (est.)]

Description: Bromoxynil is a colorless to white crystalline solid or tan powder. Odorless (pure). Molecular weight = 276.93; boiling point = (sublimes) 135°C @ 0.15 mmHg[88]; freezing/melting point = 194–195°C; 360°C (sodium or potassium salt); vapor pressure = 4.5×10^{-8} mmHg @ 20°C. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 0; reactivity 0 ₩. Moderately soluble in water; solubility = 125 ppm @ 20°C.

Potential Exposure: Bromoxynil is a hydroxybenzonitrile herbicide used for postemergent control of broadleaf weeds; on alfalfa, garlic, corn, sorghum, flax, cereals, turf and on pasture and rangelands. A United States Environmental Protection Agency RUP.

Incompatibilities: A weak acid; keep away from bases and alkalies. React with boranes, alkalies, aliphatic amines, amides, nitric acid, sulfuric acid. Keep away from oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.) and strong acids.

Permissible Exposure Limits in Air

NIOSH REL: *Nitriles:* 2 ppm, Ceiling Concentration, not to be exceeded in any 15-minute work period.

Determination in Air: Bromoxynil/bromoxynil octanoate, NIOSH: #5010. See NIOSH Criteria Document 78-212 *NITRILES*(18)

Permissible Concentration in Water: State Drinking Water Guidelines: Florida 140 μg/L. Runoff from spills or fire control may cause water pollution.

Determination in Water: State Drinking Water Guidelines: Florida 140 μg/L. Octanol−water coefficient: Log K_{ow} => 2.5. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood. Fish toxicity (threshold)(101): Low−283.24412 ppb, MATC; (octanoate).

Routes of Entry: Inhalation, dermal and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Contact may cause burns to skin and eyes. Because this material has a low vapor pressure, significant inhalation of vapors is unlikely at ordinary temperatures. May affect the iron metabolism, causing asphyxia. It is highly toxic. Forms cyanide in the body. Exposure results in headache, dizziness, rapid pulse, deep-rapid breathing, nausea, vomiting, unconsciousness, convulsions and sometimes death. May cause cyanosis (blue coloration of skin and lips caused by lack of oxygen). LD_{50} (oral, rat) = 80−190 mg/kg; LD_{50} (dermal, rat) => 2 g/kg.

Long-Term Exposure: Chronic exposure over long periods may cause fatigue and weakness. Can cause same general symptoms as hydrogen cyanide but onset of symptoms is likely to be slower. May cause liver and kidney damage. May cause skin sensitization. Human toxicity (long-term)[101]: Intermediate—10.50 ppb, Health advisory; *octanoate:* Very low—140.00 ppb, Health advisory: High—4.40230 ppb, MATC.

Points of Attack: Skin. In animals: liver, kidney damage. May be a nerve toxin.

Medical Surveillance: Preliminary medical exam to detect chronic diseases of CNS, liver, heart, kidneys, lung and skin, as well as endocrinological or immunological disturbances, should protect susceptible individuals. Periodical medical exams of internal organs, skin and eyes are important to avoid chronic occupational intoxications. They should include lab and patch tests when necessary[83]. Comprehensive physical examination with emphasis on the genitourinary tract analysis to include sperm count, motility and morphology. Other tests, such as serum testosterone, serum FSH, and serum LH may be carried out if, in the opinion of a physician, they are indicated. Liver and kidney function tests. Evaluation by a qualified allergist, including exposure history and testing, may help diagnose allergy. Pregnant women should avoid contact. Employees should be notified by a physician that this chemical may affect the reproductive system. In addition to comprehensive initial medical and work histories emphasizing reproductive experience and menstrual history, patient should have physical examination and testing of genito-urinary tract, sperm count, motility and morphology. If required, other tests, such as serum testosterone, serum FSH, and serum LH may be indicated.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves[31].

Personal Protective Methods: Wear positive pressure SCBA (SCBA). Wear chemical protective clothing that is specifically recommended by the manufacturer. It may provide little or no thermal protection. Structural firefighters' protective clothing provides limited protection in fire situations ONLY; it is not effective in spill situations where direct contact with the substance is possible[31]. Smoking, eating, and drinking before washing should be absolutely prohibited when any pesticide is being handled or used. Applicators and other handlers must wear: Coveralls worn over long-sleeved shirt and long pants; Chemical-resistant gloves such as DuPont Tychem suit fabrics; Chemical-resistant footwear plus socks; protective eye wear; Chemical-resistant headgear for overhead exposure; Chemical-resistant apron when cleaning equipment, mixing, or loading[83]. Agricultural Use/Engineering Controls: When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the WPS for agricultural pesticides, 40CFR 170.240(d)(4-6), the handler PPE requirements may be reduced or modified as specified in the WPS.

Respirator Selection: *Nitriles*: NIOSH, *10 ppm:* Sa (APF = 10) (any supplied-air respirator); *25 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); *50 ppm:* SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece); *250 ppm:* SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive pressure mode. *Escape*: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison. Store in a secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong alkalis (such as Sodium Hydroxide, Sodium Bicarbonate, etc.). Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN2588 Pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1—Poisonous materials, Technical Name Required.

Spill Handling: Issue poison warning. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Stop leak if you can do it without risk. Prevent entry into waterways, sewers, basements or confined areas. Cover with plastic sheet to prevent spreading. Absorb or cover with dry earth, sand or other noncombustible material and transfer to containers. Do not allow water to get inside containers. If a spill occurs, clean it up promptly. Don't wash it away. Instead, sprinkle the spill with sawdust, vermiculite, or kitty litter. Sweep it into a plastic garbage bag, and dispose of it as directed on the pesticide product label.

Fire Extinguishing: Thermal decomposition products may include hydrogen bromide and oxides of nitrogen and carbon. *On a small fire:* use dry chemical, CO_2 or water spray. On a large fire, use water spray, fog, or regular foam. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal; do not scatter the material. Use water spray or fog; do not use straight streams. *Fire involving storage or vehicular tanks:* Isolate for 800 m/0.5 mile in all directions; also, consider initial evacuation for 800 m/0.5 mile in all directions. Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Do not get water inside containers. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. ALWAYS stay away from tanks engulfed in fire. For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies.

Disposal Method Suggested: Do not discharge into drains or sewers. Dispose of waste material as hazardous waste using a licensed disposal contractor to an approved landfill. Incineration with effluent gas scrubbing is recommended. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. If allowed, Incineration with effluent gas scrubbing is recommended. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(102); (31); (173); (101); (138); (100).

EXTOXNET, Extension Toxicology Network, "Pesticide Information Profile, Bromoxynil," Oregon State University, Corvallis, OR (June 1996). http://extoxnet.orst.edu/pips/bromoxyn.htm.

United States Environmental Protection Agency, Office of Pesticide Programs, Pesticide Residue Limits, "Bromoxynil," 40CFR 180.324, http://www.epa.gov/pesticides/food/viewtols.htm.

United States Environmental Protection Agency, *R.E.D. FACTS, Bromoxynil*, EPA 738-F-98-011, Washington, DC (September 1998).

United States Environmental Protection Agency, Chemicals Evaluated for Carcinogenic Potential, Washington, DC (April 2006).

Bromine 660

Formula: Br

Synonyms: Brom (German); Brome (French); Bromo (Spanish)

CAS Registry Number: 7726-95-6

HSDB Number: 514

RTECS Number: EF9100000

UN/NA & ERG Number: UN1744/154

EC Number: 231-778-1 [*Annex I Index No.*: 035-001-00-5]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening TQ (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Hazard Alert: Poison inhalation hazard (gas-high acute toxicity), Powerful oxidizer, Environmental hazard.

Clean Air Act: Accidental Release Prevention/Flammable Substances, [Section 112(r)], TQ = 10,000 lb (4540 kg)

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500 lb (227 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV.D.3.b, RQ: 500 lb (227 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects[291]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, C, N; risk phrases: R26; R35; R33; R51; safety phrases: S1/2; S7/9; S26; S29/35; S41; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Bromine is a fuming red to dark reddish-brown, nonflammable, volatile liquid with a suffocating odor. Soluble in water and alcohol. Molecular weight = 159.8; specific gravity (H_2O:1) = (H_2O:1) = 3.12; boiling point = 58.8°C; freezing/melting point = −7.2°C; relative density of the vapor/air-mixture @ 20°C (air = 1) = 2.12; vapor pressure = 172 mmHg @ 20°C. The odor threshold is 3.5 ppm[41]. Hazard identification (based on NFPA-704 M Rating System): health 3−4; flammability 0; reactivity 2 ₩.

Potential Exposure: Bromine is primarily used in the manufacture of gasoline antiknock compounds (1,2-dibromoethane). Other uses are for gold extraction; in brominating hydrocarbons; in bleaching fibers and silk; in the manufacture of military gas, dyestuffs; and as an oxidizing agent. It is used in the manufacture of many pharmaceuticals and pesticides.

Incompatibilities: A powerful oxidizer. May cause fire and explosions in contact with organic or other readily oxidizable materials. Contact with aqueous ammonia, acetaldehyde, acetylene, acrylonitrile, or with metals, may cause violent reactions. Anhydrous Br_2 reacts with aluminum, titanium, mercury, potassium; wet Br_2 with other metals. Also incompatible with alcohols, antimony, alkali hydroxides, arsenites, boron, calcium nitrite, cesium monoxide, carbonyls, dimethyl formamide, ethyl phosphine, fluorine, ferrous and mercurous salts; germanium, hypophosphites, iron carbide, isobutyronphenone, magnesium phosphide, methanol, nickel carbonyl, olefins, ozone, sodium and many other substances. Attacks some coatings, and some forms of plastic and rubber. Corrodes iron, steel, stainless steel; and copper.

Permissible Exposure Limits in Air

NIOSH IDLH = 3 ppm

Conversion factor: 1 ppm = 6.54 milligram per cubic meter @ 25°C & 1 atm.

OSHA PEL: 0.1 ppm/0.7 milligram per cubic meter TWA

NIOSH REL: 0.1 ppm/0.7 milligram per cubic meter TWA; 0.3 ppm/0.8 milligram per cubic meter STEL

ACGIH TLV[1]: 0.1 ppm/0.66 milligram per cubic meter TWA; 0.1 ppm TWA; 0.2 ppm STEL

PAC* Ver. 27

PAC-1: $\mathbf{0.033_A}$ ppm

PAC-2: $\mathbf{0.24_A}$ ppm

PAC-3: $\mathbf{8.5_A}$ ppm

*AEGLs are marked with a subscript "**A**" and correspond to 60 minute values.

DFG MAK: No numerical value established. Data may be available.

Europe OEL: 0.1 ppm/0.7 milligram per cubic meter TWA

Arab Republic of Egypt: TWA 0.1 ppm (0.7 milligram per cubic meter), 1993; Australia: TWA 0.1 ppm (0.7 milligram per cubic meter); STEL 0.3 ppm (2 milligram per cubic meter), 1993; Austria: MAK 0.1 ppm (0.7 milligram per cubic meter), 1999; Belgium: TWA 0.1 ppm (0.66 milligram per cubic meter); STEL 0.3 ppm, 1993; Denmark: TWA 0.1 ppm (0.7 milligram per cubic meter), 1999; Finland: STEL 0.1 ppm (0.7 milligram per cubic meter) [skin] 1999; France: VLE 0.1 ppm (0.7 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 0.7 milligram per cubic meter, 2003; India: TWA 0.1 ppm (0.7 milligram per cubic meter); STEL 0.3 ppm (2 milligram per cubic meter), 1993; Japan: 0.1 ppm (0.65 milligram per cubic meter), 1999; Norway: TWA 0.1 ppm (0.7 milligram per cubic meter), 1999; the Philippines: TWA 0.1 ppm (0.7 mg/m^3), 1999; Poland: MAC (TWA) 0.7 milligram per cubic meter, MAC (STEL) 2 milligram per cubic meter, 1999; Russia: TWA 0.1 ppm; STEL 0.5 milligram per cubic meter, 1993; Sweden: NGV 0.1 ppm (0.7 milligram per cubic meter), KTV 0.3 ppm (2 milligram per cubic meter), 1999; Switzerland: MAK-W 0.1 ppm (0.7 milligram per cubic meter), KZG-W 0.2 ppm, 1999; Turkey: TWA 0.1 ppm (0.7 milligram per cubic meter), 1993; United Kingdom: TWA 0.1 ppm (0.66 milligram per cubic meter); STEL 0.3 ppm (2.0 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 0.1 ppm; STEL 0.2 ppm. Several States have set guidelines or standards for bromine in ambient air[60] ranging from 2.33 μ/m^3 (New York) to 7.0 μ/m^3 (Florida and North Dakota) to 11.0 μ/m^3 (Connecticut) to 17 μ/m^3 (Nevada) to 200 μ/m^3 (North Carolina).

Determination in Air: Use NIOSH Analytical Method (IV) #6011, OSHA Analytical Method ID-108.

Permissible Concentration in Water: Russia set a MAC value of 0.2 mg/L in water bodies used for domestic purposes. Maine has set a guideline[61] for drinking water of 660 μg/L.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact. Absorbed through the skin.

Harmful Effects and Symptoms

The majority of exposures to bromine occurs by inhalation and typically leads to symptoms of ocular, nasal, and respiratory irritation. A corrosive liquid, bromine can cause severe eye and skin irritation and burns that may cause permanent damage and scarring. Inhalation can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Short-Term Exposure

Symptoms of exposure can include dizziness, headache, lacrimation (discharge of tears), epistaxis (nosebleed); cough, feeling of oppression; abdominal pain; diarrhea. Signs and symptoms of poisoning include eye redness and lacrimation, nose and throat irritation, cough, and dyspnea. Ingestion of liquid bromine can cause abdominal pain and hemorrhagic gastroenteritis with secondary shock. Signs and symptoms might also include brown discoloration of mucous membranes and the tongue. *Inhalation:* small amount will cause coughing, nose bleed, dizziness, and headache followed by abdominal pain and diarrhea and sometimes measles-like eruption on trunk and extremities. *Skin contact:* causes pustules and painful nodules in exposed areas of skin; if not removed will cause deep, painful ulcers. *Ingestion (of liquid):* causes burning pain in mouth and esophagus, lips and mucous membranes stained brown; severe gastroenteritis evidenced by abdominal pain and diarrhea; cyanosis, and shock. Regular exposure to concentrations approaching the permissible exposure level causes irritability, loss of appetite; joint pains and dyspepsia. Other symptoms include loss of cornea reflexes, inflammation of the throat, thyroid dysfunction, cardiovascular disorders; disorders of digestive tract. Inhalation exposure to 11−23 milligram per cubic meter produces severe choking. 30−60 milligram per cubic meter is extremely dangerous. 200 milligram per cubic meter is fatal in a short time. Vapors can cause acute as well as chronic poisoning. It has cumulative properties. It is irritating to the eyes, and respiratory tract. Poisoning is due to the corrosive action on the gastrointestinal tract. Nervous, circulatory and renal disturbances occur after ingestion. Ingestion of liquid can cause death due to circulatory collapse and asphyxiation from swelling of the respiratory tract. The lowest oral lethal dose reported for humans is 14 mg/kg. The lowest lethal inhalation concentration reported for humans is 1000 ppm.

Long-Term Exposure: May cause acnelike eruptions on the skin. Repeated exposure may cause headache, chest pain; joint pain; and indigestion. Bronchitis or pneumonia may develop with cough, shortness of breath; and phlegm.

Points of Attack: Respiratory system, eyes, lungs, central nervous system.

Medical Surveillance: The skin, eyes, and respiratory tract should be given special emphasis during preplacement and periodic examinations. Chest X-rays as well as general health, lung, blood, liver, and kidney function should be considered. Exposure to other irritants or bromine.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Prevent skin contact. **4 hours:** (At least 4 but <8 hours of resistance to breakthrough >0.1 0.1 μg/cm^2/min): Teflon gloves, suits, boots. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: OSHA: *2.5 ppm:* Sa:Cf$^{£}$ (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprS¿$^{£}$ (APF = 25) [any PAPR with cartridge(s) providing protection against the compound of concern]. *3 ppm:* CcrFS¿ (APF = 50) [any chemical cartridge respirator with a full facepiece and cartridge(s) providing protection against the compound of concern] organic vapor and acid gas cartridge(s); or GmFS¿ (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted canister providing protection against the compound of concern]; or PaprTS¿ (APF = 50) [any PAPR with a tight-fitting facepiece and cartridge(s) providing protection against the compound of concern]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS¿ (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted canister providing protection against the compound of concern]; or SCBAE [any appropriate escape-type, self-contained breathing apparat(s)]. *Note*:$^{£}$: Substance causes eye irritation or damage; eye protection needed.¿: Only *nonoxidizable sorbents* are allowed (not charcoal).

Storage: PIH; check oxygen content prior to entering storage area. (1) Corrosive or Contact Hazard; store separately in a corrosion resistant location. (2) Color code—Blue: Health Hazard/Poison. Store in a secure poison location. (3) Color code—Yellow Stripe: Reactivity Hazard. Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Store in a cool, dry room with ventilation along the floor. Keep sealed or glass stoppered. Protect against physical damage. Keep out of direct sunlight. Separate from combustibles, organics or other readily oxidizable materials. Store above −7°C /20°F to prevent freezing but avoid heating above room temperature to prevent pressure increase which could rupture containers. Store in a cool, well-ventilated area away from incompatible materials listed above. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage.

Shipping: Bromine UN1744 Hazard class: 8; Labels: 8—Corrosive material; 6.1—Poison Inhalation Hazard, Inhalation Hazard Zone A. *Bromine solutions*, Hazard class: 8; Labels: 8—Corrosives materials; 6.1—Poison Inhalation Hazard, Inhalation Hazard Zone A; *Bromine solutions*, Hazard class: 8 Labels: 8—Corrosive material; 6.1—Poison Inhalation Hazard, Inhalation Hazard Zone B.

Spill Handling:
Bromine
Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)
First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.4/0.6.3
Night 1.2/1.9

Large spills (From a large package or from many small packages)
First: Isolate in all directions (ft/m) 1000/300
Then: Protect persons downwind (mi/km)
Day 1.8/2.9
Night 4.0/6.5

Bromine solution and/or **Bromine, solution (Inhalation Hazard Zone A)**

Small spills (From a small package or a small leak from a large package)
First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.4/0.6
Night 1.2/1.9

Large spills (From a large package or from many small packages)
First: Isolate in all directions (ft/m) 1000/300
Then: Protect persons downwind (mi/km)
Day 1.8/2.9
Night 4.0/6.6

Small spills (From a small package or a small leak from a large package)

Bromine, solution (Inhalation Hazard Zone B)
First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.3/0.5
Night 0.8/1.3

Large spills (From a large package or from many small packages)
First: Isolate in all directions (ft/m) 500/150
Then: Protect persons downwind (mi/km)
Day 1.1/1.8
Night 2.6/4.1

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Wear eye protection. Wear positive pressure breathing apparatus and special protective clothing. Ventilate area of spill or leak. Collect for reclamation by absorbing it in vermiculite, dry sand; earth, or a similar material and deposit it in sealed containers in secured sanitary landfill. Potassium carbonate, sodium carbonate, sodium bicarbonate, lime, and sodium hydroxide solutions are neutralizing agents for liquid bromine spills. Do not touch material, stop leak if possible without risk. Use water spray to reduce vapors. *Do not* absorb in sawdust or other combustible absorbents; avoid contact with metal implements. *Small spills:* absorb with sand or other noncombustible absorbent material and place in container. *Large spills:* dike spill for later disposal. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include toxic and corrosive fumes of bromine. Bromine is not combustible but enhances combustion of other substances. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Large volumes of concentrated solutions of reducing agents (bisulfites or ferrous salts) may be added[22]. The mixture is neutralized with soda ash or dilute HCl and flushed to the sewer with large volumes of water.

References
(31); (173); (101); (138); (2); (100).

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New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Bromine*, Trenton, NJ, (July 1998).

New York State Department of Health, Chemical Fact Sheet: Bromine, Bureau of Toxic Substance Assessment, Albany, NY (May 1986).

Bromine Chloride B:0663

Formula: BrCl

Synonyms: Bromine monochloride; Bromochloride; Chlorure de brome (French); Cloruro de bromo (Spanish)

CAS Registry Number: 13863-41-7

HSDB Number: 7820

RTECS Number: EF9200000

UN/NA & ERG Number: UN2901/124

EC Number: 237-601-4

Regulatory Authority and Advisory Information

Hazard Alert: Poison inhalation hazard (highly toxic gas); lacrimator, strong oxidizer, corrosive, dangerously water reactive.

United States National Primary Drinking Water Regulations: SMCL = 250 mg[Cl^-]/L as Chloride

United States DOT 49CF R172.101, Inhalation Hazardous Chemical

Hazard symbols, risk, & safety statements: Hazard symbol: O, T; risk phrases: R8; R20/22; R34; safety phrases: S2; S13; S27; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to waters (very toxic to aquatic life)

Description: A reddish-yellow mobile liquid or gas. Irritating, pungent odor. Molecular weight = 115.36; Specific gravity (H_2O:1) = 2.32 @ 25°C; boiling point = 5°C; freezing/melting point = −65°C; vapor pressure = 17.8 mmHg @ 0°C. Decomposes above 10°C, releasing highly toxic fumes of chlorine and bromine. ₩ Soluble in water; dangerous reaction forming hydrochloric acid.

Potential Exposure: Used as an industrial disinfectant.

Incompatibilities: Dangerous, unstable material. Decomposes above 10°C, releasing highly toxic chlorine gas. A strong oxidizer. Contact with gas or liquefied gas may cause burns, severe injury and/or frostbite. Reacts with moisture, water or steam, forming corrosive hydrochloric acid. Reacts violently with combustibles and reducing agents; reactions may produce enough heat to both start and support combustion. May be corrosive to metals.

Permissible Exposure Limits in Air:

PAC* Ver. 29[138]

PAC-1: 0.075 ppm

PAC-2: $\mathbf{0.83_A}$ ppm

PAC-3: $\mathbf{2.5_A}$ ppm

*AEGLs are marked with a subscript "**A**" and correspond to 60 minute values.

Routes of Entry: Ingestion, inhalation, absorbed through the skin

Harmful Effects and Symptoms

Lachrymation. The substance is corrosive to the eyes, the skin and the respiratory tract. Inhalation may cause asthma-like reactions. Inhalation may cause pneumonitis. Inhalation may cause lung edema, but only after initial corrosive effects on eyes and/or airways have become manifest. The symptoms of lung edema often do not become manifest until a few hours have passed, and they are aggravated by physical effort. Exposure may result in death. Long-term exposure: The substance may have effects on the respiratory tract and lungs, resulting in chronic inflammation and impaired functions (IARC).

Short-Term Exposure: Highly toxic by ingestion or inhalation. May cause irritation and burns of the eyes, skin and respiratory tract. Inhalation may cause respiratory irritation and damage. May cause cryogenic burns or injury from refrigerated gas. LD_{50} = (rat, inhalation) <300 ppm.

Long-Term Exposure: Prolonged or repeated exposure inhalation of bromine chloride may damage the lungs causing long-term effects on the respiratory tract and lungs; chronic inflammation and impaired functions are possible.

Points of Attack: Lungs, respiratory tract.

Medical Surveillance: Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Administer oxygen if breathing is difficult. Clothing frozen to the skin should be thawed before being removed. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. Keep victim warm and quiet. Keep victim under observation. Effects of contact or inhalation may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves.

Personal Protective Methods:

Respirator Selection: Reacts with cellulose-based absorbents, mineral-based & clay-based absorbents, expanded polymeric absorbents, and dirt/earth. Wear positive pressure SCBA. Wear chemical protective clothing that is specifically recommended by the manufacturer. It may provide little or no thermal protection. Structural firefighters' protective clothing provides limited protection in fire situations *only*; it is not effective in spill situations where direct contact with the substance is possible.

Storage: Check oxygen content prior to entering storage area. Poison Gas, Corrosive, Oxidizer. (1) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. (2) White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location; keep acids away from bases and red, yellow, and blue-coded chemicals. (3) Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Oxidizers, including oxidizing gases, should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Store in a cool, well-ventilated area away from incompatible materials listed above. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage.

Shipping: UN2901 Bromine chloride, Hazard Class: 2.3; Labels: 2.3—Poisonous gas, 8—Corrosive material, 5.1—Oxidizer Inhalation Hazard Zone B.

Spill Handling:

Bromine chloride

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 0.7/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 1250/400
Then: Protect persons downwind (mi/km)
Day 1.5/2.4
Night 4.2/6.8

Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources and dampen spilled material with toluene to avoid airborne dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Noncombustible, but as an oxidizer, this chemical may intensify an existing fire. Thermal decomposition products may include toxic chlorine gas. Prolonged exposure of the containers to intense heat may result in their violent rupturing and rocketing. Runoff from fire control may cause pollution. *Small fire: caution:* These materials do not burn but will support combustion. Some will react violently with water. Contain fire and let burn. If fire must be fought, water spray or fog is recommended. Water only; no dry chemical, CO_2 or Halon. Do not get water inside containers. Move containers from fire area if you can do it without risk. Damaged cylinders should be handled only by specialists. *Fire involving tanks:* Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Cool containers with flooding quantities of water until well after fire is out. Do not direct water at source of leak or safety devices; icing may occur. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. ALWAYS stay away from tanks engulfed in fire. For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn. As an immediate precautionary measure, isolate spill or leak area for at least 300 ft./100 m in all directions. SPILL: See ERG Table 1-Initial Isolation and Protective Action Distances on the UN/NA 2901 datasheet. *Fire*: *If tank, rail car or tank truck is involved in a fire*, ISOLATE for 800 m/0.5 mile in all directions; also, consider initial evacuation for 800 m/0.5 mile in all directions depending on weather conditions and size of spill. For spills and leaks, wear fully encapsulating, vapor protective clothing should be worn for spills and leaks. Do not touch or walk through spilled material. Keep combustibles (wood, paper, oil, etc.) away from spilled material. Stop leak if you can do it without risk. Use water spray to reduce vapors or divert vapor cloud drift. Avoid allowing water runoff to contact spilled material. Do not direct water at spill or source of leak. If possible, turn leaking containers so that gas escapes rather than liquid. Prevent entry into waterways, sewers, basements or confined areas. Isolate area until gas has dispersed. Ventilate the spill area.

Disposal Method Suggested: Dispose of contents and container to an approved waste disposal plant. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Bromine Chloride #0253*, Trenton, NJ, (April 2004).

Bromine Pentafluoride B:0670

Formula: BrF_5

Synonyms: Bromine fluoride; Pentafluorure de brome (French); Pentafluoruro de bromo (Spanish)

CAS Registry Number: 7789-30-2

HSDB Number: 7484

RTECS Number: EF9350000

UN/NA & ERG Number: (PIH) UN1745/144

EC Number: 232-157-8

Regulatory Authority and Advisory Information

Department of Homeland Security Screening TQ (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade); *Theft hazard* 45 (≥6007% concentration).

Hazard Alert: Poison inhalation hazard: exposure can be lethal, Powerful oxidizer.

United States National Primary Drinking Water Regulations: MCLG = 4 mg[F]/L; MCL = 4 mg[F]/L; SMCL = 2.0 mg [F]/L, as Fluoride.

OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 2500 lb (1135 kg)

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, O; risk phrases: R8; R9; R23/24/25; R34; safety phrases: S1; S7/8; S36/37/39; S41; 45 (see Appendix 4)

Description: Bromine pentafluoride is colorless to pale yellow fuming liquid, with pungent odor. At temperatures above boiling point this chemical is a colorless gas. Molecular weight = 174.92; specific gravity (H_2O:1) = 2.47; Relative vapor density (air = 1) = 6.1; boiling point = 40.5°C; freezing/melting point = −61°C; vapor pressure = 328 mmHg @ 20°C. Hazard identification (based on NFPA-704 M Rating System): Health 4; flammability 0; reactivity 3 ₩ Reacts explosively with water.

Potential Exposure: Bromine pentafluoride is used as an oxidizer in liquid rocket propellant combinations; it may be used in chemical synthesis.

Incompatibilities: A powerful oxidizer. Bromine pentafluoride reacts with every known element except inert gases, nitrogen, and oxygen. It reacts violently with water, acids, acid fumes (releasing highly toxic fumes of bromine and fluorine). Incompatible with halogens, arsenic, selenium, alkaline halides, sulfur, iodine, glass, metallic halides, metal oxides, and metals (except copper, stainless steel; nickel, and Monel). Fire may result from contact with combustibles or organic matter at room temperature, and contact of this substance with water produces an explosion. Even under mild conditions this substance attacks organic compounds vigorously, often causing explosion. Decomposes in heat above 460°C.

Permissible Exposure Limits in Air

OSHA PEL: None

NIOSH REL: 0.1 ppm/0.7 milligram per cubic meter TWA

ACGIH TLV[1]: 0.1 ppm/0.72 milligram per cubic meter TWA

OSHA PEL: (Shipyards) 0.1 ppm/0.7 milligram per cubic meter TWA

PAC* Ver. 29[138]

PAC-1: 0.015 ppm

PAC-2: $\mathbf{0.17_A}$ ppm

PAC-3: $\mathbf{33_A}$ ppm

*AEGLs are marked with a subscript "**A**" and correspond to 60 minute values.

Australia: TWA 0.1 ppm (0.7 milligram per cubic meter), 1993; Austria: MAK 0.1 ppm (0.7 milligram per cubic meter), 1999; Belgium: TWA 0.1 ppm (0.72 milligram per cubic meter), 1993; Denmark: TWA 0.1 ppm (0.7 milligram per cubic meter), 1999; Finland: STEL 0.1 ppm (0.7 milligram per cubic meter) [skin] 1999; France: VME 0.1 ppm (0.7 milligram per cubic meter), 1999; Norway: TWA 0.6 mg[F]/m^3, 1999; the Netherlands: MAC-TGG 0.7 milligram per cubic meter, 2003; Sweden: TWA 2 mg [F]/m^3, 1999; Switzerland: MAK-W 0.1 ppm (0.7 milligram per cubic meter), 1999; United Kingdom: TWA 0.1 ppm (0.73 milligram per cubic meter); STEL 0.3 ppm (2.2 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam; ACGIH) Threshold Limit Value: TWA 0.1 ppm. Several states have set guidelines or standards for bromine pentafluoride in ambient air[60] ranging from 7.0 μ/m^3 (North Dakota) to 11.0 μ/m^3 (Virginia) to 14.0 μ/m^3 (Connecticut) to 17.0 μ/m^3 (Nevada).

Determination in Air: Sample collection by impinger or fritted bubbler, analysis by ion-specific electrode.

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guidelines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg[F]/L.

SafeDrinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg [F]/L; SMCL = 2 mg/F/L, as Fluoride.

Routes of Entry: Inhalation, eye and/or skin contact.

Harmful Effects and Symptoms

Respiratory irritation is noted. See also "Fluorine" and "Chlorine trifluoride."

Short-Term Exposure: Can cause severe irritation and burns of the eyes and skin. Inhalation can irritate the nose and throat; higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: Can cause kidney, liver, and lung damage.

Points of Attack: Eyes, skin, and mucous membranes.

Medical Surveillance: Kidney and liver function tests. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Lung function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use of SCBA is recommended[22]. Where there is potential exists for exposures over 0.1 ppm; Use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive pressure mode. All respirators selected must be approved by NIOSH under the provisions of 42 CFR 84. The current listing of NIOSH-certified respirators can be found in the NIOSH/NPPTL Certified Equipment List, which is available on the NIOSH web site.

Storage: PIH; check oxygen content prior to entering storage area. Color code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Prior to working with bromine pentafluoride all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from water, steam, acids, acid fumes and combustibles. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: UN1745 Bromine pentafluoride 5.1; Labels: 5.1—Oxidizer, 6.1—Poison Inhalation Hazard, 8—Corrosive material, Inhalation Hazard Zone A.

Spill Handling:

Bromine pentafluoride

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

when spilled on land

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 0.9/1.5

Large spills (From a large package or from many small packages)
First: Isolate in all directions (ft/m) 600/180
Then: Protect persons downwind (mi/km)
Day 1.4/2.3
Night 3.2/5.1

when spilled in water
First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.4/0.6

Large spills (From a large package or from many small packages)
First: Isolate in all directions (ft/m) 500/150
Then: Protect persons downwind (mi/km)
Day 0.8/1.2
Night 2.7/4.3

Name and hazard class of the material must always be shown whether or not the material or its mixtures or solutions meet the definitions of the class.

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. *Gas:* Ventilate area of spill or leak to disperse gas. If this is a gas leak, stop flow of gas. If the leak from a cylinder cannot be stopped, remove the container to a safe place in the open air, and repair leak, or allow cylinder to empty. *Liquid:* Cover spill with dry lime, sand, or soda ash and deposit in closed and sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Not combustible but enhances combustion of other substances. Thermal decomposition products may include hydrogen bromide and bromine. May spontaneously ignite combustible and organic materials. *Do not* use water or water-based extinguishers to fight fire; reacts explosively with steam or water. An exception is when large amounts of combustible material are involved and fire-fighters can protect themselves by distance or barrier from the violent reaction with water. Use carbon dioxide or dry chemical on small fires[17]. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Allow gas to flow into mixed caustic soda and slaked lime solution[22]. Return unwanted cylinders to supplier if possible.

References

(31); (173); (101); (138); (122).

National Institute for Occupational Safety and Health (NIOSH), "Criteria for a Recommended Standard: Occupational Exposure to Inorganic Fluorides," NIOSH Document Number 76-103, Cincinnati, OH (1976).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Bromine Pentafluoride*, #0254, Trenton, NJ (November 2007).

Bromine Trifluoride B:0680

Formula: BrF_3
Synonyms: Trifluoroborane; Triflururode bromo (Spanish)
CAS Registry Number: 7787-71-5
HSDB Number: 7483
RTECS Number: ED2275000
UN/NA & ERG Number: (PIH) UN1746/144
EC Number: 232-132-1

Regulatory Authority and Advisory Information

Department of Homeland Security Screening TQ (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade); *Theft hazard* 45 (≥6.00% concentration)

Hazard Alert: Poison inhalation hazard: exposure can be lethal, Inhalation hazard, Corrosive, Powerful oxidizer.

OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 15,000 lb (6810 kg)

United States National Primary Drinking Water Regulations: MCLG = 4 mg[F]/L; MCL = 4 mg[F]/L; SMCL = 2.0 mg[F]/L, as Fluoride.

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, O; risk phrases: R8; R23/24/25; R35; R51; safety phrases: S1; S7/8; S36/37/39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [2-Hazard to water. (est.)]

Description: Bromine trifluoride is a noncombustible, colorless to gray-yellow fuming liquid. Extremely irritating odor. Molecular weight = 136.9. Specific gravity (H_2O:1) = 2.8 @ 20°C; boiling point = 135°C; freezing/melting point = 8.8°C. Hazard identification (based on NFPA-704 M Rating System): Health 4; flammability 0; reactivity 3 ₩. Reacts with water, forming corrosive gas.

Potential Exposure: Bromine Trifluoride is used as a fluorinating agent and an electrolytic solvent.

Incompatibilities: A powerful oxidizer; highly reactive and a dangerous explosion hazard. Contact with water or other hydrogen containing materials forms hydrogen fluoride gas. Reacts with almost all elements except for inert gases. Violent reaction with reducing agents; organic materials; strong acids; strong bases; halogens, salts (antimony salts), metal oxides; and many other materials. Attacks some plastics, rubber, or coatings.

Permissible Exposure Limits in Air

NIOSH IDLH = 250 mg[F]/m^3

OSHA PEL: 3 ppm/2.5 mg[F]/m^3 TWA

NIOSH REL: 3 ppm/2.5 mg[F]/m^3 TWA; 6 ppm/5 mg[F]/m^3, 15 minutes. Ceiling Concentration

ACGIH TLV[1]: 2.5 mg[F]/m^3 TWA; not classifiable as a human carcinogen; BEI: 3 mg[F]/g creatinine in urine *prior* to end-of-shift; 10 mg[F]/g creatinine in urine end-of-shift

PAC* Ver. 29[138]

PAC-1: **0.12**$_{\mathbf{A}}$ ppm

PAC-2: **2.0**$_{\mathbf{A}}$ ppm

PAC-3: **21**$_{\mathbf{A}}$ ppm

*AEGLs are marked with a subscript "**A**" and correspond to 60 minute values.

DFG MAK: 1 mg[F]/m^3, inhalable fraction [skin]; Peak Limitation Category II(4); Pregnancy Risk Group C; BAT: 7.0 mg[F]/g creatinine in urine at end-of-shift; 4.0 mg[F]/g creatinine in urine at the beginning of the next shift

Australia: TWA 2.5 mg[F]/m^3, 1993; Austria: MAK 2.5 mg [F]/m^3, 1999; Belgium: TWA 2.5 mg[F]/m^3, 1993; Finland: TWA 2.5 mg[F]/m^3, 1999; France: VME 2.5 mg[F]/m^3, 1999; Hungary: TWA 1 mg[F]/m^3; STEL 2 mg[F]/m^3, 1993; Norway: TWA 0.6 mg[F]/m^3, 1999; the Philippines: TWA 2.5 mg[F]/m^3, 1993; Poland: MAC (TWA) 1 mg [HF]/m^3, MAC (STEL) 3 mg[HF]/m^3, 1999; Russia: STEL 0.5 ppm (2.5 milligram per cubic meter), 1993; Sweden: NGV 2 mg[F]/m^3, 1999; Switzerland: MAK-W 1.8 ppm (1.5 mg[F]/m^3), KZG-W 3.6 ppm (3.0 mg[F]/m^3), 1999; Thailand: TWA 2.5 mg[F]/m^3, 1993; United Kingdom: TWA 2.5 mg[F]/m^3, 2000; LTEL 2.5 mg[F]/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen.

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guidelines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg[F]/L. SafeDrinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg [F]/L; SMCL = 2 mg/F/L, as Fluoride.

Routes of Entry: Inhalation, skin contact, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Bromine trifluoride can affect you when breathed in and passing through your skin. This substance is a corrosive chemical and contact can severely irritate and burn the skin and eyes (causing possible blindness). Exposure can severely irritate the nose, throat and lungs. Higher exposures can cause a build-up of fluid in the lungs which can cause death.

Long-Term Exposure: Repeated exposure can cause skin rash, lung irritation and bronchitis; and may cause a build-up of bromine and fluorine in the body.

Points of Attack: Lungs, skin.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended. Lung function tests. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Blood fluorine and bromine levels.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 minutes without stopping, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: *Clothing:* Avoid skin contact with bromine trifluoride. Wear protective gloves and clothing. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day and put on before work. *Eye Protection:* Wear splash-proof chemical goggles and face shield when working with liquid, unless full facepiece respiratory protection is worn.

Respirator Selection: NIOSH/OSHA *12.5 milligram per cubic meter:* Qm (APF = 25) (any quarter-mask respirator). *25 milligram per cubic meter:* 95XQ (APF = 10)*[any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or SA* (any supplied-air respirator). *62.5 milligram per cubic meter:* Sa: Cf (APF = 25)*+ (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25)* *if not present as a fume* (any PAPR with a high-efficiency particulate filter). *125 milligram per cubic meter:* 100F (APF = 50)$^+$ [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full face piece). *250 milligram per cubic meter:* Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50)$^+$ [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or SCBAE (any appropriate escape-type, SCBA). *Substance reported to cause eye irritation or damage; may require eye protection. *May need acid gas sorbent.

Storage: PIH; check oxygen content prior to entering storage area. (1) Color code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Bromine trifluoride must be stored to avoid contact with water (which releases hydrogen fluoride gas), ammonium halides, antimony trioxide; antimony chloride and solvents (such as ether, acetone, acetic acid, toluene, etc.), since violent reactions occur. (2) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with bromadiolone all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from organic and/or combustible materials (such as wood, cotton and straw), chloride and bromide salts and many metals. Whenever bromine trifluoride is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: UN1746 Bromine trifluoride, Hazard class 5.1; Labels: 5.1—Oxidizer, 6.1—Poison Inhalation Hazard, 8—Corrosive material, Inhalation Hazard Zone B.

Spill Handling:

Bromine trifluoride

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

When spilled on land

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 0.4/0.6

When spilled in water

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 0.4/0.6

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 300/100
Then: Protect persons downwind (mi/km)
Day 0.7/1.1
Night 2.5/4.1

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Bromine Trifluoide does not burn but may ignite combustible materials. Do not use water or foam. Use dry chemical or CO_2 extinguishers. Thermal decomposition products may include hydrogen fluoride and hydrogen bromide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (122); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Bromine Trifluoride*, Trenton, NJ (November 1998).

Bromoacetone B:0683

Formula: C_3H_5BrO

Synonyms: Acetonyl bromide; Acetyl methyl bromide; Bromoacetona (Spanish); α-Bromoacetone; Bromomethyl methyl ketone; α-Bromopropanone Bromo-2-propanone; 1-Bromo-2-propanone; B-Stoff; Martonite; Monobromoacetone; 2-Propanone, 1-bromo.

CAS Registry Number: 598-31-2

HSDB Number: 315

RTECS Number: UC0525000; AL3150000

UN/NA & ERG Number: (PIH) UN1569/131

EC Number: 209-928-2

Regulatory Authority and Advisory Information

Hazard Alert: Poison inhalation hazard, Violent lacrimator, Corrosive, Combustible liquid (highly flammable in acetone), Air reactive, Environmental hazard.

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV.D.3.b, RQ: 1000 lb (454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P017

Hazard symbols, risk, & safety statements: Hazard symbol: T, F+ (in acetone), Xi; risk phrases: R12 (in acetone); R23/24/25; R34; R36/37/38; R52; safety phrases: S24/25; S26; S36/37/39; S41 (see Appendix 4).

Description: A highly flammable, clear, colorless liquid. On standing, turns violet rapidly, even in the absence of air. On long standing it will decompose to a black resinous mass[101]. Molecular weight = 136.98; Specific gravity (H_2O:1) = 1.634 @ 23°C; boiling point = 136.1°C @ 760.0 mmHg; freezing/melting point = −36.5°C; vapor pressure = 90 mmHg @ 20°C; Flash point = 51.1 C; (in acetone) −20°C. Autoignition temperature (in acetone) => 450°C. Hazard identification (based on NFPA-704 M Rating System): (in acetone) Health 1; flammability 3; reactivity 1 ₩. Explosive limits: LEL: 2.8%, UEL: 12.8%. Sinks in water. Poor solubility in water. May form explosive mixture with air.

Potential Exposure: Used in organic synthesis, to make other chemicals; as a chemical war gas.

Incompatibilities: Decomposes upon standing. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air:

PAC* Ver. 29[138]

PAC-1: $\mathbf{0.011_A}$ ppm

PAC-2: $\mathbf{0.33_A}$ ppm

PAC-3: $\mathbf{0.98_A}$ ppm

*AEGLs are marked with a subscript "**A**" and correspond to 60 minute values.

Permissible Concentration in Water:

Determination in Water: Aquatic toxicity: TLm96: 10−100 ppm[136] Octanol−water coefficient: Log $K_{ow} = 0.1$ Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, skin or eye contact, ingestion

Harmful Effects and Symptoms

Eye irritant-severe; respiratory irritant-acute, severe, or moderate but not mild effects; Skin irritant-severe; gastrointestinal tract-acute effects

Short-Term Exposure: Very toxic by inhalation. Contact with the liquid causes painful burns. A violent lachrymator—Low concentrations are very irritating to the eyes. Vapors cause severe irritation of eyes and throat and can cause eye and lung injury. They cannot be tolerated even at low concentrations. Severe skin irritant. Causes second and third degree burns on short contact and is very injurious to the eyes.

Long-Term Exposure: Frequent or prolonged exposure may have adverse health effects.

Medical Surveillance: Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical

facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: SCBA, chemical-resistant gloves, rubber boots, full protective clothing.

Respirator Selection: Where risk assessment shows air-purifying respirators are appropriate, use a full-face respirator type (N100) United States or Type P3 (EN-143) respirators as backup to engineering controls. If the respirator is the sole means of protection, use a full-face supplied respirator. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

Storage: PIH; check oxygen content prior to entering storage area. (1) Color code—Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. (2) Color code—Red: Flammability Hazard (in acetone): Store in a flammable (liquid or solid materials) storage area or approved cabinet away from sources if ignition. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN1569 Bromoacetone, Hazard class 6.1; Labels: 6.1—Poison Inhalation Hazard; 3—Flammable liquid. Hazard, Inhalation Hazard Zone B. PG II.

Spill Handling:

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 500/150
Then: Protect persons downwind (mi/km)
Day 1.2/1.9
Night 2.3/3.6

Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources and dampen spilled material with toluene to avoid airborne dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Highly flammable (in acetone). Thermal decomposition products may include hydrogen bromide gas and oxides of carbon. Extinguish with CO_2, dry chemical, or foam. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Generators of waste (equal to or greater than 100 kg/mo) containing this contaminant, EPA hazardous waste number P017, must conform with USEPA regulations in storage, transportation, treatment and disposal of waste. A good candidate for liquid injection incineration at a temperature range of 650 to 1600°C and a residence time of 0.1 to 2 seconds. A good candidate for rotary kiln incineration at a temperature range of 820 to 1600°C and residence times of seconds for liquids and gases, and hours for solids. A good candidate for fluidized bed incineration at a temperature range of 450 to 980°C and residence times of seconds for liquids and gases, and longer for solids[USEPA].

References

(31); (173); (101); (138).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Bromoacetone*, # 0256, Trenton, NJ, (September 2002).

Bromobenzene B:0690

Formula: C_6H_5Br
Synonyms: Bromobenceno (Spanish); Bromobenzol; Monobromobenzene; Phenyl bromide
CAS Registry Number: 108-86-1
HSDB Number: 47
RTECS Number: CY9000000
UN/NA & ERG Number: UN2514/130
EC Number: 203-623-8 [*Annex I Index No.:* 602-060-00-9]

Regulatory Authority and Advisory Information

Hazard Alert: Flammable, May cause harm to the unborn child.

Safe Drinking Water Act, 55FR1470 Priority List; 40CFR 141.40(e), re: community and noncommunity water systems.

TSCA 40CFR766.38 precursor chemical substances reporting.

Hazard symbols, risk, & safety statements: Hazard symbol: Xi, N; risk phrases: R10; R38; R51/53; R61; safety phrases: S2; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [2-Hazard to waters (est.)]

Description: Bromobenzene is a flammable, clear, colorless mobile liquid with a pleasant odor. Molecular weight = 157.01; Specific gravity (H_2O:1) = 1.5 @ 20°C; boiling point = 156°C; freezing/melting point = −31°C; Flash point = 51°C; Autoignition temperature = 565°C; vapor pressure = 7.5 mmHg @ 35°C. Explosive Limits in air: LEL: 6%; UEL: 36.5%[icsc]. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 2; reactivity 0 ₩. Very slightly soluble in water; solubility = 0.04% @ 25°C.

Potential Exposure: Bromobenzene is used as an intermediate in organic synthesis, and as an additive in motor oil and fuels. During chlorination water treatment, bromobenzene can be formed in small quantities.

Incompatibilities: May form explosive mixture with air. Incompatible with strong oxidizers, alkaline earth metals (barium, calcium, magnesium, strontium, etc.), metallic salts; with risk of violent reactions. May accumulate static electrical charges; may cause ignition of its vapors.

Permissible Exposure Limits in Air

PAC Ver. 29[138]
PAC-1: 0.96 ppm
PAC-2: 11 ppm
PAC-3: 240 ppm

Hungary: TWA 3 milligram per cubic meter; STEL 6 milligram per cubic meter [skin] 1993; Russia: STEL 3 milligram per cubic meter, 1993

Determination in Water: Octanol−water coefficient: Log K_{ow} => 3. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, ingestion, skin absorption.

Harmful Effects and Symptoms

Observations in Man: Bromobenzene irritates the skin and is a CNS depressant in humans. In view of the relative paucity of data on the carcinogenicity, teratogenicity, and long-term oral toxicity of bromobenzene, estimates of the effects of chronic oral exposure at low levels cannot be made with any confidence. It is recommended that studies to produce such information be conducted before limits in drinking water can be established. Since bromobenzene was negative on the Salmonella/microsome mutagenicity test, there should be less concern than with those substances that are positive. LD_{50} = (oral-rat) 2699 mg/kg (slightly toxic)[9].

Short-Term Exposure: Irritates eyes, skin and respiratory tract. Exposure can cause dizziness, lightheadedness and unconsciousness.

Long-Term Exposure: May cause liver and kidney damage.

Points of Attack: Skin, liver, kidneys.

Medical Surveillance: Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. ACGIH recommends polyvinyl alcohol or Viton as protective materials. Also, safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive pressure mode). All respirators selected must be approved by NIOSH under the provisions of 42 CFR 84. The current listing of NIOSH-certified respirators can be found in the NIOSH/NPPTL Certified Equipment List, which is available on the NIOSH web site.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with bromobenzene all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a refrigerated area away from incompatible materials listed above. Protect from light[52]. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2514 Bromobenzene, Hazard Class: 3; Labels: 3—Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. Follow by washing spill area with alcohol then with soap and water. Do not flush spilled material into sewer. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of carbon and hydrogen bromide. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed[24].

References

(31); (173); (101); (138); (100).

National Institute for Occupational Safety and Health (NIOSH), Information Profiles on Potential Occupational Hazards: Brominated Aromatic Compounds, pp. 76−85 incl, Report PB-276, 378, Rockville, MD (October 1977).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Bromobenzene*, #0258, Trenton, NJ (November 2008).

Bromodichloromethane B:0700

Formula: $CHBrCl_2$; $BrCHCl_2$; $CHCl_2Br$

Synonyms: BDCM; Dichlorobromomethane; Methane, bromodichloro-; Monobromodichloromethane; NCI-C55243

CAS Registry Number: 75-27-4

HSDB Number: 4160

RTECS Number: PA5310000

UN/NA & ERG Number: UN2810 (toxic liquid, organic, n.o.s.)/153

EC Number: 200-856-7

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Human Limited Evidence; Animal Sufficient Evidence, *possibly carcinogenic to humans*, Group 2B, 1999

California Proposition 65 Chemical[102]: Cancer 1/1/1990

Hazard Alert: Poison, Combustible, Poison.

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.35; Nonwastewater (mg/kg), 15

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8010(1); 8240(5)

Safe Drinking Water Act (47FR 9352): Priority List (55FR1470) as bromodichloromethane

United States National Primary Drinking Water Regulations: n/a mg/L; MCL = 0.080 mg/L, as *total* trihalomethanes (TTHMs)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV.D.3.b, RQ: 5000 lb (2270 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

TSCA 40CFR716.120(a); SNUR (PMN, P-90-299) Halomethanes
Mexico: Wastewater Pollutant
Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%; listed on Canada's NDSL List.
Hazard symbols, risk, & safety statements: Hazard symbol: T, Xn, F; risk phrases: R45; R10; R22; R23/24/25; R36/37/39; R38; R39; R51; safety phrases: S7; S16; S26; S36/37/38; S40; S41; S45 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Bromodichloromethane is a liquid. Molecular weight = 163.83; specific gravity (H_2O:1) = 1.97; boiling point = 87.2°C; freezing/melting point = −55°C; flash point = −88°C. Soluble in water.

Potential Exposure: This compound may find application in organic synthesis.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air
Odor threshold = ~1675 milligram per cubic meter.
PAC Ver. 29[138]
PAC-1: 1.3 milligram per cubic meter
PAC-2: 14 milligram per cubic meter
PAC-3: 85 milligram per cubic meter
DFG MAK: [skin]; Carcinogen Category 3B

Permissible Concentration in Water: The MCL for TTHMs (including bromodichloromethane) in drinking water has been set by the United States Environmental Protection Agency at 0.10 mg/L (44 RF 68624). Illinois and Vermont have set guidelines for Bromodichloromethane in drinking water[61]. Illinois @ 1.0 μg/L and Vermont @ 100 μg/L.

Determination in Water: Gas chromatography (EPA Method 601) or GC plus mass spectrometry (EPA Method 624). Octanol−water coefficient: Log K_{ow} =< 2.0. Unlikely to bioaccumulate in marine organisms.

Harmful Effects and Symptoms
Bromodichloromethane is acutely toxic to mice. It was mutagenic in the Salmonella typhimurium TA 100 bacterial test system and carcinogenic in mice with the same qualification for result significance as for dichloromethane noted. Positive correlations between cancer mortality rates and levels of brominated trihalomethanes in drinking water in epidemiological studies have been reported. LD_{50} = (oral-rat) 916 mg/kg (slightly toxic)[9].

Short-Term Exposure: This material irritates the eyes, nose and mucous membranes[52].

Long-Term Exposure: May cause cancer in humans.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive pressure mode). All respirators selected must be approved by NIOSH under the provisions of 42 CFR 84. The current listing of NIOSH-certified respirators can be found in the NIOSH/NPPTL Certified Equipment List, which is available on the NIOSH web site.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in a refrigerated space in a tightly closed container. Protect from light[52]. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2810 Toxic liquids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1—Poisonous materials, Technical Name Required.

Spill Handling:
Toxic liquids, organic, n.o.s.
Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30

Then: Protect persons downwind (mi/km)

Day 0.2/0.3

Night 0.7/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 1000/300

Then: Protect persons downwind (mi/km)

Day 1.1/1.8

Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Contain and isolate spill to limit spread. Construct clay−bentonite dams to isolate the spill. Treatment alternatives for contaminated waste include activated charcoal treatment. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material is not combustible. Use extinguishers suitable for surrounding fire. Thermal decomposition products may include hydrogen bromide, hydrogen chloride and oxides of carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Package in epoxy-lined drums. Destroy by high-temperature incinerator equipped with an HCl scrubber.

References

(109); (102); (31); (173); (101); (138); (100).

United States Environmental Protection Agency, Halomethanes: Ambient Water Quality Criteria, Washington, DC (1980).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 6, No. 3, 39−41 (1986).

United States Public Health Service, "Toxicological Profile for Bromodichloromethane," Atlanta, Georgia, Agency for Toxic Substances and Disease Registry (December 1988).

Bromoform B:0710

Formula: $CHBr_3$

Synonyms: Bromoforme (French); Bromoformo (Spanish); Methane, tribromo-; Methenyl tribromide; Methyl tribromide; NCI-C55130; Tribrommethan (German); Tribromomethane

CAS Registry Number: 75-25-2

HSDB Number: 2517

RTECS Number: PB5600000

UN/NA & ERG Number: UN2515/159

EC Number: 200-854-6 [*Annex I Index No.:* 602-007-00-x]

Regulatory Authority and Advisory Information

Carcinogenicity: NCI: Carcinogenesis studies (gavage); clear evidence: rat; no evidence: mouse; IARC: Animal Limited Evidence; Human No Adequate Data, *not classifiable as carcinogenic to humans*, Group 3, 1999; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies.

California Proposition 65 Chemical[102]: Cancer 4/1/1991.

Hazard Alert: Possible risk of forming tumors, suspected of causing genetic defects, suspected reprotoxic hazard, environmental hazard.

Water Pollutant Standard Set (EPA), (Mexico)

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U225

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.63; Nonwastewater (mg/kg), 15

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8010 (2); 8240 (5)

United States National Primary Drinking Water Regulations: n/a mg/L; MCL = 0.080 mg/L, as TTHMs

Safe Drinking Water Act (47FR 9352): Priority List (55FR1470)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV.D.3.b, RQ: 1000 lb (454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Mexico Wastewater Pollutant, Drinking Water Pollutant

TSCA 40CFR716.120(a); 40CFR712.30(e)10 dermal absorption testing; 40CFR799.5055(c), (d)2, hazardous waste constituents subject to testing; Section 12 (b) export notification requirement.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R45; R22; R23; R36/38; R50/53; R62; R63; safety phrases: S1/2; S28; S45; S63; S41; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Bromoform is a colorless (turns yellow on exposure to air) liquid. Sweet-smelling, chloroform-like odor. Molecular weight = 252.7; Specific gravity (H_2O:1) = 2.9; boiling point = 149.5°C; freezing/melting point = 8.3°C (to hexagonal crystals); vapor pressure = 5 mmHg @ 20°C; 7.5 mmHg @ 30.5°C; Hazard identification (based on NFPA-704M Rating System): Health 2; flammability 0; reactivity 0 ₩. Soluble in water; solubility = 0.1% @ 20°C.

Potential Exposure: Bromoform is used in pharmaceutical manufacturing; as an ingredient in fire-resistant chemicals and gauge fluids; and as a solvent for waxes, greases, and oils.

Incompatibilities: Heat causes bromoform to decompose forming toxic and corrosive hydrogen bromide and bromine. Bromoform is a weak acid. Reacts violently with oxidants, bases in powdered form. Reacts with chemically active metals (alkaline metals), powdered aluminum, potassium, sodium, zinc, and magnesium and acetone under basic conditions, causing fire and explosion hazard. Attacks some forms of plastic, rubber and coating. Corrosive to most metals.

Permissible Exposure Limits in Air

NIOSH IDLH = 850 ppm

Odor threshold = 0.44 ppm.

Conversion factor: 1 ppm = 10.34 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 0.5 ppm/5 milligram per cubic meter TWA [skin]

NIOSH REL: 0.5 ppm/5 milligram per cubic meter TWA [skin]

ACGIH TLV[1]: 0.5 ppm/5.2 milligram per cubic meter TWA; confirmed animal carcinogen with unknown relevance to humans.

PAC Ver. 29[138]

PAC-1: 1.5 ppm

PAC-2: 6.8 ppm

PAC-3: 41 ppm

DFG MAK: Carcinogen Category 3B

Australia: TWA 0.5 ppm (5 milligram per cubic meter) [skin] 1993; Austria: MAK 0.5 ppm (5 milligram per cubic meter), 1999; Belgium: TWA 0.5 ppm (5.2 milligram per cubic meter) [skin] 1993; Denmark: TWA 0.5 ppm (5 milligram per cubic meter) [skin] 1999; Finland: TWA 0.5 ppm (5 milligram per cubic meter); STEL 1.5 ppm (15 milligram per cubic meter) [skin] 1999; France: VME 0.5 ppm (5 milligram per cubic meter) [skin] 1999; the Netherlands: MAC-TGG 5 mg/m^3 [skin] 2003; the Philippines: TWA 0.5 ppm (5 mg/m^3) [skin] 1993; Poland: TWA 5 milligram per cubic meter, 1999; Russia: STEL 5 milligram per cubic meter, 1993; Switzerland: MAK-W 1000 ppm (5600 milligram per cubic meter), 1999; United Kingdom: TWA 0.5 ppm (5.3 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: confirmed animal carcinogen with unknown relevance to humans. Several states have set guidelines or standards for bromoform in ambient air[60] ranging from 50 μ/m^3 (North Dakota) to 80 μ/m^3 (Virginia) to 100 μ/m^3 (Connecticut) to 110 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method #1003, Hydrocarbons, halogenated, or[18] OSHA Analytical Method #7, Organic Vapors.

Permissible Concentration in Water: United States National Primary Drinking Water Regulations: n/a mg/L; MCL = 0.080 mg/L, as TTHMs. See Regulatory Authority and Advisory Information above. Mexico's drinking water criteria is 0.002 mg/L. This substance is highly persistent; bioaccumulation or risk of cancer, reduce exposure by humans to minimum. Two states have set guidelines for bromoform in drinking water: 1.0 μg/L in Illinois and 40 μg/L in Maryland[61].

Determination in Water: Gas chromatography (EPA Method 601) or GC plus mass spectrometry (EPA Method 624). Octanol−water coefficient: Log K_{ow} = 2.4. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion, skin absorption, eye and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: *Inhalation:* Can cause irritation to the nose and throat, tearing, reddening of the face, dizziness, and death. Exposure of dogs to 7000 ppm for 8 minutes causes death. *Skin:* Can be absorbed. Large quantities can lead to symptoms listed under ingestion. *Eyes:* Can cause irritation and tearing. *Ingestion:* Causes burning of mouth and throat. Can cause headache, dizziness, disorientation, slurred speech, troubled breathing, tremors, and unconsciousness. The estimated lethal dose is 1/3 ounce for a 150-pound adult. However, LD_{50} = (oral−rat) 1147 mg/kg (slightly toxic)[9].

Long-Term Exposure: Bromoform can cause liver damage. May have an effect on the nervous system. Repeated exposure can cause skin rash. Has caused cancer in laboratory animals; whether it does so in humans is unknown. Very irritating substances, such as bromoform may affect the lungs.

Points of Attack: Skin, liver, kidneys, respiratory system, lungs, central nervous system.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Consider the points of attack in preplacement and periodic physical examinations. Liver function tests. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear appropriate clothing to prevent repeated or prolonged skin contact. **8 hours** (more than 8 hours of resistance to breakthrough $>0.1\ \mu g/cm^2/min$): polyvinyl alcohol gloves; Viton gloves, suits. Wear eye protection to prevent any reasonable probability of eye contact. Employees should wash promptly when skin is wet or contaminated. Remove nonimpervious clothing promptly if wet or contaminated.

Respirator Selection: OSHA: *12.5 ppm:* Sa:Cf$^£$ (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOv$^£$ (APF = 25) [any PAPR with organic vapor cartridge(s)]. *25 ppm:* CcrFOv (APF = 50) [any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s)]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted acid gas canister]; or PaprTOv$^£$ (APF = 50) [any PAPR with a tight-fitting facepiece and organic vapor cartridge(s)]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *850 ppm:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode. *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance causes eye irritation or damage; eye protection needed.

Storage: Color code—Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Bromoform must be stored to avoid contact with incompatible materials listed above. Store in tightly closed containers in a cool well-ventilated area away from heat and light.

Shipping: UN2515 Bromoform, Hazard Class: 6.1; Labels: 6.1—Poisonous materials.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Bromoform itself does not burn. Thermal decomposition products may include bromine and hydrogen bromide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Purify by distillation and return to suppliers[22]. Alternatively, Inclinerate with excess fuel.

References
(102); (31); (173); (101); (138); (2); (100).

United States Environmental Protection Agency, Halomethanes: Ambient Water Quality Criteria, Washington, DC (1980).

United States Environmental Protection Agency, Bromoform, Health and Environmental Effects Profile No, 28, Washington, DC, Office of Solid Waste (April 30, 1980).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 2, No. 6, 30−35 (1982).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Bromoform*, Trenton, ND (January 1986).

New York State Department of Health, Chemical Fact Sheet: Bromoform, Bureau of Toxic Substance Assessment, Albany, NY (June 2000).

1-Bromo-3-Methylbutane B:0715

Formula: $C_5H_{11}Br$

Synonyms: 1-Bromo-3-metilbutano (Spanish); 4-bromo-2-methylbutane; bromo-1 méthyl-3 butane (French); Butane, 1-bromo-3-methyl-; Isoamyl bromide; Isobutylmethyl bromide; Isopentyl bromide; 3-methyl-1-bromobutane; 3-methylbutyl bromide

CAS Registry Number: 107-82-4

HSDB Number: 7381

RTECS Number: EJ6230000

UN/NA & ERG Number: UN2341/130

EC Number: 203-522-9

Regulatory Authority and Advisory Information

Hazard Alert: Highly flammable liquid, Environmental hazard.

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xn, Xi, N; risk phrases: R10; R22; R36/37/38, R51/53; R52/53; safety phrases: S16; S26; S29/35; S36/37/39; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [2-Hazard to waters (est.)]

Description: Clear, colorless, flammable liquid. Molecular weight = 151.05; Specific gravity (H_2O:1) = 1.207 @ 20°C; boiling point = −119−120°C; freezing/melting point = −112°C; vapor pressure = 35 mmHg @ 25°C; flash point = 72°C. Henry's Law constant = 4×10^{-2} atm m^3/mol @ 25°C (est)[72]; slightly soluble in water; solubility = 2 mg/L @ 20°C. Denser than water.

Potential Exposure: 1-Bromo-3-methylbutane is a halogenated aliphatic compound.

Incompatibilities: Vapor may form explosive mixture with air. 1-Bromo-3-methylbutane is highly flammable. Keep away from heat and direct sunlight. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air:
PAC* Ver. 29[138]
PAC-1: 6 ppm
PAC-2:66 ppm
PAC-3:390 ppm

Determination in Water: Octanol−water coefficient: Log K_{ow} => 3. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, skin contact (absorbed through the skin), ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin, and respiratory tract. Vapors may cause dizziness or suffocation. A systemic toxin; may cause toxic effects if inhaled or absorbed through skin. Inhalation or contact with material may irritate or burn skin and eyes. LD_{50} = (oral-rat) >5 g/kg. Skin irritant, moderate; respiratory irritant-acute, severe, or moderate but not mild effects; eye irritant-moderate.

Long-Term Exposure: Repeated or prolonged exposure may cause health effects. Systemic toxin, chronic effects[138].

Points of Attack: Systemic toxin, chronic effects, skin, respiratory system.

Medical Surveillance: Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. Wash skin with soap and water. In case of burns, immediately cool affected skin for as long as possible with cold water. Do not remove clothing if adhering to skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves.

Personal Protective Methods: Skin protection: Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands. Body Protection: Complete suit protecting against chemicals, Flame retardant antistatic protective clothing, the type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where risk assessment shows APRs are appropriate use a full-face respirator with multipurpose combination (US) or type ABEK (EN 14387) respirator cartridges as a backup to engineering controls. If the respirator is the sole means of protection, use a full-face supplied air respirator. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

Storage: Store in a cool place, preferably refrigerated. (1) Color code—Red: Flammability Hazard: Store in a flammable (liquid or solid materials) storage area or approved cabinet away from sources if ignition. (2) Color code—Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. (3) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location; keep acids away from bases and red, yellow, and blue-coded chemicals. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area separated from strong oxidants, strong bases; strong acids. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2341 1-bromo-3-methylbutane, Hazard Class: 3; Labels: 3—Flammable liquid.

Spill Handling: As an immediate precautionary measure, isolate spill or leak area for at least 50 m/50 ft. in all directions. *Large spill*: Consider initial downwind evacuation for at least 300 m/1000 ft. *Eliminate* all ignition sources (no smoking, flares, sparks or flames in immediate area). All equipment used when handling the product must be grounded. Do not touch or walk through spilled material. Stop leak if you can do it without risk. Prevent entry into waterways, sewers, basements or confined areas. A vapor suppressing foam may be used to reduce vapors. Absorb or cover with dry earth, sand or other noncombustible material and transfer to containers. Use clean nonsparking tools to collect absorbed material. *Large spill:* Dike far ahead of liquid spill for later disposal. Water spray may reduce vapor; but may not prevent ignition in closed spaces.

Fire Extinguishing: Thermal decomposition products may include irritation, toxic and corrosive fumes of hydrogen bromide and oxides of carbon. Vapors may form explosive mixture with air. Vapors may travel to source of ignition and flashback. This chemical's vapors are heavier than air. They will spread along ground and collect in low or confined areas (sewers, basements, tanks). Vapor explosion hazard indoors, outdoors or in sewers. Runoff to sewer may create fire or explosion hazard. Containers may explode when heated. Liquid is heavier than water. Runoff from fire control or dilution water may cause pollution. *Caution*: hydrogen bromide has a very low flash point: Use of water spray when fighting fire may be inefficient. *Small fire*: Dry chemical, CO_2, water spray or regular foam. *Large fire:* Water spray, fog or regular foam. Do not use straight streams. Move containers from fire area if you can do it without risk. *Fire involving tanks or car/trailer loads*: Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. *Always* stay away from tanks engulfed in fire. For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn.

Disposal Method Suggested: This material is highly flammable. Offer surplus and nonrecyclable material to a licensed disposal facility. Carefully dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. Contact a licensed professional waste disposal service to dispose of this material. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* 1-BROMO-3-Methylbutane, Trenton, NJ (July 1988).

4-Bromophenyl Phenyl Ether B:0720

Formula: $C_{12}H_9BrO$

Synonyms: Benzene, 1-bromo-4-phenoxy-; Benzene, 2-bromo-4-phenoxy-; *p*-Bromodiphenyl ether; MBDE; Monobromodiphenyl ether; Mono bromodiphenyl oxide

CAS Registry Number: 101-55-3

HSDB Number: 2747

UN/NA & ERG Number: UN3082 (environmentally hazardous substances, liquid, n.o.s.)/171

EC Number: 202-952-4

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Combustible, Sensitization hazard, Environmental hazard.

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U030

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.055; Nonwastewater (mg/kg), 15

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV.D.3.b, RQ: 100 lb (45.4 kg).

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: F, N, Xi, Xn; risk phrases: R10, R22; R38; R41; R43; R50/53; R65; R67; safety phrases: S16; S26; S29/35; S45; S36/37/39; S45; S60, S61,S62 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water[S-A].

Description: 4-Bromophenyl phenyl ether is a brominated diphenylether and a liquid at common ambient temperatures. Molecular weight = 249.1; Specific gravity (H_2O:1) = 1.61 @ 20°C); boiling point = 305°C; 310.14°C; freezing/melting point = 18.72°C; vapor pressure = 1.5×10^{-3} mmHg @ 20°C; Flash point => 110°C. Hazard identification (based on NFPA-704 M Rating System): Health 1; flammability 1; reactivity 0 ₩. Poor solubility in water; solubility = 4.8 mg/L @ 25°C.

Potential Exposure: Very little information on 4-bromophenyl phenyl ether exists. It is pre pared by brominating diphenyl her with Br_2 @ 95−100°C in carbon tetrachloride[United States Environmental Protection Agency, 1986]. 4-Bromophenyl phenyl ether has been identified in raw water, in drinking water and in river water.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 0.33 milligram per cubic meter

PAC-2: 3.6 milligram per cubic meter

PAC-3: 21 milligram per cubic meter

Permissible Concentration in Water: *Freshwater Aquatic Life:* For 4-bromophenyl phenyl ether the criterion to protect freshwater aquatic life as derived using the guidelines is 6.2 μg/L as a 24 hour average and the concentration should not exceed 14 μg/L at any time. *Saltwater Aquatic Life:* For saltwater aquatic life, no criterion for 4-bromophenyl phenyl ether can be derived using the guidelines, and there is insufficient data to estimate a criterion using other procedures. *Human Health:* Because of a lack of adequate toxicological data on nonhuman mammals and humans, protective criteria cannot be derived at this time for this compound.

Determination in Water: *p*-Monobromodiphenyl ether (MBDE) can be determined by the standard United States Environmental Protection Agency Method 611-Haloethers. Chromatographic conditions are described in United States Environmental Protection Agency (1986). The limit of determination in municipal and industrial waste waters is 2.3 μg/L. Octanol−water coefficient: Log K_{ow} => 4. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood. According to United States Environmental Protection Agency (1986), there are monitoring data for *p*-MBDE in water in the USA. The mean concentration was 0.2 mg/L (range 0−202.7 mg/L, 2193 listings) in water.

Harmful Effects and Symptoms

4-Bromophenyl phenyl ether has been tested in the pulmonary adenoma assay, a short-termed carcinogenicity assay. Although the results were negative, several known carcinogens also gave negative results. No other health effects were available. Skin contact can cause tissue defatting and dehydration leading to dermatitis.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Storage: Color code—Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage.

Shipping: UN3082 Environmentally hazardous substances, liquid, n.o.s., Hazard class: 9; Labels: 9—Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include hydrogen bromide and oxides of carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Avoid release to the environment. High-temperature incineration with alkaline flue gas scrubbing.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, 4-Bromophenyl Phenyl Ether, Health and Environmental Effects Profile No. 30, Washington, DC, Office of Solid Waste (April 30, 1980).

United States Environmental Protection Agency, Haloethers: Ambient Water Quality Criteria, Washington, DC (1980).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 6, No. 2, 43−45 (1986).

Bromophos B:0725

Formula: $C_8H_8BrCl_2O_3PS$

Synonyms: *O*-(4-Brom-2,5-dichlor-phenyl)-*O,O*-dimethyl-monothiophosphat (German); 4-Bromo-2,5-dichlorophenyl dimethyl phosphorothionate; *O*-(4-Bromo-2,5-dichlorophenyl) *O,O*-dimethylphosphorothioic acid; Bromofos; Brofene; Bromofosmethyl; Brophene; Bruomophos (Russian); CELA S-1942; *O,O*-Dimethyl-*O*-(4-bromo-2,5-dichlorophenyl) phosphorothioate; *O,O*-Dimethyl-*O*-(2,5-dichlor-4-bromphenyl)-thionophosphat (German); *O,O*-dimethyl-*O*-(2,5-dichloro-4-bromophenyl)phosphorothioate; *O,O*-Dimethyl-*O*-(2,5-dichloro-4-bromophenyl) thiophosphate; EL 400; ENT 27,162; Methylbromofos; Methylbromophos; Monsanto-cp 51969; Netal; Nexion; Nexion-40; Omexan; OMS-658; Phosphorothioic acid, *O*-(4-bromo-2,5-dichlorophenyl) *O,O*-dimethyl ester; S 1942; Thiophosphate de *O,O*-dimethyle et de *O*-4-bromo-2,5-dichlorophenyle (French)

CAS Registry Number: 2104-96-3

HSDB Number: 6573

RTECS Number: TE7175000

UN/NA & ERG Number: UN2783 (organophosphorus pesticide, solid, n.o.s.)/152

EC Number: 218-277-3 [*Annex I Index No.:* 015-108-00-3]

Regulatory Authority and Advisory Information

Hazard Alert: Poison (Category 4), Neurotoxin (cumulative), Suspected reprotoxic hazard, Suspected of causing genetic defects.

WHO ADI (RfD) = 0.04 mg/kg/day[72]

DOT Inhalation Hazard Chemicals as organophosphates

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: Xn, N; risk phrases: R22; R33; R50/R53; R62; safety phrases: S2; S29; S41; S46; S60; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to waters

Description: White to slightly yellow crystalline solid. Commercially available as emulsifiable concentrate, dustable powders, wettable powders, granules, animal dips, fogging concentrates, and coarse powders. Molecular weight = 365.98; boiling point = 142°C @ 0.1 mmHg[Merck]; Melting point: 53°C; vapor pressure = 1×10^{-4} mmHg @ 25°C. Low solubility in water. Physical and toxicological properties may be affected by the carrier solvents used in commercial formulations.

Potential Exposure: Organophosphate insecticide, Acaricide Bromophos is a broad spectrum, noncumulative nonsystemic organophosphorus insecticide. It is used on field crops, vegetable and fruit crops, on ornamentals, and on grain storage. It is also used as a sheep dip

Incompatibilities: Keep away from oxidizers, sulfuric acid, caustics, ammonia, aliphatic amines, alkanolamines, isocyanates, alkylene oxides, epichlorohydrin. May react violently with antimony(V) pentafluoride. Incompatible with lead diacetate, magnesium, silver nitrate. In the presence of strong reducing agents such as hydrides, organophosphates form highly toxic and flammable phosphine gas. Contact with oxidizers can cause the release of toxic oxides of phosphorus.

Determination in Air: OSHA versatile sampler-2; Toluene/Acetone; Gas chromatography/Flame ionization detection; NIOSH IV(18), Method #5600, Organophosphorus Pesticides

Permissible Concentration in Water: No criteria set. Runoff from spills or fire control may cause water pollution.

Determination in Water: EAD Method 1657. The determination of organophosphorus pesticides in municipal and industrial wastewater by GC. Detection limit = 6.0 ηg/L. Octanol−water coefficient: Log K_{ow} = 5.2. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, skin absorption, ingestion, eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: May be absorbed through unbroken skin. Eye pupils are small; blurred vision; eye watering; runny nose; cough; shortness of breath; salivation;

dizziness; nausea, stomach cramps, diarrhea, and vomiting; increased blood pressure; profuse sweating; hypermotility, hallucinations; irritability; tingling of the skin; drowsiness; slow heartbeat; convulsions; fluid in lungs; loss of consciousness; incontinence; breathing stops; death. Absorbed in the respiratory and gastrointestinal tracts. Organophosphates inhibit the action of acetylcholinesterase enzymes, and alter the way in which nervous impulses are transmitted. The effects can last for hours, days, or much longer. The action of the enzymes is reestablished after new enzymes are formed. LD_{50} (oral, rat) = 1600−4000 mg/kg; LD_{50} (dermal, rat) => 5000 mg/kg[193].

Long-Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. Organophosphates may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, central nervous system, cardiovascular system, blood cholinesterase

Medical Surveillance: Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a drug or other inhalation therapy. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure.

First Aid: Speed in removing material from skin is of extreme importance. Eye contact can cause dangerous amounts of these chemicals to be quickly absorbed through the mucous membrane into the bloodstream. Immediately and gently flush eyes with plenty of warm or cold water (NO hot water) for at least 15 minutes, occasionally lifting the upper and lower eyelids. Get medical aid immediately. *Skin:* Get medical aid. Skin and/or eye contact can cause dangerous amounts of these chemicals to be absorbed into the bloodstream. Wearing the appropriate PPE equipment and respirator for organophosphate/carbamate pesticides, immediately flush skin with plenty of soap and water for at least 15 minutes while removing contaminated clothing and shoes. Shampoo hair promptly if contaminated. *Ingestion:* Call poison control. Loosen all clothing. Never give anything by mouth to an unconscious person. Get medical aid. Do NOT induce vomiting. *If conscious, alert, and able to swallow, rinse mouth and have victim drink 4 to 8 ounces of water do NOT induce vomiting but immediately administer slurry of activated charcoal (2 oz in 8 oz of water). If victim is *unconscious or having convulsions,* do nothing except keep victim warm. **In some cases you may be specifically instructed by poison control to induce vomiting by way of 2 tablespoons of syrup of ipecac (adult) washed down with a cup of water.* Do NOT give activated charcoal before or with ipecac syrup. *Inhalation:* Get medical aid. Do not contaminate yourself. Wearing the appropriate PPE equipment and respirator for organophosphate pesticides, immediately remove the victim from the contaminated area to fresh air. If the victim is not breathing, administer artificial respiration. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. If breathing is difficult, administer oxygen through bag/mask apparatus until medical help arrives. Do not leave victim unattended. *Note to physician or authorized medical personnel.* Administer atropine, 2 mg (1/30 gr) intramuscularly or intravenously as soon as any local or systemic signs or symptoms of an intoxication are noted; repeat the administration of atropine every 3 to 8 minutes until signs of atropinization (mydriasis, dry mouth, rapid pulse, hot and dry skin) occur; initiate treatment in children with 0.05 mg mg/kg of atropine; repeat at 5 to 10 minute intervals. Watch respiration, and remove bronchial secretions if they appear to be obstructing the airway; intubate if necessary. *Notes to physician or authorized medical personnel*: N-methylpyridinium-2-aldoxime (2-PAMCI) when used in conjunction with atropine reacts with the phosphorylated cholinesterase, thereby restoring normal activity to by removing the phosphorylating group. The combination of these two chemicals is synergistic and must be administered within minutes to a few hours following exposure (depending on the specific agent) to be effective. Give 2-PAMCI (Pralidoxime; Protopam), 2.5 g in 100 mL of sterile water or in 5% dextrose and water, intravenously, slowly, in 15−30 minutes; if sufficient fluid is not available, give 1 g of 2-PAMCI in 3 mL of distilled water by deep intramuscular injection; repeat this every half hour if respiration weakens or if muscle fasciculation or convulsions recur. Also Diazepam, an anticonvulsant, might be considered

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of dermal contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN 149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive pressure mode.

Storage: Color code—Blue (*dry, solid material*): Health Hazard/Poison: Store the dry material in a secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Color code—Red Stripe (*dissolved material in a flammable liquid carrier*): Flammability Hazard: Store separately from all other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from chlorine compounds, oxidizing agents; and combustible materials. Sources of ignition, such as smoking and open flames are prohibited where their chemical is handled, used, or stored, Use only non-sparking tools and equipment, especially when opening and closing containers. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Piping should be electrically bonded and grounded.

Shipping: UN2783 Organophosphorus pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1—Poisonous materials.

Spill Handling:

Initial isolation and protective action distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.3/0.4
Night 0.8/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 600/200
Then: Protect persons downwind (mi/km)
Day 1.4/2.3
Night 2.8/4.5

Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, Notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include hydrogen chloride, hydrogen bromide and oxides of phosphorus, sulfur, nitrogen and carbon. This chemical may be flammable. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (204); (100).

International Programme on Chemical Safety (IPCS), "Data Sheet on Pesticides No. 76, Bromophos," Geneva, Switzerland (1994). http://www.inchem.org/documents/pds/pds/pest76_e.htm.

International Programme on Chemical Safety (IPCS), "Pesticide Residues in Food − 1982, Bromophos," Geneva, Switzerland (1982). http://www.inchem.org/documents/jmpr/jmpmono/v82pr06.htm.

Bromophos-ethyl B:0727

Formula: $C_{10}H_{12}BrCl_2O_3PS$

Synonyms: S2225; 4-Bromo-2,5-dichloropheno 1-*O*-ester with *O,O*-diethyl phosphoro thioate; *O*-(4-Bromo-2,5-dichlorophenyl) *O,O*-diethyl phosphorothioate; CELA S-2225; *O,O*-diaethyl-*O*-(4-brom-2,5-dichlor)-phenyl-monothiophosphat (German); *O,O*-Diaethyl-*O*-(2,5-dichlor-4-bromphenyl)-thionophosphat(German); *O,O*-Diethyl *O*-2,5-dichloro-4-b romophenyl-phosphorothioate; *O,O*-Diethyl *O*-(2,5-dichloro-4-bromophenyl)thiophosphate; ENT 27,258; Ethyl bromophos; Filariol; Nexagan; OMS-659; Phosphorothioic acid, *O*-(4-bromo-2,5-dichlorophenyl) *O,O*-diethyl ester; Thiophosphate de *O,O*-diethyle et de *O*-(2,5-dichloro-4-bromo) phenyle (French)

CAS Registry Number: 4824-78-6

HSDB Number: 6574

RTECS Number: TE7000000
UN/NA & ERG Number: UN3018 (organophosphorus pesticide, liquid, toxic)/152
EC Number: 225-399-0 [*Annex I Index No.:* 015-064-00-5]
Regulatory Authority and Advisory Information
Hazard Alert: Poison (Category 3), Environmental hazard, Neurotoxin (cumulative), Environmental hazard. Agricultural chemical.
WHO ADI (RfD) = 0.003 mg/kg/day
DOT Inhalation Hazard Chemicals as organophosphates
United States DOT Regulated Marine Pollutant (49CFR 172.101, Appendix B), severe pollutant
Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.
Hazard symbols, risk, & safety statements: Hazard symbol: T, Xn, N; risk phrases: R21; R25; R33; R50/53; safety phrases: S1/2; S28; S29; S36/37; S45; S60; S61 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.
Description: Colorless to pale-yellow liquid. Molecular weight = 394.05; Specific gravity (H_2O:1) = 1.53 @ 20°C; boiling point = $>$375°C; vapor pressure = 6.5×10^{-7} mmHg @ 25°C. Practically insoluble in water.
Potential Exposure: Organophosphate insecticide. Not registered for use in the United States
Incompatibilities: May react violently with antimony(V) pentafluoride. Incompatible with lead diacetate, magnesium, silver nitrate, sulfur, and organometallic compounds. In the presence of strong reducing agents such as hydrides, organophosphates form highly toxic and flammable phosphine gas. Contact with oxidizers can cause the release of toxic oxides of phosphorus.
Permissible Exposure Limits in Air: A possible respiratory toxin.
Determination in Air: OSHA versatile sampler-2; Toluene/Acetone; Gas chromatography/Flame ionization detection; NIOSHIV, Method #5600, Organophosphorus Pesticides [18].
Permissible Concentration in Water: No criteria set. Runoff from spills or fire control may cause water pollution.
Determination in Water: EAD Method 1657. The determination of organophosphorus pesticides in municipal and industrial wastewater by GC. Detection limit = 6.0 ηg/L. Octanol−water coefficient: Log K_{ow} = 6.2. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.
Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact
Harmful Effects and Symptoms
Short-Term Exposure: Eye pupils are small; blurred vision; eye watering; runny nose; cough; shortness of breath; salivation; dizziness; nausea, stomach cramps, diarrhea, and vomiting; increased blood pressure; profuse sweating; hypermotility, hallucinations; irritability; tingling of the skin; drowsiness; slow heartbeat; convulsions; fluid in lungs; loss of consciousness; incontinence; breathing stops; death. Organophosphates inhibit the action of acetylcholinesterase enzymes, and alter the way in which nervous impulses are transmitted. The effects can last for hours, days, or much longer. The action of the enzymes is reestablished after new enzymes are formed. LD_{50} (oral, rat) = 52 mg/kg.
Long-Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. Organophosphates may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.
Points of Attack: Respiratory system, central nervous system, cardiovascular system, blood cholinesterase
Medical Surveillance: Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a drug or other inhalation therapy. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure
First Aid: Speed in removing material from skin is of extreme importance. Eye contact can cause dangerous amounts of these chemicals to be quickly absorbed through the mucous membrane into the bloodstream. Immediately and gently flush eyes with plenty of warm or cold water (NO hot water) for at least 15 minutes, occasionally lifting the upper and lower eyelids. Get medical aid immediately. *Skin:* Get medical aid. Skin and/or eye contact can cause dangerous amounts of these chemicals to be absorbed into the bloodstream. Wearing the appropriate PPE equipment and respirator for organophosphate/carbamate pesticides, immediately flush skin with plenty of soap and water for at least 15 minutes while removing contaminated clothing and shoes. Shampoo hair promptly if contaminated. *Ingestion:* Call poison control. Loosen all clothing. Never give anything by mouth to an unconscious person. Get medical aid. Do not induce vomiting. * If conscious, alert, and able to swallow, rinse mouth and have victim drink 4 to 8 ounces of water do not induce vomiting but immediately administer slurry of activated charcoal (2 oz in 8 oz of water). If victim is *unconscious or having convulsions,* do nothing except keep victim warm. **In some cases you may be specifically instructed by poison control to induce vomiting by way of 2 tablespoons of syrup of ipecac (adult) washed down with a cup of water*. Do not give activated charcoal before or with ipecac syrup. *Inhalation:* Get medical aid. Do not contaminate yourself. Wearing the appropriate PPE equipment and respirator for organophosphate pesticides, immediately remove the victim from the contaminated area to fresh air. If the victim is not breathing, administer artificial respiration. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.

If breathing is difficult, administer oxygen through bag/mask apparatus until medical help arrives. Do not leave victim unattended. *Note to physician or authorized medical personnel.* Administer atropine, 2 mg (1/30 g) intramuscularly or intravenously as soon as any local or systemic signs or symptoms of an intoxication are noted; repeat the administration of atropine every 3 to 8 minutes until signs of atropinization (mydriasis, dry mouth, rapid pulse, hot and dry skin) occur; initiate treatment in children with 0.05 mg mg/kg of atropine; repeat at 5 to 10 minute intervals. Watch respiration, and remove bronchial secretions if they appear to be obstructing the airway; intubate if necessary. *Notes to physician or authorized medical personnel*: *N*-methylpyridinium-2-aldoxime (2-PAMCI) when used in conjunction with atropine reacts with the phosphorylated cholinesterase, thereby restoring normal activity to by removing the phosphorylating group. The combination of these two chemicals is synergistic and must be administered within minutes to a few hours following exposure (depending on the specific agent) to be effective. Give 2-PAMCI (Pralidoxime; Protopam), 2.5 g in 100 mL of sterile water or in 5% dextrose and water, intravenously, slowly, in 15−30 minutes; if sufficient fluid is not available, give 1 g of 2-PAMCI in 3 mL of distilled water by deep intramuscular injection; repeat this every half hour if respiration weakens or if muscle fasciculation or convulsions recur. Also Diazepam, an anticonvulsant, might be considered

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of dermal contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. One recommendation is the use of DuPont Tychem suit fabrics[101]. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls, and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit. *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive pressure mode).

Storage: Color code—Blue: Health Hazard/Poison. Store in a secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Where possible, automatically transfer material from other storage containers to process containers.

Shipping: UN3018 Organophosphorus pesticides, liquid, toxic, Hazard Class: 6.1; Labels: 6.1—Poisonous materials.

Spill Handling: Organophosphorus compounds

Initial isolation and protective action distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.3/0.4
Night 0.8/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 600/200
Then: Protect persons downwind (mi/km)
Day 1.4/2.3
Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Do not touch spilled material. Do not breathe vapors. Stay upwind; keep out of low areas. Remove all ignition sources. Ventilate area of spill or leak. This material is a combustible liquid. For a spill or leak of a combustible liquid, shut off ignition sources; no flares, smoking or flames in hazard area. Stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Poisonous and corrosive gases are produced in fire including hydrogen chloride and oxides of phosphorus, sulfur, nitrogen and carbon. May be fatal if inhaled, ingested or absorbed through skin. Inhalation or contact with some of these materials will irritate or burn skin and eyes. Vapors may cause dizziness or suffocation. Small fires: dry chemical, carbon dioxide; water spray; or foam. *Large fires:* water spray, fog, or foam. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Firefighting gear (including SCBA) may not provide adequate protection. If exposure occurs, remove and isolate gear immediately and thoroughly decontaminate personnel. Wear positive pressure breathing apparatus and special protective clothing. Remove and isolate contaminated clothing at the site. Move container from fire area if you can do so without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Destruction by alkali hydrolysis or incineration. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (204); (100).

Bromopropanes B:0730

Formula: C_3H_7Br

Synonyms: 1-BP; 1-Bromopropane; Bromo-1 propane; 2-Bromopropane; Bromopropano (Spanish); Propane, bromo-; *N*-Propylbromide; *n*-Propyl bromide

CAS Registry Number: 106-94-5 (1-bromopropane); 75-26-3 (2-bromopropane); 26446-77-5 (mixed isomers); 109-64-8 (1,3-dibromopropane); 96-12-8 (1,2-dibromo-3-chloropropane).

HSDB Number: 1068

UN/NA & ERG Number: UN2344/129

EC Number: 203-445-0 [*Annex I Index No.:* 602-019-00-5] (1-bromopropane); 200-855-1 [*Annex I Index No.:* 602-085-00-5] (2-bromopropane)

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen: 1-Bromopropane

California Proposition 65 Chemical[102]: Cancer; Developmental/Reproductive toxin (male, female) (1-bromopropane) 12/7/04; (female, male) (2-bromopropane) 5/31/2005.

Hazard Alert: Highly flammable liquid, Possible risk of forming tumors, Reproductive toxin: Suspected of causing genetic defects.

OSHA/NIOSH Hazard Alert, DHHS (NIOSH) Publication Number 2013-150/OSHA-HA-3676-2013, Occupational exposure to 1-BP has been linked to neurological illnesses. Animal studies show that 1-BP may also cause cancer and reproductive disorders.

No Federal Exposure Regulations[193]

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%. (*n*-propyl bromide).

Hazard symbols, risk, & safety statements: (*1-bromopropane*) Hazard symbol: F+, T; risk phrases: R40; R60; R11; R36/37/38; R48/20; R63; R67; safety phrases: S21; S53; S45; (*2-bromopropane*) Hazard symbol: F+, T; risk phrases: R45; R60; R11; R48/20; R51; R66; safety phrases: S21; S41; S45; S53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class) (2-*bromopropane*): 2-Hazard to waters; (1-*bromopropane*); 1-Low hazard to water

Description: 1-Bromopropane is a volatile, colorless to pale-yellow liquid. It is toxic and highly flammable. Strong characteristic odor. Molecular weight = 123.1; Specific gravity (H_2O:1) = 1.35 @ 20°C; boiling point = 71°C; freezing/melting point = −110°C; vapor pressure = 111 mmHg @ 17.8°C; Flash point = −10°C (cc); Autoignition temperature = 490°C. Explosive Limits in air: LEL: 4.6%, 46,000 ppm[138]; UEL: unknown. Hazard identification (based on NFPA-704 M Rating System): (as *n*-propyl bromide): Health 2; flammability 3; reactivity 0 ₩. Soluble in water; solubility = 0.25% @ 20°C (1-bromopropane).

2-Bromopropane is a flammable liquid. Molecular weight = 122.98; Specific gravity (H_2O:1) = 1.31 @ 20°C; boiling point = 59.4°C; freezing/melting point = −89°C; vapor pressure = 216 mmHg @ 25°C; Flash point =< 24°C. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 3; reactivity 0 ₩. Slightly soluble in water.

Potential Exposure: Touted as a green chemical alternative. 1-Bromopropane (1-BP) is a solvent that is used in degreasing, dry cleaning, spray adhesives, and aerosol solvents. 1-Bromopropane used in many commercial industries; used as a cleaner for optics, electronics, and metals and as a solvent for aerosol-applied adhesives, such as those used in foam cushion manufacturing. Workers in certain occupations, such as sprayers in the adhesive industry and workers at polyurethane foam furniture cushion manufacturing facilities, are potentially exposed to much higher levels of 1-bromopropane than the general population. Workers in the foam adhesives industry are exposed to 1-bromopropane at levels that are similar to those that caused cancer in experimental animals. It is also used in dry cleaning and solvent sprays for aircraft maintenance, asphalt production, and synthetic fiber manufacturing. In recent years, 1-bromopropane use has increased, as a result of new industrial and commercial applications as a substitute for ozone-depleting chemicals or suspected carcinogens. For example, 1-bromopropane has been used to replace perchloroethylene, a health and environmental hazard, in dry cleaning[NTP, Fact Sheet: October 2014].

Incompatibilities: May form explosive mixture with air. Contact with strong oxidizers may cause fire and explosion.

Permissible Exposure Limits in Air

1-Bromopropane

ACGIH TLV[1]: 0.1 ppm TWA

PAC Ver. 29[138]

106-94-5, 1-bromopropane

PAC-1: 0.3 ppm

PAC-2: 120 ppm

PAC-3: 700 ppm

75-26-3, 2-bromopropane

PAC-1: 120 ppm

PAC-2: 1300 ppm

PAC-3: 1400 ppm

Determination in Air: OSHA Method 1017 (September 2013), 1-Bromopropane, 2-Bromopropane

Determination in Water: Octanol–water coefficient: Log $K_{ow} = 2.1$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, eye and/or skin contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Contact can irritate the eyes and skin. Exposure can cause dizziness, lightheadedness and unconsciousness. Very high exposures can cause death.

Long-Term Exposure: Repeated or high exposures may cause liver and lung damage. May be a developmental toxicant.

Points of Attack: Liver, lungs.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Pregnant women should avoid contact. Employees should be notified by a physician that this chemical may affect the reproductive system. In addition to comprehensive initial medical and work histories emphasizing reproductive experience and menstrual history, patient should have physical examination and testing of genito-urinary tract, sperm count, motility and morphology. If required, other tests, such as serum testosterone, serum FSH, and serum LH may be indicated. Lung and liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear solvent-resistant gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls, and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit. *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister having an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA). All respirators selected must be approved by NIOSH under the provisions of 42 CFR 84. The current listing of NIOSH-certified respirators can be found in the NIOSH/NPPTL Certified Equipment List, which is available on the NIOSH web site.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Protect against physical damage. Outside or detached storage is preferred. Prior to working with Bromopropane all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from incompatible materials listed above. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN23442-Bromopropanes, Hazard Class: 3; Labels: 3—Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquid in vermiculite, dry sand; earth or similar material and deposit in sealed containers. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include hydrogen bromide and oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(109); (102); (31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Bromopropane*. Trenton, NJ (July 2002).

United States National Toxicology Program, Fact Sheet: *1-Bromopropane*, Research Triangle Park, NC (October 2014).

Department of Health and Human Services (National Institute for Occupational Safety and Health), OSHA/NIOSH Hazard Alert, DHHS (NIOSH) Publication Number 2013-150/OSHA-HA-3676-2013, Cincinnati, OH (2013).

Brucine B:0740

Formula: $C_{23}H_{26}O_4 \cdot 4H_2O$; $C_{23}H_{26}O_4 \cdot 4H_2O$

Synonyms: Brucina (Spanish); (−)Brucine; (−)Brucine dihydrate; Brucine hydrate; 2,3-Dimethoxystrichnidin-10-one; 10,11-Dimethoxystrychnine; 2,3-Dimethoxystrychnine; Dimethoxy strychnine; 10,11-Dimethylstrychnine; Strychnidin-10-one, 2,3-Dimethoxy-; Strychnine, 2,3-dimethoxy-

CAS Registry Number: 357-57-3 (anhydrous); 5892-11-5 (hydrate)

HSDB Number: 307

RTECS Number: EH8925000

UN/NA & ERG Number: UN1570/152

EC Number: 206-614-7 [*Annex I Index No.:* 614-006-00-1] (*anhydrous*)

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Combustible.

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P018

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV.D.3.b, RQ: 100 lb (45.4 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: (*anhydrous*) Hazard symbol: T + , N; risk phrases: R26/28; R52/53; safety phrases: S1/2; S13; S41; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Brucine is colorless to white, odorless, crystalline solid with a very bitter taste. Molecular weight = 394.46; boiling point = 470°C; freezing/melting point = 178°C. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 1; reactivity 0 ₩. Poor solubility in water; solubility = 1 g/1320 mL.

Potential Exposure: Brucine is used as denaturant for Ethanol, also resolving agent for isomer separation; in the manufacture of other chemicals, in perfumes, as a medication for animals, and as a poison for rodents. It is an alkaloid, produced from strychnos seeds.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Finely dispersed material in air can cause dust explosions.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

357-57-3

PAC-1: 0.29 milligram per cubic meter

PAC-2: 3.2 milligram per cubic meter

PAC-3: 36 milligram per cubic meter

Permissible Concentration in Water: No criteria set.

Determination in Water: Octanol−water coefficient: Log K_{ow} = Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes and respiratory tract. Exposure can cause headache, nausea, vomiting, ringing in the ears; disturbed vision; restlessness, excitement, twitching and convulsions, seizures; breathing difficulties. Severe poisoning can cause paralysis, unconsciousness and death. The probable fatal dose in adult is estimated @ 1 g (Gosselin, 1984).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash or dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls, and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit. *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister having an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard: Store in a secure poison location. Protect against physical damage. Outside or detached storage is preferred. Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with brucine all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers.

Shipping: UN1570 Brucine, Hazard Class: 6.1; Labels: 6.1—Poisonous materials.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Brucine may burn but does not readily ignite. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide, or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Brucine*, Trenton, NJ (January 1999).

Gosselin, R. E., Smith, R. P., Hodge, H. C., Clinical Toxicology of Commercial Products, Baltimore/London, Williams & Wilkins, 5th ed. [II-249, III-375-379] (1984).

Buprofezin B:0745

Formula: $C_{16}H_{23}N_3OS$

Synonyms: APPLAUD; 2-*tert*-Butylimino-3-isopropyl-5-phenylperhydro-1,3,5-thidiazin-4-one; 2-*tert*-Butylimino-3-isopropyl-5-phenyl-1,3,5-thiadiazinan-4-one; 3-*tert*-Butylimino-3-isopropyl-5-Phenyl-3,4,5,6-tertrahydro-2h-1,3,5-thiadiazin-4-one; NNI-750; 4*H*-1,3,5-Thiadiazin-4-one, 2-[(1,1-dimethylethyl)imino]tetrahydro-3-(1-methylethyl)-5-phenyl-

CAS Registry Number: 69327-76-0

HSDB Number: 7610

RTECS Number: XI2865000

UN/NA& ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: Not assigned

Regulatory Authority and Advisory Information

Hazard Alert: Suspected reprotoxic hazard, Agricultural chemical.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Description: White crystalline powder. Molecular weight = 305.44; Specific gravity (H_2O:1) = 1.178 @ 20°C; boiling point = 350°C; freezing/melting point = 105−106°C; vapor pressure = 2×10^{-6} mmHg @ 25°C; Flash point = °C. Very slightly soluble in water.

Potential Exposure: Insecticide, acaricide, insect growth regulator. For insect control in food crops and greenhouse ornamentals.

Incompatibilities: Dust may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Concentration in Water: Runoff from spills or fire control may cause water pollution.

Determination in Water: Octanol−water coefficient: Log K_{ow} => 4.0. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Ingestion, inhalation, dermal contace, absorbed through the unbroken skin.

Harmful Effects and Symptoms

Short-Term Exposure: Causes moderate eye, skin, and possibly respiratory irritation. Harmful if swallowed. LD_{50} (oral, rat) => 3 g/kg; LD_{50} (dermal, rat) => 5 g/kg.

Long-Term Exposure: Ingestion of excessive amounts buprofezin may include subdued mood and diminished muscular coordination. May cause a slightly enlarged abdomen.

Points of Attack: May affect the chromosomes; breakdown of the DNA.

Medical Surveillance: Comprehensive physical examination with emphasis on the genito-urinary tract analysis to include sperm count, motility and morphology. Other tests, such as serum testosterone, serum FSH, and serum LH, may be carried out if, in the opinion of a physician, they are indicated.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Applicators and other handlers must wear: Coveralls worn over long-sleeved shirt and long pants; Chemical-resistant gloves such as DuPont Tychem suit fabrics, barrier laminate, or Viton; Chemical-resistant footwear plus socks; Protective eye wear; Chemical-resistant headgear for overhead exposure; Chemical-resistant apron when cleaning equipment, mixing, or loading[83]. Agricultural Use/Engineering Controls: When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the WPS for agricultural pesticides, 40 CFR 170.240(d)(4-6), the handler PPE requirements may be reduced or modified as specified in the WPS. Firefighters should wear NIOSH approved SCBA and full protective clothing.

Respirator Selection: Wherever and whenever workplace conditions warrant respirator use, a respiratory protection program must be followed that meets one or more of the following government standards: OSHA's 29 CFR 1910.134, ANSI Z88.2, or European Standard EN 149. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9—Miscellaneous hazardous material, Technical Name Required.

Spill Handling: First remove all sources of ignition. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid but does not readily ignite. Decomposes at about 200°C releasing toxic oxides of nitrogen, sulfur, and carbon. As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 m/150 ft. for liquids and at least 25 m/75 ft. for solids. *Fire involving storage or vehicular tanks:* Isolate for 800 m/0.5 mile in all directions; also, consider initial evacuation for 800 m/0.5 mile in all directions. *On a small fire:* use dry chemical, CO_2, water spray or regular *foam. On a large fire:* use water spray, fog or regular foam. Do not scatter spilled material with high pressure streams of water. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal. *Fire involving tanks:* From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. Always stay away from tanks engulfed in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Do not discharge into drains or sewers. Dispose of waste material as hazardous waste using a licensed disposal contractor to an approved landfill. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Incineration with effluent gas scrubbing is recommended. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138).

United States National Library of Medicine, ChemIDplus Advanced, Bethesda, MD (2016), http://chem.sis.nlm.nih.gov/chemidplus/rn/69327-76-0.

Busulfan B:0750

Formula: $C_6H_{14}O_6S_2$; $CH_3SO_2O(CH_2)_4OSO_2CH_3$

Synonyms: 1,4-Bis(methanesulfonoxy)butane; [1,4-Bis (methanesulfonyloxy)butane]; Bisulfan; Bisulphane; 1,4-Butanediol dimethanesulfonate; 1,4-Butanediol dimethanesulphonate; 1,4-Butanediol dimethyl sulfonate; Buzulfan; C.B.2041; Citosulfan; 1,4-Dimesyloxybutane; 1,4-Dimethanesulfonoxbutane; 1,4-Di(methanesulfonyloxy)buane; 1,4-Dimethanesulphonyloxybutan; 1,4-Dimethylsulfonoxybutane; GT 2041; GT41; Leucosulfan; Mablin; Methanesulfonic acid tetrame thylene ester; Mielucin; Misulban; Mitostan; Myeloleukon; Myleran; NCI-C01592; NSC-750; Sulphabutin; Tetramethylene bis (methanesulfonate); Tetramethylene dimethane sulfonate; X 149

CAS Registry Number: 55-98-1

HSDB Number: 7605

RTECS Number: EK1750000

UN/NA & ERG Number: UN3249 (Medicine, solid, toxic, n.o.s.)/151; UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 200-250-2

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen; IARC: Human Sufficient Evidence; Animal Limited Evidence*, carcinogenic to humans*, Group 1, 1998

California proposition 65 Chemical[102]: Cancer 2/27/1987.

Hazard Alert: Poison, Combustible, Poison.

Hazard symbols, risk, & safety statements: Hazard symbol: T+; risk phrases: R45; R23/24/25; R26/27/28; R36/37/38; R39/23/24/25; R46; R63; safety phrases: S7; S16; S28; S36/37; S36/37/39; S41; S45; S53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Busulfan is a white crystalline powder. Molecular weight = 246.3; freezing/melting point = 114–118°C. ₩. Decomposes in moist air and water; may release hydrogen sulfide.

Potential Exposure: A potential danger to those involved in the manufacture, formulation or use of this compound which finds application as an insect sterilant, and as a chemotherapeutic agent taken orally to treat some kinds of leukemia.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, moist air, and water.

Permissible Exposure Limits in Air

No standards or PAC available.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the skin causing rash. Exposure can cause nausea, vomiting, diarrhea, and seizures.

Long-Term Exposure: A carcinogen in humans, causes leukemia, kidney, and uterine cancer. A probable teratogen in humans. May damage the developing fetus. May cause testes damage in males (decrease sperm count, cause impotence), and decrease fertility in females. Long-term exposure may result in cataracts, lung irritation; permanent lung scarring; bone marrow damage; liver damage. Symptoms of exposure include bleeding tendencies, decreased leucoyte count or depressed bone marrow activity[52].

Points of Attack: See above.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. CBC, chest X-ray, lung function tests, liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately with water or normal saline for 20−30 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Respirator Selection: Specific respirator(s) have not been recommended by NIOSH. However, based on potential carcinogenicity, and where the potential exists for exposure, the following might be considered: *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any MSHA/NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive pressure mode). *Escape:* 100 F (APF = 50) (any air-purifying, full facepiece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Store in a refrigerator and protect from exposure to oxidizers or moisture[52]. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN3249 Medicine, solid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1—Poisonous materials. UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1—Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft.(NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate and restrict Persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen spilled material with alcohol to avoid dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120 (q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include oxides of sulfur and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: It is inappropriate and possibly dangerous to the environment to dispose of expired or waste pharmaceuticals by flushing them down the toilet or discarding them to the trash. Household quantities of expired or waste pharmaceuticals may be mixed with wet cat litter or coffee grounds, double-bagged in plastic, discard in trash. Larger quantities shall carefully take into consideration applicable DEA, EPA, and FDA regulations. If possible return the pharmaceutical to the manufacturer for proper disposal being careful to properly label and securely package the material. Alternatively, the waste pharmaceutical shall be labeled, securely packaged and transported by a state licensed medical waste contractor to dispose by burial in a licensed hazardous or toxic waste landfill or incinerator.

References
(109); (102); (31); (173); (101); (138); (100).
New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Busulfan*, Trenton, NJ (December 1998).

1,3-Butadiene B:0760

Formula: C_4H_6; $H_2C{=}CH{-}CH{=}CH_2$

Synonyms: Biethylene; Bivinyl; Buta-1,3-dien (German); α-γ-Butadiene; Buta-1,3-diene; Butadiene; 1,3-Butadieno (Spanish); Butadiènes, stabilisés (French); Butadienos, inhibidos (Spanish); Divinyl; Erythrene; NCI-C50602; Pyrrolylene; Vinylethylene

CAS Registry Number: 106-99-0

HSDB Number: 181

RTECS Number: EI9275000

UN/NA & ERG Number: UN1010 (stabilized)/116 (P)

EC Number: 203-450-8 [*Annex I Index No.:* 601-013-00-X]

Regulatory Authority and Advisory Information

Department of Home land Security Screening TQ (pounds): *Release hazard* 10,000 ($1.00% concentration).

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Known human carcinogen; IARC: Human Sufficient Evidence; Animal Limited Evidence*, carcinogenic to humans*, Group 1; NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen; EPA: (when inhaled) Carcinogenic to humans; strong evidence of human carcinogenicity; combinations of evidence.

California Proposition 65 Chemical; Carcinogen 4/1/1988; Developmental, female, male 4/16/2004.

Hazard Alert: Extremely flammable gas, Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated, Polymerization hazard (nonstabilized), Chemically unstable, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV.D.3.b, RQ: 1 lb (0.454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazard symbols, risk, & safety statements: Hazard symbol: F+, T, N; risk phrases: R45; R5; R12; R19; R21; R36/38; R38; R45; R46; R48/20; R51/53; R60; R62; R63; R65; R67; safety phrases: S1; S16; S26; S33; S36/37; S38; S41; S45; S46; S53; S62; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: 1,3-Butadiene is a toxic and extremely flammable, colorless, liquefied gas. Gasoline-like odor. Molecular weight = 54.1; Specific gravity (H_2O:1) = 0.62; boiling point = −4.4°C; freezing/melting point = −109°C; vapor pressure = 2.4 mmHg @ 20°C; 750 mmHg @ −4.7°C; Flash point = −76°C (liquid); Autoignition temperature = 420°C. The explosive limits are: LEL: 2.0%, 20,000 ppm[138]; UEL: 11.5%[17]. Hazard identification (based on NFPA −704 M Rating System): Health 2; flammability 4; reactivity 2 ₩. Floats and boils on water; practically insoluble; solubility = 0.1%.

Potential Exposure: 1,3-Butadiene is used chiefly as the principal monomer in the manufacture of many types of synthetic rubber and other chemicals. Butadiene is finding increasing usage in the formation of rocket fuels, plastics, and resins.

Incompatibilities: Self-reactive. May form explosive peroxides on exposure to air. High heat can cause a violent chemical reaction that will cause container rupture. Fires, explosions, or hazardous polymerization may result from contact with air, strong oxidizers; strong acids; ozone, rust, nitrogen dioxide, phenol, chlorine dioxide, crotonaldehyde, or a free radical polymerization initiator, such as hydroquinone. Unsafe in contact with acetylide-forming materials, such as monel, copper, and copper alloys (piping material for this gas must not contain more than 63% copper). Add inhibitor (such as tributylcatechol) to prevent self-polymerization and monitor to insure effective levels are maintained at all times. May accumulate static electrical charges, and may cause ignition of its vapors.

Permissible Exposure Limits in Air

NIOSH IDLH = 2000 ppm [LEL]

Odor Threshold = 0.45 ppm.

Conversion factor: 1 ppm = 2.21 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 1 ppm/2.21 milligram per cubic meter TWA; 5 ppm/11.05 milligram per cubic meter STEL (see CFR291910.1061 & CFR291910.19)

NIOSH REL: Potential occupational carcinogen. Reduce exposures to the lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV[1]: 2 ppm/4.4 milligram per cubic meter TWA; Suspected Human Carcinogen

PAC* Ver. 29[138]

PAC-1: $\mathbf{670_A}$ ppm

PAC-2: $\mathbf{5300_A}$ ppm [**>=** 10% LEL, lower explosive limit but <50% LEL]

PAC-3: $\mathbf{22{,}000_A}$ ppm (>LEL, lower explosive limit)

*AEGLs are marked with a subscript "**A**" and correspond to 60 minute values.

DFG MAK: Carcinogen Category 1; Germ Cell Mutagen Group 2

Australia: TWA 10 ppm (22 milligram per cubic meter), carcinogen, 1993; Austria: carcinogen, 1999; Belgium: TWA 10 ppm (22 milligram per cubic meter), carcinogen, 1993; Denmark: TWA 10 ppm (22 milligram per cubic meter), 1999; Finland: TWA 50 ppm (73 milligram per cubic meter), carcinogen, 1999; France: VME 10 ppm (36 milligram per cubic meter), 1993; Hungary: STEL 10 milligram per cubic meter, carcinogen, 1993; the Netherlands: MAC-TGG 46.2 milligram per cubic meter, 2003; Norway: TWA 1 ppm (2.2 milligram per cubic meter), 1999; the Philippines: TWA 1000 ppm (2200 milligram per cubic meter), 1993; Poland: MAC (TWA) 10 milligram per cubic meter; STEL 40 milligram per cubic meter, 1999; Russia: STEL 100 mg/m^3, 1993; Sweden: NGV 10 ppm (20 milligram per cubic meter), KTV 20 ppm (40 milligram per cubic meter), carcinogen, 1999; Switzerland: MAK-W 5 ppm (11 milligram per cubic meter), carcinogen, 1999; Turkey: TWA 1000 ppm (2200 milligram per cubic meter), 1993: United Kingdom: TWA 10 ppm (22 milligram per cubic meter), carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Suspected Human Carcinogen. The Czech Republic[35] has set a very stringent TWA of 20 milligram per cubic meter with a ceiling value of 40 milligram per cubic meter. Several states have set guidelines or standards for butadiene in ambient air[60] ranging from zero (North Dakota) to 0.003 μ/m^3 (Michigan) to 0.035 μ/m^3 (Massachusetts and North Carolina) to 220 μ/m^3 (Virginia) to 22,000 μ/m^3 (Connecticut) to 52,400 μ/m^3 (Nevada).

Determination in Air: Adsorption by charcoal tube; workup with CH_2C_{12}; analysis by GC/flame ionization detection Use NIOSH Analytical Method #1024[18] or OSHA Analytical Method ID-56.

Permissible Concentration in Water: Federal Drinking Water Guidelines: State Drinking Water Guidelines: New Hampshire 0.019 μg/L. Russia[43] set a MAC of 0.05 mg/m^3 in water bodies used for domestic purposes.

Determination in Water: Octanol−water coefficient: Log $K_{ow} =< 2.0$.

Routes of Entry: Inhalation of gas or vapor, eye and/or skin contact.

Harmful Effects and Symptoms

Initial signs and symptoms of exposure include blurred vision, nausea, prickling and dryness of the mouth, throat, and nose, followed by fatigue, headache, vertigo, decreased blood pressure and pulse rate, unconsciousness, and respiratory paralysis. Concentrations above 8000 ppm may cause narcotic effects, dizziness, headache, drowsiness, and loss of consciousness. Death can result 23 minutes after inhaling air containing 25% butadiene. It is a CNS depressant in high concentrations. It may be irritating and cause burns to skin, mucous membranes and eyes. Contact with the liquid may cause frostbite. It can asphyxiate by the displacement of air.

Short-Term Exposure: 1,3-Butadiene irritates the eyes, skin, and respiratory tract. Rapid evaporation of the liquid may cause frostbite. Inhalation of the vapors may cause effects on the CNS; sleepiness, and loss of consciousness. Very high exposures may cause death.

Long-Term Exposure: This chemical is a probable carcinogen in humans; it may have effects on the bone marrow and liver. There is limited evidence that this chemical is a teratogen in animals, and that it may also damage the testes and ovaries. It may cause heritable genetic damage in humans. Animal tests show that this substance may cause toxic effects upon human reproduction. See also NIOSH Profile (Alkenes), SRI, 2/77. NIOSH Current Intelligence Bulletin 41, 1984.

Points of Attack: Eyes, respiratory system; central nervous system; reproductive system.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Pregnant women should avoid contact. Employees should be notified by a physician that this chemical may affect the reproductive system. In addition to comprehensive initial medical and work histories emphasizing reproductive experience and menstrual history, patient should have physical examination and testing of genitourinary tract, sperm count, motility and morphology. If required, other tests, such as serum testosterone, serum FSH, and serum LH, may be indicated.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If frostbite has occurred, seek medical attention immediately; do NOT rub the affected areas or flush them with water. In order to prevent further tissue damage, do not attempt to remove frozen clothing from frostbitten areas. If frostbite has not occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. NIOSH recommends: **8 hours** (more than 8 hours of resistance to breakthrough >0.1 μg/cm^2/min): Viton gloves, suits, Saranex, Barricade-coated suits; CPF3 suits; Responder suits, Trellchem HPS suits; Trychem 1000 suits; **4 hours:** (At least 4 but <8 hours of resistance to breakthrough $>0.10.1$ μg/cm^2/min): Teflon gloves, suits, boots. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: 1,3-Butadiene (1910.1051) < or = 5 ppm (parts per million): Air-purifying half-mask or full-facepiece respirator equipped with approved butadiene or organic vapor cartridges or canisters. Cartridges or canisters shall be replaced every 4 hours. < or = 10 ppm: Air-purifying half-mask or full-facepiece respirator equipped with approved butadiene or organic vapor cartridges or canisters. Cartridges or canisters shall be replaced every 3 hours. < or = 25 ppm: (1) Air-purifying half-mask or full-facepiece respirator equipped with approved butadiene or organic vapor cartridges or canisters. Cartridges or canisters shall be replaced every 2 hours; (2) Any PAPR equipped with approved butadiene or organic vapor cartridges or canisters. Cartridges or canisters shall be replaced every[1] hour; or (3) Continuous-flow supplied-air respirator equipped with a hood or helmet. < or = 50 ppm (1): Air-purifying full-facepiece respirator equipped with approved butadiene or organic vapor cartridges or canisters. Cartridges or canisters shall be replaced every[1] hour; or (2) PAPR equipped with a tight-fitting facepiece and approved butadiene or organic vapor cartridges. PAPR cartridges shall be replaced every[1] hour. < or = 1000 ppm supplied-air respirator equipped with a half-mask or full facepiece and operated in a pressure-demand or other positive-pressure mode. >1000 ppm, unknown concentration, or firefighting (1) SCBA equipped with a full facepiece and operated in a pressure-demand or other positive-pressure mode; or (2) Any supplied-air respirator equipped with a full facepiece and operated in a pressure-demand or other positive-pressure mo de in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode. Escape from IDLH conditions (IDLH is 2000 ppm) (1) Any positive-pressure se lf-contained breathing apparatus with an appropriate service life; or (2) Any air-purifying full-facepiece respirator equipped with a front-or back-mounted butadiene or organic vapor canister.

Storage: Check oxygen content prior to entering storage area. Flammable gas. Color code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Outdoor or detached storage is preferred. Store cylinders upright. Prior to working with 1,3-butadiene, all handlers should be trained on its proper handling and storage. Do not store uninhibited 1,3-butadiene. Store in tightly closed containers in a cool, well-ventilated area away from incompatible materials listed above, heat and sunlight. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drum s must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN1010 Butadienes, stabilized or Butadienes and Hydrocarbon mixture, stabilized, containing more than 40% butadienes, Hazard Class: 2.1; Labels: 2.1—Flammable gas Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit and to disperse gas. Attempt to stop leak if without hazard. Use water spray to knock down vapors. Avoid breathing vapors. Keep upwind. Do not handle broken packages without protective equipment. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of carbon. See respirator selection for *>1000 ppm; Unknown concentration, or firefighting.* This chemical is an extremely flammable liquid. Let tank car, tank truck or storage tank burn unless leak can be stopped; with smaller tanks or cylinders, extinguish/isolate from other flammables. Stop flow of gas before extinguishing fire. *Small fires:* dry chemical or carbon dioxide. *Large fires:* water spray, fog, or foam. Move container from fire area if you can do so without risk. Stay away from ends of tanks. For massive fire in cargo area, use unmanned hose holder or monitor nozzles; if this is impossible, withdraw from area and let fire burn. Withdraw immediately in case of rising sound from venting safety device or any discoloration of tank due to fire. Cool container with water using unmanned device until well after fire is out. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Butadiene vapors are uninhibited and may form polymers in vents or flame arresters of storage tanks, resulting in stoppage of vents. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed[22].

References

(109); (31).

National Institute for Occupational Safety and Health: 1,3-Butadiene, Current Intelligence Bulletin 41, DHHS (100). (NIOSH), (2). Publication No. 84-105, Cincinnati, Ohio (February 9, 1984).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Butadiene, Washington, DC, Chemical Emergency Preparedness Program (October 31, 1985).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: 1,3-Butadiene*, Trenton, NJ (July 1998).

New York State Department of Health, Chemical Fact Sheet: Butadiene, Bureau of Toxic Substance Assessment, Albany, NY (March 1986).

Butanes B:0770

Formula: C_4H10; $CH_3CH_2CH_2CH_3$

Synonyms: A-17; A-31(hydrocarbon); B u-gas; *n*-Butane; Butano (Spanish); Butyl hydride; Diethyl; Diethyl, liquified petroleum gas; Methyl ethyl methane; Methylethylmethane; Twinkle stainless steel cleaner

iso-isomer: 1,1-Dimethylethane; Isobutane; Iso-butane; Isobutane en mélange (French); Isobutano (Spanish); Isobutano, en mezcla (Spanish); 2-methylpropane; Propane, 2-methyl; R 600A; Trimethylmethane

CAS Registry Number: 106-97-8 (n-); 75-28-5 *(iso-)* see I:0260

HSDB Number: 944 (n-)

RTECS Number: EJ4200000

UN/NA & ERG Number: UN1011/115; UN1075/115

EC Number: 203-448-7 [*Annex I Index No.:* 601-004-00-0] (*n*-); 203-450-8 [*Annex I Index No.:* 601-004-01-8] (*butane containing* $\geq$ *0.1% butadiene*)

Regulatory Authority and Advisory Information

Department of Homeland Security Screening TQ (pounds): *Release hazard* 10,000 ($\geq$1.00% concentration).

Hazard Alert: Extremely Flammable gas; Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated.

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

European/International Regulations (*n-& iso-butane*): Hazard symbol: F + ; risk phrases: R5; R12; R21; safety phrases: S1/2; S9; S16; S45.

iso-isomer: Clean Air Act: Accidental Release Prevention/Flammable Substances, [Section 112(r), Table 3], TQ = 10,000 lb (4540 kg).

Hazard symbols, risk, & safety statements: Hazard symbol: F+; risk phrases: R5; R12; R21; safety phrases: S2; S9; S16; S33; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): Non hazard to water.

Description: Butane is a colorless, extremely flammable, liquefied, compressed gas. A liquid below 30°F/ −1.1°C. Natural gas-like odor. Odor threshold: 204 ppm. Molecular weight = 58.12; Specific gravity (H_2O:1) = 0.599; Relative vapor density (air = 1) = 2.11; boiling point = −0.5°C; freezing/melting point = −135°C; vapor pressure = 1520 mm Hg @ 18.8°C; The explosive limits are: LEL: 1.6%, 16,000 ppm[138]; UEL: 8.4%; Flash point = −60°C (flammable gas); Autoignition temperature = 287°C. Hazard identification (based on NFPA-704 M Rating System): Health 1; flammability 4; reactivity 0 ₩. Practically insoluble in water; solubility = 6×10^{-3} @ 20°C.

Potential Exposure: Butane is used as a raw material for butadiene, as a fuel for household or industrial purposes (alone or in admixture with propane). It is also used as an extractant, solvent, and aerosol propellant. It is used in plastic foam production as a replacement for fluorocarbons.

Incompatibilities: Strong bases, strong oxidizers (e.g., nitrates & perchlorates), chlorine, fluorine, (nickel carbonyl + oxygen).

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 2.38 milligram per cubic meter @ 25°C & 1 atm

Odor threshold: 204 ppm.

OSHA PEL: None

NIOSH REL: 800 ppm/1900 milligram per cubic meter TWA

ACGIH TLV[1]: 800 ppm TWA
PAC* Ver. 29[138]
106-9-8 &75-28-5
PAC-1: **5500**$_{\mathbf{A}}$ ppm [>= 10% LEL, lower explosive limit but <50% LEL]
PAC-2: **17,000**$_{\mathbf{A}}$ ppm (higher than LEL, lower explosive limit)
PAC-3: **53,000**$_{\mathbf{A}}$ ppm (>LEL, lower explosive limit)
*AEGLs are marked with a subscript "**A**" and correspond to 60 minutes values.

DFG MAK: 1000 ppm (2400 milligram per cubic meter) (both isomers)

Australia: TWA 800 ppm (1900 milligram per cubic meter), 1993; Austria: MAK 800 ppm (1900 milligram per cubic meter) (all isomers), 1999; Belgium: TWA 800 ppm (1900 milligram per cubic meter), 1993; Denmark: TWA 500 ppm (1200 milligram per cubic meter), 1999; Finland: TWA 800 ppm (1900 milligram per cubic meter); STEL 1000 ppm (2350 milligram per cubic meter), 1999; France: VME 800 ppm (1900 milligram per cubic meter), 1999; Hungary: TWA 300 milligram per cubic meter; STEL 900 milligram per cubic meter, 1993; the Netherlands: MAC-TGG 1430 milligram per cubic meter, 2003; Japan: 500 ppm (1200 milligram per cubic meter), 1999; Norway: TWA 250 ppm (600 milligram per cubic meter), 1999; Poland: TWA 1900 milligram per cubic meter; STEL 3000 milligram per cubic meter, 1999; Russia: TWA 500 ppm; STEL 300 milligram per cubic meter, 1993; Switzerland: MAK-week 800 ppm (1900 milligram per cubic meter), 1999; United Kingdom: TWA 600 ppm (1450 milligram per cubic meter); STEL 750 ppm (1810 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 800. Several states have set forth guidelines or standards for butane in ambient air[60] ranging from 19 milligram per cubic meter (North Dakota) to 32 milligram per cubic meter (Virginia) to 38 milligram per cubic meter (Connecticut) to 45.2 milligram per cubic meter (Nevada).

Determination in Air: OSHA Analytical Method 56.

Permissible Concentration in Water: No criteria set but EPA[32] has suggested an ambient limit of 19,000 μg/L based on health effects.

Determination in water: Octanol–water coefficient: Log $K_{ow} = \sim 3$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, skin and/or eye contact (liquid).

Harmful Effects and Symptoms

Butane is not characterized by its toxicity but rather by its narcosis-producing potential at high exposure levels.

Short-Term Exposure: Can cause headache, lightheadedness, drowsiness, and unconsciousness from lack of oxygen. Contact with the liquid can cause frostbite.

First Aid: Move victim to fresh air. Call emergency medical care. Apply artificial respiration if victim is not breathing. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. Clothing frozen to the skin should be thawed before being removed. In case of contact with liquefied gas, thaw frosted parts with lukewarm water. Keep victim warm and quiet. Keep victim under observation. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. NIOSH recommends: **8 hours** (At least 4 but <8 hours of resistance to breakthrough >0.1 0.1 μg/cm^2/min): Butyl, Teflon gloves, suits, boots; 4H and Silver Shield gloves; Barricade-coated suits; CPF3 suits; Trychem 1000 suits; **4 hours:** (at least 4 but <8 hours of resistance to breakthrough >0.1 0.1 μg/cm^2/min): Responder suits. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Wear gas-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Large amounts of butane (800 ppm and above) will replace the amount of available oxygen and lead to suffocation. Oxygen content should never be below 19%. Use NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode).

Storage: Check oxygen content prior to entering storage area. Flammable gas. Color code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8–10 m or a 1-hour fire wall from flammable or reactive materials. Prior to working with butane all handlers should be trained on its proper handling and storage. All appropriate sections of the OSHA Standard 1910.111, Storage, Handling of Liquefied Petroleum Gases must be followed. Store in tightly closed containers in a cool, well-ventilated area away from incompatible materials listed above, and heat. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: UN1011-Butane see also Petroleum gases, liquefied, Hazard Class: 2.1; Labels: 2.1—Flammable gas. UN1075-Petroleum gases, liquefied or Liquefied petroleum gas, Hazard Class: 2.1; Labels: 2.1—Flammable gas. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Keep the gas concentration below the explosive limit range by forced ventilation[22]. Stop the flow of gas. If source of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air. Repair leak or allow cylinder to dissipate to the atmosphere. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Butane is a flammable gas. In case of fire, stop the flow of gas if it can be done safely. Use dry chemical, carbon dioxide; or halon extinguishers. Use water to keep fire-exposed containers cool and to protect personnel doing the shut-off. If a leak or spill has caught fire, use water spray to disperse gas and to protect personnel shutting off leak. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Controlled incineration. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Butane*, Trenton, NJ (August 1998).

Butanedione B:0780

Formula: $C_4H_6O_2$; $CH_3COCOCH_3$

Synonyms: Biacetyl; Butadione; Butane-2,3-dione; 2,3-Butanedione; Butanodiona (Spanish); Diacetilo (Spanish); Diacetyl; Diacétyle (French); 2,3-Diketo butane; Dimethyl diketone; Dimethylglyoxal; 2,3-Dioxobutane; Glyoxal dimethyl; Glyoxal, dimethyl-

CAS Registry Number: 431-03-8

HSDB Number: 297 as diacetyl

RTECS Number: EK2625000

UN/NA & ERG Number: UN2346/127

EC Number: 207-069-8

Regulatory Authority and Advisory Information

Hazard Alert: Highly flammable, Possible risk of forming tumors, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction).

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xn; risk phrases: R11; R20/21/22; R36/38; R41; R48/20; R48/20; R51/52/53; R65; R67; R62; safety phrases: S9; S16; S21; S26; S36/37/39; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Butanedione is a yellow-green, mobile liquid with a chlorine-like odor. Molecular weight = 86.1; Specific gravity (H_2O:1) = 0.99 @ 15°C; boiling point = 88°C; freezing/melting point = −2.4°C; vapor pressure = 57 mmHg @ 25°C; Flash point = 27°C; Autoignition temperature = 365°C. Hazard identification (based on NFPA-704 M Rating System): Health 1; flammability 3; reactivity 0 ₩. Highly soluble in water.

Potential Exposure: Butanedione is used as an aroma carrier food additive in butter, vinegar, coffee and other foods.

Incompatibilities: Butanedione Vapor may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. High heat may cause violent combustion or explosion.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 0.02 milligram per cubic meter

PAC-2: 120 milligram per cubic meter

PAC-3: 310 milligram per cubic meter

Determination in water: Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment. Octanol−water coefficient: Log K_{ow} = −1.32.

Routes of Entry: Inhalation, skin contact, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Butanedione can affect you when breathed in. Exposure can irritate the eyes, nose and throat.

Contact can irritate the skin. May have a narcotic effect on the nervous system.

Long-Term Exposure: Repeated exposure may affect the blood count and nervous system. Repeated or prolonged contact may cause skin sensitization.

Points of Attack: Skin, eyes, respiratory system; blood, nervous system.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: CBC. Consider nerve conductions studies. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: *Clothing:* Avoid skin contact with Butanedione. Wear solvent-resistant gloves and clothing.

Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day and put on before work. *Eye Protection:* Wear splash-proof chemical goggles and face shield when working with liquid, unless full facepiece respiratory protection is worn.

Respirator Selection: Where there is potential for exposures to butanedione exists, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode. All respirators selected must be approved by NIOSH under the provisions of 42 CFR 84. The current listing of NIOSH-certified respirators can be found in the NIOSH/NPPTL Certified Equipment List, which is available on the NIOSH website.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where Butanedione is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of five gallons or more of butanedione should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs and flame arresters. Use only nonspeaking tools and equipment, especially when opening and closing containers of Butanedione. Wherever butanedione is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN2346 Butanedione, Hazard Class: 3; Labels: 3—Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. Keep Butanedione out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Butanedione is a flammable liquid. Decomposition products include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Butanedione*, Trenton, NJ (October 2000).

N-Butoxyethanol B:0790

Formula: $C_6H_{14}O_2$; $C_4H_9OCH_2CH_2OH$

Synonyms: BUCS; 2-Butoxy-aethanol (German); 2-Butoxyethanol; Butyl cellosolve; Butyl oxitol; Dowanol EB; EGBE; Ektasolve EB solvent; Ethyleneglycol monobutyl ether; Ethylene glycol mono-*N*-butyl ether; Glycol butyl ether; Jeffersol EB; Poly-Solv EB

CAS Registry Number: 111-76-2

HSDB Number: 538 as ethylene glycol mono-*N*-butyl ether

RTECS Number: KJ8575000

UN/NA & ERG Number: UN1993 (flammable liquids, n.o.s.)/128; UN2369/152

EC Number: 203-905-0 [*Annex I Index No.:* 603-014-00-0]

Regulatory Authority and Advisory Information

Carcinogenicity: NTP: Carcinogenisis Studies (inhalation): some evidence: mouse, 2000; EPA: Possible Human Carcinogen; NCI: Carcinogenesis Studies (inhalation); equivocal evidence: mouse, rat; IARC: Animal Limited Evidence; Human No Adequate Data, *not classifiable as carcinogenic to humans*, Group 3

TSCA 40CFR716.120(a)

Hazard Alert: Flammable liquid, possible risk of forming tumors, suspected of causing genetic defects, suspected reprotoxic hazard, polymerization hazard, primary irritant (w/o allergic reaction), reproductive toxins.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xn; risk phrases: R10; R19; R20/21/22; R36/38; R61; R62; R63; safety phrases: S2; S36/37; S46; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

As glycol ethers:

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) includes mono-and di-ethers of ethylene glycol, diethyl glycol, and triethylene glycol $R\text{-}(OCH_2CH_2)_n\text{-}OR'$ where $n = 12$, or 3; $R =$ alkyl or aryl groups; $R' = R$, H, or groups which, when removed, yield glycol ethers with the structure: $R\text{-}(OCH_2CH)_n{-}OH$. Polymers are excluded from the glycol category.

EPCRA Section 313: Certain glycol ethers are covered. $R\text{-}(OCH_2CH_2)_n\text{-}OR'$; Where $n = 12$ or 3; $R =$ alkyl C_7 or less; or $R =$ phenyl or alkyl substituted phenyl; $R' + H$, or alkyl C_7 or less; or OR′ consisting of carboxylic ester, sulfate, phosphate, nitrate or sulfonate. Form R *de minimis* concentration reporting level: 1.0%.

Description: 2-Butoxy ethanol is a colorless liquid with a mild, ether like odor. Molecular weight = 118.20; Specific gravity (H_2O:1) = 0.90; boiling point = 171°C; freezing/melting point = −74.8°C; vapor pressure = 0.8 mmHg @ 20°C; Relative vapor density (air = 1) = 4.1; Flash point = 61°C (cc); Autoignition temperature = 238°C. Explosive limits = LEL 1.1% @ 93°C; 11,000 ppm[138]; UEL 12.7% @ 135°C. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 2; reactivity 0 ₩. Soluble in water.

Potential Exposure: This material is used as a solvent for resins in protective coatings; lacquers, varnishes and enamels. It is also used in varnish removers and in dry cleaning compounds.

Incompatibilities: May form explosive mixture with air. Can form unstable and explosive peroxides; check for peroxides prior to distillation; render harmless if positive. Decomposes, producing toxic fumes. Violent reaction with strong caustics and strong oxidizers. Attacks some coatings, plastics and rubber. Attacks metallic aluminum at high temperatures.

Permissible Exposure Limits in Air

NIOSH IDLH = 700 ppm

Conversion factor: 1 ppm = 4.83 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 50 ppm/240 milligram per cubic meter TWA [skin]

NIOSH REL: 5 ppm/24 milligram per cubic meter TWA [skin]

ACGIH TLV[1]: 20 ppm/97 milligram per cubic meter TWA; Confirmed animal carcinogen with unknown relevance to humans; BEI assigned

PAC Ver. 29[138]

PAC-1: 60 ppm

PAC-2: 120 ppm

PAC-3: 700 ppm

DFG MAK: 10 ppm (sum of all concentrations)/49 milligram per cubic meter TWA; Peak Limitation Category I(2) [skin]; Carcinogen Category 4; Pregnancy Risk Group C; BAT: 50 mg[Ethoxyacetic acid]/g creatinine in urine at end-of-shift; after several shifts (long-term).

Australia: TWA 25 ppm (120 milligram per cubic meter), [skin], 1993; Austria: MAK 20 ppm (100 milligram per cubic meter), [skin], 1999; Belgium: TWA 25 ppm (121 milligram per cubic meter), [skin], 1993; Denmark: TWA 25 ppm (120 milligram per cubic meter), [skin], 1999; Finland: TWA 25 ppm (120 milligram per cubic meter); STEL 75 ppm (350 milligram per cubic meter), [skin], 1999; France: VME 25 ppm (120 milligram per cubic meter), [skin], 1999; Hungary: TWA 100 milligram per cubic meter; STEL 200 milligram per cubic meter, [skin], 1993; the Netherlands: MAC-TGG 100 milligram per cubic meter, [skin], 2003; Norway: TWA 20 ppm (100 milligram per cubic meter), 1999; the Philippines: TWA 50 ppm (240 milligram per cubic meter), [skin], 1993; Poland: MAC (TWA) 100 milligram per cubic meter, MAC (STEL) 360 milligram per cubic meter, 1999; Russia: STEL 5 milligram per cubic meter, 1993; Sweden: NGV 10 ppm (50 milligram per cubic meter), KTV 20 ppm (100 milligram per cubic meter), [skin], 1999; Switzerland: MAK-W 20 ppm (100 milligram per cubic meter), KZG-W 40 ppm (200 milligram per cubic meter), [skin], 1999;

Turkey: TWA 50 ppm (240 milligram per cubic meter), 1993; United Kingdom: TWA 25 ppm (123 milligram per cubic meter), [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: confirmed animal carcinogen with unknown relevance to humans.

Determination in Air: Use NIOSH Analytical Method #1403[18], OSHA Analytical Method 83.

Permissible Concentration in Water: No criteria set.

Determination in Water: Octanol−water coefficient: $\text{Log } K_{ow} = 0.830$. Unlikely to bioaccumulate in marine organisms. EC_{50} [daphnia magna (water flea), 24 hour] = 1.815 mg/L.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Irritation of eyes, nose and throat; hemolysis, hemoglobinuria. LD_{50} = (oral-rat) 1480 mg/kg (slightly toxic).

Short-Term Exposure: This chemical irritates the eyes, skin, and respiratory tract. High exposure caused dizziness, lightheadedness, and unconsciousness. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Exposure could cause CNS depression and liver and kidney damage

Long-Term Exposure: The liquid defats the skin. This chemical can break down red blood cells, and cause anemia; effects the hematopoietic system, resulting in blood disorders. It can also damage the liver and kidneys.

Points of Attack: Eyes, skin, respiratory system; central nervous system; hematopoietic system; blood, kidneys, liver, lymphoid system

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Lung function tests, urinalysis and kidney function tests. CBC with reticulocyte count. Liver function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. **8 hours** (more than 8 hours of resistance to breakthrough $>0.1\ \mu g/cm^2/min$): Butyl, Viton gloves, suits, Saranex. **4 hours:** (At least 4 but <8 hours of resistance to breakthrough >0.1 $0.1\ \mu g/cm^2/min$): 4H and Silver Shield gloves. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *50 ppm:* CcrOv* (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)]; or Sa* (APF = 10) (any supplied-air respirator). *125 ppm:* Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOv* (APF = 25) [any PAPR with organic vapor cartridge(s)]. *250 ppm:* CcrFOv (APF = 50) [any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s)]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted acid gas canister]; or PaprTOv* (APF = 50) [any PAPR with a tight-fitting facepiece and organic vapor cartridge(s)]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA). *Note*: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: (1) Color code—Red: Flammability Hazard: Store in a flammable (liquid or solid materials) storage area or approved cabinet away from sources if ignition. (2) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a dark, cool, well-ventilated area. Keep in dark due to possible formation of explosive peroxides. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN1993 Flammable liquids, n.o.s., Hazard Class: 3; Labels: 3—Flammable liquid, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Enter spill area from upwind side. Establish forced ventilation to keep levels below explosive limit. Use absorbent material to permit spill removal to vapor-tight plastic bags for eventual disposal. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide; water spray; or alcohol-resistant foam extinguishers. Thermal decomposition products may include oxides of carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (2); (80); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: 2-Butoxy Ethanol*, RTK 0275, Trenton, NJ (August 2008).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 4, No. 2, 58–61 (1984).

Butoxyl B:0800

Formula: $C_7H_{14}O_3$; $CH_3COOCH_2CH_2CH(OCH_3)CH_3$

Synonyms: Acetic acid 3-methoxybutyl ester; 3-Methoxybutyl acetate; Methyl-1,3-butylene glycol acetate

CAS Registry Number: 4435-53-4

RTECS Number: EL4725000

UN/NA & ERG Number: UN1993 (flammable liquids, n.o.s.)/128

EC Number: 224-644-9

Regulatory Authority and Advisory Information

Hazard Alert: Flammable, Irritant.

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xi; risk phrases: R10; R36/37/38; safety phrases: S26; S36; (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Butoxyl is a colorless liquid. Sharp odor. Molecular weight = 146.19; Specific gravity (H_2O:1) = 0.96; boiling point = 169–173°C; Melting/Freezing point ≤ -80°C; Flash point = 62°C (cc); 77°C[17]. Hazard identification (based on NFPA-704 M Rating System): Health 1, Flammability 2; reactivity 1 ₩. Slightly soluble in water; solubility = 30 g/L.

Potential Exposure: A potential danger to those involved in the use of this material as a cleaning solvent and as a component in varnishes and casting molds.

Incompatibilities: Vapors may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Routes of Entry: Inhalation, skin absorption, Ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Butoxyl can be an eye irritant. High vapor levels can cause dizziness. LD_{50} = (oral-rat) 4210 mg/kg (slightly toxic)[9].

Long-Term Exposure: Unknown at this time.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. If local exhaust ventilation or enclosure is not used, respirators should be worn. Wear protective work clothing. Wash thoroughly immediately after exposure to Butoxyl and at the end of the work-shift. Post hazard and warning information in the work area. In addition, as part of an ongoing education and training effort, communicate all information on the health and safety hazards of Butoxyl to potentially exposed workers.

Respirator Selection: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive pressure mode). All respirators selected must be approved by NIOSH under the provisions of 42 CFR 84. The current listing of NIOSH-certified respirators can be found in the NIOSH/NPPTL Certified Equipment List, which is available on the NIOSH website.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Butoxyl must be stored to avoid contact with Oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where Butoxyl is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN1993 Butoxyl, Flammable liquids, n.o.s., Hazard Class: 3; Labels: 3—Flammable liquid, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Use water spray to reduce vapors. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Butoxyl*, Trenton, NJ (August 2009).

Butralin B:0805

Formula: $C_{14}H_{21}N_3O_4$

Synonyms: 72-A34; A-820; AMCHEM 70-25; AMCHEM a-280; Amex; Amex 820; Amexine; Aniline, *N-sec*-butyl-4-*tert*-butyl-2,6-dinitro-; Benzenamine, 4-(1,1-dimethylethyl)-*N*-(1-methylpropyl)-2,6-dinitro-; Butalin; Butraline; *N-sec*-Butyl-4-*tert*-butyl-2,6-dinitroaniline; Dibutalin; 4-(1,1-Dimethylethyl)-*N*-(1-methylpropyl)-2,6-dinitrobenzenamine; Dimethyl-ethyl-*N*-(1-methylpropyl)-2,6-dinitrobenzeneamine [4-(1,1-)]; No crab; Rutralin; Sector; Stifle; Tamex; Zitsaosol

CAS Registry Number: 33629-47-9

HSDB Number: 7355

RTECS Number: BW9500000

UN/NA & ERG Number: UN1596 (Dinitroanilines)/153; UN3082 (environmentally hazardous substances, liquid, n.o.s.)/171; UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 251-607-4

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Combustible, Possible sensitization hazard (skin), Environmental hazard, Agricultural chemical.

Marine pollutant, IMO/IMDG

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N, Xn, Xi; risk phrases: R22; R24; R36/37/38; R43; R50/53; safety phrases: S26; S36/37/39; S29/35; S45; S60; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Butralin is a yellow−orange crystalline solid or liquid. Commercial product is available as an emulsifiable concentrate. Molecular weight = 295.34; Specific gravity (H_2O:1) = 1.05 @ 20°C; Flash point => 100°C; 65°C (cc) [MSDS]. Henry's Law constant = 4.9×10^{-6} atm m^3/mol @ 25°C (est)[83]. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 1; reactivity 0 ₩. Slightly soluble in water; solubility =< 1.0 ppm. Some formulations may contain petroleum distillate. Physical and toxicological properties may be affected by carrier solvents in commercial formulations.

Potential Exposure: 2,6-Dinitroaniline herbicide; plant growth regulator. Butralin is used as a plant grow regulator on tobacco after the tobacco is topped. All tobacco is topped to stimulate desirable chemical and physical characteristics but also stimulates the growth of suckers. It may be used on food crops, broad leaf weeds and ornamentals in some countries. Butralin is been found effective in destroying opium poppy crops. All uses on food crops were canceled in January, 1991, and all uses on turf and ornamental grasses were voluntarily canceled in March, 1997. Actively registered for use in the United States Not approved for use in EU countries.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Concentration in Water: Runoff from spills or fire control may cause water pollution.

Determination in Water: Octanol−water coefficient: Log K_{ow} => 4.5. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood. Fish toxicity (threshold): Intermediate—42.17178 ppb, MATC.

Routes of Entry: Inhalation, dermal contact, ingestion

Harmful Effects and Symptoms

Short-Term Exposure: May cause irritation to the eyes, skin, or respiratory tract. May be toxic if ingested or upon dermal and/or eye contact. LD_{50} (oral, rat) = 1.5−2.5 g/kg; LD_{50} (dermal, rabbit) = 200 mg/kg[9].

Long-Term Exposure: May cause reproductive and fetal effects. Human toxicity (long-term): Low−70.00 ppb, Health advisory.

Points of Attack: Reproductive cells, chromosomes/DNA.

Medical Surveillance: Preliminary medical exam to detect chronic diseases of CNS, liver, heart, kidneys, lung and skin, as well as endocrinological or immunological disturbances, should protect susceptible individuals. Periodical medical exams of internal organs, skin and eyes are important to avoid chronic occupational intoxications. They should include lab and patch tests when necessary[83]. In addition to comprehensive initial medical and work histories emphasizing reproductive experience and menstrual history, patient should have physical examination and testing of genito-urinary tract, sperm count, motility and morphology. If required, other tests, such as serum testosterone, serum FSH, and serum LH may be indicated.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Dinitroanilines react with cellulose-based and expanded polymeric absorbents[88]. Applicators and other handlers must wear: Coveralls worn over long-sleeved shirt and long pants; Chemical-resistant gloves such as DuPont Tychem suit fabrics, barrier laminate, or Viton; Chemical-resistant footwear plus socks; Protective eye wear; Chemical-resistant headgear for overhead exposure; Chemical-resistant apron when cleaning equipment, mixing, or loading[83]. Agricultural Use/ Engineering Controls: When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the WPS for agricultural pesticides, 40 CFR 170.240(d)(4-6), the handler PPE requirements may be reduced or modified as specified in the WPS. Firefighters should wear NIOSH approved SCBA and full protective clothing.

Respirator Selection: For nuisance exposures use type P95 (US) or type P1 (EU EN 143) particle respirator. For higher level use type OV/AG/P99 (US) or type ABEK-P2 (EU EN 143) respirator cartridges. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

Storage: (1) Color code—Blue: Health Hazard/Toxics/ Poisons: Store in a secure poison location.(2) Color code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from chlorine compounds, oxidizing agents; and combustible materials. If this material contains a flammable carrier, sources of ignition, such as smoking and open flames are prohibited where their chemical is handled, used, or stored, Use only nonsparking tools and equipment, especially when opening and closing containers. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Piping should be electrically bonded and grounded.: Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN1596 Dinotoanilines, Hazard Class: 6.1; Labels: 6.1—Poisonous materials. UN3082 Environmentally hazardous substances, liquid, n.o.s., Hazard class: 9; Labels: 9—Miscellaneous hazardous material, Technical Name Required. UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9—Miscellaneous hazardous material, Technical Name Required.

Spill Handling: For dinitroaniline solids, isolate spill or leak area in all directions for at least 50 m/150 ft. Increase, in the downwind direction, as necessary. *If tank, rail car or tank truck is involved in spill*, *isolate* for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Stop leak if you can do it without risk. Prevent entry into waterways, sewers, basements or confined areas. Cover with plastic sheet to prevent spreading. Absorb or cover with dry earth, sand or other noncombustible material and transfer to containers. Do not allow water to get inside containers.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen and carbon. As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 m/150 ft. for liquids and at least 25 m/75 ft. for solids. *Fire involving storage or vehicular tanks:* Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. *On a small fire:* use dry chemical, CO_2, water spray or regular *foam. On a large fire:* use water spray, fog or regular foam. Do not scatter spilled material with high pressure streams of water. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal. *Fire involving tanks:* From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. Always stay away from tanks engulfed in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Do not discharge into drains or sewers. Dispose of waste material as hazardous waste using a licensed disposal contractor to an approved landfill. Contact a licensed disposal facility about surplus and nonrecyclable solutions. Burn in a chemical incinerator equipped with an afterburner and scrubber. Extra care must be exercised as the material in an organic solvent is highly flammable. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Incineration with effluent gas scrubbing is recommended. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office. Do not reuse container.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, "Reregistration Eligibility Decision (RED), Butralin," Office of Prevention, Pesticides and Toxic Substances, Washington, DC (May 1998). http://www.epa.gov/REDs/2075red.pdf.

Butyl Acetates B:0810

Formula: $C_6H_{12}O_2$ (*n-; sec-; tert-*); $C_6H_{12}O_2$ (*iso-*); $C_4H_9OCOCH_3$

Synonyms: *n*-isomer*:* Acetate de butyle (French); *n*-Acetato de butilo (Spanish); Acetato de butilo (Spanish); Acetic acid, *n*-butyl ester; Acetic acid, butyl ester; Aristoline (+); AZ1470 (+); AZ4140 (+); AZ4210 (+); AZ4330 (+); AZ4620 (+); AZ 1310-SF (+); AZ 1312-SFD (+); AZ 1350 J (+); AZ 1370 (+); AZ 1370-SF (+); AZ 1375 (+); AZ thinner; Butylacetat (German); *n*-Butyl acetate; *normal* Butyl acetate; 1-Butyl acetate; Butyle (acetatede) (French); *n*-Butyl ester of acetic acid; Butyl ethanoate; 6-6 Epoxy chem resin finish, clear curing agent; Good rite Nr-R; KTI1470 (+); KT I 1300 thinner; KTI 1350 J (+); KTI 1370/1375 (+); KTI II (+); Microposit 111S (+); Microposit 119S (+); Microposit 119 thinner; Microposit 1375 (+); Microposit 1400-33 (+); Microposit 1400S (+); Microposit 1470 (+); Microposit 6009 (+); Microposit Sal 601-ER7 (+); Microposit XP-6012 (+); TSMR 8800 (+); TSMR 8800 BE; Ultramac PR-1024 MB-628 resin; Ultramac solvent EPA; Waycoat 204 (+); Waycoat HPR 205/207 (+); Waycoat RX 507 (+); Xanthochrome (+); XIR-3000-T resin

sec-isomer: Acetate de butyle secondaire (French); Acetato de butilo-*sec* (Spanish); Acetic acid, 2-butoxy ester; Acetic acid, 1-methylpropyl ester; *s*-Butyl acetate; *sec*-Butyl acetate; *secondary* Butyl acetate; 2-Butyl acetate; *sec*-Butyl alcohol acetate; 1-Methyl propyl acetate

tert-isomer*:* Acetato de *terc*-butilo (Spanish); Acetic acid *t*-butyl ester; Acetic acid *tert*-butyl ester; Acetic acid, 1,1-dimethylethyl ester; Acetic acid, *tert*-butyl ester; *t*-Butyl acetate; Texaco lead appreciator; TLA

iso-isomer: Acetate d'isobutyle (French); Acetato de isobutilo (Spanish); Acetic acid, isobutyl ester; Acetic acid, 2-methylpropyl ester; Isobutyl acetate (DOT); 2-Methyl-1-

propyl acetate; 2-Methylpropyl acetate; β-Methylpropyl ethanoate

CAS Registry Number: 123-86-4 (*n*-); 105-46-4 (*sec*-); 540-88-5 (*tert*-); 110-19-0 (*iso*-)

HSDB Number: 152 (*n*-)

RTECS Number: AF7350000 (*n*-); AF380000 (*sec*-); AF7400000 (*tert*-); AI4025000 (*iso*-)

UN/NA & ERG Number: UN1123 (butyl acetates)/129; UN1213 (*iso*-)/129

EC Number: 204-658-1 [*Annex I Index No.:* 607-025-00-1] (*n*-); 203-300-1 [*Annex I Index No.:* 607-026-00-7] (*sec*-); 208-760-7 [*Annex I Index No.:* 607-026-00-7] (*tert*-); 203-745-1 [*Annex I Index No.:* 607-026-00-7] (*iso*-)

Regulatory Authority and Advisory Information

Hazard Alert: Highly flammable, Suspected reprotoxic hazard Primary irritant (w/o allergic reaction)

Clean Water Act: Section 311 Hazardous Substances/ RQ 40CFR117.3 (same as CERCLA, see below)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV.D.3.b, RQ: 5000 lb (2270 kg)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. For all isomers.

n-Isomer

Hazard symbols, risk, & safety statements: Hazard symbol: F; risk phrases: R11; R36/37/38; R63; R66; R67; safety phrases: S2; S25. *sec-, iso-, & tert-isomers:* Hazard symbol: F; risk phrases: R11; R36/37/38; R66; safety phrases: S2; S16; S23; S25; S29; S33 S41; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water. (*n-, iso-, tert-*)

Description: Butyl acetates are colorless or yellowish liquids with pleasant, fruity odors. There are 4 isomers. Molecular weight = (all isomers) 116.17.

n-Isomer: Specific gravity (H_2O:1) = 0.87; Specific gravity (H_2O:1) = 0.88; boiling point = 126−127°C; freezing/melting point = −77°C; vapor pressure = 6 mmHg @ 20°C; Flash point = 22°C; Autoignition temperature = 370°C. Flammable Limits in Air: LEL: 1.4%; 14,000 ppm; UEL: 7.6%. Hazard identification (based on NFPA-704 M Rating System): Health 1; flammability 3; reactivity 0 ₩. Soluble in water; solubility in water = 0.9% @ 20°C.

sec-isomer: Specific gravity (H_2O:1) = 0.87; boiling point = 112°C; Freezing/Melting point = −99.4°C; vapor pressure = 10 mmHg @ 20°C; Relative vapor density (air = 1) = 4.0; Flash point = 19°C (cc); Flammable Limits in Air: LEL: 1.7%, UEL: 9.8%. Hazard identification (based on NFPA-704 M Rating System): Health 1; flammability 3; reactivity 0 ₩. Slightly soluble in water; solubility in water = 0.8% @ 20°C.

tert-isomer: Specific gravity (H_2O:1) = 0.87; boiling point = 97.8°C; vapor pressure = 47 mmHg @ 25°C. Flammable Limits in Air: LEL: 1.3%, 13,000 ppm. Hazard identification (based on NFPA-704 M Rating System): Health 1; flammability 3; reactivity 0 ₩. Insoluble in water.

iso-isomer: Specific gravity (H_2O:1) = 0.87 @ 20°C; boiling point = 116.5°C; freezing/melting point = −98.8°C; vapor pressure = 17 mmHg @ 20°C; 7.5 mmHg @ 10°C; Flash point = 18°C (cc); Autoignition temperature = 421°C; Flammable Limits in Air: LEL: 1.3%, UEL: 10.5%. Hazard identification (based on NFPA-704 M Rating System): Health 1; flammability 3; reactivity 0 ₩. Slightly soluble in water; solubility = 0.6% @ 20°C.

Potential Exposure: *n*-Butyl acetate is an important solvent in the production of lacquers, leather and airplane dopes, and perfumes. It is used as a solvent and gasoline additive. *sec*-Butyl acetate is used as a widely used solvent for nitrocellulose, nail enamels and many different purposes. *tert*-Butyl acetate is common industrial solvent used in the making of lacquers, artificial leather, airplane dope, perfume; and as a food additive. Isobutyl acetate is used as a solvent and in perfumes and artificial flavoring materials.

Incompatibilities: All butyl acetates are incompatible with nitrates, strong oxidizers; strong alkalies; strong acids. Butyl acetates may form explosive mixture with air; reacts with water, on standing, to form acetic acid and *n*-butyl alcohol. Violent reaction with strong oxidizers and potassium-*tert*-butoxide. Dissolves rubber, many plastics, resins and some coatings. May accumulate static electrical charges, and may cause ignition of its vapors.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 3.03 milligram per cubic meter (*n*-isomer); 1 ppm = 4.75 milligram per cubic meter (all other @ 25°C & 1 atm isomers)

123-86-4, n-isomer

NIOSH IDLHs = 1700 ppm [LEL]

OSHA PEL: 150 ppm/710 milligram per cubic meter TWA

NIOSH REL: 150 ppm/710 milligram per cubic meter TWA; 200 ppm/950 milligram per cubic meter STEL

ACGIH TLV[1]: 50 ppm TWA; 150 ppm/713 milligram per cubic meter STEL

PAC* Ver. 29[138]

123-86-4, n-isomer

PAC-1: $\mathbf{5_A}$ ppm

PAC-2: $\mathbf{200_A}$ ppm

PAC-3: $\mathbf{3000_A}$ ppm

*AEGLs are marked with a subscript "**A**" and correspond to 60 minute values.

DFG MAK: 100 ppm/480 milligram per cubic meter TWA; Peak Limitation Category I(2); Pregnancy Risk Group C

Australia: TWA 150 ppm (710 milligram per cubic meter); STEL 200 ppm, 1993; Austria: MAK 150 ppm (700 milligram per cubic meter), 1999; Belgium: TWA 150 ppm (713 milligram per cubic meter); STEL 200 ppm (950 milligram per cubic meter), 1993; Denmark: TWA 150 ppm (710 milligram per cubic meter), 1999; Finland: TWA 150 ppm (710 milligram per cubic meter); STEL 200 ppm (950 milligram per cubic meter), 1993; France: VME 150 ppm (710 milligram per cubic meter), VLE 200 ppm (940 milligram per cubic meter), 1999; Hungary: TWA 200 milligram per cubic meter; STEL 600 milligram per cubic meter, 1993; the

Netherlands: MAC-TGG 710 milligram per cubic meter, 2003; Japan: 100 ppm (475 milligram per cubic meter), 1999; Norway: TWA 75 ppm (355 milligram per cubic meter), 1999; the Philippines: TWA 150 ppm (710 milligram per cubic meter), 1993; Poland: MAC (TWA) 200 milligram per cubic meter, MAC (STEL) 950 milligram per cubic meter, 1999; Russia: TWA 200 ppm; STEL 200 milligram per cubic meter, 1993; Sweden: NGV 100 ppm (500 milligram per cubic meter), KTV 150 ppm (700 milligram per cubic meter), 1999; Switzerland: MAK-W 150 ppm (700 milligram per cubic meter), KZG-W 300 ppm, 1999; Turkey: TWA 150 ppm (710 milligram per cubic meter), 1993; United Kingdom: TWA 150 ppm (724 milligram per cubic meter); STEL 200 ppm (966 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 200 ppm

105-46-4, sec-isomer

NIOSH IDLHs = 1700 ppm [LEL]

OSHA PEL: 200 ppm/950 milligram per cubic meter TWA

NIOSH REL: 200 ppm/950 milligram per cubic meter TWA

ACGIH TLV[1]: 200 ppm/950 milligram per cubic meter TWA

PAC Ver. 29[138]

PAC-1: 600 ppm

PAC-2: 1700 ppm [>= 10% LEL, lower explosive limit but <50% LEL]

PAC-3: 10,000 ppm [>50% LEL but <100% LEL]

Australia: TWA 200 ppm (950 milligram per cubic meter), 1993; Austria: MAK 150 ppm (700 milligram per cubic meter), 1999; Belgium: TWA 200 ppm (950 milligram per cubic meter), 1993; Denmark: TWA 150 ppm (710 milligram per cubic meter), 1999; France: VME 200 ppm (950 milligram per cubic meter), 1999; India: TWA 200 ppm (950 milligram per cubic meter), 1993; Norway: TWA 75 ppm (355 milligram per cubic meter), 1999; the Philippines: TWA 200 ppm (950 milligram per cubic meter), 1993; the Netherlands: MAC-TGG 950 milligram per cubic meter, 2003; Sweden: NGV 100 ppm (500 milligram per cubic meter), KTV 150 ppm (700 milligram per cubic meter), 1999; Switzerland: MAK-W 200 ppm (950 milligram per cubic meter), KZG-W 400 ppm (1900 milligram per cubic meter), 1999; United Kingdom: TWA 200 ppm (966 milligram per cubic meter); STEL 250 ppm (1210 milligram per cubic meter), 2000: Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV : TWA 200 ppm

540-88-5, tert-isomer

NIOSH IDLHs = 1500 ppm [LEL]

OSHA PEL: 200 ppm/950 milligram per cubic meter TWA

NIOSH REL: 200 ppm/950 milligram per cubic meter TWA

ACGIH TLV[1]: 200 ppm/950 milligram per cubic meter TWA

PAC Ver. 29[138]

PAC-1: 600 ppm

PAC-2: 1700 ppm [>= 10% LEL, lower explosive limit but < 50% LEL]

PAC-3: 10,000 ppm [> 50% LEL but <100% LEL]

DFG MAK: 20 ppm/96 milligram per cubic meter

Australia: TWA 200 ppm (950 milligram per cubic meter), 1993; Austria: MAK 150 ppm (700 milligram per cubic meter), 1999; Belgium: TWA 200 ppm (950 milligram per cubic meter), 1993; Denmark: TWA 150 ppm (710 milligram per cubic meter), 1999; France: VME 200 ppm (950 milligram per cubic meter), 1999; India: TWA 200 ppm (950 milligram per cubic meter), 1993; the Netherlands: MAC-TGG 950 milligram per cubic meter, 2003; the Philippines: TWA 200 ppm (950 milligram per cubic meter), 1993; Poland: MAC (TWA) 900 milligram per cubic meter, MAC (STEL) 900 milligram per cubic meter, 1999; Sweden: NGV 100 ppm (500 milligram per cubic meter), KTV 150 ppm (700 milligram per cubic meter), 1999; Switzerland: MAK-W 200 ppm (950 milligram per cubic meter), KZG-W 400 ppm (1900 milligram per cubic meter), 1999; United Kingdom: TWA 200 ppm (966 milligram per cubic meter); STEL 250 ppm (1210 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 200 ppm

110-29-9, iso-isomer

NIOSH IDLHs = 1300 ppm [LEL]

OSHA PEL: 150 ppm/700 milligram per cubic meter TWA

NIOSH REL: 150 ppm/700 milligram per cubic meter TWA

ACGIH TLV[1]: 150 ppm/713 milligram per cubic meter TWA

PAC Ver. 27; No values found in Ver. 29[138]

PAC-1: 450 ppm

PAC-2: 1300 ppm [>= 10% LEL, lower explosive limit but <50% LEL]

PAC-3: 7500 ppm [> 50% LEL but <100% LEL]

DFG MAK: 100 ppm/480 milligram per cubic meter; Pregnancy Risk Group C

Australia: TWA 150 ppm (700 milligram per cubic meter); STEL 187 ppm, 1993; Austria: MAK 150 ppm (700 milligram per cubic meter), 1999; Belgium: TWA 150 ppm (713 milligram per cubic meter); STEL 187 ppm (888 milligram per cubic meter), 1993; Denmark: TWA 150 ppm (710 milligram per cubic meter), 1999; France: VME 150 ppm (710 milligram per cubic meter), VLE 200 ppm (940 milligram per cubic meter), 1999; the Philippines: TWA 150 ppm (700 milligram per cubic meter), 1993; the Netherlands: MAC-TGG 700 milligram per cubic meter, 2003; United Kingdom: TWA 150 ppm (724 milligram per cubic meter); STEL 187 ppm (903 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 150 ppm

Several states have set guidelines or standards for butyl acetates in ambient air[60] as follows (all values in milligram per cubic meter):

State	*n-*	*sec-*	*tert-*	*iso-*
Connecticut	14.2	19.0	19.0	14.0
Florida 14.2	–	–	14.0	
Massachusetts	–	–	–	0.97
Nevada 16.9	22.6	22.6	16.67	
New York	14.2	–	–	14.0
South Dakota	14.2	–	–	–
Virginia 12.0	15.0	15.0	12.0	–

Determination in Air: Adsorption of charcoal, workup with CS_2, analysis by GC. Use NIOSH Analytical Method #1450 (Esters I), #1405, #2549 Volatile Organic Compounds[18] (screening), and OSHA Analytical Method 7 Organic Vapors.

Permissible Concentration in Water: Russia[43] cites an MAC in water used for domestic purposes of 0.1 mg/L (for any isomer).

Determination in Water: Octanol–water coefficient: Log $K_{ow} = 1.60$ (*n*-); 1.5 (*sec*-). Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. Passes through the unbroken skin.

Harmful Effects and Symptoms

Headaches, drowsiness, eye irritation; irritation of skin, and upper respiratory system. Humans and animals that inhale comparatively low doses of *n*-butyl acetate experience irritation of the nasal and respiratory passages and of the eyes. At higher concentrations narcosis takes place, and repeated exposures have resulted in renal and blood changes in experimental animals.

Short-Term Exposure: The substance irritates the eyes, skin, and respiratory tract. High exposures, above the occupational exposure levels, can cause weakness, head ache, and drowsiness; and may cause unconsciousness.

Long-Term Exposure: *n*-Butyl acetate may cause skin allergy. *n*-Butyl acetate has been shown to damage the developing fetus in animals. Prolonged and repeated exposure to butyl acetates can cause defatting, drying and cracking of the skin. Although many solvents and petroleum-based products cause lung, brain and disturbed sleep; these chemicals have not been adequately evaluated to determine these effects. See also NIOSH Profiles: Acetates, SRI, 2/77; *n*-Butyl acetate, SRC, 12/79; Paint and allied products manufacturing, FIRL, 4/78 and SRI, 2/7; Spray painting, FIRL, 4/78

Points of Attack: Eyes, skin, respiratory system; central nervous system.

Medical Surveillance: Consider initial effects on skin and respiratory tract in any preplacement or periodical examinations, as well as liver, lung, and kidney function.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of salt water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear solvent-resistant gloves and clothing to prevent any reasonable probability of skin or eye contact. **8 hours** (At least 4 but <8 hours of resistance to breakthrough >0.1 0.1 $\mu g/cm^2/min$): 4H and Silver Shield gloves. **4 hours:** (At least 4 but <8 hours of resistance to breakthrough $>0.10.1$ $\mu g/cm^2/min$): polyvinyl alcohol gloves; Teflon gloves, suits, boots. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *n-isomer:* OSHA: *1500 ppm:* CcrOv* (APF = 10) [any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s)]; or Sa* (APF = 10) (any supplied-air respirator). *1700 ppm:* Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOv* (APF = 25) [any PAPR with organic vapor cartridge(s)]; or CcrFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted acid gas canister]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted acid gas canister]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA). *Note*: Substance reported to cause eye irritation or damage; may require eye protection.

sec-isomer*: 1700 ppm:* Sa:Cf$^{£}$ (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or

PaprOv£ (APF = 25) [any PAPR with organic vapor cartridge(s)]; or CcrFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted acid gas canister]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted acid gas canister]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd, Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA). *Note*: Substance reported to cause eye irritation or damage; may require eye protection.

tert-isomer*: 1500 ppm:* Sa:Cf£ (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOv£ (APF = 25) [any PAPR with organic vapor cartridge(s)]; or CcrFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted acid gas canister]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted acid gas canister]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA). *Note*: Substance reported to cause eye irritation or damage; may require eye protection.

iso-isomer*: 1300 ppm:* Sa:Cf£ (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or CcrOv (APF = 10) [any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s)]; or PaprOv£ (APF = 25) [any PAPR with organic vapor cartridge(s)]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted acid gas canister]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA). *Note*: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with butyl acetates all handlers should be trained on its proper handling and storage. Before entering confined space where these chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN1123 Butyl acetates, Hazard Class: 3; Labels: 3—Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Vapor build-up may cause suffocation. For small quantities absorb on paper towels. Evaporate in a safe place (such as a fume hood). Allow sufficient time for the evaporated vapors to completely clear the hood duct work. Burn the paper in a suitable location away from combustible materials. Or, absorb liquids in activated carbon, vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: These chemicals are flammable liquids. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Water may be used as a fog to control heat and to dilute vapors and wash them from the air. Use water fog in conjunction with alcohol foam, dry chemical or carbon dioxide as extinguishing agents. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Container may explode in fire. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed. See also "Spill Handling" section above.

References

(31); (173); (101); (138); (2); (100).

National Institute for Occupational Safety and Health (NIOSH), Information Profiles on Potential Occupational Hazards-Single Chemicals: *n*-Butyl Acetate, Report TR 79-607, Rockville, MD pp. 19−27 (December 1979).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 2, No. 2, 41−43 (1982). (Isobutyl Acetate).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 3, No. 6, 35−37 (1983). (*t*-Butyl Acetate).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 4, No. 3, 38−41 (1984). (*n*-Butyl Acetate).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 4, No. 6, 82−83 (1984). (*sec*-Butyl Acetate).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: n-Butyl Acetate*, Trenton, NJ (January 2001).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: sec-Butyl Acetate*, Trenton, NJ (February 2000).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: tert-Butyl Acetate*, Trenton, NJ (December 2000).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Isobutyl Acetate*, Trenton, NJ (March 2004).

Butyl acid Phosphate B:0820

Formula: $C_8H_{21}O_4P$; $(C_4H_9O)_2PH(OH)_2$

Synonyms: Acid butyl phosphate; *n*-Butyl acid phosphate; Butyl phosphoric acid; Phosphoric acid, dibutyl ester

CAS Registry Number: 12788-93-1

RTECS Number: TB8490000

UN/NA & ERG Number: UN1718/153; UN3265/153

EC Number: 235-826-2

Regulatory Authority and Advisory Information

Hazard Alert: Combustible, Toxic, Corrosive

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: C; risk phrases: R36/37/38; R41; safety phrases: S24/25; S41 (see Appendix 4)

Description: Butyl acid phosphate is a clear white liquid. Molecular weight = 153.08; Flash point = 110°C. Hazard identification (based on NFP A-704M Rating System): Health 2; flammability 1; reactivity 1 ₩. Insoluble in water.

Potential Exposure: It is used in industrial chemicals manufacture.

Incompatibilities: Organophosphates are susceptible to formation of highly toxic and flammable phosphine gas in the presence of strong reducing agents such as hydrideds and active metals. Partial oxidation by oxidizing agents may result in the release of toxic phosphorus oxides[101] Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Routes of Entry: Inhalation, skin contact, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Butyl acid phosphate can affect you when breathed in. Contact can severely irritate the eyes, skin and respiratory tract. Can cause permanent eye damage. Inhalation can irritate the nose, throat, and lungs, causing difficult breathing and shortness of breath. Toxic; inhalation, ingestion or skin contact with material may cause severe injury or death. Contact with molten substance may cause severe burns to skin and eyes. Avoid any skin contact. Effects of contact or inhalation may be delayed[31,136].

Long-Term Exposure: Repeated or prolonged contact can cause skin rash. Very irritating substances, such as butyl acid phosphate may affect the lungs.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. If pulmonary edema develops from high exposure, medical observation is recommended for 24 to 48 hours.

Personal Protective Methods: Wear solvent-resistant gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures to Butyl acid phosphate exists, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode. All respirators selected must be approved by NIOSH under the provisions of 42 CFR 84. The current listing of NIOSH-certified respirators can be found in the NIOSH/NPPTL Certified Equipment List, which is available on the NIOSH website.

Storage: (1) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. (2) Color code—Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. Store in tightly closed containers is a cool, well-ventilated area away from potentially high heat sources. Prior to working with butyl acid phosphate you should be trained on its proper handling and storage.

Shipping: UN1718 Butyl acid phosphate, Hazard class: 8; Labels: 8—Corrosive material. UN326 Corrosive liquid, acidic, organic, n.o.s.; Hazard class: 8; Labels: 8—Corrosive material, technical name required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include oxides of phosphorus and carbon. Runoff from fire control or dilution water may be corrosive and/or toxic and cause pollution. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156.

References

(31); (101); (138).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Butyl Acid Phosphate*, Trenton, NJ (September 2000).

n-Butyl Acrylate B:0830

Formula: $C_7H_{12}O_2$; $CH_2{=}CHCOOC_4H_9$

Synonyms: Acrilato de *n*-butilo (Spanish); Acrylic acid *n*-butyl ester; Acrylic acid, butyl ester; *n*-Butyl acrylate; *normal*

Butyl acrylate; Butylacrylate, inhibited; Butyl 2-propenoate; 2-Propenoic acid, butyl ester

CAS Registry Number: 141-32-2

HSDB Number: 305

RTECS Number: UD3150000

UN/NA & ERG Number: UN2348/129 (P)

EC Number: 205-480-7 [*Annex I Index No.:* 607-062-00-3]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Limited Evidence; Human No Adequate Data*, not classifiable as carcinogenic to humans*, Group 3.

Hazard Alert: Flammable, Sensitization hazard (skin), Possible risk of forming tumors, Suspected of causing genetic defects, Polymerization hazard (nonstabilized), Primary irritant (w/o allergic reaction), environmental hazard.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%; NPRI

Hazardous to aquatic life or environment, with possible long-lasting effects[194]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: Xi, N; risk phrases: R11; R19; R21/22/23; R36/37/38; R43; R62; safety phrases: S2; S9; S29/35; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Butyl acrylate is a colorless liquid. Molecular weight = 128.17; specific gravity (H_2O:1) = 0.89 @ 20°C; boiling point = 145−148°C; freezing/melting point = −64.6°C; vapor pressure = 4 mmHg @ 20°C; relative vapor density (air = 1) = 4.4; flash point = 29°C; vapor pressure = 7.5 mmHg @ 30.4°C; Autoignition temperature = 292°C. Explosive limits in air: LEL: 1.3%; UEL: 9.9%[17]. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 2; reactivity 2 ₩. Slightly soluble in water; solubility in water = 0.14%.

Potential Exposure: Butyl acrylate is a monomer, used in the production of polymers, copolymers, and resins; solvent for coatings; adhesives, paints and binders.

Incompatibilities: May form explosive mixture with air. Heat, sparks, open flame, light, reducing agents; or peroxides may cause explosive polymerization. Incompatible with strong acids; amines, halogens, hydrogen compounds, oxidizers, sunlight, or other catalysts.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 5.24 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: None

NIOSH REL: 10 ppm/55 milligram per cubic meter TWA

ACGIH TLV[1]: 2 ppm; 11 milligram per cubic meter TWA [sensitizer]; not classified as a human carcinogen

PAC* Ver. 29[138]

PAC-1: $\mathbf{8.3_A}$ ppm

PAC-2: $\mathbf{130_A}$ ppm

PAC-3: $\mathbf{480_A}$ ppm

*AEGLs are marked with a subscript "**A**" and correspond to 60 minute values.

DFG MAK: 2 ppm/11 milligram per cubic meter TWA; Peak Limitation Category I(2) *as acrylic acid, n-butyl ester*

Australia: TWA 10 ppm (55 milligram per cubic meter), 1993; Austria: MAK 10 ppm (55 milligram per cubic meter), 1999; Belgium: TWA 10 ppm (52 milligram per cubic meter), 1993; Denmark: TWA 10 ppm (55 milligram per cubic meter), 1999; Finland: TWA 10 ppm (55 milligram per cubic meter); STEL 20 ppm (110 milligram per cubic meter) [skin] 1999; France: VME 10 ppm (55 milligram per cubic meter), 1999; Hungary: TWA 20 milligram per cubic meter; STEL 40 milligram per cubic meter, 1993; the Netherlands: MAC-TGG 11 milligram per cubic meter, 2003; Norway: TWA 10 ppm (55 milligram per cubic meter), 1999; Poland: TWA 20 milligram per cubic meter; STEL 70 milligram per cubic meter, 1999; Russia: STEL 10 milligram per cubic meter, 1993; Sweden: NGV 10 ppm (50 milligram per cubic meter), KTV 15 ppm (80 milligram per cubic meter), 1999; Switzerland: MAK-W 10 ppm (55 milligram per cubic meter), KZG-W 20 ppm (110 milligram per cubic meter), 1999; United Kingdom: TWA 10 ppm (53 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Some states have set guidelines or standards for Butyl acrylate in ambient air[60] ranging from 900 μ/m^3 (Virginia) to 1100 μ/m^3 (Connecticut) to 1310 μ/m^3 (Nevada).

Determination in Air: See OSHA Analytical Method PV2011, butyl acrylate

Permissible Concentration in Water: Russia[43] set a MAC of 0.01 mg/L in water bodies used for domestic purposes.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 2.4. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Ingestion, skin and eye contact.

Harmful Effects and Symptoms

n-Butyl acrylate was found to be but moderately irritating to the skin. As an eye irritant it produced corneal necrosis in an unwashed rabbit eye, similar to that produced by ethyl alcohol. Exposure of rats @ 1000 ppm for 4 hours proved lethal to 5 of 6 rats exposed; however, rats survived a 30-minutes exposure to 7000 ppm. There is a close similarity in toxic response by inhalation, skin and eye to methyl acrylate. LD_{50} = (oral-rat) 900 mg/kg (slightly toxic).

Short-Term Exposure: This chemical can pass through the skin. The substance severely irritates the eyes, skin and respiratory tract. Inhalation can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. High exposure may cause liver damage.

Long-Term Exposure: May cause liver and lung damage. May cause skin sensitization and allergy. Similar solvents and petroleum-based chemicals have been shown to cause brain and nerve damage.

Points of Attack: Skin, eyes.

Medical Surveillance: Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Lung function tests. Liver function tests. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Interview for brain effects.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear solvent-resistant gloves and clothing to prevent any reasonable probability of skin or eye contact. Prevent skin contact. **8 hours**: (At least 4 but <8 hours of resistance to breakthrough >0.1 0.1 $\mu g/cm^2/min$): 4H and Silver Shield gloves, Responder suits; Trychem 1000 suits; **4 hours:** (At least 4 but <8 hours of resistance to breakthrough >0.1 0.1 $\mu g/cm^2/min$): Teflon gloves, suits, boots. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). All respirators selected must be approved by NIOSH under the provisions of 42 CFR 84. The current listing of NIOSH-certified respirators can be found in the *NIOSH/NPPTL Certified Equipment List*, which is available on the NIOSH Web site

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with Butyl acrylate all handlers should be trained on its proper handling and storage. Do not store unless stabilized. Before entering confined space where Butyl acrylate may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well ventilated, fireproof area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2348 Butyl acrylate, stabilized, Hazard Class: 3; Labels: 3—Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Cover liquids with dry lime or soda ash; or absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible and highly reactive liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify

downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 7, No. 3, 61−75 (1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Butyl Acrylate*, Trenton, NJ (August 1998).

Butyl Alcohols B:0840

Formula: $C_4H_{10}O$; C_4H_9OH

Synonyms: *n-isomer:* Alcohol butilico-*n* (Spanish); Alcool butylique (French); *n*-Butanol; 1-Butanol; Butan-1-ol; Butanol; *normal* Butyl alcohol; Butyl alcohol (DOT); Butyl hydroxide; Butyric alcohol; CCS 203; CEM420; DAG154; 6-6 Epoxy chemresin finish, clear curing agent; Epoxy solvent cure agent; 1-Hydroxybutane; Isanol; Kester 5612 protecto; Methylolpropane; *normal* Primary butyl alcohol; Propyl carbinol; Propyl methanol; Protecto 5612; Tebol-88; Tebol-99

sec-isomer: Alcohol *sec*-butilico (Spanish); Alcool butylique secondaire (French); *sec*-Butanol; 2-Butanol; Butan-2-ol; Butanol-2; *secondary* Butyl alcohol; 2-Butyl alcohol; Butylene hydrate; CCS301; Ethylmethyl carbinol; 2-Hydroxybutane; Methyl ethyl carbinol; 1-Methypropyl alcohol; S.B.A.; Tanol secondaire (French)

tert-isomer: Alcohol *terc*-butilico (Spanish); Alcool butylique tertiaire (French); *tert*-Butanol; 1-Butanol; Butanol tertiaire (French); *tert*-Butyl hydroxide; 1,1-Dimethylethanol; Methanol, trimethyl-; 2-Methyl-2-propanol; NCI-C55367; 2-Propanol, 2-methyl-; TBA; Tertiary butyl alcohol; Trimethyl carbinol; Trimethyl methanol

iso-isomer: 197 rosin flux; 4282 flux; Alcohol isobutilico (Spanish); Alcool isobutylique (French); Alcowipe; Alpha 100 flux; Alpha 850-33 flux; Aqua-Sol flux; Avantine; Boron B-30; Boron B-40; Boron B-50; Boron B-60; Burmar Lab Clean; C-589; Chemtranic flux stripper; Copper 2 reagent; CP290B activator; DAG 154; Dazzlens cleaner; ENTAC 349 biocide; ENTEC 327 surfactant; Epoxy cure agent; FC-95; Fermentation butyl alcohol; Film remover; Glid-Guard epoxy safety blue; Hardness 2 test solution; High Grade 1086; 1-Hydroxymethylpropane; IBA; Isobutanol; Isopropyl carbinol; Kester 103 thinner; Kester 108 thinner; Kester 145 rosin flux; Kester 1585 rosin flux; Kester 185 rosin flux; KTI Cop Rinse I/II; KTI mask protective coating; KTI NMD-25(+); KTI PBS rinse; KTI PMMA rinse; Lens cleaner M6015; Magic glass cleaner and antifogging fluid; Markem320 cleaner; 2-Methyl-1-propanol; 2-Methylpropyl alcohol; Microposit NPE-210 solution; Omega meter solution; Opti Skan scan cleaner; Organo flux 3355-11; PBS developer; PBS rinse; PC-96 solvent soluble resist; Primer 910-S; 1-Propanol, 2-methyl-; RCRA No. U140; RN-10 E-Beam negative resist rinse; RN-11 developer; RN-11 E-beam negative resist rinse; Rosin flux; Rosin flux Kester 135/1544 Mil; RP-10 E-beam positive resist rinse; Scan Kleen; Solder flux; Solder flux 2163 organic; Solder flux thinner; Sterets preinjection swabs; Surfynol 104PA surfactant; True Blue glass cleaner; Uvex primer 910S; Vandalex 124; Vandalex 20; VWR glass cleaner; Whirlwind glass cleaner; WRS200S solution; Xerox cleaner, Formula A; Xerox film remover, Tip Wipes

CAS Registry Number: 71-36-3 (*n*-); *(alt.)* 42031-19-6; *(alt.)* 107569-51-7; *(alt.)* 220713-25-7; 78-92-2 (*sec*-); *(alt.)* 15892-23-6; 75-65-0 (*tert*-); 78-83-1 (*iso*-)

HSDB Number: 48 (*n*-)

RTECS Number: EO1400000 (*n*-); EO1750000 (*sec*-); EO1925000 (*tert*-); NP9625000 (*iso*-)

UN/NA & ERG Number: UN1120 (*butanols*)/129; UN1212 (*iso*-butanol)/129

EC Number: 200-751-6 [*Annex I Index No.:* 603-004-00-6] (*n*-); 201-158-5 [*Annex I Index No.:* 603-127-00-5] (*sec*-); 200-889-7 [*Annex I Index No.:* 603-005-00-1] (*tert*-); 201-148-0 [*Annex I Index No.:* 603-108-00-1] (*iso*-)

Regulatory Authority and Advisory Information

Carcinogenesis Studies (*tert*-isomer) NTP: (drinking water); some evidence: mouse, rat NCI: (water); equivocal evidence: mouse, rat

Hazard Alert: (*n*-isomer); Highly flammable, Suspected reprotoxic hazard, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction), (*sec*-isomer): Highly flammable, Suspected of causing genetic defects, (*tert*-isomer): Highly flammable, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction), (*iso*-isomer): Highly flammable, Possible risk of forming tumors, Suspected of causing genetic defects.

n-isomer, unless otherwise noted.

Listed for Tier 1 screening as an endocrine disruptor[88].

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U031; (*iso-isomer*) U140

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 5.6; Nonwastewater (mg/kg), 2.6

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL:g/L): 8015 (50)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 5.6; Nonwastewater (mg/kg), 2.6

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 5.6; Nonwastewater (mg/kg), 170

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV.D.3.b, RQ: 5000 lb (2270 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%; NPRI.

Hazard symbols, risk, & safety statements: Hazard Symbol (general-for all isomers): T, F, Xi, Xn; risk phrases: R11; R22; R36/37/38; R39/23/24/25; R; R41; R62; R63; R67; safety phrases: S2; S7/9; S13; S21; S26; S36/37/39; S45; S46 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): (*all-isomers*) 1-Low hazard to water.

Description: There are four isomers. *n*-and *sec*-Butyl alcohols, are colorless liquids with strong, sweet, alcoholic odor. *tert*-Butyl alcohol is a colorless crystalline powder or liquid (above 26°C) with a camphor-like odor. It is often used in aqueous solution. *iso*-butyl alcohol is a colorless liquid with a mild, sweet, and musty odor. Molecular weight (all isomers) = 74.12.

n-isomer: Boiling point = 117°C; freezing/melting point = −90°C; Specific gravity (H_2O:1) = 0.81; vapor pressure = 6 mmHg @ 20°C; relative vapor density (air = 1) = 2.6; relative density of vapor/air-mixture @ 20°C (air = 1) = 1.01; Flash point = 35°C (cc); Autoignition temperature = 345°C. Explosive limits in air: LEL: 1.4%; UEL: 11.2%. Hazard identification (based on NFPA-704 M Rating System): Health 1; flammability 3; reactivity 0 ₩. Soluble in water; solubility in water = 9% @ 20°C.

sec-isomer: Boiling point = 100°C; freezing/melting point = −115°C; specific gravity (H_2O:1) = 0.81; vapor pressure = 12 mmHg @ 20°C; relative vapor density (air- = 1) = 2.55; relative density of vapor/air-mixture @ 20°C (air = 1) = 1.03; flash point = 24°C (cc); Autoignition temperature = 406°C. Explosive limits in air: LEL: 1.7%; UEL: 9.0%. Hazard identification (based on NFPA-704 M Rating System): Health 1; flammability 3; reactivity 0 ₩. Solubility in water = 16% @ 20°C.

tert-isomer: Boiling point = 83°C; freezing/melting point = 25°C; Specific gravity (H_2O:1) = 0.79 (solid); vapor pressure = 42 mmHg @ 25°C; Relative vapor density (air = 1) = 2.6; Relative density of vapor/air-mixture @ 20°C (air = 1) = 1.06; Flash point = 11°C (cc); Autoignition temperature = 470°C. Explosive limits in air: LEL: 2.4%; UEL: 8.0%. Hazard identification (based on NFPA-704 M Rating System): Health 1; flammability 3; reactivity 0 ₩. Good solubility in water; solubility in water = 4.

iso-isomer: Boiling point = 108°C; freezing/melting point = −102°C; Specific gravity (H_2O:1) = 0.80; vapor pressure = 9 mmHg @ 20°C; Relative vapor density (air- = 1) = 2.55; Relative density of vapor/air-mixture @ 20°C (air = 1) = 1.02; Flash point = 28°C (cc); Autoignition temperature = 415°C; Explosive limits in air: LEL: 1.2%; 12,000 ppm[138]; UEL: 10.9%. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 3; reactivity 0 ₩ Solubility in water = 9% @ 20°C.

Potential Exposure: Butyl alcohols are used as solvents for paints, lacquers, varnishes, natural and synthetic resins, gums, vegetable oils, dyes, camphor, and alkaloids. They are also used as an intermediate in the manufacture of pharmaceuticals and chemicals; in the manufacture of artificial leather, safety glass; rubber and plastic cements, shellac, raincoats, photographic films, perfumes; and in plastic fabrication.

Incompatibilities: Butyl alcohols may form explosive mixture with air. In all cases they are Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Attacks some plastics, rubber and coatings. *n*-Butanol is incompatible with strong acids; halogens, caustics, alkali metals; aliphatic amines; isocyanates. *sec*-Butanol forms an explosive peroxide in air. Ignites with chromium trioxide. Incompatible with strong oxidizers; strong acids; aliphatic amines; isocyanates, organic peroxides. *tert*-Butanol is incompatible with strong acids (including mineral acid), including mineral acids; strong oxidizers or caustics, aliphatic amines; isocyanates, alkali metals (i.e., lithium, sodium, potassium, rubidium, cesium, francium). *iso*-Butanol is incompatible with strong acids; strong oxidizers; caustics, aliphatic amines; isocyanates, alkali metals and alkali earth. May react with aluminum at high temperatures.

Permissible Exposure Limits in Air

71-36-3, n-isomer

NIOSH IDLH = 1400 ppm [LEL]

OSHA PEL: 100 ppm/300 milligram per cubic meter TWA [skin]

NIOSH REL: 50 ppm/150 milligram per cubic meter TWA

ACGIH TLV[1]: 20 ppm/61 milligram per cubic meter TWA

PAC* Ver. 29[138]

PAC-1: 60 milligram per cubic meter

PAC-2: 800 milligram per cubic meter

PAC-3: 8000 [>50% LEL but <100% LEL]

78-92-2, sec-isomer

NIOSH IDLH = 2000 ppm

OSHA PEL: 150 ppm/450 milligram per cubic meter TWA [skin]

NIOSH REL: 100 ppm/305 milligram per cubic meter TWA; 150 ppm/455 milligram per cubic meter STEL

ACGIH TLV[1]: 100 ppm/300 milligram per cubic meter TWA

PAC* Ver. 29[138]
PAC-1: 150 milligram per cubic meter
PAC-2: 220 milligram per cubic meter
PAC-3: 10,000 [> 50% LEL but < 100% LEL]
Australia: TWA 100 ppm (305 milligram per cubic meter); STEL 150 ppm, 1993; Austria: MAK 50 ppm (150 milligram per cubic meter), 1999; Belgium: TWA 100 ppm (303 milligram per cubic meter); STEL 150 ppm (455 milligram per cubic meter), 1993; Denmark: TWA 50 ppm (150 milligram per cubic meter), [skin], 1999; Finland: TWA 100 ppm (300 milligram per cubic meter), [skin], 1999; France: VME 100 ppm (300 milligram per cubic meter), 1999; Japan: 100 ppm (300 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 450 milligram per cubic meter, 2003; Norway: TWA 25 ppm (75 milligram per cubic meter), 1999; the Philippines: TWA 150 ppm (450 milligram per cubic meter), 1993; Poland: TWA 300 milligram per cubic meter; STEL 450 milligram per cubic meter, 1999; Russia: TWA 100 ppm; STEL 10 milligram per cubic meter, 1993; Sweden: TWA 50 ppm (150 milligram per cubic meter); STEL 75 ppm (250 milligram per cubic meter), [skin], 1999; Switzerland: MAK-W 100 ppm (300 milligram per cubic meter), KZG-W 200 ppm (600 milligram per cubic meter), 1999; Turkey: TWA 150 ppm (450 milligram per cubic meter), 1993; United Kingdom: TWA 100 99 m (308 milligram per cubic meter); STEL 150 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 100 ppm
75-65-0, tert-Isomer
NIOSH IDLH = 1600 ppm [LEL]
OSHA PEL: 100 ppm/300 milligram per cubic meter TWA [skin]
NIOSH REL: 100 ppm/300 milligram per cubic meter TWA; 150 ppm/450 milligram per cubic meter STEL
ACGIH TLV[1]: 100 ppm/303 milligram per cubic meter TWA
PAC Ver. 29[138]
PAC-1: 150 ppm
PAC-2: 1300 ppm
PAC-3: 8000 ppm
DFG MAK: 100 ppm/310 milligram per cubic meter TWA; Peak Limitation Category I(1); Pregnancy Risk Group C.
Australia: TWA 50 ppm (150 milligram per cubic meter), [skin], 1993; Austria: MAK 50 ppm (150 milligram per cubic meter), 1999; Belgium: STEL 50 ppm (152 milligram per cubic meter), [skin], 1993; Denmark: TWA 50 ppm (150 milligram per cubic meter), [skin], 1999; Finland: TWA 50 ppm (150 milligram per cubic meter); STEL 75 ppm (225 milligram per cubic meter), [skin], 1999; France: VLE 50 ppm (150 milligram per cubic meter), 1999; Hungary: TWA 100 milligram per cubic meter; STEL 200 milligram per cubic meter, [skin], 1993; India: TWA 50 ppm (150 milligram per cubic meter), [skin], 1993; Japan: 50 ppm (150 milligram per cubic meter), [skin], 1999; Norway: TWA 25 ppm (75 milligram per cubic meter). 1999; the Philippines: TWA 100 ppm (300 milligram per cubic meter), 1993; Poland: TWA 50 milligram per cubic meter; STEL 140 milligram per cubic meter, 1999; Russia: STEL 50 ppm (10 milligram per cubic meter), 1993; Sweden: NGV 15 ppm (45 milligram per cubic meter), TGV 30 ppm (90 milligram per cubic meter), [skin], 1999; Switzerland: MAK-W 50 ppm (150 milligram per cubic meter), KZG-W 100 ppm (300 milligram per cubic meter), [skin], 1999; Turkey: TWA 100 ppm (300 milligram per cubic meter), 1993; United Kingdom: STEL 50 ppm (154 milligram per cubic meter), [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 20 ppm
78-83-1, iso-isomer
NIOSH IDLH = 1600 ppm
Odor threshold = 3.6 ppm
OSHA PEL: 100 ppm/300 milligram per cubic meter TWA [skin]
NIOSH REL: 50 ppm/150 milligram per cubic meter TWA
ACGIH TLV[1]: 50 ppm/61 milligram per cubic meter TWA
PAC Ver. 29[138]
PAC-1: 150 ppm
PAC-2: 1300 ppm [>= 10% LEL, lower explosive limit but < 50% LEL]
PAC-3: 8000 ppm [> 50% LEL but < 100% LEL]
DFG MAK: 100 ppm, STEL short-term level 200 ppm, 30 minutes, 4 times per shift
Australia: 50 ppm; Russia: MAC = 10 milligram per cubic meter; Yugoslavia: 66 ppm; United Kingdom: 50 ppm, 10 minutes-STEL, 75 ppm.

Several states have set guidelines or standards for butyl alcohols in ambient air[60] as follows (all values in milligram per cubic meter):

State	***n-***	***sec-***	***tert-***	***iso-***
Connecticut	6.0	6.1	–	–
Massachusetts	0.021	–	–	0.021
Nevada 3.57	7.26	–	–	
New York	3.0	–	–	–
South Dakota	3.0	–	–	–
Virginia 1.25	3.05	–	2.5	

NIOSH 1405, 1450; OSHA 7 (*n*-, *sec*-and *iso*-isomers); NIOSH 1450; OSHA 7 (*tert*-isomer)[18]

Permissible Concentration in Water: No criteria set, but EPA has suggested[32] ambient limits as follows based on health effects: *n*-isomer 2070 μg/L; *sec*-6200 μg/L*; iso*-2070 μg/L*; tert*-4140 μg/L Russia[43] set a MAC for butyl alcohol of 1.0 mg/mL in water bodies used for domestic purposes and 0.03 mg/L in water bodies used for fishery purposes[35].

Determination in water: Octanol−water coefficient: Log K_{ow} = All isomers are < 1.0 as follows: 0.9 (*n*-isomer); 0.6 (*sec*-isomer); 0.4 (*tert*-isomer); 0.8 (*iso*-isomer)

Routes of Entry: Ingestion, inhalation, skin and/or eye contact. Passes through the unbroken skin (*n*-, *iso*-isomer).

Harmful Effects and Symptoms

Short-Term Exposure: The vapors of butyl alcohols irritate the eyes and respiratory tract. They can irritate the skin and cause rash or burning feeling on contact. May affect the CNS. Exposure to high concentrations could cause headache, nausea, vomiting, and dizziness. Exposure to high levels of the *n*-isomer may cause unconsciousness and may lead to irregular heartbeat. The oral LD_{50} value for rats for the various isomers are as follows: (*n*-isomer) 790 mg/kg; (*sec*-isomer) 6480 mg/kg; (*iso*-isomer) 2460 mg/kg; (*tert*-isomer) 3500 mg/kg.

Long-Term Exposure: Repeated or prolonged contact with skin may cause dermatitis, drying and cracking of the skin. Exposure to the *n*-isomer can damage the liver, heart, and kidneys; cause hearing loss and affect sense of balance.

Points of Attack: Eyes, skin, respiratory system; central nervous system.

Medical Surveillance: *n-isomer*: whole blood (chemical/metabolite). Expired air; Liver and kidney function tests, hearing test (audiogram) and test for balance, EKG test. *tert-isomer:* Liver and kidney function tests. *iso-isomer:* Evaluate for brain effects and possible neuropsychological testing.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear solvent-resistant gloves and clothing to prevent any reasonable probability of skin or eye contact.

n-isomer: **8 hours** (more than 8 hours of resistance to breakthrough >0.1 μg/cm^2/min): Butyl, Teflon gloves, suits, boots; Viton gloves, suits; 4H and Silver Shield gloves; Barricade-coated suits; CPF3 suits; Responder suits. **4 hours:** (At least 4 but <8 hours of resistance to breakthrough >0.1 0.1 μg/cm^2/min): Neoprene rubber gloves, suits, boots. *sec-isomer*: **(8 hours** (more than 8 hours of resistance to breakthrough >0.1 μg/cm^2/min): 4 H and Silver Shield gloves. **4 hours:** (At least 4 but <8 hours of resistance to breakthrough >0.1 0.1 μg/cm^2/min): Butyl, Nitrile.

Iso-isomer: Prevent skin contact. **8 hours**: butyl rubber gloves, suits, boots; Neoprene rubber gloves, suits, boots; Viton gloves, suits; Responder suits. **4 hours**: nitrile rubber gloves, suits, boots; 4 H and Silver Shield gloves

tert-isomer: **8 hours** (more than 8 hours of resistance to breakthrough >0.1 μg/cm^2/min): Butyl, 4H and Silver Shield gloves, Responder suits All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *n-isomer: 1250 ppm:* Sa:Cf$^{£}$ (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOv$^{£}$ [any PAPR with organic vapor cartridge(s)]. *1400 ppm:* CcrFOv (APF = 50) [any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s)]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted acid gas canister]; or PaprTOv$^{£}$ [any PAPR with a tight-fitting facepiece and organic vapor cartridge(s)]; SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

*Substance causes eye irritation or damage; eye protection needed.

sec-isomer: NIOSH: *1000 ppm:* CcrOv* [any chemical cartridge respirator with organic vapor cartridge(s)]; or SA* (any supplied-air respirator). *2000 ppm:* Sa:Cf (APF = 25)* (any supplied-air respirator operated in a continuous-flow mode); or PaprOv* (APF = 25) [any PAPR with organic vapor cartridge(s)]; or CcrFOv (APF = 50) [any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s)]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted acid gas canister]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into* *unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

*Substance reported to cause eye irritation or damage; may require eye protection.

iso-isomer: 500 ppm: CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)]; or Sa (APF = 10) (any supplied-air respirator). *1250 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOv (APF = 25) [any PAPR with organic vapor cartridge(s)]. *1600 ppm:* CcrFOv (APF = 50) [any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s)]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted acid gas canister]; or PaprTOv (APF = 50) [any PAPR with a tight-fitting facepiece and organic vapor cartridge(s)]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

tert-isomer: 1600 ppm: Sa:Cf$^{£}$ (APF = 25)* (any supplied-air respirator operated in a continuous-flow mode); or PaprOv$^{£}$ [any PAPR with organic vapor cartridge(s)]; or CcrFOv (APF = 50) [any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s)]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted acid gas canister]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

*Substance causes eye irritation or damage; eye protection needed.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with butyl alcohols all handlers should be trained on its proper handling and storage. Before entering confined space where these may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN1120 Butanols, Hazard Class: 3; Labels: 3—Flammable liquid. UN1212 Isobutanol or Isobutyl alcohol, Hazard Class: 3; Labels: 3—Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in activated charcoal, vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. The *tert*-isomer may be in powdered form; collect powdered material in the most convenient and safe manner and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Butyl alcohols are flammable liquids (*tert*-isomer may also be a flammable solid). Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers (recommended). Water may be ineffective because of low flash point. Thermal decomposition products may include oxides of carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration, or bury absorbed waste in an approved land fill[22].

References

(31); (173); (101); (138); (80); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 2, 44–46 (1982).

United States Environmental Protection Agency, Isobutyl alcohol, Health and Environmental Effects Profile No. 120, Washington, DC, Office of Solid Waste (April 30, 1980).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Isobutyl alcohol, Washington, DC (March 31, 1983).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: n-Butyl Alcohol*, Trenton, NJ (November 1998).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: sec-Butyl Alcohol*, Trenton, NJ (September 1998).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: tert-Butyl Alcohol*, Trenton, NJ (October 1998).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Isobutyl Alcohol*, Trenton, NJ (April 1997).

Butyl Amines B:0850

Formula: $C_4H_{11}N$; $C_5H_{13}N$ (*Methylbutylamine, −*); $C_{12}H_{27}N$ (Tributylamine); $C_4H_9NH_2$

Synonyms: *n-isomer:* 1-Aminobutan (German); 1-Aminobutane; 1-Butanamine; *n*-Butilamina (Spanish); *n*-Butylamin (German); *n*-Butylamine; *normal* Butylamine; Mono-*n*-butylamine; Monobutylamine; Norvalamine

sec-isomer: 2-AB; 2-Aminobutane; 2-Aminobutane base; Butafume; 2-Butanamine; *sec*-Butilamina (Spanish); Butilamina-*sec* (Spanish); *sec*-Butylamine, (*s*)-; *secondary* Butyl amine; Butyl 2-aminobutane; CSC 2-aminobutane; Deccotane; Decotane; Frucote; 1-Methylpropylamine; Propylamine, 1-methyl; Tutane

tert-isomer: 2-Aminoisobutane; 2-Amino-2-methylpropane; Butilamina-*terc* (Spanish); *tert*-Butylamine; Butylamine, *tert*-; 1,1-Dimethylethylamine; 2-Methyl-2-propanamine; Trimethylaminomethane; Trimethylcarbinylamine

iso-isomer: 1-Amino-2-methylpropane; Isobutilamina (Spanish); Isobutylamine; 2-Methylpropylamine; Monoisobutylamine; 1-Propanamine, 2-methyl-; Valamine

CAS Registry Number: 109-73-9 (*n*-); 13952-84-6 (*sec*-); 513-49-5 (*S*)-*sec*-2-); 75-64-9 (*tert*-); 78-81-9 (*iso*-); *102-82-9 (tri-n-; tributylamine)*; 110-68-9 (*methylbutylamine, N-*)

HSDB Number: 515 (*n*-)

RTECS Number: EO2975000 (*n*-); EO3325000 (*sec*-); EO3327000 (*sec*-2-); EO3330000 (*tert*-); NP9900000 (*iso*-)

UN/NA & ERG Number: UN1125 (*n*-Butylamine)/132; UN1214 (Isobutylamine)/132

EC Number: 203-699-2 [*Annex I Index No.:* 612-005-00-0] (*n*-); 237-732-7 [*Annex I Index No.:* 612-052-00-7] (*sec*-); 208-164-7 [*Annex I Index No.:* 612-052-00-7] (*sec*-2-); 200-888-1 (*tert*-); 201-145-4 (*iso*-)

Regulatory Authority and Advisory Information

Hazard Alert: (*n*-isomer) Poison, Highly flammable liquid, Corrosive, Possible risk of forming tumors, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction). (*sec*-isomer) Highly flammable liquid, Agricultural chemical, Drug.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV.D.3.b, RQ: 1000 lb (454 kg)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. (−).

n-isomer: Hazard symbols, risk, & safety statements: Hazard symbol: T, F, C; risk phrases: R11; R20/21/22; R35; R36/37/38; safety phrases: S1/2; S3; S16; S26; S29; S36/37/39; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

sec-& sec-2-isomers: Hazard symbols, risk, & safety statements: Hazard symbol: F+, C, N; risk phrases: R12; R20/22; R35; R5 1/53; safety phrases: S1/2; S9; S16; S26; S28; S36/37/39; S45; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): (*sec*-) 2-Hazard to water.

tert-& iso-isomers: Hazard symbols, risk, & safety statements: Hazard symbol: F, T, C; risk phrases: R11; R12 (*tert*-isomer); R20/22; R35; R52/53; safety phrases: S16; S26; S28; S36/37/39; S45; S61 (see Appendix4) (*tert*-isomer).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Tributylamine: Hazard symbols, risk, & safety statements: Hazard symbol: F, T, C; risk phrases: R11; R22; R23/24; R38; R5 1/53; safety phrases: S25; S28; S36/37; S45; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Butyl amines are highly flammable, colorless liquids (*n*-turns yellow on standing) with ammoniacal or fish-like odors. *n*-isomer: Molecular weight = 73.2; Specific gravity (H_2O:1) = 0.76; boiling point = 78°C; freezing/melting point = −43.9°C; Relative vapor density (air = 1) = 2.5; vapor pressure = 82 mmHg @ 20°C; 93 mmHg @ 25°C; Relative density of vapor/air-mixture @ 20°C (air = 1) = 1.2; Flash point = −12°C (cc); Autoignition temperature = 312°C.

Explosive limits in air: LEL: 1.7%, 17,000 ppm[138]; UEL: 9.8%. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 3; reactivity 0 ₩. Soluble in water; solution is highly basic. *sec*-isomer: Molecular weight = 73.16; Specific gravity (H_2O:1) = 0.72 @ 20°C; boiling point = 63°C; freezing/melting point = −104°C; vapor pressure = 178 mmHg @ 25°C; relative vapor density (air = 1) = 2.5; flash point = −9°C (cc); explosive limits in air: LEL: 1.7%, 17,000 ppm[138]; UEL: unknown. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 3; reactivity 0 ₩. Soluble in water. *tert*-isomer: Colorless liquid. Strong amine odor. Molecular weight = 73.14; Specific gravity (H_2O:1) = 0.73 @ 20°C; boiling point = 44−46°C; freezing/melting point = −67.3°C; Relative vapor density (air = 1) = 2.5; vapor pressure = 292 mmHg @ 20°C; Relative density of vapor/air-mixture @ 20°C (air = 1) = 1.6; flash point = −9°C (cc); Autoignition temperature = 380°C. Explosive limits in air: LEL: 1.7% @ 100°C; UEL: 8.9%@100°C. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 4; reactivity 0 ₩. Soluble in water. *iso*-isomer: Molecular weight = 73.14; boiling point = 63°C; Specific gravity (H_2O:1) = 0.724 @ 20°C; relative vapor density (air = 1) = 2.5; flash point = −9°C (cc); Autoignition temperature = 377.8°C. Explosive limits in air: LEL: 3.4%; UEL: 9.0% Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 3; reactivity 0 ₩. Soluble in water.

513-49-5*, (S)-sec-isomer*: Molecular weight = 73.16; specific gravity (H_2O:1) = 0.724 @ 20°C; boiling point = 63°C; freezing/melting point = −104°C; vapor pressure = 0.0724 mmHg @ 20°C. Explosive limits in air: LEL: 1.7%, 17,000 ppm.

110-68-9, *Methylbutylamine, N*: Molecular weight = 87.19; Specific gravity (H_2O:1) = 0.734 @ 20°C; boiling point = 217°C; freezing/melting point = −75°C; explosive limits in air: LEL: 2.7%, 22,000 ppm.

102-82-9, tri-N-isomer, Tributylamine: Molecular weight = 185.4; specific gravity (H_2O:1) = 0.793 @ 25°C; boiling point = 91°C; explosive limits in air: LEL: 2.7%, 22,000 ppm.

Potential Exposure: Alert: (*n*-isomer): Possible risk of forming tumors, suspected of causing genetic defects, suspected reprotoxic hazard, Primary irritant (w/o allergic reaction), (*sec*-isomer): Drug. *n*-Butylamine is used in pharmaceuticals; dyestuffs, rubber, chemicals, emulsifying agents; photography, desizing agents for textiles; pesticides, and synthetic agents. *sec*-Butylamine is used as a fungistate. *tert*-Butylamine is used as a chemical intermediate in the production of *tert*-Butylaminoethyl methacrylate (a lube oil additive); as an intermediate in the production of rubber and in rust preventatives and emulsion deterrents in petroleum products. It is used in the manufacture of several drugs.

Incompatibilities: May form explosive mixture with air. May accumulate static electrical charges, and may cause ignition of its vapors. *n*-Butylamine is a weak base; reacts with strong oxidizers and acids, causing fire and explosion hazard. Incompatible with organic anhydrides; isocyanates, vinyl acetate; acrylates, substituted allyls; alkylene oxides; epichlorohydrin, ketones, aldehydes, alcohols, glycols, phenols, cresols, caprolactum solution. Attacks some metals in presence of moisture. The *tert*-isomer will attack some forms of plastics.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 2.99 milligram per cubic meter @ 25°C & 1 atm

109-73-9, n-isomer

NIOSH IDLH = 300 ppm

Odor threshold = 0.24−13.9 ppm.

OSHA PEL: 5 ppm/15 milligram per cubic meter Ceiling Concentration [skin

NIOSH REL: 5 ppm/15 milligram per cubic meter Ceiling Concentration [skin]

ACGIH TLV[1]: 5 ppm/15 milligram per cubic meter, Ceiling Concentration [skin]

milligram per cubic meter [skin] Ceiling Concentration

PAC Ver. 29[138]

PAC-1: 6 ppm

PAC-2: 50 ppm

PAC-3: 300 ppm [>= 10% LEL, lower explosive limit but <50% LEL]

DFG MAK: 2 ppm/6.1 milligram per cubic meter TWA; Peak Limitation Category I(2), a momentary value of 10 ppm/30 milligram per cubic meter should not be exceeded; Pregnancy Risk Group C

Australia: TWA 5 ppm (15 milligram per cubic meter), [skin], 1999; Austria: MAK 5 ppm (15 milligram per cubic meter), [skin], 1993; Belgium: STEL 5 ppm (15 milligram per cubic meter), [skin], 1993; Denmark: TWA 5 ppm (15 milligram per cubic meter), [skin], 1999; Finland: STEL 5 ppm (15 milligram per cubic meter), [skin], 1999; France: VLE 5 ppm (15 milligram per cubic meter), [skin], 1999; Japan: 5 ppm (15 milligram per cubic meter), 1999; the Netherlands: MAC 15 milligram per cubic meter, [skin], 2003; Norway: TWA 5 ppm (15 milligram per cubic meter), 1999; the Philippines: TWA 5 ppm (15 milligram per cubic meter), [skin], 1993; Russia: STEL 5 ppm (10 milligram per cubic meter), [skin], 1993; Sweden: ceiling 5 ppm (15 milligram per cubic meter), [skin], 1999; Switzerland: MAK-W 5 ppm (15 milligram per cubic meter); STEL 25 ppm (75 milligram per cubic meter), [skin], 1999; Thailand: TWA 5 ppm (15 milligram per cubic meter), 1993; Turkey: TWA 5 ppm (15 milligram per cubic meter), [skin], 1993; United Kingdom: STEL 5 ppm (15 milligram per cubic meter), [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: ceiling 5 ppm [skin]

All isomers

DFG MAK: 5 ppm/15 milligram per cubic meter

13952-84-6, sec-isomer

PAC Ver. 29[138]

PAC-1: 6 ppm
PAC-2: 10 ppm
PAC-3: 31 ppm
DFG MAK: 2 ppm/6.1 milligram per cubic meter TWA; Peak Limitation Category I(2), a momentary value of 10 mL/m^3/30 milligram per cubic meter should not be exceeded; Pregnancy Risk Group C
Austria: MAK 5 ppm (15 milligram per cubic meter), [skin], 1999; Denmark: TWA 5 ppm (15 milligram per cubic meter), [skin], 1999; Norway: TWA 5 ppm (15 milligram per cubic meter), 1999; Switzerland: MAK-W5 ppm (15 milligram per cubic meter); STEL 25 ppm (75 milligram per cubic meter), 1999
75-64-9, tert-isomer
PAC Ver. 29[138]
PAC-1: 0.85 ppm
PAC-2: 0.93 ppm
PAC-3: 56 ppm
78-81-9, iso-isomer
PAC Ver. 29[138]
PAC-1: 6 ppm
PAC-2: 10 ppm
PAC-3: 15 ppm
DFG MAK: 2 ppm/6.1 milligram per cubic meter TWA; Peak Limitation Category I(2), a momentary value of 10 mL/m^3/30 milligram per cubic meter should not be exceeded [Ceiling Concentration]; Pregnancy Risk Group C.
Austria: MAK 5 ppm (15 milligram per cubic meter), [skin], 1999; Denmark: TWA 5 ppm (15 milligram per cubic meter), [skin], 1999; Switzerland: MAK-W 5 ppm (15 milligram per cubic meter); STEL 25 ppm (75 milligram per cubic meter), 1999
Several states have set guidelines or standards for *n*-butylamine in ambient air[60] ranging from 50.0 μ/m^3 (New York) to 75 μ/m^3 (South Carolina) to 80 μ/m^3 (Virginia) to 150 μ/m^3 (North Dakota) to 357 μ/m^3 (Nevada).
513-49-5, (S)-sec-isomer
PAC Ver. 29[138]
PAC-1: 6 ppm
PAC-2: 10 ppm
PAC-3: 31 ppm
110-68-9, methylbutylamine – Ver. 29[138]
PAC-1: 1.3 ppm
PAC-2: 14 ppm
PAC-3: 86 ppm
102-82-9, tri-n-isomer; *tributylamine*
PAC Ver. 29[138]
PAC-1: 0.049 ppm
PAC-2: 0.54 ppm
PAC-3: 3.2 ppm

Determination in Air: Adsorption on H_2SO_4 treated silica gel, desorption with 50% methanol, analysis by gas chromatography/flame ionization detection, see NIOSH (IV) #2012.

Permissible Concentration in Water: No criteria set, but EPA[32] has suggested ambient water limits for butyl amines (*n*-, *iso*-, or *tert*-isomer) as 207 μg/L based on health effects.

Determination in Water: Octanol–water coefficient: Log K_{ow} (*n*-isomer) = 0.9; (*tert*-isomer) = 0.4.

Routes of Entry: Inhalation and percutaneous absorption, ingestion, and eye and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Contact with butylamine can irritate and burn the eyes with possible permanent damage. Skin contact can cause irritation, burns and blisters. Inhalation can cause nose and throat irritation, "flushed" feeling, headache, dizziness, coughing, shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. The LD_{50} rat value range from 78 mg/kg (*tert*) to 366 mg/kg (*n*-butyl) and all 4 are designated moderately toxic.

Long-Term Exposure: Repeated exposure may cause itching and skin rash. May cause bronchitis to develop with phlegm, and/or shortness of breath. Exposure to high levels of isobutylamine can affect the heart.

Points of Attack: Skin, eyes, respiratory system.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Lung function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Rinse out mouth and *do not* induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. *n-isomer:* **8 hours** (more than 8 hours of resistance to breakthrough >0.1 μg/cm^2/min): Responder suits; Trychem 1000 suits; **4 hours:** (At least 4 but <8 hours of resistance to breakthrough >0.1 0.1 μg/cm^2/min): Trellchem HPS suits. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *n*-isomer: *50 ppm:* CcrS* (APF = 10) [any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern]; or Sa* (APF = 10) (any supplied-air respirator). *125 ppm:* Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprS* (APF = 25) [any PAPR with cartridge(s) providing protection against the compound of concern]. *250 ppm:* CcrFS (APF = 50) [any chemical cartridge respirator with a full facepiece and cartridge(s) providing protection against the compound of concern]; or GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted canister providing protection against the compound of concern]; or PaprTS (APF = 50) [any PAPR with a tight-fitting facepiece and cartridge(s) providing protection against the compound of concern]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *300 ppm:* SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd, Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted canister providing protection against the compound of concern]; or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: (1) Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet. (2) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Store in a refrigerator.

Keep under an inert atmosphere for long-term storage[52]. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area separated from strong oxidants, strong bases; strong acids. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN1125 *n*-Butylamine, Hazard Class: 3; Labels: 3—Flammable liquid, 8—Corrosive material. UN2014 Isobutylamine, Hazard Class: 3; Labels: 3—Flammable liquid, 8—Corrosive material.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated Waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Use a licensed professional waste disposal service to dispose of this material. Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed[22].

References

(31); (173); (101); (138); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 2, No. 3, 68−70 (1982) and 6, No. 2, 45−48 (1986) (*n*-Butylamine).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 3, No. 6, 40−42 (1983) (*sec*-Butylamine).

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National Institute for Occupational Safety and Health (NIOSH), Information Profiles on Potential Occupational Exposure s-Single Chemicals: *tert*-Butylamine, Report TR79-607, Rockville, MD pp. 28−33 (December 1979).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Butylamine*, Trenton, NJ (August 1998).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Isobutylamine*, Trenton, NJ (May 1999).

Butylate B:0860

Formula: $C_{11}H_{23}NOS$; $CH_3CH_2SCON[CH_2CH(CH_3)_2]_2$

Synonyms: Bis(2-methylpropyl)carbamothioic acid *S*-ethyl ester; Butilate; Diisobutylthiocarbamic acid *S*-ethyl ester; Diisocarb; *S*-Ethyl bis(2-methylpropyl)carbamothioate; *S*-Ethyl *N*,*N*-diisobutylthiocarbamate; *S*-Ethyldiisobutyl thiocarbamate; Ethyl *N*,*N*-diisobutylthiocarbamate; Ethyl-*N*, *N*-diisobutylthiolcarbamate; R-1910; Stauffer R-1910; Sutan

CAS Registry Number: 2008-41-5

HSDB Number: 1714

RTECS Number: EZ7525000

UN/NA & ERG Number: UN3082 (environmentally hazardous substances, liquid, n.o.s.)/171

EC Number: 217-916-3

Regulatory Authority and Advisory Information

Hazard Alert: Combustible, Environmental hazard.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.003; Nonwastewater (mg/kg), 1.4.

Hazardous to aquatic life or environment, with possible long-lasting effects[293]. Toxic to aquatic life with long-lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: N, Xn; risk phrases: R20; R36/37/38; R51/53; safety phrases: S16; S26; S29/35; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [2-Hazard to water. (est.)]

Description: Butylate is a clear liquid with an aromatic odor. Molecular weight = 217.4; Specific gravity (H_2O:1) = 0.94; boiling point = 130°C @ 10 mmHg @ 20°C; vapor pressure = 1×10^{-3} mmHg. Low solubility in water; solubility = 44 mg/L.

Potential Exposure: A thiocarbamate herbicide. A potential danger to those involved in the manufacture, formulation or application of this carbamate herbicide which is used to control weed seeds in the soil prior to sowing crops.

Incompatibilities: Thiocarbamate esters are combustible. They react violently with powerful oxidizers such as calcium hypochlorite. Poisonous gases are generated by the thermal decomposition of thiocarbamate compounds, including carbon disulfide, oxides of sulfur, oxides of nitrogen, hydrogen sulfide, ammonia, and methylamine. Many materials in this group slowly decompose in aqueous solution to form carbon disulfide and methylamine or other amines. Such decompositions are accelerated by acids. Flammable gases are generated by the combination of thiocarbamates with aldehydes, nitrides, and hydrides. Thiocarbamates are incompatible with acids, peroxides, and acid halides.

Permissible Exposure Limits in Air

No standards or PAC available.

Permissible Concentration in Water: A NOAEL in the range of 24−40 mg/kg body weight/day/has been determined by United States Environmental Protection Agency. This leads to derivation of a 10-day Health advisory: for Butylate of 2.4 mg/L and a lifetime Health advisory: of 0.05 mg/L for a 70-kg man. Wisconsin has set a guideline for Butylate in drinking water of 200 μg/L[61].

Determination in Water: Analysis of Butylate is by a GC method applicable to the determination of certain nitrogen- and phosphorus-containing pesticides in water samples. In this method, approximately 1 L of sample is extracted with methylene chloride. The extract is concentrated and the compounds are separated using capillary column GC. Measurement is made using a nitrogen-phosphorus detector. The method detection limit has not been determined for Butylate, but it is estimated that the detection limits for analytes included in this method are in the range of 0.1−2 μg/L. Fish Tox: 22.61732000 ppb MATC (INTERMEDIATE).

Harmful Effects and Symptoms

Applying the criteria described in EPA's guidelines for assessment of carcinogenic risk, butylate may be placed in Group C: a possible human carcinogen. This category is for substances that show limited evidence of carcinogenity in animals and inadequate evidence in humans. LD_{50} (rat) = 4000 mg/kg (slightly toxic).

Long-Term Exposure: Human Tox = 400.00000 ppb Health advisory: (VERY LOW).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately.

If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Respirator Selection: *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any MSHA/NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full facepiece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, SCBA). All respirators selected must be approved by NIOSH under the provisions of 42 CFR 84. The current listing of NIOSH-certified respirators can be found in the NIOSH/NPPTL Certified Equipment List, which is available on the NIOSH Web site.

Storage: Color code—Green: General storage may be used. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, dry place.

Shipping: UN3082 Environmentally hazardous substances, liquid, n.o.s., Hazard class: 9; Labels: 9—Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Soil Adsorption Index (K_{oc}) = 400.

Fire Extinguishing: Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include oxides of nitrogen, sulfur and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, "Health advisory: Butylate, Washington, DC, Office of Drinking Water (August 1987).

Butylated Hydroxyanisole B:0863

Formula: $C_{11}H_{16}O_2$

Synonyms: Antioxyne B; Antrancine 12; BHA; BOA; *tert*-Butyl-4-hydroxyanisole 2(3)-; *tert*-Butyl-4-hydroxyanisole; *tert*-Butyl-4-methoxyphenol; 2-*tert*-Butyl-4-methoxyphenol; *tert*-Butyl-*p*-hydroxyanisole; *tert*-Butylhydroxyanisole Butylhydroxyanisole(1,1-dimethylethyl)-4-methoxyphenol; EEC No. E320; Embanox; Nipantiox 1-F; Phenol, *tert*-butyl-4-methoxy-; Premerge plus; Protex; Sustan 1-F; Sustane; Sustane 1-F; Tenox BHA; Vertac

CAS Registry Number: 25013-16-5

HSDB Number: 3913

RTECS Number: SL1945000

UN/NA & ERG Number: UN 2811 (toxic solid, organic, n.o.s.)/154; UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 246-563-8

Regulatory Authority and Advisory Information

Carcingenicity: NTP, 11th Report, Reasonably anticipated to be a human carcinogen; IARC, Group 2B: The agent is possibly carcinogenic to humans.

California Proposition 65 Chemical[102]: Cancer, 1/1/1990

Hazard Alert: Combustible, Sensitization hazard, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard. Listed for Tier1 screening as an endocrine disruptor[88].

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xi, Xn; risk phrases: R45; R20; R36/37/38; R40; R43; R62; R63; safety phrases: S26; S36/37/39; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water. (est.)

Description: Combustible white, beige or slightly yellow waxy solid. Aromatic odor. Slightly bitter, burning taste. Molecular weight = 180.27; boiling point = 264−270°C @ 733 mmHg; freezing/melting point = 47.8−55°C; flash point = 156°C; Soluble in water; solubility =< 1 mg/mL @ 20°C[88].

Potential Exposure:

Incompatibilities: Butylated hydroxyanisole degrades with prolonged exposure to sunlight. Exhibits antioxidant properties and synergism with acids, BHT, propyl gallate, hydroquinone, methionine, lecithin and thiodipropionic acid. It exhibits antioxidant properties as a scavenger of free radicals. It is incompatible with oxidizing agents and ferric salts[101].

Determination in Water: Log K_{ow} => 3. Values above 3.0 are likely to bioaccumulate in aquatic organisms.
Routes of Entry: Eyes, skin, ingestion
Harmful Effects and Symptoms
Short-Term Exposure: Toxic by ingestion. Symptoms of exposure to butylated hydroxyanisole may include exacerbation of vasomotor rhinitis, conjunctival irritation and redness, asthma, facial flushing, marked diaphoresis, headaches, dull retrosternal pain and somnolence[101].
Long-Term Exposure: A possible carcinogen. May cause allergic contact dermatitis and hypersensitivity reactions following skin contact or inhalation. Possible tumorigen, mutagen, birth defects, based on animal studies.
Points of Attack: Skin, lungs, reproductive system.
Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Pregnant women should avoid contact. Employees should be notified by a physician that this chemical may affect the reproductive system. In addition to comprehensive initial medical and work histories emphasizing reproductive experience and menstrual history, patient should have physical examination and testing of genito-urinary tract, spermcount, motility and morphology. If required, other tests, such as serum testosterone, serum FSH, and serum LH may be indicated. If skin or lung sensitization is suspected, consider evaluation by a qualified allergist, including exposure history and testing, may help diagnose allergy.
First Aid: *Eyes:* first check the victim for contact lenses and remove if present. Flush victim's eyes with water or normal saline solution for 20 to 30 minutes while simultaneously calling a hospital or poison control center. Do not put any ointments, oils, or medication in the victim's eyes without specific instructions from a physician. Immediately transport the victim after flushing eyes to a hospital even if no symptoms (such as redness or irritation) develop. *Skin:* immediately flood affected skin with water while removing and isolating all contaminated clothing. Gently wash all affected skin areas thoroughly with soap and water. Immediately call a hospital or poison control center even if no symptoms (such as redness or irritation) develop. Immediately transport the victim to a hospital for treatment after washing the affected areas. *Inhalation:* immediately leave the contaminated area; take deep breaths of fresh air. Immediately call a physician and be prepared to transport the victim to a hospital even if no symptoms (such as wheezing, coughing, shortness of breath, or burning in the mouth, throat, or chest) develop. Provide proper respiratory protection to rescuers entering an unknown atmosphere. Whenever possible, SCBA should be used; if not available, use a level of protection greater than or equal to that advised under protective clothing. *Ingestion:* do not induce vomiting. If the victim is conscious and not convulsing, give 1 or 2 glasses of water to dilute the chemical and immediately call a hospital or poison control center. Be prepared to transport the victim to a hospital if advised by a physician. If the victim is convulsing or unconscious, do not give anything by mouth, ensure that the victim's airway is open and lay the victim on his/her side with the head lower than the body. Do not induce vomiting. Immediately transport the victim to a hospital. *Other:* since this chemical is a known or suspected carcinogen you should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician will depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure[101].
Personal Protective Methods: If Tyvek-type disposable protective clothing is not worn during Handling of this chemical, wear disposable Tyvek-type sleeves taped to your gloves (minimal protection).
Respirator Selection: Based on potential carcinogenicity the following is recommended by NIOSH: *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA-or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-face-piece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).
Storage: Color code—Blue: Color code—Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, dry place or refrigerator away from incompatible materials.
Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1—Poisonous materials, Technical Name Required. UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9—Miscellaneous hazardous material, Technical Name Required.
Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft.(NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Small spills and leakage: should a spill occur while you are handling this chemical, first remove all sources of ignition, then you should dampen the solid spill material with 60%−70% ethanol and transfer the dampened material to a suitable container. Use absorbent paper dampened with 60%−70% ethanol to pick up any remaining material. Seal the absorbent paper, and any of your clothes, which may be contaminated, in a vapor-tight plastic bag for eventual disposal. Solvent wash all contaminated surfaces with 60%−70% ethanol followed by washing with a soap and water

solution. Do not reenter the contaminated area until the Safety Officer (or other responsible person) has verified that the area has been properly cleaned.

Fire Extinguishing: Thermal decomposition products may include oxides of carbon. Fires involving this compound can be controlled with a dry chemical, carbon dioxide or Halon extinguisher.

Disposal Method Suggested: Dispose of contents and container to an approved waste disposal plant. All federal, state, and local environmental regulations must be observed.

References

(102); (31); (173); (101); (138); (100).

Butyl Benzyl Phthalate B:0870

Formula: $C_{19}H_{20}O_4$; $C_6H_4(OCOC_4H_9)(OCOCH_2C_6H_5)$; 1,2-$C_6H_4(COOCH_2C_6H_5)(COOC_4H_9)$

Synonyms: Ashland butyl benzyl phthalate; BBP; 1,2-Benzenedicarboxylic acid, butyl phenylmethyl ester*; n*-Benzyl butyl phthalate; Benzyl butyl phthalate; *normal* Butyl benzyl phthalate; Ftalato de butilbencilo (Spanish); Monsanto butyl benzyl phthalate; NCI-C54375; Palatinol BB; Santicizer 160; Sicol; Unimoll BB

CAS Registry Number: 85-68-7; *(alt.)* 58128-78-2

HSDB Number: 2107

RTECS Number: TH9990000

UN/NA & ERG Number: UN3082 (environmentally hazardous substances, liquid, n.o.s.)/171

EC Number: 201-622-7 [*Annex I Index No.:* 607-430-00-3]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Limited evidence; Human No Adequate Data, Group 3, 1999; NTP: Carcinogenesis Studies (feed); some evidence: rat; NCI: Carcinogenesis Studies (feed); clear evidence: rat; no evidence: mouse[54]; EPA: Possible Human Carcinogen.

California Proposition 65 Chemical[102]: Developmental/Reproductive toxin. 12/2/2005.

Hazard Alert: Combustible, Endocrine disruptor (high), Possible risk of forming tumors, Reproductive toxin: possible risk of gene damage/impaired fertility; Suspected reprotoxic hazard, Environmental hazard.

United States Environmental Protection Agency TSCA Section 8(e) Risk Notification, 8EHQ-0892-9016; 8EHQ-0892-9174; 8EHQ-0892-8845

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.017; Nonwastewater (mg/kg), 28

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8060 (5); 8270 (10)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV.D.3.b, RQ: 100 lb (45.4 kg)

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%; NPRI.

Hazardous to aquatic life or environment, with possible long-lasting effects[293]. Toxic to aquatic life with long-lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R45; R61; R50/53; R50; R62; R63; safety phrases: S29; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Butyl benzyl phthalate is a clear, oily liquid with a slight odor. Molecular weight = 312.39; Specific gravity (H_2O:1) = 1.16; boiling point = 370°; freezing/melting point = −34.7°C; relative vapor density (air = 1): 10.8; vapor pressure = very low; Flash point = 199°C; Autoignition temperature = 422°C. Hazard identification (based on NFPA-704 M Rating System): Health 1; flammability 1; reactivity 0 ₩. Practically insoluble in water.

Potential Exposure: Butyl benzyl phthalate is used as a plasticizer for polyvinyl and cellulosic resins. It is also used as an organic intermediate.

Incompatibilities: Incompatible with strong acids; nitrates, oxidizers. Destructive to rubber and paint.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PA C-1: 15 milligram per cubic meter

PA C-2: 77 milligram per cubic meter

PA C-3: 460 milligram per cubic meter

Denmark: TWA 3 milligram per cubic meter, 1999; Russia: STEL 1 milligram per cubic meter, 1993; Sweden: NGV 3 milligram per cubic meter, KTV 5 milligram per cubic meter, 1999; United Kingdom: TWA 5 milligram per cubic meter, 2000. Two states have set guidelines or standards for butyl benzyl phthalate in ambient air[60], New York and Florida: 100 μm^3

Permissible Concentration in Water: No criteria set. Butyl phthalate esters in general are classified as priority toxic pollutants by EPA[6]. Listed by Mexico for waste water as phthalate esters.

Determination in Water: Octanol−water coefficient: Log K_{ow} => 4.5. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, can be absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin, and the respiratory tract. Skin contact may cause a burning sensation. High levels of this chemical may cause dizziness and lightheadedness. LD_{50} = (oral-rat) 2330 mg/kg (slightly toxic).

Long-Term Exposure: May affect liver and kidney function. Repeated exposure may damage the nervous system; causing weakness, "pins and needles," and poor coordination in arms and legs. May affect the endocrine system.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Pregnant women should avoid contact. Employees should be notified by a physician that this chemical may affect the reproductive system. In addition to comprehensive initial medical and work histories emphasizing reproductive experience and menstrual history, patient should have physical examination and testing of genitourinary tract, sperm count, motility and morphology. If required, other tests, such as serum testosterone, serum FSH, and serum LH may be indicated. Liver and kidney function tests. Examination of the nervous system; including nerve conduction tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for 20−30 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Specific respirator(s) have not been recommended by NIOSH. However, based on potential carcinogenicity, and where there is potential exists for exposure, the following might be considered: *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any MSHA/NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full facepiece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, dry place or refrigerator away from incompatible materials listed above. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN3082 Environmentally hazardous substances, liquid, n.o.s., Hazard class: 9; Labels: 9—Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or foam extinguishers. Water may cause frothing. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full

facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Atomize into an incinerator together with a flammable solvent[22].

References

(102); (31); (173); (101); (138); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 2, No. 2, 15−17 (1982).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Butyl Benzyl Phthalate*, Trenton, NJ (May 1998).

N-Butyl Bromide B:0880

Formula: C_4H_9Br; $CH_6(CH_2)_3Br$

Synonyms: 1-Bromobutane; *n*-Bromobutane; Bromo-1 butane (French); 1-Bromobutano (Spanish); Bromure de *n*-butyle (French); Bromuro de *N*-butilo (Spanish); Butane, 1-bromo-; 1-Butyl bromide; Butyl bromide; Methyl ethyl bromomethane

CAS Registry Number: 109-65-9. Much of the same information in this record may apply to *sec*-Butyl Bromide [2-Bromo butane (78-76-2)]

HSDB Number: 2195

RTECS Number: EJ6225000

UN/NA & ERG Number: UN1126 (*n*-isomer)/130; UN2339 (*sec*-isomer)/130

EC Number: 203-691-9 (109-65-9); 201-140-7 (78-76-2)

Regulatory Authority and Advisory Information

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazard Alert: Highly flammable, Suspected of causing genetic defects, Environmental hazard.

Hazardous to aquatic life or environment, with possible long-lasting effects[293]. Toxic to aquatic life with long-lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: F, N, Xi; risk phrases: R11; R36/38; R51/53; R62; safety phrases: S16; S21; S26; S29/35; S37/39; S45; S61; 41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Butyl bromide is a highly flammable, colorless liquid with a pleasant odor. Molecular weight = 137.04. Specific gravity (H_2O:1) = 1.28 @ 20°C; boiling point = 101.3°C; freezing/melting point = −112.4; vapor pressure = 42 mmHg @ 25°C; vapor density (air = 1) = 4.68; flash point = 17.2°C (*n*-); 21°C (*sec*-isomer). Autoignition temperature = 269°C. Explosive limits: LEL: 2.5% @ 100°C; UEL: 6.6% @ 100°C. Hazard identification (based on NFPA-704 M Rating System): Health 1; flammability 3; reactivity 0 ₩. Insoluble in water.

Potential Exposure: Butyl bromide is used to make other chemicals, including pharmaceuticals.

Incompatibilities: Vapor may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. May accumulate static electrical charges and cause ignition of its vapors.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 4.4 ppm

PAC-2: 49 ppm

PAC-3: 290 ppm

Determination in Water: Toxic to aquatic organisms.

Routes of Entry: Inhalation, ingestion (*sec*-butyl bromide passes through the skin)

Harmful Effects and Symptoms

Short-Term Exposure: Causes eye, skin and respiratory tract irritation. Inhalation can cause coughing, wheezing and/or shortness of breath. High levels can cause you to feel dizzy, lightheaded, and to pass out. Very high levels can cause death.

Long-Term Exposure: Repeated exposure may cause liver and kidney damage. There is limited evidence that Butyl bromide may damage the developing fetus.

Points of Attack: Liver, kidney.

Medical Surveillance: For those with frequent or potentially high exposure, the following are recommended before beginning work and at regular times after that: liver function tests; kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash

immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures to Butyl bromide, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA approve SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode. All respirators selected must be approved by NIOSH under the provisions of 42 CFR 84. The current listing of NIOSH-certified respirators can be found in the NIOSH/NPPTL Certified Equipment List, which is available on the NIOSH web site.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with Butyl bromide all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where Butyl bromide is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of Butyl bromide should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of Butyl bromide.

Shipping: UN1126 & UN23391- & 2-Bromobutane, Hazard Class: 3; Labels: 3—Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include hydrogen bromide and oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Butyl Bromide*, Trenton, NJ (July 1996).

n-Butyl Chloride B:0890

Formula: C_4H_9Cl; $CH_3(CH_2)_3Cl$

Synonyms: Bromuro de *N*-butilo (Spanish); Butane, 1-chloro-*;* Butyl chloride; 1-Chlorobutane; *n*-Chlorobutane; Chlorure de butyle (French); Cloruro de *n*-butilo (Spanish); NCI-C06155*; n*-Propylcarbinyl chloride

CAS Registry Number: 109-69-3 (*n*-); 78-86-4 (*sec*-)

HSDB Number: 4167 (*n*-); 115 (*sec*-)

RTECS Number: EJ6300000

UN/NA & ERG Number: UN1127 (chlorobutanes)/130

EC Number: 203-696-6 [*Annex I Index No.:* 602-059-00-3] (*n*-); 201-151-7 (*2-chlorobutane*)

Regulatory Authority and Advisory Information

Carcinogenicity: EPA: Not Classifiable as to human carcinogenicity; NCI: Carcinogenesis studies (gavage); no evidence: mouse, rat.

Hazard Alert: Extremely flammable, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard.

Hazard symbols, risk, & safety statements: (*n-isomer*) Hazard symbol: F+; risk phrases: R12; R51; R62; R63; safety phrases: S2; S9; S16; S29; (*sec-isomer*): Hazard symbol: F; risk phrases: R11; R51; R62; R63; safety phrases: S2; S7/9; S16; S29; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): (*n-& sec-butyl-isomers*) 2-Hazard to water.

Description: Butyl chloride is a highly flammable, clear, colorless liquid. Molecular weight = 92.6 (*n*-and *sec*-isomers); Specific gravity (H_2O:1) = 0.89 @ 15°C (*n*-); 0.8.73 (*sec*-); boiling point = 77°C; 69°C (*sec*-isomer); freezing/melting point = −123°C; vapor pressure = 80 mmHg @ C; Flash point = −9°C (*n*-isomer); −10°C (*sec*-isomer)

Relative vapor density (air = 1) = 3.2 (*n*-and *sec*-isomers); vapor pressure = 81 mmHg @ 20°C; Autoignition temperature = 240°C. Explosive limits: LEL: 1.8%; UEL: 10.1%. Insoluble in water. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 4; reactivity 0 ₩; (*sec*-)Health 2; flammability 4; reactivity 0 ₩. Practically insoluble in water; solubility = 0.7% @ 12°C.

Potential Exposure: Butyl chloride is used as a solvent; as a medicine to control worms, and to make other chemicals.

Incompatibilities: Vapor may form explosive mixture with air. May accumulate static electrical charges, and may cause ignition of its vapors. Water contact slowly forms hydrochloric acid. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, alkaline earth, and alkali metals; finely divided metal. Attacks metals in presence of moisture. Attacks some plastics, rubber, or coatings.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

109-69-3 (n-)

PAC-1: 4.1 ppm

PAC-2: 45 ppm

PAC-3: 340 ppm

78-86-4 (sec-)

PAC-1: 0.34 ppm

PAC-2: 3.8 ppm

PAC-3: 340 ppm

Norway: TWA 0.5 ppm (1.5 milligram per cubic meter), 1999; Russia: STEL 0.5 milligram per cubic meter, [skin], 1993

Determination in Water: Toxic to aquatic organisms.

Determination in water: Octanol−water coefficient: Log K_{ow} = 2.6.

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin and respiratory tract. Butyl chloride can affect you when breathed in. High levels can cause you to feel dizzy, lightheaded, and pass out. Very high levels can affect the nervous system and cause death. *sec*-Butyl chloride and *tert*-butyl chloride may have similar effects.

Long-Term Exposure: Unknown at this time. May affect the nervous system.

Points of Attack: Eyes, respiratory system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility.

When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures to Butyl chloride, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode. All respirators selected must be approved by NIOSH under the provisions of 42 CFR 84. The current listing of NIOSH-certified respirators can be found in the NIOSH/NPPTL Certified Equipment List, which is available on the NIOSH web site.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Butyl chloride is incompatible with oxidizers (such as perchlorates, peroxides, permanganates, chlorates and nitrates). Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where Butyl chloride is handled, used, or stored. Metal containers involving the transfer of five gallons or more of Butyl chloride should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of Butyl chloride.

Shipping: UN1127 Chlorobutanes require, Hazard Class: 3; Labels: 3—Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include phosgene. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Butyl Chloride*, Trenton, NJ (July 2002).

sec-Butyl Chloroformate B:0895

Formula: $C_5H_9ClO_2$; $(CH_3)_2CHCH_2OCOCl$

Synonyms: Chlorocarbonic acid isobutyl ester; Chloroformic acid isobutyl ester; Formic acid, chloro-, isobutyl ester; Isobutoxycarbonyl chloride; Isobutyl chlorocarbonate; Isobutyl chloroformate; Isobutyloxycarbonyl chloride; 2-Methylpropyl carbonochloridate; 2-Methylpropyl chloroformate

CAS Registry Number: 543-27-1

UN/NA & ERG Number: (PIH) UN2742/155; UN3390/154

EC Number: 208-840-1

Regulatory Authority and Advisory Information

Hazard Alert: Poison inhalation hazard, Flammable liquid, Corrosive, Dangerously water reactive, Possible environmental hazard.

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Hazard symbols, risk, & safety statements: Hazard symbol: F, T+, C, N; risk phrases: R11; R20; R23; R24; R26; R34; R35; R36/37/38; R51; safety phrases: S26; S29/35; S36/37/39; S41; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: A combustible, colorless to light-colored liquid. Molecular weight = 136.58; specific gravity (H_2O:1) = 1.04 @ 20°C; 1.053; boiling point = 128.7°C; vapor pressure = 16.5 mmHg @ 0°C; relative vapor density (air = 1) = 4.7; Flash point = 27°C. Insoluble and sinks in water. Decomposes exothermically in water, releasing hydrogen chloride fumes.

Potential Exposure: This is a high volume chemical with production exceeding 1 million pounds annually in the U.S [Scorecard]. No specific use found.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, alcohols, ethers, amines. Forms explosive mixture with air above flash point (27°C). Compounds of the carboxyl group react with all bases, both inorganic and organic (i.e., amines) releasing substantial heat, water and a salt that may be harmful. Incompatible with arsenic compounds (releases hydrogen cyanide gas), diazo compounds, dithiocarbamates, isocyanates, mercaptans, nitrides, and sulfides (releasing heat, toxic and possibly flammable gases), thiosulfates and dithionites (releasing hydrogen sulfate and oxides of sulfur). Decomposes exothermically in water. Reacts with moisture in air to produce highly corrosive and toxic fumes of hydrogen chloride gas.

Permissible Exposure Limits in Air:

PAC* Ver. 29[138]

PAC-1: 0.6 ppm

PAC-2: $\mathbf{2.2}_{\mathbf{A}}$ ppm

PAC-3: $\mathbf{6.7}_{\mathbf{A}}$ ppm

*AEGLs are marked with a subscript "**A**" and correspond to 60 minute values.

DFG MAK: 0.2 ppm, 1.1 milligram per cubic meter; Peak limitation category I(2); Pregnancy risk group C

Permissible Concentration in Water:

Determination in Water: Octanol−water coefficient: Log K_{ow} = 1.53. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, skin absorption, ingestion

Harmful Effects and Symptoms

Short-Term Exposure: Very corrosive to skin, eyes, and mucous membranes. Very toxic by ingestion, inhalation and skin absorption. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Eye irritant-severe; respiratory irritant-acute, severe, or moderate but not mild effects; Skin irritant-severe; gastrointestinal tract-acute effects

Long-Term Exposure: Repeated or prolonged exposure may cause lung damage.

Points of Attack: Respiratory system.

Medical Surveillance: Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Rinse out mouth and *do not* induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. Rest and medical observation is essential. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposure to this chemical, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: PIH; check oxygen content prior to entering storage area. Poison, Corrosive, flammable liquid. (1) Color code—Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. (2) White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. (3) Red: Flammability Hazard: Store in a flammable (liquid or solid materials) storage area or approved cabinet away from sources if ignition.

Shipping: UN2742 Chloroformates, toxic, corrosive, flammable, n.o.s., Hazard class: 6.1; Labels: 6.1—Poison Inhalation Hazard, 8—Corrosive material; 3—Flammable liquid; Technical Name Required, Potential Inhalation Hazard (Special Provision 5). PG II. UN3390 Toxic by inhalation liquid, corrosive, n.o.s. with an LC_{50} $\leq 1000\ mL/m^3$ and saturated vapor concentration ≥ 10 LC_{50}, Hazard Class: 6.1; Labels: 6.1—Poisonous materials, 8—Corrosive material, Technical Name Required, Inhalation Hazard Zone B.

Spill Handling:

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.3/0.5
Night 0.4/0.6

Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources and dampen spilled material with toluene to avoid airborne dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Reacts violently with water. Thermal decomposition products may include phosgene, hydrogen chloride, and oxides of carbon. *Note*: Most foams will react with the material and release corrosive/toxic gases. *Small fire*: Use carbon dioxide, dry chemical, dry sand, alcohol-resistant foam. *Large fire*: Water spray, fog or alcohol-resistant foam.

For chlorosilanes, do not use water; use AFFF alcohol-resistant medium-expansion foam. Move containers from fire area if you can do it without risk. Use water spray or fog; do not use straight streams. *Fire involving tanks or car/trailer loads*: Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Do not get water inside containers.

Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. ALWAYS stay away from tanks engulfed in fire[31].

Disposal Method Suggested: Disposal of unused product must be undertaken by qualified personnel who are knowledgeable in all applicable regulations and follow all pertinent safety precautions including the use of appropriate protective equipment. For proper handling and disposal, always comply with federal, state, and local regulations.

References

(31); (101); (138); (100).

tert-Butyl Chromate B:0900

Formula: $C_8H_{18}CrO_4$; $[(CH_3)_3CO]_2CrO_2$

Synonyms: Bis(*tert*-butyl) chromate; Chromato *terc*-butilico (Spanish); Chromic acid, di-*tert*-butyl ester of chromic acid; *tert*-Butyl chromate(VI)

CAS Registry Number: 1189-85-1

HSDB Number: 2960

RTECS Number: GB2900000

UN/NA & ERG Number: UN 3082 (environmentally hazardous substances, liquid, n.o.s.)/1711189-85-1

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen; IARC: Human Sufficient Evidence, *carcinogenic to humans*, Group 1, 1990

California Proposition 65 Chemical[102]: (*hexavalent chromium*) Cancer 2/27/1987; Developmental/Reproductive toxin (male, female) 12/19/2008

Hazard Alert: Exposure can be lethal, Highly flammable (in carbon tetrachloride solution) otherwise, it is combustible, strong oxidizer, organometallic, reproductive toxin, environmental hazard.

as chromium compounds:

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Clean Water Act: 40CFR116.4 Hazardous Substances; RQ 40CFR117.3 (same as CER CLA); 40CFR423, Appendix A, Priority Pollutants; 40CFR401.15 Section 307 Toxic Pollutants as chromium and compounds.

EPA ADI: Chromium(VI) = 0.175 mg/day/man. EPA estimated adequate and safe intake levels for chromium: **Infants:** age 0.0−0.5 year: 0.01−0.04 mg/day; age 0.5−1.0 year: 0.02−0.06 mg/day. **Children** age 1−3 year: 0.02−0.08 mg/day; age 4−6 year: 0.03−0.12 mg/day; age 7−10 year: 0.05−0.20 mg/day; age > or = 11 year: 0.05−0.20 mg/day. **Adults**: 0.05−0.20 mg/day.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, D007 (chromium compounds)

EPCRA (Section 313): Includes any unique chemical substance that contains chromium as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: Chromium(VI) compounds: 0.1%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%. NPRI; CEPA Priority Substance List.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: E, T+, O, N, Xi; risk phrases: R45; R2; R8; R9; R2; R8; R21; R25; R26; R34; R42/43; R46; R48/23; R50/53; R60; R61; R62; safety phrases: S29/35; S41; S45; S53; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)]

Description: *tert*-Butyl chromate is a highly flammable, clear, colorless, hygroscopic, corrosive, flammable liquid or red crystals from petroleum ether. Solution in carbon tetrachloride is highly flammable. Molecular weight = 230.3; freezing/melting point = −5 to 0°C; −2.8°C. Hazard identification (based on NFPA-704 M Rating System): Health 4; flammability 1; 3 (in carbon tetrachloride solution); reactivity 1 ₩ (Oxidizer)[70]. Soluble in water (hydrolyzed).

Potential Exposure: Butyl chromate is used in specialty reactions as an organic source of chromium; in making catalysts; and as a curing agent for urethane foams.

Incompatibilities: *tert*-Butyl chromate is a strong oxidizer; reacts violently with reducing agents (such as lithium, sodium, aluminum and their hydrides and hydrazine); combustible materials. Water solutions of *tert*-butyl chromate react violently with strong bases. Incompatible with strong acids (i.e., hydrochloric, sulfuric and nitric); alcohols, and easily oxidized materials, such as paper, wood, sulfur, aluminum and plastics.

Permissible Exposure Limits in Air

NIOSH IDLH = 15 mg[Cr(VI)]/m; 30 milligram per cubic meter (as CrO_3)

OSHA PEL: 0.005 mg$[CrO_3]/m^3$ [skin] see 29CFR1910.1026

NIOSH REL: 0.001 mg$[CrO_3]/m^3$ TWA, potential carcinogen, limit exposure to lowest feasible level. NIOSH considers all Cr(VI) compounds (including chromic acid, *tert*-butyl chromate, zinc chromate, and chromyl chloride) to be potential occupational carcinogens. See NIOSH Pocket Guide, Application A & C.

ACGIH TLV[1]: 0.01 mg[CrO_3]/m^3 Ceiling concentration [skin], Confirmed Human Carcinogen; BEI issued
No PAC available.

DFG MAK: [skin] Danger of skin sensitization; Carcinogen Category 2; TRK: 0.05 mg [Cr]/m^3; 20 μg/L [Cr] in urine at end-of-shift.

Denmark: TWA 0.5 mg[Cr]/m^3, 1999; France: VLE 0.1 milligram per cubic meter, [skin], 1999; Japan: 0.5 mg [Cr]/m^3, 1999; the Philippines: TWA 0.1 milligram per cubic meter, [skin], 1993; Switzerland: TWA 0.05 milligram per cubic meter, [skin], 1993; Thailand: TWA 0.1 milligram per cubic meter, 1993; United Kingdom: TWA 0.5 mg[Cr]/m^3, carcinogen, 2000; the Netherlands: MAC 0.1 milligram per cubic meter, [skin], 2003: Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Ceiling Concentration 0.1 milligram per cubic meter [skin]. Several states have set guidelines or standards for *t*-butyl chromate in ambient air[60] ranging from 0.5 μ/m^3 (Virginia) to 1.0 μ/m^3 (North Dakota) to 2.0 μ/m^3 (Connecticut and Nevada).

Determination in Air: Use NIOSH Analytical Methods #7600, 7604, 7605, 7703, 9101, and OSHA Analytical Methods ID-103, ID-215, W-4001.

Permissible concentration in Water: The EPA[6] has designated chromium as a priority toxic pollutant. State Drinking Water Guidelines: California 10 μg[Cr(VI)]/L; Maine 35 μg[Cr(VI)]/L.

Routes of Entry: Inhalation, skin absorption, ingestion and skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Contact can cause severe eye and skin irritation and acid like burns with possible permanent damage to the eyes. Inhalation can cause irritation of the respiratory tract with coughing and wheezing. Exposure can cause head ache, nausea, vomiting, diarrhea, and wheezing. Higher exposures may cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: Hexavalent chromium compounds have been determined to be human carcinogens. May cause lung cancer. Breathing this chemical can cause a hole in the "bone" dividing the inner nose (septum), sometime with discharge, bleeding and/or formation of a crust. *tert*-butyl chromate can cause allergies to the skin and lung. Prolonged skin contact can cause, burns, blisters and deep necrotic ulcers. Can cause liver and kidney damage.

Points of Attack: Respiratory system, lungs, skin, eyes, central nervous system.

Medical Surveillance: NIOSH lists the following tests: Blood gas analysis, CBC; chest X-ray, electrocardiogram, liver function tests; pulmonary function tests, sputum cytology, urine (chemical/metabolite), urinalysis (routine), white blood cell count/differential. Consider the points of attack in preplacement and periodic physical examinations: Examination of the skin and nose. Evaluation by a qualified allergist. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Liver and kidney function tests. Urine test for chromates (chemical metabolite). This test is most accurate shortly after exposure. This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Pregnant women should avoid contact. Employees should be notified by a physician that this chemical may affect the reproductive system. In addition to comprehensive initial medical and work histories emphasizing reproductive experience and menstrual history, patient should have physical examination and testing of genitourinary tract, sperm count, motility and morphology. If required, other tests, such as serum testosterone, serum FSH, and serum LH may be indicated.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Note to Physician: In case of fume inhalation, treat pulmonary edema. Consider administering prednisone or other corticosteroid orally to reduce tissue response to fume. Positive pressure ventilation may be necessary. Treat metal fume fever with bed rest, analgesics and antipyretics.

Personal Protective Methods: Wear appropriate clothing to prevent any possibility of skin contact. Gloves: Silver Shield/4H; Coveralls: DuPont Tychem CSM, Responder, and TK (for *known carcinogens*). Prevent skin contact (as chromic acid and chromates). **8 hours** (more than 8 hours of resistance to breakthrough >0.1 μg/cm^2/min): polyethylene gloves, suits, boots; polyvinyl chloride gloves, suits, boots; Saranex-coated suits; **4 hours** (At least 4 but <8 hours of resistance to breakthrough $>0.10.1$ μg/cm^2/

min): butyl rubber gloves, suits, boots; Viton gloves, suits. Wear eye protection to prevent any possibility of eye contact. Employees should wash immediately when skin is wet or contaminated and daily at the end of each work shift. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash. Specific engineering controls are recommended in NIOSH Criteria Document #76-129, chromium(VI).

Respirator Selection: NIOSH, as chromates: *at any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Check oxygen content prior to entering storage area. Color code—Yellow Stripe: Reactivity Hazard (strong oxidizer); Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with *tert*-butyl chromate all handlers should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in an explosion-proof refrigerator away from incompatible materials listed above. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Store in a cool, well-ventilated area away from incompatible materials listed above. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage.

Shipping: UN3082 Environmentally hazardous substances, liquid, n.o.s., Hazard class: 9; Labels: 9—Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, sand, water spray; or foam extinguishers. Thermal decomposition products may include oxides of chromium and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(109); (102); (31); (173); (101); (138); (2); (122); (100).

National Institute for Occupational Safety and Health (NIOSH), *Criteria for a Recommended Standard: Occupational. Exposure to Chromium*, NIOSH Document Number 76-129, Cincinnati, OH (1979).

United States Environmental Protection Agency, *Health Assessment Document: Chromium,* EPA 600/8-83-014F, Washington, DC (1984).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: tert-Butyl Chromate*, Trenton, NJ (September 1998).

1,2-Butylene Oxide B:0910

Formula: C_4H_8O

Synonyms: 1,2-Butene oxide; α-Butylene oxide; 1,2-Epoxybutane; 2-Ethyloxirane; Oxirane, ethyl-; Propyl oxirane

CAS Registry Number: 106-88-7; much of the same information in this record may apply to 2,3-Butylene oxide: 3266-23-7

HSDB Number: 2855

RTECS Number: EK3675000

UN/NA & ERG Number: UN3022/127 (P)

EC Number: 203-438-2 [*Annex I Index No.:* 603-102-00-9]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC (*106-88-7*): Human No Adequate Data, animal Limited Data*, possibly carcinogenic to humans*, Group 2B; NCI: Carcinogenesis Studies (inhalation); clear evidence: rat; no evidence: mouse.

Hazard Alert: Highly flammable, Polymerization hazard, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction).

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV.D.3.b, RQ: 1 lb (0.454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

TSCA 40CFR712.30(d); 40CFR716.120 (a)

Canada, NPRI.

Hazard symbols, risk, & safety statements: (106-88-7) Hazard symbol: F, Xn, N; risk phrases: R11; R19; R20/21/22; R36/37/38; R40; R52/53; R62; R63; safety phrases: S2; S9; S16; S21; S29; S36/37; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Butylene oxide is a watery-white liquid with and ethereal odor. Molecular weight = 72.1 (1,2-and 2,3-isomers); Specific gravity (H_2O:1) = 0.83; boiling point = 63.3°C; freezing/melting point = −130°C; vapor pressure = 142 mmHg @ 20°C; 176 mmHg @ 25°C relative vapor density (air = 1) = 2.2; relative density of the vapor/air-mixture @ 20°C (air = 1) = 1.3; Flash point = −22°C; Autoignition temperature = 439°C. Explosive limits in air: LEL: 1.7%; UEL: 19%. Hazard identification (based on NFPA-704 M Rating System) Health 2; flammability 3; reactivity 2 ₩. Soluble in water; solubility = 9.5% @ 25°C.

Potential Exposure: It is used as a stabilizer in chlorinated solvents, and to make other chemicals, such as gasoline additives.

Incompatibilities: May form explosive mixture with air. Unless inhibited, can form unstable and explosive peroxides. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Polymerization will occur in the presence of acids, strong bases and chlorides of tin, iron and aluminum. Storage tanks and other equipment should be absolutely dry and free from air, ammonia, acetylene, hydrogen sulfide, rust and other contaminants. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Attacks some plastics. May accumulate static electric charges that can result in ignition of its vapors. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Permissible Exposure Limits in Air

PAC* Ver. 29[138]

106-88-7

PAC-1: $\mathbf{72}_{\mathbf{A}}$ ppm

PAC-2: $\mathbf{140}_{\mathbf{A}}$ ppm

PAC-3: $\mathbf{330}_{\mathbf{A}}$ ppm

*AEGLs are marked with a subscript "**A**" and correspond to 60 minutes values.

DFG MAK: [skin] Carcinogen Category 2

Austria: [skin], carcinogen, 1999

Permissible Concentration in Water: No criteria set.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 0.4. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Butylene oxide can cause severe irritation of the eyes, skin, and respiratory tract, with coughing and/or shortness of breath. High exposures can cause dizziness, lightheadedness and unconsciousness. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: 1,2-Butylene oxide is possibly carcinogenic to humans. It may cause mutations and damage to the developing fetus. Prolonged or repeated skin contact may cause blisters or other disorders. 2,2-Butylene oxide may affect the nervous system.

Points of Attack: Skin, lungs, central nervous system; reproductive system.

Medical Surveillance: Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Lung function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear solvent-resistant gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls, and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit. *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical acid all handlers should be trained on its proper handling and storage. Protect against physical damage. Store only if inhibited. Outside or detached storage is preferred. Store in tightly closed containers in a cool, well-ventilated area away from incompatible materials listed above. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN3022 1,2-Butylene oxide, stabilized, Hazard Class: 3; Labels: 3—Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquid in vermiculite, dry sand; earth or similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a highly flammable liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: "1, 2-Butylene oxide*," Trenton, NJ (February 2003).

Butyl Ether B:0920

Formula: $C_8H_{18}O$; $C_4H_9OC_4H_9$

Synonyms: 1-Butoxybutane; Di-*n*-butyl ether; Dibutyl ether; Dibutyl oxide; Ether butylique (French); 1,1′-Oxybis (butane); 1,1-Oxybis-butane

CAS Registry Number: 142-96-1
HSDB Number: 306 as dibutyl ether
RTECS Number: EK5425000
UN/NA & ERG Number: UN1149/128
EC Number: 205-575-3 [*Annex I Index No.:* 603-054-00-9]

Regulatory Authority and Advisory Information

Hazard Alert: Highly flammable, Primary irritant (w/o allergic reaction).

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xi, N; risk phrases: R11; R 36/37/38; R52/53; safety phrases: S2; S21; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Butyl Ether is a flammable, colorless liquid with a mild, ethereal odor. Molecular weight = 130.3. Boiling point = 142°C; specific gravity (H_2O:1) = 0.77; freezing/melting point = −985°C; Vapor pressure = 8 mmHg @ 25°C; relative vapor density (air = 1) = 4.48; flash point = 25°C; Autoignition temperature = 194°C. Explosive limits: LEL: 1.5%, 15,000 ppm; Explosive limits in air: LEL: 7.6%. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 3; reactivity 1 ₩. Insoluble in water.

Potential Exposure: It is used as a solvent for hydrocarbons, fatty materials; extracting agent in used metals separation; solvent purification, making other chemicals.

Incompatibilities: May form explosive mixture with air. May accumulate static electrical charges, and may cause ignition of its vapors. Incompatible with strong acids; oxidizers. Contact with air or light may form unstable and explosive peroxides, especially anhydrous form.

Permissible Exposure Limits in Air

PAC Ver. 29[138]
PAC-1: 2.6 ppm
PAC-2: 29 ppm
PAC-3: 170 ppm

Determination in Water: Octanol−water coefficient: Log K_{ow} => 3. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation of vapor, skin contact, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: May be poisonous if inhaled or absorbed through skin. Inhalation of vapors may cause dizziness or suffocation. Skin or eye contact may cause irritation. Repeated or prolonged skin contact may cause rash. The vapor irritates the nose, throat and bronchial tubes and may cause nose bleeds, hoarseness, cough, phlegm and/or tightness in the chest. Overexposure can also cause headache and make you feel dizzy and lightheaded. Higher levels can cause unconsciousness and even death.

Points of Attack: Skin, eyes, respiratory system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures to butyl ether, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode. All respirators selected must be approved by NIOSH under the provisions of 42 CFR 84. The current listing of NIOSH-certified respirators can be found in the NIOSH/NPPTL Certified Equipment List, which is available on the NIOSH web site.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with butyl ether all handlers should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Butyl ether must be stored in a cool, dark place, separated from oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area. Protect storage containers from physical damage. Sources of ignition, such as smoking and open flames, are prohibited where Butyl ether is handled, used or stored. Metal containers involving the transfer of 5 gallons or more of butyl ether should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of Butyl ether.

Shipping: UN1149 Butyl ethers & Dibutyl ethers, Hazard Class: 3; Labels: 3—Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Butyl Ether*, Trenton, NJ (October 2000).

n-Butyl Glycidyl Ether B:0930

Formula: $C_7H_{14}O_2$: $C_4H_9OCH_2CH\text{-}CH_2$

Synonyms: *n*-BGE; BGE; 1-Butoxy-2,3-epoxypropane; (Butoxymethyl) oxiraine; 1,2-Epoxy-3-butoxy propane; 2,3-Epoxypropyl butyl ether; Gylcidy butyl ether

CAS Registry Number: 2426-08-6

HSDB Number: 299

RTECS Number: TX4200000

UN/NA & ERG Number: UN1993 (flammable liquids, n.o.s.)/128

EC Number: 219-376-4 [*Annex I Index No.:* 603-039-00-7]

Regulatory Authority and Advisory Information

Carcinogenicity: DFG (suspected).

California Proposition 65 Chemical[102]: Developmental/Reproductive toxin, male *delisted 4/4/2014*.

Hazard Alert: Suspected reprotoxic hazard, Suspected of causing genetic defects, Sensitization hazard (skin), Primary irritant (w/o allergic reaction).

TSCA: 716.120(c); 40CFR712.30(d)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: Xi, N; risk phrases: R10; R20/22; R37; R40; R43; R52/53; R62; R63; R68; safety phrases: S2; S24/25; S36/37; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: *n*-Butyl glycidyl ether is a colorless liquid with slight irritating odor. Molecular weight = 130.2; specific gravity (H_2O:1) = 0.92 @ 20°C; boiling point = 169°C; relative vapor density (air = 1) = 4.5; vapor pressure = 3.2 mmHg @ 25°C; flash point = 58°C. Explosive limits in air: LEL: 11,580 ppm; soluble in water; solubility 2% @ 20°C.

Potential Exposure: NIOSH has estimated human exposures @ 18,000. Used as reactive diluent for epoxy resins, flooring, laminating, and electrical; and as a stabilizer, viscosity-reducing agent, as acid acceptor for solvents; and as a chemical intermediate.

Incompatibilities: May form explosive mixture with air. Air and light form unstable and explosive peroxides. Contact with strong oxidizers may cause fire and explosions. Contact with strong caustics may cause polymerization. Attacks some plastics and rubber.

Permissible Exposure Limits in Air

NIOSH IDLH = 250 ppm

Conversion factor: 1 ppm = 5.33 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 50 ppm/270 milligram per cubic meter TWA

NIOSH REL: 5.6 ppm/30 milligram per cubic meter [15-minutes] Ceiling Concentration

ACGIH TLV[1]: 3 ppm/16 milligram per cubic meter [skin, sensitizer]

PAC Ver. 29[138]

PAC-1: 9 ppm

PAC-2: 580 ppm

PAC-3: 3500 ppm [>= 10% LEL, lower explosive limit but <50% LEL]

DFG MAK: [skin] danger of skin sensitization; Carcinogen Category 3B; Germ Cell Mutation Category 2

Australia: TWA 25 ppm (135 milligram per cubic meter), 1993; Austria: Suspected: carcinogen, 1999; Belgium: TWA

25 ppm (133 milligram per cubic meter), 1993; Denmark: TWA 6 ppm (30 milligram per cubic meter), 1999; Finland: STEL 25 ppm (135 milligram per cubic meter), [skin], 1999; France: VME 25 ppm (135 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 135 milligram per cubic meter, 2003; the Philippines: TWA 50 ppm (270 milligram per cubic meter), 1993; Sweden: NGV 10 ppm (50 milligram per cubic meter), TKV 15 ppm (80 milligram per cubic meter), 1999; Switzerland: MAK-W 25 ppm (135 milligram per cubic meter), KZG-W 50 ppm (270 milligram per cubic meter), [skin], 1999; Turkey: TWA 50 ppm (270 milligram per cubic meter), 1993; United Kingdom: TWA 25 ppm (135 milligram per cubic meter), 2000: Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 25 ppm. Several states have set guidelines or standards for butyl glycidyl ether in ambient air[60] ranging from 1.35 milligram per cubic meter (Connecticut and North Dakota) to 2.25 milligram per cubic meter (Virginia) to 3.21 milligram per cubic meter (Nevada).

Determination in Air: Use NIOSH Analytical Method #1616 and OSHA Analytical Method 7, Organic Vapors.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritation of eyes, skin, and respiratory tract with wheezing and coughing. Exposure can cause headache, lightheadedness, dizziness, lack of coordination; and fainting. High levels can cause unconsciousness and even death. LD_{50} = (oral-rat) 2050 mg/kg (slightly toxic).

Long-Term Exposure: There is limited evidence that this chemical can cause mutations. *n*-Butyl glycidyl ether may cause skin allergy. DFG lists danger of skin and respiratory sensitization. May cause lung and liver disorders.

Points of Attack: Eyes, skin, respiratory system; central nervous system. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Lung function tests. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Evaluation by a qualified allergist. Pulmonary function tests, expired air. Liver function tests. Pregnant women should avoid contact. Employees should be notified by a physician that this chemical may affect the reproductive system. In addition to comprehensive initial medical and work histories emphasizing reproductive experience and menstrual history, patient should have physical examination and testing of genitourinary tract, sperm count, motility and morphology. If required, other tests, such as serum testosterone, serum FSH, and serum LH may be indicated.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *56 ppm:* CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)]; or Sa (APF = 10) (any supplied-air respirator). *140 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOv (APF = 25) [any PAPR with organic vapor cartridge(s)]. *250 ppm:* CcrFOv (APF = 50) [any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s)] or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted acid gas canister]; or PaprTOv (APF = 50) [any PAPR with a tight-fitting facepiece and organic vapor cartridge(s)]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd, Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where *n*-butyl glycidyl ether may be present, check to make sure that an explosive concentration does not exist. Store in a fireproof refrigerator in tightly closed containers under an inert atmosphere[52], separated from strong oxidants, strong bases; strong acids. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN1993 Flammable liquids, n.o.s., Hazard Class: 3; Labels: 3—Flammable liquid, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Absorb spills with paper or other absorbent material. Seal in vapor-tight plastic bags or sealed containers. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide; water spray, alcohol, or polymer foam extinguishers. Thermal decomposition products may include oxides of carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed[24].

References

(102); (31); (173); (101); (138); (2); (100).

National Institute for Occupational Safety and Health (NIOSH), “Criteria for a Recommended Standard: Occupational Exposure to Glycidyl Ethers”, NIOSH Document Number 78-166, Cincinnati, OH (1978).

National Institute for Occupational Safety and Health (NIOSH), Information Profiles on Potential Occupational Hazards: Clycidyl Ethers, Report PB 276-678, Rockville, MD, pp. 116−123 (October 1977).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: n-Butyl Glycidyl Ether*, Trenton, NJ (December 1998).

n-Butyl Isocyanate B:0935

Formula: C_5H_9NO

Synonyms: Butante *n*-isocyanato-; *n*-Butil isocianato (Spanish); Butyl isocyanate; 1-Isocyanatobutane; Isocyanate de *n*-butyle (French); Isocyanic acid, butyl ester

CAS Registry Number: 111-36-4

HSDB Number: 5548

HSDB Number: 5548

RTECS Number: NQ8250000

UN/NA & ERG Number: (PIH) UN2485/155

EC Number: 203-862-8

Regulatory Authority and Advisory Information

Hazard Alert: Poison inhalation hazard, Highly flammable liquid, Polymerization hazard, Dangerously water reactive, Sensitizer (lungs), Electrostatic hazard.

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%.

Hazard symbols, risk, & safety statements: Hazard symbol: F, T+; risk phrases: R11; R19; R21/22; R26; R34; R37; R42/42; safety phrases: S21; S23; S26; S28; S36/37/39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1—Low hazard to water.

Description: Colorless, flammable liquid. Molecular weight = 99.13; specific gravity (H_2O:1) = 0.88 @ 20°C; boiling point = 115°C; freezing/melting point = −73°C; vapor pressure = 18 mmHg @ 25°C; relative vapor density (air = 1) = 3.00; flash point = 18.9°C; Autoignition temperature => 400°C. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 3; reactivity 2 ₩ (dangerously water reactive). Henry’s Law constant = 2.1×10^{-3} atm m^3/mol @ 25°C (est.)[72]. Slightly soluble in water; solubility = 1.4×10^3 mg/L @

25°C (est.)[72]. Reaction with water can release hydrogen cyanide.

Potential Exposure: *N*-Butyl isocyanate is used as a reagent in organic synthesis; used as intermediates in production of pharmaceuticals, carbamate and urea insecticides, and fungicides. It is also used in the production of sulfonylurea antidiabetic drugs[72].

Incompatibilities: Vapor may form explosive mixture with air. Isocyanates are highly flammable and reactive with many compounds, even with themselves. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Reaction with moist air, water or alcohols may form amines and insoluble polyureas and react exothermically, releasing toxic, corrosive or flammable gases, including carbon dioxide; and, at the same time, may generate a violent release of heat increasing the concentration of fumes in the air. Incompatible with amines, aldehydes, alkali metals, ammonia, carboxylic acids, caprolactum, alkaline materials, glycols, ketones, mercaptans, hydrides, organotin catalysts, phenols, strong acids, strong bases, strong reducing agents such as hydrides, urethanes, ureas. Elevated temperatures or contact with acids, bases, tertiary amines, and acylchlorides may cause explosive polymerization. Contact with metals may evolve flammable hydrogen gas. Attacks some plastics, rubber and coatings. May accumulate static electrical charges, and may cause ignition of its vapors.

Permissible Exposure Limits in Air:
PAC* Ver. 29[138]
PAC-1: $\mathbf{0.01_A}$ ppm
PAC-2: $\mathbf{0.083_A}$ ppm
PAC-3: $\mathbf{0.25_A}$ ppm
*AEGLs are marked with a subscript "**A**" and correspond to 60 minutes values.

Permissible Concentration in Water: Soluble in water, reacts slowly

Determination in Water: Octanol–water coefficient: Log $K_{ow} = < 2.26$ (est.)[72]. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion or skin/eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Toxic. Inhalation, ingestion or contact (skin, eyes) with vapors or substance may cause severe injury, burns or death. Reaction with water or moist air will release toxic, corrosive or flammable gases. Eye irritant-severe; Eye-acute effects other than irritation; Respiratory irritant-acute, severe, or moderate but not mild irritant effects; Skin irritant-severe; Nervous system toxin-acute effects; Narcotic; Respiratory toxin-acute effects other than severe or moderate irritation; Gastrointestinal tract-acute effects[138]. LD_{50} = (oral-rat) 600 mg/kg.

Long-Term Exposure: Respiratory toxin-chronic effects; Respiratory sensitizer

Points of Attack: Lungs

Medical Surveillance: Evaluation by a qualified allergist, including exposure history and testing, may help diagnose allergy. Lung function test.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves.

Personal Protective Methods: Wear chemical protective clothing that is specifically recommended by the manufacturer. It may provide little or no thermal protection. Structural firefighters' protective clothing provides limited protection in fire situations *only*; it is not effective in spill situations where direct contact with the substance is possible.

Respirator Selection: Where there is potential exists for exposure to butyl isocyanate use respirators and components tested and approved under appropriate government standards: NIOSH/MSHA or European Standard EN149-approved supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full-face-piece, hood, or helmet in the continuous flow mode.

Storage: PIH; check oxygen content prior to entering storage area. (1) Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet at 2–8°C. (2) Color code—Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. Keep away from moisture, water, steam. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in a fireproof refrigerator in tightly closed containers under an inert atmosphere[52], separated from strong oxidants, strong bases; strong acids. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2485 *n*-Butyl isocyanate, Hazard Class: 6.1; Labels: 6.1—Poison Inhalation Hazard, 3—Flammable liquid. Hazard, Inhalation Hazard Zone B. PGI.

Spill Handling:

***n*-Butyl isocyanate**

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.5/0.8
Night 1.1/1.8

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 1000/300
Then: Protect persons downwind (mi/km)
Day 2.5/4.1
Night 4.2/6.8

Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. *Small spill:* Cover with *dry* earth, *dry* sand, or other noncombustible material followed with plastic sheet to minimize spreading or contact with water or rain. Use clean nonsparking tools to collect material and place material into loosely covered plastic containers for later disposal. Stop the release if it can be done safely from a distance. Prevent material and runoff from entering sewers and waterways if it can be done safely well ahead of the release. Use vapor suppressing foam to disperse vapors-contain runoff. Water spray may reduce vapor, but may not prevent ignition in enclosed spaces. Consider application of alcohol-resistant (AFFF) foam to large areas of spilled liquid to control vapors. Ventilate confined area if it can be done without placing personnel at risk. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120 (q) may be applicable.

Fire Extinguishing: Highly flammable, easily ignited by heat, sparks or flames. Thermal decomposition products may include hydrogen cyanide and oxides of nitrogen and carbon. Substance will slowly react with water, releasing flammable hydrogen gas. *Note:* Most foams will react with this chemical, releasing toxic and corrosive gases. *Small fire*: Use CO_2, dry chemical, dry sand, alcohol-resistant foam. Containers may explode when heated or if contaminated with water. Vapors may form explosive mixture with air: indoors, outdoors and sewers explosion hazards. Vapors are heavier than air; they will spread along ground and collect in low or confined areas (sewers, basements, tanks). Vapors may travel to source of ignition and flashback. Runoff from fire control or dilution water may be corrosive and/or toxic and cause pollution. Stay upwind and uphill. Remove all ignition sources. All equipment used to handle this material must be grounded. If material or contaminated runoff from fire control enters waterways, notify downstream users of potentially contaminated water. Wear positive-pressure, SCBA. Wear chemical protective clothing which is specifically recommended by the manufacturer. Structural firefighter's protective clothing provides only limited protection. *Small fire*: Extinguish with *dry* chemical, CO_2, *dry* sand, or alcohol-resistant foam. *Large fire*: Use water spray or alcohol-resistant foam if it is available in sufficient amounts. Under favorable conditions, experienced crews can use coordinated fog streams to sweep the flames off the surface of the burning liquid. Keep exposures cool to protect against reignition. Do not direct straight streams into the liquid. Cool exposed containers with large quantities of water from unattended equipment or remove intact containers if it can be done safely. *Do not get water on spilled substance or inside containers*. If cooling streams are ineffective (*venting sound increases in volume and pitch, tank discolors or shows signs of deforming*), withdraw immediately to a secure location. Always stay away from ends of tanks, especially when engulfed in flames. Always stay away from ends of tanks, especially when engulfed in flames. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156.

Disposal Method Suggested: Dispose of contents and container to an approved waste disposal plant. Use a licensed professional waste disposal service to dispose of this material. *Caution:* this chemical is highly flammable with a low flash point (<20°C). Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (100).

United States Department of Energy, Office of Environment, Health, Safety, and Security, *Protective Action Criteria (PAC) with AEGLs, ERPGs, & TEELs: Rev. 29 for Chemicals of Concern*, Washington, DC (May, 2016).

tert-Butyl Isocyanate B:0937

Formula: C_5H_9NO

Synonyms: 1,1-Dimethylethyl isocyanate; Isocianato de *tert*-butilo (Spanish); Isocyanate de *tert*-butyle (French); 2-Isocyanato-2-methylpropane; isocyanic acid, *tert*-butyl ester

CAS Registry Number: 1609-86-5

UN/NA & ERG Number: (PIH) UN2484/155

EC Number: 216-544-9

Regulatory Authority and Advisory Information

Hazard Alert: Poison inhalation hazard: exposure can be lethal, highly flammable, Polymerization hazard, dangerously water reactive, sensitization hazard.

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Hazard symbols, risk, & safety statements: Hazard symbol: F, T+; risk phrases: R11; R14; R19; R22; R26; R34; R37; R42; safety phrases: S16; S21; S26; S30; S36/37/39; S45; S61.

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: A clear, colorless, flammable liquid. Pungent odor. Molecular weight = 99.13; Specific gravity (H_2O:1) = 0.867 @ 25°C; boiling point = 85.5°C; relative vapor density (air = 1) = 3.00; flash point = −3.5°C. Hazard identification (based on NFPA-704 M Rating System): Health 4; flammability 3; reactivity 2 ₩ (dangerously water reactive). Less dense than water; insoluble. Slow reaction with water is dangerous.

Potential Exposure: *tert*-Butyl isocyanate is used as a reagent in organic synthesis; used as intermediates in production of pharmaceuticals and other chemicals.

Incompatibilities: Highly flammable liquid and vapor; forms explosive mixture with air. Isocyanates are highly flammable and reactive with many compounds, even with themselves. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Reaction with moist air, water or alcohols may form amines and insoluble polyureas and react exothermically, releasing toxic, corrosive or flammable gases, including carbon dioxide; and, at the same time, may generate a violent release of heat increasing the concentration of fumes in the air. Incompatible with amines, aldehydes, alkali metals, ammonia, carboxylic acids, caprolactum, alkaline materials, glycols, ketones, mercaptans, hydrides, organotin catalysts, phenols, strong acids, strong bases, strong reducing agents such as hydrides, urethanes, ureas. Elevated temperatures or contact with acids, bases, tertiary amines, and acyl-chlorides may cause explosive polymerization. Attacks some plastics, rubber and coatings. Contact with metals may evolve flammable hydrogen gas. May accumulate static electrical charges, and may cause ignition of its vapors.

Permissible Exposure Limits in Air:

PAC* Ver. 29[138]

PAC-1: 0.0099 milligram per cubic meter
PAC-2: 0.11 milligram per cubic meter
PAC-3: 0.65 milligram per cubic meter

Determination in Water: Octanol−water coefficient: Log K_{ow} = Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Ingestion, inhalation, skin/eye absorption.

Harmful Effects and Symptoms

Short-Term Exposure: Very toxic and corrosive by inhalation, ingestion and skin or eye absorption. May be fatal if inhaled. Extremely irritating and possibly destructive, possibly burns, to the skin, eyes and upper respiratory tract. May cause inflammation, spasms, cough, wheezing and shortness of breath. Exposure may cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Nausea, allergy of skin and lungs, and severe headache can occur. Poisonous if ingested. LD_{50} = (oral-rat) <400 mg/kg.

Long-Term Exposure: May cause skin and respiratory tract sensitization, allergies.

Points of Attack: Skin, lungs and respiratory tract.

Medical Surveillance Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose lung and/or skin allergy.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear chemical protective clothing that is specifically recommended by the manufacturer. It may provide little or no thermal protection. Structural firefighters' protective clothing provides limited protection in fire situations *only*; it is not effective in spill situations where direct contact with the substance is possible.

Respirator Selection: Wear positive pressure SCBA. Where there is potential exists for exposure to butyl isocyanate use respirators and components tested and approved under appropriate government standards: NIOSH/MSHA or European Standard EN149-approved [ABEK (EN 14387)] supplied-air respirator with a full face-piece operated in the positive-pressure mode, or with a full-face-piece, hood, or helmet in the continuous flow mode.

Storage: PIH; check oxygen content prior to entering storage area. (1) Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet at 2−8°C. (2) Color code—Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. Keep away from moisture, water, steam. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in a fireproof refrigerator in tightly closed containers under an inert atmosphere[52], separated from strong oxidants, strong bases; strong acids. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2484 *tert*-Butyl isocyanate, Hazard class: 6.1; Labels: 6.1—Poison Inhalation Hazard, 3—Flammable liquid. Inhalation Hazard Zone A. PGI.

Spill Handling:

tert-Butyl isocyanate

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908)548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 300/90
Then: Protect persons downwind (mi/km)
Day 0.7/1.1
Night 1.7/2.7

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 2000/600
Then: Protect persons downwind (mi/km)
Day 4.5/7.24
Night 7+/11.27

Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources and dampen spilled material with toluene to avoid airborne dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Vapors heavier than air. Thermal decomposition products may include toxic oxides of nitrogen and carbon. Highly flammable: Easily ignited by heat, sparks or flames. Vapors may form explosive mixture with air:indoors, outdoors, and sewers explosion hazards. Most vapors are heavier than air. They will spread along ground and collect in low or confined areas (sewers, basements, tanks). Vapors may travel to source of ignition and flashback. Those substances designated with a (P) may polymerize explosively when heated or involved in a fire. Substance will react with water (some violently) releasing flammable, toxic or corrosive gases and runoff. Contact with metals may evolve flammable hydrogen gas. Containers may explode when heated or if contaminated with water.

Disposal Method Suggested: Dispose of contents and container to an approved waste disposal plant. Use a licensed professional waste disposal service to dispose of this material. *Caution:* this chemical is highly flammable with a very low flash point (−3.5°C). Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (101); (138); (100).

United States Department of Energy, Office of Safeguards, Security and Emergency Preparedness, Office of Environment, Health, Safety, and Security, *Protective Action Criteria (PAC) with AEGLs, ERPGs, & TEELs: Rev. 29 for Chemicals of Concern*, Washington, DC (May, 2016).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: tert-Butyl Isocyanate*, #1791, Trenton, NJ (July 2000).

Butyl Isovalerate B:0940

Formula: $C_9H_{18}O_2$: $CH_3CH_2CH(CH_3)COOC_4H_9$

Synonyms: Butanoic acid, 3-methyl-, butyl ester*;* *n*-Butyl isopentanoate*;* *n*-Butyl isovalerate; Butyl isovalerianate; Butyl 3-methyl-butyrate; Isovaleric acid, butylester

CAS Registry Number: 109-19-3

HSDB Number: 6383

RTECS Number: NY1502000

UN/NA & ERG Number: UN1993 (flammable liquids, n.o.s.)/128; UN3272 (Esters, n.o.s.)/127

EC Number: 203-654-7

Regulatory Authority and Advisory Information

Hazard Alert: Flammable, Primary irritant (w/o allergic reaction).

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xi; risk phrases: R10; R36/37/38; R51; safety phrases: S26; S36; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Butyl Isovalerate is a clear liquid. Molecular weight = 158.27; specific gravity = 0.87.4@ 20°C; boiling point = 150°C; flash point = 53°C. Hazard identification (based on NFPA 704 M Rating System): Health 0; flammability 2; reactivity 0 ₩. Very slightly soluble in water.

Potential Exposure: May be used as a specialty solvent; food additive.

Incompatibilities: Vapor may form explosive mixture with air. Reaction, possibly violent, on contact with oxidizers. Compounds of the carboxyl group react with all bases, both inorganic and organic (i.e., amines) releasing substantial heat, water and a salt that may be harmful. Incompatible with arsenic compounds (releases hydrogen cyanide gas), diazo compounds, dithiocarbamates, isocyanates, mercaptans, nitrides, and sulfides (releasing heat, toxic and possibly flammable gases), thiosulfates and dithionites (releasing hydrogen sulfate and oxides of sulfur).

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Determination in Water: Toxic to aquatic organisms. Octanol−water coefficient: Log $K_{\mathrm{ow}} = < 3.0$. Values above 3.0 are likely to bioaccumulate in aquatic organisms.

Routes of Entry: Ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Avoid skin and eye contact. Do not inhale mists or vapors. Symptoms include headache; muscle weakness; giddiness, nausea, vomiting, confusion, delirium, coughing, labored and difficult breathing; coma and even death. This ester is a skin irritant, and has a high oral toxicity; the oral LD_{50} for rabbit is 8.2 mg/kg. Toxicity information of this chemical is grouped with *n*-butyl acetate. It is classified as moderately toxic. Probable oral lethal dose for humans is 0.5−5 g/kg (between 1 ounce and a pint) for a 150 lb person. It is a mild irritant and central nervous depressant. Also, it is less toxic than the parent alcohol.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective, thick nitrile rubber or latex gloves and clothing to prevent any reasonable probability of skin or eye contact. Avoid the use of natural rubber, textile, leather or other synthetic material (e.g., PVC, butyl rubber, etc.) gloves. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where butyl isovalerate may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN3272 Ethers, n.o.s., Hazard class: 3; Labels: 3—Flammable liquid. UN1993 Flammable liquids, n.o.s., Hazard Class: 3; Labels: 3—Flammable liquid, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include oxides of carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Butyl Isovalerate, Washington, DC, Chemical Emergency Preparedness Program (October 31, 1985).

Butyl Lactate B:0950

Formula: $C_6H_{11}O_3$; $CH_3CHOHCOO(CH_2)_3$

Synonyms: Butyl α-hydroxypropionate; Butyl lactate; 2-Hydroxypropanoic acid, butyl ester; Lactato de *n*-butilo (Spanish); Lactic acid, butyl ester

CAS Registry Number: 138-22-7

HSDB Number: 7905

RTECS Number: OD4025000

UN/NA & ERG Number: UN1993 (flammable liquids, n.o.s.)/128

EC Number: 205-316-4

Regulatory Authority and Advisory Information

Hazard Alert: Flammable liquid, Primary irritant (w/o allergic reaction).

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xi; risk phrases: R10; R36/37/38; safety phrases: S26; S36; S37/38 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Butyl lactate is a liquid. Molecular weight = 146.19; boiling point = 170°C @ 760 mmHg; freezing/melting point = −43°C; flash point = 71°C (oc)[17]. Autoignition temperature = 340−382°C. Hazard identification (based on NFPA-704 M Rating System): Health 1; flammability 2; reactivity 0 ₩. Slightly soluble in water.

Potential Exposure: Butyl lactate is used in making paints, inks, perfumes, dry cleaning fluids; as a resin solvent in varnishes and lacquers.

Incompatibilities: May form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

OSHA PEL: None

NIOSH REL: 5 ppm/25 milligram per cubic meter TWA

ACGIH TLV[1]: 5 ppm/30 milligram per cubic meter TWA

Australia: TWA 5 ppm (25 milligram per cubic meter), 1993; Belgium: TWA 5 ppm (30 milligram per cubic meter), 1993; Denmark: TWA 5 ppm (25 milligram per cubic meter), 1999; Finland: TWA 1 ppm (6 milligram per cubic meter); STEL 3 ppm (18 milligram per cubic meter), 1999; France: VME 5 ppm (25 milligram per cubic meter), 1999; Norway: TWA 5 ppm (25 milligram per cubic meter), 1999; Switzerland: MAK-W 5 ppm (30 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 20 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 5 ppm.

Determination in Air: No method available.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritation to the eyes, skin, nose, throat, and may cause headaches and cough. Symptoms may also include drowsiness, CNS depression; nausea, vomiting. At concentrations of 7 ppm with short peaks of 11 ppm, workers experienced headaches, upper respiratory system irritation and coughing. Some complained of sleepiness and headache in the evening after work and occasional nausea and vomiting was experienced. When exposures were below 1.4 ppm, however, no symptoms were manifested.

Long-Term Exposure: Headaches, feeling sleepy, and nausea may develop in the evening after exposure during the day.

Points of Attack: Eyes, skin, respiratory system; central nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical

facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where butyl lactate may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: A UN1993 Flammable liquids, n.o.s., Hazard Class: 3; Labels: 3—Flammable liquid, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: n-Butyl Lactate*, Trenton, NJ (September 2000).

Butyl Mercaptan B:0960

Formula: $C_4H_{10}S$; $CH_3CH_2CH_2CH_2SH$

Synonyms: *n*-Butanethiol; 1-Butanethiol; Butanethiol; Butane-thiol; *n*-Butyl mercaptan; *n*-Butyl thioalcohol; 1-Mercaptobutane; NCI-C60866; Thiobutyl alcohol

CAS Registry Number: 109-79-5

HSDB Number: 290

RTECS Number: EK6300000

UN/NA & ERG Number: UN2347/130

EC Number: 203-705-3

Regulatory Authority and Advisory Information

Hazard Alert: Highly flammable liquid, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction).

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, F, Xn; risk phrases: R11; R20/22; R21/22; R36/37/38; R50; R62; safety phrases: S9; S16; S21; S23; S26; S33; S36/37; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Butyl mercaptan is a flammable, colorless liquid with a strong, skunk-like odor. The Odor Threshold in air is 0.00097 ppm. Molecular weight = 90.19; Specific gravity (H_2O:1) = 0.83 @ 20°C; boiling point = 99°C;

freezing/melting point = −116°C; vapor pressure = 35 mmHg @ 20°C; 75 mmHg @ 34.5°C; relative vapor density (air = 1) = 3.1; Flash point = 2°C (cc)[17]; Autoignition temperature ≤225°C. Explosive limits: LEL: 1.4%; UEL: 10.2%. Hazard identification (based on NFPA-704 M Rating System): Health 1; flammability 3; reactivity 0 ₩. Slightly soluble in water; solubility = 0.06% @ 20°C.

Potential Exposure: The major use is in the production of organophosphorus compounds, thiolcarbamates; more specifically insecticides, herbicides, acaricides, and defoliants.

Incompatibilities: May form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Attacks some plastics and rubber.

Permissible Exposure Limits in Air

NIOSH IDLH = 500 ppm

OSHA PEL: 10 ppm/35 milligram per cubic meter TWA

NIOSH REL: 0.5 ppm/1.8 milligram per cubic meter [15-minutes] Ceiling Concentration

ACGIH TLV[1]: 0.5 ppm/1.8 milligram per cubic meter TWA

PAC Ver. 29[138]

PAC-1: 4.5 ppm

PAC-2: 50 ppm

PAC-3: 2500 ppm [>= 10% LEL, lower explosive limit but <50% LEL]

DFG MAK: 0.5 ppm/1.9 milligram per cubic meter TWA; Peak limitation II(2)

Austria: MAK 0.5 ppm (1.5 milligram per cubic meter), 1999; Denmark: TWA 0.5 ppm (1.5 milligram per cubic meter), 1999; Finland: TWA 0.5 ppm (1.5 milligram per cubic meter); STEL 1.5 ppm (4.5 milligram per cubic meter), 1999; France: VME 0.5 ppm (1.5 milligram per cubic meter), 1999; India: TWA 0.5 ppm (1.5 milligram per cubic meter), 1993; Poland: TWA 1 milligram per cubic meter; STEL 2 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 1.5 milligram per cubic meter, 2003; Switzerland: MAK-W 0.5 ppm (1.9 milligram per cubic meter), KZG-W 1 ppm (3.8 milligram per cubic meter), 1999; Turkey: TWA 10 ppm (35 milligram per cubic meter), 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: 0.5 ppm TLV. Several states have set guidelines or standards for butyl mercaptan in ambient air[60] ranging from 5 μ/m^3 (New York) to 15 μ/m^3 (North Dakota and South Carolina) to 25 μ/m^3 (Virginia) to 30 μ/m^3 (Connecticut) to 36 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method #2525 and #2542

Permissible Concentration in Water: No criteria set, but EPA[32] has suggested an ambient water limit of 21 μg/L based on health effects.

Determination in Water: Octanol−water coefficient: Octanol−water coefficient: Log $K_{ow} = 2.3$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

In animals-narcosis, in coordination, weakness; cyanosis, pulmonary irritation, eye irritation; paralysis. LD_{50} = (oral-rat) 1500 mg/kg (slightly toxic).

Short-Term Exposure: Irritates the eyes, skin, and respiratory tract. Skin contact can cause a skin rash. The substance may affect the thyroid gland. High concentrations can cause weakness, nausea, dizziness, headache, and confusion. Very high concentrations (above the occupational exposure limit) exposure may affect the CNS and cause unconsciousness. In animals: narcosis, loss of coordination; lassitude (weakness, exhaustion); cyanosis, pulmonary irritation; liver, kidney damage

Long-Term Exposure: Repeated exposure can cause skin rash and affect eyes, skin, respiratory system; CNS; liver, and kidneys

Points of Attack: Eyes, skin, respiratory system; central nervous system; liver, kidneys.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Remove clothing immediately if wet or contaminated to avoid flammability hazard. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *5 ppm:* CcrFOv (APF = 50) [any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s)]; or Sa (APF = 10) (any supplied-air respirator). *12.5 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOv (APF = 25) [any PAPR with organic vapor cartridge(s)]. *25 ppm:* CcrFOv (APF = 50) [any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s)]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted acid gas canister]; or PaprTOv (APF = 50) [any PAPR with a tight-fitting facepiece and organic vapor cartridge(s)]; SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *500 ppm:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode. *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Store in tightly closed containers in a cool, well-ventilated area away from heat, oxidizers, or acids.

Shipping: UN2347 Butyl mercaptan, Hazard Class: 3; Labels: 3—Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Stop discharge if possible. Evacuate area in case of large spill. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of sulfur and carbon. Use dry chemical, carbon dioxide; water spray; or alcohol foam (preferred) extinguishers. Water may be ineffective in firefighting. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration (1093°C) followed by scrubbing with a caustic solution.

References

(31); (173); (101); (138); (2); (100).

National Institute for Occupational Safety and Health (NIOSH), Information Profiles on Potential Occupational Hazards: Report PB 276,678, Rockville, MD pp. 169−176 (October 1977).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Butyl Mercaptan*, Trenton, NJ (February 2003)

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 1, No. 6, 39-40 (1981)

Butyl Methacrylate B:0970

Formula: $C_8H_{14}O_2$

Synonyms: *n*-Butyl methacrylate; Butyl 2-methacrylate; *n*-Butyl α-methylacrylate; Butyl 2-methyl-2-propenoate; Metacrilato de *n*-butilo (Spanish); Methacrylate de butyle (French); Methacrylic acid, butyl ester; Methacrylsaeure butyl ester (German); 2-Methyl butylacrylate; 2-Propenic acid, 2-methyl-, butyl ester

CAS Registry Number: 97-88-1

HSDB Number: 289

RTECS Number: OZ3675000

UN/NA & ERG Number: UN2227/130 (P)

EC Number: 202-615-1 [*Annex I Index No.:* 607-033-00-5]

Regulatory Authority and Advisory Information

Hazard Alert: Flammable, Drug; Suspected of causing genetic defects, Polymerization hazard (nonstabilized), Sensitization hazard (skin), Primary irritant (w/o allergic reaction).

TSCA 40CFR716.120(a).

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xi; risk phrases: R10; R19; R21/22/23; R36/37/38; R43; R61; R62; safety phrases: S2 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Butyl methacrylate is a flammable, colorless liquid with a mild odor. Molecular weight = 142.22; specific gravity (H_2O:1) = 0.884 @ 20°C; boiling point = 163°C; freezing/melting point = −75°C; relative vapor density (air = 1) = 4.9; vapor pressure = 2 mmHg @ 20°C; flash point = 52°C (oc); Autoignition temperature = 294°C.

Explosive limits: LEL: 2.8%, 28,000 ppm[138]; UEL: 8%. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 2; reactivity 0 ₩. Practically insoluble in water; solubility = 0.6% @ 20°C.

Potential Exposure: Butyl methacrylate is used in resins, solvents, coatings, adhesives, dental materials and textile emulsions.

Incompatibilities: Forms an explosive mixture with air. Unless inhibitor is maintained at the proper level, oxidizers, heat, ultraviolet light, contamination, or moisture may cause polymerization. May accumulate static electrical charges and cause ignition of its vapors.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 19 milligram per cubic meter

PAC-2: 210 milligram per cubic meter

PAC-3: 1300 milligram per cubic meter

DFG MAK: [skin] Danger of skin sensitization.

Denmark: TWA 50 ppm (290 milligram per cubic meter), 1999; Russia: STEL 30 milligram per cubic meter, 1993; Sweden: NGV 50 ppm (300 milligram per cubic meter), KTV 75 ppm (450 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 59 milligram per cubic meter, 2003.

Determination in Air: No criteria set.

Determination in water: No criteria set. Octanol−water coefficient: Log $K_{ow} = 2.26-3.01$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Contact can irritate the eyes and skin. Inhalation can irritate the respiratory tract with coughing, wheezing and/or shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: Butyl methacrylate may cause skin allergy. There is limited evidence that this chemical is teratogen in animals.

Points of Attack: Skin, reproductive system.

Medical Surveillance: Evaluation by a qualified allergist. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear solvent-resistant gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls, and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit. *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Protect against physical damage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Outside or detached storage is preferred. Prior to working with butyl methacrylate all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from incompatible materials listed above, light and heat. Butyl methacrylate should be kept refrigerated and inhibited with 10 ppm hydroquinone monomethylether.

Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2227 Butyl methacrylate, stabilized, Hazard Class: 3; Labels: 3—Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquid in vermiculite, dry sand; earth or similar material and deposit in sealed containers. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Butyl Methacrylate*, Trenton, NJ (July 2000).

Butylphenols B:0980

Formula: $C_{10}H_{14}O$; $C_4H_9C_6H_4OH$

Synonyms: *o-n-isomer:* 2-*n*-Butylphenol

o-sec-isomer: o, sec-Butylphenol; 2-*sec*-Butylphenol

o-tert-isomer: 2-*t*-Butylphenol; Phenol, *o*-(*tert*-butyl)-

p-sec-isomer: p, sec-Butylphenol; 4-*sec*-Butylphenol

p-tert-isomer: Butylphen; *p,tert*-Butylphenol; 4-*t*-Butylphenol; 4-*tert*-Butylphenol; 4-(1,1-Demethylethyl) phenol; 1-Hydroxy-4-*tert*-butylbenzene; UCAR butylphenol 4-*t*

CAS Registry Number: 3180-09-4 (*o*-isomer); 89-72-5 (*o-sec*-isomer); 99-71-8 (*p-sec*-isomer); 4074-43-5 (*m*-isomer); 88-18-6 (*o-tert*-isomer); 98-54-4 (*p-ter*t-isomer); 1638-22-8 (*p*-isomer); 28805-86-9 (mixed isomers)

RTECS Number: SJ8850000 (*o-n*-isomer); SJ8920000 (*o-sec*-isomer); SJ8810000 (*m*-isomer); SJ8924000 (*p-sec*-isomer); SJ8925000 (*p-tert*-isomer); SJ8922500 (*p-n*-isomer)

UN/NA & ERG Number: UN2430/153

Regulatory Authority and Advisory Information

Hazard Alert: *all isomers*: Poison, Combustible, Corrosive; *p-tert*-isomer: Possible risk of forming tumors, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction), (*o-sec*-and *o-tert*-isomers): Primary irritant (w/o allergic reaction), Environmental hazard.

o-sec-isomer: United States Environmental Protection Agency, FIFRA 1998 Status of Pesticides: Canceled (*p-tert-isomer*)

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. (*o-sec*-; *p-tert*-; *p*-; *o*-; *m*-; *p-tert*-isomers).

Hazard symbols, risk, & safety statements: Hazard Symbol: C; risk phrases; R20/21/22; R34; R62-(*p-tert*-isomer); safety phrases: S26; S27; S28; S36/37/39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to waters (*o-, sec*-and *o-tert-isomers*)

Description: The butylphenols include several isomers. Solid butylphenols (28805-86-9) generally have properties similar to the above: Molecular weight = 150; specific gravity (H_2O:1) = 1037 @ 25°C; boiling point = 240°C @ 750 mmHg; freezing/melting point = 97−99°C; flash point = 113°C. The two most highly regulated are o-*sec*-butylphenol and *p-tert*-butylphenol. Their properties are as follows: *o-sec-isomer* (89-72-5): Colorless liquid or solid (below 16°C). Molecular weight = 150.22; boiling point = 108°C; Flash point = 108°C. Insoluble in water. *p-tert-isomer* (98-54-4): White crystalline solid. Molecular weight = 150.24; boiling point = 237°C; freezing/melting point = 97°C; flash point = 115°C (oc); Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 1, reactivity 0 ₩. Insoluble in water.

Potential Exposure: Butylphenols may be used as intermediates in manufacturing varnish and lacquer resins; as a germicidal agent in detergent disinfectants; as a pour point depressant, in motor-oil additives; de-emulsifier for oil; soap-antioxidant, plasticizer, fumigant, and insecticide.

Incompatibilities: Vapors may form explosive mixture with air. These phenol/cresol materials can react with oxidizers; reaction may be violent. Incompatible with strong reducing substances such as hydrides, nitrides, alkali metals, and sulfides. Flammable gas (H_2) is often generated, and the heat of the reaction may cause the gas to ignite and explode. Heat is also generated by the acid-base reaction with bases; such heating may initiate polymerization of the organic compound. React with boranes, alkalies, aliphatic amines, amides, nitric acid, sulfuric acid. Phenols are sulfonated very readily (for example, by concentrated sulfuric acid at room temperature). These reactions generate heat. Phenols are also nitrated very rapidly, even by dilute nitric acid and can explode when heated. Many phenols form metal salts that may be detonated by mild shock[101].

Permissible Exposure limits in Air

Conversion factor: 1 ppm = 6.14 milligram per cubic meter @ 25°C & 1 atm

89-72-5, o-sec-isomer

OSHA PEL: None

NIOSH REL: 5 ppm/30 milligram per cubic meter TWA [skin]

ACGIH TLV[1]: 5 ppm/31 milligram per cubic meter TWA [skin]

Australia: TWA 5 ppm (30 milligram per cubic meter), [skin], 1993; Austria: MAK 5 ppm (30 milligram per cubic meter), 1999; Belgium: TWA 5 ppm (31 milligram per cubic meter), [skin], 1993; Denmark: TWA 5 ppm (30 milligram per cubic meter), [skin], 1999; France: VME 5 ppm (30 milligram per cubic meter), [skin], 1999; Switzerland: MAK-W 5 ppm (30 milligram per cubic meter), [skin], 1999; United Kingdom: TWA 5 ppm (31 milligram per cubic meter), [skin], 2000; the Netherlands: MAC-TGG 30 milligram per cubic meter, [skin], 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam, Israel: TWA 5 ppm [skin]

98-54-4, p-tert-isomer

PAC Ver. 29[138]

PAC-1: 1.5 milligram per cubic meter

PAC-2: 40 milligram per cubic meter

PAC-3: 240 milligram per cubic meter

DFG MAK: 0.080 ppm/0.5 milligram per cubic meter TWA; Peak Limitation Category II(2); [skin] Danger of skin sensitization; Pregnancy Risk Group D

Australia: TWA 10 ppm (60 milligram per cubic meter); STEL 20 ppm, 1993; Austria: MAK 0.08 ppm (0.5 milligram per cubic meter), [skin], 1999; Denmark: TWA 0.08 ppm (0.5 milligram per cubic meter), [skin], 1999; Switzerland: MAK-W 0.08 ppm (0.5 milligram per cubic meter), LZG-(week) 0.4 ppm, [skin], 1999; the Netherlands: MAC-TGG 0.5 milligram per cubic meter, 2000

Several states have set guidelines or standards for the o-*sec*-isomer in ambient air[60] ranging from 300 μ/m^3 (North Dakota) to 500 μ/m^3 (Virginia) to 600 μ/m^3 (Connecticut) to 714 μ/m^3 (Nevada).

Determination in Air: OSHA Method: PV2085 (*p-tert*-isomer)

Permissible Concentration in Water: No criteria set.

Determination in Water: Octanol−water coefficient: $\text{Log } K_{ow} = 2.4 - > 3.0$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Inhalation may cause irritation to nose, throat and lungs. Sensitization may occur. Skin contact studies with animals suggest that severe irritation at concentrations above 10% may occur. May cause rash, redness and irritation, especially when skin is wet. Absorption is significant and contact may lead to allergic reaction. Eye studies with animals suggest that severe irritation may occur. Ingestion studies on animals suggest that 8 oz. may be lethal to a 150 lb person. Toxicity by Ingestion: Grade 2; LD_{50} = (rat, oral) 3250 mg/kg[136]

Long-Term Exposure: May cause skin color changes by contact or inhalation of levels between 10 and 100 ppm. Allergy may develop after repeated exposure. Liver damage may also occur. There is limited evidence that butylphenol causes skin cancer in animals. Repeated or prolonged skin contact can cause skin ulcers and lead to permanent loss of skin pigment in affected areas.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-or dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *No respirator listed by NIOSH for Butylphenols*. If misting or vapor occur consider using a NIOSH/MSHA (US) or EN 149 (Europe)-approved organic cartridge respirator or NIOSH: *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full facepiece respirator with an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: (1) Corrosive or Contact Hazard; Store separately in a corrosion resistant location. (2) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with butyl phenol all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2430 Alkylphenols, solid, n.o.s. (including C2-C12 homologues), Hazard class: 8; Labels: 8—Corrosive material.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Butylphenol is combustible. Use dry chemical, carbon dioxide; or foam extinguishers. Thermal decomposition products may include oxides of carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (85); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Butylphenol*, Trenton, NJ (May 1986).

New York State Department of Health, Chemical Fact Sheet: *p-tert*-Butylphenol, Bureau of Toxic Substance Assessment, Albany, NY (March 1986).

New Jersey Department of Health and Senior Services, *Hazardous Sub stances Fact Sheet: o-sec*-Butylphenol, Trenton, NJ (August 2000).

Butyl Propionate B:0990

Formula: $C_7H_{14}O_2$: $C_2H_5COOC_4H_9$

Synonyms: Butyl propanoate; *N*-Butyl propionate; Propanoic acid butyl ester; Propionic acid, butyl ester; Propionato de butilo (Spanish); Propionates de butyle (French)

CAS Registry Number: 590-01-2

RTECS Number: UE8245000

UN/NA & ERG Number: UN1914/130

EC Number: 209-669-5 [*Annex I Index No.:* 607-029-00-3]

Regulatory Authority and Advisory Information

Hazard Alert: Highly flammable, Primary irritant (w/o allergic reaction).

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xi; risk phrases: R11; R18; R36/37/38; safety phrases: S2 (in consumer products); S16; S21; S26; S36/37/39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Butyl propionate is a flammable, colorless to straw-yellow liquid with an apple-like odor. Molecular weight = 130.2; boiling point = 145°C; specific gravity

(H_2O:1) = 0.89 @ 0°C; melting/freezing point = −90°C; vapor pressure = 2.9 mmHg @ 20°C; relative density @ 20°C of the saturated vapor/air-mixture (air = 1) = 1.01; flash point = 32°C; Autoignition temperature = 426°C. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 3; reactivity 0 ₩. Practically insoluble in water.

Potential Exposure: It is used as a solvent or lacquer thinner; and in perfumes and flavorings.

Incompatibilities: Vapor may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 34 milligram per cubic meter

PAC-2: 370 milligram per cubic meter

PAC-3: 990 milligram per cubic meter

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: The substance irritates the eyes, skin, and the respiratory tract.

Long-Term Exposure: Unknown at this time.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear solvent-resistant gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls, and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit. *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Protect against physical damage. Outside or detached storage is preferred. Prior to working with butyl propionate all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from incompatible materials listed above. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN1914 Butyl propionates, Hazard Class: 3; Labels: 3—Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquid in vermiculite, dry sand; earth or similar material and deposit in sealed containers. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Butyl Propionate*, Trenton, NJ (November 1998).

4-Butyrolactone B:0995

Formula: $C_4H_6O_2$

Synonyms: *gamma*-6480; Agrisynth BLO; *gamma*-BL; BLO; BLON; 4-Butanolide; 1,2-Butanolide; 1,4-Butanolide; Butyric acid, 4-hydroxy-, *gamma*-lactone; Butyric acid lactone; Butyro lactone; *gamma*-Butyrolactone; 4-Butyrolactone; Butyrylactone; *gamma*-Butyrylactone; γ-Butyrylactone; 4-Deoxytetronic acid; Dihydro-2(3*H*)-furanone; FEMA No. 3291; 4-Hydroxybutanoic acid lactone; 4-Hydroxybutanoic acid, *gamma*-lactone; *gamma*-Hydroxybutyric acid cyclic ester; 4-Hydroxybutyric acid lactone; 4-Hydroxybutyric acid, *gamma*-lactone; *gamma*-Hydroxybutyric acid lactone; *gamma*-Hydroxybutyrolactone; NCI-C55878; NIH 10540; 2-Oxolanone; Tetrahydro

CAS Registry Number: 96-48-0

HSDB Number: 4290

RTECS Number: LU3500000

UN/NA & ERG Number: UN2810 (toxic liquid, organic, n.o.s.)/153

EC Number: 202-509-5

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: is not classifiable as to its carcinogenicity to humans., Group 3, 1999.

List 1, DEA chemical code 2011 (Title 21 CFR1310.02) *gamma*-Butyrolactone (GBL; Dihydro-2 (3H)-furanone; 1,2-Butanolide; 1,4-Butanolide; 4-Hydroxybutanoic acid lactone; *gamma*-hydroxybutyric acid lactone)

Hazard Alert: Poison, Flammable, Narcotic, Cholinesterase toxin, Neurotoxin; Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard.

Hazard symbols, risk, & safety statements: (106-88-7) Hazard symbol: F, Xn, N; risk phrases: R10; R22; R36; R62; R63; safety phrases: S26; S36; S39 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Oily, colorless, clear liquid. Faint, pleasant odor. Molecular weight = 86.1; Specific gravity (H_2O:1) = 1.129 @ 20°C; 1.41 @ 0°C; boiling point = 204−205°C @ 760 mmHg; freezing/melting point = −45°C; vapor pressure = < 1 mmHg @ 25°C; relative vapor density (air = 1) = 3; Henry's Law constant = 5.3×10^{-8} atm m^3/mol @ 25°C (est)[72]. Flash point = 98.3°C; Autoignition temperature −450°C; explosive limits: LEL: 1.4%, 14,000 ppm; UEL 6.9%; Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 2; reactivity 0 ₩. Soluble in water; solubility ≥ 100mg/L @ 12.90°C. Hygroscopic; volatile on contact with steam.

Potential Exposure: Used as a chemical intermediate for making other chemicals, including pesticides, cosmetics, and pharmaceuticals; as a solvent for paint, nail polish removers, and industrial chemicals. Used in electronics, drilling and petroleum industries as a stabilizer and solvent. Used as a flavoring agent in various foods and beverages, including grains and breakfast foods, candy, and alcoholic and nonalcoholic drinks. Drug of abuse: the United States Food and Drug Administration has warned the public not to purchase or consume products, containing *gamma*-butyrolactone (GBL). FDA has also asked the companies that manufacture these products to voluntarily recall them. The agency has received reports of serious health problems—some that are potentially life-threatening—associated with the use of these products. Although labeled as dietary supplements and marketed under various brand names, these products are illegally marketed unapproved new drugs. False advertising claims include building muscles, improved physical performance, enhanced sex, reduced stress and induced sleep.

Incompatibilities: 4-Butyrolactone is incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, alcohols, amines, strong and inorganic acids, strong bases. Rapidly hydrolyzed by bases and slowly hydrolyzed by acids. It is hygroscopic and volatile with steam. Combustible; vapor may form explosive mixture with air.

Permissible Exposure Limits in Air:

PAC Ver. 29[138]

PAC-1: 3.6 milligram per cubic meter

PAC-2: 39 milligram per cubic meter

PAC-3: 310 milligram per cubic meter

Determination in Air: Gas chromatography.

Permissible Concentration in Water: Colorimetric titration

Determination in Water: Octanol−water coefficient: Log $K_{ow} = < 1$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion, skin and eye contact. May be absorbed through the unbroken skin.

Harmful Effects and Symptoms

Short-Term Exposure: Toxic, may be harmful if inhaled, swallowed or absorbed through skin. Avoid any eye or skin contact. Effects of contact or inhalation may be delayed. Eye contact may cause serious damage. Vapor may act as an anesthesia, causing dizziness and sleepiness; high levels may cause victim to pass out. Department of Energy profile: Cholinesterase toxin; Eye irritant-severe; Eye-acute effects other than irritation; Respiratory irritant-acute, severe, or moderate but not mild irritant effects; Skin irritant-severe; Heart cardiovascular system-acute effects; Brain-acute effects CNS-acute effects; Narcotic; Nervous system toxin-acute effects.[138] LD_{50} = (oral-rat) >1.5 g/kg. LD_{50} = (inhalation-rat) >5 g/m^3/4H.

Long-Term Exposure: May be narcotic; neurotoxic. Based on animal studied, it may be a tumorigen, mutagen and a reproduction hazard.

Points of Attack: Eyes, central nervous system, Reproductive system.

Medical Surveillance: Pregnant women should avoid contact. Employees should be notified by a physician that this chemical may affect the reproductive system. In addition to comprehensive initial medical and work histories emphasizing reproductive experience and menstrual history, patient should have physical examination and testing of genito-urinary tract, sperm count, motility and morphology. If required, other tests, such as serum testosterone, serum FSH, and serum LH may be indicated. Eye examination. In addition to comprehensive initial medical and work histories emphasizing reproductive experience and menstrual history, patient should have physical examination and testing of genito-urinary tract, sperm count, motility and morphology. If required, other tests, such as serum testosterone, serum FSH, and serum LH may be indicated.

First Aid: *Eyes*: first check the victim for contact lenses and remove if present. Flush victim's eyes with water or normal saline solution for 20 to 30 minutes. Simultaneously, call a hospital or poison control center. Do not put any ointments, oils, or medication in the victim's eyes without specific instructions from a physician. Immediately transport the victim after flushing eyes to a hospital even if no symptoms (such as redness or irritation) develop. *Skin*: immediately flood affected skin with water while removing and isolating all contaminated clothing. Gently wash all affected skin areas thoroughly with soap and water. If symptoms such as redness or irritation develop, immediately call a physician and be prepared to transport the victim to a hospital for treatment. *Inhalation*: immediately leave the contaminated area; take deep breaths of fresh air. If symptoms (such as wheezing, coughing, shortness of breath, or burning in the mouth, throat, or chest) develop, call a physician and be prepared to transport the victim to a hospital. Provide proper respiratory protection to rescuers entering an unknown atmosphere. Whenever possible, SCBA should be used; if not available, use a level of protection greater than or equal to that advised under protective clothing. *Ingestion*: *do not induce vomiting*. If the victim is conscious and not convulsing, give 1 or 2 glasses of water to dilute the chemical and immediately call a hospital or poison control center. Be prepared to transport the victim to a hospital if advised by a physician. If the victim is convulsing or unconscious, do not give anything by mouth, ensure that the victim's airway is open and lay the victim on his/her side with the head lower than the body. *Do not induce vomiting*. Immediately transport the victim to a hospital.

Personal Protective Methods: Wear positive pressure SCBA. Wear chemical protective clothing that is specifically recommended by the manufacturer. It may provide little or no thermal protection. Structural firefighters' protective clothing provides limited protection in fire situations ONLY; it is not effective in spill situations where direct contact with the substance is possible.

Respirator Selection: Where the neat test chemical is weighed and diluted, wear a NIOSH-approved half face respirator equipped with an organic vapor/acid gas cartridge (specific for organic vapors, HCl, acid gas and SO_2) with a dust/mist filter.

Storage: Color code—Blue: Health Hazard: Store in a secure poison location away from sources of ignition, under refrigerated temperatures (darkens with heat) and protect from contact with moisture, inorganic acids, amines, alcohols, bases and oxidizers. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: Listed by some sources as unregulated. UN2810 Toxic liquids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1—Poisonous materials, Technical Name Required.

Spill Handling: As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 m/150 ft. for liquids and at least 25 m/75 ft. for solids. Keep unauthorized personnel away. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Stay upwind. Keep out of low areas. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Stop leak if you can do it without risk. Prevent entry into waterways, sewers, basements or confined areas. Cover with plastic sheet to prevent spreading. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120 (q) may be applicable.

Fire Extinguishing: Combustible. Thermal decomposition products include oxides of carbon. Containers may explode when heated. Runoff from fire control or dilution water may be corrosive and/or toxic and may cause pollution. Runoff may pollute waterways. If tank, rail car or tank truck is involved in a fire, isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. *Small Fire*: Fires involving this material can be controlled with a dry chemical, carbon dioxide or Halon extinguisher. *Large Fire*: Water spray, fog or alcohol resistant foam. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal; do not scatter the material. Use water spray or fog; do not use straight streams. *Fire involving Tanks or Car/Trailer Loads:* Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Do not get water inside containers. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. *Always* stay away from tanks engulfed in fire. For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn. *Do not* get water inside containers.

Disposal Method Suggested: Use a licensed professional waste disposal service to dispose of this material. Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. It is inappropriate and possibly dangerous to the environment to dispose of expired or waste drugs and pharmaceuticals by flushing them down the toilet or discarding them to the trash. Household quantities of expired or waste pharmaceuticals may be mixed with wet cat litter or coffee grounds, double-bagged in plastic, discard in trash. Larger quantities shall carefully take into consideration applicable DEA, EPA, and FDA regulations. If possible return the pharmaceutical to the manufacturer for proper disposal being careful to properly label and securely package the material. Alternatively, the waste pharmaceutical shall be labeled, securely packaged and transported by a state licensed medical waste contractor to dispose by burial in a licensed hazardous or toxic waste landfill or incinerator. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (100).

p-tert-Butyltoluene B:1000

Formula: $C_{11}H_{16}$; *p*-$CH_3C_6H_4C_4H_9$

Synonyms: *p*-Methyl-*tert*-butylbenzene; 1-Methyl-4-*tert*-butylbenzene; TBT

CAS Registry Number: 98-51-1

HSDB Number: 5008

RTECS Number: XS8400000

UN/NA & ERG Number: UN2667/152

EC Number: 202-675-9

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Flammable liquid, Primary irritant (w/o allergic reaction), Environmental hazard.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects[293]. Toxic to aquatic life with long-lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N, Xn; risk phrases: R10; R20/21/22; R23/24/25; R36/37/37; R50; safety phrases: S16; S26; S29; S36/37/39; S45; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: *p-tert*-Butyltoluene is a colorless liquid. Aromatic gasoline-like odor. Molecular weight = 148.18; boiling point = 193-194°C; boiling point = 192.78°C; freezing/melting point = −52.2°C; vapor pressure = 0.68 mmHg @20°C; flash point = 57.8°C. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 2; reactivity 0 ₩. Insoluble in water.

Potential Exposure: This material is used as a solvent for resins and as an intermediate in organic synthesis.

Incompatibilities: May form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. May accumulate static electrical charges, and may cause ignition of its vapors.

Permissible Exposure Limits in Air

NIOSH IDLH = 100 ppm

Conversion factor: 1 ppm = 6.07 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 10 ppm/60 milligram per cubic meter TWA

NIOSH REL: 10 ppm/60 milligram per cubic meter TWA; 20 ppm/120 milligram per cubic meter STEL

ACGIH TLV[1]: 1 ppm/6.1 milligram per cubic meter TWA

No PAC available.

DFG MAK: No numerical value established. Data may be available.

Australia: TWA 10 ppm (61 milligram per cubic meter); STEL 20 ppm, 1993; Austria: MAK 10 ppm (60 milligram per cubic meter), 1993; Denmark: TWA 10 ppm (60 milligram per cubic meter), 1999; Finland: TWA 10 ppm (60 milligram per cubic meter); STEL 20 ppm (120 milligram per cubic meter) [skin] 1999; France: VME 10 ppm (60 milligram per cubic meter), 1999; Norway: TWA 10 ppm (60 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 6.1 milligram per cubic meter, 2003; Switzerland: MAK-W 10 ppm (60 milligram per cubic meter), KZG-W 20 ppm (120 milligram per cubic meter), 1999; Turkey: TWA 10 ppm (60 milligram per cubic meter), 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 1 ppm. The state of Virginia has set a limit in ambient air[60] of 1.0 milligram per cubic meter. Several states have set guidelines or standards for this compound in ambient air[60] ranging from 600 to 1200 μ/m^3 (North Dakota) to 1000 μ/m^3 (Virginia) to 1200 μ/m^3 (Connecticut) to 1429 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method 1501

Aromatic hydrocarbons or OSHA Analytical Method 7, Organic Vapors[18].

Routes of Entry: Inhalation, ingestion, eye and skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin, and respiratory tract; dry nose and throat; and headaches; low blood pressure; tachycardia; abnormal cardiovascular system behavior; CNS depression; hematopoietic depression. LD_{50} = (oral-rat) 1500 mg/kg (slightly toxic). This chemical may cause effects on the CNS.

Long-Term Exposure: The liquid defats the skin, and may have effects on the liver and kidneys.

Points of Attack: Eyes, skin, respiratory system; cardiovascular system; central nervous system; bone marrow, liver, kidneys.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. CBC, electrocardiogram.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear appropriate clothing to prevent repeated or prolonged skin contact. **8 hours** (more than 8 hours of resistance to breakthrough $>0.1\ \mu g/cm^2/min$): polyvinyl alcohol gloves; Viton gloves, suits. **4 hours:** (At least 4 but <8 hours of resistance to breakthrough >0.1 $0.1\ \mu g/cm^2/min$): nitrile, 4 H and Silver Shield gloves. Wear eye protection to prevent any reasonable probability of eye contact. Employees should wash promptly when skin is wet or contaminated. Remove nonimpervious clothing promptly if wet or contaminated.

Respirator Selection: *100 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); PaprOv (APF = 25) [any PAPR with organic vapor cartridge (s)]; or CcrFOv (APF = 50) [any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s)]; GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted acid gas canister]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode. *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance causes eye irritation or damage; eye protection needed.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2667 Butyltoluenes, Hazard Class: 6.1; Labels: 6.1—Poisonous materials.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include oxides of carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration, preferably in admixture with a more flammable solvent[24].

References

(31); (173); (101); (138); (2); (100).

NIOSH/OSHA, Occupational Health Guidelines for Chemical Hazards, DHHS, NIOSH Publication No. 81-123; 88-118; Supplements. I–IV, Cincinnati, OH, (1981–1995).

Butyl Trichlorosilane B:1010

Formula: $C_4H_9Cl_3S$; $CH_3(CH_2)_3SiCl_3$

Synonym s: *n*-Butiltriclorosilano (Spanish); Butylsilicon trichloride*;* *n*-Butyltrichlorosilane

CAS Registry Number: 7521-80-4

HSDB Number: 283

RTECS Number: VV2080000

UN/NA & ERG Number: UN1747/155

EC Number: 231-38-3

Regulatory Authority and Advisory Information

Department of Homeland Security Screening TQ (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade).

Hazard Alert: Flammable, Corrosive, Violently water reactive.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: F, C; risk phrases: R10; R14; R34; safety phrases: S1; S26; S36/37/39; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Butyl trichlorosilane is a colorless liquid. Molecular weight = 191.57. Specific gravity (H_2O:1) = 1.16 @ 20°C; boiling point = 149°C; flash point = 45°C (cc); 54°C (oc)[17]. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 2; reactivity 2 ₩. Insoluble in water. Reacts violently with water, rapidly releasing corrosive hydrogen chloride gas.

Potential Exposure: This is a raw material for silicone resin production.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Chlorosilanes react vigorously with bases and both organic and inorganic acids genera ting toxic and/or flammable gases. Chlorosilanes react with water, moist air, or steam to produce heat and toxic, corrosive fumes of hydrogen chloride. They may also produce flammable gaseous hydrogen. Attacks metals in the presence of moisture.

Permissible Exposure Limits in Air

PAC* Ver. 29[138]

PAC-1: $\mathbf{0.6_A}$ ppm

PAC-2: $\mathbf{7.3_A}$ ppm

PAC-3: $\mathbf{33_A}$ ppm

*AEGLs are marked with a subscript "**A**" and correspond to 60 minutes values.

Routes of Entry: Inhalation, skin, eyes.

Harmful Effects and Symptoms

Short-Term Exposure: Butyl trichlorosilane is a corrosive chemical and can cause severe eye burns leading to permanent damage. Contact can cause severe skin burns. Exposure to vapors can irritate the eyes, nose and throat. Butyl trichlorosilane can affect you when breathed in. Exposure can irritate the lungs, causing coughing and/or shortness of breath. Higher exposure can cause a build-up of the fluid in the lungs (pulmonary edema). This can cause death.

Long-Term Exposure: Repeated exposure may cause bronchitis to develop with cough, phlegm, and/or shortness of breath.

Points of Attack: Lungs.

Medical Surveillance Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Post hazard and warning information in the work area. In addition, as part of an ongoing education and training effort, communicate all information on the health and safety hazards of butyl trichlorosilane to potentially exposed workers.

Respirator Selection: Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls, and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit. *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFAg (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: (1) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. (2) Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with butyl trichlorosilane all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from moisture and incompatible materials listed above. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN1747 Butyl trichlorosilane, Hazard class: 8; Labels: 8—Corrosive material, 3—Flammable liquid.

Spill Handling:

Butyl trichlorosilane ***when spilled on water.***

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

when spilled in water

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.2/0.3

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.4/0.6
Night 1.1/1.8

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products include hydrogen chloride, chlorine, phosgene, and oxides of carbon. Use dry chemical or carbon dioxide. Foam extinguishers are not recommended. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Butyl Trichlorosilane*, Trenton, NJ (September 1998).

Butyl Vinyl Ether B:1020

Formula: $C_6H_{12}O$; $CH_2{=}CHOC_4H_9$

Synonyms: Butane, 1-(ethenyloxy)-; Butoxyethene; 1-(Ethenyloxy)butane; Ether, butyl vinyl; Vinyl *n*-butyl ether; Vinyl butyl ether

CAS Registry Number: 111-34-2

HSDB Number: 6384

RTECS Number: KN5900000

UN/NA & ERG Number: UN2352/127 (P)

EC Number: 203-860-7

Regulatory Authority and Advisory Information

Hazard Alert: Highly flammable, Polymerization hazard.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: F; risk phrases: R11; R19; R51; safety phrases: S9; S14; S16; S21; S33; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [2-Hazard to water. (est.)]

Description: Butyl vinyl ether is an extremely flammable, colorless liquid. ether like odor. Molecular weight = 100.2; specific gravity (H_2O:1) = 0.8; boiling point = 94°C; freezing/melting point = −112.8°C; vapor density (air = 1) = 3.5; flash point = −9.4°C (oc);[17] Autoignition temperature = 255°C. Hazard identification (based on NFP A-704 M Rating System): Health 2; flammability 3; reactivity 1 ₩. Slightly soluble in water.

Potential Exposure: This material may be used in organic synthesis and in copolymer manufacture.

Incompatibilities: Vapors may form explosive mixture with air. Moderately explosive by spontaneous chemical reaction. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Able to form unstable peroxides, which can cause polymerization.

Permissible Exposure Limits in Air

No standards or PAC available.

Routes of Entry: Inhalation, skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: May be poisonous if inhaled or absorbed through skin. Vapors may cause dizziness or suffocation. Contact may irritate or burn skin and eyes. LD_{50} = (oral-rat) 15,000 mg/kg.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear solvent-resistant gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls, and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit. *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister

having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).
Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with butyl vinyl ether all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.
Shipping: UN2352 Butyl vinyl ether, stabilized, Hazard Class: 3; Labels: 3—Flammable liquid.
Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Stay upwind. Remove all ignition sources. Stop leak if you can do so without risk. Use water spray to reduce vapors. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.
Fire Extinguishing: Dangerous, fire risk. Thermal decomposition products may include oxides of carbon. For small fires use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. For large fires use water spray, fog, or alcohol foam. Move containers from fire area if you can do so without risk. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.
Disposal Method Suggested: Controlled incineration.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Butyl Vinyl Ether, Washington, DC, Chemical Emergency Preparedness Program (October 31, 1985).

Butyraldehyde B:1030

Formula: C_4H_8O
Synonyms: Aldehyde butyrique (French); Butal; Butaldehyde; Butalyde; Butanal; Butirraldehido (Spanish); *n*-Butyl aldehyde; Butyl aldehyde; Butyral; Butyraldehyd (German); *n*-Butyraldehyde; Butyric acid; Butyric aldehyde; NCI-C56291
CAS Registry Number: 123-72-8
HSDB Number: 2798
RTECS Number: ES2275000
UN/NA & ERG Number: UN1129/129 (P)
EC Number: 204-646-6 [*Annex I Index No.:* 605-006-00-2]
Regulatory Authority and Advisory Information
Hazard Alert: Highly flammable, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction), Polymerization hazard.
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%; NPRI.
Hazard symbols, risk, & safety statements: Hazard symbol: F; risk phrases: R3; R11; R19; R36/37/38; R63; safety phrases: S2; S9; S21; S29; S33 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.
Description: Butyraldehyde is a highly flammable, colorless liquid with a pungent odor. Molecular weight = 72.12; specific gravity (H_2O:1) = 0.79; boiling point = 75°C; freezing/melting point = −99°C; flash point = −6.7°C; relative vapor density (air = 1) = 2.5; Autoignition temperature = 218°C. Explosive limits in air: LEL: 1.9%; UEL: 12.5%. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 3; reactivity 0 ₩. Slowly mixes with water; solubility = 7%.
Potential Exposure: Used in making synthetic resins, solvents, and plasticizers.
Incompatibilities: May form explosive mixture with air. Butyraldehyde can presumably form explosive peroxides, and may polymerize due to heat or contact with acids or alkalis. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, caustics, ammonia, aliphatic amines; alkanolamines, aromatic amines. May accumulate static electrical charges, and may cause ignition of its vapors. Possible self-reaction in air; undergoes rapid oxidation to

butyric acid in May corrode steel due to corrosive action of butyric acid.

Permissible Exposure Limits in Air

Odor threshold = 0.009 ppm.

PAC Ver. 29[138]

PAC-1: 75 ppm

PAC-2: 430 ppm

PAC-3: 830 ppm

Russia: STEL 5 milligram per cubic meter, [skin].

Permissible Concentration in Water: No criteria set.

Determination in Water: Octanol−water coefficient: Log K_{ow} =< 1.2. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Butyraldehyde is corrosive. Irritates the eyes, skin, and respiratory tract. Eye or skin contact may cause burns and possible permanent damage. High exposure can cause dizziness and lightheadedness. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: Prolonged or repeated skin exposure may cause skin disorders. Testing has not been completed to determine the carcinogenicity of butyraldehyde. However, the limited studies to date indicate that these substances have chemical reactivity and mutagenicity similar to acetaldehyde and malonaldehyde. Therefore, NIOSH recommends that careful consideration should be given to reducing exposures to this aldehyde. Further information can be found in the *NIOSH Current Intelligence Bulletin 55: Carcinogenicity of Acetaldehyde and Malonaldehyde, and Mutagenicity of Related Low-Molecular-Weight Aldehydes* [DHHS (NIOSH), Publication No. 91-112].

Points of Attack: Lungs, skin.

Medical Surveillance: Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear solvent-resistant gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls, and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit. *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Protect against physical damage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Outside or detached storage is preferred. Prior to working with Butyraldehyde all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from incompatible materials listed above. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN1129 Butyraldehyde, Hazard Class: 3; Labels: 3—Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquid in vermiculite, dry sand; earth or similar noncombustible absorbent material and deposit in sealed containers. *Do not* use sawdust or other combustible absorbent. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated run off enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Butyraldehyde*, Trenton, NJ (July 2002).

Butyric Acid B:1040

Formula: $C_4H_8O_2$: $CH_3(CH_2)_2COOH$

Synonyms: Acido butirico (Spanish); Butanic acid; *n*-Butanoic acid; Butanoic acid; Buttersaeure (German); *n*-Butyric acid; *normal* Butyric acid; Butyric acid; Ethylacetic acid; 1-Propanecarboxylic acid; Propylformic acid

CAS Registry Number: 107-92-6; Much of the following information may also apply to 79-31-2 (Isobutyric acid)

HSDB Number: 940

RTECS Number: ES5425000

UN/NA & ERG Number: UN2820 (butyric acid)/153; UN2529 (isobutyric acid)/132

EC Number: 203-532-3 [*Annex I Index No.*: 607-135-00-X] (107-92-6); 201-195-7 [*Annex I Index No.*: 607-063-00-9] (79-31-2)

Regulatory Authority and Advisory Information

Hazard Alert: Flammable, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction)

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV.D.3.b, RQ: 5000 lb (2270 kg)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: (*butyric acid; 107-92-6*) Hazard symbol: C; risk phrases: R34; R35; R37; safety phrases: S1/2; S26; S36; S45; (*isobutyric acid; 79-31-2*) Hazard symbol: F, C, Xn; risk phrases: R10; R21/22; R34; R35; R36/37/38; R61; safety phrases: S2; S26/; S36; R45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Butyric acid is a combustible, oily liquid with an unpleasant odor. The Odor Threshold is 0.0001 ppm[41]. Molecular weight = 88.12; specific gravity (H_2O:1) = 0.96; boiling point = 163.5°C; freezing/melting point = −7.87°C; vapor pressure = 0.44 mmHg @ 20°C; 1.65 @ 25°C; flash point = 72°C; Autoignition temperature = 440°C. Flammable Limits in Air: LEL: 2%; UEL: 10%. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 2; reactivity 0 ₩. Highly soluble in water.

Potential Exposure: In manufacture of butyrate esters, some of which go into artificial flavoring.

Incompatibilities: May form explosive mixture with air. Incompatible with sulfuric acid, caustics, ammonia, aliphatic amines; isocyanates, strong oxidizers; alkylene oxides; epichlorohydrin.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 1.4 ppm

PAC-2: 16 ppm

PAC-3: 110 ppm

The former-USSR-UNEP/IRPTC joint project MAC value is 2.5 ppm (10 milligram per cubic meter)[43] for workplace air. They also cite a momentary MAC value of 0.015 milligram per cubic meter and an allowable average daily MAC of 0.01 milligram per cubic meter in ambient air of residential areas.

Permissible Concentration in Water: No criteria set.

Determination in Water: Octanol−water coefficient: $\text{Log } K_{\text{ow}} = 0.8$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Butyric acid is a medium-strong corrosive acid. Can cause severe eye and skin irritation and burns leading to permanent damage. Inhalation can cause respiratory tract irritation, coughing, wheezing and/or shortness of breath. LD_{50} = (oral-rat) 2940 mg/kg (slightly toxic)[9].

Long-Term Exposure: Can affect the blood. Repeated exposures may cause bronchitis to develop with coughing, phlegm, and/or shortness of breath. May cause kidney damage.

Points of Attack: Skin, eyes and respiratory system.

Medical Surveillance: Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Lung function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting.

Personal Protective Methods: Wear solvent-resistant gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls, and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit. *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Protect against physical damage. Outside or detached storage is p referred. Prior to working with butyric acid all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from incompatible materials listed above. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2820 Butyric acid, Hazard class: 8; Labels: 8—Corrosive material. UN2529 Isobutyric acid, Hazard Class: 3; Labels: 3—Flammable liquid, 8—Corrosive material.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquid in vermiculite, dry sand; earth or similar material and deposit in sealed containers. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental

protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (100).

Sax, N.I., Ed., "*Dangerous Properties of Industrial Materials Report*" 2, No. 3, 71−73 (1982).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Butyric Acid*, Trenton, NJ (August 1998).

C

Cacodylic Acid C:0050

Formula: $C_2H_7AsO_2$

Synonyms: Acide cacodylique (French); Acide dimethylarsinique (French); Acido cacodilico (Spanish); Agent blue; Alkarsodyl; Ansan; Ansar; Ansar 160; Ansar 560; Arsinic acid, dimethyl-; Bolls-Eye; Cacodilato de sodio (Spanish); Cacodylate de sodium (French) Chexmate; Cottonaide HC; Dilic; Dimethylarsenic acid; Dimethylarsinic acid; Dimethylarsinic arsinic acid; DMAA; Erase; Hydroxydimethylarsine oxide; Monocide; Montar; Phylar; Phytar 138; Phytar 560; Phytar 600; Rad-E-Cate 25; Salvo; Silvisar 510; Sylvicor

CAS Registry Number: 75-60-5; 124-65-2 (sodium salt)

HSDB Number: 360 as dimethylarsenic acid; 731 as sodium cacodylate

RTECS Number: CH7525000

UN/NA & ERG Number: UN1572/151; UN1688/152 (sodium salt); UN3280 (organoarsenic compounds, liquid, n.o.s.)/151

EC Number: 200-883-4

Regulatory Authority and Advisory Information

Carcinogenicity: EPA: Classification category B2, Probable human carcinogen.

California Proposition 65 Chemical[102]: Cancer 5/1/1996

Hazard Alert: Exposure can be lethal, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction), Organometallic, Strong reducing agent, Environmental hazard. Agricultural Chemical, Drug.

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 1 lb (0.454 kg)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U136

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

EPCRA Section 313 Form R (as organic arsenic compound) *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as dimethylarsinic acid

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0% as arsenic, water-soluble compounds, n.o.s.

Canada: Priority Substance List & Restricted Substances/Ocean Dumping *forbidden* (CEPA), National Pollutant Release Inventory (NPRI) (arsenic compounds).

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T+; risk phrases: R45; R27/28; R50/53; R62; R63; safety phrases: S13; S28; S29/35; S41; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Cacodylic acid is a colorless, odorless, crystalline solid arsenic compound. Molecular weight = 138.02; boiling point = 200°C; freezing/melting point = 195°C. Hazard identification (based on NFPA-704 M Rating System): Health 4, flammability 0, reactivity 0[70]. Highly soluble in water.

Cacodylic acid, sodium salt (sodium cacodylate): Molecular weight = 159.99; freezing/melting point = 200°C. Hygroscopic.

Potential Exposure: Used as an herbicide, soil sterilant and in timber thinning. Has been used as a chemical warfare agent.

Incompatibilities: A strong reducing agent. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Aqueous solution reacts violently with chemically active metals releasing toxic arsenic fumes. Incompatible with oxidizers, sulfuric acid; caustics (strong bases), reducing agents; ammonia, amines, isocyanates, alkylene oxides; epichlorohydrin.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 2.8 milligram per cubic meter

PAC-2: 25 milligram per cubic meter

PAC-3: 140 milligram per cubic meter

Arsenic, organic compounds

OSHA PEL: 0.5 mg[As]/m^3 TWA

NIOSH REL: Not established. See NIOSH Pocket Guide, Appendix A

ACGIH TLV[1]: 0.01 mg[As]/m^3 TWA; Confirmed Human Carcinogen; BEI established.

PAC Ver. 29[138]

124-65-2 (sodium salt)

PAC-1: 3.2 milligram per cubic meter

PAC-2: 86 milligram per cubic meter

PAC-3: 510 milligram per cubic meter

Determination in Air: Filter; Reagent: Ion chromatography/hydride atomic absorption (AA): NIOSH IV [#5022, Arsenic, organo-][18].

Permissible Concentration in Water: EPA[6] recommends a zero concentration of arsenic for human health reasons. Federal Drinking Water Guidelines: EPA 10 μg/L; State Drinking Water Guidelines: Arizona 10 μg/L; Connecticut 10 μg/L. Toxic pollutant designated pursuant to Section 307 (a) (1) of the Clean Water Act and is subject to effluent limitations (arsenic and inorganic and organic arsenic) [40 CFR 401.15 (7/1/1987)]. Canadian Drinking Water Standards: IMAC 0.025 [As] mg/L. Runoff from spills or fire control may cause water pollution.

Determination in Water: See OSHA Analytical Method ID-105 for arsenic. The AA graphite furnace technique is

Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens.
DOI: http://dx.doi.org/10.1016/B978-0-323-38968-6.00003-X

often used for measurement of total arsenic in water. It also has been standardized by EPA. Total arsenic may be determined by digestion followed by silver diethyldithiocarbamate; an alternative is AA; another is inductively coupled plasma (ICP) optical emission spectrometry. Fish Tox = 2841.14769000 ppb MATC (VERY LOW).

Routes of Entry: Inhalation, ingestion; skin and/or eye contact. This chemical can be absorbed through the skin, thereby increasing exposure.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin, and respiratory tract. Skin contact can also cause burning, itching, thickening, and color changes.

Long-Term Exposure: Certain other arsenic compounds have been identified as carcinogen. Although this chemical has not been identified as a carcinogen it should be handled with extreme caution. May cause an ulcer of the "bone" dividing the inner nose. It can cause disturbed sleep; thickening of the skin with patch areas of darkening and loss of pigment, or the development of white lines in the nails. May cause liver and kidney damage. Repeated exposure can lead to a metallic or garlic taste in the mouth; loss of appetite; nausea, vomiting, difficulty in swallowing; stomach pain; diarrhea, and possible death. *In animals*: Irritation skin, possible dermatitis; respiratory distress; diarrhea; kidney damage; muscle tremor, convulsions; possible gastrointestinal tract; reproductive effects; possible liver damage. Human Tox = 5.61798 ppb CHCL (Chronic Human Carcinogen Level) (HIGH).

Points of Attack: Skin, respiratory system; kidneys, central nervous system; liver, gastrointestinal tract; reproductive system.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure. Test for urine arsenic. Levels should not be greater than 100 μg/g of creatinine in the urine. Examine the skin for abnormal growths. Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: For severe poisoning, BAL (British Anti-Lewisite), Dimercaprol, dithiopropanol ($C_3H_8OS_2$) has been used to treat toxic symptoms of certain heavy metals poisoning—including arsenic. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5). For milder poisoning *penicillamine* (*not penicillin*) has been used, both with mixed success. Side effects occur with such treatment and it is never a substitute for controlling exposure. It can only be done under strict medical care.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any concentrations above the NIOSH REL, or where there is no REL, At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) [any self-contained breathing apparatus (SCBA) that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode]; or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFAg100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with cacodylic acid all handlers should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Store in tightly closed containers in a cool, well-ventilated area away from oxidizing agents; chemically active metals; strong bases; moisture, fertilizers, seeds, insecticides, and fungicides.

Shipping: UN1572 Cacodylic acid & UN1688 Sodium Cacodylate, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN3465 Organoarsenic compound, solid, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required

Spill Handling:

Organoarsenic compound, solid or liquid

Initial isolation and protective action distances
Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)
First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.5/0.8

Large spills (From a large package or from many small packages)
First: Isolate in all directions (ft/m) 500/60
Then: Protect persons downwind (mi/km)
Day 1.1/1.8
Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Stay upwind; keep out of low areas. Wear self-contained (positive pressure if available) breathing apparatus and full protective clothing. Do not touch spilled material; stop leak if you can do it without risk. *Small liquid spills:* take up with sand or other noncombustible absorbent material into clean, dry container and cover; move containers from spill area. *Large spills:* dike far ahead of spill for later disposal. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical may burn, but does not readily ignite. Thermal decomposition products may include arsenic hydride, oxides of arsenic, metal, and carbon. Use dry chemical, carbon dioxide; water spray; alcohol foam or polymer foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution-control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(102); (31); (173); (101); (138); (100).
New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Cacodylic Acid, Trenton, NJ (January 1999).
New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Sodium Cacodylate #1687, Trenton, NJ (July 2008, revised).

Cadmium and Inorganic Compounds C:0100

Formula: Cd
Synonyms: Cadmio (Spanish); C.I. 77180; Colloidal cadmium; Elemental cadmium; Kadmium (German)
CAS Registry Number: 7440-43-9 (elemental)
HSDB Number: 282
RTECS Number: EU9800000 (metal)
UN/NA & ERG Number: UN2570 (for cadmium compounds)/154
EC Number: 231-152-8 [*Annex I Index No.:* 048-002-00-0]
Regulatory Authority and Advisory Information
Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen; Cadmium and Cadmium compounds; IARC: Animal Sufficient Evidence (cadmium and cadmium compounds), Limited evidence (metal); Human Sufficient Evidence, *carcinogenic to humans*, Group 1, 1997
California Proposition 65 Chemical[102]: Cancer 10/1/1987; Developmental/Reproductive toxin (male) 5/1/1997
Alert (metal): Combustible, Pyrophoric hazard, Possible risk of forming tumors, Reproductive toxin: Possible risk of gene damage/impaired fertility; Suspected reprotoxic hazard, Environmental hazard.
Banned or Severely Restricted (many countries) (UN)[13,35]
Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112). Includes any unique chemical substance that contains cadmium as part of that chemical's infrastructure
United States National Primary Drinking Water Regulations: MCLG = 0.005 mg[Cd]/L; MCL = 0.005 mg [Cd]/L as Cadmium
Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/1992); Toxic Pollutant (Section 401.15)
United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): D006
RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed
RCRA Toxicity Characteristic (Section 261.24), Maximum Concentration of Contaminants, regulatory level, 1.0 mg/L

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.69; Nonwastewater (mg/L), 0.19 TCLP

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 601 (40); 7130 (50); 7131 (1)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg). *Note*: No release report required if diameter of pieces is equal to or exceeds 0.004 in

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B): Severe pollutant, as cadmium compounds

Mexico Drinking Water Criteria: 0.01 mg/L.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%. as cadmium, elemental, also cadmium chloride, cadmium oxide, cadmium sulfate; NPRI; CEPA Priority Substance List, Ocean dumping prohibited; Drinking Water Quality: 0.005 mg/L MAC.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

European/International Regulations (*cadmium*): Hazard symbol: T+, N; risk phrases: R45; R17; R26; R48/23/25; R50/53; R62; R63; R68; R50/53; R62; R63; safety phrases: S29; S53; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class):3-Severe hazard to waters.

Description: Cadmium is a bluish-white metal. Molecular weight = 112.4; boiling point = 765°C; freezing/melting point = 321°C; autoignition temperature (*metal dust*) = 250°C. Hazard identification (based on NFPA-704 M Rating System): (*powder*) Health 3, flammability 2, reactivity 0. Insoluble in water. The only cadmium mineral, greenockite (CdS), is rare; however, small amounts of cadmium are found in zinc, copper, and lead ores. It is generally produced as a by-product of these metals, particularly zinc. Cadmium is insoluble in water but is soluble in acids. "Cadmium dust" includes dust of various cadmium compounds, such as $CdCl_2$. "Cadmium fume" has the composition Cd/CdO.

Potential Exposure: Cadmium is a highly corrosion resistant and is used as a protective coating for iron, steel, and copper; it is generally applied by electroplating, but hot dipping and spraying are possible. Cadmium may be alloyed with copper, nickel, gold, silver, bismuth, and aluminum to form easily fusible compounds. These alloys may be used as coatings for other materials; welding electrodes, solders, etc. It is also utilized in electrodes of alkaline storage batteries, as a neutron absorber in nuclear reactors, a stabilizer for polyvinyl chloride plastics, a deoxidizer in nickel plating; an amalgam in dentistry; in the manufacture of fluorescent lamps, semiconductors, photocells, and jewelry, in process engraving, in the automobile and aircraft industries; and to charge Jones reductors. Various cadmium compounds find use as fungicides, insecticides, nematocides, polymerization catalysts, pigments, paints, and glass; they are used in the photographic industry and in glazes. Cadmium is also a contaminant of superphosphate fertilizers. Human exposure to cadmium and certain cadmium compounds occurs through inhalation and ingestion. The entire population is exposed to low levels of cadmium in the diet because of the entry of cadmium into the food chain as a result of its natural occurrence. Tobacco smokers are exposed to an estimated 17 μg/cigarette. Cadmium is present in relatively low amounts in the earth's crust; as a component of zinc ores, cadmium may be released into the environment around smelters.

Incompatibilities: Air exposure with cadmium powder may cause self-ignition. Moist air slowly oxidizes cadmium forming cadmium oxide. Cadmium dust is incompatible with strong oxidizers, ammonium nitrate; elemental sulfur; hydrazoic acid; selenium, zinc, tellurium. Contact with acids cause a violent reaction, forming flammable hydrogen gas.

Permissible Exposure Limits in Air

NIOSH IDLH = 9 mg [Cd]/m^3 (dust and fume)

OSHA PEL: *dust and fume* 0.005 mg[Cd]/m^3 TWA [*Note:* The PEL applies to all cadmium compounds (as Cd).]

NIOSH REL: Potential carcinogen. Limit exposure to lowest feasible level. [*Note:* The REL applies to all cadmium compounds (as Cd).]

ACGIH TLV[1]: 0.01 mg[Cd]/m^3 inhalable dust, Suspected Human Carcinogen; 0.002 mg[Cd]/m^3, respirable dust, Suspected Human Carcinogen; BEI: 5 mg[Cd]/g creatinine, urine; 5 mg[Cd]/L, blood

PAC* Ver. 29[138]

PAC-1: **0.10**$_A$ mg/m

PAC-2: **0.76**$_A$ mg/m

PAC-3: **4.7**$_A$ mg/m

*AEGLs (Acute Emergency Guideline Levels) are in **bold face**. Subscript "A" signifies 60-minute AEGL.

Cadmium and inorganic compounds

DFG MAK: [skin]; Carcinogen Category 1; Germ Cell Mutagen Group: 3A

Arab Republic of Egypt: TWA 0.05 milligram per cubic meter, 1993; Australia: TWA 0.05 milligram per cubic meter, 1993; Austria: carcinogen, 1999; Belgium: TWA 0.05 milligram per cubic meter, 1993; Denmark: TWA 0.01 milligram per cubic meter, 1999; Finland: TWA 0.02 milligram per cubic meter, carcinogen, 1999; France: VME 0.05 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 0.005 milligram per cubic meter, 2003; Japan: 0.05 milligram per cubic meter, Group 1 carcinogen, 1999; Norway: TWA 0.05 milligram per cubic meter, 1999; the Philippines: TWA 0.2 milligram per cubic meter, 1993; Poland: MAC (TWA) (*fume*) 0.02 milligram per cubic meter, MAC (STEL) (*fume*) 0.05 milligram per cubic meter, 1999; MAC (TWA) (*dust*): 0.04 milligram per cubic meter, MAC (STEL) (*dust:*) 0.2 milligram per cubic meter, 1999; Russia: TWA 0.01 milligram per cubic meter; STEL 0.05 milligram per cubic meter, 1993; Sweden: NGV 0.05 milligram per cubic meter (total *dust*), 1999; Sweden: TWA 0.01 milligram per cubic meter (respirable *dust*), 1999; Switzerland: MAK-W 0.05 milligram per cubic meter, carcinogen, 1999; Thailand: TWA 0.2 milligram per cubic meter; STEL 0.5 milligram per cubic meter, 1993; Turkey: TWA 0.2 milligram per cubic meter, 1993; United Kingdom: TWA 0.025 mg[Cd]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Suspected Human Carcinogen. Several states have set guidelines or standards for cadmium in ambient air[60] ranging from 0 (North Dakota) to 0.0006 μ/m^3 (Rhode Island) to 0.0055 μ/m^3 (North Carolina) to 0.0056 μ/m^3 (Massachusetts) to 0.07 (Montana) to 0.12 μ/m^3 (Pennsylvania) to 0.25 μ/m^3 (South Carolina) to 0.4 μ/m^3 (Connecticut and South Dakota) to 0.8 μ/m^3 (Virginia) to 1.0 μ/m^3 (Nevada) to 2.0 μ/m^3 (New York).

Determination in Air: Collection of particles on a filter, workup with acid and measurement by AA has been specified by NIOSH. For *dust* Use NIOSH Analytical Methods #7048 (Cd) and #7300 (Elements), #7303, #9102, or OSHA: ID-121, ID-125G, ID-189, ID-206; *fume*: NIOSH #7048, #7300, #7301, #7303, #7200 (Welding and Brazing Fume), and OSHA ID-121, ID-125G, ID-189, ID-206.

Permissible Concentration in Water: Safe Drinking Water Act (47FR 9352): MCL, 0.005 mg[Cd]/L; MCLG, 0.005 mg[Cd]/L. State Drinking Water Standards: Arizona 10 μg/L; State Drinking Water Guidelines: Arizona 5 μg/L; Maine 5 μg/L; Minnesota 4 μg/L.

Determination in Water: Total cadmium may be determined by digestion followed by AA of colorimetric (Dithizone) analysis or by ICP Optical Emission Spectrometry. Dissolved cadmium is determined by 0.45 μ filtration followed by the previously cited methods.

Routes of Entry: Inhalation or ingestion of fumes or dust.

Harmful Effects and Symptoms

Short-Term Exposure: *Inhalation:* Dust may cause irritation of the nose and throat. Nonfatal lung inflammation has been reported from concentrations of 0.5−2.5 milligram per cubic meter. In 4−10 hours after exposure severe chest pain; with persistent cough and difficult breathing; headache, chills, muscle aches; nausea, vomiting, diarrhea. Fluid in the lungs (pulmonary edema) and dark-purple coloration of the skin may occur. Pulmonary edema is a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Breathing becomes more difficult and is accompanied by wheezing or coughing of blood. Other symptoms which may occur 12−36 hours after exposure in addition to those above include dizziness, irritability, gastrointestinal disturbances; shortness of breath; fever, profuse sweating; exhaustion and inflammation of the lungs. Death may result within 7−10 days after exposure. The average concentrations of fume responsible for fatalities have been 40−50 milligram per cubic meter for 1 hour, 9 milligram per cubic meter for 5 hours, or 5 milligram per cubic meter for 8 hours. *Skin:* Absorption is negligible. *Eyes:* Cadmium compound dust may cause irritation. *Ingestion:* A dose of 15−30 mg (1/1000 oz) of metal or soluble compounds may cause increased salivation; choking, vomiting, abdominal pain; anemia, kidney malfunction; diarrhea; and persistent desire to empty the bladder. Symptoms may occur within 15−30 minutes after ingestion. May cause heart and lung failure.

Long-Term Exposure: Cadmium can cause kidney and possibly other organ damage. Continued exposure to low levels of cadmium in air may cause irreversible lung injury, abnormal lung function, and kidney disease. Other consequences of cadmium exposures are inflammation of the nose and throat, open sores in the nose, soreness; bleeding and reduced nose size; loss of sense of smell; damage to the olfactory nerve; yellow cadmium stains on teeth; sleeplessness, nausea; lack of appetite; weight loss; anemia, lung distention with scar formation; and liver damage. May cause bone disease characterized by softening, bending, and reduction in bone size. Difficulty walking; pain in back and extremities; and spontaneous fractures may result. Inhalation of 0.06−0.68 milligram per cubic meter for 4−8 years may cause throat irritation, cough, chest pain, upset stomach, and fatigue. Exposure to levels of 3.0−15.0 milligram per cubic meter of fumes or dust over a period of 20 years has caused lung distention, anemia; protein in urine and kidney dysfunction. Studies indicate that there is an increased incidence of prostatic cancer and possible kidney and respiratory cancer in cadmium workers. Cadmium causes birth defects in rats, mice, and hamsters; whether it does so in humans is not known.

Points of Attack: Kidney damage, respiratory system, lungs, prostate, blood.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure. In preemployment physical examinations, emphasis should be given to a history of, or actual presence of: significant kidney disease, smoking history, and respiratory disease. A chest X-ray and baseline pulmonary function study is recommended. Periodic examinations should emphasize the respiratory system, including pulmonary function tests, kidneys and blood. A low molecular weight proteinuria may be the earliest indication of renal toxicity. The trichloroacetic acid test may pick this up, but more specific quantitative studies would be preferable. If renal disease due to cadmium is present, there may also be increased excretion of calcium, amino acids, glucose, and phosphates.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy. *Note to physician:* For severe poisoning, *do not* use BAL, dimercaprol, dithiopropanol ($C_3H_8OS_2$) as it is contraindicated or ineffective in poisoning from cadmium.

Personal Protective Methods: Cadmium dust (metal) Prevent skin contact. Any barrier that will prevent contamination from the dry chemical. Wear protective eye protection, gloves, and clothing to prevent skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield to prevent any possibility of eye contact, unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full facepiece respirator with an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue (*carcinogen*): Health Hazard: Store in a secure poison location. Prior to working with cadmium all handlers should be trained on its proper handling and storage. Cadmium must be stored to avoid contact with sulfur, selenium, tellurium, ammonium nitrate, and hydrazoic acid, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates). Sources of ignition, such as smoking and open flames are prohibited where cadmium is used, handled, or stored in a manner that could create a potential fire or explosion hazard. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2570 Cadmium compounds, Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable powder. Thermal decomposition products may include metal oxides. Use dry chemicals appropriate for metal fires, or dry sand. Use no other extinguishing agents. *Do not use water*. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: With cadmium compounds in general, precipitation from solution as sulfides, drying and return of the material to suppliers for recovery is recommended. Cadmium may be recovered from battery scrap as an alternative to disposal[22]. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(109); (102); (31); (173); (101); (138); (2); (170); (100).

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Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 1, No. 1, 36−38 (1980) and 3, No. 5, 72−76 (1983).

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United States Environmental Protection Agency, Health advisory: Cadmium, Washington, DC, Office of Drinking Water (March 31, 1987).

United States Public Health Service, "Toxicological Profile for Cadmium," Agency for Toxic Substances and Disease Registry (November 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Cadmium, Trenton, NJ (December 1999).

Cadmium Acetate C:0110

Formula: $C_4H_6CdO_4$; $Cd(C_2H_3O_2)_2$

Synonyms: Acetic acid, cadmium salt; Aceto cadmio (Spanish); Bis(acetoxy)cadmium; Cadmium(II) acetate; Cadmium diacetate; C.I. 77185

CAS Registry Number: 543-90-8

HSDB Number: 280

RTECS Number: EU9810000

UN/NA & ERG Number: UN2570/154

EC Number: 208-853-2

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Sufficient Evidence; Human Sufficient Evidence, *carcinogenic to humans*, Group 1; NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen

California Proposition 65 Chemical[102]: Cancer 10/1/1987

Hazard Alert: Poison, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Environmental hazard.

Clean Air Act: Toxic Pollutant (Section 401.15), Hazardous Air Pollutants (Title I, Part A, Section 112). *Note:* Includes any unique chemical substance that contains cadmium as part of that chemical's infrastructure

United States National Primary Drinking Water Regulations: MCLG = 0.005 mg[Cd]/L; MCL = 0.005 mg [Cd]/L as Cadmium

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B): Severe pollutant, as cadmium compounds

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. as cadmium acetate; NPRI; CEPA Priority Substance List, Ocean dumping prohibited, as cadmium compounds.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, N; risk phrases:R45; R20/21/22; R25; R26; R46; R48/23/25; R50/53; R60; R61; R62; R63; safety phrases: S22; S28; R29; R35; S36/37; S45; S53; S60; S61; 41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Cadmium acetate is a colorless crystalline solid; freezing/melting point = 130°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 0. Soluble in water.

Potential Exposure: Cadmium acetate is used in ceramics, textile dyeing, and printing and electroplating; and to make other acetate compounds.

Incompatibilities: Compounds of the carboxyl group react with all bases, both inorganic and organic (i.e., amines) releasing substantial heat, water, and a salt that may be harmful. Incompatible with arsenic compounds (releases hydrogen cyanide gas), diazo compounds, dithiocarbamates, isocyanates, mercaptans, nitrides, sulfides (releasing heat, toxic, and possibly flammable gases), thiosulfates, and dithionites (releasing hydrogen sulfate and oxides of sulfur). Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

NIOSH IDLH = 9 mg [Cd]/m^3
OSHA PEL: *dust and fume* 0.005 mg[Cd]/m^3 TWA
NIOSH REL: Potential carcinogen. Limit exposure to lowest feasible level.
ACGIH TLV[1]: 0.01 mg[Cd]/m^3 inhalable dust, Suspected Human Carcinogen; 0.002 mg[Cd]/m^3, respirable dust, Suspected Human Carcinogen; BEI: 5 mg[Cd]/g creatinine, urine; 5 mg[Cd]/L, blood
PAC Ver. 29[138]
PAC-1: 0. 021 milligram per cubic meter
PAC-2: 1.6 milligram per cubic meter
PAC-3: 9.6 milligram per cubic meter
DFG MAK: [skin]; Carcinogen Category 1; Germ Cell Mutagen Group: 3A
Arab Republic of Egypt: TWA 0.05 milligram per cubic meter, 1993; Australia: TWA 0.05 milligram per cubic meter, 1993; Austria: carcinogen, 1999; Belgium: TWA 0.05 milligram per cubic meter, 1993; Denmark: TWA 0.01 milligram per cubic meter, 1999; Finland: TWA 0.02 milligram per cubic meter, carcinogen, 1999; France: VME 0.05 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 0.005 milligram per cubic meter, 2003; Japan: 0.05 milligram per cubic meter, Group 1 carcinogen, 1999; Norway: TWA 0.05 milligram per cubic meter, 1999; the Philippines: TWA 0.2 milligram per cubic meter, 1993; Poland: MAC (TWA) *(fume)* 0.02 milligram per cubic meter, MAC (STEL) *(fume)* 0.05 milligram per cubic meter, 1999; MAC (TWA) *(dust):* 0.04 milligram per cubic meter, MAC (STEL) *dust* 0.2 milligram per cubic meter, 1999; Russia: TWA 0.01 milligram per cubic meter; STEL 0.05 milligram per cubic meter, 1993; Sweden: NGV 0.05 milligram per cubic meter (total *dust*), 1999; Sweden: TWA 0.01 milligram per cubic meter (respirable *dust*), 1999; Switzerland: MAK-W 0.05 milligram per cubic meter, carcinogen, 1999; Thailand: TWA 0.2 milligram per cubic meter; STEL 0.5 milligram per cubic meter, 1993; Turkey: TWA 0.2 milligram per cubic meter, 1993; United Kingdom: TWA 0.025 mg[Cd]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Suspected Human Carcinogen. See also this section in the entry on Cadmium. North Carolina has set a guideline for cadmium acetate in ambient air[60] of 0.0055 μ/m^3.

Determination in Air: Collection of particles on a filter, workup with acid and measurement by AA has been specified by NIOSH. For *(dust):* Use NIOSH Analytical Methods #7048 (Cd) and #7300 (Elements), #7303, #9102, or OSHA: ID-121, ID-125G, ID-189, ID-206.

Permissible Concentration in Water: Federal Drinking Water Guidelines: MCLG = 0.005 mg[Cd]/L; MCL = 0.005 mg[Cd]/L; State Drinking Water Standards: Arizona 10 μg/L; State Drinking Water Guidelines: Arizona 5 μg/L; Maine 5 μg/L; Minnesota 4 μg/L.

Routes of Entry: Inhalation of dust, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Cadmium Acetate can affect us when breathed in. Cadmium Acetate is a carcinogen; handle with extreme caution. High exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Risk is greatest near dust or fume from heating or grinding cadmium acetate.

Long-Term Exposure: Repeated lower exposure can cause permanent kidney damage, emphysema, low blood sugar, and/or lowered sense of smell. Serious damage can occur at levels below the PEL. See also entry on “Cadmium.”

Medical Surveillance: Before beginning employment and at regular times after that, the following is recommended: Urine test for Cadmium (levels should be less than 10 μg/L of urine). Urine test for “low molecular weight proteins” (electrophoresis method best). urinalysis (UA). Complete blood count (CBC). Lung function test. These should be repeated after suspected overexposure. For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: Consider chest X-ray after acute overexposure.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Note to physician: For severe poisoning, do not use BAL, dimercaprol, dithiopropanol ($C_3H_8OS_2$) as it is contraindicated or ineffective in poisoning from cadmium.

Personal Protective Methods: *Clothing:* Avoid skin contact with Cadmium Acetate. Wear protective gloves and clothing. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day and put on before work. *Eye Protection:* Eye protection is included in the recommended respiratory protection.

Respirator Selection: $<$ or $= 50$ μg/m^3 Half-mask, air-purifying respirator (APR) equipped with a high-efficiency filter*. $<$ or $= 125$ μg/m^3 (1) Powered APR (PAPR) with a loose-fitting hood or helmet equipped with a high-efficiency filter* or (2) Supplied-air respirator with a loose-fitting hood or helmet facepiece operated in continuous-flow mode. $<$ or $= 250\ \mu g/m^3$ (1) Full-facepiece APR equipped with a high-efficiency filter*; (2) PAPR with a tight-fitting half-mask equipped with a high-efficiency filter*; or (3) Supplied-air respirator with a tight-fitting half-mask operated in continuous-flow mode. $<$ or $=$ $1250\ \mu g/m^3$ (1) PAPR with a tight-fitting full facepiece equipped with a high-efficiency filter* or (2) Supplied-air respirator with a tight-fitting full facepiece operated in continuous-flow mode. $<$ or $= 5000\ \mu g/m^3$ Supplied-air respirator with half-mask or full facepiece operated in pressure-demand or other positive-pressure mode. $>5000\ \mu g/m^3$ or unknown concentration (1) SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode or (2) Supplied-air respirator with a full facepiece operated in pressure-demand or other positive-pressure mode and equipped with an auxiliary escape-type SCBA operated in pressure-demand mode. *Firefighting:* SCBA with full facepiece operated in pressure-demand or other positive-pressure mode. Note: Quantitative fit testing is required for all tight-fitting APRs where airborne concentration of cadmium exceeds 10 times the TWAP EL ($10 \times 5\ \mu g/m^3 = 50\ \mu g/m^3$). A full facepiece respirator is required when eye irritation is expected.

* A high-efficiency filter means a filter that is at least 99.97% efficient against monodispersed particles of 0.3 μm in diameter or higher.

Storage: Color code—Blue: Health Hazard: Store in a secure poison location. Prior to working with Cadmium Acetate all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from heat and incompatible materials listed above. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2570 Cadmium compounds, Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Cadmium acetate itself does not burn. Thermal decomposition products may include oxides of cadmium metal and oxides of carbon. Extinguish fire using an agent suitable for type of surrounding fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Precipitation as sulfide, drying and return to supplier[22]. Incineration is not recommended.

References

(109); (102); (31); (173); (101); (138); (2); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" No. 4, 59–70 (1984).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Cadmium Acetate, Trenton, NJ (January 2001).

Cadmium Bromide C:0120

Formula: Br_2Cd; $CdBr_2$

Synonyms: Bromuro de cadmio (Spanish); Cadmium dibromide

CAS Registry Number: 7789-42-6

HSDB Number: 279

RTECS Number: EU9935000

UN/NA & ERG Number: UN2570/154

EC Number: 232-165-1

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Sufficient Evidence; Human Sufficient Evidence, *carcinogenic to humans*, Group 1; NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen.

California Proposition 65 Chemical[102]: Cancer 10/1/1987

Hazard Alert: Poison, Environmental hazard.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112). Includes any unique chemical substance that contains cadmium as part of that chemical's infrastructure

United States National Primary Drinking Water Regulations: MCLG = 0.005 mg[Cd]/L; MCL = 0.005 mg [Cd]/L as Cadmium

Clean Water Act: Toxic Pollutant (Section 401.15); Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B): Severe pollutant, as cadmium compounds

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. as cadmium salts, n.o.s.; NPRI; CEPA Priority Substance List, Ocean dumping prohibited, as cadmium compounds.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: N, Xn; risk phrases: R20/21/22; R36/37/38; R50/53; R60; R61; safety phrases: S16; S26; S29; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Cadmium bromide is a white to yellowish crystalline powder. Molecular weight = 272.22; specific gravity (H_2O:1) = 5.2: boiling point = 863°C; freezing/melting point = 567°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 0. Soluble in water.

Potential Exposure: Cadmium bromide is used in photography, engraving, and lithography.

Permissible Exposure Limits in Air

NIOSH IDLH = 9 mg [Cd]/m^3

OSHA PEL: *dust and fume* 0.005 mg[Cd]/m^3 TWA

NIOSH REL: Potential carcinogen. Limit exposure to lowest feasible level.

ACGIH TLV[1]: 0.01 mg[Cd]/m^3 inhalable dust, Suspected Human Carcinogen; 0.002 mg[Cd]/m^3, respirable dust, Suspected Human Carcinogen; BEI: 5 mg[Cd]/g creatinine, urine; 5 mg[Cd]/L, blood

PAC Ver. 29[138]

PAC-1: 0.24 milligram per cubic meter

PAC-2: 18 milligram per cubic meter

PAC-3: 11 milligram per cubic meter

DFG MAK: [skin]; Carcinogen Category 1; Germ Cell Mutagen Group: 3A

Arab Republic of Egypt: TWA 0.05 milligram per cubic meter, 1993; Australia: TWA 0.05 milligram per cubic meter, 1993; Austria: carcinogen, 1999; Belgium: TWA 0.05 milligram per cubic meter, 1993; Denmark: TWA 0.01 milligram per cubic meter, 1999; Finland: TWA 0.02 milligram per cubic meter, carcinogen, 1999; France: VME 0.05 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 0.005 milligram per cubic meter, 2003; Japan: 0.05 milligram per cubic meter, Group 1 carcinogen, 1999; Norway: TWA 0.05 milligram per cubic meter, 1999; the Philippines: TWA 0.2 milligram per cubic meter, 1993; Poland: MAC (TWA) *(fume)* 0.02 milligram per cubic meter, MAC (STEL) *(fume)* 0.05 milligram per cubic meter, 1999; MAC (TWA) *(dust):* 0.04 milligram per cubic meter, MAC (STEL) *dust* 0.2 milligram per cubic meter, 1999; Russia: TWA 0.01 milligram per cubic meter; STEL 0.05 milligram per cubic meter, 1993; Sweden: NGV 0.05 milligram per cubic meter (total *dust*), 1999; Sweden: TWA 0.01 milligram per cubic meter (respirable *dust*), 1999; Switzerland: MAK-W 0.05 milligram per cubic meter, carcinogen, 1999; Thailand: TWA 0.2 milligram per cubic meter; STEL 0.5 milligram per cubic meter, 1993; Turkey: TWA 0.2 milligram per cubic meter, 1993; United Kingdom: TWA 0.025 mg[Cd]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Suspected Human Carcinogen. See also this section in the entry on "Cadmium." North Carolina has set a guideline for cadmium acetate in ambient air[60] of 0.0055 μ/m^3.

Determination in Air: Collection of particles on a filter, workup with acid and measurement by AA has been specified by NIOSH. For *(dust):* Use NIOSH Analytical Methods #7048 (Cd) and #7300 (Elements), #7303, #9102, or OSHA: ID-121, ID-125G, ID-189, ID-206

Permissible Concentration in Water: Federal Drinking Water Guidelines: MCLG = 0.005 mg[Cd]/L; MCL = 0.005 mg[Cd]/L; State Drinking Water Standards: Arizona 10 μg/L; State Drinking Water Guidelines: Arizona 5 μg/L; Maine 5 μg/L; Minnesota 4 μg/L.

Determination in Water: Total cadmium may be determined by digestion followed by AA of colorimetric (Dithizone) analysis or by ICP Optical Emission Spectrometry. Dissolved cadmium is determined by 0.45 μ filtration followed by the previously cited methods. See also Ref.[49].

Routes of Entry: Inhalation of dust, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Cadmium bromide can affect you when breathed in. Cadmium bromide is a carcinogen; handle with extreme caution. High exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Risk is greatest near dust or fume from heating or grinding cadmium acetate.

Long-Term Exposure: Repeated exposures can cause anemia, permanent kidney damage; emphysema; low blood count and/or loss of sense of smell; fatigue; yellow staining of teeth. Cadmium bromide should be handled as a potential teratogenic agent and reproductive hazard, since several related cadmium compounds are known teratogens and decreases fertility in males and females. Repeated low exposures (below the OSHA PEL) can cause permanent kidney damage, which can go unnoticed without testing until severe. Kidney stones can also occur. Emphysema and/or lung scarring can occur from a single high exposure or repeated lower exposures. A recognized carcinogen of the connective tissue, lungs, and liver.

Points of Attack: Respiratory system; kidneys, liver.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended: Urine test for cadmium (levels should be less than 10 μg of cadmium per liter of urine). Urine test for low molecular weight proteins (electrophoresis method best). Urine analysis (UA). CBC. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Lung function tests. These should be repeated after suspected overexposure. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy. *Note to physician:* For severe poisoning, do not use BAL, dimercaprol, dithiopropanol ($C_3H_8OS_2$) as it is contraindicated or ineffective in poisoning from cadmium.

Personal Protective Methods: *Clothing:* Avoid skin contact with cadmium bromide. Wear protective gloves and clothing. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. *Eye Protection:* Eye protection is included in the recommended respiratory protection.

Respirator Selection: $<$ or $= 50\ \mu g/m^3$ Half-mask, APR equipped with a high-efficiency filter*. $<$ or $= 125\ \mu g/m^3$ (1) PAPR with a loose-fitting hood or helmet equipped with a high-efficiency filter* or (2) Supplied-air respirator with a loose-fitting hood or helmet facepiece operated in continuous-flow mode. $<$ or $= 250\ \mu g/m^3$ (1) Full-facepiece APR equipped with a high-efficiency filter*; (2) PAPR with a tight-fitting half-mask equipped with a high-efficiency filter*; or (3) Supplied-air respirator with a tight-fitting half-mask operated in continuous-flow mode. $<$ or $= 1250\ \mu g/m^3$ (1) PAPR with a tight-fitting full facepiece equipped with a high-efficiency filter* or (2) Supplied-air respirator with a tight-fitting full facepiece operated in continuous-flow mode. $<$ or $= 5000\ \mu g/m^3$ Supplied-air respirator with half-mask or full facepiece operated in pressure-demand or other positive-pressure mode. $>5000\ \mu g/m^3$ or unknown concentration (1) SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode or (2) Supplied-air respirator with a full facepiece operated in pressure-demand or other positive-pressure mode and equipped with an auxiliary escape-type SCBA operated in pressure-demand mode. *Firefighting:* SCBA with full facepiece operated in pressure-demand or other positive-pressure mode. Note: Quantitative fit testing is required for all tight-fitting APRs where airborne concentration of cadmium exceeds 10 times the TWA PEL ($10 \times 5\ \mu g/m^3 = 50\ \mu g/m^3$). A full facepiece respirator is required when eye irritation is expected.

* A high-efficiency filter means a filter that is at least 99.97% efficient against monodispersed particles of 0.3 μm in diameter or higher.

Storage: Color code—Blue: Health Hazard: Store in a secure poison location. Prior to working with cadmium bromide all handlers should be trained on its proper handling and storage. Cadmium bromide must be stored to avoid contact with Potassium, since violent reactions occur. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN 2570 Cadmium compounds, Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Cadmium bromide itself does not burn. Thermal decomposition products may include fumes of cadmium and bromine. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBA that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(173); (101); (109); (102); (31); (2); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 3, No. 5, 76–79 (1983).
New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Cadmium bromide, Trenton, NJ (February 2001).

Cadmium Chloride C:0130

Formula: $CdCl_2$

Synonyms: Caddy; Cadmium dichloride; Cloruro de cadmio (Spanish); Dichlorocadmium; Kadmiumchlorid (Germany); VI-CAD; Cadmium chloride, 2–5 hydrate (hemipentahydrate).

CAS Registry Number: 10108-64-2; 7790-78-5 (hemipentahydrate; cadmium chloride 5/2 hydrate)

HSDB Number: 278 (10108-64-2 & 7790-78-5)

RTECS Number: EV0175000

UN/NA & ERG Number: UN2570/154

EC Number: 048-008-00-3

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Sufficient Evidence; Human Sufficient Evidence, *carcinogenic to humans*, Group 1; NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen.

California Proposition 65 Chemical[102]: Cancer 10/1/1987.

Hazard Alert: Poison, Agricultural Chemical Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Environmental hazard.

Banned or Severely Restricted (In pesticides in UK)[13] (other) (UN)[35]

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112). Includes any unique chemical substance that contains cadmium as part of that chemical's infrastructure

United States National Primary Drinking Water Regulations: MCLG = 0.005 mg[Cd]/L; MCL = 0.005 mg[Cd]/L as Cadmium.

Clean Water Act: Toxic Pollutant (Section 401.15); Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

Superfund/EPCRA 40 CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B): Severe pollutant, as cadmium compounds

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%, as cadmium chloride; NPRI; CEPA Priority Substance List, Ocean dumping prohibited, as cadmium compounds.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, N; risk phrases: R28; R22; R25; R26; R36/37/38; R45; R48/23/25; R50/53; R60; R61; R62; R63; safety phrases: S1; S22; S28; S29; S36/37/39; S45; S53; S60; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Cadmium chloride is a colorless, odorless, crystalline solid, or powder. Molecular weight = 183.30; specific gravity (H_2O:1) = 4.06; boiling point = 964°C; freezing/melting point = 568°C; vapor pressure = 10 mmHg @ 656°C; hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 0. Soluble in water; solubility = 140 g/100 mL @ 20°C.

Cadmium chloride, hemipentahydrate: Molecular weight = 456.71; specific gravity (H_2O:1) = 3.33.

Potential Exposure: Cadmium chloride is used in dyeing and printing of fabrics; in electronic component manufacture; in photography; used as a pesticide and in nonpasture turf fungicides.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, sulfur, selenium, potassium.

Permissible Exposure Limits in Air

NIOSH IDLH = 9 mg [Cd]/m^3

OSHA PEL: *dust and fume* 0.005 mg[Cd]/m^3 TWA

NIOSH REL: Potential carcinogen. Limit exposure to lowest feasible level.

ACGIH TLV[1]: 0.01 mg[Cd]/m^3 inhalable dust, Suspected Human Carcinogen; 0.002 mg[Cd]/m^3, respirable dust, Suspected Human Carcinogen; BEI: 5 mg[Cd]/g creatinine, urine; 5 mg[Cd]/L, blood

PAC Ver. 29[138]

10108-64-2

PAC-1: 0.16 milligram per cubic meter

PAC-2: 1.2 milligram per cubic meter

PAC-3: 7.6 milligram per cubic meter

7790-78-5, hemipentahydrate

PAC-1: 0.1 milligram per cubic meter

PAC-2: 0.77 milligram per cubic meter

PAC-3: 9.5 milligram per cubic meter

DFG MAK: [skin]; Carcinogen Category 1; Germ Cell Mutagen Group: 3A

Arab Republic of Egypt: TWA 0.05 milligram per cubic meter, 1993; Australia: TWA 0.05 milligram per cubic meter, 1993; Austria: carcinogen, 1999; Belgium: TWA 0.05 milligram per cubic meter, 1993; Denmark: TWA 0.01 milligram per cubic meter, 1999; Finland: TWA 0.02 milligram per cubic meter, carcinogen, 1999; France: VME 0.05 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 0.005 milligram per cubic meter, 2003; Japan: 0.05 milligram per cubic meter, Group 1 carcinogen, 1999; Norway: TWA 0.05 milligram per cubic meter, 1999; the Philippines: TWA 0.2 milligram per cubic meter, 1993; Poland: MAC (TWA) (*fume*) 0.02 milligram per cubic meter, MAC (STEL) (*fume*) 0.05 milligram per cubic meter, 1999; MAC (TWA) (*dust*)*:* 0.04 milligram per cubic meter, MAC (STEL) *dust* 0.2 milligram per cubic meter, 1999; Russia: TWA 0.01 milligram per cubic meter; STEL 0.05 milligram per cubic meter, 1993; Sweden: NGV 0.05 milligram per cubic meter (total *dust*), 1999; Sweden: TWA 0.01 milligram per cubic meter (respirable *dust*), 1999; Switzerland: MAK-W 0.05 milligram per cubic meter, carcinogen, 1999; Thailand: TWA 0.2 milligram per cubic meter; STEL 0.5 milligram per cubic meter, 1993; Turkey: TWA 0.2 milligram per cubic meter, 1993; United Kingdom: TWA 0.025 mg[Cd]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Suspected Human Carcinogen. See also this section in the entry on "Cadmium." North Carolina has set a guideline for cadmium acetate in ambient air[60] of 0.0055 μ/m^3. Guidelines for cadmium chloride in ambient air have been set[60] ranging from 1.67 μ/m^3 (New York) to 5.0 μ/m^3 (Florida).

Determination in Air: Collection of particles on a filter, workup with acid and measurement by AA has been specified by NIOSH. For (*dust*): Use NIOSH Analytical Methods #7048 (Cd) and #7300 (Elements), #7303, #9102, or OSHA: ID-121, ID-125G, ID-189, ID-206

Permissible Concentration in Water: Federal Drinking Water Guidelines: MCLG = 0.005 mg[Cd]/L; MCL = 0.005 mg[Cd]/L; State Drinking Water Standards: Arizona 10 μg/L; State Drinking Water Guidelines: Arizona 5 μg/L; Maine 5 μg/L; Minnesota 4 μg/L.

Determination in Water: Total cadmium may be determined by digestion followed by AA of colorimetric (Dithizone) analysis or by ICP Optical Emission Spectrometry. Dissolved cadmium is determined by 0.45 μ filtration followed by the previously cited methods[49].

Routes of Entry: Inhalation of dust, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Eye contact can cause irritation. Cadmium chloride can cause severe irritation of the gastrointestinal tract and the respiratory tract. Inhalation can cause nose, throat, and lung irritation. Fumes can cause flu-like illness with chills, headache, aching muscles, and/or fever. Higher exposures can cause nausea, salivation, vomiting, cramps, diarrhea, and pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Cadmium chloride is highly toxic. As little as 14.5 mg of Cd orally causes nausea and vomiting; 8.9 g has caused death. Cadmium salts cause cramps, nausea, vomiting, and diarrhea. Acute poisoning causes lung damage.

Long-Term Exposure: Cadmium can cause kidney damage. This chemical is a probable carcinogen in humans, with some evidence that it causes prostate and kidney cancer in humans, and it has been shown to cause lung and testes cancer in animals. It may also be a reproductive hazard in humans. Repeated low exposures may cause permanent kidney and liver damage, anemia, and/or loss of the sense of smell. Chronic poisoning damages kidneys, lungs, bones, and causes blood changes (anemia).

Points of Attack: See above on harmful effects and symptoms.

Medical Surveillance: Urine test for cadmium. Urine test for "low molecular weight proteins" to detect kidney damage. UA. CBC. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Lung function tests. Consider chest X-ray following acute overexposure.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy. *Note to physician:* For severe poisoning, do not use BAL, dimercaprol, dithiopropanol ($C_3H_8OS_2$) as it is contraindicated or ineffective in poisoning from cadmium.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, head gear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: < or = 50 μg/m^3 Half-mask, APR equipped with a high-efficiency filter*. < or = 125 μg/m^3 (1) PAPR with a loose-fitting hood or helmet equipped with a high-efficiency filter* or (2) Supplied-air respirator with a loose-fitting hood or helmet facepiece operated in continuous-flow mode. < or = 250 μg/m^3 (1) Full-facepiece APR equipped with a high-efficiency filter*; (2) PAPR with a tight-fitting half-mask equipped with a high-efficiency filter*; or (3) Supplied-air respirator with a tight-fitting half-mask operated in continuous-flow mode. < or = 1250 μg/m^3 (1) PAPR with a tight-fitting full facepiece equipped with a high-efficiency filter* or (2) Supplied-air respirator with a tight-fitting full facepiece operated in continuous-flow mode. < or = 5000 μg/m^3 Supplied-air respirator with half-mask or full facepiece operated in pressure-demand or other positive-pressure mode. >5000 μg/m^3 or unknown concentration (1) SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode or (2) Supplied-air respirator with a full facepiece operated in pressure-demand or other positive-pressure mode and equipped with an auxiliary escape-type SCBA operated in pressure-demand mode. *Firefighting:* SCBA with full facepiece operated in pressure-demand or other positive-pressure mode. *Note:* Quantitative fit testing is required for all tight-fitting APRs where airborne concentration of cadmium exceeds 10 times the TWA PEL (10×5 μg/m^3 = 50 μg/m^3). A full facepiece respirator is required when eye irritation is expected.

* A high-efficiency filter means a filter that is at least 99.97% efficient against monodispersed particles of 0.3 μm in diameter or higher.

Shipping: UN2570 Cadmium compounds, Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use agent suitable for surrounding fire. Cadmium chloride itself does not burn. Thermal decomposition products may include hydrogen chloride and oxides of metal cadmium. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBA that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: It is preferred to convert the salt to the nitrate, precipitate it with H_2S, filter, wash and dry the precipitate and return it to the supplier.

References

(109); (102); (31); (173); (101); (138); (2); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 2, No. 3, 73–76 (1982).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Cadmium chloride, Trenton, NJ (April 2002).

Cadmium Oxide C:0140

Formula: CdO; Na_2CdO_2 (disodium salt); K_2CdO_2 (dipotassium salt)

Synonyms: Cadmium monoxide; Cadmium oxide brown; Cadmium oxide fume; Oxido de cadmio (Spanish)

CAS Registry Number: 1306-19-0 (*oxide and fume*)

HSDB Number: 1613

RTECS Number: EV1925000; EV1930000 (*fume*)

UN/NA & ERG Number: UN2570/154

EC Number: 215-146-2 [*Annex I Index No.:* 048-002-00-0]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Sufficient Evidence; Human Sufficient Evidence, *carcinogenic to humans*, Group 1; NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen.

California Proposition 65 Chemical[102]: Cancer 10/1/1987.

Hazard Alert: Poison, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard (*fume*), Possible risk of forming tumors, Environmental hazard.

Banned or Severely Restricted (Czech Republic, Germany) (UN)[35]

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112). Includes any unique chemical substance that contains cadmium as part of that chemical's infrastructure

United States National Primary Drinking Water Regulations: MCLG = 0.005 mg[Cd]/L; MCL = 0.005 mg [Cd]/L as Cadmium

Clean Water Act: Toxic Pollutant (Section 401.15), as cadmium compounds

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (045.4 kg)

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B): Severe pollutant, as cadmium compounds

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%. as cadmium oxide;

NPRI; CEPA Priority Substance List, Ocean dumping prohibited, as cadmium compounds.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R45; R26; R48/23/25; R50/53; R62; R63; R68; safety phrases: S29; S41; S45; S53; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to waters

Description: Cadmium oxide forms brownish-red crystals or a yellow to dark brown amorphous powder. Molecular weight = 128.4; specific gravity (H_2O:1) = 8.15; freezing/melting point = 900°C (slow decomposition begins @ 700°C); sublimation point = 1559°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 0. Very slightly soluble in water.

z-0013, dipotassium cadmium oxide: Molecular weight = 222.61; *disodium cadmium oxide*: Molecular weight = 190.39.

Potential Exposure: Cadmium oxide is used as an electroplating chemical and in the manufacture of semiconductors and cadmium electrodes; synthesis of other cadmium salts; a component of silver alloys, phosphorus, glass and ceramic glazes, semiconductors, and batteries. Used as a vermicide.

Incompatibilities: Oxides of cadmium react explosively with magnesium, especially when heated. Heat above 700°C causes slow decomposition. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); light metals: contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, hydrogen sulfide, hydrazine nitrate. May ignite combustibles, such as wood, paper, oil, etc.

Permissible Exposure Limits in Air

NIOSH IDLH = 9 mg [Cd]/m^3

OSHA PEL: *dust and fume* 0.005 mg[Cd]/m^3 TWA

NIOSH REL: Potential carcinogen. Limit exposure to lowest feasible level.

ACGIH TLV[1]: 0.01 mg[Cd]/m^3 inhalable dust, Suspected Human Carcinogen; 0.002 mg[Cd]/m^3, respirable dust, Suspected Human Carcinogen; BEI: 5 mg[Cd]/g creatinine, urine; 5 mg[Cd]/L, blood

1306-19-0, cadmium oxide

PAC Ver. 29[138]

PAC-1: 0.11 milligram per cubic meter

PAC-2: 0.87 milligram per cubic meter

PAC-3: 5.4 milligram per cubic meter

z-0013, dipotassium cadmium oxide

PAC-1: 0.2 milligram per cubic meter

PAC-2: 1.5 milligram per cubic meter

PAC-3: 9.3 milligram per cubic meter

z-0016, disodium cadmium oxide

NIOSH IDLH = 9 mg [Cd]/m^3

PAC-1: 0.17 milligram per cubic meter

PAC-2: 1.3 milligram per cubic meter

PAC-3: 8 milligram per cubic meter

DFG MAK: [skin]; Carcinogen Category 1; Germ Cell Mutagen Group: 3 A

Arab Republic of Egypt: TWA 0.05 mg[Cd]/m^3 (*fume*) 1993; Australia: TWA 0.05 milligram per cubic meter, Carcinogen (*fume*), 1993; Austria: carcinogen, 1999; Belgium: STEL 0.05 milligram per cubic meter, Carcinogen (*fume*), 1993; TWA 0.05 milligram per cubic meter, 1993; Denmark: TWA 0.01 mg[Cd]/m^3, 1999; Finland: TWA 0.01 milligram per cubic meter, Carcinogen (*fume*), 1999; carcinogen, 1993; France: VLE 0.05 milligram per cubic meter (*fume*), carcinogen, 1999; the Netherlands: MAC-TGG 0.005 mg[Cd]/m^3, 2003; Hungary: STEL 0.05 milligram per cubic meter, carcinogen, 1993; Japan: 0.05 mg[Cd]/m^3, *carcinogenic to humans*, Group 1 carcinogen, 1999; Norway: TWA 0.05 mg [Cd]/m^3, 1999; the Philippines: TWA 0.1 milligram per cubic meter (*fume*), 1993; Poland: MAC (TWA) (*fume*) 0.02 mg [Cd]/m^3, MAC (STEL) (*fume*) 0.05 mg[Cd]/m^3, 1999; MAC (TWA) (*dust*): 0.04 mg[Cd]/m^3, MAC (STEL) (*dust*): 0.2 mg [Cd]/m^3, 1999; Sweden: carcinogen, 1999; Switzerland: MAK-W 0.05 milligram per cubic meter (*fume*), carcinogen, 1999; Thailand: TWA 0.1 milligram per cubic meter; STEL 0.3 milligram per cubic meter (*fume*), 1993; Turkey: TWA 0.1 milligram per cubic meter (*fume*), 1993; United Kingdom: TWA 0.025 mg[Cd]/m^3; STEL 0.05 mg[Cd]/m^3, 2000; New Zealand, Singapore, Vietnam: ACGIH TLV: Suspected Human Carcinogen. North Carolina has set a guideline for cadmium acetate in ambient air[60] of 0.0055 μ/m^3. Several states have set guidelines or standards for cadmium oxide in ambient air[60] ranging from 0.167 μ/m^3 (New York) to 0.25 μ/m^3 (South Carolina) to 0.40 μ/m^3 (Virginia) to 0.5 μ/m^3 (Florida) to 1.0 μ/m^3 (Nevada).

Determination in Air: For (*dust*): use NIOSH Analytical Methods #7048 (Cd) and #7300 (Elements), #7303, #9102, or OSHA: ID-121, ID-125G, ID-189, ID-206

Permissible Concentration in Water: Federal Drinking Water Guidelines: MCLG = 0.005 mg[Cd]/L; MCL = 0.005 mg[Cd]/L; State Drinking Water Standards: Arizona 10 μg/L; State Drinking Water Guidelines: Arizona 5 μg/L; Maine 5 μg/L; Minnesota 4 μg/L.

Determination in Water: Total cadmium may be determined by digestion followed by AA of colorimetric (Dithizone) analysis or by ICP Optical Emission Spectrometry. Dissolved cadmium is determined by 0.45 μ filtration followed by the previously cited methods[49].

Routes of Entry: Inhalation and ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Eye contact causes irritation. Inhalation can cause irritation of the nose and throat; irritation of the lungs with coughing and shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Cadmium oxide can cause metal fume fever with chills, headache, aching muscles, metallic taste; and/or fever. Exposure can cause nausea, salivation, vomiting, cramps, and diarrhea. Symptoms for cadmium poisoning include metallic taste in the mouth, headache, shortness of breath; chest pain; cough with foamy or bloody sputum; pulmonary rales; weakness; leg pains and pulmonary edema. The lethal inhalation dose of cadmium oxide in humans is 2500 milligram per cubic meter for a minute exposure. Lethal exposure has been established @ 50 mg (cadmium)/m^3 for 1 hour for cadmium oxide dust and 0.5 hour for the fume. These concentrations may be inhaled without sufficient discomfort to warn worker of exposure. Acute exposure by inhalation may cause death by anoxia. The lowest human toxic inhalation concentration is 8630 μ/m^3/5 hours for the fume.

Long-Term Exposure: Lungs (tracheobronchitis, pneumonitis), kidneys (possible kidney stones), and liver may be affected or damaged by repeated or prolonged exposure. Cadmium oxide is probably carcinogenic to humans; there is some evidence of lung and prostate cancer. There is limited evidence that this chemical is a teratogen in animals. Long-term exposure can cause anemia, brittle and painful bones; loss of sense of smell; fatigue; and/or yellow staining of teeth. Cancer Site: (prostatic & lung cancer)[77].

Medical Surveillance: Urine test for cadmium. Urine test for "low molecular weight proteins" to detect kidney damage. UA. CBC. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Lung function tests. Liver function tests. Consider chest X-ray following acute overexposure.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy. *Note to Physician:* In case of fume inhalation, treat pulmonary edema. Give prednisone or other corticosteroid orally to reduce tissue response to fume. Positive-pressure ventilation may be necessary. Treat metal fume fever with bed rest, analgesics, and antipyretics. The symptoms of metal fume fever may be delayed for 4–12 hours following exposure: it may last less than 36 hours.

Note to physician: For severe poisoning, do not use BAL, dimercaprol, dithiopropanol ($C_3H_8OS_2$) as it is contraindicated or ineffective in poisoning from cadmium.

Personal Protective Methods: Cadmium fume (CdO) Prevent skin contact. **8 hours** (more than 8 hours of resistance to breakthrough >0.1 μg/cm^2/min): Neoprene rubber gloves, suits, boots; nitrile rubber gloves, suits, boots. Persons with respiratory disorders should be excluded from contact with this material. A Class I, Type B, biological safety hood should be used when mixing, handling, or preparing cadmium oxide. Wear protective eye protection, gloves, and clothing to prevent any skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: < or = 50 μg/m^3 Half-mask, APR equipped with a high-efficiency filter*. < or = 125 μg/m^3 (1) PAPR with a loose-fitting hood or helmet equipped with a high-efficiency filter* or (2) Supplied-air respirator with a loose-fitting hood or helmet facepiece operated in continuous-flow mode. < or = 250 μg/m^3 (1) Full-facepiece APR equipped with a high-efficiency filter*; (2) PAPR with a tight-fitting half-mask equipped with a high-efficiency filter*; or (3) Supplied-air respirator with a tight-fitting half-mask operated in continuous-flow mode. < or = 1250 μg/m^3 (1) PAPR with a tight-fitting full facepiece equipped with a high-efficiency filter* or (2) Supplied-air respirator with a tight-fitting full facepiece operated in continuous-flow mode. < or = 5000 μg/m^3 Supplied-air respirator with half-mask or full facepiece operated in pressure-demand or other positive-pressure mode. >5000 μg/m^3 or unknown concentration (1) SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode or (2) Supplied-air respirator with a full facepiece operated in pressure-demand or other positive-pressure mode and equipped with an auxiliary escape-type SCBA operated in pressure-demand mode. *Firefighting:* SCBA with full facepiece operated in pressure-demand or other positive-pressure mode. Note: Quantitative fit testing is required for all tight-fitting APRs where airborne concentration of cadmium exceeds 10 times the TWA PEL ($10 \times 5\ \mu g/m^3 = 50\ \mu g/m^3$). A full facepiece respirator is required when eye irritation is expected.

* A high-efficiency filter means a filter that is at least 99.97% efficient against monodispersed particles of 0.3 μm in diameter or higher.

Storage: Color code—Blue: Health Hazard: Store in a secure poison location. Prior to working with cadmium oxide all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area, away from magnesium, oxidizers, combustible materials; heat, moisture, and acids. Where this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2570 Cadmium compounds, Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Stay upwind and out of low areas. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid, but may increase fire activity. Use any extinguishing agent. Thermal decomposition products in fire include oxides of cadmium and oxygen. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBA that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Form nitrate with HNO_3, precipitate with H_2S, filter, package and return to supplier.

References

(109); (102); (31); (173); (101); (138); (2); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 4, No. 4, 77−83 (1984) (Cadmium oxide fumes).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Cadmium oxide, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Cadmium oxide, Trenton, NJ (September 1998).

Cadmium Stearate C:0150

Formula: $C_{36}H_{72}CdO_4$; $Cd(C_{17}H_{36}COO)_2$

Synonyms: Alaixol II; Cadmium octadeconoate; Estearato de cadmio (Spanish); Kadmiumstearat (German); Octadecanoic acid, cadmium salt; Stearic acid, cadmium salt

CAS Registry Number: 2223-93-0

HSDB Number: 5529

RTECS Number: RG1050000

UN/NA & ERG Number: UN2570/154

EC Number: 218-743-6

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Sufficient Evidence; Human Sufficient Evidence, *carcinogenic to humans*, Group 1; NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen.

California Proposition 65 Chemical[102]: Cancer 10/1/1987

Hazard Alert: Poison, Combustible, Possible risk of forming tumors, Environmental hazard.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112). Includes any unique chemical substance that contains cadmium as part of that chemical's infrastructure

United States National Primary Drinking Water Regulations: MCLG = 0.005 mg[Cd]/L; MCL = 0.005 mg [Cd]/L as Cadmium

Clean Water Act: Toxic Pollutant (Section 401.15), as cadmium compounds

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1000 lb (454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 1000/10,000 lb (454/4540 kg)

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B): Severe pollutant, as cadmium compounds

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. as cadmium stearate; NPRI; CEPA Priority Substance List, Ocean dumping prohibited, as cadmium compounds.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R45; R20/21/22; R50/53; safety phrases: S29; S45; S53; S60, S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Cadmium stearate is a crystalline solid. Molecular weight = 681.48; freezing/melting point = ~105°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 1, reactivity 0.

Potential Exposure: Used as a lubricant and stabilizer in polyvinyl chloride plastics[101].

Incompatibilities: Cadmium stearate has weak oxidizing or reducing powers. Redox reactions can however still occur[101].

Permissible Exposure Limits in Air

NIOSH IDLH = 9 mg [Cd]/m^3

OSHA PEL: *dust and fume* 0.005 mg[Cd]/m^3 TWA

NIOSH REL: Potential carcinogen. Limit exposure to lowest feasible level. See *NIOSH Pocket Guide*, Appendix A

ACGIH TLV[1]: 0.01 mg[Cd]/m^3 inhalable dust, Suspected Human Carcinogen; 0.002 mg[Cd]/m^3, respirable dust, Suspected Human Carcinogen; BEI: 5 mg[Cd]/g creatinine, urine; 5 mg[Cd]/L, blood

PAC Ver. 29[138]

PAC-1: 0.61 milligram per cubic meter

PAC-2: 4.6 milligram per cubic meter

PAC-3: 28 milligram per cubic meter

DFG MAK: Carcinogen Category 1; Germ Cell Mutagen Group: 3 A

Arab Republic of Egypt: TWA 0.05 milligram per cubic meter, 1993; Australia: TWA 0.05 milligram per cubic meter, 1993; Austria: carcinogen, 1999; Belgium: TWA 0.05 milligram per cubic meter, 1993; Denmark: TWA 0.01 milligram per cubic meter, 1999; Finland: TWA 0.02 milligram per cubic meter, carcinogen, 1999; France: VME 0.05 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 0.005 milligram per cubic meter, 2003; Japan: 0.05 milligram per cubic meter, Group 1 carcinogen, 1999; Norway: TWA 0.05 milligram per cubic meter, 1999; the Philippines: TWA 0.2 milligram per cubic meter, 1993; Poland: MAC (TWA) (*fume*) 0.02 milligram per cubic meter, MAC (STEL) (*fume*) 0.05 milligram per cubic meter, 1999; MAC (TWA) (*dust*): 0.04 milligram per cubic meter, MAC (STEL) *dust* 0.2 milligram per cubic meter, 1999; Russia: TWA 0.01 milligram per cubic meter; STEL 0.05 milligram per cubic meter, 1993; Sweden: NGV 0.05 milligram per cubic meter (total *dust*), 1999; Sweden: TWA 0.01 milligram per cubic meter (respirable *dust*), 1999; Switzerland: MAK-W 0.05 milligram per cubic meter, carcinogen, 1999; Thailand: TWA 0.2 milligram per cubic meter; STEL 0.5 milligram per cubic meter, 1993; Turkey: TWA 0.2 milligram per cubic meter, 1993; United Kingdom: TWA 0.025 mg[Cd]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Suspected Human Carcinogen. See also this section in the entry on "Cadmium." North Carolina has set a guideline for cadmium acetate in ambient air[60] of 0.0055 μ/m^3.

Determination in Air: Collection of particles on a filter, workup with acid and measurement by AA has been specified by NIOSH. For (*dust*): Use NIOSH Analytical Methods #7048 (Cd) and #7300 (Elements), #7303, #9102, or OSHA: ID-121, ID-125G, ID-189, ID-206

Permissible Concentration in Water: Federal Drinking Water Guidelines: MCLG = 0.005 mg[Cd]/L; MCL = 0.005 mg[Cd]/L; State Drinking Water Standards: Arizona 10 μg/L; State Drinking Water Guidelines: Arizona 5 μg/L; Maine 5 μg/L; Minnesota 4 μg/L.

Determination in Water: Total cadmium may be determined by digestion followed by AA of colorimetric (Dithizone) analysis or by ICP Optical Emission Spectrometry. Dissolved cadmium is determined by 0.45 μ filtration followed by the previously cited methods[49].

Routes of Entry: Inhalation and ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Acute poisoning produces severe nausea, vomiting, diarrhea, and abdominal and chest pains. Dry mouth, salivation, and metallic taste have been reported. If ingested, may result in exhaustion, collapse, shock, and death within a period of 24 hours. Acute toxicity most notably occurs secondary to cadmium ingestion or inhalation of cadmium fumes. Poisoning from inhalation is relatively rare but dangerous, having a mortality rate of about 15%. Toxic inhaled concentrations in humans have been reported @ 147 milligram per cubic meter/35 minutes and @ 1800 μ/m^3/2 years. LD_{50} (oral-rat) = 1125 mg/kg; the oral LD_{50} mouse is 590 mg/kg.

Long-Term Exposure: Cadmium can cause kidney damage. Yellow rings may be seen in teeth when chronically exposed to cadmium. A probable human carcinogen and teratogen.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Note to physician: For severe poisoning, do not use BAL, dimercaprol, dithiopropanol ($C_3H_8OS_2$) as it is contraindicated or ineffective in poisoning from cadmium.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/ manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: $<$ or $=$ $50\,\mu g/m^3$ Half-mask, APR equipped with a high-efficiency filter*. $<$ or $=$ $125\,\mu g/m^3$ (1) PAPR with a loose-fitting hood or helmet equipped with a high-efficiency filter* or (2) Supplied-air respirator with a loose-fitting hood or helmet facepiece operated in continuous-flow mode. $<$ or $=$ $250\,\mu g/m^3$ (1) Full-facepiece APR equipped with a high-efficiency filter*; (2) PAPR with a tight-fitting half-mask equipped with a high-efficiency filter*; or (3) Supplied-air respirator with a tight-fitting half-mask operated in continuous-flow mode. $<$ or $= 1250\,\mu g/m^3$ (1) PAPR with a tight-fitting full facepiece equipped with a high-efficiency filter* or (2) Supplied-air respirator with a tight-fitting full facepiece operated in continuous-flow mode. $<$ or $=$ $5000\,\mu g/m^3$ Supplied-air respirator with half-mask or full facepiece operated in pressure-demand or other positive-pressure mode. $>5000\,\mu g/m^3$ or unknown concentration (1) SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode or (2) Supplied-air respirator with a full facepiece operated in pressure-demand or other positive-pressure mode and equipped with an auxiliary escape-type SCBA operated in pressure-demand mode. *Firefighting:* SCBA with full facepiece operated in pressure-demand or other positive-pressure mode. *Note:* Quantitative fit testing is required for all tight-fitting APRs where airborne concentration of cadmium exceeds 10 times the TWA PEL ($10 \times 5\,\mu g/m^3 = 50\,\mu g/m^3$). A full facepiece respirator is required when eye irritation is expected.

* A high-efficiency filter means a filter that is at least 99.97% efficient against monodispersed particles of $0.3\,\mu m$ in diameter or higher.

Storage: Color code—Blue: Health Hazard: Store in a secure poison location. Prior to working with Cadmium stearate all handlers should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored. Store in tightly closed containers in a cool, well-ventilated area, away from incompatible materials. Where this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN2570 Cadmium compounds, Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Do not touch spilled material. Stay upwind, keep out of low areas. Wear self-contained (positive pressure if available) breathing apparatus and full protective clothing. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include metal oxides of cadmium and carbon. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBA that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(109); (102); (31); (173); (101); (138); (2); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Cadmium Stearate, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

Cadmium Sulfate C:0160

Formula: $O_4S \cdot Cd$

Synonyms: Cadmium monosulfate; Cadmium sulfate; Sulfuric acid, cadmium(2+) salt; Sulfuric acid, cadmium(II) salt; Sulfuric acid, cadmium salt

CAS Registry Number: 10124-36-4; (*alt.*) 31119-53-6; (*alt.*) 62642-07-3; 7790-84-3 (hydrate)

HSDB Number: 274

UN/NA & ERG Number: UN2570/154

EC Number: 233-331-6 [*Annex I Index No.:* 048-009-00-9]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Sufficient Evidence; Human Sufficient Evidence, *carcinogenic to humans*, Group 1; NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen.

California Proposition 65 Chemical[102]: Cancer 10/1/1987.
Hazard Alert: Poison, Agricultural Chemical Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Environmental hazard.
United States National Primary Drinking Water Regulations: MCLG = 0.005 mg[Cd]/L; MCL = 0.005 mg [Cd]/L as Cadmium; SMCL = 250 mg[SO_4^{-2}]/L as Sulfate
Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112). Includes any unique chemical substance that contains cadmium as part of that chemical's infrastructure
Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants
RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed
EPCRA (Section 313): Includes any unique chemical substance that contains cadmium as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: (inorganic compounds: 0.1%; organic compounds: 1.0%)
Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%. NPRI; CEPA Priority Substance List, Ocean dumping prohibited
United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B): Severe pollutant, as cadmium compounds.
Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.
Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R45; R26; R48/23/25; R62; R63; R68; R50/53; safety phrases: S29; S53; S45; S60; S61 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Cadmium sulfate is a white to colorless, odorless, crystalline substance. Molecular weight = 208.46; specific gravity (H_2O:1) = 4.69; freezing/melting point = 1000°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 0. Soluble in water; solubility = 76 g/100 mL @ 0°C.
Cadmium sulfate, hydrate: Molecular weight = 226.49; specific gravity (H_2O:1) = 3.79 @ 20°C.

Potential Exposure: It is used in pigments, electroplating; as a fungicide; and in synthetic and analytical chemistry. Also used in fluorescent screens; as an electrolyte.

Incompatibilities: Acts as a weak inorganic acid; neutralizes bases. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, sulfur, selenium, tellurium, zinc.

Permissible Exposure Limits in Air
NIOSH IDLH = 9 mg [Cd]/m^3
OSHA PEL: *dust and fume* 0.005 mg[Cd]/m^3 TWA
NIOSH REL: Potential carcinogen. Limit exposure to lowest feasible level.
ACGIH TLV[1]: 0.01 mg[Cd]/m^3 inhalable dust, Suspected Human Carcinogen; 0.002 mg[Cd]/m^3, respirable dust, Suspected Human Carcinogen; BEI: 5 mg[Cd]/g creatinine, urine; 5 mg[Cd]/L, blood
10124-36-4
PAC Ver. 29[138]
PAC-1: 0.19 milligram per cubic meter
PAC-2: 1.4 milligram per cubic meter
PAC-3: 8.7 milligram per cubic meter
DFG MAK: [skin]; Carcinogen Category 1; Germ Cell Mutagen Group: 3 A
Arab Republic of Egypt: TWA 0.05 milligram per cubic meter, 1993; Australia: TWA 0.05 milligram per cubic meter, 1993; Austria: carcinogen, 1999; Belgium: TWA 0.05 milligram per cubic meter, 1993; Denmark: TWA 0.01 milligram per cubic meter, 1999; Finland: TWA 0.02 milligram per cubic meter, carcinogen, 1999; France: VME 0.05 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 0.005 milligram per cubic meter, 2003; Japan: 0.05 milligram per cubic meter, Group 1 carcinogen, 1999; Norway: TWA 0.05 milligram per cubic meter, 1999; the Philippines: TWA 0.2 milligram per cubic meter, 1993; Poland: MAC (TWA) (*fume*) 0.02 milligram per cubic meter, MAC (STEL) (*fume*) 0.05 milligram per cubic meter, 1999; MAC (TWA) (*dust*): 0.04 milligram per cubic meter, MAC (STEL) *dust* 0.2 milligram per cubic meter, 1999; Russia: TWA 0.01 milligram per cubic meter; STEL 0.05 milligram per cubic meter, 1993; Sweden: NGV 0.05 milligram per cubic meter (total *dust*), 1999; Sweden: TWA 0.01 milligram per cubic meter (respirable *dust*), 1999; Switzerland: MAK-W 0.05 milligram per cubic meter, carcinogen, 1999; Thailand: TWA 0.2 milligram per cubic meter; STEL 0.5 milligram per cubic meter, 1993; Turkey: TWA 0.2 milligram per cubic meter, 1993; United Kingdom: TWA 0.025 mg[Cd]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Suspected Human Carcinogen. See also this section in the entry on "Cadmium." North Carolina has set a guideline for cadmium acetate in ambient air[60] of 0.0055 μ/m^3.
7790-84-3, hydrate
PAC Ver. 29[138]
PAC-1: 0.1 milligram per cubic meter
PAC-2: 0.76 milligram per cubic meter
PAC-3: 11 milligram per cubic meter

Determination in Air: Collection of particles on a filter, workup with acid and measurement by AA has been specified by NIOSH. For (*dust*): Use NIOSH Analytical Methods #7048 (Cd) and #7300 (Elements), #7303, #9102, or OSHA: ID-121, ID-125G, ID-189, ID-206

Permissible Concentration in Water: Federal Drinking Water Guidelines: MCLG = 0.005 mg[Cd]/L; MCL = 0.005 mg[Cd]/L; State Drinking Water Standards: Arizona

10 μg/L; State Drinking Water Guidelines: Arizona 5 μg/L; Maine 5 μg/L; Minnesota 4 μg/L.

Determination in Water: Total Cadmium may be determined by digestion followed by AA of colorimetric (Dithizone) analysis or by ICP Optical Emission Spectrometry. Dissolved Cadmium is determined by 0.45 μ filtration followed by the previously cited methods[49].

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes on contact. Inhalation irritates the nose, throat, and lungs with coughing and/or shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Cadmium sulfate can cause nausea, salivation, vomiting; cramps and diarrhea; metal fume fever with flu-like symptoms; chills, headache, weakness; metallic tasted in the mouth.

Long-Term Exposure: Cadmium can cause kidney damage. Repeated exposure can cause anemia, brittle and painful bones; diminished or loss of the sense of smell; fatigue, and/or yellow staining of the teeth. May cause lung and prostate cancer; kidney damage with kidney stones; liver damage; lung damage with bronchitis, cough, phlegm, and/or shortness of breath. There is some evidence that cadmium sulfate is a teratogen in humans.

Points of Attack: Lungs, liver, kidneys, blood.

Medical Surveillance: Urine test for Cd (levels should be less than 10 μg/L of urine). Urine test for low molecular weight proteins (β-2-microglobulin) to detect kidney damage. CBC. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Lung function tests. Liver function tests. Consider chest X-ray following acute overexposure.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy. *Note to Physician:* In case of fume inhalation, treat for pulmonary edema. Give prednisone or other corticosteroid orally to reduce tissue response to fume. Positive-pressure ventilation may be necessary. Treat metal fume fever with bed rest, analgesics, and antipyretics. The symptoms of metal fume fever may be delayed for 4–12 hours following exposure: it may last less than 36 hours.

Note to physician: For severe poisoning, do not use BAL, dimercaprol, dithiopropanol ($C_3H_8OS_2$) as it is contraindicated or ineffective in poisoning from cadmium.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should Wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: < or = 50 μg/m^3 Half-mask, APR equipped with a high-efficiency filter*. < or = 125 μg/m^3 (1) PAPR with a loose-fitting hood or helmet equipped with a high-efficiency filter* or (2) Supplied-air respirator with a loose-fitting hood or helmet facepiece operated in continuous-flow mode. < or = 250 μg/m^3 (1) Full-facepiece APR equipped with a high-efficiency filter*; (2) PAPR with a tight-fitting half-mask equipped with a high-efficiency filter*; or (3) Supplied-air respirator with a tight-fitting half-mask operated in continuous-flow mode. < or = 1250 μg/m^3(1) PAPR with a tight-fitting full facepiece equipped with a high-efficiency filter* or (2) Supplied-air respirator with a tight-fitting full facepiece operated in continuous-flow mode. < or = 5000 μg/m^3 Supplied-air respirator with half-mask or full facepiece operated in pressure-demand or other positive-pressure mode. >5000 μg/m^3 or unknown concentration (1) SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode or (2) Supplied-air respirator with a full facepiece operated in pressure-demand or other positive-pressure mode and equipped with an auxiliary escape-type SCBA operated in pressure-demand mode. *Firefighting:* SCBA with full facepiece operated in pressure-demand or other positive-pressure mode. Note: Quantitative fit testing is required for all tight-fitting APRs where airborne concentration of cadmium exceeds 10 times the TWA PEL (10×5 μg/m^3 = 50 μg/m^3). A full facepiece respirator is required when eye irritation is expected.

* A high-efficiency filter means a filter that is at least 99.97% efficient against monodispersed particles of 0.3 μm in diameter or higher.

Storage: Color code—Blue: Health Hazard: Store in a secure poison location. Prior to working with Cadmium sulfate, all handlers should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers and metals.

Shipping: UN2570 Cadmium compounds, Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Thermal decomposition products may include oxides cadmium and sulfur. Use dry chemical, carbon dioxide; water spray; or alcohol-resistant foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streamsare ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBA that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(109); (102); (31); (173); (101); (138); (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Cadmium Sulfate, Trenton, NJ (September 1998).

Cadmium Sulfide C:0170

Formula: CdS

Synonyms: Aurora yellow; Cadmium golden 366; Cadmium lemon yellow 527; Cadmium monosulfide; Cadmium orange; Cadmium primrose 819; Cadmium sulfide; Cadmium yellow; Cadmium yellow 000; Cadmium yellow 10G concentrate; Cadmium yellow 892; Cadmium yellow conc. golden; Cadmium yellow conc. lemon; Cadmium yellow conc. primrose; Cadmium yellow oz dark; Cadmium yellow primrose 47-4100; Cadmopur golden yellow N; Cadmopur yellow; Capsebon capsebon; C.I. 77199; C.I. Pigment orange 20; C.I. Pigment yellow 37; Ferro lemon yellow; Ferro orange yellow; Ferro yellow; Greenockite; NCI-C02711

CAS Registry Number: 1306-23-6

HSDB Number: 1614

UN/NA & ERG Number: UN2570/154

EC Number: 215-147-8 [*Annex I Index No.:* 048-010-00-4]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Sufficient Evidence; Human Sufficient Evidence, *carcinogenic to humans*, Group 1; NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen

California Proposition 65 Chemical[102]: Cancer 10/1/1987.

Hazard Alert: Poison, Possible risk of forming tumors, Suspected reprotoxic hazard, Environmental hazard.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112). Includes any unique chemical substance that contains cadmium as part of that chemical's infrastructure

United States National Primary Drinking Water Regulations: MCLG = 0.005 mg[Cd]/L; MCL = 0.005 mg [Cd]/L as Cadmium

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed

EPCRA (Section 313): Includes any unique chemical substance that contains cadmium as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: (inorganic compounds: 0.1%; organic compounds: 1.0%)

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B): Severe pollutant, as cadmium compounds.

Hazard symbols, risk, & safety statements: Hazard symbol: T; risk phrases: R45; R22; R48/23/25; R620; R63; R68; R53; safety phrases: S53; S45; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Cadmium sulfide is an odorless, crystalline, lemon yellow to orange solid. Molecular weight = 144.46; specific gravity (H_2O:1) = 4.83; Sublimation point = 978°C. Insoluble in water.

Potential Exposure: Used in pigments; as an active ingredient in dandruff shampoos; making photoconductors, solar cells, and other electronic components.

Incompatibilities: Contact with water or moisture releases poisonous hydrogen sulfide gas. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, hydrogen azide, zinc, selenium, tellurium, and other metals, iodine monochloride.

Permissible Exposure Limits in Air

NIOSH IDLH = 9 mg [Cd]/m^3

OSHA PEL: *dust and fume* 0.005 mg[Cd]/m^3 TWA

NIOSH REL: Potential carcinogen. Limit exposure to lowest feasible level.

ACGIH TLV[1]: 0.01 mg[Cd]/m^3 inhalable dust, Suspected Human Carcinogen; 0.002 mg[Cd]/m^3, respirable dust, Suspected Human Carcinogen; BEI: 5 mg[Cd]/g creatinine, urine; 5 mg[Cd]/L, blood

PAC Ver. 29[138]

PAC-1: 0.13 milligram per cubic meter

PAC-2: 0.98 milligram per cubic meter

PAC-3: 6 milligram per cubic meter

DFG MAK: [skin]; Carcinogen Category 1; Germ Cell Mutagen Group: 3A

Arab Republic of Egypt: TWA 0.05 milligram per cubic meter, 1993; Australia: TWA 0.05 milligram per cubic meter, 1993; Austria: carcinogen, 1999; Belgium: TWA 0.05 milligram per cubic meter, 1993; Denmark: TWA 0.01 milligram per cubic meter, 1999; Finland: TWA 0.02 milligram per cubic meter, carcinogen, 1999; France: VME 0.05 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 0.005 milligram per cubic meter, 2003; Japan: 0.05 milligram per cubic meter, Group 1 carcinogen, 1999; Norway: TWA 0.05 milligram per cubic meter, 1999; the Philippines: TWA 0.2 milligram per cubic meter, 1993; Poland: MAC (TWA) (*fume*) 0.02 milligram per cubic meter, MAC (STEL) (*fume*) 0.05 milligram per cubic meter, 1999; MAC (TWA) (*dust*): 0.04 milligram per cubic meter, MAC (STEL) *dust* 0.2 milligram per cubic meter, 1999; Russia: TWA 0.01 milligram per cubic meter; STEL 0.05 milligram per cubic meter, 1993; Sweden: NGV 0.05 milligram per cubic meter (total *dust*), 1999; Sweden: TWA 0.01 milligram per cubic meter (respirable *dust*), 1999; Switzerland: MAK-W 0.05 milligram per cubic meter, carcinogen, 1999; Thailand: TWA 0.2 milligram per cubic meter; STEL 0.5 milligram per cubic meter, 1993; Turkey: TWA 0.2 milligram per cubic meter, 1993; United Kingdom: TWA 0.025 mg[Cd]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Suspected Human Carcinogen. See also this section in the entry on "Cadmium." North Carolina has set a guideline for cadmium acetate in ambient air[60] of 0.0055 μ/m^3.

Determination in Air: Collection of particles on a filter, workup with acid and measurement by AA has been specified by NIOSH. For (*dust*): Use NIOSH Analytical Methods #7048 (Cd) and #7300 (Elements), #7303, #9102, or OSHA: ID-121, ID-125G, ID-189, ID-206

Permissible Concentration in Water: Federal Drinking Water Guidelines: MCLG = 0.005 mg[Cd]/L; MCL = 0.005 mg[Cd]/L; State Drinking Water Standards: Arizona 10 μg/L; State Drinking Water Guidelines: Arizona 5 μg/L; Maine 5 μg/L; Minnesota 4 μg/L.

Determination in Water: Total cadmium may be determined by digestion followed by AA of colorimetric (Dithizone) analysis or by ICP Optical Emission Spectrometry. Dissolved cadmium is determined by 0.45 μ filtration followed by the previously cited methods[49].

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes on contact. Inhalation irritates the nose, throat, and lungs with coughing and/or shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Cadmium sulfate can cause nausea, salivation, vomiting; cramps and diarrhea; metal fume fever with flu-like symptoms; chills, headache, weakness; metallic tasted in the mouth.

Long-Term Exposure: Cadmium can cause kidney damage. Repeated exposure can cause anemia, brittle and painful bones; diminished or loss of the sense of smell; fatigue; and/or yellow staining of the teeth. May cause lung cancer; kidney damage with kidney stones; liver damage, lung damage with bronchitis, cough, phlegm, and/or shortness of breath; damage to the testes; and may damage the developing fetus. There is some evidence that cadmium sulfate is a teratogen in humans.

Points of Attack: Lungs, liver, kidneys, blood.

Medical Surveillance: Urine test for Cd (levels should be less than 10 μg/L of urine). Urine test for low molecular weight proteins (β-2-microglobulin) to detect kidney damage. CBC. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Lung function tests. Liver function tests. Consider chest X-ray following acute overexposure.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy. *Note to Physician:* In case of fume inhalation, treat pulmonary edema. Give prednisone or other corticosteroid orally to reduce tissue response to fume. Positive-pressure ventilation may be necessary. Treat metal fume fever with bed rest, analgesics, and antipyretics. The symptoms of metal fume fever may be delayed for 4−12 hours following exposure: it may last less than 36 hours.

Note to physician: For severe poisoning, do not use BAL, dimercaprol, dithiopropanol ($C_3H_8OS_2$) as it is contraindicated or ineffective in poisoning from cadmium.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: < or = 50 μg/m^3 Half-mask, APR equipped with a high-efficiency filter*. < or = 125 μg/m^3 (1) PAPR with a loose-fitting hood or helmet equipped with a high-efficiency filter* or (2) Supplied-air respirator with a loose-fitting hood or helmet facepiece operated in continuous-flow mode. < or = 250 μg/m^3 (1) Full-facepiece APR equipped with a high-efficiency filter*; (2) PAPR with a tight-fitting half-mask equipped with a high-efficiency filter*; or (3) Supplied-air respirator with a tight-fitting half-mask operated in continuous-flow mode. < or = 1250 μg/m^3 (1) PAPR with a tight-fitting full facepiece equipped with a high-efficiency filter* or (2) Supplied-air respirator with a tight-fitting full facepiece operated in continuous-flow mode. < or = 5000 μg/m^3 Supplied-air respirator with half-mask or full facepiece operated in pressure-demand or other positive-pressure mode. >5000 μg/m^3 or unknown concentration (1) SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode or (2) Supplied-air respirator with a full facepiece operated in pressure-demand or other positive-pressure mode and equipped with an auxiliary escape-type SCBA operated in pressure-demand mode. *Firefighting:* SCBA with full facepiece operated in pressure-demand or other positive-pressure mode. *Note:* Quantitative fit testing is required for all tight-fitting APRs where airborne concentration of cadmium exceeds 10 times the TWA PEL ($10 \times 5\ \mu g/m^3 = 50\ \mu g/m^3$). A full facepiece respirator is required when eye irritation is expected.

* A high-efficiency filter means a filter that is at least 99.97% efficient against monodispersed particles of 0.3 μm in diameter or higher.

Storage: Color code—Blue: Health Hazard: Store in a secure poison location. Prior to working with Cadmium sulfide, all handlers should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Store in tightly closed containers in a cool, dark, well-ventilated area away from oxidizers and metals, strong acids; water or moisture, and other incompatible materials listed above.

Shipping: UN2570 Cadmium compounds, Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: *Do not* use water. Use dry chemical extinguishers appropriate for metal fires. Thermal decomposition products may include sulfur oxides and hydrogen sulfide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBA that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Use a licensed professional waste disposal service to dispose of this material. All federal, state, and local environmental regulations must be observed. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform to EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(109); (102); (31); (173); (101); (138); (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Cadmium Sulfide, Trenton, NJ (September 1998).

Calcium C:0200

Formula: Ca
***Synonyms*:** Atomic calcium; Blood-coagulation factor IV; Calcicat; Calcio, pirofórico (Spanish); Calcio, metal yaleaciones de, pirofóricas (Spanish); Calcio, aleaciones de, pirofóricas (Spanish); Calcium metal, crystalline; Calcium element; Calcium alloys, pyrophoric; Calcium, alliages pyrophoriques de (French); Calcium, metal and alloys, pyrophoric; Calcium, métallique et alliages pyrophoriques de (French); Calcium, pyrophoric; Calcium, pyrophorique (French); Elemental calcium
CAS Registry Number: 7440-70-2
HSDB Number: 273
RTECS Number: EV8040000
UN/NA & ERG Number: UN1401/138; UN1855 (calcium, pyrophoric)/135
EC Number: 231-179-5 [*Annex I Index No.:* 020-001-00-X]

Regulatory Authority and Advisory Information

Hazard Alert: Combustible, Pyrophoric (powder/fine dust), Violently reactive with water (emits flammable gas).

Hazard symbols, risk, & safety statements: Hazard symbol: F; risk phrases: R15/29; R17; safety phrases: S2; S8; S24/25; S43 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [1-Low hazard to water. (est.)]

Description: Calcium is a silvery-white metal when freshly cut, which tarnishes to a blue-gray color in air. It can also be found as a powder. Molecular weight = 40.1; specific gravity (H_2O:1) = 1.54; boiling point = 1485°C; freezing/melting point = 842°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 1, reactivity 2. ₩ Violent reaction with water releasing flammable hydrogen gas.
Potential Exposure: Calcium is used as a raw material for aluminum, copper, and lead alloys.
Incompatibilities: Forms hydrogen gas on contact with air; finely divided material or dust may ignite spontaneously. A strong reducing agent; reacts violently with water, acids, strong oxidizers (such as chlorine, bromine, and fluorine), alkaline carbonates, dinitrogen tetroxide; halogenated hydrocarbons; lead chloride, halogens, alkaline hydroxides, oxygen, silicon, sulfur, chlorine, fluorine, chlorine trifluoride, and many other substances. Reacts with water to produce flammable hydrogen gas.

Permissible Exposure Limits in Air

PAC Ver. 27; No values found in Ver. 29[138]
PAC-1: 30 milligram per cubic meter
PAC-2: 330 milligram per cubic meter
PAC-3: 2000 milligram per cubic meter

Determination in Air: Use NIOSH (IV) Analytical Method # 7020 (Calcium).
Routes of Entry: Inhalation of dust.

Harmful Effects and Symptoms

Contact with the dust can severely irritate and burn the eyes and skin. Exposure to the dust can irritate the air passages and lungs. Calcium is a reactive chemical and is an explosion hazard.
Short-Term Exposure: Eye contact can cause irritation and possible permanent damage. Skin contact can cause irritation and burns. Inhalation can irritate air passages and lungs, causing coughing and difficult breathing.
Points of Attack: Eyes, skin, and respiratory system.
Medical Surveillance: Lung function tests are recommended on a preemployment and regular postemployment basis.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.
Personal Protective Methods: *Clothing:* Avoid skin contact with Calcium. Wear protective gloves and clothing. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. *Eye Protection:* Wear chemical goggles and face shield when working with Calcium, unless full facepiece respiratory protection is worn.
Respirator Selection: Where there is potential exists for exposure to calcium, use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece respirator with a high-efficiency particulate filter. Greater protection is provided by a PAPR. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode. All respirators selected must be approved by NIOSH under the provisions of 42 CFR 84. The current listing of NIOSH-certified respirators can be found in the NIOSH/NPPTL Certified Equipment List, which is available on the NIOSH website.
Storage: Color code—Red Stripe: Dangerous when wet materials release flammable gases on contact with water. Do not store this material in a room protected by water sprinkler systems. Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Do not store in a basement. Store in tightly closed containers in a cool, well-ventilated area away from water, moisture, oxidizers, and acids. Wherever calcium is used, handled, manufactured, or stored,

use explosion-proof electrical equipment and fittings. Store in kerosene or other neutral oil. Do not store large quantities of calcium in rooms with sprinkler systems. A detached fire resistant building is recommended for large storage.

Shipping: UN1401 Calcium, Hazard Class: 4.3; Labels: 4.3-Dangerous when wet material. UN 1855 Calcium, pyrophoric or Calcium alloys, pyrophoric, Hazard Class: 4.3; Labels: 4.3-Dangerous when wet material.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Calcium dust may ignite spontaneously in air. In contact with water or moisture, calcium releases hydrogen gas which can be explosive. Thermal decomposition products include metal oxide. Containers may explode in fire. Fire may restart after it has been extinguished. Use dry graphite, soda ash; powdered salt or appropriate metal fire extinguisher. *Do not use water*, CO_2, or dry chemical extinguishers since they are ineffective. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBA that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Calcium metal may be burned in an open furnace[22].When burning calcium waste in a steel pan, dry steam may be directed to the waste with due care to avoid splashing.

References

(31); (173); (101); (138); (170); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Calcium, Trenton, NJ (September 1998).

Calcium Carbide C:0220

Formula: C_2Ca; CaC_2

Synonyms: Acetylongen; Calcium acetylide; Calcium dicarbide; Carbide, acetylenogen; Carbure de calcium (French); Carburo de calcio (Spanish)

CAS Registry Number: 75-20-7

HSDB Number: 1434

RTECS Number: EV9400000

UN/NA & ERG Number: UN1402/138

EC Number: 200-848-3 [*Annex I Index No.:* 006-004-00-9]

Regulatory Authority and Advisory Information

Hazard Alert: Highly flammable, Dangerously water reactive (may cause spontaneous fire).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg).

Hazard symbols, risk, & safety statements: Hazard symbol: F; risk phrases: R11; R14/15; R37/38; R41; safety phrases: S2; S8; S21; S26; S30; S39; S43 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Calcium carbide is a grayish-black granules, powder, or lumps. Slight garlic odor. Molecular weight = 64.1; specific gravity (H_2O:1) = 2.22; boiling point ≥ 447°C; freezing/melting point = about 2300°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 3, reactivity 2 ₩ (water reactive).

Potential Exposure: A potential danger to those involved in the manufacture and handling of carbide and the generation of acetylene.

Incompatibilities: Water contact or moist air forms calcium hydroxide and explosive acetylene gas with risk of fire and explosion. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, hydrogen chloride, methanol, copper salt solutions, lead fluoride, magnesium, selenium, silver nitrate, iron trichloride, tin dichloride, sodium peroxide, stannous chloride, sulfur.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 120 milligram per cubic meter

PAC-2: 1300 milligram per cubic meter

PAC-3: 7900 milligram per cubic meter

Routes of Entry: Inhalation and ingestion.

Harmful Effects and Symptoms

Irritation of skin, eyes, and respiratory tract. Inhalation of dust may cause lung edema.

Short-Term Exposure: Corrosive. Contact with eyes or skin causes severe irritation and burns with possible permanent eye damage and ulcers to the skin. Irritates the lungs with coughing and/or shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: Can irritate the lungs. Exposure may cause bronchitis with coughing, phlegm, and/or shortness of breath.

Points of Attack: Eyes, skin, and respiratory tract.

Medical Surveillance: Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Lung function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash or dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit. *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode).

Storage: Color code—Red Stripe: Dangerous when wet materials release flammable gases on contact with water. Do not store this material in a room protected by water sprinkler systems. Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Do not store in a basement. Prior to working with calcium carbide all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from moisture and without sprinkler protection and avoid contact with incompatible materials. Use only nonsparking tools and equipment especially when opening and closing containers of calcium carbide. Metal containers involving the transfer of this chemical should be grounded and bonded. Use explosion-proof electrical equipment in the carbide-handling area. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN1402 Calcium carbide, Hazard Class: 4.3; Labels: 4.3-Dangerous when wet material.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Ventilate area of spill. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Wet calcium carbide produces highly flammable acetylene gas. Dry calcium carbide itself is not flammable. *Do not use water*, foam, carbon dioxide, or halogen extinguishers on fire. Use dry chemical, sand, soda ash; or lime extinguishers. Thermal decomposition products may include oxides of calcium and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBA that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Mixing with large quantity of water using pilot flame to ignite evolved acetylene. Lime residue sent to landfill.

References

(31); (173); (101); (138); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 2, No. 1, 91−93 (1982).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Calcium carbide, Trenton, NJ (March 2003).

Calcium Carbonate C:0230

Formula: $CCaO_3$; $CaCO_3$

Synonyms: Agricultural limestone; Agstone; Aragonite; Atomit; Bell mine pulverized limestone; Calcite; Calcium (II)carbonate (1:1); Carbonic acid, calcium salt (1:1); Chalk; Domolite; Franklin; Limestone; Lithographic stone; Marble; Portland stone; Sohnhofen stone; Vaterite. The monocarbonate is a Food and Drug Administration (FDA) and foreign over-the-counter drug with more than 250 registered trade names.

CAS Registry Number: 1317-65-3 (dolomite; limestone); 471-34-1 (carbonic acid, calcium salt)

HSDB Number: 927

RTECS Number: EV9580000; FF9335000 (monocarbonate)

EC Number: 207-439-9; 215-279-6 (limestone)

Regulatory Authority and Advisory Information

Hazard Alert: Primary irritant (w/o allergic reaction) (monocarbonate).

WGK[100] (German Aquatic Hazard Class): Nonhazard to water.

Description: Calcium carbonate is a white, odorless powder, or crystalline solid. Molecular weight = 100.09; specific gravity (H_2O:1) = 2.7 to 2.95; freezing/melting point = 825 to 1339°C (decomposes). Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 0, reactivity 0. Very slightly soluble in water; solubility = 0.001%. In some of the literature the monocarbonate (CAS 471-34-1) is listed: freezing/melting point = 825°C (decomposes).

Potential Exposure: Calcium carbonate is used as a source of lime; neutralizing agent; manufacturing or rubber, plastics, paint and coatings; sealants, paper, dentifrices, ceramics, putty, polishes and cleaners, insecticides, inks and cosmetics; whitewash; Portland cement; antacids; analytical chemistry, and others.

Incompatibilities: Calcium carbonate decomposes in high temperature forming carbon dioxide and corrosive materials.

Reacts with acids producing carbon dioxide gas release. Incompatible with acids, ammonium salts; fluorine. NIOSH also lists alum as incompatible, but this is questionable.

Permissible Exposure Limits in Air

OSHA PEL: 15 milligram per cubic meter (respirable fraction) TWA; 5 milligram per cubic meter (total dust) TWA

NIOSH REL: 10 milligram per cubic meter TWA, total dust; 5 milligram per cubic meter (respirable dust) TWA

ACGIH TLV[1]: Withdrawn.

471-34-1, carbonic acid, calcium salt

PAC Ver. 29[138]

PAC-1: 45 milligram per cubic meter

PAC-2: 210 milligram per cubic meter

PAC-3: 1300 milligram per cubic meter

Australia: TWA 10 milligram per cubic meter, 1993; Belgium: TWA 10 milligram per cubic meter, 1993; Poland: MAC (TWA) dust 10 milligram per cubic meter, 1999; Russia: STEL 6 milligram per cubic meter, 1993; Switzerland: MAK-W 6 milligram per cubic meter (resp. dust), 1999; United Kingdom: TWA 10 milligram per cubic meter, total inhalable dust, 2000; United Kingdom: TWA 4 milligram per cubic meter, respirable dust, 2000; the Netherlands: MAC-TGG 10 milligram per cubic meter, for regular and monocarbonate, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 10 milligram per cubic meter [(E)]

Determination in Air: NIOSH Analytical Method #7020 (Calcium), Method #7303, or OSHA Analytical Method ID-121. See also NIOSH analytical Methods #0500 for nuisance dust, total and 0600 for nuisance dust, respirable.

Routes of Entry: Inhalation of dust, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Inhalation can cause irritation to nose. Eye contact can cause irritation. *Ingestion:* Large amounts can cause irritability, nausea, dehydration, and constipation. Estimated lethal dose is over 2 lb.

Long-Term Exposure: Ingestion of more than 8 g (1/3 oz) a day can cause blood and kidney disorders.

Points of Attack: Eyes, respiratory system; digestive system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear safety glasses.

Respirator Selection: Wear dust mask.

Storage: Color code—Green: General storage may be used. Store to avoid contact with acids.

Shipping: The DOT Performance-Oriented Packaging Standards[19] do not cite calcium carbonate.

Spill Handling: Scoop up and place in suitable container. Discard with regular trash.

Fire Extinguishing: This chemical is a noncombustible solid. Use extinguishing agents suitable for surrounding materials.
Disposal Method Suggested: Landfills. It is the responsibility of chemical waste generators to determine if a discarded chemical is classified as a hazardous waste. See 40 CFR Parts 261.3 for United States Environmental Protection Agency guidelines for the classification determination. In addition, in order to ensure complete and accurate classification, waste generators must consult state and local hazardous waste regulations.

References

(31); (173); (101); (138); (100).
New York State Department of Health, Chemical Fact Sheet: Calcium Carbonate, Bureau of Toxic Substance Assessment, Albany, NY (March 1986).

Calcium Chlorate C:0240

Formula: $CaCl_2O_6$; $Ca(ClO_3)_2$
Synonyms: Calcium chlorate aqueous solution; Chlorate de calcium (French); Chloric acid, calcium salt
CAS Registry Number: 10137-74-3
HSDB Number: 253
RTECS Number: FN9800000
UN/NA & ERG Number: UN1452 (solid)/140; UN2429 (solution)/140
EC Number: 233-378-2
Regulatory Authority and Advisory Information
WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.
Description: Calcium chlorate forms white to yellow deliquescent crystals. Molecular weight = 243; specific gravity (H_2O:1) = 2.71; freezing/melting point = 340° (decompositional loses H_2O of crystallization @ $>100°$). Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 0, reactivity 0, O oxidizer. Highly soluble in water.
Potential Exposure: Calcium chlorate is used in making fireworks, herbicides (weed killers) and in photography.
Incompatibilities: A strong oxidizer. Reacts, possibly with risk of fire and explosion, with acids (especially organic acids), reducing agents; aluminum, arsenic, chemically active metals; combustible materials; ammonium compounds; charcoal, copper, cyanides; manganese dioxide, metal sulfides; phosphorus, sulfur.
Permissible Exposure Limits in Air
No standards or PAC available.
Permissible Concentration in Water: *Chlorates:* State Drinking Water Guidelines: California 800 μg/L; Maine 7 μg/L.
Routes of Entry: Inhalation of dust, ingestion.
Harmful Effects and Symptoms
Short-Term Exposure: Calcium chlorate can affect you when breathed in. Contact can irritate the skin and eyes. Inhalation can cause irritation of the respiratory tract. Calcium chlorate may damage the kidneys. Very high exposures can interfere with the ability of the blood to carry oxygen, causing headaches, dizziness, weakness, a bluish skin color, and even death. High exposures can cause death. LD_{50} (oral-rat) = 4500 mg/kg[41].
Long-Term Exposure: Can affect the kidneys, liver, heart, and blood.
Points of Attack: Eyes, skin, respiratory system; blood.
Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: methemoglobin level. EKG. Kidney and liver function tests.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.
Note to Physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.
Personal Protective Methods: Avoid skin contact with Calcium Chlorate. Wear protective gloves and clothing. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Wear dust-proof goggles when working with powders or dust, unless full facepiece respiratory protection is worn.
Respirator Selection: Where there is potential exists for exposure to Calcium Chlorate, use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode. All respirators selected must be approved by NIOSH under the provisions of 42 CFR 84. The current listing of NIOSH-certified respirators can be found in the NIOSH/NPPTL Certified Equipment List, which is available on the NIOSH website.
Storage: Oxidizer. Potentially explosive. Color code—Yellow: Reactive Hazard; Store in a location separate from

other materials, especially organic materials, flammables and combustibles, and other incompatible materials. Oxidizers, including oxidizing gases, should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Store in tightly closed containers in a cool, well-ventilated area away from strong acids (such as Hydrochloric, Sulfuric, and nitric); chemically active metals (such as potassium, sodium, magnesium, and zinc). Calcium chlorate must be stored to avoid contact with organic matter; ammonium compounds, aluminum, copper, cyanides, flammable vapors, and other oxidizable materials, since violent reactions occur. Avoid storage on wood floors. Friction, heat, or physical shocks may cause calcium chlorate to ignite and explode. Wherever calcium chlorate is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: UN1452 Calcium chlorate, Hazard Class: 5.1; Labels: 5.1-Oxidizer. UN2429 Calcium chlorate, aqueous solution, Hazard Class: 5.1; Labels: 5.1-Oxidizer.

Spill Handling: *For dry material:* Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

For solution: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid that increases the combustion of other substances. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include chlorine. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBA that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: For barium chlorate, the UN[22] recommends using a vast volume of a reducing agent (bisulfites, ferrous salts or hypo) followed by neutralization and flushing to the sewer with abundant water. This should be applicable here as well.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Calcium Chlorate, Trenton, NJ (October 2001).

Calcium Chloride C:0250

Formula: $CaCl_2$

Synonyms: Calcium chloride, anhydrous; Calplus; Caltac

CAS Registry Number: 10043-52-4; 7774-34-7 (hexahydrate); 22691-02-7 (hydrate); 10035-04-8, dihydrate

HSDB Number: 923

RTECS Number: EV9800000

EC Number: 233-140-8 [*Annex I Index No.:* 017-013-00-2] (*10043-52-4*)

Regulatory Authority and Advisory Information

Hazard Alert: Possible risk of forming tumors, Suspected of causing genetic defects.

European/International Regulations (*22691-02-7*): Hazard symbol: Xi; risk phrases: R11; R36; R62; safety phrases: S2; S22; S24 S33; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Calcium chloride is a colorless to off-white crystalline solid which is deliquescent (absorb water). When heated, crystals lose water @ 100°C. Molecular weight = 110.98; specific gravity (H_2O:1) = 2.15; boiling point = 1935°C (decomposes); freezing/melting point = 775°C. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 0, reactivity 0. Soluble in water; solubility = 75% @ 20°C.

Potential Exposure: Calcium chloride is used as road salt for melting snow, a drying agent in desiccators, for dehydrating organic liquids and gases, in refrigeration brines and antifreeze, as a dust-proofing agent, food additives, concrete hardening accelerator, and others. May react with strong oxidizers.

Incompatibilities: The solution in water is a weak base. Reacts with zinc in presence of moisture, forming highly flammable hydrogen gas. Dissolves violently in water with generation of much heat. Incompatible with water, bromine trifluoride; 2-furan, percarboxylic acid. May attack some building materials and metals in the presence of moisture.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

10043-52-4

PAC-1: 12 milligram per cubic meter
PAC-2: 130 milligram per cubic meter
PAC-3: 790 milligram per cubic meter

22691-02-7, hydrate

PAC-1: 13 milligram per cubic meter
PAC-2: 140 milligram per cubic meter
PAC-3: 850 milligram per cubic meter

10035-04-8, dihydrate

PAC-1: 16 milligram per cubic meter
PAC-2: 170 milligram per cubic meter
PAC-3: 1100 milligram per cubic meter

7774-34-7, hexahydrate

PAC-1: 24 milligram per cubic meter
PAC-2: 260 milligram per cubic meter
PAC-3: 1600 milligram per cubic meter

Routes of Entry: Inhalation of dust; ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Inhalation of dust may cause burning, irritation of the nose, mouth, and throat, nose bleeds, and breakdown of nasal tissue. Skin contact with dry skin solid may cause severe irritation. Contact with wet skin or concentrated solutions can cause more severe irritation and burns. Ingestion may cause irritation of the mouth, throat, and stomach, nausea, and vomiting. Eye contact may cause irritation, burning, and some damage to the surface of the eye. LD_{50} (oral-rat) = 1000 mg/kg (slightly toxic).

Long-Term Exposure: Repeated or prolonged contact with skin may cause dermatitis. Prolonged or repeated inhalation may cause ulcerations of the nasal mucous membrane.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear goggles or face shield if eye hazard exists, coveralls and rubber gloves. Natural rubber, Neoprene, and polyvinyl chloride are among the recommended protective materials.

Respirator Selection: Dust mask or dust respirator may be helpful in preventing inhalation exposures.

Storage: Keep tightly sealed in a cool, dry place away from incompatible materials.

Shipping: There are no label or maximum shipping quantity requirements set by DOT[19].

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material, and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use extinguishing agent suitable for surrounding fire. Thermal decomposition products may include chlorine. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBA that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Add large volumes of water. Add excess soda ash, then neutralize with HCl. Route to sewage plant or use as landfill sludge.

References

(31); (173); (101); (138); (80); (100).

New York State Department of Health, Chemical Fact Sheet: Calcium Chloride, Bureau of Toxic Substance Assessment, Albany, NY (March 1986).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 2, No. 1, 93−94 (1982).

Calcium Chromate C:0260

Formula: $CaCrO_4$

Synonyms: Calcium chromate(IV); Calcium chrome yellow; Calcium chromium oxide; Calcium monochromate; Chromato calcico (Spanish); Chromic acid, calcium salt (1:1); C.I. 77223; C.I. Pigment yellow 33; Gelbin; Yellow ultramarine

CAS Registry Number: 13765-19-0

HSDB Number: 248

RTECS Number: GB2750000

UN/NA & ERG Number: UN3288 (Toxic solids inorganic)/151

EC Number: 237-366-8 [*Annex I Index No.:* 024-008-00-9]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human Sufficient Evidence; Animal Sufficient Evidence, *carcinogenic to humans*, Group 1, 1997; NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen; EPA *(inhalation)*: Known human carcinogen; EPA *(oral)*: Not Classifiable as to human carcinogenicity; NTP: Known to be a human carcinogen.

California Proposition 65 Chemical[102]: (*hexavalent chromium*) Cancer 2/27/1987; Developmental/Reproductive toxin (male, female) 12/19/2008

Hazard Alert: Poison, Strong oxidizer, Possible risk of forming tumors, Reproductive toxin, Environmental hazard.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Clean Water Act: 40CFR116.4 Hazardous Substances; RQ 40CFR117.3 (same as CERCLA); 40CFR423, Appendix A, Priority Pollutants; 40CFR401.15 Section 307 Toxic Pollutants as chromium and compounds.

EPA Acceptable daily intake (ADI): Chromium(VI) = 0.175 mg/day/man; Chromium(III) = 125 mg/day/man. EPA estimated adequate and safe intake (EASI) levels for chromium: **Infants:** age 0.0−0.5 years: 0.01−0.04 mg/day; age 0.5−1.0 year: 0.02−0.06 mg/day. **Children** age 1−3 years: 0.02−0.08 mg/day; age 4−6 years: 0.03−0.12 mg/day; age 7−10 years: 0.05−0.20 mg/day; age > or = 11 years: 0.05−0.20 mg/day. **Adults**: 0.05−0.20 mg/day.

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): D007

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, O, N; risk phrases:R45; R8, R22; R50/53; R60; R61; safety phrases: S17; S29/35; S53; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)]

Description: Calcium chromate is a yellow crystalline solid, often used in solution. Odorless. It normally occurs as the dehydrate and loses water @ 200°C. Molecular weight = 156.07; specific gravity (H_2O:1) = 2.89; freezing/melting point = 999°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 0, reactivity 0. Insoluble in water.

Potential Exposure: Calcium chromate is used as a pigment, corrosion inhibitor; in the manufacture of chromium; in oxidizing reactions; in battery depolarization.

Incompatibilities: A strong oxidizer. Incompatible with boron (violent reaction), ethanol, combustibles, organic, or other easily oxidized materials.

Permissible Exposure Limits in Air

As chromium(VI), inorganic insoluble compounds

NIOSH IDLH = 15 mg[Cr(VI)]/m^3

OSHA PEL: 0.005 mg[Cr(VI)]/m^3 TWA Concentration. See 29CFR1910.1026

NIOSH REL: 0.001 mg[Cr]/m^3 TWA, potential carcinogen, limit exposure to lowest feasible level. NIOSH considers all Cr(VI) compounds (including chromic acid, *tert*-butyl chromate, zinc chromate, and chromyl chloride) to be potential occupational carcinogens. See *NIOSH Pocket Guide*, Appendices A and C.

ACGIH TLV[1]: 0.01 mg[Cr]/m^3 TWA, Confirmed Human Carcinogen

PAC Ver. 29[138]

PAC-1: 0.003 milligram per cubic meter

PAC-2: 7.8 milligram per cubic meter

PAC-3: 47 milligram per cubic meter

DFG MAK: Danger of skin sensitization; Carcinogen Category 2; TRK: 0.05 mg[Cr]/m^3; 20 μg/L [Cr] in urine at end-of-shift

The above exposure limits are for air levels only. When skin contact also occurs, you may be overexposed, even though air levels are less than the limits listed above. Some states have set guidelines or standards for calcium chromate in ambient air[60]: North Carolina, zero; Massachusetts, 0.0008 μ/m^3.

Determination in Air: Use NIOSH Analytical Method (IV) #7024, Chromium.

Permissible Concentration in Water: State Drinking Water Guidelines: California 10 μg[Cr(VI)]/L; Maine 35 μg[Cr(VI)]/L.

Determination in Water: Be AA using either direct aspiration into a flame or a furnace technique[49].

Routes of Entry: Skin contact, inhalation of dust, ingestion. This chemical can be absorbed through the skin, thereby increasing exposure.

Harmful Effects and Symptoms

Short-Term Exposure: *Inhalation:* Exposure to 0.18−1.4 milligram per cubic meter can cause irritation of nose and throat within 2 weeks; disintegration of nasal tissue; coughing, wheezing, headache, painful breathing, and fever within 8 weeks. Skin contact can cause severe irritation. Contact with damaged skin can cause deep sores known as "chrome holes." Eye contact can cause severe chemical burns and possible loss of vision. Ingestion can cause severe sore throat and irritation of the throat, stomach and intestine, which can develop into tissue damage.

Long-Term Exposure: Calcium chromate is a carcinogen in humans, and has been shown to cause lung, liver, bladder, etc. cancer. Inhalation can cause breakdown of nasal tissue and a hole in the septum dividing the inner nose. Exposed persons may develop skin allergy, bronchitis, lung allergy; and kidney damage.

Points of Attack: Lungs, kidneys, skin, respiratory system; eyes, gastrointestinal system.

Medical Surveillance: NIOSH lists the following tests: Blood gas analysis, CBC; chest X-ray, electrocardiogram, liver function tests; pulmonary Function tests, sputum cytology, urine (chemical/metabolite), UA (routine), white blood cell count/differential. For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: Urine test for chromates. This test is most accurate shortly after exposure. Exam of the skin and nose. If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing; may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Prevent skin contact. (as chromic acid and chromates) **8 hours** (more than 8 hours of resistance to breakthrough $>0.1\ \mu g/cm^2/min$): Polyethylene gloves, suits, boots; polyvinyl chloride gloves, suits, boots; Saranex-coated suits; **4 hours** (At least 4 but <8 hours of resistance to breakthrough $>0.1\ \mu g/cm^2/min$): butyl rubber gloves, suits, boots; Viton gloves, suits. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-(if using solution) or dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Specific engineering controls are recommended in NIOSH Criteria Document #76-129, Chromium(VI).

Respirator Selection: NIOSH, as chromates: *at any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Check oxygen content prior to entering storage area. Color code—Blue (carcinogen): Health Hazard: Store in a secure poison location. Calcium chromate must be stored to avoid contact with combustible, organic or other easily oxidized materials (such as paper, wood, sulfur, aluminum, hydrazine, and plastics), since violent reactions occur. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Store in a cool, well-ventilated area away from incompatible materials listed above. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43A *Codes for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage.

Shipping: UN3288 Toxic solids, inorganic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: *Dry material:* Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Solution: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical may burn but does not readily ignite. Thermal decomposition products may include metal oxides of chromium. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Container may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBA that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Reduce to trivalent chromium and precipitate as chromium(III) hydroxide. Compact the sludge and dispose in single purpose special waste dumps[22].

References

(109); (102); (31); (173); (101); (138); (2); (122); (100).

New York State Department of Health, Chemical Fact Sheet: *Calcium Chromate (VI)*, Bureau of Toxic Substance Assessment, Albany, NY (January 1986).

United States Environmental Protection Agency, *Health advisory: Chromium*, Washington, DC, Office of Drinking Water (March 31, 1987).

United States Public Health Service, *Toxicological Profile for Chromium*, Washington, DC, Agency for Toxic Substance and Disease Registry (October 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Calcium Chromate*, Trenton, NJ (September 1998).

United States Environmental Protection Agency, *Health Assessment Document: Chromium*, EPA 600/8-83-014F, Washington, DC (1984).

Calcium Cyanamide C:0270

Formula: $CCaN_2$; $CaCN_2$

Synonyms: Aero-cyanamid; Aero-cyanamid, Special grade; Alzodef; Calcium carbimide; Calcium cyanamid; CCC; Cianamida calcica (Spanish); Cyanamid; Cyanamide; Cyanamide calcique (French); Cyanamide, calcium salt (1:1); Cyanamid granular; Cyanamid special grade; Cy-L 500; Lime nitrogen; NCI-C02937; Nitrogen lime; Nitrolime; USAFCY-2

CAS Registry Number: 156-62-7

HSDB Number: 1328

RTECS Number: GS6000000

UN/NA & ERG Number: UN1403 (Calcium cyanamide, with more than 0.1% Calcium carbide)/138

EC Number: 205-861-8 [*Annex I Index No.:* 615-017-00-4]

Regulatory Authority and Advisory Information

Hazard Alert: Combustible, Corrosive, Water reactive (emits flammable gas), Agricultural Chemical Possible risk of forming tumors, Suspected of causing genetic defects, Environmental hazard.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Superfund/EPCRA 40 CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as cyanide mixtures, cyanide solutions or cyanides, inorganic, n.o.s.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%; NPRI.

Hazard symbols, risk, & safety statements: Hazard symbol: Xn, C; risk phrases: R15; R22; R37; R41; R51; R62; safety phrases: S2; S22; S26; S36/37/S39; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Calcium cyanamide is a blackish-gray, shiny crystalline material or powder. Molecular weight = 80.11; specific gravity (H_2O:1) = 2.29; freezing/melting point = 1340°C (sublimes > 1500°C). Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 1, reactivity 1₩. Insoluble in water; reaction, releasing explosive acetylene gas and ammonia.

Potential Exposure: Calcium cyanamide is used in agriculture as a fertilizer, herbicide; defoliant for cotton plants; and pesticide. It is also used in the manufacture of dicyandiamide and calcium cyanide as a desulfurizer in the iron and steel industry; and in steel hardening.

Incompatibilities: Commercial grades of calcium cyanamide may contain calcium carbide; contact with any form of moisture solutions may cause decomposition, liberating explosive acetylene gas and ammonia. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. May polymerize in water or alkaline solutions to dicyanamide. Contact with all solvents tested also causes decomposition.

Permissible Exposure Limits in Air

OSHA PEL: None

NIOSH REL: 0.5 milligram per cubic meter TWA

ACGIH TLV[1]: 0.5 milligram per cubic meter TWA, not classifiable as a human carcinogen

PAC Ver. 29[138]

PAC-1: 1.5 milligram per cubic meter

PAC-2: 5.6 milligram per cubic meter

PAC-3: 50 milligram per cubic meter

DFG MAK 1 milligram per cubic meter, measured as the, inhalable fraction [skin]; Peak Limitation Category II(2).

Australia: TWA 0.5 milligram per cubic meter, 1993; Austria: MAK 0.5 milligram per cubic meter [skin] 1999; Denmark: TWA 0.5 milligram per cubic meter, 1999; Finland: TWA 0.5 milligram per cubic meter; STEL 1.5 milligram per cubic meter, 1999; France: VME

0.5 milligram per cubic meter, 1999; Norway: TWA 0.5 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 0.5 milligram per cubic meter, 2003; Switzerland: MAK-W 0.5 milligram per cubic meter [skin] 1999; United Kingdom: LTEL 0.5 milligram per cubic meter; STEL 1 milligram per cubic meter, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Several states have set guidelines or standards for calcium cyanamide in ambient air[60] ranging from 5.0 μ/m^3 (North Dakota) to 8.0 μ/m^3 (Virginia) to 10.0 μ/m^3 (Connecticut) to 12.0 μ/m^3 (Nevada).

Determination in Air: Filter; none; Gravimetric; IV NIOSH Analytical Method #0500, Particulates NOR, total dust. Use NIOSH Analytical Method #7904; #6010, cyanides.

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 200 μg[CN]/L; State Drinking Water Standards: California 150 μg[CN]/L; State Drinking Water Guidelines: Arizona 220 μg[CN]/L; Maine. 140 μg [CN]/L; Minnesota 100 μg[CN]/L. United States Army field drinking-water standards for cyanide: 2 mg[CN]/L assuming a water consumption of 15 L/day and 6 mg[CN]/L assuming a water consumption of 5 L/day. United States Army field drinking-water standards for cyanide, long-term consumption 0.5 mg[CN]/L; Short-term consumption; Raw water constituents (maximum) 20 mg[CN]/L.

Determination in Water: Toxic to aquatic organisms.

Routes of Entry: Inhalation of dust, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Calcium cyanamide can cause nausea, headache, dizziness, and flushing of the skin. It is a Primary irritant (w/o allergic reaction) of the mucous membranes of the respiratory tract, eyes, and skin. Drinking alcohol shortly before or within 1−2 days after exposure can cause a severe reaction. Inhalation may result in rhinitis, pharyngitis, laryngitis, and bronchitis. Conjunctivitis, keratitis, and corneal ulceration may occur. An itchy erythematous dermatitis has been reported and continued skin contact leads to the formation of slowly healing ulcerations on the palms and between the fingers. Sensitization occasionally develops. Chronic rhinitis and perforation on the nasal septum have been reported after long exposures. All local effects appear to be due to the caustic nature of cyanamide.

Long-Term Exposure: Calcium cyanamide may damage the developing fetus. This chemical may damage the nervous system; causing numbness, and weakness in the hands and feet. Prolonged contact can cause skin ulcers. It causes a characteristic vasomotor reaction. There is erythema of the upper portions of the body, face and arms accompanied by nausea, fatigue, headache, dyspnea, vomiting, oppression in the chest, and shivering. Circulatory collapse may follow in the more serious cases. The vasomotor response may be triggered or intensified by alcohol ingestion. Pneumonia or lung edema may develop. Cyanide ion is not released in the body, and the mechanism of toxic action is unknown.

Points of Attack: Eyes, skin, respiratory system; vasomotor system.

Medical Surveillance: Examination of the nervous system. Evaluation by a qualified allergist. Evaluate skin, respiratory tract, and history of alcohol intake in placement or periodic examinations.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eye wash. In addition to personal protective equipment, waterproof barrier creams may be used to provide additional face and skin protection.

Respirator Selection: *Up to 25 milligram per cubic meter:* Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any SCBA with full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front -or back-mounted canister providing protection against the compound of concern and having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: (1) Color code—Red Stripe: Dangerous when wet materials release flammable gases on contact with water. Do not store this material in a room protected by water sprinkler systems. Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Do not store in a basement. Store under inert gas. (2) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area separated from strong oxidants, strong bases; strong acids. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN1403 Calcium cyanamide with >1% calcium carbide, Hazard Class: 4.3; Labels: 4.3-Dangerous when wet material.

Spill Handling: Restrict persons not wearing protective equipment from the danger area of spill until clean-up is complete. Remove all ignition sources. Ventilate area of spill. Collect spilled material in the most convenient and safe manner and deposit in sealed containers for reclamation or for disposal in an approved facility. Absorb liquid containing calcium cyanamide in vermiculite, dry sand; earth, or similar material. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Do not use foam extinguishers or water. Use dry chemical, soda ash; or lime. Thermal decomposition products may include oxides of nitrogen, calcium, and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBA that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (2); (80); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 2, No. 6, 38−41 (1982).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Calcium cyanamide, Trenton, NJ (June 2005).

Calcium Cyanide C:0280

Formula: C_2CaN_2; $Ca(CN)_2$

Synonyms: Calcid; Calcyan; Calcyanide; Cianuro calcico (Spanish); Cyanogas; Cyanure de calcium (French)

CAS Registry Number: 592-01-8

HSDB Number: 242

RTECS Number: EW0700000

UN/NA & ERG Number: UN1575/157

EC Number: 209-740-0 [*Annex I Index No.:* 020-002-00-5]

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Environmental hazard.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

United States National Primary Drinking Water Regulations: MCLG = 0.2; MCL = 0.2 mg[CN^-]/L as cyanide

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P021

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg)

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as cyanide mixtures, cyanide solutions or cyanides, inorganic, n.o.s.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. as cyanide compounds, inorganic, n.o.s.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R28; R32; R50/53; safety phrases: S1/2; S7/8; S23; S36/37; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Calcium cyanide is a white crystalline solid or powder. Odor of hydrogen cyanide. Molecular weight = 92.12; specific gravity (H_2O:1) = 1.853 @ 20°C; freezing/melting point ≥ 350°C (dangerous decomposition below MP). Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 1. Soluble in water; violent reaction.

Potential Exposure: Calcium cyanide is used as a fumigant; as a rodenticide; in leaching precious metal ores; in the manufacture of stainless steel; and as a stabilizer for cement. Used as raw material for production of nitrogenous compounds and in treatment of alcoholism.

Incompatibilities: Contact with water, acids, acidic salts; moist air, or carbon dioxide, forms highly toxic and flammable hydrogen cyanide. Incompatible with fluorine, magnesium. Reacts violently when heated with nitrites, nitrates, chlorates, and perchlorates. Calcium cyanide decomposes in high heat forming hydrogen cyanide and nitrous oxides fumes.

Permissible Exposure Limits in Air

NIOSH IDLH = 25 mg[CN]/m^3

OSHA PEL: 5 ppm[CN] TWA

NIOSH REL: 4.7 ppm/5 mg[CN]/m^3 [10 minutes] Ceiling Concentration

ACGIH TLV[1]: 5 mg[CN]/m^3 [skin] Ceiling Concentration

PAC* Ver. 29[138]

PAC-1: $\mathbf{3.8_A}$ milligram per cubic meter

PAC-2: $\mathbf{13_A}$ milligram per cubic meter

PAC-3: $\mathbf{28_A}$ milligram per cubic meter

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60-minute values.

DFG MAK: 2 mg[CN]/m^3 inhalable fraction TWA; Peak Limitation Category II(1) [skin]; Pregnancy Risk Group: C

Determination in Air: Use NIOSH Analytical Method #7904; #6010, cyanides.

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 200 μg[CN]/L; State Drinking Water Standards: California 150 μg[CN]/L; State Drinking Water Guidelines: Arizona 220 μg[CN]/L; Maine. 140 μg [CN]/L; Minnesota 100 μg[CN]/L. United States Army field drinking-water standards for cyanide: 2 mg[CN]/L assuming a water consumption of 15 L/day and 6 mg[CN]/L assuming a water consumption of 5 L/day. United States Army field drinking-water standards for cyanide, long-term consumption 0.5 mg[CN]/L; Short-term consumption; Raw water constituents (maximum) 20 mg[CN]/L.

Routes of Entry: Can be absorbed through the skin, inhalation, ingestion.

Harmful Effects and Symptoms

Calcium cyanide is highly toxic. The lethal human dose is 18 mg/kg. The hazard is that of hydrogen cyanide. The dust is irritating to the eyes, nose, and throat[41]. Inhalation or ingestion causes headache, nausea, vomiting, and weakness; high concentrations are rapidly fatal.

Short-Term Exposure: The substance is corrosive to the eyes, skin, and respiratory tract. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. May affect the central nervous system; blood, heart, and respiratory tract.

Long-Term Exposure: Repeated or prolonged contact with skin may cause dermatitis. May be a reproductive toxin in humans.

Points of Attack: Skin, lungs.

Medical Surveillance: Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Lung function tests. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Do not allow water to enter nose or mouth. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy. Use amyl nitrate capsules if symptoms of cyanide poisoning develop. All area employees should be trained regularly in emergency measures for cyanide poisoning and in CPR. A cyanide antidote kit should be kept in the immediate work area and must be rapidly available. Kit ingredients should be replaced every 1−2 years to ensure freshness. Persons trained in the use of this kit; oxygen use, and CPR, must be quickly available.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should Wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 25 milligram per cubic meter:* Sa (APF = 10) (any supplied-air respirator) or SCBAF (APF = 50) (any SCBA with full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern and having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with Calcium cyanide all handlers should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored. Store in tightly closed containers in a cool, well-ventilated area away from moisture, water, acids, and oxidizers. Protect against physical damage to containers.

Shipping: UN1575 Calcium cyanide, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. Keep material out of drains, sewers, streams. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical or dry sand. Do not use foam, water, carbon dioxide. Thermal decomposition products may include phosgene and hydrogen chloride. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBA that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Add cyanide waste to strong alkaline sodium hypochlorite. Let stand 24 hours then flush to sewage plant[22].

References

(31); (173); (101); (138); (2); (80); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 2, No. 1, 95−96 (1982).

Calcium Fluoride C:0290

Formula: CaF_2

Synonyms: Calcium difluoride; Fluorite; Fluorspar; Fluospar; Met-Spar

CAS Registry Number: 7789-75-5

HSDB Number: 995

RTECS Number: EW1760000

EC Number: 232-188-7

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Suspected reprotoxic hazard, Suspected of causing genetic defects.

United States National Primary Drinking Water Regulations: MCLG = 4 mg[F]/L; MCL = 4 mg[F]/L; SMCL = 2.0 mg[F]/L, as Fluoride.

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Calcium fluoride is colorless crystalline or white, powdery substance. Molecular weight = 78.08; specific gravity (H_2O:1) = 3.18 @ 20°C; boiling point = 2495°C; freezing/melting point = 1418°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 0, reactivity 0. Practically insoluble in water.

Potential Exposure: Calcium fluoride is used for production of hydrofluoric acid; as a flux in steel manufacture; in smelting; electric arc welding, making glass and ceramics; and to fluoridate drinking water.

Permissible Exposure Limits in Air

NIOSH IDLH = 250 mg[F]/m^3

OSHA PEL: 3 ppm/2.5 mg[F]/m^3 TWA

NIOSH REL: 3 ppm/2.5 mg[F]/m^3 TWA; 6 ppm/5 mg[F]/m^3, 15 minutes Ceiling Concentration

ACGIH TLV[1]: 2.5 mg[F]/m^3 TWA; BEI: 3 mg[F]/g creatinine in urine prior to end-of-shift; 10 mg[F]/g creatinine in urine end-of-shift

PAC Ver. 29[138]

PAC-1: 15 milligram per cubic meter

PAC-2: 170 milligram per cubic meter

PAC-3: 1000 milligram per cubic meter

DFG MAK: 1 mg[F]/m^3, inhalable fraction [skin]; Peak Limitation Category II(4); Pregnancy Risk Group C; BAT: 7.0 mg[F]/g creatinine in urine at end-of-shift; 4.0 mg[F]/g creatinine in urine at the beginning of the next shift

Australia: TWA 2.5 mg[F]/m^3, 1993; Austria: MAK 2.5 mg [F]/m^3, 1999; Belgium: TWA 2.5 mg[F]/m^3, 1993; Finland: TWA 2.5 mg[F]/m^3, 1999; France: VME 2.5 mg[F]/m^3, 1999; Hungary: TWA 1 mg[F]/m^3; STEL 2 mg[F]/m^3, 1993; Norway: TWA 0.6 mg[F]/m^3, 1999; the Philippines: TWA 2.5 mg[F]/m^3, 1993; Poland: MAC (TWA) 1 mg [HF]/m^3, MAC (STEL) 3 mg[HF]/m^3, 1999; Russia: STEL 0.5 ppm (2.5 milligram per cubic meter), 1993; Sweden: NGV 2 mg[F]/m^3, 1999; Switzerland: MAK-W 1.8 ppm (1.5 mg[F]/m^3), KZG-W 3.6 ppm (3.0 mg[F]/m3), 1999;

Thailand: TWA 2.5 mg[F]/m^3, 1993; United Kingdom: TWA 2.5 mg[F]/m^3, 2000; LTEL 2.5 mg[F]/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen.

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guide lines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg[F]/L. Safe Drinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg[F]/L; SMCL = 2 mg/F/L, as Fluoride.

Routes of Entry: Inhalation of dust, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: *Inhalation:* May cause difficult breathing; burning of mouth, throat, and nose which may result in bleeding. These may be felt @ 7.5 milligram per cubic meter. Nausea, vomiting, profuse sweating, and excess thirst may occur at higher levels. *Skin:* May cause rash, itching, and burning of skin. Solutions of 1% strength may cause sores if not removed promptly. *Eyes:* May cause severe irritation. *Ingestion:* Most reported instances of fluoride toxicity are due to accidental ingestion and it is difficult to associate symptoms with dose. 5−40 mg may cause nausea, diarrhea, and vomiting. More severe symptoms of burning and painful abdomen; sores in mouth; throat and digestive tract; tremors, convulsions, and shock will occur from about 1 g. Death may result by ingestion of 2−5 g (1/6 oz).

Long-Term Exposure: Repeated exposure may cause poor appetite; nausea, constipation, or diarrhea. Repeated exposure to fluoride chemicals may cause stiffness in muscles or ligaments and even crippling; this could take years to develop. Fluoride may increase bone density, stimulate new bone growth or cause calcium deposits in ligaments. This may become a problem at levels of 20−50 milligram per cubic meter or higher. Mottling of the teeth may occur at this level.

Points of Attack: Eyes, skin, respiratory system; bones.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Urine fluoride level (normal is less than 4 mg/L).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. A doctor or authorized paramedic may consider administering aluminum hydroxide gel, if conscious.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should Wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls, and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit. NIOSH/OSHA *12.5 milligram per cubic meter:* Q_m (APF = 25) (any quarter-mask respirator). *25 milligram per cubic meter:* 95XQ (APF = 10)* [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or SA* (any supplied-air respirator). *62.5 milligram per cubic meter:* Sa:Cf (APF = 25)*$^+$ (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25)* *if not present as a fume* (any powered APR with a high-efficiency particulate filter). *125 milligram per cubic meter:* 100F (APF = 50)$^+$ [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *250 milligram per cubic meter:* Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50)$^+$ [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or SCBAE (any appropriate escape-type, SCBA). *Substance reported to cause eye irritation or damage; may require eye protection. *May need acid gas sorbent.

Storage: Color code—Green: General storage may be used. Store in tightly closed containers in a cool, well-ventilated area away from acids, and chemically active metals (such as potassium, sodium, magnesium, and zinc) because corrosive hydrogen fluoride (HF) will be produced.

Shipping: Calcium fluoride is not specifically covered by DOT[19] in its Performance-Oriented Packaging Standards.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Use any extinguishing agent suitable for surrounding fire. Thermal decomposition products may include HF and oxices of calcium. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBA that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (122); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 1, No. 8, 47−48 (1981).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Calcium Fluoride, Trenton, NJ (May 1986).

New York State Department of Health, *Chemical Fact Sheet Calcium Fluoride*, Bureau of Toxic Substance Assessment, Albany, NY (March 1986).

Calcium Hydride C:0293

Formula: CaH_2

Synonyms: Calcium dihydride; Hydrolith

CAS Registry Number: 7789-78-8; 57308-10-8 [calcium hydrogen (−1) ion]

HSDB Number: 8095

RTECS Number: EW 2440000

UN/NA & ERG Number: UN1404/138

EC Number: 232-189-2 [*Annex I Index No.:* 001-004-00-5]

Regulatory Authority and Advisory Bodies

Hazard Alert: Highly flammable, Dangerous when wet: reacts with water (emits flammable gas; self-ignition possible), Strong reducing agent, Air reactive.

Hazard symbols, risk, & safety statements: Hazard symbol: F+; risk phrases: R11; R14; R15/29; safety phrases: S7/8; S21; S24/25; S43 (no water); S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Calcium hydride is a grayish-white crystalline solid. Molecular weight = 42.24; specific gravity (H_2O:1) = 1.7; freezing/melting point = 816°C (It begins to decompose at about 600°C). Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 3, reactivity 3₩. Reacts with water, releasing flammable hydrogen gas and may form a corrosive solution[101].

Potential Exposure: Calcium Hydride is used as a drying and reducing agent and a cleaner for blocked up oil wells.

Incompatibilities: Dust may form explosive mixture with air. Reacts with water, moist air, and steam, releasing flammable hydrogen gas; and may self-ignite in air. A strong reducing agent; incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Incompatible with metal halogenates, silver fluoride, and tetrahydrofuran.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

7789-78-8

PAC-1: 12 milligram per cubic meter

PAC-2: 130 milligram per cubic meter

PAC-3: 790 milligram per cubic meter

Permissible Concentration in Water: No criteria set (calcium hydride reacts with water in any event).

Routes of Entry: Inhalation of dust, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Calcium hydride can affect you when breathed in. Contact with skin or eyes can cause severe burns. Exposure can irritate the eyes, nose, and throat. Breathing Calcium hydride can irritate the lungs, causing coughing and/or shortness of breath. Higher exposures can cause a build-up of fluid in the lungs (pulmonary edema). This can cause death.

Long-Term Exposure: Although it is unknown whether calcium hydride causes lung damage, similar very irritating substances are capable of causing lung damage.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended. Lung function tests. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: *Clothing:* Avoid skin contact with Calcium Hydride. Wear protective gloves and clothing. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. *Eye Protection:* Wear dust-proof goggles and face shield when working with powders or dust, unless full facepiece respiratory protection is worn.

Respirator Selection: Where there is potential exists for exposure to Calcium Hydride use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode. All respirators selected must be approved by NIOSH under the provisions of 42 CFR 84. The current listing of NIOSH-certified respirators can be found in the NIOSH/NPPTL Certified Equipment List, which is available on the NIOSH website.

Storage: Color code—Red Stripe: Dangerous when wet materials release flammable gases on contact with water. Do not store this material in a room protected by water sprinkler systems. Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Do not store in a basement. Calcium hydride must be stored to avoid contact with water or steam, since violent reactions occur and flammable hydrogen gas is produced. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: UN1404 Calcium hydride, Hazard Class: 4.3; Labels: 4.3-Dangerous when wet material.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: *Do not use any hydrous (water, foam, etc.) extinguishing agents*. Fire may restart after it has been extinguished. Use dry chemical, soda ash; or lime extinguishers. Thermal decomposition products may include calcium hydroxide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBA that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Calcium Hydride, Trenton, NJ (March 2000).

Calcium Hydroxide C:0295

Formula: CaH_2O_2: $Ca(OH)_2$

Synonyms: Bell mine; Calcium hydrate; Carboxide; Hydrated kemikal; Hydrated lime; Lime water; Slaked lime

CAS Registry Number: 1305-62-0

UN/NA & ERG Number: UN3262/154

HSDB Number: 919

RTECS Number: EW2800000
EC Number: 215-137-3
Regulatory Authority and Advisory Information
Hazard Alert: Suspected of causing genetic defects, Corrosive, Primary irritant (w/o allergic reaction).
Hazard symbols, risk, & safety statements: Hazard symbol: T, Xi, C; risk phrases: R23/25; R33; R36/37/38; R62; safety phrases: S24/25; S26; S27; S36/37/39; S45 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.
Description: Calcium hydroxide is a soft white crystalline, odorless powder with an alkaline, bitter taste. Molecular weight = 74.11; specific gravity (H_2O:1) = 2.24 @ 25°C; boiling point = decomposes; freezing/melting point = 580°C (decomposes; dehydrates to calcium oxide). Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 0, reactivity 2. Insoluble in water. *Note*: Readily absorbs CO_2 from the air to form calcium carbonate.
Potential Exposure: Calcium hydroxide is used in agriculture and in fertilizer manufacture; it is used in the formulation of mortar, plasters, and cements; it is used as a scrubbing and neutralizing agent in the chemical industry. For making insecticides, acaricides, and products to control arthropods[97].
Incompatibilities: May react violently with acids, maleic anhydride, nitromethane, nitroethane, nitropropane, nitroparaffins, and phosphorus.
Permissible Exposure Limits in Air
OSHA PEL: 15 milligram per cubic meter (total dust) TWA; 5 milligram per cubic meter (respirable fraction) TWA
NIOSH REL: 5 milligram per cubic meter TWA
ACGIH TLV[1]: 5 milligram per cubic meter TWA
PAC Ver. 29[138]
PAC-1: 1 milligram per cubic meter
PAC-2: 240 milligram per cubic meter
PAC-3: 1500 milligram per cubic meter
Australia: TWA 5 milligram per cubic meter, 1993; Austria: MAK 5 milligram per cubic meter, 1999; Belgium: TWA 5 milligram per cubic meter, 1993; Denmark: TWA 5 milligram per cubic meter, 1999; Finland: TWA 5 milligram per cubic meter, 1999; France: VME 5 milligram per cubic meter, 1999; Norway: TWA 5 milligram per cubic meter, 1999; Poland: AC (TWA) 2 milligram per cubic meter, 1999; Switzerland: MAK-W 5 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 5 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 5 milligram per cubic meter. Several states have set guidelines or standards for calcium hydroxide in ambient air[60] ranging from 50 μ/m^3 (North Dakota) to 80 μ/m^3 (Virginia) to 100 μ/m^3 (Connecticut) to 119 μ/m^3 (Nevada).
Determination in Air: Filter collection followed by AA analysis. Use NIOSH Analytical Method #7020 for Calcium. See also OSHA Analytical Method ID-121.
Routes of Entry: Inhalation of dust, ingestion.
Harmful Effects and Symptoms
Short-Term Exposure: A corrosive. *Inhalation:* May cause severe irritation to mouth, throat, and lungs if dust is inhaled. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. *Skin:* May cause painful irritation and chemical burns on contact with open cuts or sores or on prolonged contact with intact skin. *Eyes:* Powders and slurries may cause severe chemical burns. Blindness can result. *Ingestion:* Powders, crystals, or slurries may give rise to irritation, soreness, and chemical burns. The estimated lethal dose is about 1 lb.
Long-Term Exposure: Repeated or prolonged contact with skin may cause dermatitis. Lungs may be affected by repeated or prolonged exposure to dust particles.
Points of Attack: Eyes, skin, respiratory system.
Medical Surveillance: Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Consider chest X-ray following acute overexposure.
First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.
Personal Protective Methods: Prevent skin contact. Wear chemical protective clothing which is specifically recommended by the manufacturer. Structural firefighter's protective clothing provides only limited protection. Gloves, eye protection, and coveralls should be worn if contact with Calcium hydroxide is likely. **8 hours** (more than 8 hours of resistance to breakthrough $>0.1\ \mu g/cm^2/min$): natural rubber gloves, Neoprene rubber gloves, suits, boots; nitrile rubber gloves, suits, boots.

Respirator Selection: A dust mask or respirator with dust cartridges. Where there is potential exists for exposure to maneb, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location; keep acids away from bases and red, yellow, and blue-coded chemicals. Prior to working with calcium hydroxide all handlers should be trained on its proper handling and storage. The area should be cool and adequately ventilated. Store in containers protected from physical damage separated from acids and other incompatible materials listed above.

Shipping: UN3262 Corrosive solid, basic, inorganic, n.o.s., Hazard class: 8; Labels: 8-Corrosive material, Technical Name required.

Spill Handling: As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 m/150 ft for liquids and at least 25 m/75 ft for solids. Keep unauthorized personnel away. Stay upwind. Keep out of low areas. Ventilate enclosed areas. Eliminate all ignition sources (no smoking, flares, sparks, or flames in immediate area). Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Stop leak if you can do it without risk. Prevent entry into waterways, sewers, basements, or confined areas. Absorb or cover with dry earth, sand, or other noncombustible material and transfer to containers. *Do not get water inside containers.*

Fire Extinguishing: If tank, rail car, or tank truck is involved in a fire, *isolate* for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. This chemical is a noncombustible solid, however decomposition releases corrosive and toxic fumes. *Small Fire*: Dry chemical, CO_2, or water spray. *Large Fire*: Dry chemical, CO_2, alcohol-resistant foam or water spray. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal; do not scatter the material. Fire involving Tanks or Car/Trailer Loads Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. *Do not get water inside containers*. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. *Always* stay away from tanks engulfed in fire. Keep exposures cool to protect against reignition. Do not direct straight streams into the liquid. Cool exposed containers with large quantities of water from unattended equipment or remove intact containers if it can be done safely. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBA that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Landfill or admixture with acid industrial wastes prior to lagooning.

References

(31); (173); (101); (138); (2); (80); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 1, No. 8, 48−50 (1981).

New York State Department of Health, *Chemical Fact Sheet:* Calcium Hydroxide, Bureau of Toxic Substance Assessment, Albany, NY (January 1986).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Calcium Hydroxide, Trenton, NJ (June 2005).

Calcium Hypochlorite C:0300

Formula: $CaCl_2O_2$: $Ca(OCl)_2$

Synonyms: B-K powder; Bleaching powder; Calcium chlorohydrochlorite; Calcium hypochloride; Calcium oxychloride; Caporit; CCH; Chloride of lime; Chlorinated lime; Hipoclorito calcico (Spanish); HTH; Hy-Chlor; Hypochlorous acid, calcium; Hyporit; Induclor; Lime chloride; Lo-Bax; Losantin; Perchloron; Pittabs; Pittchlor; Pittcide; Prestochlor; Pulsar; Stellos

CAS Registry Number: 7778-54-3

HSDB Number: 914

RTECS Number: NH3485000

UN/NA & ERG Number: UN1748 [mixtures dry with >39% available chlorine (8.8% available oxygen)]/140; UN2208 (with >10% but not >39% available Cl)/140; UN2880 (hydrated mixtures, with not <5.5% but not >10% water)/140

EC Number: 231-908-7 [*Annex I Index No.:* 017-012-00-7]

Regulatory Authority and Advisory Information

Hazard Alert: Powerful oxidizer, Corrosive, Dangerously water reactive, Environmental hazard.

United States National Primary Drinking Water Regulations: MCLG = 0.08 mg[ClO_2]/L; M CL = 1.0 mg [ClO_2]/L as chlorite.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg).

Hazard symbols, risk, & safety statements: Hazard symbol: O, C, N; risk phrases: R8; R22; R31; R34; R50; safety phrases: S1/2; S26; S29/35; S36/37/39; S43; S41; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Calcium hypochlorite is a white powder, granule, or pellets with a strong chlorine-like odor. Molecular weight = 142.98; specific gravity (H_2O:1) = 2.35; freezing/melting point = about 100°C [decomposes (possibly explosively)]. Hazard identification (based on NFPA-704 M Rating System) (active chlorine > 39%): Health 3, flammability 0, reactivity 1₩. Soluble in water; reacts slowly releasing chlorine gas; solubility = 21% @ 25°C.

Potential Exposure: Calcium hypochlorite is used to kill algae and bacteria, in bleach and in pool chemical products.

Incompatibilities: A powerful oxidizer. Decomposes in heat or sunlight; becomes explosive above 100°C/212°F. Incompatible with strong acids; water and other forms of moisture, reducing agents; combustible materials; all other chemicals, especially acetylene, aniline and all other amines, anthracene, carbon tetrachloride, iron oxide, manganese oxide, mercaptans, diethylene glycol monomethyl ether, nitromethane, organic matter; organic sulfides, phenol, 1-propanethiol, propyl mercaptan, sulfur, turpentine, organic sulfur compounds. Attacks various metals, releasing flammable hydrogen gas.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 2.6 milligram per cubic meter

PAC-2: 28 milligram per cubic meter

PAC-3: 170 milligram per cubic meter

Permissible Exposure Limits in Water: United States National Primary Drinking Water Regulations: MCLG = 0.08 mg[ClO_2]/L; MCL = 1.0 mg[ClO_2]/L as chlorite.

Determination in Water: The substance is very toxic to aquatic organisms[CDC/NIOSH].

Routes of Entry: Inhalation of dust, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Calcium hypochlorite can affect you when breathed in. Calcium hypochlorite may cause mutations. Handle with extreme caution. Exposure can severely irritate the eyes, nose, and throat. Contact can severely irritate the skin. Exposure can severely irritate the "voice box" (larynx), bronchial tubes, and lungs. Higher levels can cause a build-up of fluid in the lungs (pulmonary edema). This can cause death.

Long-Term Exposure: Chlorite may cause anemia; infants, young children, and fetuses of pregnant women: nervous system effects. Repeated or prolonged contact can irritate the lungs; may cause bronchitis.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Avoid skin contact with Calcium hypochlorite. Wear protective gloves and clothing. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Natural rubber, Neoprene, and polyvinyl chloride are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Wear dust-proof goggles and face shield when working with powders or dust unless full facepiece respiratory protection is worn.

Respirator Selection: Where there is potential exists for exposure to Calcium hypochlorite, use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece respirator with a high-efficiency particulate filter. Greater protection is provided by a PAPR. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet, in the continuous-flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode. All respirators selected must be approved by NIOSH under the provisions of 42 CFR 84. The current listing of NIOSH-certified respirators can be found in the NIOSH/NPPTL Certified Equipment List, which is available on the NIOSH website.

Storage: Color code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially organic materials, flammables and combustibles, and other incompatible materials. Oxidizers, including oxidizing gases, should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Prior to working with Calcium hypochlorite all handlers should be trained on its proper handling and storage. Calcium hypochlorite must be stored to avoid contact with strong acids (such as hydrochloric, sulfuric, and nitric); ammonium compounds (such as ammonia and ammonium hydroxide) and amines (such as aniline), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from water or moisture and combustibles (such as wood, paper or oil). When heated above 100°C, Calcium hypochlorite becomes explosive. Protect containers against physical damage. Avoid storage for long periods, particularly at summer temperatures. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: UN1748 Calcium hypochlorite, dry or Calcium hypochlorite mixtures dry with >39% available chlorine (8.8% available oxygen), Hazard Class: 5.1; Labels: 5.1-Oxidizer. UN2208 Calcium hypochlorite mixtures, dry, with >10% but not >39% available chlorine, Hazard Class: 5.1; Labels: 5.1-Oxidizer. UN2880 Calcium hypochlorite, hydrated or Calcium hypochlorite, hydrated mixtures, with not <5.5% but not >16% water, Hazard Class: 5.1; Labels: 5.1-Oxidizer.

Spill Handling:

UN1748 (calcium hypochlorite, dry) is on the DOT's list of dangerous water-reactive materials which create large amounts of toxic vapor when *spilled in water:* Dangerous from 0.5 to 10 km (0.3−6.0 mi) downwind.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable

Fire Extinguishing: This chemical is a strong oxidizer and will increase the intensity of any fire. Use water only. *Do not use chemical or carbon dioxide extinguishers*. Thermal decomposition products may include hydrogen chloride and oxides of carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBA that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve the material in water and add to a large volume of concentrated reducing agent solution, then acidify the mixture with H_2SO_4. When reduction is complete, soda ash is added to make the solution alkaline. The alkaline liquid is decanted from any sludge produced, neutralized, and diluted before discharge to a sewer or stream. The sludge is landfilled.

References

(31); (173); (101); (138); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 1, No. 8, 50−52 (1981) and 4, No. 3, 76−79 (1984).

New York State Department of Health, *Chemical Fact Sheet* Calcium hypochlorite, Bureau of Toxic Substance Assessment, Albany, NY (March 1986).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Calcium Hypochlorite, Trenton, NJ (April 2003).

CDC?NIOSH CDC A to Z index, Calcium hypochlorite.

Calcium Methanearsonate C:0305

Formula: $C_2H_8As_2O_6 \cdot Ca$

Synonyms: Arsonic acid, methyl-, calcium salt (2:1); Calar; **Calcium methanearsonate**; Calcium acid methanearsonate; Calcium hydrogen methanearsonate; Cama; Methanearsonic acid, calcium salt (2:1); Methylarsonic acid, calcium salt (2:1); Super dal-e-rad; Super dal-e-rad-calar; Super crab-e-rad-calar; Weed-B-Gon

CAS Registry Number: 5902-95-4

RTECS Number: PA1800000

UN/NA & ERG Number: UN3280 (organoarsenic compound, liquid, n.o.s.)/151

EC Number: 227-598-8

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Environmental hazard.

WHO Acute Hazard: Class III, Slightly hazardous as cacodylic acid, the parent chemical

CLEAN AIR ACT: Hazardous Air Pollutants (Title I, Part A, Section 112) as arsenic compounds

Clean Water Act: Toxic pollutant designated pursuant to Section 307(a)(1) of the Federal Water Pollution Control Act and is subject to effluent limitations: 40 CFR 401.15 (7/1/2001).

PAN (Pesticide Action Network) Bad Actor; possible groundwater contaminant

RCRA Section 261 Hazardous Constituents, waste number D004

EPCRA Section 304 RQ: CERCLA, 1 lb (0.454 kg)

EPCRA (Section 313): Includes any unique chemical substance that contains arsenic as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: (inorganics) 0.1%; organics 1.0%

United States DOT Regulated marine pollutant (49CFR172.101, Appendix B) as arsenates, liquid, n.o.s.; arsenates, solid, n.o.s.; arsenical pesticides liquid, toxic, flammable, n.o.s.

California EPA AB2588-Air Toxics "Hot Spots" Chemicals (CAL) as arsenic compounds

Permissible Exposure Limits for Chemical Contaminants (CAL/OSHA) as arsenic compounds

The "Director's List" (CAL/OSHA) as arsenic compounds

Hazard symbols, risk, & safety statements: Hazard symbol: Xi, N; risk phrases: R36/37/38; safety phrases: S26; S29/35; S36; S61 (see Appendix 4)

Description: Colorless liquid. Odorless. Molecular weight = 315.98; boiling point = 393°C; freezing/melting point = 160.5°C; flash point = 204−206°C. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 0, reactivity 0. Highly soluble in water.

Potential Exposure: Organoarsenic herbicide, and defoliant used to control a wide variety of broadleaf weeds and annual grasses, primarily in industrial and residential environments.

Incompatibilities: Keep this material away from bases, heavy metal salts, strong oxidizers; alkaline materials. Contact with reducing agents may release toxic arsine gas.

Permissible Exposure Limits in Air:

Arsenic, organic compounds

OSHA PEL: 0.5 mg[As]/m^3 TWA

ACGIH TLV[1]: 0.01 mg[As]/m^3 TWA; Confirmed Human Carcinogen; Biological Exposure Index (BEI): Determinant: Inorganic arsenic plus methylated metabolites in urine; Sampling Time: end of workweek; BEI = 35 μg [As]/L. The determinant may be present in biological specimens collected from subjects who have not been occupationally exposed, at a concentration which could affect interpretation of the result. Such background concentrations are incorporated in the BEI value.

NIOSH IDLH = 5 mg[As]/m^3

PAC

As arsenic, organic compounds Ver. 26, no value in Ver. 29[138]

PAC-1: 1.5 milligram per cubic meter

PAC-2: 2.5 milligram per cubic meter

PAC-3: 350 milligram per cubic meter

Determination in Air: Filter; Reagent: Ion chromatography/hydride AA: NIOSH IV [#5022, Arsenic, organo-][18].

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 10 μg[As]/L; State Drinking Water Guide lines: Arizona 10 μg[As]/L; Connecticut 10 μg[As]/L EPA Maximum Contaminant Level (MCL): 0.010 mg[As]/L [40 CFR 141.62]. Canadian Drinking Water Standards: IMAC 0.025 mg[As]/L.

Determination in Water: *For arsenic:* The AA graphite furnace technique is often used for measurement of total arsenic in water. It also has been standardized by EPA. Total arsenic may be determined by digestion followed by silver diethyldithiocarbamate; an alternative is AA; another is ICP optical emission spectrometry. See OSHA Method #ID-105 for arsenic[58].

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. May be absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Irritating to skin and eyes (tearing, redness, blurred vision). If swallowed, will cause nausea, vomiting, diarrhea. High exposure may cause loss of consciousness. Poisonous. Grade 2; LD_{50} (oral, rat) = 0.5−5 g/kg; >5 g/kg.

Long-Term Exposure: Repeated contact may cause skin sensitivity. Chronic exposure to arsenic compounds can cause dermatitis and digestive disorders. Renal damage may develop. In animals: kidney damage; muscle tremor, seizure; possible gastrointestinal tract, reproductive effects; possible liver damage.

Points of Attack: Skin, kidneys, liver. Possible neurotoxicant.

Medical Surveillance: Preliminary medical exam to detect chronic diseases of CNS, liver, heart, kidneys, lung, and skin, as well as endocrinological or immunological disturbances, should protect susceptible individuals. Periodical medical exams of internal organs, skin, and eyes are important to avoid chronic occupational intoxications. They should include lab and patch tests if necessary[30]. Kidney function tests. Examination by a qualified allergist. Liver and kidney function tests. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Consider chest X-ray following acute overexposure. Test for urine arsenic. Levels should not be greater than 100 μg/g of creatinine in the urine. Examine the skin for abnormal growths.

First Aid: If artificial respiration is administered, *avoid mouth-to-mouth resuscitation; use bag/mask apparatus*. Remove contaminated clothing and shoes. Flush affected areas with plenty of water. If in eyes, hold eyelids open and flush with plenty of water. If swallowed and victim is conscious and able to swallow, have victim drink 4 to 8 oz of water and have victim induce vomiting. If swallowed and victim is unconscious or having convulsions, do nothing except keep victim warm.

Respirator Selection: *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or

European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location.

Shipping: UN3280 Organoarsenic compound, liquid, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required, Potential Inhalation Hazard (Special Provision 5).

Spill Handling:

Organoarsenic compound, solid, or liquid

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.5/0.8

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 500/60
Then: Protect persons downwind (mi/km)
Day 1.1/1.8
Night 2.8/4.5

Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources and dampen spilled material with toluene to avoid airborne dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include arsine and oxides of arsenic. This chemical is a noncombustible solid. Use any extinguishing agent suitable for surrounding fires. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBA that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Do not discharge into drains or sewers. Dispose of waste material as hazardous waste using a licensed disposal contractor to an approved landfill. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. If allowed, Incineration with effluent gas scrubbing is recommended[22]. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Noncombustible containers should be crushed and buried under more than 40 cm of soil[30]. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office. Chemical Treatability of Arsenic—(1) Concentration Process: Chemical Precipitation; Chemical Classification: Metal; Scale of Study: Pilot Scale; Type of Wastewater Used: Domestic Wastewater + Pure Compound; Results of Study: 5 ppm @ 4 gpm @ pH = 7.0. Iron system—90% reduction; low lime system—80% reduction; high lime system—76% reduction; (3 coagulant systems were used; Iron system used 45 ppm as Fe of $Fe_2(SO_4)_3$ @ pH = 6.0. Low lime system used 20 ppm Fe of $Fe_2(SO_4)_3$ and 260 ppm of CaO @ pH = 10.0. High lime system used 600 ppm of CaO @ pH = 11.5. Chemical coagulation was followed by multimedia filtration). (2) Concentration Process: Chemical Precipitation; Chemical Classification: Metal; Scale of Study: Full Scale Continuous Flow; Type of Wastewater Used: Domestic Wastewater; Results of Study: Effluent character (ppb): 2.5, 56% reduction with lime; 3.3, 24% reduction with lime; (lime dose of 350−400 ppm as calcium oxide @ pH = 11.3)[72].

References

(31); (173); (101); (138); (204).

United States Department of Agriculture, United States Residue Limits for Veterinary Drugs and Unavoidable Contaminants in Meat, Poultry, and Egg Products.21 CFR 556.60. http://www.fsis.usda.gov/OPHS/red2000/appendix3.pdf.

Calcium Oxide C:0320

Formula: CaO
Synonyms: Burnt lime; Calcia; Calx; Fluxing lime; Lime; Lime, burned; Lime, unslaked; Oxydede calcium (French); Pebble lime; Quicklime
CAS Registry Number: 1305-78-8
HSDB Number: 1615
RTECS Number: EW3100000
UN/NA & ERG Number: UN1910/157
EC Number: 215-138-9
Regulatory Authority and Advisory Information
WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Calcium oxide, CaO, occurs as white or grayish-white lumps or granular powder. The presence of iron gives it a yellowish or brownish tint. Molecular weight = 56.1; specific gravity (H_2O:1) = 3.34; boiling point = 2850°C; freezing/melting point = 2572°C; hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 0, reactivity 2. Soluble in water (reactive).

Potential Exposure: Calcium oxide is used as a refractory material; a binding agent in bricks; plaster, mortar, stucco, and other building materials. A dehydrating agent, a flux in steel manufacturing, and a laboratory agent to absorb CO_2. Used in the manufacture of aluminum, magnesium, glass, pulp and paper, sodium carbonate, calcium hydroxide, chlorinated lime, calcium salts; and other chemicals. Used in the flotation of nonferrous ores; water and sewage treatment; oil treatment in agriculture; dehairing hides; in the clarification of cane and beet sugar juice; and in fungicides, insecticides, drilling fluids, and lubricants.

Incompatibilities: The water solution is a medium strong base. Reacts with water, forming calcium hydroxide and sufficient heat to ignite nearby combustible materials. Reacts violently with acids, halogens, metals.

Permissible Exposure Limits in Air
NIOSH IDLH = 25 milligram per cubic meter
OSHA PEL: 5 milligram per cubic meter TWA
NIOSH REL: 2 milligram per cubic meter TWA
ACGIH TLV[1]: 2 milligram per cubic meter TWA
PAC Ver. 29[138]
PAC-1: 6 milligram per cubic meter
PAC-2: 110 milligram per cubic meter
PAC-3: 660 milligram per cubic meter
DFG MAK: No numerical value established. Data may be available.

Australia: TWA 2 milligram per cubic meter, 1993; Austria: MAK 2 milligram per cubic meter, 1999; Belgium: TWA 2 milligram per cubic meter, 1993; Denmark: TWA 2 milligram per cubic meter, 1999; Finland: TWA 2 milligram per cubic meter, 1999; France: VME 2 milligram per cubic meter, 1999; India: TWA 2 milligram per cubic meter, 1993; the Netherlands: MAC-TGG 2 milligram per cubic meter, 2003; Norway: TWA 2 milligram per cubic meter, 1999; the Philippines: TWA 5 milligram per cubic meter, 1993; Poland: MAC (TWA) 2 milligram per cubic meter, MAC (STEL) 6 milligram per cubic meter, 1999; Sweden: NGV 2 milligram per cubic meter, KTV 5 milligram per cubic meter, 1999; Switzerland: MAK-W 3 milligram per cubic meter, KZG-W 4 milligram per cubic meter, 1999; Turkey: TWA 5 milligram per cubic meter, 1993; United Kingdom: TWA 2 milligram per cubic meter, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 2 milligram per cubic meter; the Czech Republic: 4 milligram per cubic meter. Several states have set guidelines or standards for calcium oxide in ambient air[60] ranging from 20 μ/m^3 (North Dakota) to 35 μ/m^3 (Virginia) to 40 μ/m^3 (Connecticut) to 48 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method #7020, Method #7303, or OSHA Analytical Method ID-121.

Routes of Entry: Inhalation of dust.

Harmful Effects and Symptoms
Short-Term Exposure: The corrosive action of calcium oxide is due primarily to its alkalinity and exothermic reaction with water. It is irritating and may be caustic to the skin, conjunctiva, cornea, and mucous membranes of upper respiratory tract; may produce burns or dermatitis with desquamation and vesicular rash, lacrimation, spasmodic blinking, ulceration; and ocular perforation, ulceration and inflammation of the respiratory passages; ulceration of nasal and buccal mucosa, and perforation of nasal septum. Bronchitis and pneumonia have been reported from inhalation of dust. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. The lower respiratory tract may not be affected because irritation of upper respiratory passages is so severe that workers may be forced to leave the area.

Long-Term Exposure: Repeated or prolonged contact with skin may cause brittle nails and thickening and cracking of the skin. Repeated or prolonged exposure to dust particles may cause lung problems. Calcium oxide may cause ulceration and perforation of the cartilage separating the nose (septum).

Points of Attack: Respiratory system, skin, and eyes.

Medical Surveillance: Preemployment physical examinations should be directed to significant problems of the eyes, skin, and the upper respiratory tract. Periodic examinations should evaluate the skin; changes in the eyes, especially the cornea and conjunctiva; mucosal ulcerations of the nose, mouth and nasal septum; and any pulmonary symptoms. Smoking history should be known.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions,

including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear appropriate clothing to prevent any reasonable probability of skin or eye contact. Wear eye protection to prevent any possibility of eye contact. Employees should wash promptly when skin is contaminated and daily at the end of each work shift. Work clothing should be changed daily if it is possible that clothing is contaminated. Remove nonimpervious clothing if contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *10 milligram per cubic meter*: Q_m (APF = 25) (any quarter-mask respirator); *20 milligram per cubic meter:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *25 milligram per cubic meter:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25) (any powered, APR with a high-efficiency particulate filter); or 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full facepiece respirator with an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location; keep acids away from bases and red, yellow, and blue-coded chemicals. Prior to working with calcium oxide all handlers should be trained on its proper handling and storage. Should be stored on dry flooring in a fire resistant room, well protected from the weather. The area should be cool and adequately ventilated. Store in containers protected from physical damage; acids and oxidizing materials, such as permanganate, dichromate, or chlorine.

Shipping: UN1910 Calcium oxide, Hazard class: 8; Labels: 8-Corrosive material.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Contact with water or moisture may generate enough heat to ignite nearby combustible materials. Avoid the use of water. Do not use carbon dioxide, foam, or halogenated fire extinguishers. Thermal decomposition products may include harmful and irritating gases. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBA that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Pretreatment involves neutralization with hydrochloric acid to yield calcium chloride. The calcium chloride formed is treated with soda ash to yield the insoluble calcium carbonate. The remaining brine solution may be discharged into sewers and waterways[22].

References

(31); (173); (101); (138); (2); (80); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 2, No. 1, 98–99 (1982).

New York State Department of Health, *Chemical Fact Sheet* Calcium Oxide, Bureau of Toxic Substance Assessment, Albany, NY (January 1996).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Calcium Oxide, Trenton, NJ (April 2003).

Calcium Peroxide C:0330

Formula: CaO_2

Synonyms: Calcium dioxide; Calcium superoxide

CAS Registry Number: 1305-79-9

HSDB Number: 965

RTECS Number: EW3865000

UN/NA & ERG Number: UN1457/140 (P)

EC Number: 215-139-4

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Strong oxidizer, Explosive, Polymerization hazard, Corrosive (skin, eyes), Dangerously water reactive.

Hazard symbols, risk, & safety statements: Hazard symbol: O, E; risk phrases: R2; R8; R14; R19, R23/24/25; R34; R36/37/38; safety phrases: S7/8; S17; S36/37/39; S41; 45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Calcium peroxide is a grayish-white or yellowish odorless crystalline solid. Molecular weight = 72.1; freezing/melting point = 275°C (decomposes). Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 2. Insoluble in water; slow reaction releasing calcium hydroxide.

Potential Exposure: Calcium peroxide is used as a seed disinfectant, an antiseptic, and a rubber stabilizer.

Incompatibilities: Slow reaction with water or other forms of moisture, releasing calcium hydroxide Calcium peroxide is a strong alkali and a strong oxidizer. Incompatible with reducing agents, including hydrides; acids, combustible materials; polysulfide polymers. Rapid decomposition $>200°C$.

Permissible Exposure Limits in Air

No standards or PAC available.

Routes of Entry: Inhalation of dust, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Calcium peroxide can affect you when breathed in. Contact can severely irritate and may burn the skin and eyes. Exposure can irritate the eyes, nose, and throat. Higher levels can irritate the lungs, causing coughing, and/or shortness of breath. Still higher exposures may cause a build-up of fluid in the lungs (pulmonary edema). This can cause death.

Long-Term Exposure: Prolonged exposure can damage the skin. Very irritating substances may cause problems.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: *Clothing:* Avoid skin contact with Calcium Peroxide. Wear protective gloves and clothing. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day and put on before work. *Eye Protection:* Wear dust-proof goggles with face shield when working with powders or dust, unless full facepiece respiratory protection is worn.

Respirator Selection: Where there is potential exists for exposures to calcium peroxide, use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece respirator equipped with particulate (dust/fume/mist) filters. Greater protection is provided by a PAPR. Particulate filters must be checked every day before work for physical damage, such as rips or tears and replaced as needed. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode. All respirators selected must be approved by NIOSH under the provisions of 42 CFR 84. The current listing of NIOSH-certified respirators can be found in the NIOSH/NPPTL Certified Equipment List, which is available on the NIOSH website.

Storage: Check oxygen content prior to entering storage area. Color code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially organic materials, flammables and combustibles, and other incompatible materials. Oxidizers, including oxidizing gases, should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Prior to working with calcium peroxide all handlers should be trained on its proper handling and storage. Calcium Peroxide must be stored to avoid contact with combustible materials (such as wood, paper, oil, fuels, etc.), since violent reactions occur. Store in tightly closed containers. Store in a cool, well-ventilated area away from incompatible materials listed above. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use, and storage of cylinders should be in compliance with

OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage.

Shipping: UN1457 Calcium peroxide, Hazard Class: 5.1; Labels: 5.1-Oxidizer.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Calcium Peroxide is an oxidizer and will greatly increase the intensity of a fire. Extinguish fire using an agent suitable for type of surrounding fire. Thermal decomposition products may include calcium hydroxide and harmful and irritating gases. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBA that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Calcium Peroxide, Trenton, NJ (March 2000).

Calcium Phosphide C:0340

Formula: Ca_3P_2

Synonyms: Photophor; Tricalcium diphosphide

CAS Registry Number: 1305-99-3

HSDB Number: 963

RTECS Number: EW3860000

UN/NA & ERG Number: UN1360/139

EC Number: 215-142-0 [*Annex I Index No.:* 015-003-00-2]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade).

Hazard Alert: Exposure can be lethal, Dangerously water reactive (emits toxic gas), Air reactive, Strong reducing agent, Environmental hazard.

Hazardous to aquatic life or environment, with possible long-lasting effects[291]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, F, N; risk phrases: R15/29; R28; R50; safety phrases: S1/2; S22; S29/35; S36/37; S41; S43; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Calcium phosphide is a gray granular solid or reddish-brown crystalline solid. It has a musty odor, somewhat like acetylene. Molecular weight = 182.18; specific gravity (H_2O:1) = 2.51 @ 20°C; freezing/melting point = ~1600°C. Hazard identification (based on NFPA-704 M Rating System): Health 4, flammability 0, reactivity 2 ₩. Water reactive, releases flammable and highly toxic phosphine gas.

Potential Exposure: Calcium phosphide is used to kill rodents; used in explosives and fireworks.

Incompatibilities: A strong reducing agent. Forms spontaneously combustible phosphine gas in moist air. Contact with water or acids release phosphine gas, and can cause explosions. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, chlorine monoxide, halogens, halogen acids, oxygen, sulfur.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 0.091 ppm

PAC-2: $\mathbf{1.0}_{\mathrm{A}}$ ppm

PAC-3: $\mathbf{1.8}_{\mathrm{A}}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60-minute values.

Permissible Concentration in Water: Reacts violently with water as noted above.

Routes of Entry: Inhalation of dust, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Calcium phosphide can severely irritate the eyes, skin, and respiratory tract. It may affect the gastrointestinal tract. Phosphine (liberated from calcium phosphide) is an acute local irritant; it may cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Phosphine is toxic upon inhalation, causing restlessness, tremors, fatigue, gastric pain; diarrhea, coma, and convulsions. Also, calcium phosphide is a dangerous fire and explosion hazard. Exposure may cause respiratory failure, resulting in death.

Long-Term Exposure: Repeated exposure to calcium phosphide may cause damage to the central nervous system, liver, kidneys, central nervous system, and cardiovascular system.

Points of Attack: See above.

Medical Surveillance: Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: *Clothing:* Avoid skin contact with Calcium phosphide. Wear protective gloves and clothing. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day and put on before work. *Eye Protection:* Wear dust-proof goggles when working with powders or dust, unless full facepiece respiratory protection is worn.

Respirator Selection: Where there is potential exists for exposure to Calcium phosphide, use Respiratory protection: Particle filter P2 or P3; color code white or NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode. All respirators selected must be approved by NIOSH under the provisions of 42 CFR 84. The current listing of NIOSH-certified respirators can be found in the NIOSH/NPPTL Certified Equipment List, which is available on the NIOSH website.

Storage: (1) Color code—Red Stripe: Dangerous when wet materials release flammable gases on contact with water. Do not store this material in a room protected by water sprinkler systems. Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Do not store in a basement. Color code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Keep away from moisture. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers (such as chlorine, bromine, and fluorine), strong acids (such as hydrochloric, sulfuric, and nitric); oxygen, sulfur or moisture, since violent reactions occur. Sources of ignition, such as smoking, and open flames, are prohibited where Calcium phosphide is handled, used, or stored. Use only nonsparking tools and equipment, especially when opening and closing containers of Calcium phosphide. Wherever Calcium phosphide is used, handled, manufactured, or stored, used explosion-proof electrical equipment and fittings. Do not store large amounts of this material in a room protected by water sprinkler systems. Protect containers against physical damage.

Shipping: UN1360 Calcium phosphide, Hazard Class: 4.3; Labels: 4.3-Dangerous when wet material.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

UN1360 (calcium phosphide) is on the DOT's list of dangerous water-reactive materials which create large amounts of toxic vapor when *spilled in water:* Dangerous from 0.5 to 10 km (0.3−6.0 mi) downwind.

Fire Extinguishing: Thermal decomposition products may include oxides of phosphorus and metal. Contact with water forms highly toxic and flammable phosphine gas. *Do not use water* or foam extinguishers. Use dry chemical, dry sand; soda ash, or lime extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBA that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Disposal of unused product must be undertaken by qualified personnel who are knowledgeable in all applicable regulations and follow all pertinent safety precautions including the use of appropriate protective equipment. For proper handling and disposal, always comply with federal, state, and local regulations.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Calcium phosphide, Trenton, NJ (February 1987).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 2, No. 1, 102−103 (1982).

Calcium Sulfate C:0350

Formula: CaO_4S; $CaSO_4$

Synonyms: *anhydrous:* Anhydrite; Anhydrous calcium sulfate; Anhydrous gypsum; Anhydrous sulfate of lime; Calcium salt of sulfuric acid; *dihydrate:* Gypsum; *hemihydrate:* Plaster of Paris

CAS Registry Number: 7778-18-9 (anhydrous); *(alt.)* 23296-15-3; 10101-41-4 (dihydrate); 10034-76-1 (hemihydrate); 13397-24-5 (hemihydrate-gypsum)

HSDB Number: 902

RTECS Number: WS6920000 (anhydrous); EW 4150000 (dihydrate)

EC Number: 231-900-3 (anhydrous)

Regulatory Authority and Advisory Information

United States National Primary Drinking Water Regulations: SMCL = 250 mg[SO_4^{-2}]/L as Sulfate

Hazard symbols, risk, & safety statements: Hazard symbol: Xi; risk phrases: R36/37/38; safety phrases: S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Calcium sulfate forms white to clear crystals. It is commonly encountered in the anhydrous form or as the dihydrate. Molecular weight = 136.08; specific gravity (H_2O:1) = 2.96; freezing/melting point = (decomposes) 1570°C. Hazard identification (based on NFPA-704 M Rating System): (*anhydrous; dihydrate*) Health 2, flammability 0, reactivity 1. Practically insoluble in water; solubility = 0.3% @ 20°C.

Potential Exposure: Calcium sulfate is used as a pigment; in Portland cement, in tiles and plaster; in polishing powders, a filler in paints and paper coatings; in the drying of gases and liquids; a soil conditioner; in molds and surgical casts; in wallboard, and many others.

Incompatibilities: Contact with diazomethane, aluminum, phosphorus, and water may cause explosions. *Note:* Hygroscopic material (i.e., absorbs moisture from the air). Reacts with water, forming gypsum and plaster of Paris.

Permissible Exposure Limits in Air

OSHA PEL: [Particulates not otherwise regulated] 15 milligram per cubic meter TWA total dust; TWA; 5 milligram per cubic meter TWA, respirable fraction

NIO SH REL: 10 milligram per cubic meter TWA, total dust; 5 milligram per cubic meter TWA, respirable fraction

ACGIH TLV[1]: 10 milligram per cubic meter TWA inhalable fraction (2005)

7778-18-9, anhydrous

PAC Ver. 29[138], no value in Ver. 29[138]

PAC-1: 30 milligram per cubic meter

PAC-2: 330 milligram per cubic meter

PAC-3: 2000 milligram per cubic meter

DFG MAK: 1.5 milligram per cubic meter respirable fraction (previously "fine *dust*"); 4 milligram per cubic meter inhalable fraction (previously "total *dust*"); Pregnancy Risk Group: C

Australia: TWA 10 milligram per cubic meter, 1993; Austria: MAK 6 milligram per cubic meter (*dust*), 1999; Belgium: TWA 10 milligram per cubic meter, 1993; United Kingdom: LTEL 10 milligram per cubic meter (total *dust*), 5 milligram per cubic meter (resp. dust), 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 10 milligram per cubic meter[(E)].

Determination in Air: By filter collection and gravimetric means. Particulates NOR: NIOSH #0500, total dust or #0600 (respirable).

Routes of Entry: Inhalation of dust, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: *Inhalation:* May cause irritation of mouth, throat, nose, and lungs. Senses of smell and taste may be lessened. Nose irritation may lead rhinitis and cause nose to bleeding. *Skin:* May cause irritation in open sores. The harsh washing and abrasive action necessary to remove this material may also lead to irritation. *Eyes:* Dust may irritate eyes. *Ingestion:* May cause blockage of digestive system if material hardens.

Long-Term Exposure: May cause nose irritation accompanied by sneezing, tear formation, and excessive fluid secretion. Animal studies suggest that pneumonia and other more serious lung disorders may occur.

Points of Attack: Eyes, skin, respiratory system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least

15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear loose-fitting clothing of dust-tight material and safety goggles.

Respirator Selection: A dust mask should be worn if irritation effects become apparent.

Storage: Color code—Green: General storage may be used. The hemihydrate and anhydrous forms should be stored in tightly sealed containers.

Shipping: Calcium sulfate is a "NONREGULATED MATERIAL."[19]

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Cleanup using methods that do not raise dust, such as vacuum and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Use any extinguisher suitable for surrounding fire. Thermal decomposition products may include oxides of sulfur and metal. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBA that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Landfilling.

References

(31); (173); (101); (138); (80); (100).

New York State Department of Health, *Chemical Fact Sheet* Calcium Sulfate, Bureau of Toxic Substance Assessment, Albany, NY (March 1986).

Camphene C:0360

Formula: $C_{10}H_{10}$

Synonyms: Bicyclo-(2.2.1)heptane; 3,3-Dimethylen-enorcamphene; 2,2-Dimethyl-3-methylene-; 2-2-Dimethyl-3-methylene norborane; 3,3-Dimethyl-2-methylene norcamphone

CAS Registry Number: 79-92-5; 565-00-4 (±-camphene); 5794-03-6 (IR-camphene); 5794-04-7(IS-camphene)

HSDB Number: 900

RTECS Number: EX1055000

UN/NA & ERG Number: UN1325 (flammable solids, organic, n.o.s.)/133; UN2319 [terpene hydrocarbons, n.o.s. (Camphene)]/128

EC Number: 201-234-8; 209-275-3 (±-camphene); 227-336-2 (IR-camphene); 227-337-8 (IS-camphene)

Regulatory Authority and Advisory Information

Hazard Alert: Highly flammable solid, Environmental hazard.

Hazard symbols, risk, & safety statements: Hazard symbol: F, N; risk phrases: R11; R36; R51/53; safety phrases: S16; S26; S33; S60; S61; S41 (see Appendix 4).

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: F, N; risk phrases: R11; safety phrases: S21; S29/35; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Camphene is a colorless to white crystalline solid, Camphor, or turpentine odor. It may be shipped as a liquid. Freezing/Melting point = 50°C. Molecular weight = 136.24; boiling point = 159°C; freezing/melting point = 37°C; flash point = 42°C (oc); 33°C (cc). Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 3, reactivity 0. Insoluble in water.

Potential Exposure: Camphene is used to manufacture synthetic camphor; for making moth-proofing and in the cosmetics, perfume, and food flavoring industries.

Incompatibilities: Forms explosive mixture with air. Emulsions in xylene may violently decompose on contact with iron or aluminum above 70°C. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Contact with reducing agents may cause exothermic reaction, releasing flammable hydrogen gas.

Permissible Exposure Limits in Air

No standards or PAC available.

Permissible Concentration in Water: No criteria set. Highly toxic to aquatic life with long-lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Determination in Water: Octanol−water coefficient: Log $K_{\mathrm{ow}} = > 4$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation of vapors, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Camphene can affect you when breathed in and by passing through your skin. Contact can irritate the eyes and skin. Exposure can irritate the eyes, nose, and throat. Higher levels can cause you to feel dizzy, excited, sweaty, and have a headache. At very high levels, confusion, nausea, drowsiness, coma, and kidney damage can occur. LD_{50} (oral-rat) ≥5000 mg/kg (slightly toxic).

Long-Term Exposure: Similar chemicals also can cause skin allergy. It is not known if camphene can cause the same problem.

Points of Attack: Eyes, skin, respiratory system; kidneys.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: kidney function tests. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: *Clothing:* Avoid skin contact with camphene. Wear protective gloves and clothing. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day and put on before work. *Eye Protection:* Eye protection is included in the recommended respiratory protection.

Respirator Selection: Where there is potential exists for exposure to camphene, use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece respirator with a high-efficiency particulate filter. Greater protection is provided by a PAPR. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode. All respirators selected must be approved by NIOSH under the provisions of 42 CFR 84. The current listing of NIOSH-certified respirators can be found in the NIOSH/NPPTL Certified Equipment List, which is available on the NIOSH website.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with camphene all handlers should be trained on its proper handling and storage. Camphene must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where Camphene is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Use only nonsparking tools and equipment, especially when opening and closing containers of camphene.

Shipping: UN1325 Flammable solids, organic, n.o.s., Hazard Class: 4.1; Labels: 4.1-Flammable solid. UN2319 Terpene hydrocarbons, n.o.s., Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner, using nonsparking tools, and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable solid. Thermal decomposition products may include oxides of carbon. The crystals do not easily ignite, but they release flammable vapor at room temperature. Heating greatly increases the release of these flammable vapors. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBA that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Camphene, Trenton, NJ (November 2000).

Camphor C:0370

Formula: $C_{10}H_{16}O$

Synonyms: Bicyclo-(2.2.1.)-heptanone; Bicyclo 2.2.1 heptan-2-one,1,7,7-trimethyl-; Bornane, 2-*oxo*-; 2-Bornanone; 2-Camphanone; Camphor, natural; 2-Camphorone; DL-Camphor; Formosa camphor; Gum camphor; Huile de camphre (French); Japan camphor; Kampfer (German); 2-Keto-1,7,7-trimethylnorcamphane; Laurel camphor; Matricaria camphor; Norcamphor, synthetic camphor; 1,7,7-Trimethyl-; 1,7,7-Trimethylbicyclo (2.2.1)-2-heptanone; 1,7,7-Trimethylnorcamphor

CAS Registry Number: 76-22-2; 8008-51-3 (camphor oil)

HSDB Number: 37

RTECS Number: EX1225000

UN/NA & ERG Number: UN2717 (synthetic)/133; UN1130 (oil)/128

EC Number: 200-945-0

Regulatory Authority and Advisory Information

Hazard Alert: Flammable solid, Possible risk of forming tumors, Suspected of causing genetic defects.

Banned or Severely Restricted (in juvenile drugs) (UN)[13]

FDA-over the counter drug.

Hazard symbols, risk, & safety statements: Hazard symbol: T, F, Xi, Xn; risk phrases: R11; R20/21/22; R36/37/38; R62; safety phrases: S16; S26; S36/37/39; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Camphor is a colorless glassy solid. Penetrating, characteristic odor. Molecular weight = 152.26; specific gravity (H_2O:1) = 0.99; boiling point = 204°C; freezing/melting point = 180°C (natural); 165°C (synthetic); flash point = 66°C (solid); 47°C (oil); autoignition temperature = 460°C. Explosive limits: LEL: 0.6%, UEL: 3.5%. Hazard identification (based on NFPA-704 M Rating System) (*solid*): Health 3, flammability 2, reactivity 0. Insoluble in water; (*oil):* Health 2, flammability 2, reactivity 0.

Potential Exposure: Camphor, a natural product, is used as a plasticizer for cellulose esters and ethers; it is used in lacquers and varnishes; and in explosives and pyrotechnics formulations. It is used as a moth repellent and as a medicinal.

Incompatibilities: May form explosive mixture with air. Violent, possibly explosive, reaction with strong oxidizers, especially chromic anhydride, potassium permanganate. May accumulate static electrical charges, and may cause ignition of its vapors.

Permissible Exposure Limits in Air

NIOSH IDLH = 200 milligram per cubic meter

Odor threshold = 0.079 milligram per cubic meter.

OSHA PEL: 2 milligram per cubic meter TWA

NIOSH REL: 2 milligram per cubic meter TWA

ACGIH TLV[1]: 2 ppm/12 milligram per cubic meter TWA; 3 ppm/19 milligram per cubic meter STEL, not classifiable as a human carcinogen

DFG MAK: 2 ppm/13 milligram per cubic meter TWA; Peak Limitation Category II(2).

Australia: TWA 2 ppm (12 milligram per cubic meter); STEL 3 ppm (18 milligram per cubic meter), 1993; Austria: MAK 2 ppm (13 milligram per cubic meter), 1999; Belgium: TWA 2 ppm (12 milligram per cubic meter); STEL 3 ppm (19 milligram per cubic meter), 1993; Denmark: TWA 2 ppm (12 milligram per cubic meter), 1999; Finland: TWA 0.3 ppm (2 milligram per cubic meter); STEL 0.9 ppm (6 milligram per cubic meter), 1993; France: VME 2 ppm (12 milligram per cubic meter), 1999; Norway: TWA 2 ppm (12 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 12 milligram per cubic meter, 2003; the Philippines: TWA 2 ppm, 1999; Russia: STEL 3 milligram per cubic meter, 1993; Switzerland: MAK-W 2 ppm (13 milligram per cubic meter), 1999; United Kingdom: TWA 2 ppm (13 milligram per cubic meter); STEL 3 ppm (19 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 3 ppm. Several states have set guidelines or standards for camphor in ambient air[60] ranging from 80 μ/m^3 (Connecticut) to 120−180 μ/m^3 (Virginia) to 286 μ/m^3 (Nevada).

Determination in Air: Charcoal absorption is followed by CS_2, workup and analysis by gas chromatography (GC). Use NIOSH Analytical Method #1301, Ketones II, Method #2553, or OSHA Analytical Method 7, Organic Vapors.

Routes of Entry: Inhalation, ingestion; skin and eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Contact can irritate the eyes and skin. Inhalation can cause respiratory tract irritation and coughing. Exposure can cause nausea, vomiting, diarrhea, headaches, dizziness, excitement, irrational behavior; mental confusion; epileptiform convulsions. Higher exposures can cause unconsciousness and death.

Long-Term Exposure: Camphor may cause kidney damage.

Points of Attack: Central nervous system; eyes, skin; respiratory system.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Whole blood (chemical/metabolite): blood urea nitrogen, calcium, carbon dioxide; blood sugar/glucose, uranalysis; kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear appropriate clothing to prevent repeated or prolonged skin contact. Wear eye protection to prevent any reasonable probability of eye contact. Employees should wash promptly when skin is wet or contaminated. Work clothing should be changed daily if it is possible that clothing is contaminated. Remove nonimpervious clothing promptly if wet or contaminated.

Respirator Selection: OSHA: *50 milligram per cubic meter:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); PaprOvHie (APF = 25) (any air-purifying full facepiece respirator equipped with an organic vapor cartridge in combination with a high-efficiency particulate filter). *100 milligram per cubic meter:* CcrFOv100 (APF = 50) [any air-purifying full facepiece respirator equipped with organic vapor cartridge(s) in combination with an N100, R100, or P100 filter]; or GmFOv100 (APF = 50) (any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter); or PaprTOvHie (APF = 50) (any powered, APR with a tight-fitting facepiece and organic vapor cartridge(s) in combination with a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *200 milligram per cubic meter:* SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA). Note: Substance causes eye irritation or damage; eye protection needed.

Storage: Color code—Red (liquid): Flammability Hazard: Store in a flammable materials storage area. Color code—Red Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Store flammable solids up to maximum allowable quantity per control area in an approved flammable storage area. Do not store in a basement. Prior to working with camphor all handlers should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Camphor must be stored to avoid contact with oxidizers, such as permanganates, nitrates, peroxides, chlorates, and perchlorates, and especially chromic anhydride, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat, sparks, or flame. Sources of ignition, such as smoking and open flames are prohibited where camphor is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2717 Camphor, synthetic, Hazard Class: 4.1; Labels: 4.1-Flammable solid. UN1130 camphor oil, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Establish forced ventilation to keep levels below explosive limit. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Combustion produces lots of soot. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include oxides of carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBA that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration of a solution in a flammable solvent.

References

(31); (173); (101); (138); (2); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 1, No. 8, 52−54 (1981).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Camphor, Trenton, NJ (June 2005).

Cantharidin C:0380

Formula: $C_{10}H_{12}O_4$
Synonyms: Can; Cantharides camphor; 1,2-Dimethyl-3,6-epoxyperhydrophthalic anhydride; 2,3-Dimethyl-7-oxabicyclo[2.2.1] heptane-2,3-dicarboxylic anhydride; 4,7-Epoxyisobenzofuran-1,3-dione, hexahydro-3a, 7a-dimethyl-, (3a a, 4b, 7b, 7a a)-; 7-Oxabicyclo[2.2.1]heptane-2,3-dicarboxylic anhydride, 2,3-dimethyl-
CAS Registry Number: 56-25-7
HSDB Number: 2181
RTECS Number: RN8575000
EC Number: 200-263-3
Regulatory Authority and Advisory Information
Carcinogenicity: IARC: Animal Limited Evidence, Human No Data, *not classifiable as carcinogenic to humans*, Group 3, 1998
Hazard Alert: Extremely toxic (deadly poison), Combustible, Possible risk of forming tumors, Human data, Natural product
Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg)
Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg).
Hazard symbols, risk, & safety statements: Hazard symbol: T+; risk phrases: R23/24/25; R27/28; R36/37/38; safety phrases: S13; S28; S36/37/39; S45; S53; S41 (see Appendix 4)
Description: Cantharidin is a brown to black powder. Molecular weight = 196.22; freezing/melting point = 218°C (begins to sublime @ 110°C); vapor pressure = 0.02 mmHg @ 25°C. Explosive limits: LEL: 6000 ppm; UEL: unknown. Hazard identification (based on NFPA-704 M Rating System): Health 4, flammability 1, reactivity 0.
Potential Exposure: Formerly used as a counterirritant and vesicant. Also used for the removal of benign epithelial growths, e.g., warts. Used as an experimental antitumor agent. The active ingredient in "Spanish fly," a reputed aphrodisiac.
Permissible Exposure Limits in Air
PAC Ver. 29[138]
PAC-1: 0.39 milligram per cubic meter
PAC-2: 4.3 milligram per cubic meter
PAC-3: 33 milligram per cubic meter
Routes of Entry: Inhalation, ingestion, skin contact.
Harmful Effects and Symptoms
Short-Term Exposure: A deadly poison by ingestion. Symptoms from ingestion include vomiting; abdominal pain; shock; bloody diarrhea; pain in throat and stomach; swelling and blistering of tongue, difficulty in swallowing; salivation, slow and painful urination; and thirst. There may be delirium, fainting, and titanic convulsions. Eye contact results in irritation with much swelling of the lids. Initial tissue reaction upon contact with the skin is swelling, followed by blister formation within 24 hours. It is classified as super toxic. Probable oral lethal dose in humans is less than 5 mg/kg or a taste of less than 7 drops for a 70-kg (150 lb) person. It is very toxic by absorption through skin.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. For ingestion, induce vomiting with syrup of ipecac.
Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.
Shipping: Cantharidin is not specifically listed in the DOT Performance-Oriented Packaging Standards[19] with respect to labeling requirements or restrictions on shipping quantities.
Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain

and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include oxides of carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBA that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: It is inappropriate and possibly dangerous to the environment to dispose of expired or waste drugs and pharmaceuticals by flushing them down the toilet or discarding them to the trash. Household quantities of expired or waste pharmaceuticals may be mixed with wet cat litter or coffee grounds, double-bagged in plastic, discard in trash. Larger quantities shall carefully take into consideration applicable DEA, EPA, and FDA regulations. If possible return the pharmaceutical to the manufacturer for proper disposal being careful to properly label and securely package the material. Alternatively, the waste pharmaceutical shall be labeled, securely packaged, and transported by a state licensed medical waste contractor to dispose by burial in a licensed hazardous or toxic waste landfill or incinerator.

References

(31); (173); (101); (138).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Canthariden, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 1, No. 2, 27–28 (1980).

Caprolactam C:0390

Formula: $C_6H_{11}NO$

Synonyms: Aminocaproic lactam; 6-Aminohexanoic acid cyclic lactam; 2-Azacycloheptanone; *epsilon*-Caprolactam; Caprolactama (Spanish); 6-Caprolactum; Caprolattame (French); Cyclohexanone isooxime; Hexahydro-2*H*-azepine-2-one; Hexahydro-2-azepinone; Hexahydro-2*H*-azepin-2-one; 6-Hexanelactum; Hexanone isoxime; Hexanonisoxim (German); 1,6-Hexolactam; 2-Ketohexamethyleneimine; 2-Ketohexamethylenimine; NCI-C50646; 2-Oxohexamethyleneimine; 2-Oxohexam ethylenimine; 2-Perhydroazepinone

CAS Registry Number: 105-60-2

HSDB Number: 187

RTECS Number: CM3675000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n. o.s.)/154

EC Number: 203-313-2 [*Annex I Index No.:* 613-069-00-2]

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction).

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: Xn; risk phrases: R20/22; R36/37/38; R62; R63; safety phrases: S2; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Caprolactum is a white crystalline combustible solid with an unpleasant odor. The Odor Threshold is 0.3 milligram per cubic meter. Molecular weight = 113.16; specific gravity (H_2O:1) = 1.02 @ 75°C (liquid); boiling point = 269°C; freezing/melting point = 69.3°C; vapor pressure =
8×10^{-8} mmHg @ 20°C; flash point = 125°C (oc); 139°C (cc); autoignition temperature = 375°C. Explosive limits: LEL: 1.84%; UEL: 8.0%. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 1, reactivity 0. Highly soluble in water; solubility = 53%.

Potential Exposure: Caprolactam is used in the manufacture of nylon, plastics, bristles, film, coatings, synthetic leather, plasticizers, and paint vehicles; as a crossslinking agent for curing polyurethanes; and in the synthesis of lysine.

Incompatibilities: Caprolactum decomposes on heating, and on burning producing toxic fumes including nitrogen oxides, ammonia. Reacts violently with strong oxidizers, producing toxic fumes. Toxic decomposition above 400°C.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 4.63 milligram per cubic meter

OSHA PEL: none

NIOSH REL: (*dust*): 1 milligram per cubic meter TWA; 3 milligram per cubic meter STEL; (*vapor*): 0.22 ppm/1 milligram per cubic meter TWA; 0.66 ppm/3 milligram per cubic meter STEL

PAC Ver. 29[138]

PAC-1: 3 milligram per cubic meter

PAC-2: 40 milligram per cubic meter

PAC-3: 240 milligram per cubic meter

DFG MAK: 5 milligram per cubic meter, measured as the, inhalable fraction. Peak Limitation Category I(2); Pregnancy Risk Group C

Australia: (*dust*): TWA 1 milligram per cubic meter; STEL 3 milligram per cubic meter; (*vapor*): TWA 5 ppm (20 milligram per cubic meter); STEL 10 ppm 1993; Austria: MAK 5 milligram per cubic meter (*dust*), 1999; Belgium: (*dust*): TWA 1 milligram per cubic meter; STEL 3 milligram per cubic meter; (*vapor*): TWA 4.3 ppm (20 milligram per cubic meter); STEL 8.6 ppm (40 milligram per cubic meter), 1993; Denmark: TWA 5 ppm (25 milligram per cubic meter), 1999; (*dust*): Denmark: TWA 1 milligram per cubic meter, 1999; Finland: TWA 1 milligram per cubic meter; STEL 3 milligram per cubic meter (*dust*), 1999; the Netherlands: Fume: MAC-TGG 20 milligram per cubic meter; (*dust*): MAC-TGG 1 milligram per cubic meter, 2003; France: VME 1 milligram per cubic meter (*dust*): 5 ppm (20 milligram per cubic meter) (*vapor*), 1999; Hungary: TWA 1 milligram per cubic meter; STEL 2 milligram per cubic meter (*dust*), 1993; Norway: TWA 5 ppm (25 milligram per cubic meter), moist, 1999; Poland: MAC (TWA) 10 milligram per cubic meter (*dust*), 1999; Russia: STEL 10 milligram per cubic meter (*dust*), 1993; Sweden: TWA 5 milligram per cubic meter; STEL 10 milligram per cubic meter, 1999; Switzerland: MAK-W5 milligram per cubic meter (*dust*), 1999; United Kingdom: (*dust*): TWA 1 milligram per cubic meter; STEL 3 milligram per cubic meter; (*vapor*): TWA 5 ppm (23 milligram per cubic meter); STEL 10 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TL V: STEL 3 milligram per cubic meter (*particulate*). Several states have set guidelines or standards for caprolactam in ambient air ranging from 10 μ/m^3 (North Dakota) to 24 μ/m^3 (Nevada) to 160 μ/m^3 (Virginia) to 400 μ/m^3 (Connecticut).

Determination in Air: Use OSHA Analytical Method PV-2012, Caprolactum. Samples are collected by drawing a known volume of air through OSHA versatile sampler (OVS-7) tubes, containing a glass fiber filter and two sections of XAD-7 adsorbent. Samples are extracted with methanol and analyzed by high performance liquid chromatography (HPLC) using an ultraviolet (UV) detector.

Permissible Concentration in Water: The former USSR-UNEP/IRPTC joint project[43] has adopted Russian value[35] of a MAC of 1 mg/L in water used for domestic purposes.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = -0.19$.

Routes of Entry: Inhalation, ingestion; skin and eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: The vapor irritates the eyes, skin, and respiratory tract. Inhalation may affect the central nervous system. Skin contact can cause irritation and serious burns if contact is prolonged and confined. Other symptoms of exposure include epistaxis (nosebleed); dermatitis, skin sensitization; asthma, dizziness, headache, abdominal cramps; diarrhea, nausea, vomiting. High exposures may also cause irritability, confusion, and convulsions (seizures). Exposure in airborne dust @ 5 milligram per cubic meter causes skin irritation in some people but not @ 1 milligram per cubic meter. Sensitivity has not been related to race, skin pigmentation, or other common indices of sensitivity. The prevalence of dermatoses among workers in a caprolactam manufacturing plant, showed that contact dermatitis and eczema of the hands were most prevalent. Dry erythematous squamous foci on smooth skin was a typical manifestation. Light sensitivity of the eyes was produced by inhalation of caprolactam at 0.11 milligram per cubic meter and higher. The olfactory threshold was 0.30 milligram per cubic meter. An oral dose of 3−6 g was given daily for 3−5 years for the treatment of obesity in 90 subjects. No toxic effects were observed. There was no effect on appetite; and only one person developed an allergy to caprolactam.

Long-Term Exposure: Exposure may damage the developing fetus and may affect the reproductive ability of males. Caprolactam may damage the liver and/or kidneys. Repeated or prolonged contact may cause skin sensitization and dermatitis. The substance may have effects on the nervous system. Exposure to high concentrations over many years may cause irritability and confusion.

Points of Attack: Eyes, skin, respiratory system; central nervous system; cardiovascular system, liver, kidneys.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures (half the TLV or greater), the following are recommended: Liver and kidney function tests. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. If symptoms develop or overexposure has occurred, the following may also be useful: EEG (brain wave test), skin testing with dilute Caprolactam may help diagnose allergy, if done by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large

quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures *over 5 ppm* (*vapor*): or 1 milligram per cubic meter (*dust*), use a NIOSH/MSHA or European Standard EN 149-approved respirator equipped with organic vapor cartridges and a particulate prefilter. More protection is provided by a full facepiece respirator than by a half-mask respirator, and even greater protection is provided by a PAPR. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode. All respirators selected must be approved by NIOSH under the provisions of 42 CFR 84. The current listing of NIOSH-certified respirators can be found in the NIOSH/NPPTL Certified Equipment List, which is available on the NIOSH website.

Storage: Color code—Green: General storage may be used. Prior to working with caprolactum all handlers should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers and heat. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft (NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Restrict persons not wearing protective equipment from the danger area of spill until clean-up is complete. Collect spilled material in the most convenient and safe manner and deposit in sealed containers for reclamation or for disposal in an approved facility. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical will burn but does not easily ignite. Extinguish fire using any agent suitable for the type of surrounding fire. If heated to more than 100°C, caprolactam boils, giving off Thermal decomposition products may include oxides of nitrogen. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBA that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Controlled incineration (oxides of nitrogen are removed from the effluent gas by scrubbers and/or thermal devices). Also, Caprolactam may be recovered from Caprolactam still bottoms or nylon waste[22].

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Caprolactam, Trenton, NJ (December 2005).

Capsaicin C:0395

Formula: $C_{18}H_{27}NO_3$

Synonyms: Agrigard; Capsaicin (in oleoresin of capsicum); Capsaicine; Capsyn (Capsaicin + Dihydrocapsaicin + Nordihydrocapsacin); Deer-off; Frontiersman; Halt; Keepout; Major Capsaicinoids (Capsaicin + Dihydrocapsaicin + Nordihydrocapsacin); *N*-[(4-Hydroxy-3-methoxyphenyl)methyl]-8-methyl-6-nonenamide; 8-M ethyl-*N*-vanillyl-6-nonenamide,(*E*)-(8CI); 6-Nonenamide, 8-methyl-*N*-vanillyl-, (*E*)-(8CI); 6-Nonenamide, *N*-[(4-hydro xy-3-methoxyphenyl)methyl]-8-methyl-, (*E*)-(9CI); Styptysat; *trans*-8-M ethyl-*N*-vanillyl-6-noneamide; *trans*-

N-[(4-Hydroxy-3-methoxyphenyl)methyl]-8-methyl-6-noneamide

CAS Registry Number: 404-86-4

HSDB Number: 954

RTE CS Number: RA8530000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 206-969-8

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Possible sensitization hazard, Possible risk of forming tumors, Suspected reprotoxic hazard

Poison Category: 3

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xi; risk phrases: R25; R36/37/38; R41; R42; R43; safety phrases: S2; S22; S26; S28; S36/37/39; S41; S41 (see Appendix 4)

Description: Crystalline solid, rectangular plates, or scales. Pungent odor and burning taste. Molecular weight = 305.40; boiling point = 210−218°C; freezing/melting point = 65ºC; flash point = 112.8 (cc). Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 0, reactivity 0. Practically insoluble in cold water.

Potential Exposure: Botanical animal and insect repellent used to repel birds, voles, deer, rabbits, squirrels, insects, and attacking dogs. Capsaicin, which is made from the Capsicum red chili pepper can be used indoors to protect carpets and upholstered furniture, and outdoors to protect fruit and vegetable crops, flowers, ornamental plants, shrubbery, trees, and lawns. It is also used in pepper sprays such as MACE, and as an analgesic in creams, lotions and solid sticks to reduce arthritic, postoperative and neuopathic pain, such as shingles. Capsaicin is obtained by grinding dried, ripe *Capsicum frutescens* L. chili peppers into a fine powder. The oleoresin is derived by distilling the powder in a solvent and evaporating the solvent. The resulting highly concentrated liquid has little odor but has an extremely pungent taste

Incompatibilities: Slowly hydrolyzes in water, releasing ammonia and forming acetate salts.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 3.4$[193]. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Eyes and skin

Harmful Effects and Symptoms

Short-Term Exposure: Irritates skin, eyes, and mucous membranes. Poisonous if ingested; with severe gastritis, stomach pain, and diarrhea. Probable oral lethal dose (human) 0.5−5 g/kg, between 1 oz and 1 pt (or 1 lb) for 70-kg person[88].

LD_{50} (oral, rat) = 98- > 2500 mg/kg[88].

Long-Term Exposure; Suspected reprotoxic hazard.

Points of Attack: Nerve endings and eyes. May cause reproductive and fetal effects.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Applicators and other handlers must wear: Coveralls worn over long-sleeved shirt and long pants; Chemical-resistant gloves such as DuPont Tychem suit fabrics, barrier laminate, or Viton; Chemical-resistant footwear plus socks; Protective eye wear; Chemical-resistant headgear for overhead exposure; Chemical-resistant apron when cleaning equipment, mixing, or loading[72]. Agricultural Use/Engineering Controls: When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the Worker Protection Standard (WPS) for agricultural pesticides, 40 CFR 170.240(d)(4-6), the handler PPE requirements may be reduced or modified as specified in the WPS. Firefighters should wear NIOSH-approved SCBA and full protective clothing.

Respirator Selection: Wherever and whenever workplace conditions warrant respirator use, a respiratory protection program must be followed that meets one or more of the following requirements: OSHA's 29 CFR 1910.134, ANSI Z88.2, or European Standard EN 149.

Storage: Color code—Blue: Health Hazard/Poison: Store in a tightly closed container in a dry, well-ventilated, and secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Where possible, automatically transfer material from other storage containers to process containers.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft (NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Dampen the spilled material with water. Cleanup with dampened absorbent paper and transfer material to a suitable trash container. Seal the absorbent paper and your clothing in a vapor-tight plastic bag for eventual disposal. Wash all contaminated surfaces with a soap and water solution. Do not reenter the contaminated area until an expert verifies that the area has been properly cleaned.

Fire Extinguishing: On small fire, use dry chemical powder, carbon dioxide, or water spray. On a large fire, use water spray, fog, or regular alcohol-resistant foam. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal. Use water spray or fog; do not scatter material using straight water jet streams. *If tank, rail car, or tank truck is involved in a fire*, *isolate* for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Do not allow water to get inside containers. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. *Always* stay away from tanks engulfed in fire. For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn.

Disposal Method Suggested: Do not discharge into drains or sewers. Dispose of waste material as hazardous waste using a licensed disposal contractor to an approved landfill. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Incineration with effluent gas scrubbing is recommended[22]. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Noncombustible containers should be crushed and buried under more than 40 cm of soil[30]. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (204).

United States Environmental Protection Agency, “Reregistration Eligibility Decision (RED) Facts, Capsaicin,” Office of Prevention, Pesticides and Toxic Substances, Washington, DC (June 1992). http://www.epa.gov/REDs/factsheets/4018fact.pdf.

United States Environmental Protection Agency, Office of Pesticide Programs, Pesticide Residue Limits, “Capsaicin,” 40 CFR 180.1165, www.epa.gov/pesticides/food/viewtols.htm.

Gosselin, R.E., Hodge, H.C., Smith, R.P., and Gleason, M.N., Clinical Toxicology of Commercial Products. 4th ed. Baltimore: Williams and Wilkins, p. II-145, 1976.

Captafol C:0400

Formula: $C_{10}H_9Cl_4NO_2S$

Synonyms: Captafol; Captatol; Captofol; 4-Cyclohexene-1,2-dicarboximide, *n*-(1,1,2,2-tetrachloroethyl)thiol-; Difolatan; Difosan; Folcid; 1*H*-Isoindole-1,3(2*H*)-dione,3a,4,7,7a-tetrahydro-2-(1,1,2,2-tetrachloroethyl)thio-; Ortho 5865; Sanspor; Sulfonimide; Sulpheimide*;* *n*-(1,1,2,2-Tetrachloraethylthio)-cyclohex-4-en-1,4-diacarboximid (German)*;* *n*-[(1,1,2,2-Tetrachloroethyl)-thio]-4-cyclohexene-1,2-dicarboximide*;* *n*-1,1,2,2-Tetrachloroethylmercapto-4-cyclohexene-1,2-carboximide*;* *n*-[(1,1,2,2-Tetrachloroethyl)sulfenyl]-*cis*-4-cyclohexene-1,2-dicarboximide*;* *n*-(1,1,2,2-Tetrachloroethylthio)-4-cyclohexene-1,2-dicarboximide

CAS Registry Number: 2425-06-1

HSDB Number: 340

RTECS Number: GW4900000

UN/NA & ERG Number: UN2773 (Phthalimide derivative pesticides, solid, toxic)/151; UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 219-363-3 [*Annex I Index No.:* 613-046-00-7]

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Animal, Sufficient Evidence; Human, No Available Data; Group 2 A

California Proposition 65 Chemical[102]: Cancer 10/1/1988.

Hazard Alert: Poison, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction).

Banned or Severely Restricted (Germany, Norway) (UN)[13]

Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)]

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R42; R45; R50/53; R62; R63; safety phrases: S53; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)]

Description: Captafol is a white crystalline solid. Molecular weight = 349.06; boiling point = 161°C (decomposes); freezing/melting point = 160.5°C; vapor pressure = 8×10^{-6} mmHg @ 20°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 0, reactivity 0. Practically insoluble in water; solubility = 0.0001%.

Potential Exposure: Captafol is a thiophthalimide fungicide. Those engaged in the manufacture, formulation, and application of this fungicide. Captafol is not currently registered for use on field crops or stored produce in the United States.

Incompatibilities: Reacts violently with bases, causing fire and explosion hazard. Not compatible with strong acids or acid vapor, oxidizers. Strong alkaline conditions contribute to instability. Attacks some metals.

Permissible Exposure Limits in Air

OSHA PE L: None

NIOSH REL: 0.1 milligram per cubic meter TWA [skin]; Limit exposure to lowest feasible concentration. NIOSH considers this chemical to be a potential occupational carcinogen as defined by the OSHA carcinogen policy [29 CFR 1990].

ACGIH TLV[1]: 0.1 milligram per cubic meter TWA [skin], not classifiable as a human carcinogen

No PAC available.
Australia: TWA 0.1 milligram per cubic meter, 1993; Belgium: TWA 0.1 milligram per cubic meter, 1993; Denmark: TWA 0.1 milligram per cubic meter [skin], 1999; France: VME 0.1 milligram per cubic meter [skin], carcinogen, 1993; Norway: TWA 0.1 milligram per cubic meter, 1999; Switzerland: MAK-W 0.1 milligram per cubic meter [skin], 1999; United Kingdom: TWA 0.1 milligram per cubic meter, carcinogen, 2000. Several states have set guidelines or standards for captafol in air[60] ranging from 1.0 μ/m^3 (North Dakota) to 1.5 μ/m^3 (Virginia) to 2.0 μ/m^3 (Connecticut and Nevada).

Determination in Air: Use NIOSH Analytical Method #0500

Routes of Entry: Inhalation, ingestion, skin.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates eyes, skin, and respiratory tract. Captafol can affect you when breathed in and by passing through your skin. Caprafol may cause an asthma-like allergy. Future exposures can cause asthma attacks with shortness of breath; wheezing, cough, and/or chest tightness. Exposure can irritate the skin. It can also cause a skin allergy to develop. Exposure to the sun (or other ultraviolet light) after exposure to Captafol may cause severe rash with itching, swelling, and blistering.

Long-Term Exposure: Repeated or prolonged contact cause skin sensitization, dermatitis, allergic conjunctivitis. Repeated or prolonged inhalation exposure may cause asthma. The substance may have damaging effects on the liver and kidneys. Captafol is a probable carcinogen in humans. There is some evidence that it causes liver cancer in humans, and it has caused kidney cancer in animals. Captafol may cause mutations. Handle with extreme caution.

Points of Attack: Skin, respiratory system; liver, kidneys.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function test; lung function test. Skin testing with dilute captafol may help diagnose allergy, if done by a qualified allergist.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: *Clothing:* Avoid skin contact with captafol. Wear protective gloves and clothing. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. *Eye Protection:* Wear dust-proof goggles when working with powders or dust, unless full facepiece respiratory protection is worn. Use splash-proof chemical goggles and face shield when working with liquids containing Captafol.

Respirator Selection: Where there is potential exists for Exposures over *0.1 milligram per cubic meter*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece respirator with a pesticide cartridge. Increased protection is obtained from full facepiece APRs. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous-flow mode; or use a MSHA/NIOAH approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode. All respirators selected must be approved by NIOSH under the provisions of 42 CFR 84. The current listing of NIOSH-certified respirators can be found in the NIOSH/NPPTL Certified Equipment List, which is available on the NIOSH website.

Storage: Color code—Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. Prior to working with captafol all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from heat, acids, acid fumes, or strong oxidizers (such as peroxides, chlorates, perchlorates, nitrates, and permanganates), since violent reactions occur. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN 2773 Phthalimide derivative pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN 2811: Isolation Distance, Spill: 25 m/75 ft (NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. If Captafol is in liquid or slurry form, absorb it with vermiculite, dry sand; earth or a similar material. Dispose of the absorbing material in an approved facility. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid, but it may be dissolved in a flammable liquid. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. The substance decomposes on heating or on burning, producing toxic and corrosive fumes, including hydrogen chloride, nitrogen oxides; sulfur oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBA that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Hydrolysis[22].

References

(109); (102); (31); (173); (101); (138); (2); (80); (100).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Captafol, Trenton, NJ (June 2005).

Captan C:0410

Formula: $C_9H_8Cl_3NO_2S$

Synonyms: Aacaptan; Agrosol S; Agrox 2-Way and 3-Way; Amercide; Bangton; Bean seed protectant; Captaf; Captaf 85W; Captan 50W; Captancapteneet 26,538; Captane; Captex; 4-Cyclohexene-1,2-dicarboximide, *n*-[(Trichloromethyl) mercapto]; ENT 26538; ESSO Fungicide 406; Flit 406; Fungicide 406; Fungus Ban type II; Glyodex 37-22; Hexacap; 1*H*-Isoindole-1,3(2*H*)-dione,3a,4,7,7a-tetrahydro-2-[(trichlo romethyl)thiol]-; Isopto carbachol; Isotox seed treater “D” and “F”; Kaptan; le Captane (French); Malipur; Merpan; Micro-Check 12; Miostat; NCI-0077; Neracid; Orthocide; Orthocide 406; Orthocide 50; Orthocide 7.5; Orthocide 75; Orthocide 83; Osocide; *n*-Trichloromethylmercapto-4-cyclohexene-1,2-dicarboximide; *n*-(Trichloromethylmercapto)-d (sup 4)-tetrahydrophthalimide; *n*-[(Trichloromethyl) thio]-4-cyclohexene-1,2-dicarboximide; *n*-Trichloromethylthiocyclohex-4-ene-1,2-dicarboximide; *n*-Trichloromethylthio-*cis*-*δ*(sup4)-cyclohexene-1,2-dicarboximide; *n*-[(Trichloromethyl)thio]-*δ*-4-tetrahydrophthalimide; *n*-[(Trichloromethyl)thio] tetrahydrophthalimide; *n*-Trichloromethylthio-3a,4,7,7a-tetrahydrophthalimide; Trimegol; Vancide 89; Vancide 89RE; Vancide P-75; Vangard K; Vanicide; Vondcaptan

CAS Registry Number: 133-06-2

HSDB Number: 951

RTECS Number: GW5075000

UN/NA & ERG Number: UN2773 (Phthalimide derivative pesticides, solid, toxic)/151

EC Number: 205-087-0 [*Annex I Index No.:* 613-044-00-6]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Limited Evidence; Human No Adequate Data; Group 3; NCI: Carcinogenesis Bioassay (feed); clear evidence: mouse; no evidence: rat.

California Proposition 65 Chemical[102]: Cancer 1/1/1990.

Hazard Alert: Poison, Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Sensitization hazard, Primary irritant (w/o allergic reaction), Environmental hazard.

Banned or Severely Restricted (Finland, Sweden) (UN)[13]

United States Environmental Protection Agency, FIFRA 1998 Status of Pesticides: Supported

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV.D.3.b, RQ: 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects[291]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N, Xi; risk phrases: R23/24/25; R40; R41; R43; R51; R62; R63; safety phrases: S1/2; S26; S29/35; S36/37/39; S41; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Captan, when pure, is a colorless crystalline solid. The technical grade is a cream to yellow powder with a strong odor. It is commonly dissolved in a “carrier” which may be combustible. Molecular weight = 300.6; boiling point = (decomposes) 177°C; freezing/melting point = (decomposes) 178°C; vapor pressure = 1×10^{-5} mmHg @20°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 2, reactivity 0. Very slightly soluble in water; solubility = 0.005 g/L @ ~25°C.

Potential Exposure: Captan is a thiophthalimide compound used as an agricultural fungicide for field crops and storage of produce and also as a preservative in cosmetics; an over-the-counter-drug.

Incompatibilities: Incompatible with tetraethyl pyrophosphate, parathion. Keep away from strong alkaline materials (e.g., hydrated lime) as captan may become unstable. May react with water releasing hydrogen chloride gas. Corrosive to metals in the presence of moisture.

Permissible Exposure Limits in Air

OSHA PEL: None

NIOSH REL: Carcinogen 5 milligram per cubic meter TWA; Limit exposure to lowest feasible concentration. NIOSH considers this chemical to be a potential occupational carcinogen as defined by the OSHA carcinogen policy [29 CFR 1990].

ACGIH TLV[1]: 5 milligram per cubic meter TWA, inhalable fraction [sensitizer]; confirmed animal carcinogen with unknown relevance to humans.

PAC Ver. 29[138]

PAC-1: 15 milligram per cubic meter

PAC-2: 26 milligram per cubic meter

PAC-3: 160 milligram per cubic meter

Australia: TWA 5 milligram per cubic meter, 1993; Belgium: TWA 5 milligram per cubic meter, 1993; Denmark: TWA 5 milligram per cubic meter, 1999; Finland: TWA 5 milligram per cubic meter, 1999; France: VME 5 milligram per cubic meter, carcinogen, 1999; Norway: TWA 5 milligram per cubic meter, 1999; Switzerland: MAK-W 5 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 5 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: confirmed animal carcinogen with unknown relevance to humans. Several states have set guidelines or standards for captan in ambient air[60] ranging from 11.9 μ/m^3 (Kansas) to 35 μ/m^3 (Pennsylvania) to 50 μ/m^3 (North Dakota) to 100 μ/m^3 (Connecticut) to 119 μ/m^3 (Nevada).

Determination in Air: OSHA versatile sampler-2; Reagent; High-pressure liquid chromatography/Ultraviolet detection; IV NIOSH Analytical Method #5601. Organonitrogen pesticides. OSHA versatile sampler-2; Reagent; High-pressure liquid chromatography/Ultraviolet detection; NIOSH Analytical Method (IV) #5601.

Permissible Concentration in Water: A no-adverse-effect level of drinking water has been calculated by NAS/NRC as 0.35 mg/L. The former USSR/UPEN joint project[43] set a MAC of 2.0 mg/L in water bodies used for domestic purposes.

Guidelines have been set in two states for Captan in drinking water ranging from 100 μg/L in Maine to 350 μg/L in California.

Determination in Water: Fish Tox = 25.36705000 ppb MATC (INTERMEDIATE). Octanol—water coefficient: Log $K_{ow} = 2.4$. Values above 3.0 are likely to bioaccumulate in aquatic organisms.

Routes of Entry: Skin contact, inhalation of dust, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: The substance irritates the eyes and the skin. The acute oral LD_{50} value for rats in 9000 mg/kg (insignificantly toxic). Most of the chronic-oral-toxicity data on captan suggest that the no-adverse-effect or toxicologically safe do sage is about 1000 ppm (50 mg/kg/day). However, on the basis of fetal mortality observed in monkeys exposed to captan (12.5 mg/kg/day), the ADI of captan has been established at 0.1 mg/kg of body weight by the FAO/WHO. Based on long-term feeding studies results in rats and dogs, ADIs were calculated at 0.05 mg/kg/day for captan. A rebuttal presumption against registration for captan was issued on August 19, 1980 by EPA on the basis of possible oncogenicity, mutagenitcity, and teratogenicity. LD_{50} = 9000 mg/kg[77]

Long-Term Exposure: Repeated or prolonged contact with skin may cause skin allergy to develop. Once this occurs, even very small future exposures can cause itching and a skin rash. Exposure may cause mutations or damage the developing fetus; however, this needs further study. Animal studies have found the development of cancer in animals. Whether captan is a human cancer hazard is currently being studied. Human Tox = 145.83333 ppb CHCL (Chronic Human Carcinogen Level) (VERY LOW).

Points of Attack: Eyes, skin, respiratory system; gastrointestinal tract; liver; kidneys. Cancer site in animals: duodenal tumors.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: Skin testing with dilute captan may help diagnose allergy, if done by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with captan all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from water, heat, and incompatible materials. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2773 Phthalimide derivative pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/ 75 ft (NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Absorb liquid containing captan in vermiculite, dry sand; earth, or similar material. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Soil Adsorption Index (K_{oc}) = 200.

Fire Extinguishing: Captan may burn, but does not ignite readily. Use dry chemical, CO_2, or foam extinguishers. *Do not use water.* At high temperatures, captan decomposes and produces Thermal decomposition products may include oxides of sulfur and nitrogen, hydrogen chloride and phosgene. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBA that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Captan decomposes fairly readily in alkaline media (pH > 8). It is hydrolytically stable at neutral or acid pH but decomposes when heated alone at its freezing/melting point. Alkaline hydrolysis is recommended[22].

References

(102); (31); (173); (101); (138); (80); (100).

NIOSH Manual of Analytical Methods, 4th Edition, Issue 1, *Organonitrogen pesticides*, page 7of 21, Cincinnati, OH, 1/15/1998.

Carbachol Chloride C:0420

Formula: $C_6H_{15}ClN_2O_2$

Synonyms: 2-[(Aminocarbonyl)oxy]-*N*,*N*,*N*-trimethylethanaminium chloride; Cabacolina; Carbachol; Carbacholin; Carbacholine chloride; Carbamic acid, Ester with choline chloride; Carbamiotin; Carbamoylcholine chloride; Carbamylcholine chloride; Carbochol; Carbocholin; Carbyl; Carcholin; Choline carbamate chloride; Choline chlorine carbamate; Choline, chlorine carbamate (ester); Coletyl; Doryl (pharmaceutical); (2-Hydroxyethyl)trimethylammonium chloride carbamate; Isopto carbachol; Jestryl; Lentin; Lentine (French); Miostat; Mistura C; Moryl; P.V. carbachol; TL 457; Vasoperif

CAS Registry Number: 51-83-2

HSDB Number: 6373

RTECS Number: GA0875000

UN/NA & ERG Number: UN3249 (Medicine, solid, toxic, n.o.s.)/151; UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 200-127-3

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Drug

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg)

Superfund/EPCRA 40 CFR302.4, Appendix A and Section IV. D.3.b, RQ: 500 lb (227 kg).

Hazard symbols, risk, & safety statements: Hazard symbol: T; risk phrases: R25; R28; R36/37/38; R50/53; safety phrases: S26; S28; S45; S36/37/39; S45; S53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Carbachol chloride is a crystalline odorless powder which, on standing in an open container, develops a faint odor resembling that of an aliphatic amine. Molecular weight = 182.68; freezing/melting point = 203°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 0.

Potential Exposure: Used in veterinary medicine as a cholinergic; parasympathomimetic, used chiefly in large animals, especially for colic in the horse.

Incompatibilities: Carbachol chloride is a carbamate ester. Esters are generally incompatible with nitrates. Moisture may cause hydrolysis or other forms of decomposition. Carbamates are incompatible with strong acids and bases, and especially incompatible with strong reducing agents such as hydrideds and active metals. Contact with active metals or nitrides form flammable gaseous hydrogen. Incompatible with strongly oxidizing acids, peroxides, and hydroperoxides.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 1.4 milligram per cubic meter

PAC-2: 15 milligram per cubic meter

PAC-3: 90 milligram per cubic meter

Routes of Entry: Ingestion, skin contact.

Harmful Effects and Symptoms

Highly toxic by ingestion. LD_{50} (oral-rat) = 40 mg/kg.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with carbachol chloride all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from incompatible materials.

Shipping: UN3249 Medicine, solid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft (NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include hydrogen chloride and oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBA that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: It is inappropriate and possibly dangerous to the environment to dispose of expired or waste pharmaceuticals by flushing them down the toilet or discarding them to the trash. Household quantities of expired or waste pharmaceuticals may be mixed with wet cat litter or coffee grounds, double-bagged in plastic, discard in trash. Larger quantities shall carefully take into consideration applicable DEA, EPA, and FDA regulations. If possible return the pharmaceutical to the manufacturer for proper disposal being careful to properly label and securely package the material. Alternatively, the waste pharmaceutical shall be labeled, securely packaged, and transported by a state licensed medical waste contractor to dispose by burial in a licensed hazardous or toxic waste landfill or incinerator.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Carbachol Chloride, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 7, 40−41 (1981).

Carbaryl C:0430

Formula: $C_{12}H_{11}NO_2$: $C_{10}H_7OOCNHCH_3$

Synonyms: Arilat; Arilate; Arylam; Bercema NMC50; Caprolin; Carbamic acid, methyl-, 1-naphthyl ester; Carbamine; Carbaryl, NAC; Carbatox; Carbatox 60; Carbatox 75; Carbavur; Carbomate; Carpolin; Carylderm; Compound 7744; Crag Sevin; Denapon; Dicarbam; Dyna-Carbyl; ENT 23969; Experimental insecticide 7744; Gamonil; Germain's; Hexavin; Karbaspray; Karbatox; Karbosep; Menapham; Methylcarbamate 1-naphthalenol; *n*-Methylcarbamate de 1-naphtyle (French); Methylcarbamic acid, 1-naphthyl ester; *n*-Methyl-1-naphthyl-carbamat (German); *n*-Methyl α-naphthylcarbamate; *n*-Methyl-1-naphthyl carbamate; *n*-Methyl-α-naphthylurethan;

Microcarb; Mugan; Murvin; Murvin 85; NAC; 1-Naphthol; α-Naphthyl *n*-methylcarbamate; 1-Naphthyl *n*-methylcarbamate; 1-Naphthyl *n*-methyl-carbamate; 1-Naphthyl methylcarbamate; NMC 50; Oltitox; OMS-29; OMS 629; Panam; Pomex; Prosevor 85; Ravyon; Seffein; Septene; Sevimol; Sevin; Sevin 4; Sewin; Sok; Tercyl; Thinsec; Tornado; Tricarnam; UC7744 (Union Carbide); Union Carbide 7744; Vioxan

CAS Registry Number: 63-25-2; *(alt.)* 11095-11-7; *(alt.)* 52001-89-5

HSDB Number: 952

RTECS Number: FC5950000

UN/NA & ERG Number: UN2757 (carbamate pesticides, solid, toxic)/151; UN2811 (toxic solid, organic, n.o.s.)/153

EC Number: 200-555-0 [*Annex I Index No.:* 006-011-00-7]

Regulatory Authority and Advisory Information

California Proposition 65 Chemical[102]: Cancer: 2/5/10; Developmental/Reproductive toxin (male) 8/7/2009.

Hazard Alert: Poison, Possible neurotoxic effects (methyl carbamate), Combustible, Possible risk of forming tumors, Reproductive toxin: possible risk of gene damage/impaired fertility; Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction), Environmental hazard, Agricultural chemical.

United States Environmental Protection Agency, FIFRA 1998 Status of Pesticides: Supported

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water

Priority Chemicals (57FR41331, 9/9/1992)

RCRA 40 CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.006; Nonwastewater (mg/kg), 0.14

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Canada: Drinking water MAC = 0.09 mg/L.

Hazard symbols, risk, & safety statements: Hazard symbol: Xn, N; risk phrases: R20/22; R40; R50; R62; R63; safety phrases: S2; S36/37; S41; S46; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Carbaryl is a white or grayish, odorless, crystalline solid; or various other forms including liquid and paste. Molecular weight = 201.24; boiling point = (decomposes below BP); freezing/melting point = 142°C; vapor pressure $= < 4 \times 10^{-5}$ mmHg @ 25°C; flash point = ~200°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 1, reactivity 0. Practically insoluble in water; solubility = 0.02 g/L @ 30°C.

Potential Exposure: Used as a broad spectrum insecticide and as acaricide and molluscicide. Workers engaged in production, formulation, and application of carbaryl as a contact insecticide for fruits, vegetables, cotton, and other crops.

Incompatibilities: Contact with strong oxidizers can cause fire and explosions.

Permissible Exposure Limits in Air

NIOSH IDLH = 100 milligram per cubic meter

OSHA PEL: 5 milligram per cubic meter TWA

NIOSH REL: 5 milligram per cubic meter TWA

ACGIH TLV[1]: 5 milligram per cubic meter TWA; not classifiable as a human carcinogen

PAC Ver. 29[138]

PAC-1: 1.5 milligram per cubic meter

PAC-2: 100 milligram per cubic meter

PAC-3: 600 milligram per cubic meter

DFG MAK: 5 milligram per cubic meter measured as the, inhalable fraction TWA; Peak Limitation Category II(4) [skin].

Arab Republic of Egypt: TWA 5 milligram per cubic meter, 1993; Australia: TWA 5 milligram per cubic meter, 1993; Austria: MAK 5 milligram per cubic meter [skin], 1999; Belgium: TWA 5 milligram per cubic meter, 1993; Denmark: TWA 5 milligram per cubic meter [skin], 1999; France: VME 5 milligram per cubic meter, 1999; Hungary: STEL 1 milligram per cubic meter, 1993; the Netherlands: MAC-TGG 5 milligram per cubic meter, 2003; Japan: 5 milligram per cubic meter [skin], 1999; Norway: TWA 5 milligram per cubic meter, 1999; the Philippines: TWA 5 milligram per cubic meter, 1993; Poland: MAC (TWA) 1 milligram per cubic meter, MAC (STEL) 8 milligram per cubic meter, 1999; Russia: STEL 1 milligram per cubic meter, 1993; Switzerland: MAK-W 5 milligram per cubic meter [skin], 1999; Thailand: TWA 5 milligram per cubic meter, 1993; United Kingdom: LTEL 5 milligram per cubic meter; STEL 10 milligram per cubic meter, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen.

Several states have set guidelines or standards for carbaryl in ambient air[60] ranging from $3.5\ \mu/m^3$ (Pennsylvania) to $11.9050\ \mu/m^3$ (Kansas) to $50\ \mu/m^3$ (North Dakota) to $80\ \mu/m^3$ (Virginia) to $100\ \mu/m^3$ (Connecticut) to $119\ \mu/m^3$ (Nevada).

Determination in Air: Use NIOSH Analytical Method #5601, NIOSH Analytical Method #5006, and OSHA Analytical Method 63. Organonitrogen pesticides. OSHA versatile sampler-2; Reagent; High-pressure liquid chromatography/Ultraviolet detection.

Permissible Concentration in Water: A no-adverse-effect-level in drinking water has been calculated as 0.574 mg/L by NAS/NRC. The UNEP/USSR joint project[43] set a MAC of 0.1 mg/L in water used for domestic purposes and 0.0005 mg/L in water bodies used for fishery purposes. Some states have set guidelines for carbaryl in drinking water[61] ranging from 10 μg/L (Wisconsin) to 60 μg/L (California) to 164 μg/L (Maine) to 574 μg/L (Kansas). See Regulatory section for Canada drinking water level.

Determination in Water: Octanol−water coefficient: Log $K_{\mathrm{ow}} = 1.6$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, skin contact or eye contact, skin absorption.

Harmful Effects and Symptoms

Short-Term Exposure: Carbaryl irritates the eyes, skin, and respiratory tract. The hot liquid may cause severe skin burns. The substance may affect the nervous system; resulting in convulsions and respiratory failure. The effects may be delayed. LD_{50} (oral-rat) = 250 mg/kg (moderately toxic). Single doses of up to about 140 mg (0.005 oz) have been reported to cause no effect. However, a single dose of about 200 mg has caused stomach pain and excessive sweating. Individual responses may vary. Several milliliters (0.1 fluid oz) of an 80% solution of carbaryl has caused nausea, salivation, headache, tremors, and excessive tearing. 500 mL (1 pt) of an 80% solution has resulted in death. LD_{50} = 250 mg/kg[77]

Long-Term Exposure: The major health problem associated with occupational exposure to Carbaryl is related to its inhibition of the enzyme cholinesterase in the central, autonomic, and peripheral nervous systems. The inhibition of cholinesterase allows acetylcholine to accumulate at these sites and thereby leads to over stimulation of innervated organs. The signs and symptoms observed as a consequence of exposure to carbaryl in the work-place environment are manifestations of excessive cholinergic stimulation, e.g., nausea, vomiting, mild abdominal cramping, dimness of vision, dizziness, headache, difficulty in breathing; and weakness. Carbaryl may affect the kidneys and nervous system. It may cause mutations and be a teratogen in humans. There is limited evidence that it reduces fertility in both males and females.

Points of Attack: Respiratory system, skin, central nervous system; cardiovascular system.

Medical Surveillance: NIOSH recommends that workers subject to carbaryl exposure have comprehensive preplacement medical examinations, with subsequent annual medical surveillance. If symptoms develop or overexposure has occurred, the following may be useful: kidney function tests, urine (chemical/metabolite), UA. Exam of the nervous system. If done within 2−3 hours after exposure, serum and RBC cholinesterase levels may be helpful. Levels can return to normal before the exposed person feels well.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Prevent skin contact; **4 hours**: natural rubber gloves, Neoprene rubber gloves, suits, boots; nitrile rubber gloves, suits, boots; polyvinyl chloride gloves, suits, boots. Wear appropriate clothing to prevent repeated or prolonged skin contact. Wear eye protection to prevent any reasonable probability of eye contact. Employees should wash promptly when skin is contaminated. Work clothing should be changed daily if it is possible that clothing is contaminated. Remove nonimpervious clothing promptly if contaminated. Any employee whose work involves likely exposure of the skin to carbaryl or carbaryl formulations, e.g., mixing of formulations, shall wear full-body coveralls or the equivalent, impervious gloves, i.e., highly resistant to the penetration of carbaryl, impervious footwear and when there is danger of carbaryl coming in contact with the eyes, goggles or a face shield. Any employee engaged in field application of carbaryl shall be provided with, and required to wear, the following protective clothing and equipment: goggles, full-body coveralls, impervious footwear, and a protective head covering. Employees working as flaggers in the aerial application of carbaryl shall be provided with, and required to wear, full-body coveralls or waterproof rainsuits, protective head coverings; impervious gloves and impervious footwear. Significant engineering controls are recommended for this chemical in NIOSH Criteria Document #77-107.

Respirator Selection: Engineering controls should be used, wherever feasible to maintain carbaryl concentrations below the prescribed limits, and respirators should only be used in certain nonroutine or emergency situations. During certain agricultural applications, however, respirators must be used. *Up to 50 milligram per cubic meter:* Sa* (APF = 10) (any supplied-air respirator). *Up to 100 milligram per cubic meter:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA). *Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—Blue: Health Hazard: Store in a secure poison location. Prior to working with carbaryl all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Carbaryl must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine), since violent reactions occur. Sources of ignition, such as smoking and open flames are prohibited where carbaryl is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2757 Carbamate pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN 2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft (NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. If spill involves a liquid containing carbaryl, absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Carbaryl is a noncombustible solid but may be dissolved in flammable liquids. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; or foam extinguishers. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBA that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed. Submit to alkaline hydrolysis before disposal[22]. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(102); (31); (173); (101); (138); (2); (80); (100).

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NIOSH Manual of Analytical Methods, 4th Edition, Issue 1, *Organonitrogen pesticides*, page 7of 21, Cincinnati, OH, 1/15/1998.

Carbendazim C:0434

Formula: $C_9H_9N_3O_2$

Synonyms: Abacol; Aimcozim; BAS 3460; Bas 67054; Battal; Bavistin; BCM; Bendazim; *N*-2-(Benzimidazolyl) carbamate; 2-Benzimidazolecarbamic acid, methyl ester; Benzimidazole-2-carbamic acid, methyl ester; 1*H*-Benzimid azol-2-ylcarbamic acid methyl ester; BMC; Carbamic acid, 1*H*-benzimidazole-2-yl-, methyl ester; Carbate; Carbendazime; Carbendazole; Carbendazol; Carbendazym; Carbendor; Cekudazim; Corbel; CTR 6669; Custos; Defensor; Delsene; Derosal; Derroprene; E-965; Equitdazin; Fungisol; HOE 17411; Imisol; Kemdazin; Lignasan; Mbc; Mergal; 2-(Methoxy-carbonylamino)-benzimidazol; 2-(Methoxycarbonylamino)-benzimidazole; Methyl 1*H*-benzemedazol-2-yl carbamate; Methyl 2-benzimidazolecarbamate; Methyl benzimidazole-2-yl carbamate; Pillarstin; Polyphase; Rodazim; Stempor; Supercarb, triticol; Triticol; U-32.104

CAS Registry Number: 10605-21-7

HSDB Number: 6581

RTECS Number: DD6500000

UN/NA & ERG Number: UN3082 (environmentally hazardous substances, liquid, n.o.s.)/171

EC Number: 234-323-0 [*Annex I Index No.:* 613-048-00-8]

Regulatory Authority and Advisory Information

Cancinogenicity: EPA Group C, possible human carcinogen

Hazard Alert: Nerve Toxin, Suspected of causing genetic defects, Reproductive toxin: possible endocrine disruptor, Environmental hazard.

United States DOT Regulated United States DOT Regulated marine pollutant (49CFR172.101, Appendix B)

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R45; R33; R46; R60; R61; safety phrases: S50/S53; S53; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to waters

Description: Colorless crystalline solid or light-gray powder. Commercially supplied as dry concentrate that is mixed with water for spraying. Molecular weight = 191.21; boiling point = decomposes; specific gravity (H_2O:1) = 1.452; freezing/melting point = (decomposes) 302−307°C; vapor pressure 4.9×10^{-10} mmHg @ 20°C. Slightly soluble in water; solubility = 0.008/pH7 @ 24°C.

Potential Exposure: Carbendazim is a benzimidazole/carbamate systemic fungicide used as a drench to control a broad range of fungi in cereals, vegetables, oilseed rape, sugar beets, grapes, tomatoes, pome fruit, and stone fruit. It is also used in postharvest storage and as treatment in seed preplanting, frequently in combination with other fungicides. In some areas, it has been used to combat Dutch Elm disease.

Incompatibilities: Carbamates are incompatible with reducing agents, strong acids, oxidizing acids, peroxides, and bases. Contact with active metals or nitrides cause the release of flammable, and potentially explosive, hydrogen gas.

Permissible Exposure Limits in Air: No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Determination in Air: Organonitrogen pesticides. OSHA versatile sampler-2; Reagent; High-pressure liquid chromatography/Ultraviolet detection; NIOSH Analytical Method (IV) #5601.

Permissible Concentration in Water: Runoff from spills or fire control may cause water pollution.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 1.5$. Unlikely to bioaccumulate in marine organisms. Fish toxicity (threshold)[101]: High—1.44530 ppb, MATC.

Routes of Entry: Skin absorption, ingestion, inhalation

Harmful Effects and Symptoms

Short-Term Exposure: Eye pupils are small; blurred vision; eye watering; runny nose; cough; shortness of breath; salivation; nausea, stomach cramps, diarrhea, and vomiting; increased blood pressure; profuse sweating; hypermotility, hallucinations; agitation; tingling of the skin; slow heartbeat; convulsions; fluid in lungs; loss of consciousness; incontinence; breathing stops; death. Carbamate insecticides inhibit the cholinesterase activity of enzymes, causing accumulation of acetylcholine at synapses and altering the way in which nervous impulses are transmitted. However, within several hours carbamates spontaneously detach from the enzymes. LD_{50} (oral, rat) = 6400 mg/kg[77].

Long-Term Exposure: A potent acetylcholinesterase (AChE) inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, central nervous system, cardiovascular system, skin, eyes, plasma, and red blood cell cholinesterase. May be a liver toxin.

Medical Surveillance: This chemical is a suspected or known human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and advice for medical monitoring. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a drug or other inhalation therapy. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. Routine biological monitoring of pesticide applicators and field workers includes testing of plasma and red blood cell acetylcholinesterase levels (for enzyme poisoned by this chemical). These tests are normally accurate only if done within about 2 hours of exposure. If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When acetylcholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover.

First Aid: Speed in removing material from eyes and skin is of extreme importance. *Eyes:* Eye contact can cause dangerous amounts of these chemicals to be quickly absorbed through the mucous membrane into the bloodstream. Immediately and gently flush eyes with plenty of warm or cold water (NO hot water) for at least 15 minutes, occasionally lifting the upper and lower eye lids. Get medical aid immediately. *Skin:* Get medical aid. Dermal contact can cause dangerous amounts of these chemicals to be absorbed into the bloodstream. Wearing the appropriate PPE equipment and respirator for carbamate pesticides, immediately flush skin with plenty of soap and water for at least 15 minutes while removing contaminated clothing and shoes. Shampoo hair promptly if contaminated; protect eyes. *Ingestion:* Call poison control. Loosen all clothing. Never give anything by mouth to an unconscious person. Get medical aid. Do NOT induce vomiting. * If conscious, alert, and able to swallow, rinse mouth and have victim drink 4 to 8 oz of water. Check to see if poison control instructs you to use ipecac syrup, otherwise administer slurry of activated charcoal (2 oz in 8 oz of water). If victim is *UNCONSCIO United States OR HAVING CONVULSIONS*, do nothing except keep victim warm. **In some cases you may be specifically instructed by poison control to induce vomiting by way of 2 tablespoons of syrup* *of ipecac (adult) washed down with a cup of water.* Do NOT give activated charcoal before or with ipecac syrup. *Inhalation:* Get medical aid. Do not contaminate yourself. Wearing the appropriate PPE equipment and respirator for carbamate pesticides, immediately remove the victim from the contaminated area to fresh air. If the victim is not breathing, administer artificial respiration. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. If breathing is difficult, administer oxygen through bag/mask apparatus until medical help arrives. Do not leave victim unattended. *Note to physician or authorized medical personnel.* Administer atropine, 2 mg (1/30 g) intramuscularly or intravenously as soon as any local or systemic signs or symptoms of an intoxication are noted; repeat the administration of atropine every 3 to 8 minutes until signs of atropinization (mydriasis, dry mouth, rapid pulse, hot and dry skin) occur; initiate treatment in children with 0.05 mg mg/kg of atropine; repeat at 5 to 10-minute intervals. Watch respiration, and remove bronchial secretions if they appear to be obstructing the airway; intubate if necessary. *Medical note:* 2-PAMCI may be contraindicated in the case of some carbamate poisonings.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of dermal contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. DuPont Tychem suit fabrics[88] All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000): (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive pressure breathing apparatus). *Escape*: GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison. Store in a secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong alkalis (such as Sodium Hydroxide, Sodium Bicarbonate, etc.).

Shipping: UN3082 Environmentally hazardous substances, liquid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required

Spill Handling: For solids, isolate spill or leak area in all directions for at least 25 m/75 ft. Increase, in the downwind direction, as necessary. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Stop leak if you can do it without risk. Prevent entry into waterways, sewers, basements, or confined areas. Cover with plastic sheet to prevent spreading. Absorb or cover with dry earth, sand, or other noncombustible material and transfer to containers. Do not allow water to get inside containers.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen and carbon. *On small fire*, use dry chemical powder, carbon dioxide, water spray, or foam. *On large fire*, use water spray, fog, or alcohol-resistant foam. Do not scatter material using straight water jet streams. Dike fire control water for later disposal; do not scatter the material. Move containers from fire area if you can do it without risk. *Fire involving storage or vehicular tanks:* Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Do not allow water to get inside containers. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. *Always* stay away from tanks engulfed in fire. For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn.

Disposal Method Suggested: Do not discharge into drains or sewers. Dispose of waste material as hazardous waste using a licensed disposal contractor to an approved landfill. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Incineration with effluent gas scrubbing is recommended. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (100).

NIOSH Manual of Analytical Methods, 4th Edition, Issue 1, *Organonitrogen pesticides*, page 7of 21, Cincinnati, OH, 1/15/1998.

United States National Library of Medicine, ChemIDplus Advanced, Bethesda MD, http://chem.sis.nlm.nih.gov/chemidplus/rn/10605-21-7.

Carbetamide C:0437

Formula: $C_{12}H_{16}N_2O_3$

Synonyms: 11,561 RP; δ-(−)-Carbanilic acid(1-ethylcarbamoyl)ethyl ester; Carbetamex; Carbetamid (German); **Carbetamide**; Helmsman; δ-*N*-Ethyllactamide carbanilate (ester); δ-(−)-1-(Ethylcarbamoyl)ethylphenyl carbamate; (R)-*N*-Ethyl-2-[((phenylamino) carbonyl) oxy] propanamide; Legurame; *N*-Ethyl-2-[((phenylamino)carbonyl)oxy] propanamide, (*d*) isomer; (Phenylcarbamoyloxy)-2-*N*-ethylpropionamide; 2-Phenyl-carbamoyloxy-*N*-aethyl-propionamid (German); *N*-Phenyl-1-(ethylcarbamoyl-1)-ethylcarbamate, *d*-isomer; Riot; Scrum

CAS Registry Number: 16118-49-3

RTECS Number: FD8900000

UN/NA & ERG Number: UN2757 (carbamate pesticides, solid, toxic)/151

EC Number: 240-286-6

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Agricultural chemical.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R33; R40; R50/53; R63; safety phrases: S22; S26; S36; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)]

Description: Carbetamide is a colorless, crystalline powder, or solid. Molecular weight 236.27; freezing/melting point = 110°C; boiling point = 234°C (decomposes); vapor pressure = $< 1 \times 10^{-5}$ mmHg @ 20°C. Highly soluble in water; solubility = 3300 ppm @ 20°C.

Potential Exposure: Carbamate herbicide used to kill unwanted plants.

Incompatibilities: Slowly hydrolyzes in water, releasing ammonia and forming acetate salts. Carbamates are incompatible with reducing agents, strong acids, oxidizing acids, peroxides, and bases. Contact with active metals or nitrides cause the release of flammable, and potentially explosive, hydrogen gas. Amides react with azo and diazo compounds to generate toxic gases. Flammable gases are formed by the reaction of organic amides with strong reducing agents such as hydrideds and active metals. Amides are very weak bases (weaker than water). Mixing amides with dehydrating agents such as phosphorus pentoxide or thionyl chloride generates the corresponding nitrile. The combustion of these compounds generates mixed oxides of nitrogen (NOx). This compound is decomposed by strong base or acid[101].

Determination in Water: Octanol−water coefficient: Log $K_{ow} = < 2.0$. Unlikely to bioaccumulate in marine organisms.

Permissible Concentration in Water: No criteria set. Runoff from spills or fire control may cause water pollution.

Routes of Entry: Skin absorption, ingestion, inhalation.

Harmful Effects and Symptoms

Short-Term Exposure: Eye pupils are small; blurred vision; eye watering; runny nose; cough; shortness of breath; salivation; nausea, stomach cramps, diarrhea, and vomiting; increased blood pressure; profuse sweating; hypermotility, hallucinations; agitation; tingling of the skin; slow heartbeat; convulsions; fluid in lungs; loss of consciousness; incontinence; breathing stops; death. Carbamate insecticides inhibit the cholinesterase activity of enzymes, causing accumulation of acetylcholine at synapses and altering the way in which nervous impulses are transmitted. However, within several hours carbamates spontaneously detach from the enzymes. LD_{50} (oral, rat) = 1718 mg/kg.

Long-Term Exposure: A potent acetylcholinesterase (AChE) inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver or thyroid damage. Human toxicity (long term)[101]: High—7.00 ppb, Health advisory.

Points of Attack: Respiratory system, lungs, central nervous system, cardiovascular system, skin, eyes, plasma, and red blood cell cholinesterase; liver, thyroid.

Medical Surveillance: Preliminary medical exam to detect chronic diseases of CNS, liver, heart, kidneys, lung, and skin, as well as endocrinological or immunological disturbances, should protect susceptible individuals. Periodical medical exams of internal organs, skin, and eyes are important to avoid chronic occupational intoxications. They should include lab and patch tests if necessary[30]. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a drug or other inhalation therapy. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. Before employment and at regular times after that, the following are recommended: Plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When acetylcholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider CBC. Consider chest X-ray following acute overexposure.

First Aid: Speed in removing material from eyes and skin is of extreme importance. *Eyes:* Eye contact can cause dangerous amounts of these chemicals to be quickly absorbed through the mucous membrane into the bloodstream. Immediately and gently flush eyes with plenty of warm or cold water (NO hot water) for at least 15 minutes, occasionally lifting the upper and lower eyelids. Get medical aid immediately. *Skin:* Get medical aid. Dermal contact can cause dangerous amounts of these chemicals to be absorbed into the bloodstream. Wearing the appropriate PPE equipment and respirator for carbamate pesticides, immediately flush skin with plenty of soap and water for at least 15 minutes while removing contaminated clothing and shoes. Shampoo hair promptly if contaminated; protect eyes.

Ingestion: Call poison control. Loosen all clothing. Never give anything by mouth to an unconscious person. Get medical aid. Do NOT induce vomiting. * If conscious, alert, and able to swallow, rinse mouth and have victim drink 4 to 8 oz of water. Check to see if poison control instructs you to use ipecac syrup, otherwise administer slurry of activated charcoal (2 oz in 8 oz of water). If victim is *UNCONSCIO United States OR HAVING CONVULSIONS*, do nothing except keep victim warm. **In some cases you may be specifically instructed by poison control to induce vomiting by way of 2 tablespoons of syrup of ipecac (adult) washed down with a cup of water*. Do NOT give activated charcoal before or with ipecac syrup. *Inhalation:* Get medical aid. Do not contaminate yourself. Wearing the appropriate PPE equipment and respirator for carbamate pesticides, immediately remove the victim from the contaminated area to fresh air. If the victim is not breathing, administer artificial respiration. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. If breathing is difficult, administer oxygen through bag/mask apparatus until medical help arrives. Do not leave victim unattended. *Note to physician or authorized medical personnel*. Administer atropine, 2 mg (1/30 g) intramuscularly or intravenously as soon as any local or systemic signs or symptoms of an intoxication are noted; repeat the administration of atropine every 3 to 8 minutes until signs of atropinization (mydriasis, dry mouth, rapid pulse, hot and dry skin) occur; initiate treatment in children with 0.05 mg mg/kg of atropine; repeat at 5 to 10-minute intervals. Watch respiration, and remove bronchial secretions if they appear to be obstructing the airway; intubate if necessary. *Medical note:* 2-PAMCI may be contraindicated in the case of some carbamate poisonings.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of dermal contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. DuPont Tychem suit fabrics[NOAA] All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000): (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10, 000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive pressure breathing apparatus). *Escape*: GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison. Store in a secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong alkalis (such as Sodium Hydroxide, Sodium Bicarbonate, etc.).

Shipping: UN2757 Carbamate pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: For solids, isolate spill or leak area in all directions for at least 25 m/75 ft. Increase, in the downwind direction, as necessary. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Stop leak if you can do it without risk. Prevent entry into waterways, sewers, basements, or confined areas. Cover with plastic sheet to prevent spreading. Absorb or cover with dry earth, sand, or other noncombustible material and transfer to containers. Do not allow water to get inside containers.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen and carbon. *On small fire*, use dry chemical powder, carbon dioxide, water spray, or foam. *On large fire*, use water spray, fog, or regular alcohol-resistant foam. Do not scatter material using straight water jet streams. Dike fire control water for later disposal; do not scatter the material. Move containers from fire area if you can do it without risk. *If tank, rail car, or tank truck is involved in a fire*, isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Do not allow water to get inside containers. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. *Always* stay away from tanks engulfed in fire. For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn.

Disposal Method Suggested: Do not discharge into drains or sewers. Dispose of waste material as hazardous waste using a licensed disposal contractor to an approved land fill. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Incineration with effluent gas scrubbing is recommended. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (204); (100).

International Programme on Chemical Safety (IPCS), "Carbamate Pesticides: A General Introduction," World

Health Organization, Geneva, Switzerland (1986). http://www.inchem.org/documents/ehc/ehc/ehc64.htm.

Carbofuran C:0440

Formula: $C_{12}H_{15}NO_3$
Synonyms: A13-27164; Bay 70143; Bay 704143; Bay 78537; 7-Benzofuranol, 2,3-dihydro-2,2-dimethyl-, methylcarbamate; Brifur; Carbamic acid, methyl-, 2,2-dimethyl-2,3-dihydrobenzofuran-7-yl ester; Carbofurano (Spanish); Carbosip 5G; Chinufur; Crisfuran; Curaterr; D 1221; 2,3-Dihydro-2,2-dimethyl-7-benzofuranol *n*-methylcarbamate; 2,3-Dihydro-2,2-dimethyl-7-benzofuranol methylcarbamate; 2,3-Dihydro-2,2-dimethylbenzofuran-7-yl methylcarbamate; 2,3-Dihydro-2,2-dimethylbenzofuranyl-7 *N*-methylcarbamate; 2,2-Dimethyl-7-coumaranyl *n*-methylcarbamate; 2,2-Dimethyl-2,2-dihydro benzofuranyl-7 *n*-methylcarbamate; 2,2-D imethyl-2,3-dihyd ro-7-benzo furanyl *n*-methylcarbamate; ENT 27,164; FMC 10242; Furadan; Furadan 10G; Furadan 3G; Furadan 4F; Furadan G; Furodan; Kenofuran; Methyl carbamic acid 2,3-dihydro-2,2-dimethyl-7-benzofuranylester; Nex; NIA-10242; Niagara 10242; Niagra 10242; Niagra NIA-10242; NSC 167822; Pillarfuran; Yaltox
CAS Registry Number: 1563-66-2
HSDB Number: 1530
RTECS Number: FB9450000
UN/NA & ERG Number: UN2757 (carbamate pesticides, solid, toxic)/151; UN2811 (toxic solid, organic, n.o.s.)/153
EC Number: 216-353-0 [*Annex I Index No.:* 006-026-00-9]
Regulatory Authority and Advisory Information
Hazard Alert: Poison, Possible neurotoxic effects (methyl carbamate), Suspected of causing genetic defects, Suspected reprotoxic hazard, Environmental hazard, Agricultural chemical.
Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)
RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.006; Nonwastewater (mg/kg), 0.14
United States National Primary Drinking Water Regulations: MCLG = 0.04 mg/L; MCL = 0.04 mg/L.
Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 10/10,000 lb (4.54/4540 kg)
Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg)
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)
Canada: Drinking water quality, 0.09 mg/L MAC.
Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)] (as dustable powder formulations containing a combination of: Benomyl @ or >7%; carbofuran @ or >10%; thiram @ or >15%).
Hazard symbols, risk, & safety statements: Hazard symbol: T+, N; risk phrases: R26/28; R50/53; R62; R63; safety phrases: S1/2; S36/37; S41; S45; S60; S61 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.
Description: Carbofuran is white, odorless crystalline solid. Molecular weight = 221.28; specific gravity (H_2O:1) = 1.18; boiling point = 149°C (decomposes); freezing/melting point = 150−153°C; vapor pressure = 2.3×10^{-7} mmHg @ 25°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 0. Soluble in water; solubility = 0.07 g/L @25°C.
Potential Exposure: A potential danger to those involved in the manufacture, formulation, and application of this insecticide, acaricide, and nematocide.
Incompatibilities: Alkaline substances, acid, strong oxidizers, such as perchlorates, peroxides, chlorates, nitrates, permanganates.
Permissible Exposure Limits in Air
OSHA PEL: None
NIOSH REL: 0.1 milligram per cubic meter TWA
ACGIH TLV[1]: 0.1 milligram per cubic meter TWA, inhalable fraction and vapor; BEI issued; not classifiable as a human carcinogen (2001).
PAC Ver. 29[138]
PAC-1: 0.3 milligram per cubic meter
PAC-2: 0.43 milligram per cubic meter
PAC-3: 3.7 milligram per cubic meter
Australia: TWA 0.1 milligram per cubic meter, 1993; Belgium: TWA 0.1 milligram per cubic meter, 1993; Denmark: TWA 0.1 milligram per cubic meter, 1999; France: VME 0.1 milligram per cubic meter, 1993; India: TWA 0.1 milligram per cubic meter, 1993; Norway: TWA 0.1 milligram per cubic meter, 1999; Poland: MAC (TWA) 0.1 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 0.1 milligram per cubic meter, 2003; United Kingdom: TWA 0.1 milligram per cubic meter, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Several states have set guidelines or standards for carbofuran in ambient air[60] ranging from 1.0 μ/m^3 (North Dakota) to 1.6 μ/m^3 (Virginia) to 2.0 μ/m^3 (Connecticut and Nevada).
Determination in Air: Use NIOSH Analytical Method #5006, (IV) #5601, and OSHA Analytical Method 63. Organonitrogen pesticides. OSHA versatile sampler-2; Reagent; High-pressure liquid chromatography/Ultraviolet detection.
Permissible Concentration in Water: Safe Drinking Water Act (47 FR 9352): MCL, 0.04 mg/L; MCLG, 0.04 mg/L. EPA[47] has determined 1-day, 10-day, and longer term health advisories for a 10-kg child of 50 μg/L of Carbofuran. The longer term (1 year) value for a 70-kg adult is 0.18 mg/L or 180 μg/L. A lifetime Health advisory: for a 70-kg adult has been determined to be 36 μg/L of Carbofuran. Most

recently, EPA has proposed a limit of 40 μg/L in drinking water[62]. Some states have set guidelines for carbofuran in drinking water[61] ranging from 10 μg/L (Massachusetts) to 15 μg/L (New York) to 36 μg/L (Arizona and Minnesota) to 50 μg/L (Kansas and Wisconsin).

Determination in Water: Analysis of Carbofuran is by a high performance liquid chromatographic procedure used for the determination of *n*-methyl carbamoyloximes and *n*-methylcarbamates in drinking water (United States Environmental Protection Agency 1984). In this method, the water sample is filtered and a 400-μL aliquot is injected into a reverse phase HPLC column. Separation of compounds is achieved using gradient elution chromatography. After elution from the HPLC column, the compounds are hydrolyzed with sodium hydroxide. The methylamine formed during hydrolysis is reacted with *o*-phthalaldehyde (OPA) to form a fluorescent derivative which is detected using a fluorescence detector. The method detection limit has been estimated to be approximately 0.9 μg/L for carbofuran. Octanol−water coefficient: Log K_{ow} (octanol/water partition coefficient) = 2.32.

Routes of Entry: Inhalation, ingestion, skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Carbofuran may affect the nervous system; resulting in convulsions and respiratory failure. Cholinesterase inhibitor. Exposure may result in death. The effects may be delayed and exposed personnel should be kept under medical observation. Symptoms include headache, giddiness; blurred vision weakness, nausea, cramps, diarrhea, chest discomfort, sweating, contraction of pupils; tearing, salivation; Blue lips; lungs and abdomen fill with fluid, convulsions, coma; loss of reflexes and sphincter control. This material is extremely poisonous. The LD_{50} rat is 5.3 mg/kg May be fatal if swallowed, inhaled, or absorbed through skin. Contact may burn skin or eyes. Probable lethal oral dose to humans 5−50 mg/kg or 7 drops to 1 teaspoon for 150 lb person. LD_{50} = 5.3 mg/kg[77]

Long-Term Exposure: The major health problem associated with occupational exposure to carbofuran is related to its inhibition of the enzyme cholinesterase in the central, autonomic, and peripheral nervous systems. The inhibition of cholinesterase allows acetylcholine to accumulate at these sites and thereby leads to over stimulation of innervated organs. The signs and symptoms observed as a consequence of exposure to Carbofuran in the work-place environment are manifestations of excessive cholinergic stimulation, e.g., nausea; vomiting; mild abdominal cramping; dimness of vision; dizziness, headache, difficulty in breathing; and weakness. Carbofuran may affect the immune system.

Points of Attack: Central nervous system; peripheral nervous system; blood cholinesterase.

Medical Surveillance: Before starting work, at regular times after that, and if any symptoms develop, or overexposure occurs, the following is recommended: serum and red blood cell cholinesterase levels (a special test for the substance in the body that Carbofuran affects). For this substance these tests are accurate only if done within about 2 hours of exposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Effects may be delayed; keep victim under observation.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash or dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for Exposures over *0.1 milligram per cubic meter*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator with a pesticide cartridge. More protection is provided by a full facepiece respirator than by a half-mask respirator, and even greater protection is provided by a PAPR. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode. All respirators selected must be approved by NIOSH under the provisions of 42 CFR 84. The current listing of NIOSH-certified respirators can be found in the NIOSH/NPPTL Certified Equipment List, which is available on the NIOSH website.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with carbofuran all handlers should be trained on its proper handling and storage. Carbofuran must be stored to avoid contact with acids and strong oxidizers (such as perchlorates, peroxides, chlorates, nitrates, and permanganates). Store in tightly closed containers in a cool, well-ventilated area.

Shipping: UN2757 Carbamate pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.
Spill Handling: UN2811: Isolation Distance, Spill: 25 m/ 75 ft (NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers for reclamation or for disposal in an approved facility. Absorb liquid containing carbofuran in vermiculite, dry sand; earth, or similar material. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.
Fire Extinguishing: Carbofuran itself does not burn. The substance decomposes on heating, producing toxic fumes including nitrogen oxides. Dike fire control water for later disposal, do not scatter the material. Stay at maximum distance from fire. Extinguish fire using an agent suitable for the type of surrounding fire; use dry chemical, carbon dioxide; water spray; or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately.
Disposal Method Suggested: Alkaline hydrolysis is the recommended mode of disposal[22]. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (2); (80); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Carbofuran, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

United States Environmental Protection Agency, "Preliminary Determination to Cancel Registrations of Carbofuran Products," Federal Register 54, No. 15, 3744-3754 (January 25, 1989).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Carbofuran, Trenton, NJ (June 2005).

NIOSH Manual of Analytical Methods, 4th Edition, Issue 1, *Organonitrogen pesticides*, page 7of 21, Cincinnati, OH, 1/15/1998.

Carbon Black C:0450

Formula: C
Synonyms: Acetylene black; Channel black; C.I. Pigment black 7; Elemental carbon; Furnace black; Lamp black; thermal black
CAS Registry Number: 1333-86-4
HSDB Number: 953
RTECS Number: FF5800000
UN/NA & ERG Number: UN1993 (liquid)/128; UN1361 (Carbon, Animal, or Vegetable origin)/133
EC Number: 215-609-9
Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human, Inadequate Evidence, animal Sufficient Evidence, *possibly carcinogenic to humans*, Group 2B, 1996[1].

California Proposition 65 Chemical[102]: (*airborne, unbound particles of respirable size*), Cancer 2/21/2003.

Hazard Alert: Combustible solid or highly flammable liquid, Possible risk of forming tumors, Suspected reprotoxic hazard.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, F (liquid), Xi, Xn; risk phrases: R11; R18; R24/25; R36/37; R40; R63; safety phrases: S22; S26; S36/37; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): Nonhazard to water.

Description: Carbon black (essentially elemental carbon), is a black or brown liquid or solid (powder). Odorless solid. Carbon black oil is flammable and has a petroleum odor. Molecular weight = 12; freezing/melting point = ~3550°C (sublimes). Hazard identification (based on NFPA-704 M Rating System) (*activated, type C-1*): Health 1, flammability 1 (solid) 3 (liquid), reactivity 1. Insoluble in water. Combustible solid may contain flammable hydrocarbons.
Potential Exposure: Used as reinforcing agent and filler for rubber; colorants for ink, paint, and plastics. Workers in carbon black production or in its use in rubber compounding, ink and paint manufacture, plastics compounding, dry-cell battery manufacture.
Incompatibilities: Carbon blacks containing over 8% volatiles may pose an explosion hazard. Dust can form an explosive mixture in air. A reducing agent; keep away from strong oxidizers, such as chlorates, bromates, nitrates.
Permissible Exposure Limits in Air

NIOSH IDLH = 1750 milligram per cubic meter

OSHA PEL: 3.5 milligram per cubic meter TWA

NIOSH REL: 3.5 milligram per cubic meter TWA; Potential human carcinogen, in the presence of PAHs, NIOSH recommends that exposure to carbon black be limited to the lowest feasible concentration. 0.1 mg[PAHs]/m^3 [10-hour] TWA[Carbon black, in the presence of polycyclic aromatic hydrocarbons (PACs)]. See *NIOSH Pocket Guide*, Appendices A and C.

ACGIH TLV[1]: 3.5 milligram per cubic meter TWA; not classifiable as a human carcinogen

DFG MAK: Carcinogen Category 3B, inhalable dust.

PAC Ver. 29[138]

PAC-1: 9 milligram per cubic meter

PAC-2: 99 milligram per cubic meter

PAC-3: 590 milligram per cubic meter

DFG MAK: Carcinogen Category 3B, inhalable fraction

Australia: TWA 3 milligram per cubic meter, 1993; Belgium: TWA 3.5 milligram per cubic meter, 1993; Denmark: TWA 3.5 milligram per cubic meter, 1999; Finland: TWA 3.5 milligram per cubic meter; STEL 7 milligram per cubic meter, 1999; France: VME 3.5 milligram per cubic meter, 1999; Norway: TWA 3.5 milligram per cubic meter, 1999; the Philippines: TWA 3.5 milligram per cubic meter, 1993; the Netherlands: MAC-TGG 3.5 milligram per cubic meter, 2003; Sweden: NGV 3 milligram per cubic meter [dust], 1999; United Kingdom: TWA 3.5 milligram per cubic meter; STEL 7 milligram per cubic meter, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen. The former USSR-UNEP/IRPTC joint project[43] set a MAC in ambient air in residential areas of 0.15 milligram per cubic meter on a momentary basis and 0.005 milligram per cubic meter on an average daily basis. Several states have set guidelines or standards for carbon black in ambient air[60] ranging from 117 μ/m^3 (New York) to 35 μ/m^3 (North Dakota) to 50 μ/m^3 (Virginia) to 70 μ/m^3 (Connecticut) to 83 μ/m^3 (Nevada).

Determination in Air: Filtration from air is followed by gravimetric analysis as described in NIOSH Analytical Method #5000[18]. See also NIOSH Analytical Method 5800, Polycyclic aromatic compounds (PAC), and OSHA Analytical Method ID-196.

Permissible Concentration in Water: The former USSR-UNEP/IRPTC joint project[43] set a MAC in water bodies used for domestic purposes of 1.0 mg/L.

Routes of Entry: Inhalation, skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Inhalation may cause irritation to respiratory tract. Skin contact may cause irritation. Eye contact may cause irritation. *Ingestion:* Animal studies show that toxic effects are unlikely, although carbon black contains several substances that are toxic and known carcinogens.

Long-Term Exposure: Exposure to levels well above 3.5 milligram per cubic meter for several months may result in damage to the skin and nails; temporary or permanent damage to the lungs and breathing passages; and adversely affect the heart. Carbon black containing PAH greater than 0.1% should be considered a suspect carcinogen. Lungs may be affected by repeated or prolonged exposure at very high concentrations: Some carbon blacks may contain compounds which are carcinogenic; and as organic extracts of these have been classified as possibly carcinogenic to humans, special care should be taken to avoid exposure to such extracts. Lung effects remain controversial and may be due to contaminants. It is probable that minor effects reported are nonspecific effects associated with exposure to nuisance dusts in general. Polycyclic aromatic hydrocarbons (PAH) are reportedly present in some carbon blacks. Depending on the process of manufacture, there are variations in their chemical compositions.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater) the following are recommended before beginning work and at regular times after that: chest X-ray (to be read by a special NIOSH "B reader" radiologist); lung function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin and PAH contamination is present, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA *Up to 17.5 milligram per cubic meter:* Qm (APF = 5) (any quarter-mask respirator). *Up to 35 milligram per cubic meter:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *Up to 87.5 milligram per cubic meter:* Sa:Cf (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25) (any powered, APR with a high-efficiency particulate filter). *Up to 175 milligram per cubic meter:* 100 F (APF = 50) (any air purifying), full facepiece respirator with and N100, R100, or P100 filter. Any powered, APR with a tight-fitting facepiece and a high-efficiency particulate filter. Any SCBA with a full facepiece. Any supplied-air respirator with a full facepiece. *up to 1750 milligram per cubic meter:* Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

In presence of polycyclic aromatic hydrocarbons: NIOSH *At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode) *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Oil: Color code—Red: Flammability Hazard: Store in a flammable (liquid or solid materials) storage area or approved cabinet away from sources if ignition. Color code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Prior to working with carbon black all handlers should be trained on its proper handling and storage. Carbon black must be stored to avoid contact with chlorates, bromates, and nitrates, since violent reactions occur. Sources of ignition, such as smoking and open flames are prohibited where carbon black is used, handled, or stored in a manner that could create a potential fire or explosion hazard. If carbon black contains more than 0.1% PAHs it should be used, handled, and stored in a regulated area as a carcinogen. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Carbon black oil: UN1993 Flammable liquids, n.o.s., Hazard Class: 3; Labels: 3-Flammable liquid, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of carbon. Use dry chemical, sand, water spray; or foam extinguishers. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBA that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested

Dump into a landfill or incinerate as a slurry[22].

References

(102); (31); (173); (101); (18); (100).

National Institute for Occupational Safety and Health (NIOSH), *Information Profiles on Potential Occupational Hazards: Carbon Black*, Report PB-276,678, Rockville, MD (October 1977).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Carbon Black, Washington, DC (August 1, 1976).

National Institute for Occupational Safety and Health (NIOSH), *Criteria for a Recommended Standard: Occupational Exposure to Carbon Black*, NIOSH Document Number 78-204, Cincinnati, OH (1978).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet: Carbon Black*, Trenton, NJ (July 1998).

New York State Department of Health, *Chemical Fact Sheet*

Carbon Black, Bureau of Toxic Substance Assessment, Albany, NY (January 1986 and Version 2).

Carbon Dioxide C:0460

Formula: CO_2

Synonyms: Acetylene black; Channel black; C.I. Pigment black 7; Elemental carbon; Furnace black; Lamp black; thermal black

CAS Registry Number: 124-38-9

HSDB Number: 516

RTECS Number: FF6400000

UN/NA & ERG Number: (PIH) UN1013 (compressed)/120, UN2187 (refrigerated liquid)/120, UN 1845 (solid, dry ice)/120

EC Number: 204-696-9

Regulatory Authority and Advisory Information

Hazard Alert: Poison inhalation hazard, Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated, Suspected of causing genetic defects; FDA-over the counter drug.

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T; risk phrases: R5; R21; R62; safety phrases: S33; S38; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): Nonhazard to water.

Description: Carbon dioxide is a colorless, odorless, noncombustible gas. Molecular weight = 44.01; specific gravity (H_2O:1) = 0.72; boiling point = (sublimes); freezing/melting point = −78.3°C (sublimes); −56.66[138]; vapor pressure = 750 mmHg @ −78.6; Carbon dioxide is commonly shipped in the compressed liquid form, and the solid form (dry ice). Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 0. Slightly soluble in water; solubility = 0.2% @ 25°C.

Potential Exposure: Gaseous Carbon dioxide is used to carbonate beverages; as a weak acid in the textile, leather, and chemical industries; in water treatment; and in the manufacture of aspirin and white lead; for hardening molds in foundries; in food preservation, in purging tanks and pipe lines; as a fire extinguisher, in foams; and in welding. Because it is relatively inert, it is utilized as a pressure medium. It is also used as a propellant in aerosols; to promote plant growth in green houses; it is used medically as a respiratory stimulant; in the manufacture of carbonates; and to produce an inert atmosphere when an explosive or flammable hazard exists. The liquid is used in fire extinguishing equipment; in cylinders for inflating life rafts; in the manufacturing of dry ice, and as a refrigerant. Dry ice is used primarily as a refrigerant. Occupational exposure to carbon dioxide may also occur in any place where fermentation processes may deplete oxygen with the formation of carbon dioxide, e.g., in mines, silos, wells, vats, ships' holds, etc.

Incompatibilities: The substance decomposes on heating above 2000°C producing toxic carbon monoxide. Reacts violently with strong bases and alkali metals. Various metal dusts from chemically active metals, such as magnesium, zirconium, titanium, aluminum, chromium, and manganese are ignitable and explosive when suspended and heated in carbon dioxide.

Permissible Exposure Limits in Air

NIOSH IDLH = 40,000 ppm

OSHA PEL: 5000 ppm/9000 milligram per cubic meter TWA

NIOSH REL: 5000 ppm/9000 milligram per cubic meter TWA; 30,000 ppm/54,000 milligram per cubic meter STEL

ACGIH TLV[1]: 5000 ppm/9000 milligram per cubic meter TWA; 30,000 ppm/54,000 milligram per cubic meter STEL

DFG MAK: 5000 ppm/9100 milligram per cubic meter TWA; Peak Limitation Category II(2)

Australia: TWA 5000 ppm (9000 milligram per cubic meter); STEL 30000 ppm, 1993; Austria: MAK 5000 ppm (9000 mg. m^3), 1999; Belgium: TWA 5000 ppm (9000 milligram per cubic meter); STEL 30000 ppm, 1993; Denmark: TWA 5000 ppm (9000 milligram per cubic meter), 1999; Finland: TWA 5000 ppm (9000 milligram per cubic meter), 1999; Hungary: STEL 9000 milligram per cubic meter, 1993; Japan: 5000 ppm (9000 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 9000 milligram per cubic meter, 2003; Norway: TWA 5000 ppm (9000 milligram per cubic meter), 1999; the Philippines: TWA 5000 ppm (9000 milligram per cubic meter), 1993; Poland: MAC (TWA) 9000 milligram per cubic meter, MAC (STEL) 27000 milligram per cubic meter, 1999; Russia: TWA 5000 ppm, 1993; Sweden: NGV 5000 ppm (9000 milligram per cubic meter), KTV 10000 ppm (18000 milligram per cubic meter), 1999; Switzerland: MAK-W 5000 ppm (9000 milligram per cubic meter), 1999; Thailand: TWA 5000 ppm (9000 milligram per cubic meter), 1993; Turkey: TWA 5000 ppm (9000 milligram per cubic meter), 1993; United Kingdom: TWA 5000 ppm (9150 milligram per cubic meter); STEL 15000 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 30,000 ppm. States with guidelines or standards for CO_2 in ambient air are[60]: 150 milligram per cubic meter (Virginia) and 214 milligram per cubic meter (Nevada).

Determination in Air: Gas collection bag; none; GC/Thermal conductivity detector; IV NIOSH Analytical Method #6603. Collection in a bag followed by GC. See OSHA Analytical Method ID-172.

Routes of Entry: Inhalation of gas.

Harmful Effects and Symptoms

Short-Term Exposure: Inhalation of high concentrations of this gas may cause headache, shortness of breath; nausea, vomiting, dizziness, hyperventilation, and unconsciousness. Rapid evaporation of the liquid or skin contact with "dry ice" may cause frostbite. On loss of containment, this liquid evaporates very quickly causing supersaturation of the air with serious risk of suffocation when in confined areas. Carbon dioxide is a simple asphyxiant. Concentrations of 10% (100,000 ppm) can produce unconsciousness and death from oxygen deficiency. A concentration of 5% may produce shortness of breath and headache. Continuous exposure to 1.5% CO_2 may cause changes in some physiological processes. The concentration of carbon dioxide in the blood affects the rate of breathing.

Long-Term Exposure: Long-term exposure at levels between 5000 and 20,000 ppm of carbon dioxide can affect the acid−base balance, causing acidosis, and can affect calcium metabolism.

Points of Attack: Lungs, skin, cardiovascular system.

Medical Surveillance: Consider evaluation of body calcium and acid−base balance.

First Aid: If dry ice gets into the eyes, get medical attention. If this chemical contacts the skin, get medical attention for frostbite. If a person breathes in large amounts of this chemical, move the exposed person to fresh air at once and perform rescue breathing and CPR if heart action has stopped. Transfer promptly to a medical facility. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Carbon dioxide is a heavy gas and accumulates at low levels in depressions and along the floor. Generally, adequate ventilation will provide sufficient protection for the worker. Where concentrations are of a high order, supplied-air respirators are recommended.

Respirator Selection: *40,000 ppm:* Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd, Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* SCBAE (any appropriate escape-type, SCBA).

Storage: Check oxygen content prior to entering storage area. Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with carbon dioxide all handlers should be trained on its proper handling and storage. Carbon dioxide must be stored to avoid contact with chemically active metals (such as potassium, sodium, magnesium, and zinc) especially in combination with peroxides, since violent reactions occur. Protect containers from physical damage. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: Carbon dioxide (UN1013, UN2187), Hazard Class: 2.2; Labels: 2.2-Nonflammable compressed gas. Dry ice (UN1845), Hazard class 9 is considered a "miscellaneous hazardous material" and does not require a label. The gas and refrigerated liquid fall in Hazard Class 2.2 and there is no Packing Group; solid, dry ice falls in Hazard Class 9. Solid, dry ice carries the symbol "AW." The letter "A" restricts the application of requirements of this subchapter to materials offered or intended for transportation by aircraft, unless the material is a hazardous substance or a hazardous waste. The letter "W" restricts the application of requirements of this subchapter to materials offered or intended for transportation by vessel, unless the material is a hazardous substance or a hazardous waste. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: Inhalation hazard. If carbon dioxide gas is leaked, take the following steps. Restrict persons not wearing protective equipment from area of leak until clean-up is complete. Ventilate area of leak to disperse the gas. Stop flow of gas. If source of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air; repair leak or allow cylinder to empty. If carbon dioxide liquid or solid is spilled or leaked, take the following steps: restrict persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Ventilate the area of spill or leak.

Fire Extinguishing: Containers may explode in fire. Extinguish fire using an agent suitable for type of surrounding fire. Carbon dioxide itself does not burn. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBA that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Vent to atmosphere[22].

References

(31); (173); (101); (138); (100).

National Institute for Occupational Safety and Health (NIOSH), "Criteria for a Recommended Standard: Occupational Exposure to Carbon Dioxide", NIOSH Document Number 76-194, Cincinnati, OH (1976).

New York State Department of Health, *Chemical Fact Sheet* Carbon Dioxide, Albany, NY, Bureau of Toxic Substance Assessment (May 1986).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Carbon Dioxide, Trenton, NJ (October 2001).

Carbon Disulfide C:0470

Formula: CS_2

Synonyms: Carbon bisulfide; Carbon bisulfide; Carbon disulfide; Carbone (sufurede) (French); Carbon sulfide; Dithiocarbonic anhydride; Kohlendisulfid (schwefelkohlenstoff) (German); NCI-C04591; Schwefelkohlenstoff (German); Sulphocarbonic anhydride; Weeviltox

CAS Registry Number: 75-15-0

HSDB Number: 52

RTECS Number: FF6650000

UN/NA & ERG Number: UN1131/131

EC Number: 200-843-6 [*Annex I Index No.:* 006-003-00-3]

Regulatory Authority and Advisory Information

Department of Home land Security Screening Threshold Quantity (pounds): *Release hazard* 20,000

California Proposition 65 Chemical[102]: Developmental/Reproductive toxin (male, female) 7/1/1989.

Hazard Alert: Poison, Extremely flammable liquid, Dangerous inhalation hazard with poor warning properties, Reproductive toxin: possible risk of gene damage/impaired fertility; Suspected reprotoxic hazard, Environmental hazard.

Banned or Severely Restricted (in agriculture) (several countries) (UN)[13]

United States Environmental Protection Agency, TSCA Section 8(e) Risk Notification, 8EHQ-0393-8888

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); Accidental Release Prevention/Flammable Substances (Section 112 [r], Table 3), TQ = 20,000 lb (9080 kg)

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P022

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 3.8; Nonwastewater (mg/L), 4.8 TCLP

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8240 (5)

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 10, 000 lb (4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV.D.3.b, RQ: 100 lb (45.4 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as carbon bisulfide

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%. NPRI.

Hazard symbols, risk, & safety statements: Hazard symbol: F+, T; risk phrases: R12; R36/38; R45; R48/23; R51; R61; R62; R63; safety phrases: S1/2; S16; S33; S36/37; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Carbon disulfide is a highly refractive, flammable liquid; which, in pure form has a sweet odor and in commercial and reagent grades has a foul smell. It can be detected by odor at about 1 ppm but the sense of smell fatigues rapidly and, therefore, odor does not serve as a good warning property. Molecular weight = 76.13; specific gravity (H_2O:1) = 1.26; boiling point = 46.3°C; freezing/melting point = −110.8°C; vapor pressure = 279 mm Hg @ 25°C; flash point = −30°C; autoignition temperature = 90°C. The explosive limits are LEL: 1.3%; UEL: 50%. Hazard identification (based on NF PA-704 M Rating System): Health 3, flammability 4, reactivity 0. Slightly soluble in water; solubility = 0.3%.

Potential Exposure: Carbon disulfide is used in the manufacture of viscose rayon; ammonium salts; carbon tetrachloride; carbanilide, xantho genates; flotation agents; soil disinfectants; dyes; electronic vacuum tubes; optical glass; paints, enamels, paint removers; varnishes; varnish removers; tallow, textiles, explosives; rocket fuel; putty; preservatives, and rubber cement; as a solvent for phosphorus, sulfur, selenium, bromine, iodine; alkali cellulose; fats, waxes, lacquers, camphor, resins, and cold vulcanized rubber. It is also used in degreasing; chemical analysis; electroplating; grain fumigation; oil extraction; and drycleaning. It is widely used as a pesticide intermediate.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Also incompatible with chemically active metals (such as sodium, potassium, zinc), azides, organic amines, halogens. May explosively decompose on shock, friction, or concussion. May explode on heating. The substance may spontaneously ignite on contact with air and on contact with hot surfaces, producing toxic fumes of sulfur dioxide. Reacts violently with oxidants to produce oxides of sulfur and carbon monoxide, and causing fire and explosion hazard. Attacks some forms of plastic, rubber, and coating.

Permissible Exposure Limits in Air

NIOSH IDLH = 500 ppm

Conversion factor: 1 ppm = 3.11 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 20 ppm TWA; 30 ppm, Ceiling Concentration; 100 ppm [30 minutes maximum peak per 8-hour shift]

NIOSH REL: 1 ppm/3 milligram per cubic meter TWA; 10 ppm/30 milligram per cubic meter STEL [skin]

ACGIH TLV[1]: 1 ppm/3.13 milligram per cubic meter TWA [skin]; Not Classifiable as a Human carcinogen, BEI: 5 mg/g [2-Thiothiazolidine-4-carboxylic acid (TTCA)] creatinine in urine at end-of-shift

PAC* Ver. 29[138]

PAC-1: **13**$_{\mathbf{A}}$ ppm

PAC-2: **160**$_{\mathbf{A}}$ ppm

PAC-3: **480**$_{\mathbf{A}}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60-minute values.

DFG MAK: 5 ppm/16 milligram per cubic meter TWA; Peak Limitation II(2) [skin] Pregnancy Risk Group B; BAT: 4 mg/g [2-Thio-4-thiazolidine carboxylic acid (TTCA)] creatinine in urine at end-of-shift

Arab Republic of Egypt: TWA 10 ppm (30 milligram per cubic meter) [skin], 1993; Australia: TWA 10 ppm (30 milligram per cubic meter) [skin], 1993; Austria: MAK 10 ppm (30 milligram per cubic meter) [skin], 1999; Belgium: TWA 10 ppm (31 milligram per cubic meter) [skin], 1993; Denmark: TWA 5 ppm (15 milligram per cubic meter)

[skin], 1999; Finland: TWA 5 ppm (15 milligram per cubic meter) [skin], 1999; France: VME 10 ppm (30 milligram per cubic meter), VLE 25 ppm (75 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 30 milligram per cubic meter [skin], 2003; India: TWA 10 ppm (30 milligram per cubic meter) [skin], 1993; Japan: 10 ppm (31 milligram per cubic meter) [skin], 1999; Norway: TWA 5 ppm (15 milligram per cubic meter), 1999; the Philippines: TWA 20 ppm (60 milligram per cubic meter) [skin], 1993; Poland: MAC (TWA) 18 milligram per cubic meter, MAC (STEL) 30 milligram per cubic meter, 1999; Russia: TWA 10 ppm; STEL 1 milligram per cubic meter, 1993; Sweden: NGV 5 ppm (16 milligram per cubic meter), KTV 8 ppm (25 milligram per cubic meter) [skin], 1999; Thailand: TWA 20 ppm (60 milligram per cubic meter); STEL 30 ppm (90 milligram per cubic meter), 1993; Turkey: TWA 10 ppm (65 milligram per cubic meter) [skin], 1993; United Kingdom: TWA 10 ppm (32 milligram per cubic meter) [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 10 ppm [skin]. Russia[43] set a MAC of 1.0 milligram per cubic meter in work-place air, of 0.03 milligram per cubic meter in ambient residential air on a momentary basis, and 0.003 milligram per cubic meter in residential ambient air on a daily average basis. Several states have set guidelines or standards for carbon disulfide in ambient air[60] ranging from 60 μ/m^3 (Connecticut) to 100 μ/m^3 (New York) to 150 μ/m^3 (South Carolina) to 186 μ/m^3 (North Carolina) to 300 μ/m^3 (Florida and North Dakota) to 714 μ/m^3 (Nevada). The WHO[35] has recommended a TWA of 10 milligram per cubic meter for male workers, and a TWA of 3 milligram per cubic meter for women of fertile age.

Determination in Air: Adsorption on charcoal, workup with benzene, GC analysis per NIOSH Analytical Method #1600 and Method #3800[18].

Permissible Concentration in Water: State Drinking Water Guidelines: Arizona 830 μg/L; California 160 μg/L; Florida 350 μg/L; Maine 600 μg/L; Minnesota 700 μg/L. New Hampshire 70 μg/L; Wisconsin 1000 μg/L. EPA[32] has suggested a permissible ambient goal of 830 μg/L.

Determination in Water: Octanol–water coefficient: $\text{Log}\,K_{\text{ow}} = 1.8$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation of vapor which may be compounded by percutaneous absorption of liquid or vapor; ingestion, and skin and eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Carbon disulfide irritates the eyes, skin, and respiratory tract. Swallowing the liquid may cause aspiration into the lungs with the risk of chemical pneumonitis. This chemical may affect the central nervous system. In acute poisoning, early excitation of the central nervous system occurs, followed by depression with stupor, restlessness, and unconsciousness. If recovery occurs, the patient usually passes through the after-stage of narcosis, with nausea, vomiting, headache, etc. Also possible are motor disturbances of the bowel; anemia; disturbances of cardiac rhyth; loss of weight; polyuria and menstrual disorders. Severe chronic poisoning may also result in liver degeneration and jaundice. Exposure can cause a loss of consciousness. Exposure far above the PEL may result in death. The probable oral lethal dose for a human is between 0.5 and 5 g/kg or between 1 oz and 1 pt (or 1 lb) for a 70-kg (150 lb) person. In chronic exposures, the central nervous system is damaged and results in the disturbance of vision and sensory changes at the most common early symptoms. Lowest lethal dose for humans has been reported @ 14 mg/kg or 0.98 g for a 70-kg person. Alcoholics and those suffering from neuropsychic trouble are at special risk.

Long-Term Exposure: Repeated or prolonged contact with skin may cause skin allergy, dermatitis; increased cholesterol; artherosclerosis; high blood pressure; heart disease; and damage to the eyes; and other organs from its effects on arteries. Carbon disulfide may affect the central nervous system; resulting in severe neurobehavioral effects; polyneuritis, psychoses. Animal tests show that this substance possibly causes toxic effects upon human reproduction.

Points of Attack: The material affects the central nervous system; cardiovascular system; eyes, kidneys, liver, and skin.

Medical Surveillance: Preplacement and periodic medical examinations should be concerned especially with skin, eyes, central and peripheral nervous system; cardiovascular disease; as well as liver and kidney function. Electrocardiograms should be taken. CS_2, can be determined in expired air, blood, and urine. The iodine-azide test detects carbon disulfide metabolites in the urine, and it may indicate other sulfur compounds. Examination of the nervous system. NIOSH lists the following medical tests: blood urea nitrogen, electrocardiogram, expired air, ophthalmic examination; urine (chemical/metabolite)/sediment; liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Prevent skin contact. **8 hours** (more than 8 hours of resistance to breakthrough $>0.1\ \mu g/cm^2/min$): polyvinyl alcohol gloves; Viton gloves, suits; 4H and Silver Shield gloves; Barricade-coated suits; Responder suits, Trellchem HPS suits; Trychem 1000 suits;

4 hours (At least 4 but <8 hours of resistance to breakthrough >0.1 μg/cm^2/min): Teflon gloves, suits, boots. Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. NIOSH recommends the use of Viton and polyvinyl alcohol as protective material. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *10 ppm:* CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)]; or Sa (APF = 10) (any supplied-air respirator). *25 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOv (APF = 25) [any powered, APR with organic vapor cartridge(s)]. *50 ppm:* CcrFOv (APF = 50) [any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s)]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister]; or PaprTOv (APF = 50) [any powered, APR with a tight-fitting facepiece and organic vapor cartridge(s)]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *500 ppm:* Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8–10 m or a 1-hour fire wall from flammable or reactive materials. Prior to working with carbon disulfide all handlers should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN1131 Carbon disulfide, Hazard Class: 3; Labels: 3-Flammable liquid, 6.1-Poisonous materials.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. For small leaks, absorb on paper towels. Evaporate the spills in a safe place, such as a fume hood. Large quantities can be reclaimed or collected and atomized in a suitable combustion chamber equipped with an appropriate effluent gas-cleaning device. If Carbon disulfide is spilled in water, neutralize with agricultural lime, crushed limestone, or sodium bicarbonate. If dissolved, apply activated carbon at 10 times the spilled amount. Use mechanical dredges or lifts to remove immobilized masses of pollutants and precipitates. In case of a spill or leak from a drum or smaller container or a small leak from a tank, isolate 50 ft in all directions. In case of a large spill, first isolate 100 ft in all directions, then evacuate in a downwind direction an area 0.2 mi wide and 0.3 mi long. Do not touch spilled material; stop leak if you can do it without risk. Use water spray to reduce vapors. Wear positive pressure breathing apparatus and special protective clothing. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Note that the ignition temperature is dangerously low: 100°C. Vapors may be ignited by contact with ordinary light bulb; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur. If the vapor concentration exceeds 2% by volume or is unknown, self-contained breathing mask with full face should be used by all persons entering contaminated area to fight fires. Wear special protective clothing. Isolate for ½ mi in all directions if tank car or truck is involved in fire. Use dry chemical, carbon dioxide, or other inert gas extinguishers. Foam may be ineffective. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBA that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: This compound is a very flammable liquid which evaporates rapidly. It burns with a Blue flame to carbon dioxide (harmless) and sulfur dioxide. Sulfur dioxide has a strong suffocating odor; 1000 ppm in air is lethal to rats. The pure liquid presents an acute fire and explosion hazard. The following disposal procedure is suggested[22]: All equipment or contact surfaces should be grounded to avoid ignition by static charges. Absorb on vermiculite, sand, or ashes and cover with water. Transfer underwater in buckets to an open area. Ignite from a distance with an excelsior trail. If quantity is large, Carbon disulfide may be recovered by distillation and repackaged for use.

References

(102); (31); (173); (101); (138); (80); (100).

National Institute for Occupational Safety and Health (NIOSH), "Criteria for a Recommended Standard: Occupational Exposure to Carbon Disulfide", NIOSH Document Number 77-156, Cincinnati, OH (1977).

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United States Environmental Protection Agency, Chemical Hazard Information Profile: Carbon Disulfide, Washington, DC, Chemical Emergency Preparedness Program (October 31, 1985).

New York State Department of Health, *Chemical Fact Sheet* Carbon Disulfide, Bureau of Toxic Substance Assessment, Albany, NY (May 1986)

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Carbon Disulfide, Trenton, NJ (August 2001).

Carbon Monoxide C:0480

Formula: CO

Synonyms: Carbone (oxyde de) (French); Carbonic oxide; Carbon oxide (CO); Exhaust gas; Flue gas; Kohlenmonoxid (German); Monóxido de carbono (Spanish); Monóxido de carbono, comprimido (Spanish); Monoxyde de carbone (French); Monoxyde de carbone, comprimé (French) Oxyde de carbone (French)

CAS Registry Number: 630-08-0

HSDB Number: 903

RTECS Number: FG3500000

UN/NA & ERG Number: UN1016 (compressed)/119; NA9202 (cryogenic liquid)/168

EC Number: 211-128-3 [*Annex I Index No.:* 006-001-00-2]

Regulatory Authority and Advisory Information

California Proposition 65 Chemical[102]: Developmental/ Reproductive toxin 7/1/1989.

Hazard Alert: Poison inhalation hazard (gas), Extremely flammable gas, Toxic gas, Reproductive toxin: possible risk of gene damage/impaired fertility; Suspected reprotoxic hazard, Damage to organs (prolonged or repeated exposure).

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazard symbols, risk, & safety statements: Hazard symbol: F+, T; risk phrases: R12; R23; R48/23; R61; R62; R63; safety phrases: S53; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Carbon monoxide is a flammable, colorless, odorless, tasteless gas, partially soluble in water. Molecular weight = 28.01; specific gravity (H_2O:1) = 1.15; boiling point = ∼ −190°C; freezing/melting point = −205°C; relative vapor density (air = 1) = 0.97; vapor pressure = > 35 atm; flash point = −190°C; autoignition temperature = 605°C. The explosive limits are: LEL: 12.5%; UEL: 74.20%. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 4, reactivity 0. Soluble in water; solubility = 2% @ 20°C.

Potential Exposure: Carbon monoxide is used in metallurgy as a reducing agent, particularly in the Mond process for nickel; in organic synthesis, especially in the Fischer−Tropsch process for petroleum products, and in the oxo reaction; and in the manufacture of metal carbonyls. It is usually encountered in industry as a waste product of incomplete combustion of carbonaceous material (complete combustion produces CO_2). The major source of CO emission in the atmosphere is the gasoline-powered internal combustion engine. Special industrial processes which contribute significantly to CO emission are iron foundries, particularly the cupola; fluid catalytic crackers; fluid coking; and moving-bed catalytic crackers in thermal operations in carbon black plants; beehive coke ovens; basic oxygen furnaces, sintering of blast furnace feed in steel mills; and formaldehyde manufacture. There are numerous other operations in which a flame touches a surface that is cooler than the ignition temperature of the gaseous part of the flame where exposure to CO may occur, e.g., arc welding, automobile repair; traffic control; tunnel construction; firefighting; mines, use of explosives, etc.

Incompatibilities: Forms extremely explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. In the presence of finely dispersed metal powders the substance forms toxic and flammable carbonyls. May react vigorously with oxygen, acetylene, chlorine, fluorine, nitrous oxide.

Permissible Exposure Limits in Air

NIOSH IDLH = 1200 ppm

Conversion factor = 1 ppm = 1.15 milligram per cubic meter

OSHA PEL: 50 ppm/55 milligram per cubic meter TWA

NIOSH REL: 35 ppm/40 milligram per cubic meter TWA; 200 ppm/229 milligram per cubic meter, Ceiling Concentration

ACGIH TLV[1]: 25 ppm/29 milligram per cubic meter TWA; BEI: 3.5% carboxyhemoglobin (CO-Hb) in blood at end-of-shift; 20 ppm CO in end-exhaled air at end-of-shift.

PAC* Ver. 29[138]

PAC-1: 75 ppm

PAC-2: $\mathbf{83_A}$ ppm

PAC-3: $\mathbf{330_A}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60-minute values.

DFG MAK: 30 ppm/35 milligram per cubic meter TWA; Peak Limitation Category II(1); Pregnancy Risk Group B; BAT: 5% carboxyhemoglobin (CO-Hb) in blood at end-of-shift

Arab Republic of Egypt: TWA 50 ppm (55 milligram per cubic meter), 1993; Australia: TWA 50 ppm (55 milligram per cubic meter); STEL 400 ppm (440 milligram per cubic meter), 1993; Austria: MAK 30 ppm (33 milligram per cubic meter), 1999; Belgium: TWA 50 ppm (57 milligram per cubic meter); STEL 400 ppm (458 milligram per cubic meter), 1993; Denmark: TWA 35 ppm (40 milligram per cubic meter), 1999; Finland: TWA 30 ppm (34 milligram per cubic meter); STEL 75 ppm (86 milligram per cubic meter), 1999; France: VME 50 ppm (55 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 29 milligram per cubic meter, 2003; India: TWA 50 ppm (55 milligram per cubic meter); STEL 400 ppm (440 milligram per cubic meter), 1993; Japan: 50 ppm (57 milligram per cubic meter), 1999; Norway: TWA 35 ppm (40 milligram per cubic meter), 1999; the Philippines: TWA 50 ppm (55 milligram per cubic meter), 1993; Poland: MAC (TWA) 30 milligram per cubic meter, MAC (STEL) 180 milligram per cubic meter, 1999; Russia: TWA 50 ppm; STEL 20 milligram per cubic meter, 1993; Sweden: NGV 35 ppm (40 milligram per cubic meter), KTVSTEL 100 ppm (120 milligram per cubic meter), 1999; Switzerland: MAK-W 30 ppm (35 milligram per cubic meter), KZG-W 60 ppm (70 milligram per cubic meter), 1999; Thailand: TWA 50 ppm (55 milligram per cubic meter), 1993; Turkey: TWA 50 ppm (55 milligram per cubic meter), 1993; United Kingdom: LTEL 50 ppm (55 milligram per cubic meter); STEL 300 ppm, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 25 ppm. The former USSR-UNEP/IRPTC joint project[43] set a MAC in work-place air of 20 milligram per cubic meter and MAC values for ambient air in residential areas of 3 milligram per cubic meter on a momentary basis and 1 milligram per cubic meter on an average daily basis. Several states have set guidelines or standards for CO in ambient air[60] ranging from 10−40 μ/m^3 (Arizona) to 1310 μ/m^3 (Nevada) to 10,000 μ/m^3 (10 milligram per cubic meter) (Connecticut).

Determination in Air: NIOSH Analytical Method (IV) #6604, OSHA Analytical Methods ID-209 and ID-210.

Permissible Concentration in Water: No criteria set, but EPA[32] has suggested a permissible ambient level of 552 μg/L based on health effects.

Routes of Entry: Inhalation of gas.

Harmful Effects and Symptoms

Short-Term Exposure: Carbon monoxide may affect the blood, cardiovascular system, and central nervous system. Exposure at high levels may result in a loss of consciousness and death. Carbon monoxide combines with hemoglobin to form carboxyhemoglobin which interferes with the oxygen-carrying capacity of blood, resulting in a state of tissue hypoxia. The typical signs and symptoms of acute CO poisoning are headache, dizziness, drowsiness, vomiting, collapse, coma, and death. Initially the victim is pale; later the skin and mucous membranes may be cherry-red in color. Loss of consciousness occurs at about the 50% carboxyhemoglobin level. The amount of carboxyhemoglobin formed is dependent on concentration and duration of CO exposure; ambient temperature; health, and metabolism of the individual. The formation of carboxyhemoglobin is a reversible process. Recovery from acute poisoning usually occurs without sequelae unless tissue hypoxia was severe enough to result in brain cell degeneration. Carbon monoxide at low levels may initiate or enhance deleterious myocardial alterations in individuals with restricted coronary artery blood flow and decreased myocardial lactate production. Severe carbon monoxide poisoning has been reported to permanently damage the extrapyramidal system, including the basal ganglia.

Long-Term Exposure: Causes damage to organs through prolonged or repeated exposure. Carbon monoxide may affect the nervous system and the cardiovascular system, causing neurological and cardiac disorders. Suspected to cause reproductive effects, such as neurological problems; low birth weight; increased still births; and congenital heart problems. The DFG lists pregnancy risk to fetus probable.

Points of Attack: Central nervous system; lungs, blood, cardiovascular system.

Medical Surveillance: Preplacement and periodic medical examinations should give special attention to significant cardiovascular disease and any medical conditions which could be exacerbated by exposure to CO. Heavy smokers may be at greater risk. Methylene chloride exposure may also cause an increase of carboxyhemoglobin. Smokers usually have higher levels of carboxyhemoglobin than nonsmokers (often 5%−10% or more). Carboxyhemoglobin levels are reliable indicators of exposure and hazard. Carboxyhemoglobin should be tested within a few hours following exposure to the gas. EKG. Examination of the nervous system. Persons with heart disease should not be exposed to levels of CO above 35 ppm. Medical tests listed by NIOSH: whole blood (chemical/metabolite)/carboxyhemoglobin (end-of-shift, end of work-week), CBC; expired air (end-of-shift, end of work-week).

First Aid: *Gas:* Move victim to fresh air. Call emergency medical care. Apply artificial respiration if victim is not breathing. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; induce artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. In case of contact with liquefied gas, thaw frosted parts with lukewarm water. Keep victim warm and quiet. Keep victim under observation for 24 to 48 hours. Effects of contact or inhalation may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves.

Refrigerated liquid: Move victims to fresh air. Call emergency medical care. Apply artificial respiration if victim is not breathing. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. In case of contact with liquefied gas, thaw frosted parts with lukewarm water. Keep victim warm and quiet. Keep victim under observation. Effects of contact or inhalation may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves.

Personal Protective Methods: Under certain circumstances where carbon monoxide levels are not exceedingly high, gas masks with proper canisters can be used for short periods, but are not recommended. In areas with high concentrations, self-contained air apparatus is recommended.

Respirator Selection: NIOSH: *350 ppm:* Sa (APF = 10) (any supplied-air respirator). *875 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *1500 ppm:* GmFS *end of service life indicator (ESLI) required.* [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10, 000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS *end of service life indicator (ESLI) required.* [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Check oxygen content prior to entering storage area. Poison gas. (1) Color code—Blue: Health Hazard/ Poison: Store in a secure poison location. This gas is highly toxic. Even slight exposure to these gasses can cause death. Store outdoors in a secure, restricted area that containing warning signs. This area must be roofed and shaded with the cylinders stored off the ground and separated from all other products assigned to other hazard categories and radiant heat sources on nonwooden floors. If indoors, store in a well-ventilated areas in temperatures not to exceed 50°C. (2) Color code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Prior to working with Carbon monoxide all handlers should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Carbon monoxide must be stored to avoid contact with strong oxidizers, such as chlorine or chlorine dioxide, since violent reactions occur. Keep containers in a cool, well-ventilated area away from heat, flame, and sunlight. Metal containers involving the transfer of 5 gal or more of liquid carbon monoxide should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of carbon monoxide. Sources of ignition, such as smoking and open flames are prohibited where carbon monoxide is used, handled, or stored. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: UN1016 Carbon monoxide, compressed, Hazard class: 2.3; Labels: 2.3-Poisonous gas; 2.1-Flammable gas, Inhalation Hazard Zone D. NA9202 Carbon monoxide, refrigerated liquid (cryogenic liquid), Hazard class: 2.3; Labels: 2.3-Poisonous gas; 2.1-Flammable gas, Domestic (United States), Inhalation Hazard Zone D. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling:

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package) UN1016/UN9202

Carbon monoxide & Carbon monoxide, compressed

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 600/180
Then: Protect persons downwind (mi/km)
Day 0.8/1.2
Night 3.0/4.8

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit and to disperse the gas. Stop the flow of gas if it can be done safely. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place; and repair leak or allow cylinder to empty. Keep this chemical out of confined spaces, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This gas is under pressure; containers may rupture and explode when heated. This chemical is a flammable gas that can cause explosion. Use dry chemical extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBA that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed[22]. Carbon monoxide can also be recovered from gas mixtures as an alternative to disposal.

References

(102); (31); (173); (101); (138); (100).

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New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Carbon Monoxide, Trenton, NJ (May 2006).

Carbon Oxysulfide C:0490

Formula: COS

Synonyms: Carbon monoxide monosulfide; Carbon oxide sulfide; Carbon oxygen sulfide; Carbon oxygen sulfide; Carbon oxysulfide; Carbonyl sulfide-(32)S; Carbonyl sulfide; Oxycarbon sulfide; Oxycarbon sulfide; SCO; Sulfuro decarbonilo (Spanish)

CAS Registry Number: 463-58-1

HSDB Number: 6127

RTECS Number: FG6475000; FG6400000

UN/NA & ERG Number: UN2204/119

EC Number: 207-340-0

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (carbon oxysulfide); *Theft hazard* 500 (≥56.67% concentration) (carbonyl sulfide)

Hazard Alert: Poison inhalation hazard (gas), Extremely flammable gas, Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); Accidental Release Prevention/Flammable Substances (Section 112 [r], Table 3), TQ = 10,000 lb (4540 kg)

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 10,000 lb (4540 kg)

Superfund/EPCRA 40 CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: F+, Xn; risk phrases: R5; R12; R20; R21; R36/37/38; R50/53; safety phrases: S1; S7; S9; S16; S26; S33; S38; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Carbonyl sulfide is a colorless gas or cold liquid. Molecular weight = 60.08. Specific gravity (H_2O:1) = 2.46; boiling point = −50°C. freezing/melting point = −138.8°C; vapor pressure = 750 mmHg @ −50.4°C; flammable limits: LEL: 12%; UEL: 29%. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 4, reactivity 1.

Potential Exposure: Carbon oxysulfide is an excellent source of usable atomic sulfur, therefore, it can be used in various chemical syntheses, such as the production of episulfides, alkenylthiols, and vinylicthiols. It is also used to make viscose rayon. It is probable that the largest source of carbon oxysulfide is as a by-product from various organic syntheses and petrochemical processes. Carbon oxysulfide is always formed when carbon, oxygen, and sulfur, or their compounds, such as carbon monoxide; carbon disulfide, and sulfur dioxide, are brought together at high temperatures. Hence, carbon, oxysulfide is formed as an impurity in various types of manufactured gases and as a by-product in the manufacture of carbon disulfide. Carbon oxysulfide is also often present in refinery gases.

Incompatibilities: Carbon oxysulfide can form explosive mixture with air. Incompatible with strong bases. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

PAC* Ver. 29[138]

PAC-1: 15 ppm

PAC-2: $\mathbf{55_A}$ ppm

PAC-3: $\mathbf{150_A}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60-minute values.

Routes of Entry: Inhalation, absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Can cause irritation of the eyes, skin, and respiratory tract. Contact with the liquefied gas can cause frostbite. Inhalation can cause irritation, coughing, and sneezing. High exposure can cause salivation, nausea, vomiting, diarrhea, sweating, weakness, and muscle cramps. It may cause tachycardia or arrhythmia. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. COS is an irritant to the lungs and trachea. It depresses the central nervous system. It can be fatal by paralysis of the respiratory system[22]. The acute toxicity of carbon oxysulfide was examined by Japanese workers. Exposure of laboratory animals to this contaminant of coal gas and petroleum gas was associated with pathological changes in the brain, medulla oblongata; liver, kidney, and lung. When rats were placed in chambers containing 0.05% and 0.2% Carbon oxysulfide, death occurred in 10 and 0.5−1.0 hours, respectively.

Long-Term Exposure: High or repeated exposure may affect the nervous system causing headache, dizziness, and confusion with memory problems. May cause brain damage; reduced memory; inability to concentrate; and/or personality changes. COS can cause bronchitis with coughing, phlegm and/or shortness of breath.

Points of Attack: Lungs, brain, central nervous system.

Medical Surveillance: Evaluate the cerebellar, autonomic, and peripheral nervous systems. Brain functions. tests include: EKG, complete nervous system evaluation, chest X-ray following acute overexposure.

First Aid: *Gas:* Move victim to fresh air. Call emergency medical care. Apply artificial respiration if victim is not breathing. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; induce artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. In case of contact with liquefied gas, thaw frosted parts with lukewarm water. Keep victim warm and quiet. Keep victim under observation. Effects of contact or inhalation may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves.

Refrigerated liquid: Move victims to fresh air. Call emergency medical care. Apply artificial respiration if victim is not breathing. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. In case of contact with liquefied gas, thaw frosted parts with lukewarm water. Keep victim warm and quiet. Keep victim under observation. Effects of contact or inhalation may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. If frostbite has occurred, seek medical attention immediately; do NOT rub the affected areas or flush them with water. In order to prevent further tissue damage, do NOT attempt to remove frozen clothing from frostbitten areas. If frostbite has NOT occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear nonvented impact resistant goggles when working with gasses. When working with liquid, wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Wear rubber gloves and coveralls[24].

Respirator Selection: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode).

Storage: Check oxygen content prior to entering storage area. Poison gas. (1) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. This gas is highly toxic. Even slight exposure to these gasses can cause death. Store outdoors in a secure, restricted area that containing warning signs. This area must be roofed and shaded with the cylinders stored off the ground and separated from all other products assigned to other hazard categories and radiant heat sources on nonwooden floors. If indoors, store in a well-ventilated areas in temperatures not to exceed 50°C. (2) Color code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Prior to working with carbon oxysulfide all handlers should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Carbon oxysulfide must be stored to avoid contact with bases and strong oxidizers, since violent reactions occur. Keep containers in a cool, well-ventilated area away from heat, flame, and sunlight. Metal containers involving the transfer of 5 gal or more of liquid carbon oxysulfide should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of COS. Sources of ignition, such as smoking and open flames are prohibited where carbon oxysulfide is used, handled, or stored. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. The storage area for flammable toxic gases should have electrical equipment conforming to Article 500 of the National Electrical Code.

Shipping: UN2204 Carbonyl sulfide, Hazard Class: 2.3; Labels: 2.3-Poisonous gas, 2.1-Flammable gas, Inhalation Hazard Zone C. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling:

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.2/0.3

Large spills (From a large package or from many small packages)
First: Isolate in all directions (ft/m) 1000/300
Then: Protect persons downwind (mi/km)
Day 0.8/1.2
Night 2.2/3.5

Liquid: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit and allow to vaporize. Or, cover the spill with weak hypochlorite solution (up to 15%). After 12 hours, the produce may be neutralized and flushed to a sewer with abundant water. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Gas: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit and to disperse the gas. Stop the flow of gas if it can be done safely. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place; and repair leak or allow cylinder to empty. Keep this chemical out of confined spaces, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: COS is a flammable gas or liquid. Fire may restart after it has been extinguished. Thermal decomposition products may include hydrogen sulfide and sulfur oxides. This gas is under pressure; containers may rupture and explode when heated. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBA that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Dissolve in a combustible solvent, such as alcohol, benzene, etc. Burn in a furnace with afterburner and scrubber to remove SO_2[22].

References

(31); (173); (101); (138); (100).

National Institute for Occupational Safety and Health (NIOSH), Information Profiles on Potential Occupational Hazards-Ingle Chemicals: Carbon Oxysulfide, pp 34−38, Publ. No. TR79-607, Rockville, MD (December 1979).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Carbonyl Sulfide, Trenton NJ (May 2009).

Carbon Tetrabromide C:0500

Formula: CBr_4

Synonyms: Carbon bromide; Methane, tetrabromide; Methane, tetrabromo-; Tetrabromide methane; Tetrabromomethane

CAS Registry Number: 558-13-4

HSDB Number: 2032

RTECS Number: FG4725000

UN/NA & ERG Number: UN2516/151

EC Number: 209-189-6

Regulatory Authority and Advisory Information

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, N, Xi, Xn; risk phrases: R22; R26; R23/24/25; R36/37/38; R41; R50/53; safety phrases: S24; S26; S27; S36/37; S39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Carbon tetrabromide, is a colorless powder, white crystalline solid, or yellow-brown crystals. Slight odor. Molecular weight = 331.65; boiling point = 189.8°C; freezing/melting point = 90°C; vapor pressure = 40 mmHg @ 96.1°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 0, reactivity 0. Very slightly soluble in water; solubility = 0.02%.

Potential Exposure: CBr_4 is used in organic synthesis.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, lithium and hexacyclohexyldiilead, since violent reactions may occur.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 13.57 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: None

NIOSH REL: 0.1 ppm/1.4 milligram per cubic meter TWA; 0.3 ppm/4 milligram per cubic meter STEL

ACGIH TLV[1]: 0.1 ppm/1.4 milligram per cubic meter TWA; 0.3 ppm/4.1 milligram per cubic meter STEL

No PAC available.

Australia: TWA 0.1 ppm (1.4 milligram per cubic meter); STEL 0.3 ppm, 1993; Belgium: TWA 0.1 ppm (1.4 milligram per cubic meter); STEL 0.3 ppm, 1993; Denmark: TWA 0.1 ppm (1.4 milligram per cubic meter), 1999; Finland: TWA 0.1 ppm (1.4 milligram per cubic meter); STEL 0.4 ppm [skin], 1999; France: VME 0.1 ppm (1.4 milligram per cubic meter), 1999; Norway: TWA 0.1 ppm (1.4 milligram per cubic meter), 1999; Switzerland: MAK-W 0.1 ppm (1.4 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 1.4 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 0.3 ppm. Several states have set guidelines or standards for CBr_4 in ambient air[60] ranging from 14−40 μ/m^3 (North Dakota) to 20 μ/m^3 (Virginia) to 28 μ/m^3 (Connecticut) to 33 μ/m^3 (Nevada).

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: The material is a potent lachrymator even at low concentrations. Carbon tetrabromide is corrosive to the eyes and skin and may cause permanent damage. Inhalation can cause severe irritation of the respiratory tract. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. It can affect the nervous system; liver, and kidneys. Exposure to high concentrations may result in unconsciousness.

Long-Term Exposure: The substance may damage the liver and kidneys.

Points of Attack: Eyes, skin, respiratory system; liver, kidneys.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater) the following are recommended before beginning work and at regular times after that: Liver and kidney function tests. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. If symptoms develop or overexposure is suspected, the following may be useful: Liver and kidney function tests. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should Wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures over 0.1 ppm; Use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode. All respirators selected must be approved by NIOSH under the provisions of 42 CFR 84. The current listing of NIOSH-certified respirators can be found in the NIOSH/NPPTL Certified Equipment List, which is available on the NIOSH website.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with carbon tetrabromide all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers and other incompatible materials listed above.

Shipping: UN2516 Carbon tetrabromide, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. Absorb liquid containing Carbon Tetrabromide in vermiculite, dry sand; earth, or similar material. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible liquid. Thermal decomposition products may include hydrogen bromide and oxides of carbon. Use any agent suitable for surrounding fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBA that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Purify by distillation and return to suppliers.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Carbon Tetrabromide, Trenton, NJ (April 1998).

Carbon Tetrachloride C:0510

Formula: CCl_4

Synonyms: Benzinoform; Carbona; Carbon chloride; Carbon tet; ENT 4705; Fasciolin; Flukoids; Freon 10; Halon 104; Katharin; Methane tetrachloride; Methane, tetrachloro-; Necatorina; Necatorine; Perchloromethane; R10; Tetrachloormetan; Tetrachlorkohlenstoff, tetra (German); Tetrachlormethan (German); Tetrachlorocarbon; Tetrachloromethane; Tetrachlorure de carbone (French); Tetracloruro de carbono (Spanish); Tetrafinol; Tetraform; Tetrasol; Twawpit; UN1846; Univerm; Vermoestricid

CAS Registry Number: 56-23-5

HSDB Number: 53

RTECS Number: FG4900000

UN/NA & ERG Number: UN1846/151

EC Number: 200-262-8 [*Annex I Index No.:* 602-008-00-5]

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Animal Sufficient Evidence; Human, Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B[9]; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies.

California Proposition 65 Chemical[102]: Cancer 10/1/1987.

Hazard Alert: Poison, Possible risk of forming tumors, Reproductive toxin: possible risk of gene damage/impaired fertility; Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction), Environmental hazard. Listed for Tier 1 screening as an endocrine disruptor[88].

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); Stratospheric ozone protection (Title VI, Subpart A, Appendix A), Class I, Ozone Depletion Potential (ODP) = 1.1

United States National Primary Drinking Water Regulations: MCL = 0 mg/L; MCL 0.005 mg/L as carbon tetrachloride.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/1992); Toxic Pollutant (Section 401.15)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U211, D019

RCRA Toxicity Characteristic (Section 261.24), Maximum Concentration of Contaminants, regulatory level, 0.5 mg/L

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.057; Nonwastewater (mg/kg), 6.0

RCRA Maximum Concentration Limit for Ground Water Protection (Section 264.94): 8010 (1); 8240 (5)

Superfund/EPCRA 40 CFR302.4, Appendix A and Section IV.D.3.b, RQ: 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%. NPRI; CEPA Toxic Substance List

Mexico, Drinking water criteria, 0.004 mg/L.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R23/24/25; R40; R48/23; R59; R52/53; R62; R63; safety phrases: S1/2; S23; S36/37; S41; S45; S57; S59; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Carbon tetrachloride is a colorless, nonflammable liquid with a characteristic ethereal odor. The Odor Threshold is 0.52 mg/L in water and 140−548 ppm in air. Molecular weight = 153.84; boiling point = 76.5°C; freezing/melting point = −23°C; vapor pressure =

91 mmHg @ 20°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 0. Very slightly soluble in water; solubility = 0.05%.

Potential Exposure: Carbon tetrachloride, and organochlorine, is used as a solvent for oils, fats, lacquers, varnishes, rubber, waxes, and resins. Fluorocarbons are chemically synthesized from it. It is also used as an azeotropic drying agent for spark plugs; a dry-cleaning agent; a fire extinguishing agent; a fumigant, and an anthelmintic agent. The use of this solvent is widespread, and substitution of less toxic solvents when technically possible is recommended.

Incompatibilities: Oxidative decomposition on contact with hot surfaces, flames, or welding arcs. Carbon tetrachloride decomposes forming toxic phosgene fumes and hydrogen chloride. Decomposes violently (producing heat) on contact with chemically active metals, such as aluminum, barium, magnesium, potassium, sodium, fluorine gas, allyl alcohol, and other substances, causing fire and explosion hazard. Attacks copper, lead, and zinc. Attacks some coatings, plastics, and rubber. Becomes corrosive when in contact with water; corrosive to metals in the presence of moisture.

Permissible Exposure Limits in Air

NIOSH IDLH = 200 ppm

Conversion factor: 1 ppm = 6.29 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 10 ppm TWA; 25 ppm STEL; 200 ppm [5-minute maximum peak in any 3 hours] STEL

NIOSH REL: 2 ppm/12.6 milligram per cubic meter STEL [60-minute] STEL; Limit exposure to lowest feasible concentration. NIOSH considers this chemical to be a potential occupational carcinogen as defined by the OSHA carcinogen policy [29 CFR 1990]. *See NIOSH Pocket Guide*, Appendix A.

ACGIH TLV[1]: 5 ppm/31 milligram per cubic meter TWA; 10 ppm/63 milligram per cubic meter STEL [skin]; Suspected Human Carcinogen

PAC* Ver. 29[138]

PAC-1: 1.2 ppm

PAC-2: $\mathbf{13}_{\mathbf{A}}$ ppm

PAC-3: $\mathbf{340}_{\mathbf{A}}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60-minute values.

DFG MAK: 0.5 ppm/3.2 milligram per cubic meter TWA; Peak Limitation Category II(2) [skin]; Carcinogen Category 4; Pregnancy Risk Group C; BAT: 3.5 μg/L in blood end-of-shift

Arab Republic of Egypt: TWA 5 ppm (30 milligram per cubic meter) [skin], 1993; Australia: TWA 5 ppm (30 milligram per cubic meter) [skin], carcinogen, 1993; Austria: MAK 10 ppm (65 milligram per cubic meter) [skin], Suspected: carcinogen, 1999; Belgium: TWA 5 ppm (31 milligram per cubic meter) [skin], carcinogen, 1993; Denmark: TWA 2 ppm (13 milligram per cubic meter) [skin], 1999; Finland: TWA 5 ppm (31 milligram per cubic meter); STEL 10 ppm (63 milligram per cubic meter) [skin], carcinogen, 1999; France: VME 2 ppm (12 milligram per cubic meter), VLE 10 ppm (60 milligram per cubic meter), carcinogen, 1999; the Netherlands: MAC-TGG 3.2 milligram per cubic meter [skin], 2003; India: TWA 5 ppm (30 milligram per cubic meter) [skin], carcinogen, 1993; Japan: 5 ppm (31 milligram per cubic meter) [skin], 2B carcinogen, 1999; Norway: TWA 2 ppm (13 milligram per cubic meter), 1999; the Philippines: TWA 10 ppm (65 milligram per cubic meter) [skin], 1993; Poland: MAC (TWA) 20 milligram per cubic meter, MAC (STEL) 100 milligram per cubic meter, 1999; Russia: TWA 10 ppm; STEL 20 milligram per cubic meter, 1993; Sweden: NGV 2 ppm (13 milligram per cubic meter), KTV 3 ppm (19 milligram per cubic meter) [skin], carcinogen, 1999; Switzerland: MAK-W 5 ppm (30 milligram per cubic meter); STEL 10 ppm (60 milligram per cubic meter) [skin], 1999; Thailand: TWA 10 ppm; STEL 25 ppm, 1993; United Kingdom: TWA 2 ppm (13 milligram per cubic meter) [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 10 ppm [skin]. Several states have set guidelines or standards for CCl_4 in ambient air[60] ranging from 0 (North Dakota) to 0.03 μ/m^3 (Rhode Island) to 0.0667 μ/m^3 (Indiana) to 0.67 μ/m^3 (Massachusetts and North Carolina) to 72 μ/m^3 (Pennsylvania) to 100 μ/m^3 (New York) to 150 μ/m^3 (South Carolina) to 300 μ/m^3 (Connecticut and Virginia) to 714 μ/m^3 (Nevada).

Determination in Air: Charcoal adsorption followed by workup with CS_2 and analysis by GC; Use NIOSH Analytical Method # 1003 for Hydrocarbons, Chlorinated or OSHA Analytical Method 7, Organic Vapors.

Permissible Concentration in Water: Safe Drinking Water Act (47FR 9352): MCL, 0.005 mg/L; MCLG, zero. Federal Drinking Water Standards: EPA 5 μg/L; State Drinking Water Standards: California 0.5 μg/L; Florida 3 μg/L; New Jersey 2 μg/L; State Drinking Water Guidelines: Arizona 0.27 μg/L; Connecticut 5 μg/L; Maine 3 μg/L; Minnesota 3 μg/L.

Determination in Water: GC (EPA Method 601) or GC plus mass spectrometry (EPA Method 624). Octanol–water coefficient: Log K_{ow} (octanol/water partition coefficient) = 2.6.

Routes of Entry: Inhalation of vapor, percutaneous absorption, ingestion, skin, and eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Carbon tetrachloride irritates the eyes, causing redness.

Inhalation: Levels of 20 ppm may cause dizziness, headache, vomiting; visual disturbances; extreme fatigue; nose and throat irritation. Other symptoms may include restlessness, loss of balance, twitching, and tremors. Severe exposure can lead to liver, kidney, eye, and nerve damage that may be delayed after exposure; can cause breathing stoppage, coma, and death. 1000 ppm for an unspecified time has caused death. *Skin:* May cause irritation and redness; carbon tetrachloride is readily absorbed through the skin. Symptoms as listed above may occur through skin absorption even when vapor concentrations are below OSHA Standards. *Ingestion:* May cause severe abdominal pain with diarrhea, followed by symptoms described under inhalation. Death may occur by ingestion of as little as 1/2 teaspoon. Between 45 and 100 ppm, carbon tetrachloride may cause headache, drowsiness, fatigue, nausea, and vomiting. 100−300 ppm may cause additional effects of mental confusion; weight loss and sluggishness. Liver, kidney, eye, and nerve damage can result from more severe exposures. Coma and death may occur.

Long-Term Exposure: Repeated or prolonged skin contact may cause dermatitis. Carbon tetrachloride is a possible human carcinogen. Cancer site in animals: liver cancer.

Points of Attack: Central nervous system; eyes, lungs, liver, kidneys, skin.

Medical Surveillance: Preplacement and periodic examinations should include an evaluation of alcohol intake and appropriate tests for liver and kidney functions. Special attention should be given to the central and peripheral nervous system; the skin, and blood. Expired air and blood levels may be useful as indicators of exposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Prevent skin contact. **8 hours** (more than 8 hours of resistance to breakthrough $>0.1\ \mu g/cm^2/min$): polyvinyl alcohol gloves; Viton gloves, suits; 4H and Silver Shield gloves; Barricade-coated suits; Responder suits; **4 hours** (At least 4 but <8 hours of resistance to breakthrough $>0.1\ \mu g/cm^2/min$): Teflon gloves, suits, boots. Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 500) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with carbon tetrachloride all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Carbon tetrachloride must be stored to avoid contact with chemically active metals, such as sodium, potassium, and magnesium, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area. Always store pesticides in their original containers, complete with labels that list ingredients, directions for use, and first aid steps in case of accidental poisoning. Never store pesticides in cabinets with or near food, animal feed, or medical supplies. Do not store pesticides in places where flooding is possible or in places where they might spill or leak into wells, drains, ground water, or surface water[72]. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN1846 Carbon tetrachloride, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible liquid. Use any extinguishing agent suitable for surrounding fire. Thermal decomposition products may include phosgene and hydrogen chloride. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBA that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration, preferably after mixing with another combustible fuel; care must be exercised to assure complete combustion to prevent the formation of phosgene; an acid scrubber is necessary to remove the halo acids produced[22]. Recover and purify by distillation where possible.

References

(109); (102); (31); (173); (101); (138); (2); (203); (100).

National Institute for Occupational Safety and Health (NIOSH), *Criteria for a Recommended Standard: Occupational Exposure to Carbon Tetrachloride*, NIOSH Document Number 76-133, Cincinnati, OH (1976).

United States Environmental Protection Agency, Carbon Tetrachloride: Ambient Water Quality Criteria, Washington, DC (1980).

National Academy of Sciences, Chloroform, Carbon Tetrachloride and Other Halomethanes: An Environmental Assessment, Washington, DC (1978).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 2, 30−32 (1980) and 3, No. 5, 88−94 (1983).

United States Public Health Service, "Toxicological Profile for Carbon Tetrachloride," Atlanta, Georgia, agency for Toxic Substance and Disease Registry (December 1988).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Carbon Tetrachloride, Trenton, NJ (August 1998).

New York State Department of Health, *Chemical Fact Sheet: Carbon Tetrachloride*, Bureau of Toxic Substance Assessment, Albany, NY (January 1986 and Version 2).

Carbonyl Fluoride C:0520

Formula: CF_2O; COF_2

Synonyms: Carbon difluoride oxide; Carbon fluoride oxide; Carbonic difluoride; Carbon oxyfluoride; Carbonyl difluoride; Difluoroformaldehyde; Fluophosgene; Fluoroformyl fluoride; Fluorophosgene; Fluoruro de carbonilo (Spanish)

CAS Registry Number: 353-50-4

HSDB Number: 6010

RTECS Number: FG6125000

UN/NA & ERG Number: (PIH) UN2417/125

EC Number: 206-534-2

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Theft hazard* 45 (≥12.00% concentration)

Hazard Alert: Poison inhalation hazard: exposure can be lethal, Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated.

United States National Primary Drinking Water Regulations: MCLG = 4 mg[F]/L; MCL = 4 mg[F]/L; SMCL = 2.0 mg[F]/L, as Fluoride.

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U033

RCRA, 40C FR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 40 CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1000 lb (454 kg)

OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TPQ = 10,000 lb (4540 kg)

United States DOT 49CF R172.101, Inhalation Hazardous Chemical

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T+; risk phrases: R5; R8; R21; R22; R23/24/25; R34; safety phrases: S1; S3/7; S9; S33; S36/37/39; S38; S41; S45 (see Appendix 4).

Description: Carbonyl fluoride is colorless or light yellow, hygroscopic, compressed liquefied gas. Pungent, highly irritating and suffocating odor. Molecular weight = 66.01; specific gravity (H_2O:1) = 1.39 @ −114°C; boiling point = −83°C; freezing/melting point = −114°C; relative vapor density (air = 1) = 2.29; vapor pressure = 55.4 atm. Hazard identification (based on NFPA-704 M Rating System): Health 4, flammability 0, reactivity ₩. Reacts with water.

Potential Exposure: Carbonyl fluoride is a carboxy halide. The major source of exposure to COF_2 results from the thermal decomposition of fluoro carbon plastics, such as PTFE in air. Carbonyl fluoride is used for synthesizing fluoroalkanes, difluoroisocyanates, and fluorinated alkyl isocyanates. It may have been used as a military poison gas.

Incompatibilities: Reacts with water to form toxic and corrosive HF gas. HF gas is highly reactive and forms explosive hydrogen gas on contact with metals. Do not use cast iron or malleable fittings with carbonyl fluoride. Carbonyl fluoride decomposes on heating above 450°C producing toxic gases, including HF. Not compatible with hexafluoroisopropylidene-amino lithium; reaction may be dangerous.

Permissible Exposure Limits in Air

OSHA PEL: None

NIOSH REL: 2 ppm/5 milligram per cubic meter TWA; 5 ppm/15 milligram per cubic meter STEL

ACGIH TLV[1]: 2 ppm/5.4 milligram per cubic meter TWA; 5 ppm/13 milligram per cubic meter STEL

PAC* Ver. 29[138]

PAC-1: 0.025 ppm

PAC-2: $\mathbf{0.28_A}$ ppm

PAC-3: $\mathbf{0.83_A}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60-minute values.

Australia: TWA 2 ppm (5 milligram per cubic meter); STEL 5 ppm, 1993; Austria: MAK 2.5 mg[F]/m^3, 1999;

Denmark: TWA 2.99 m (6 milligram per cubic meter), 1999; Finland: STEL 2 ppm (5 milligram per cubic meter), 1999; France: VME 2 ppm (5 milligram per cubic meter), 1999; Norway: TWA 2 ppm (5 milligram per cubic meter), 1999; Poland: MAC (TWA) 1 mg(HF)/m^3, MAC (STEL) 3 mg(HF)/m^3, 1999; Switzerland: MAK-W 2 ppm (5 milligram per cubic meter), 1999; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 5 ppm. Several states have set guidelines or standards for COF_2 in ambient air[60] ranging from 50−150 μ/m^3 (North Dakota) to 100 μ/m^3 (Connecticut) to 119 μ/m^3 (Nevada).

Determination in Air: None available.

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guidelines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg [F]/L. Safe Drinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg[F]/L; SMCL = 2 mg/F/L, as Fluoride.

Routes of Entry: Inhalation, skin and/or eye contact. May be absorbed through the skin.

Harmful Effects and Symptoms

The compound decomposes in the body to HF[190].

Short-Term Exposure: The substance irritates the eyes, skin, and is corrosive to the respiratory tract. Exposure can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Rapid evaporation of the liquid may cause frostbite. On an acute basis, COF_2 is about as toxic as HF as a respiratory irritant gas. Carbonyl fluoride is rapidly hydrolyzed to hydro fluoric acid and carbon dioxide HF burns on skin or in eyes cause immediate redness, severe pain, possible swelling, and may lead to early necrosis. See entry for hydrogen fluoride: H:0450 Prompt medical attention is essential, if not mandatory.

Long-Term Exposure: The long-term effects are due to the fluoride ion generated by hydrolysis; this inhibits succinic dehydrogenase activity, since this is a fluoride-sensitive enzyme. May cause liver and kidney damage. Repeated exposure may cause bronchitis. Chronic exposure: gastrointestinal pain, muscle fibrosis, skeletal fluorosis (NIOSH).

Points of Attack: Eyes, skin, respiratory system; bone, liver, kidneys.

Medical Surveillance: Liver and kidney function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy. If frostbite has occurred, seek medical attention immediately; do NOT rub the affected areas or flush them with water. In order to prevent further tissue damage, do NOT attempt to remove frozen clothing from frostbitten areas. If frostbite has NOT occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear nonvented, impact resistant goggles when working with gas. Wear indirect-vent and splash-proof chemical goggles and face shield when working with liquid unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls, and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit. NIOSH: *(fluorides) 12.5 milligram per cubic meter*: Qm (APF = 25) (any quarter-mask respirator). *25 milligram per cubic meter:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or SA (APF = 10)* (any supplied-air respirator). *62.5 milligram per cubic meter:* Sa: Cf (APF = 25)* (any supplied-air respirator operated in a continuous-flow mode); or*$^+$ *if not present as a fume* PaprHie (APF = 25) (any powered, APR with a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *250 milligram per cubic meter:* Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp

(APF = 10,000) (any SCBA that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* HieF^{+} (any air-purifying, full facepiece respirator with a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA). *Substance reported to cause eye irritation or damage; may require eye protection. *May need acid gas sorbent.

Storage: Check oxygen content prior to entering storage area. Poison gas. (1) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. This gas is highly toxic. Even slight exposure to these gasses can cause death. Store outdoors in a secure, restricted area that containing warning signs. This area must be roofed and shaded with the cylinders stored off the ground and separated from all other products assigned to other hazard categories and radiant heat sources on nonwooden floors. If indoors, store in a well-ventilated areas in temperatures not to exceed 50°C. (2) Corrosive. Color code—White stripe: Contact Hazard; Store separately; not compatible with materials in solid white category. Storage area must be absolutely dry. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169 with the recommendations of the Compressed Gas Association.

Shipping: UN2417 Carbonyl fluoride, Hazard class: 2.3; Labels: 2.3-Poisonous gas, 8-Corrosive material, Inhalation Hazard Zone B. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling:

Carbonyl fluoride

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

carbonyl fluoride and carbonyl fluoride, compressed

First: Isolate in all directions (ft/m) 300/90
Then: Protect persons downwind (mi/km)
Day 0.4/0.6
Night 1.4/2.3

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 2000/600
Then: Protect persons downwind (mi/km)
Day 2.3/3.7
Night 5.0/8.0

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak to disperse the gas. Stop the flow of gas if it can be done safely. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place; and repair leak or allow cylinder to empty. *Do not use water or wet method.* Keep this chemical out of confined spaces, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include HF. This chemical may burn but does not readily ignite. This gas is under pressure; containers may rupture and explode when heated. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBA that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier.

References

(31); (173); (101); (138); (122).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Carbonyl Fluoride, Trenton, NJ (March 1999).

Carbophenothion C:0530

Formula: $C_{11}H_{16}ClO_2PS_3$; $(C_2H_5O)_2PSSCH_2SC_6H_4Cl$

Synonyms: Acarithion; Akarithion; *S*-[(*p*-Chlorophenylthio) methyl] *O,O*-diethyl phosphorodithioate; *S*-(4-Chlorophenylthio methyl) diethyl phosphoro thiolothionate; Dagadip; *O,O*-Diaethy-S-[(4-chlor- phenyl-thio)-methyl] dithiophosphat (German); *O,O*-Diethyl *S*-*p*-chlorophenylthio methyl dithiophosphate; *O,O*-Diethyl *S*-(*p*-chlorophenylthiomethyl) phosphorodithioate; *O,O*-Diethyldithiophosphoric acid, *p*-chlorophenylthiomethyl ester; *O*,*O*-Diethyl *p*-chlorophenylmercaptomethyl dithiophosphate; *O*,*O*-Diethyl 4-chlorophenylmercaptomethyl dithiophosphate; Dithiophosphatede *O*,*O*-diethyle et de (4-chlorophenyl) thiomethyle (French); Endyl; ENT 23, 708; Garrathion; Lethox; Nephocarb; Oleoakarithion; R-1303; Stauffer R-1303; Trithion miticide

CAS Registry Number: 786-19-6

HSDB Number: 958

RTECS Number: ID5250000

UN/NA & ERG Number: (PIH) UN3018 (organophosphorus pesticides, liquid, toxic)/152; UN2783 (organophosphorus pesticide, solid, n.o.s.)/152

EC Number: 212-324-1 [*Annex I Index No.:* 015-044-00-6]

Regulatory Authority and Advisory Information

Hazard Alert: Poison inhalation hazard, Neurotoxin (cumulative), Suspected reprotoxic hazard, Environmental hazard.

Banned or Severely Restricted (in agriculture) (India) (UN)[13]

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500 lb (227 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 500 lb (227 kg)

United States DOT Regulated Marine Pollutant (49CFR 172.101, Appendix B), severe pollutant

United States DOT 49CFR172.101, Inhalation Hazardous Chemical, as organic phosphate, Substance ID: EDF-041.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R24/25; R33; R50/53; safety phrases: S1/2; S28; S36/37; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)]

Description: Carbophenothion is a colorless to light amber liquid with a characteristic odor. Molecular weight = 342.87. Specific gravity (H_2O:1) = 1.3; boiling point = 82°C @ 0.01 mmHg; relative vapor density (air = 1) = 11.78. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 0.

Potential Exposure: Those engaged in the manufacture or application of this material, which is an insecticide and acaricide; primarily for citrus crops and deciduous fruits and nuts.

Incompatibilities: The substance decomposes on heating or on burning, producing toxic fumes including phosphorus oxides, sulfur oxides, hydrogen chloride. Contact with oxidizers may cause the release of phosphorous oxides. Contact with strong reducing agents, such as hydrides; may cause the formation of flammable and toxic phosphine gas.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 0.62 milligram per cubic meter

PAC-2: 6.8 milligram per cubic meter

PAC-3: 24 milligram per cubic meter

Permissible Concentration in Water: No criteria set.

Determination in Water: Octanol−water coefficient: Log K_{ow} (octanol/water partition coefficient) = 5.1

Routes of Entry: Inhalation, ingestion, and skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: The substance may affect the nervous system; resulting in convulsions and respiratory failure. Cholinesterase inhibitor. Exposure may result in death. Produces headaches, nausea, weakness, and dizziness. Symptoms may include nausea, vomiting; abdominal cramps; diarrhea; excessive salivation; headache, giddiness, weakness; muscle twitching; difficult breathing; blurring or dimness of vision; and loss of muscle coordination. Death may occur from failure of the respiratory center; paralysis of the respiratory muscles; intense broncho constriction, or all three. This material is highly toxic; the estimated fatal oral dose is 0.6 g for a 150-lb (70 kg) person. Oral LD_{50} for rats is 6.8 mg/kg.

Long-Term Exposure: Cholinesterase inhibitor; cumulative effect is possible: see acute hazards/symptoms. The state of Massachusetts lists this chemical as a neurotoxin.

Points of Attack: Respiratory system, lungs; central nervous system; cardiovascular system; skin, eyes, plasma, and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider CBC. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls, and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit. *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: UN3018 Organophosphorus pesticides, liquid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN 2783 Organophosphorus pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous material.

Spill Handling:

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.3/0.4
Night 0.8/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 600/200
Then: Protect persons downwind (mi/km)
Day 1.4/2.3
Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Do not touch spilled material. Do not breathe vapors. Stay upwind; keep out of low areas. Remove all ignition sources. Ventilate area of spill or leak. This material is a combustible liquid. For a spill or leak of a combustible liquid, shut off ignition sources; no flares, smoking, or flames in hazard area. Stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include hydrogen chloride and oxides of phosphorus, sulfur, nitrogen, and carbon. This material may burn, but does not ignite readily. *For small fires*: use dry chemicals, carbon dioxide; water spray; or foam. *For large fires*: use water spray, fog, or foam. Stay upwind; keep out of low areas. Move container from fire area if you can do it without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Wear positive pressure breathing apparatus and special protective clothing. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Container may explode in heat of fire. Fire and runoff from fire control water may produce irritating or poisonous gases. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBA that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Hydrolysis by hypochlorites may be used, as may incineration, In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (80); (100).

Sax, N.I., Ed., "*Dangerous Properties of Industrial Materials Report*," 2, No. 4, 55–59, New York, Van Nostrand Reinhold Co. (1982).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Carbophenothion, Washington, DC, Chemical Emergency Preparedness Program (October 31, 1985).

Carbosulfan C:0535

Formula: $C_{20}H_{32}N_2O_3S$

Synonyms: Advantage; Carbamic acid, [(dibutylamino) thio]methyl-, 2,3-dihydro-2,2-dimethyl-7-benzofuranyl ester; Carbamicacid, [(dibutylamino)thio] methyl-, 2,2-dimethyl-2,3-dihydro-7-benzofuranylester; [(Dibutylamino) thio]methylcarbamic acid, 2,2-dimethyl-2,3-dihydro-7-benzofuranyl ester; 2,2-Dihydro-2,2-dimethyl-7-benzofuranyl [(dibutylamino)thio]methylcarbamate; 2,3-Dihydro-2,2-dimethyl-7-benzofuranyl(di-*N*-butylaminosulfenyl)methylcarbamate; FMC 35001; Marshall Rallis (India); Posse

CAS Registry Number: 55285-14-8; (alt.) 73468-61-8

RTECS Number: EZ3815000

UN/NA & ERG Number: UN2992 (carbamate pesticides, liquid, toxic)/151*;* UN2810 (toxic liquid, organic, n.o.s.)/153

EC Number: 259-565-9

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Possible neurotoxic effects (methyl carbamate), Suspected of causing genetic defects, Sensitization hazard, Primary irritant (w/o allergic reaction), Environmental hazard, Agricultural chemical.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, Xi, N; risk phrases: R23/25; R26; R33; R36/37/38; R43; R50/53; R62; safety phrases: S1/2; S28, S29/35; S36/37, S38, S45, S60; S61, S63 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)]

Description: Orange-yellow thick liquid. Molecular weight = 380.59; boiling point = 219°C; flash point = 137°C. vapor pressure = low or no volatility. Low solubility in water.

Incompatibilities: Carbamates are incompatible with strong oxidizing acids, peroxides, and hydro-peroxides; strong reducing agents such as hydrides; strong acids and bases. Contact with nitrides or chemically active metals (aluminum, copper, magnesium, neptunium, sodium, tin, titanium, zinc, etc.) causes the release of potentially explosive hydrogen gas and a metal salt.

Potential Exposure: Carbosulfan is a carbamate insecticide and a low toxic derivative from cabofuran. It is a broad spectrum insecticide, nematicide, miticide, effective against pests and mites. It is used to protect alfalfa, apple, citrus, corn, deciduous fruit, potato, rice, sorghum, soybean, sugar beets, sugarcane, and other vegetable, field, tree and orchard crops. It is used for seed treatments

Permissible Concentration in Water: No criteria set. Runoff from spills or fire control may cause water pollution.

Determination in Water: Octanol–water coefficient: Log $K_{ow} = > 7$. Values at or above 3.0 are likely to bioaccumulate in marine organisms.

Routes of Entry: Skin absorption, ingestion, inhalation

Harmful Effects and Symptoms

Short-Term Exposure: Eye pupils are small; blurred vision; eye watering; runny nose; cough; shortness of breath; salivation; nausea, stomach cramps, diarrhea, and vomiting; increased blood pressure; profuse sweating; hypermotility, hallucinations; agitation; tingling of the skin; slow heartbeat; convulsions; fluid in lungs; loss of consciousness; incontinence; breathing stops; death. Carbamate insecticides inhibit the cholinesterase activity of enzymes, causing accumulation of acetylcholine at synapses and altering the way in which nervous impulses are transmitted. However, within several hours carbamates spontaneously detach from the enzymes. LD_{50} (oral, rat) = 51 mg/kg.

Long-Term Exposure: A potent acetylcholinesterase (AChE) inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, central nervous system, cardiovascular system, skin, eyes, plasma, and red blood cell cholinesterase.

Medical Surveillance: Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a drug or other inhalation therapy. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. Before employment and at regular times after that, the following are recommended: Plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1–2 weeks while red blood cell levels may be reduced for 1–3 months. When acetylcholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider CBC. Consider chest X-ray following acute overexposure

First Aid: Speed in removing material from eyes and skin is of extreme importance. *Eyes:* Eye contact can cause dangerous amounts of these chemicals to be quickly absorbed through the mucous membrane into the bloodstream. Immediately and gently flush eyes with plenty of warm or cold water (NO hot water) for at least 15 minutes, occasionally lifting the upper and lower eyelids. Get medical aid immediately. *Skin:* Get medical aid. Dermal contact can cause dangerous amounts of these chemicals to be absorbed into the bloodstream. Wearing the appropriate PPE equipment and respirator for carbamate pesticides, immediately flush skin with plenty of soap and water for at least 15 minutes while removing contaminated clothing and shoes. Shampoo hair promptly if contaminated; protect eyes. *Ingestion:* Call poison control. Loosen all clothing. Never give anything by mouth to an unconscious person. Get medical aid. Do NOT induce vomiting. * If conscious, alert, and able to swallow, rinse mouth and have victim drink 4 to 8 oz of water. Check to see if poison control instructs you to use ipecac syrup, otherwise administer slurry of activated charcoal (2 oz in 8 oz of water). If victim is *UNCONSCIO United States OR HAVING CONVULSIONS*, do nothing except keep victim warm. **In some cases you may be specifically instructed by poison control to induce vomiting by way of 2 tablespoons of syrup of ipecac (adult) washed down with a cup of water.* Do NOT give activated charcoal before or with ipecac syrup. *Inhalation:* Get medical aid. Do not contaminate yourself. Wearing the appropriate PPE equipment and respirator for carbamate pesticides, immediately remove the victim from the contaminated area to fresh air. If the victim is not breathing, administer artificial respiration. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. If breathing is difficult, administer oxygen through bag/mask apparatus until medical help arrives. Do not leave victim unattended. *Note to physician or authorized medical personnel.* Administer atropine, 2 mg (1/30 g) intramuscularly or intravenously as soon as any local or systemic signs or symptoms of an intoxication are noted; repeat the administration of atropine every 3 to 8 minutes until signs of atropinization (mydriasis, dry mouth, rapid pulse, hot and dry skin) occur; initiate treatment in children with 0.05 mg mg/kg of atropine; repeat at 5 to 10-minute intervals. Watch respiration, and remove bronchial secretions if they appear to be obstructing the airway; intubate if necessary. *Medical note:* 2-PAMCI may be contraindicated in the case of some carbamate poisonings.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of dermal contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. DuPont Tychem suit fabrics[101]. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000): (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive pressure breathing apparatus). *Escape*: GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison. Store in a secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong alkalis (such as Sodium Hydroxide, Sodium Bicarbonate, etc.).

Shipping: UN2992 Carbamate pesticides, liquid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials; UN2810 Toxic liquids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2810: Isolation Distance, Spill: 25 m/75 ft (NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. For solids, isolate spill or leak area in all directions for at least 25 m/75 ft. Increase, in the downwind direction, as necessary. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Stop leak if you can do it without risk. Prevent entry into waterways, sewers, basements, or confined areas. Cover with plastic sheet to prevent spreading. Absorb or cover with dry earth, sand, or other noncombustible material and transfer to containers. Do not allow water to get inside containers.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen, sulfur, and carbon. *On small fire*, use dry chemical powder, carbon dioxide, water spray, or foam. *On large fire*, use water spray, fog or regular alcohol-resistant foam. Do not scatter material using straight water jet streams. Dike fire control water for later disposal; do not scatter the material. Move containers from fire area if you can do it without risk. *If tank, rail car, or tank truck is involved in a fire*, isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Do not allow water to get inside containers. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. *Always* stay away from tanks engulfed in fire. For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn.

Disposal Method Suggested: Do not discharge into drains or sewers. Dispose of waste material as hazardous waste using a licensed disposal contractor to an approved landfill. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Incineration with effluent gas scrubbing is recommended[22]. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Noncombustible containers should be crushed and buried under more than 40 cm of soil[30]. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (101); (138); (204); (100).

Carboxin C:0540

Formula: $C_{12}H_{13}O_2NS$; $C_6H_2NHCO\text{-}C_5OSH_7$

Synonyms: Carbathiin; 5-Carboxanilido-2,3-dihydro-6-methyl-1,4-oxathiin; Carboxine; Carboxin oxathion pesticide; Caswell No. 165 A; D-735; DCMO; 2,3-Dihydro-5-carboxanilido-6-methyl-1,4-oxathiin; 2,3-Dihydro-6-methyl-1,4-oxathiin-5-carboxanilide; 5,6-Dihydro-2-methyl-1,4-oxathiin-3-carboxanilide; 2,3-Dihydro-6-methyl-5-phenylcarbamoyl-1,4-oxathiin; 5,6-Dihydro-2-methyl-*N*-phenyl-1,4-oxathiin-3-carboxamide; DMOC; EPA pesticide chemical code 090201; F-735; Flo ProV seed protectant; NSC 263492; 1,4-Oxathiin-3-carboxamide,5,6-dihydro-2-methyl-*N*-phenyl; 1,4-Oxathiin-3-carboxanilide,5,6-dihydro-2-methyl; 1,4-Oxathiin-3-carboxanilide,5,6-dihydro-2-methyl-; 1,4-Oxathiin-2,3-dihydro-5-carboxanilido-6-methyl; V 4X; Vitaflo; Vitavax; Vitavax 100; Vitavax 735d; Vitavax 75 PM; Vitavax 75W

CAS Registry Number: 5234-68-4

HSDB Number: 1532

RTECS Number: RP4550000

UN/NA & ERG Number: UN2588 (pesticides, solid, toxic, n.o.s.)/155

EC Number: 226-031-1

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Combustible, Suspected of causing genetic defects, Agricultural chemical.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: Xi, Xn; risk phrases: R20/21/22; R36/37/38; safety phrases: S26; S36; S41 (see Appendix 4).

Description: Carboxin is a white crystalline solid. Molecular weight = 235.32; freezing/melting point = 91.5−95°C (depending on crystal structure); vapor pressure = 1.78×10^{-7} mmHg. Practically insoluble in water; solubility = 25 mg/L; 0.15 g/L @20°C.

Potential Exposure: A potential danger to those involved in the production, Formulation and application of this systemic fungicide, seed protectant and wood preservative.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Avoid heat and humidity. Thermal decomposition products may include cyanide gas and cyanide salts.

Permissible Exposure Limits in Air

No standards or PAC available.

Permissible Concentration in Water: The no-observed-adverse-effect level has been determined by EPA to be 10 mg/kg body weight/day. This results in a long-term Health advisory: of 3.5 mg/L and a lifetime Health advisory: of 0.7 mg/L.

Determination in Water: Analysis of carboxin is by a GC method applicable to the determination of certain nitrogen-phosphorus containing pesticides in water samples. In this method, approximately 1 L of sample is extracted with methylene chloride. The extract is concentrated and the compounds are separated using capillary column GC. Measurement is made using a nitrogen phosphorus detector. The method detection limit has not been determined for carboxin, but it is estimated that detection limits for analyses included in this method are in the range of 0.1−2 μg/L. Fish toxicity (threshold)[77]: High—1.06008 ppb, MATC.

Harmful Effects and Symptoms

LD_{50} (oral-mouse) = 3550 mg/kg (slightly toxic). A value for LD_{50} rat of 430 mg/kg puts carboxin in the moderately toxic category.

Short-Term Exposure: Harmful if swallowed, inhaled, or absorbed by the skin or eyes.

Long-Term Exposure: Based on animal studies, carboxin may cause kidney damage. Human toxicity (long term)[77]: Extra high—0.91 ppb, Health advisory.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable

probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls, and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit. *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with carboxin all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: UN2588 Pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include cyanide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBA that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed[22].

References

(31); (173); (101); (138).

United States Environmental Protection Agency, “Health advisory: Carboxin,” Office of Drinking Water, Washington, DC, 8/(1987).

Carmustine C:0550

Formula: $C_5H_9Cl_2N_3O_2$

Synonyms: BCNU; BiCNU; Bis(chloroethyl) nitrosourea; 1,3-Bis(2-chloroethyl)-nitrosourea; Bischloroethyl nitrosourea; *N,N′*-Bis(2-chloroethyl)-*N*-nitrosourea; Carmubris; Carmustin; FDA 0345

CAS Registry Number: 154-93-8

HSDB Number: 7761 as 1,3-bis(2-chloroethyl)-nitrosourea

RTECS Number: YS2625000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154; UN3249 (medicine, solid, toxic, n.o.s.)/151

EC Number: 205-838-2

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen: Nitrosourea Chemotherapeutic Agents, bis(chloroethyl) nitrosourea; IARC: (BCNU) Animal Sufficient Evidence; Human, Limited Evidence, *probably carcinogenic to humans*, *probably carcinogenic to humans*, Group 2A, 1998

California Proposition 65 Chemical[102]: Cancer 7/1/1987; Developmental/Reproductive toxin 7/1/1990.

Hazard Alert: Poison, Possible risk of forming tumors, Reproductive toxin: Suspected of causing genetic defects, Drug, Hazard symbols, risk, & safety statements: Hazard symbol: T+; risk phrases: R45; R28; R60; R61; R62; safety phrases: S22; S36/37/39; S41; S45; S53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Carmustine is an orange-yellow crystalline solid or powder. Molecular weight = 114.1; freezing/melting point = 30−32°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 0, reactivity 0.

Potential Exposure: BCNU has been used since 1971 as an antineoplastic agent in the treatment of Hodgkin’s lymphoma; multiple meyloma; and primary or metastatic brain tumors. It also has been reported to have antiviral, antibacterial, and antifungal activity, but no evidence was found that it is used in these ways. BCNU is not known to be naturally occurring. Health professionals who handle this drug (for example, pharmacists, nurses, and physicians) may possibly be exposed to BCNU during drug preparation, administration, or cleanup; however, the risks can be avoided through use of containment equipment and proper work practices.

Incompatibilities: Acids and acid solutions above pH 7 cause rapid decomposition. Most stable at pH 4 in aqueous solution or petroleum ether[101].

Permissible Exposure Limits in Air

No standards or PAC available.

As a confirmed carcinogen, exposure must be kept to the lowest feasible level.

Harmful Effects and Symptoms

Short-Term Exposure: Symptoms include nausea, vomiting, diarrhea, dyspnea; flushing of the skin; esophagitis; cytotoxic effects on the liver, kidneys and central nervous system; delayed bone-marrow suppression (e.g., leukopenia and thrombocytopenia). LD_{50} (oral-rat) = 120 mg/kg (highly toxic).

Long-Term Exposure: Potential human carcinogen. May cause liver, kidney and nervous system damage.

Points of Attack: Liver, kidney, central nervous system; bone marrow.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure. Liver and kidney function tests. Examination of the nervous system.

First Aid: *Skin Contact:* Flood all areas of body that have contacted the substance with water. Don't wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others. *Eye Contact:* Remove any contact lenses at once. Immediately flush eyes well with copious quantities of water or normal saline for at least 20−30 minutes. Seek medical attention. *Inhalation:* Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing, or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion:* Contact a physician, hospital, or poison center at once. If the victim is unconscious or convulsing, do not induce vomiting or give anything by mouth. Assure that the patient's airway is open and lay him on his side with his head lower than his body and transport immediately to a medical facility. If conscious and not convulsing, give a glass of water to dilute the substance. Vomiting should not be induced without a physician's advice.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: When thresholds for carcinogens that would protect 100% of the population had not been identified, NIOSH usually recommended that occupational exposures to carcinogens be limited to the lowest feasible concentration. To ensure maximum protection from carcinogens through the use of respiratory protection, NIOSH also recommended that only the most reliable and protective respirators be used. *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter ck-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from acids[52]. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN3249 Medicine, solid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft (NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Dampen spilled material with 60%−70% ethanol to avoid airborne dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is

complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include hydrogen chloride and oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: It is inappropriate and possibly dangerous to the environment to dispose of expired or waste pharmaceuticals by flushing them down the toilet or discarding them to the trash. Household quantities of expired or waste pharmaceuticals may be mixed with wet cat litter or coffee grounds, double-bagged in plastic, discard in trash. Larger quantities shall carefully take into consideration applicable DEA, EPA, and FDA regulations. If possible return the pharmaceutical to the manufacturer for proper disposal being careful to properly label and securely package the material. Alternatively, the waste pharmaceutical shall be labeled, securely packaged and transported by a state licensed medical waste contractor to dispose by burial in a licensed hazardous or toxic waste landfill or incinerator.

References

(109); (102); (31); (173); (101); (138); (100).

Carvone C:0560

Formula: $C_{10}H_{14}O$

Synonyms: D-Carvone; δ-Carvone; dextro-Carvone; 1-6, 8(9)-*p*-Menthadien-2-one; δ-1-Methyl-4-isopropenyl-6-cyclohexen-2-one

CAS Registry Number: 2244-16-8

HSDB Number: 707

RTECS Number: OS8670000

UN/NA & ERG Number: UN2810 (toxic liquid, organic, n.o.s.)/153

EC Number: 218-827-2

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Flammable, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction).

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xi; risk phrases: R23/24/25; R61; R62; safety phrases: S24/25; S45.

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Carvone is a pale yellow to white clear liquid. Molecular weight = 150.22; boiling point = 230°C; flash point = 93°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 2, reactivity 0.

Potential Exposure: Carvone is found in various natural oils, including caraway and dillseed; mandarin peel and spearmint oils. A food additive, it is used in flavoring liqueurs; in perfumes and soaps.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

No standards or PAC available.

Routes of Entry: Ingestion and skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin, and respiratory tract. This material is highly toxic by ingestion skin absorption. LD_{50} (oral-rat) = 3.71 mg/kg.

First Aid: *Skin Contact:* Flood all areas of body that have contacted the substance with water. Don't wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others. *Eye contact:* Remove any contact lenses at once. Flush eyes well with copious quantities of water or normal saline for at least 20−30 minutes. Seek medical attention. *Inhalation:* Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to nay rescuers. If coughing, difficult breathing, or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion:* If convulsions are not present, give a glass or two of water or milk to dilute the substance. Assure that the person's airway is unobstructed and contact a hospital or poison center immediately for advice on whether or not to induce vomiting.

Storage: (1) Color code—Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. (2) Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Store in a cool, dry place, or in a refrigerator.

Shipping: UN2810 Toxic liquids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak

until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Follow by washing surfaces well first with alcohol, then with soap and water. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Carvone, Washington, DC, Chemical Emergency Preparedness Program (October 31, 1985).

Catechol C:0570

Formula: $C_6H_6O_2$: $C_6H_4(OH)_2$

Synonyms: Benzene, *o*-dihydroxy-; *o*-Benzenediol; 1,2-Benzenediol; Burmar Nophenol-922 HB; Catacol (Spanish); Catechin; C.I. 76500; C.I. Oxidation base 26; *o*-Dihydroxybenzene; 1,2-Dihydroxybenzene; *o*-Dioxybenzene; *o*-Diphenol; Durafur developer C; Fouramine PCH; Fourrine 68; *o*-Hydroquinone; *o*-Hydroxyphenol; 2-Hydroxyphenol; NCI-C55856; Oxyphenic acid; P-370; Pelagol gray C; *o*-Phenylenediol; Pyrocatechin; Pyrocatechine; Pyrocatechinic acid; Pyrocatechol; Pyrocatechuic acid

CAS Registry Number: 120-80-9

HSDB Number: 1436

RTECS Number: UX1050000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 204-427-5 [*Annex I Index No.:* 604-016-00-4]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Sufficient Evidence, Human No Adequate Data, *possibly carcinogenic to humans*, Group 2B, 1999.

California Proposition 65 Chemical[102]: Cancer 7/15/2003.

Hazard Alert: Poison, Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard.

Banned or Severely Restricted(In Cosmetics)[35], (Czech Republic)

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: Xn; risk phrases: R20/21/22; R36/38; R51; R62; R63; safety phrases: S2; S22; S26; S27; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Catechol is a white crystalline solid. Turns brown on contact with light and air. Molecular weight = 110.11; specific gravity (H_2O:1) = 1.344 @ 20°C; boiling point = 245.5°C; freezing/melting point = 104.6°C. It sublimes readily; vapor pressure = 10 mmHg@ 117°C; flash point = 127°C; autoignition temperature = 512°C. Explosive Limits in air: LEL: 1.4%; UEL-Unknown. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 1, reactivity 2. Solubility in water = 44%.

Potential Exposure: Used as a chemical intermediate; pharmaceutical and veterinary drug; as an antiseptic; in photography; in dyestuff manufacture and application. It is also used in electroplating, in the formulation of specialty inks; in antioxidants; and light stabilizers.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

OSHA PEL: None

NIOSH REL: 5 ppm/20 milligram per cubic meter TWA [skin]

ACGIH TLV[1]: 5 ppm/23 milligram per cubic meter TWA [skin]; confirmed animal carcinogen with unknown relevance to humans.

PAC Ver. 29[138]

PAC-1: 15 ppm
PAC-2: 96 ppm
PAC-3: 570 ppm
Australia: TWA 5 ppm (20 milligram per cubic meter), 1993; Austria: MAK 5 ppm (20 milligram per cubic meter), 1999; Belgium: TWA 5 ppm (23 milligram per cubic meter), 1993; Denmark: TWA 5 ppm (20 milligram per cubic meter), 1999; Finland: TWA 5 ppm (22 milligram per cubic meter); STEL 10 ppm (45 milligram per cubic meter), 1999; France: VME 5 ppm (20 milligram per cubic meter), 1999; Norway: TWA 5 ppm (20 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 20 milligram per cubic meter, 2003; Switzerland: MAK-W 5 ppm (23 milligram per cubic meter), 1999; United Kingdom: TWA 5 ppm (23 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Confirmed animal carcinogen with unknown relevance to humans. Several states have set guidelines or standards for catechol in ambient air[60] ranging from 200 μ/m^3 (North Dakota) to 350 μ/m^3 (Virginia) to 400 μ/m^3 (Connecticut) to 476 μ/m^3 (Nevada).

Determination in Air: None available.

Permissible Concentration in Water: EPA[32] has suggested a permissible ambient goal of 280 μg/L on a health basis. Russia set a MAC in surface water of 0.1 mg/L.

Determination in Water: Octanol–water coefficient: Log $K_{ow} = < 1$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Skin absorption, skin and eye contact, inhalation of vapors, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Catechol can affect you when breathed in. It can also rapidly enter the body through the skin. Death can occur from extensive skin contact. Lower exposures can cause skin burns, headaches, nausea, muscle twitching and convulsions. Skin allergy with rash can also occur. Catechol is a lacrimator. It irritates the respiratory and digestive tracts. It is corrosive to the eyes and can cause severe burns. The substance may affect the central nervous system; causing depression, convulsions, and respiratory failure. Because this is a potential mutagen, handle it as a possible cancer-causing substance, with extreme caution. Exposure lowers the ability of the blood to carry oxygen, causing a bluish color of the skin. Absorption through the skin results in illness akin to that which phenol produces except convulsions are more pronounced. Catechol increases blood pressure, apparently from peripheral vasoconstriction. Catechol can cause death, apparently initiated by respiratory failure. LD_{50}(rat-oral) = 260 mg/kg (moderately toxic).

Long-Term Exposure: Repeated or prolonged contact may cause skin sensitization and allergy. A mutagen that may have a cancer or reproductive risk. High or repeated damage may cause kidney and liver damage. Repeated lower exposures can cause methemoglobinemia, with blue color to the skin, rapid breathing, and dizziness.

Points of Attack: Eyes, skin, respiratory system; central nervous system; kidneys.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: tests for liver and kidney function. Blood methemoglobin level. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Note to Physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures *over 5* ppm; Use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece respirator with a high-efficiency particulate filter. Greater protection is provided by a PAPR. If while wearing a filter, cartridge or canister respirator, you can smell, taste, or otherwise detect 1,2-Dihydroxybenznene, or in the case of a full facepiece respirator you experience eye irritation, leave the area immediately. Check to make sure the respirator-to-face seal is still good. If it is, replace the filter, cartridge, or canister. If the seal is no longer good, you may need a new respirator.

Where there is potential for high exposures exists, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode. All respirators selected must be approved by NIOSH under the provisions of 42 CFR 84. The current listing of NIOSH-certified respirators can be found in the NIOSH/NPPTL Certified Equipment List, which is available on the NIOSH website.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with catechol all handlers should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers and acids. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN 2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft (NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Dampen spilled material with water to avoid dust or use a vacuum. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, alcohol foam, or carbon dioxide. Water and conventional foam may be ineffective[41]. Thermal decomposition products may include oxides of carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(102); (31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* 1,2-Dihydroxybenzene, Trenton, NJ (December 1999).

Cesium Hydroxide C:0580

Formula: CsHO; CsOH

Synonyms: Cesium hydroxide; Cesium hydrate; Cesium hydroxide dimer

CAS Registry Number: 21351-79-1

HSDB Number: 7906

RTECS Number: FK9800000

UN/NA & ERG Number: UN2682 (solid)/157; UN2681 (solution)/154

EC Number: 244-344-1

Regulatory Authority and Advisory Information

Hazard Alert: Primary irritant (w/o allergic reaction).

WGK[100] (German Aquatic Hazard Class): No value found. [1-Low hazard to water. (est.)]

Description: Cesium hydroxide is a colorless-to-yellow crystalline compound. It is often used in a water solution. Molecular weight = 142.91; specific gravity (H_2O:1) = 3.68; freezing/melting point = 315°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 0. Highly soluble in water; solubility 395% @ 15°C.

Potential Exposure: Cesium hydroxide may be used as a raw material for other cesium salts; such as the chloride which in turn may be used to produce cesium metal. Cesium metal is used in electronic devices.

Incompatibilities: Cesium hydroxide is the strongest base known. Keep away from all acids. It must be stored in silver or platinum and out of contact with air because of its reactivity with glass. CsOH causes the generation of considerable heat in contact with water or moisture. Contact with many organic compounds, many metals (i.e., aluminum, lead, tin, zinc), glass, oxygen, or carbon dioxide causes a violent reaction.

Permissible Exposure Limits in Air

OSHA PEL: None

NIOSH REL: 2 milligram per cubic meter TWA

ACGIH TLV[1]: 2 milligram per cubic meter TWA

PAC Ver. 29[138]

PAC-1: 6 milligram per cubic meter

PAC-2: 19 milligram per cubic meter

PAC-3: 110 milligram per cubic meter

Australia: TWA 2 milligram per cubic meter, 1993; Belgium: TWA 2 milligram per cubic meter, 1993;

Denmark: TWA 2 milligram per cubic meter, 1999; Finland: TWA 2 milligram per cubic meter, 1999; France: VME 2 milligram per cubic meter, 1999; Russia: STEL 0.3 milligram per cubic meter, 1993; the Netherlands: MAC-TGG 2 milligram per cubic meter, 2003; United Kingdom: TWA 2 milligram per cubic meter, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 2 milligram per cubic meter. Several states have set guidelines or standards for CsOH in ambient air[60] ranging from 20 μ/m^3 (North Dakota) to 35 μ/m^3 (Virginia) to 40 μ/m^3 (Connecticut) to 48 μ/m^3 (Nevada).

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Corrosive to eyes, skin, and respiratory tract. Effects may include severe pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. This chemical can cause permanent damage. LD_{50} (oral-rat) = 570 mg/kg (slightly toxic).

Long-Term Exposure: May cause lung irritation with the development of bronchitis, shortness of breath; coughing, phlegm.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater) the following are recommended before beginning work and at regular times after that. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: *Clothing:* Avoid skin contact with cesium hydroxide. Wear protective gloves and clothing. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. ACGIH recommended protective gloves be made of butyl rubber; natural rubber, nitrile rubber, Neoprene or polyvinyl chloride. *Eye Protection:* Wear dust-proof goggles and face shield when working with powders or dusts unless full facepiece respiratory protection is worn. Wear gas-proof goggles and face shield where cesium hydroxide is in solution, unless full facepiece respiratory protection is worn.

Respirator Selection: Where there is potential exists for exposures over 2 milligram per cubic meter, use a MSHA/NKIOSH approved full facepiece respirator equipped with a particulate (dust/fume/mist) filter. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode. All respirators selected must be approved by NIOSH under the provisions of 42 CFR 84. The current listing of NIOSH-certified respirators can be found in the NIOSH/NPPTL Certified Equipment List, which is available on the NIOSH website.

Storage: Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with cesium hydroxide all handlers should be trained on its proper handling and storage. Cesium hydroxide should be stored in silver or platinum away from air because it reacts violently with oxygen. Store in tightly closed containers in a cool, well-ventilated area away from moisture and incompatible materials listed above.

Shipping: UN2682 Cesium hydroxide, Hazard class: 8; Labels: 8-Corrosive material. UN2681 Cesium hydroxide, solution, Hazard class: 8; Labels: 8-Corrosive material.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. *Do not use water* in clean-up. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. *Do not use water*. Use dry chemical appropriate for extinguishing metal fires. Thermal decomposition products may include oxides metal of carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSH 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Cesium Hydroxide, Trenton, NJ (August 1998).

Chloral C:0590

Formula: C_2HCl_3O; CCl_3CHO

Synonyms: Acetaldehyde, trichloro-; Anhydrous chloral; Chloral, anhydrous, inhibited; Cloralio; Ethanal, trichloro-; Grasex; 2,2,2-Trichloroacetaldehyde; Trichloroacetaldehyde; Trichloroethanal; Tricloroacetaldehido (Spanish)

CAS Registry Number: 75-87-6 (chloral); 302-17-0 (chloral hydrate)

HSDB Number: 2557

RTECS Number: FM7870000 (chloral); FM8750000 (chloral hydrate)

UN/NA & ERG Number: UN2075 (chloral, anhydrous, inhibited); UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 200-911-5; 206-117-5 [*Annex I Index No.:* 605-014-00-6 (chloral hydrate)]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC (*chloral and chloral hydrate*): Animal, limited evidence; Human, inadequate evidence, *not classifiable as carcinogenic to humans*, Group 3, 1995; NCI: Carcinogenesis Studies (gavage); equivocal evidence: mouse, rat; EPA (*chloral hydrate*): Possible Human Carcinogen; (*oral*): Cannot be Determined.

Hazard Alert: Poison (chloral hydrate): Flammable, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard.

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U034, as chloral.

RCRA, 40CFR 261, Appendix 8 Hazardous Constituents, as chloral

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 5000 lb (2270 kg), as chloral.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. As chloral.

Hazard symbols, risk, & safety statements: Hazard symbol: T, F; (*chloral hydrate*) risk phrases: R10; R25; R36/38; R51; R61; R62; R63; safety phrases: S1/2; S25; S41; S45 (see Appendix 4).

WGK[100] (Germ an Aquatic Hazard Class): 2-Hazard to waters (*chloral hydrate*)

Description: Chloral is a combustible, oily liquid with a pungent irritating odor. Molecular weight = 147.39; specific gravity (H_2O:1) = 1.51 @ °20 C; boiling point = 97.8°C; freezing/melting point = −57.5°C; vapor pressure = 75 mmHg @ 33.8°C; flash point = 75°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 2, reactivity 1. Soluble in water. Chloral hydrate is colorless crystals, with characteristic odor. Molecular weight = 165.40; boiling point = 97°C (decomposes); freezing/melting point = 57−60°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 2, reactivity 1. Very soluble in water.

Potential Exposure: Chloral is used as an intermediate in the manufacture of such pesticides as DDT, methoxychlor, DDVP, naled, trichlorfon, and TCA. Chloral is also used in the production of chloral hydrate; used as a therapeutic agent with hypnotic, sedative, and narcotic effects; used in a time prior to the introduction of barbiturates.

Incompatibilities: Chloral hydrate reacts with strong bases forming chloroform. Contact with acids, or exposure to light may cause polymerization. Reacts with water, forming chloral hydrate. Reacts with oxidizers, with a risk of fire or explosions.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

75-87-6, chloral

PAC-1: 3.9 milligram per cubic meter

PAC-2: 43 milligram per cubic meter

PAC-3: 260 milligram per cubic meter

302-17-0, chloral hydrate

PAC-1: 2.5 milligram per cubic meter

PAC-2: 27 milligram per cubic meter

PAC-3: 95 milligram per cubic meter

Russia has recommended a maximum concentration in work-room air of 220 milligram per cubic meter.

Permissible Concentration in Water: There are no United States criteria but Russia has set 0.2 mg/L as the MAC for water bodies used for domestic purposes[43].

Determination in Water: Octanol−water coefficient: Log K_{ow} = < 1. Unlikely to bioaccumulate in marine organisms.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin, respiratory tract. Skin and eye contact may cause burns. Chloral may affect the central nervous system; kidneys, liver, and the cardiovascular system, causing impaired functions or damage. Exposure to high levels may cause tiredness, dizziness, lightheadedness, and loss of consciousness. Specific information on the pharmacokinetic behavior, carcinogenicity, mutagenitcity, teratogenicity, and other reproductive effects of chloral was not found in the available literature. However, the pharmacokinetic behavior of chloral may be similar to chloral hydrate, where metabolism to ritchloroethanol and trichloroacetic acid and excretion via the urine (and possibly bile) have been observed. Chloral hydrate produced skin tumors in 4 of 20 mice dermally exposed. Alcohol synergistically increases the depressant effect of the compound, creating a potent depressant commonly referred to as "Mickey Finn" or "knock-out drops." Addiction to chloral hydrate through intentional abuse of the compound has been reported.

Long-Term Exposure: Repeated skin contact may cause acne-like rash. Repeated contact may cause sedation. Chronic effects from respiratory exposure to chloral as indicated in laboratory animals include reduction of kidney function and serum transaminase activity; change in central nervous system function (unspecified); decrease in ant(toxic and enzyme-synthesizing function of the liver); and alteration of morphological characteristics of peripheral blood. Slowed growth rate, leukocytosis and changes in the arterial blood pressure were also observed.

Points of Attack: Inhalation, ingestion.

Medical Surveillance. Lung function tests. Serum trichloroethanol level.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Where there is potential for exposure to chloral:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with Chloral all handlers should be trained on its proper handling and storage. Protect from light, moisture, air, and acids. DEA regulations require storage in a locked storage area. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft (NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include hydrogen chloride. Use dry chemical, carbon dioxide; or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration after mixing with another combustible fuel; care must be taken to assure complete combustion to prevent phosgene formation; an acid scrubber is necessary to remove the halo acids produced.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chloral, Health and Environmental Effects Profile No. 34, Office of Solid Waste, Washington, DC (April 30, 1980).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Chloral, Trenton, NJ (April 2004).

Chloramben C:0600

Formula: $C_7H_5Cl_2NO_2$

Synonyms: ACP-M-728; Amben; Ambiben; Amiben; Amibin; 3-Amino-2,5-dichlorobenzoic acid; 3-Amino-2, 6-dichlorobenzoic acid; Amoben; Benzoic acid, 3-amino-2,5-dichloro-; Chlorambed; Chloramben, aromatic carboxylic acid; Chloramben benzoic acid herbicide; Chlorambene; 2,5-Dichloro-3-aminobenzoic acid; NCI-C00055; Ornamental weeder; Vegaben; Vegiben; Weedone garden weeder

CAS Registry Number: 133-90-4

HSDB Number: 564 as amiben

RTECS Number: DG1925000

UN/NA & ERG Number: UN2588 (Pesticides, solid, toxic, n.o.s.)/151

EC Number: 205-123-5

Regulatory Authority and Advisory Information

Carcinogenicity: NTP: Carcinogenesis Studies; positive evidence: mouse; NCI: Results negative, rat.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xn; risk phrases: R36/37/38; R34; R40; R45; R50; safety phrases: S22; S26; S36/37/39; S45; S53; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Chloramben is a colorless, odorless, crystalline solid. Molecular weight = 206.03; freezing/melting point = 200−201°C; vapor pressure = 6.8×10^{-3} mmHg @ 100°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 0. Soluble in water; solubility = 690 ppm @ 25°C.

Potential Exposure: A General Use Pesticide (GUP) that is no longer produced or sold in the United States. It is used as an herbicide for grasses, broadleaf weeds, soybeans, beans, and some vegetables. Workers involved in the manufacture, formulation, or application of this reemergence herbicide.

Incompatibilities: Rapidly decomposed by light. Strong acids and acid fumes.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 11 milligram per cubic meter

PAC-2: 120 milligram per cubic meter

PAC-3: 690 milligram per cubic meter

Russia set a MAC in ambient air in residential areas of 0.01 milligram per cubic meter on a momentary basis and 0.006 milligram per cubic meter on an average daily basis.

Pennsylvania[60] set a guideline for chloramben in ambient air of 1.3333 milligram per cubic meter.

Permissible Concentration in Water: The USSR[35] set a MAC of 0.5 mg/L in surface water. A lifetime Health advisory: of 0.105 mg/L has been determined by EPA (see "References" below).

Routes of Entry: Inhalation, passes through the skin.

Harmful Effects and Symptoms

The available data on Chloramben are very sparse. Much additional information is needed regarding its chronic toxicity, teratogenicity, and carcinogenicity before limits can be confidently set. No-observed-adverse-effect doses for chloramben were 15 mg/kg/day. Based on these data an ADI was calculated at 0.015 mg/kg/day. The LD_{50} rat is 3500 mg/kg (slightly toxic).

Short-Term Exposure: Skin or eye contact may cause irritation.

Long-Term Exposure: There is evidence that this chemical causes cancer in animals. It may cause cancer of the liver. Repeated exposure may cause skin rash with itching. Human toxicity (long term)[77]: Very low—100.00 ppb, Health advisory.

Points of Attack: Skin, liver.

Medical Surveillance: Liver function tests. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions,

including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: When thresholds for carcinogens that would protect 100% of the population had not been identified, NIOSH usually recommended that occupational exposures to carcinogens be limited to the lowest feasible concentration. To ensure maximum protection from carcinogens through the use of respiratory protection, NIOSH also recommended that only the most reliable and protective respirators be used. *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter ck-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with chloramben all handlers should be trained on its proper handling and storage. Store in a cool, dry place or a refrigerator, and avoid contact with strong acids; acid fumes and light. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2588 Pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide; water spray; or foam extinguishers. Thermal decomposition products may include toxic chloride fumes and nitrous oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Chloramben is stable to heat, oxidation, and hydrolysis in acidic or basic media. The stability is comparable to that of benzoic acid. Wet oxidation or incineration are recommended disposal methods[22].

References

(31); (173); (101); (138).

National Cancer Institute, Bioassay of Chloramben for Possible Carcinogenicity, Technical Report Series No. 25, Bethesda, Maryland (1977).

Sax, N.I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 3, 28–29, New York, Van Nostrand Reinhold Co. (1981). (As 3-Amino-2,5-dichlorobenzoic acid).

United States Environmental Protection Agency, Health advisory: Chloramben. Washington, DC, Office of Drinking Water (August 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Chloramben. Trenton, NJ (September 1998).

Chlorambucil C:0610

Formula: $C_{14}H_{19}Cl_2NO_2$: $(ClCH_2CH_2)_2N\text{-}C_6H_4\text{-}(CH_2)_3COOH$

Synonyms: Ambochlorin; Amboclorin; Benzenebutanoic acid, 4-[Bis(2-chloroethyl)amino]-; 4-[Bis(2-Chloro ethyl) amino]benzenebutanoic acid; γ-[*p*-bis(2-Chloroethyl)aminophenyl]butyric acid; 4-[bis(2-Chloroethyl)amino]-benzenebutanoic acid; 4-(*p*-[bis(2-Chloroethyl)amino]phenyl) butyric acid; 4-[*p*-bis(β-Chloroethyl)aminophenyl]butyric acid; CB 1348; Chloraminophene; Chloroambucil; Chloroaminophen; Chlorobutin; Chlorobutine; Clorambucil (Spanish); γ(*p*-Di-(2-chloroethyl)amino phenyl)butyric acid; *N*,*N*-Di-2-chloro ethyl-γ-*p*-amino phenylbutyric acid; *p*-(*N*,*N*-Di-2-chloroethyl)a minophenyl butyric acid; *p*-*N*,*N*-Di-(β-chloroethyl)aminophenylbutyric acid; Ecoril; Elcoril; Leukeran; Leukersan; Leukoran; Linfolizin; Linfolysin; NCI-CO3485; NSC-3088; Phenylbuyyric acid nitrogen mustard

CAS Registry Number: 305-03-3

HSDB Number: 3026

RTECS Number: ES7525000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 206-162-0

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen; IARC: Human, Sufficient Evidence; Animal, Sufficient Evidence, *carcinogenic to humans*, Group 1, 1998.

California Proposition 65 Chemical[102]: Cancer 2/27/1987; Developmental/Reproductive toxin 1/1/1989.

Hazard Alert: Poison, Combustible, Reproductive toxin, Drug.

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U035

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg)

Hazard symbols, risk, & safety statements: Hazard symbol: T; risk phrases: R25; R36/37/38; R45; R50/53; safety phrases: S13; S26; S45; S53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Chlorambucil is a crystalline solid. Molecular weight = 304.24; freezing/melting point = 64−66°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 1, reactivity 0. Insoluble in water.

Potential Exposure: Chlorambucil, an anticancer drug, is a derivative of nitrogen mustard. This drug is primarily used as an antineoplastic agent for treating lymphocytic leukemia; malignant lymphomas; follicular lymphoma; and Hodgkin's disease. The treatments are not curative but do produce some marked remissions. Chlorambucil has also been tested for treatment of chronic hepatitis, rheumatoid arthritis; and as an insect chemosterilant. All of the chemical used in this country is imported from the United Kingdom. Work exposure in the United States would be limited to workers formulating the tablets, or to those patients receiving the drug.

Incompatibilities: Moisture. Chlorambucil is an alkylating agent. Reacts with proteins and a variety of nucleophilic compounds[101]. Compounds of the carboxyl group react with all bases, both inorganic and organic (i.e., amines) releasing substantial heat, water, and a salt that may be harmful. Incompatible with arsenic compounds (releases hydrogen cyanide gas), diazo compounds, dithiocarbamates, isocyanates, mercaptans, nitrides, sulfides (releasing heat, toxic, and possibly flammable gases), thiosulfates, and dithionites (releasing hydrogen sulfate and oxides of sulfur).

Permissible Exposure Limits in Air

No standards or PAC available.

Harmful Effects and Symptoms

Short-Term Exposure: Chlorambucil irritates the eyes, and respiratory tract. Exposure can cause dizziness; loss of coordination; numbness, weakness; muscle twitching; convulsions and unconsciousness. Symptoms of exposure to this compound include leukemia, dyspnea, cough, interstitial fibrosis, and menstrual cycle changes or disorders. It may cause keratitis epithelialis in association with exfoliative dermatitis and reversible *pseudotumor cerebri* with papilledema. It may also cause vomiting, lethargy, and unconsciousness with grand mal seizures. Other symptoms include convulsions, infertility, reversible and permanent sterility, lymphopenia, neutropenia, bone marrow suppression, gastrointestinal disturbances such as nausea, diarrhea and oral ulceration, hepatotoxicity, jaundice, drug fever, skin hypersensitivity, peripheral neuropathy, sterile cystitis, fibrosis, vasculitis and depletion of primordial follicles, skin rash, bleeding, unusual lumps, agitated behavior, and ataxia. LD_{50} (oral-rat) = 76 mg/kg (moderately toxic)[101].

Long-Term Exposure: This chemical is a carcinogen in humans. It has been shown to cause lung cancer and leukemia. It is a probable teratogen in humans and may damage the testes in males and decrease fertility in females. Causes nausea and vomiting and CNS excitation in humans. It may cause hyperuricemia, which may lead to acute renal failure, reversible pancytopenia, sideroblastic anemia, and myeloblastic leukemia. Exposure may cause erythroleukemia, reticulum-cell sarcoma, lymphosarcoma, myelosuppression, viral, fungal and bacterial infections, chromosomal damage and oligospermia, azoospermia, and disappearance of testicular germinal cells in males. It may cause irreversible bone marrow depression, central nervous excitation, and jerky movements. It may also cause thrombocytopenia, leucopenia and hemorrhage of the skin and mucous membranes. Other symptoms of exposure include coma, irritation to the skin and mucous membranes, lymphocytopenia, cutaneous pigmentation, adrenal cortical insufficiency, and neurotoxicity. It may cause amenorrhea and dermatitis. When administered to a pregnant woman, the offspring may develop unilateral renal agenesis. It may be injurious to the developing retina[101].

Points of Attack: Lung, kidney, liver, blood.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure. Liver and kidney function tests, lung function tests, CBC.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear or dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Based on potential carcinogenicity the following is recommended by NIOSH: *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with chlorambucil all handlers should be trained on its proper handling and storage. Store in cool, dry place. Store in sealed ampules or in amber screw-capped bottles or vials with Teflon cap liners. Solutions may be stored in bottles or vials with a silicone system having a Teflon liner and sampled with needle and syringe. Prevent exposure to light. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: *Isolation Distance, Spill*: 25 m/75 ft (NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. (When used as a weapon) As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 m/150 ft for liquids and at least 25 m/75 ft for solids. Increase, in the downwind direction, as necessary, the isolation distance shown above. Eliminate all ignition sources (no smoking, flares, sparks, or flames in immediate area). Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Stop leak if you can do it without risk. Prevent entry into waterways, sewers, basements, or confined areas. Absorb or cover with dry earth, sand, or other noncombustible material and transfer to containers. Do not get water inside containers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Thermal decomposition products may include hydrogen chloride and oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: It is inappropriate and possibly dangerous to the environment to dispose of expired or waste drugs and pharmaceuticals by flushing them down the toilet or discarding them to the trash. Household quantities of expired or waste pharmaceuticals may be mixed with wet cat litter or coffee grounds, double-bagged in plastic, discard in trash. Larger quantities shall carefully take into consideration applicable DEA, EPA, and FDA regulations. If possible return the pharmaceutical to the manufacturer for proper disposal being careful to properly label and securely package the material. Alternatively, the waste pharmaceutical shall be labeled, securely packaged, and transported by a state licensed medical waste contractor to dispose by burial in a licensed hazardous or toxic waste landfill or incinerator. Permanganate oxidation, high temperature incineration with scrubbing equipment, or microwave plasma treatment.

References

(109); (101); (102); (31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Chlorambucil, Trenton, NJ (April 1999).

Sax, N. I., Ed., “Dangerous Properties of Industrial Materials Report,” 1, No. 4, 43−44 (1981) and 5, No. 1, 49−53 (1985).

Chloramphenicol C:0620

Formula: $C_{11}H_{12}Cl_2N_2O_5$; $O_2NC_6H_4CHOHCH(NHCOCHCl_2)CH_2OH$

Synonyms: Acetamide, 2,2-dichloro-*N*-(β-hydroxy-α-(hydroxymethyl)-*p*-nitrophenethyl)-, δ-(−)-Threo-; Acetamide, 2,2-dichloro-*N*-[2-hydroxy-1-(hydroxymethyl)-2-(4-nitrophenyl)ethyl]-; Acetamide, 2,2-dichloro-*N*-2-hydroxy-1-(hydroxymethyl)-2-(4-nitrophenyl)ethyl-, R-(R*, R*)-; Alficetyn; Ambofen; Amphenicol; Amphicol; Amseclor; Aquamycetin; Austracil; Austracol; Biocetin; Biophenicol; CAF; CAM; CAP; Catilan; Chemicetin; Chemicetina; Chlomin; Chlomycol; Chloramex; D-Chloramp henicol; Chloramsaar; Chlorasol; Chlora-tabs; Chloricol; Chloro-25 Vetag; Chlorocaps; Chlorocid; Chlorocide; Chlorocidin C; Chlorocidin C Tetran; Chlorocol; Chloromycetin; Chloromycetin R; Chloronitrin; Chloroptic; Cidocetine; Ciplamycetin; Cloramficin; Cloramicol; Cloramidina; Clorocyn; Cloromisan; Clorosintex; Comycetin; CPH; Cylphenicol; Desphen; Detreomycine; Dextromycetin; Doctamicina; D-Threochloramphenicol; D-Threo-*N*-dichloroacetyl-1-*p*-nitrophenyl-2-amino-1,3-propanediol; D-Threo-*N*-(1,1′-dihydroxy-1-*p*-nitrophenylisopropyl)dichloroacetamide; D-Threo-1-(*p*-nitrophenyl)-2-(dichloroacetylamino)-1,3-propanediol; Econochlor; Embacetin; Emetren; Enicol; Enteromycetin; Erbaplast; Ertilen; Farmicetina; Fenicol; Globenicol; Glorous; Halomycetin; Hortfenicol; I337A; Intramycetin; Isicetin; Ismicetina; Isophenicol; Isoptofenicol; Juvamycetin; Kamaver; Kemicetina; Kemicetine; Klorita; Klorocid S; Leukomyan; Leukomycin; Levomicetina; Levomycetin; Loromisan; Loromisin; Mastiphen; Mediamycetine; Micloretin; Micochlorine; Micoclorina; Microcetina; Mychel; Mycinol; NCI-C55709; Normimycin V; Novochlorocap; Novomycetin; Novophenicol; NSC 3069; Oftalent; Oleomycetin; Opclor; Opelor; Ophthochlor; Ophtochlor; Otachron; Otophen; Pantovernil; Paraxin; Pentamycetin; Quemicetina; Rivomycin; Romphenil; Septicol; Sificetina; Sintomicetina; Sintomicetine R; Stanomycetin; Synthomycetin; Synthomycetine; Synthomycine; Tevcocin; Tevcosin; D-(−)-Threochloramphenicol; D-(−)-Threo-2-dichloroacetamido-1-*p*-nitrophenyl-1,3-propanediol; D-(−)-Threo-2,2-dichloro-*N*-[b-hydroxy-α-(hydroxymethyl)]-*p*-nitrophenethylacetamide; D-(−)-Threo-1-*p*-nitrophenyl-2-dichloracetamido-1,3-propanediol; Tifomycin; Tifomycine; Treomicetina; U-6062; Unimycetin; Veticol

CAS Registry Number: 56-75-7

HSDB Number: 3027

RTECS Number: AB6825000

UN/NA & ERG Number: UN3249 (Medicine, solid, toxic, n.o.s.)/151: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 200-287-4

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC[9]: Human, Limited evidence, animal Inadequate Evidence, *probably carcinogenic to humans*, Group 2A, 1990

California Proposition 65 Chemical[102]: Cancer *delisted 1/4/2013*

Hazard Alert: Poison, Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard.

Banned or Severely Restricted (Medical Uses Restricted) (UN)[13]

Hazard symbols, risk, & safety statements: Hazard symbol: T; risk phrases: R45; R51; R62; R63; safety phrases: S29; S45; S53; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Chloramphenicol is a white to grayish-white or yellowish-white crystalline solid. Molecular weight = 323.13; freezing/melting point = 151°C; vapor pressure = 1.7×10^{-13} mmHg @ 25°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 0. Slightly soluble in water.

Potential Exposure: An antibiotic derived from *streptomyces venezuelae*. A potential danger to those involved in the manufacture, formulation, and application of this antibiotic and antifungal agent.

Incompatibilities: Compounds of the carboxyl group react with all bases, both inorganic and organic (i.e., amines), releasing substantial heat, water, and a salt that may be harmful. Incompatible with arsenic compounds (releases hydrogen cyanide gas), diazo compounds, dithiocarbamates, isocyanates, mercaptans, nitrides, sulfides (releasing heat, toxic, and possibly flammable gases), thiosulfates, and dithionites (releasing hydrogen sulfate and oxides of sulfur).

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 1.5 milligram per cubic meter

PAC-2: 10 milligram per cubic meter

PAC-3: 500 milligram per cubic meter

The FDA has set standards for *Good Manufacturing Practices for Drugs and Pharmaceuticals*. These should be followed for personal protection as well as product quality. See the FDA regulation 21 CFR 210. Also, there may be no safe level of exposure to a carcinogen, so all contact should be reduced to the lowest possible level. It should be recognized that this chemical can be absorbed through the skin, thereby increasing exposure.

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Chloramphenicol can affect you when breathed in and by passing through your skin. Skin or eye contact can cause irritation. Exposure can damage the bone marrow's ability to make blood cells and/or platelets (for blood clotting). This can lead to severe illness or death.

Long-Term Exposure: High or repeated exposure can damage the liver. Effects on the nervous system may also occur, such as numbness and tingling in the fingers or toes and blurred vision. Chloramphenicol is a carcinogen, mutagen, and teratogen. LD_{50} (oral-rat) = 2500 mg/kg (slightly toxic).

Points of Attack: Liver, nervous system; blood.

Medical Surveillance: Before beginning employment and monthly after that, the following is recommended: CBC with platelet count. If symptoms develop or overexposure is suspected, the following may be useful: liver function tests; exam of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: When thresholds for carcinogens that would protect 100% of the population had not been identified, NIOSH usually recommended that occupational exposures to carcinogens be limited to the lowest feasible concentration. To ensure maximum protection from carcinogens through the use of respiratory protection, NIOSH also recommended that only the most reliable and protective respirators be used. *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter ck-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with Chloramphenicol all handlers should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: UN3249 Medicine, solid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: *Isolation Distance, Spill*: 25 m/75 ft (NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide; water spray; or foam extinguishers. Thermal decomposition products may include chlorine and nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: It is inappropriate and possibly dangerous to the environment to dispose of expired or waste pharmaceuticals by flushing them down the toilet or discarding them to the trash. Household quantities of expired or waste pharmaceuticals may be mixed with wet cat litter or coffee grounds, double-bagged in plastic, discard in trash. Larger quantities shall carefully take into consideration applicable DEA, EPA, and FDA regulations. If possible return the pharmaceutical to the manufacturer for proper disposal being careful to properly label and securely package the material. Alternatively, the waste pharmaceutical shall be labeled, securely packaged, and transported by a state licensed medical waste contractor to dispose by burial in a licensed hazardous or toxic waste landfill or incinerator.

References

(109); (102); (31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Chloramphenicol, Trenton, NJ (April 1998).

Chlordane C:0630

Formula: $C_{10}H_6Cl_8$

Synonyms: Aspon-Chlordane; Belt; CD 68; Chlordan; Chlorindan; Chlorkil; Chlorodane; Clordano (Spanish); Corodane; Cortilan-Neu; Dichlorochlordene; Dowchlor; ENT 25,552-X; ENT 9932; γ-Chlordan; HCS 3260; Kypchlor; M140; M410; 4,7-Methanoindan, 1,2,3,4,5,6,7,8,8-octachloro-2,3,3a, 4,7,7a-hexahydro-; 4,7-Methanoindan, 1,2,4,5,6,8,8-octachloro 3a,4,7,7a-tetra hydro; 4,7-Methano-1*H*-indene,1,2,4,5,6,7,8,8-octachloro-2,3,3a,4,7,7a-hexahydro-; NCI-C00099; Niran; Octachlor; Octachlorodihydrodicyclopentadiene; 1,2,4,5,6,7,8,8-Octachloro-2,3,3a,4,7,7a-hexahydro-4,7-methano-1*H*-indene; 1,2,4,5,6,7,8,8-Octachloro-2,3,3a,4,7,7a-hexahydro-4,7-methanoindene; 1,2,4,5,6,7,8,8-Octachloro-3a,4,7,7a-hexahydro-4,7-methylene indane; Octachloro-4,7-methanohydroindane; 1,2,4,5,6,7,8,8-Octachloro-4,7-methano-3a,4,7,7a-tetrahydroindane; Octachloro-4,7-methanotetrahydroindane; 1,2,4,5,6,7,8,8-Octachloro-3a,4,7,7a-tetrahydro-4,7-methanoindan; 1,2,4,5,6,7,8,8-Octachloro-3a,4,7,7a-tetrahydro-4,7-methanoindane; 1,2,4,5,6,7,10,10-Octachloro-4,7,8,9-tetrahydro-4,7-methyleneindane; 1,2,4,5,6,7,8,8-Octachlor-3a,4,7,7a-tetrahydro-4,7-endo-methano-indan (German); Octaklor; Oktaterr; OMS 1437; Ortho-klor; SD 5532; Shell SD-5532; Synklor; TAT; TAT Chlor 4; Top ichlor 20; Topiclor; Topiclor 20; Toxichlor; Velsicol 1068

CAS Registry Number: 57-74-9 (cis- & trans-); 12789-03-6 (technical grade); *(alt.)* 39400-80-; *(alt.)* 53637-13-1

HSDB Number: 802

RTECS Number: PB9800000

UN/NA & ERG Number: UN2996 (organochlorine pesticide, liquid, toxic)/151

EC Number: 200-349-0 [*Annex I Index No.:* 602-047-00-8]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal, Sufficient Evidence, Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B, 2001; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies; (*technical grade*): Likely to produce cancer in humans; NCI[9] Carcinogenesis Bioassay (feed); clear evidence: mouse; no evidence: rat.

California Proposition 65 Chemical[102]: Cancer 1/1/1988.

Hazard Alert: Poison, Highly flammable, Possible risk of forming tumors, Endocrine disruptor (high), Suspected of causing genetic defects, Suspected reprotoxic hazard, Environmental hazard, Agricultural chemical.

Banned or Severely Restricted (in agriculture) (many countries) (UN)[13,35]

Persistent Organic Pollutants (UN)

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

United States National Primary Drinking Water Regulations: MCL = 0 mg/L; MCL = 0.002 mg/L.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/1992); Toxic Pollutant (Section 401.15) as technical mixture and metabolites.

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U036; Tox #: D020 Regulated level = 0.03 mg/L.

RCRA Toxicity Characteristic (Section 261.24), Maximum Concentration of Contaminants, regulatory level, 0.03 mg/L

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L) (*alpha*- and *gamma*-isomers) 0.0033; Nonwastewater (mg/kg), 0.26

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8080 (0.1); 8250 (10)

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg)

Superfund/EPCRA 40 CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR 172.101, Appendix B), severe pollutant

Canada, Drinking water quality: 0.007 mg/L MAC

Mexico, Drinking water quality: 0.003 mg/L

Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)]

List of Stockholm Convention POPs: Annex A (Elimination).

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292].

Hazard symbols, risk, & safety statements: (*57-74-9*) Hazard symbol: F (in solution such as hexane), Xn, N; risk phrases: R11 (in solution); R21/22; R40; R50/53; R62;

R63; safety phrases: S2; S21; S29/35; S36/37/39; S41; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)]

Description: Chlordane is a colorless, or light-yellow or amber, thick liquid. Pungent, chlorine-like odor. It may occur as a crystalline solid. Molecular weight = 409.76; specific gravity (H_2O:1) = 1.6 @ 25°C; boiling point = 175°C; freezing/melting point = 104−107°C; vapor pressure = 0.00001 mmHg; Practically insoluble in water; solubility = 0.0001%. The *commercial grade* of chlordane is a noncombustible liquid, but may be utilized in flammable solutions: Flash point = 56°C has been found in the literature, but his may vary depending on the carrier. Hazard identification (based on NFPA-704 M Rating System): (*in a flammable solution such as n-hexane*) Health 3, flammability 3, reactivity 0; (*dry*) Health 3; flammability 1; reactivity 0. Practically insoluble in water.

Potential Exposure: Chlordane is a broad spectrum insecticide of the group of polycyclic chlorinated hydrocarbons called cyclodiene insecticides. Chlordane has been used extensively since the 1950s for termite control; as an insecticide for homes and gardens; and as a control for soil insects during the production of crops, such as corn. Both the uses and the production volume of chlordane have decreased extensively since the issuance of a registration suspension notice for all food crops and home and garden uses of chlordane by the United States Environmental Protection Agency. However, significant commercial use of chlordane for termite control continues. Special groups at risk include children as a result of milk consumed; fishermen and their families because of the high consumption of fish and shellfish, especially freshwater fish; persons living downwind from treated fields; and persons living in houses treated with chlordane pesticide control agents.

Incompatibilities: Contact with strong oxidizers may cause fire and explosions. High heat and contact with alkaline solutions cause decomposition with the production of toxic fumes including chlorine, phosgene, hydrogen chloride. Attacks iron, zinc, plastics, rubber, and coatings.

Permissible Exposure Limits in Air

NIOSH IDLH = 100 milligram per cubic meter

OSHA PEL: 0.5 milligram per cubic meter TWA [skin]

NIOSH REL: 0.5 milligram per cubic meter TWA [skin]. NIOSH considers this chemical to be a potential occupational carcinogen as defined by the OSHA carcinogen policy [29 CFR 1990]. See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV[1]: 0.5 milligram per cubic meter TWA [skin]; confirmed animal carcinogen with unknown relevance to humans

PAC Ver. 29[138]

57-74-9

PAC-1: 4.5 milligram per cubic meter

PAC-2: 50 milligram per cubic meter

PAC-3: 500 milligram per cubic meter

DFG MAK: 0.5 milligram per cubic meter, inhalable fraction [skin]; Peak limitation II(8); Carcinogen Category 3B

Arab Republic of Egypt: TWA 0.5 milligram per cubic meter [skin], 1993; Australia: TWA 0.5 milligram per cubic meter; STEL 2 milligram per cubic meter [skin], Carcinogen 1993; Austria: MAK 0.5 milligram per cubic meter [skin], Suspected: carcinogen, 1999; Belgium: TWA 0.5 milligram per cubic meter; STEL 2 milligram per cubic meter [skin], 1993; Denmark: TWA 0.5 milligram per cubic meter [skin], 1999; Finland: carcinogen, 1999; France: VME 0.5 milligram per cubic meter [skin], carcinogen, 1999; the Netherlands: MAC-TGG 0.5 milligram per cubic meter [skin], 2003; Norway: TWA 0.5 milligram per cubic meter, 1999; the Philippines: TWA 0.5 milligram per cubic meter [skin], 1993; Russia: STEL 0.01 milligram per cubic meter [skin], 1993; Switzerland: MAK-W 0.5 milligram per cubic meter [skin], 1999; Thailand: TWA 0.5 milligram per cubic meter, 1993; Turkey: TWA 0.5 milligram per cubic meter [skin], 1993; United Kingdom: LTEL 0.5 milligram per cubic meter; STEL 2 milligram per cubic meter [skin], 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: confirmed animal carcinogen with unknown relevance to humans. Several states have set guidelines or standards for chlordane in ambient air[60] ranging from 0.068 μ/m^3 (Massachusetts) to 0.36 μ/m^3 (Pennsylvania) to 1.19 μ/m^3 (Kansas) to 1.7 μ/m^3 (New York) to 2.5 μ/m^3 (Connecticut and South Carolina) to 5.0 μ/m^3 (Florida) to 5−20 μ/m^3 (North Dakota) to 8.0 μ/m^3 (Virginia) to 12.0 μ/m^3 (Nevada).

Determination in Air: Filter/Chromosorb tube-102; Toluene; GC/Electrochemical detection; NIOSH Analytical Method (IV) #5510 or OSHA Analytical Method 67.

Permissible Concentration in Water: Safe Drinking Water Act (47FR 9352): MCLG, zero; MCL, 0.002 mg/L. Federal Drinking Water Standards: EPA 2 μg/L; State Drinking Water Standards: California 0.1 μg/L; New Jersey 0.5 μg/L; State Drinking Water Guidelines: Arizona 0.022 μg/L; Connecticut 0.3 μg/L; Maine 0.3 μg/L.

Determination in Water: Filter/Chromosorb tube-102; Toluene; GC/Electrochemical detection; NIOSH Analytical Method (IV) #5510. GC (EPA Method 608) or GC plus mass spectrometry (EPA Method 625). Octanol−water coefficient: Log K_{ow} = 2.8. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood. Fish toxicity (threshold)[77]: Extra high—0.04936 ppb, MATC.

Routes of Entry: Inhalation, skin absorption; ingestion and skin and eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Chlordane can irritate the eyes and skin and can cause burns on contact. Skin rash or acne may develop. The vapor can irritate the respiratory tract. Exposure can cause blurred vision, nausea, headache, abdominal pain, and vomiting. Exposure at high levels may result in disorientation, tremors, convulsions, respiratory failure, and death. Medical observation is indicated. Symptoms include increased sensitivity to stimuli, tremors; muscular a lack of coordination; and convulsions with or without coma. Fatal oral dose to adult humans is between 6 and 60 g with onset of symptoms within 45 minutes to several hours after ingestion, although symptoms have occurred following very small doses either orally or by skin exposure. Some reports of delayed development of liver disease, blood disorders, and upset stomach. Chlordane is considered to be borderline between a moderately and highly toxic substance. The oral LD_{50} for rats is 283 mg/kg.

Long-Term Exposure: This chemical has been shown to cause liver cancer in animals and may be a human carcinogen. It may damage the developing fetus. Chlordane may damage the kidneys, liver and affect the immune system. May cause an acne-like rash following skin contact. Human toxicity (long term)[77]: High—2.00 ppb, MCL.

Points of Attack: Central nervous system; eyes, lungs, liver, kidneys, skin.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Liver and kidney function tests. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. CBC.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. **8 hours** (more than 8 hours of resistance to breakthrough >0.1 μg/cm^2/min): CPF3 suits, Trellchem HPS suits; **4 hours** (At least 4 but <8 hours of resistance to breakthrough >0.1 μg/cm^2/min): Teflon gloves, suits, boots. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. When working with liquid, wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with Chlordane all handlers should be trained on its proper handling and storage. Chlordane must be stored to avoid contact with strong oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Always store pesticides in their original containers, complete with labels that list ingredients, directions for use, and first aid steps in case of accidental poisoning. Never store pesticides in cabinets with or near food, animal feed, or medical supplies. Do not store pesticides in places where flooding is possible or in places where they might spill or leak into wells, drains, ground water, or surface water[72]. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2996 Organochlorine pesticides, liquid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Do not touch spilled material. Use water spray to reduce vapors. Stay upwind. Avoid breathing vapors. Wear positive pressure breathing apparatus and full protective clothing. Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. *Small spills*: absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. *Large spills*: dike far ahead of spill for later disposal. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible liquid but it may be dissolved in flammable or combustible liquids for commercial application. Thermal decomposition products may include chlorine, phosgene, hydrogen chloride. If the flammable or combustible commercial material catches fire, use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Chlordane is dehydrochlorinated in alkali to form "nontoxic" products, a reaction catalyzed by traces of iron, but the reaction is slow. The environmental hazards of the products are uncertain. Chlordane is completely dechlorinated by sodium in isopropyl alcohol. The UN Recommends incineration methods for disposal of chlordane[22]. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(102); (31); (173); (101); (138); (203); (80); (100).

United States Environmental Protection Agency, Chlordane: Ambient Water Quality Criteria, Washington, DC (1980).

United States Environmental Protection Agency, Chlordane, Health and Environmental Effects Profile No. 35, Office of Solid Waste, Washington, DC (April 30, 1980).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 2, 33−35 (1980) and 3, No. 5, 94−99 (1983) and 7, No. 6, 46−55 (1987).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Chlordane, Washington, DC, Chemical Emergency Preparedness Program (October 31, 1985).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet: Chlordane*, Trenton, NJ (April 1998).

New York State Department of Health, *Chemical Fact Sheet* Chlordane, Bureau of Toxic Substance Assessment, Albany, NY (March 1986).

United States Public Health Service, *Toxicological Profile for Chlordane*, Atlanta, Georgia, agency of Toxic Substances and Disease Registry (December 1988).

Chlordecone (Kepone) C:0640

Formula: $C_{10}Cl_{10}O$

Synonyms: Chlordecone; Ciba 8514; Compound 1189; 1,2,3,5,6,7,8,9,10,10-Decachloro(5.2.2.$0^{2.6}$.$0^{3.9}$.$0^{5.8}$)decano-4-one; Decachloroketone; Decachlorooctahydrokepone-2-one; 1,1a,3,3a,4,5,5,5a,5b,6-Decachlorooctahydro-1,3,4-metheno-2*H*-cyclobuta(cd)pentalen-2-one; 1,1a,3,3a,4, 5,5,5a,5b,6-Decachlorooctahydro-1,3,4-metheno-2*H*-cyclobuta (c,d)pentalen-2-one; Decachlorooctahydro-1,3,4-metheno-2*H*-cyclobuta(cd)-pentalen-2-one; Decachlorooctahydro-1,3,4-metheno-2*H*-cyclobuta(cd)pentalen-2-one; Decachlorotetracyclodecanone; Decachlorotetrahydro-4,7-methanoindeneone; ENT 16,391; GC-1189; General chemicals 1189; Kepone; Merex; 1,3,4-Metheno-2*H*-cyclobuta(cd)pentalen-2-one,1,1a,3,3a,4,5,5a,5b,6-decachlorooctahydro-, Kepone; NCI-C00191

CAS Registry Number: 143-50-0

HSDB Number: 1558 as kepone

RTECS Number: PC8575000

UN/NA & ERG Number: UN2761/151

EC Number: 205-601-3 [*Annex I Index No.:* 606-019-00-6]

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC[9]: Animal Sufficient Evidence; Human No Adequate Data, *possibly carcinogenic to humans*, Group 2B; NTP[10]; DFG[3]: (Animal Positive, Human Suspected); EPA (*oral*): Likely to produce cancer in humans.

California Proposition 65 Chemical[102]: Cancer 1/1/1988; Developmental/Reproductive toxin 1/1/1989.

Hazard Alert: Poison, Combustible, Possible risk of forming tumors, Endocrine disruptor (high), Reproductive toxin: possible risk of gene damage/impaired fertility; Suspected reprotoxic hazard.

Banned or Severely Restricted (many countries) (UN)[13,35]

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U142

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.0011; Nonwastewater (mg/kg), 0.13

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg)

List of Stockholm Convention POPs: Annex A (Elimination)

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R24/25; R40; R50/53; R62; R63; safety phrases: S1/2; S22; S36/37; S45; S60; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)]

Description: Kepone is a tan to white, odorless crystalline solid. Molecular weight = 490.60; freezing/melting point = 360°C (sublimes); vapor pressure = 3×10^{-7} mmHg @ 25°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 1, reactivity 0. Soluble in water; solubility = 0.5 @ 100°C.

Potential Exposure: Kepone was registered for the control of rootborers on bananas with a residue tolerance of 0.01 ppm. This constituted the only food or feed use of Kepone. Nonfood uses included wireworm control in tobacco fields and bait to control ants and other insects in indoor and outdoor areas. A rebuttable presumption against registration of chlordecone was issued by the United States Environmental Protection Agency on March 25, 1976 on the basis of oncogenicity. The trademarked Kepone and products of six formulations were the subject of voluntary cancellation according to a United States Environmental Protection Agency notice dated July 27, 1977. In a series of decisions, the first of which was issued on June 17, 1976, the EPA effectively canceled all registered products containing Kepone as of May 1, 1978.

Incompatibilities: Acids, acid fumes.

Permissible Exposure Limits in Air

OSHA PEL: None

NIOSH REL: Carcinogen, 0.001 milligram per cubic meter TWA. Limit exposure to lowest feasible concentration. NIOSH considers this chemical to be a potential occupational carcinogen as defined by the OSHA carcinogen policy [29 CFR 1990]. See *NIOSH Pocket Guide*, Appendix A.

PAC Ver. 29[138]

PAC-1: 1.6 milligram per cubic meter

PAC-2: 17 milligram per cubic meter

PAC-3: 100 milligram per cubic meter

DFG MAK: Carcinogen Category 3B

Austria: Suspected: carcinogen, 1999; France: carcinogen, 1993. Guidelines or standards for Kepone in ambient air have been set[60] ranging from 0 (South Carolina) to 0.03 μ/m^3 (New York) to 0.88 μg/L (Pennsylvania).

Determination in Air: Collection by membrane filter and backup impinger containing NaOH solution, workup with benzene, analysis by GC with electron capture detector. Use NIOSH Analytical Method #5508.

Routes of Entry: Inhalation of dust, ingestion, skin absorption.

Harmful Effects and Symptoms

In July 1975, a private physician submitted a blood sample to the Center for Disease Control (CDC) to be analyzed for Kepone, a chlorinated hydrocarbon pesticide. The sample had been obtained from a Kepone production worker who suffered from weight loss; nystagmus, and tremors. CDC notified the state epidemiologist that high levels of Kepone were present in the blood sample, and he initiated an epidemiologic investigation which revealed other employees suffering with similar symptoms. It was evident to the state official after visiting the plant that the employees had been exposed to kepone at extremely high concentrations through inhalation, ingestion, and skin absorption. He recommended that the plant be closed, and company management complied. Of the 113 current and former employees of this Kepone-manufacturing plant examined, more than half exhibited clinical symptoms of kepone poisoning. Medical histories of tremors (called "kepone shakes" by employees), visual disturbances; loss of weight; nervousness, insomnia, pain in the chest and abdomen and; in some cases, infertility and loss of libido were reported. The employees also complained of vertigo and lack of muscular coordination. The intervals between exposure and onset of the signs and symptoms varied between patients but appeared to be dose related. NIOSH has received a report on a carcinogenesis bioassay of technical grade Kepone which was conducted by the National Cancer Institute using Osborne-Mendel rats and B6C3F1 mice, Kepone was administered in the diet at two tolerated dosages. In addition to the clinical signs of toxicity, which were seen in both species, a significant increase ($P < 0.05$) of hepatocellular carcinoma in rats given large dosages of Kepone and in mice at both dosages was found. Rats and mice also had extensive hyperplasia of the liver. In view of these findings, NIOSH must assume that Kepone is a potential human carcinogen. LD_{50} (oral-rat) = 95 mg/kg (moderately toxic).

Short-Term Exposure: May be poisonous if absorbed through the skin. Skin or eye contact may cause irritation and rash. Poisonous if swallowed. Exposure can cause headache, nervousness, tremor; liver, kidney damage; visual disturbance; ataxia, chest pain; skin erythema (skin redness).

Long-Term Exposure: Has been shown to cause liver cancer in animals; potential human carcinogen. May cause testicular atrophy; low sperm count; damage to the developing fetus; reproductive damage; sterility, breast enlargement; skin changes; liver and kidney damage; brain and nervous system damage with hyperactivity; hyperexcitability; muscle spasms, tremors.

Points of Attack: Eyes, skin, respiratory system; central nervous system; liver, kidneys, reproductive system. Cancer site in animal: liver cancer.

Medical Surveillance: Employers shall make medical surveillance available to all workers occupationally exposed to kepone, including personnel periodically exposed during routine maintenance or emergency operations. Periodic examinations shall be made available at least on an annual basis.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Qualified medical personnel may consider the administration of cholestyramine resin (QUESTRAN). Medical personnel should wear Neoprene gloves as protection against contamination (Dreisbach).

Personal Protective Methods: *Protective Clothing:* (1) Coveralls or other full-body protective clothing shall be worn in areas where there is occupational exposure to Kepone. Protective clothing shall be changed at least daily at the end of the shift and more frequently if it should become grossly contaminated. (2) Impervious gloves, aprons, and footwear shall be worn at operations where solutions of Kepone may contact the skin. Protective gloves shall be worn at operations where dry Kepone or materials containing Kepone are handled and may contact the skin. (3) Eye protective devices shall be provided by the employer and used by the employees where contact of Kepone with eyes is likely. Selection, use, and maintenance of eye protective equipment shall be in accordance with the provisions of the American National Standard Practice for Occupational and Educational Eye and Face Protection, aNSI Z87.1-1968. Unless eye protection is afforded by a respirator hood or facepiece, protective goggles or a face shield shall be worn at operations where there is danger of contact of the eyes with dry or wet materials containing Kepone because of spills, splashes, or excessive dust or mists in the air. (4) The employer shall ensure that all personal protective devices are inspected regularly and maintained in clean and satisfactory working condition. (5) Work clothing may not be taken home be employees. The employer shall provide for maintenance and laundering of protective clothing. (6) The employer shall ensure that precautions necessary to protect laundry personnel are taken while soiled protective clothing is being laundered. (7) The employer shall ensure that Kepone is not discharged into municipal waste treatment systems or the community air.

Respiratory Protection from Kepone: Engineering controls shall be used wherever feasible to maintain airborne Kepone concentrations at or below that recommended. Compliance with the environmental exposure limit by the use of respirators is allowed only when airborne Kepone concentrations are in excess of the work-place environmental limit because required engineering controls are being installed or tested when nonroutine maintenance or repair is being accomplished, or during emergencies. When a respirator is thus permitted, it shall be selected and used in accordance with NIOSH requirements.

Respirator Selection: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure location in a cool, dry place, or refrigerator under inert atmosphere[52]. Keep away from acids and acid fumes. Prior to working with kepone all handlers should be trained on its proper handling and storage. Always store pesticides in their original containers, complete with labels that list ingredients, directions for use, and first aid steps in case of accidental poisoning. Never store pesticides in cabinets with or near food, animal feed, or medical supplies. Do not store pesticides in places where flooding is possible or in places where they might spill or leak into wells, drains, ground water, or surface water[72]. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2761 Organochlorine pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Do not touch spilled material. Use water spray to reduce vapors. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. For larger spills, dike far ahead of spill for later disposal. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Use dry chemical, carbon dioxide; halon, water spray, or standard foam. Thermal decomposition products may include toxic chlorides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: A process has been developed which effects chlordecone degradation by treatment of aqueous wastes with UV radiation in the presence of hydrogen in aqueous sodium hydroxide solution. Up to 95% decomposition was effected by this process. Chlordecone previously presented serious disposal problems because of its great resistance to bio- and photo degradation in the environment. It is highly toxic to normally occur in degrading microorganisms. Although it can undergo some photodecomposition when exposed to sunlight to the dihydro compound (leaving a compound with 8 chloro substituents) that degradation product does not significantly reduce toxicity. Disposal by incineration with HCl scrubbing is recommended[22].

References

(109); (102); (31); (173); (101); (138); (2); (203); (80); (100).

National Institute for Occupational Safety and Health (NIOSH), *Recommended Standard for Occupational Exposure to Kepone*, Washington, DC (January 27, 1976).

United States Environmental Protection Agency, *Reviews of the Environmental Effects of Pollutants: I. Mirex and Kepone, Report EPA 600/1-78-013*, Cincinnati, OH (1978).

National Academy of Sciences, *Kepone, Mirex, Hexachlorocyclopentadiene: An Environmental Assessment*, Washington, DC (1978).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Kepone, Trenton, NJ (July 2001).

Chlorendic Acid C:0644

Formula: $C_9H_4Cl_6O_4$

Synonyms: Bicyclo(2.2.1)hept-5-ene-2,3-dicarboxylic acid, 1,4,5,6,7,7-hexachloro-; HET acid; 1,4,5,6,7,7-Hexachloro-5-norbornene-2,3-dicarboxylic acid; Hexachloroendome thylenetetrahydrophthalic acid; 5-Norbornene-2,3-dicarboxylic acid, 1,4,5,6,7,7-hexachloro-

CAS Registry Number: 115-28-6

HSDB Number: 2915

RTECS Number: RB9000000

UN/NA & ERG Number: UN2928/154

EC Number: 204-078-9

Regulatory Authority and Advisory Information

Carcinogenicty: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen see cameo; IARC[9]: Animal Sufficient Evidence; Human No Adequate Data, *possibly carcinogenic to humans*, Group 2B

California Proposition 65 Chemical[102]: Cancer, 7/9/1989

Hazard Alert: Poison, Possible risk of forming tumors, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

TSCA (40 CFR 716.120) Section 8(d) Health and Safety Data Reporting Rule. This rule requires manufacturers, importers, and processors of listed chemical substances and mixtures to submit to EPA copies and lists of unpublished health and safety studies.

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xi; risk phrases: R45; R36/37/38; R40. R41; R51; R62; safety phrases: S16; S22; S26; S36/37/39; S41; S45; S53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [2-Hazard to water. (est.)]

Description: Chlorendic acid is a colorless crystalline solid. Molecular weight = 388.9; freezing/melting point = 209°C; specific gravity (H_2O:1) = 0.95 @ 20°C; vapor pressure = 1.4×10 mmHg @ 25°C; Henry's Law constant = 3×10^{-4} atm m^3/mol @ 25°C (est)[72]. Low solubility in water; solubility = < 0.5 g/100 g @ 25°C; <1 mg/L @ 21°C.

Potential Exposure: Chlorendic acid is used to make other chemicals, polyester resins; in fiberglass reinforced resins; used for anticorrosion equipment and flame retardant applications of fabrics.

Incompatibilities: Compounds of the carboxyl group react with all bases, both inorganic and organic (i.e., amines) releasing substantial heat, water, and a salt that may be harmful. Incompatible with arsenic compounds (releases hydrogen cyanide gas), diazo compounds, dithiocarbamates, isocyanates, mercaptans, nitrides, sulfides (releasing heat, toxic, and possibly flammable gases), thiosulfates, and dithionites (releasing hydrogen sulfate and oxides of sulfur).

Permissible Exposure Limits in Air: No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Determination in Water: Octanol−water coefficient: $\text{Log } K_{\text{ow}} = 2.3$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Ingestion, inhalation, skin contact

Harmful Effects and Symptoms

Short-Term Exposure: Causes irritation of the eyes, skin and respiratory tract.

Long-Term Exposure: May cause cancer.

Medical Surveillance: Chlorendic acid is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA)

Storage: (1) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location; keep acids away from bases and red, yellow and blue-coded chemicals. (2) Color code—Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. Store in tightly closed containers is a cool, well-ventilated area away from potentially high heat sources. Prior to working with butyl acid phosphate you should be trained on its proper handling and storage.

Shipping: UN2928 Toxic solids, corrosive, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, 8-Corrosive material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Chlorendic acid is combustible when exposed to direct flame, but is self-extinguishing when the flame is removed[193]. Thermal decomposition products may include hydrogen chloride and oxides of carbon. To extinguish fire, use dry chemical, carbon dioxide, or Halon.

Disposal Method Suggested: Dispose of contents and container to an approved waste disposal plant. All federal, state, and local environmental regulations must be observed.

References

(109); (102); (31); (173); (101); (138); (100).

Chlorethoxyfos C:0645

Formula: $C_6H_{11}Cl_4O_3PS$

Synonyms: *O,O*-Diethyl *O*-(1,2,2,2-tetrachloro ethyl) phosphorothioate; *O,O*-Diethyl *O*-(1,2,2,2-tetrachloro ethyl) thionophosphate; Phosphorothioic acid, *O,O*-diethyl *O*-(1,2,2,2-tetrachloroethyl)ester; DPX-43898; Fortress 2.5 G; fortress 5 G; SD 208304

CAS Registry Number: 54593-83-8

HSDB Number: 7131

RTE CS Number: TF6150000

UN/NA & ERG Number: (PIH) UN2783 (organophosphorus pesticide, solid, n.o.s.)/152; UN3018 (organophosphorus pesticide, liquid, n.o.s.)/152

EC Number: Not assigned

Regulatory Authority and Advisory Information

Carcinogenicity: EPA Group D, Not classifiable as a human carcinogen.

Hazard Alert: Poison inhalation hazard: exposure can be lethal, Combustible, Poison, Neurotoxin (cumulative), Environmental hazard.

United States DOT 49CFR172.101, Inhalation Hazard Chemical as organophosphates

Marine pollutant (in bulk by water)

Hazardous to aquatic life or environment, with possible long-lasting effects[291]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T +, Xi, N; risk phrases: R26/27/28; R33; R36; R50; safety phrases: S26, S28; S36/37, S38, S39; S35; S41; S45, S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Gray to reddish-brown granular solid or colorless liquid. Mild sulfur-like odor. Molecular weight = 335.89; 235.06 (P-); specific gravity (H_2O:1) = 1.41; boiling point = 110°C; freezing/melting point = (decomposes) 112°C; flash point = 127.6°C; vapor pressure = 8×10^{-4} mmHg @ 25°C. Hazard identification (based on NFPA-704 M Rating System): Health 4, flammability 1, reactivity 0. Very low solubility in water; solubility <1 mg/L @ 20°C; (technical) 3 ppm. Physical and toxicological properties may be affected by the carrier solvents used in commercial formulations.

Potential Exposure: An organophosphate insecticide, chlorethoxyfos is a restricted use organophosphate insecticide registered for use in the United States on field corn, seed corn, sweet corn, and popcorn for the control of corn rootworms, wireworms, cutworms, seed corn maggots, white grubs, and symphylans. A United States Environmental Protection Agency Restricted Use Pesticide (RUP). Not currently listed for use in EU countries.

Incompatibilities: May react violently with antimony(V) pentafluoride. Incompatible with lead diacetate, magnesium, silver nitrate. In the presence of strong reducing agents such as hydrides, organophosphates form highly toxic and flammable phosphine gas. Contact with oxidizers can cause the release of toxic oxides of phosphorus.

Permissible Exposure Limits in Air: No standards have been set.

Determination in Air: OSHA versatile sampler-2; Toluene/Acetone; GC/Flame ionization detection; NIOSH IV, Method #5600, Organophosphorus Pesticides[18].

Determination in Water: EAD Method 1657. The determination of organophosphorus pesticides in municipal and industrial wastewater by GC. Detection limit = 6.0 ηg/L. Octanol−water coefficient: Log K_{ow} = > 4.5. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood. Fish toxicity (threshold): Extra high—0.40299 ppb, MATC.

Routes of Entry: Inhalation, skin absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Organophosphates are highly toxic. Symptoms may develop rapidly, or there may be a delay of several hours following exposure before they become noticeable. The delay tends to be longer in the case of some compounds that dissolve fats, lipids, oils, and nonpolar solvents such as toluene. Symptoms may increase in severity for more than a single day and last for several days. In severe cases of organophosphate intoxication, respiratory failure may occur.

Short-Term Exposure: Highly dangerous; can be fatal if inhaled, swallowed, or absorbed through the skin. Eye pupils are small; blurred vision; eye watering; runny nose; cough; shortness of breath; salivation; dizziness; nausea, stomach cramps, diarrhea, and vomiting; increased blood pressure; profuse sweating; hypermotility, hallucinations; irritability; tingling of the skin; drowsiness; slow heartbeat; convulsions; fluid in lungs; loss of consciousness; incontinence; breathing stops; death. Organophosphates inhibit the action of acetylcholinesterase enzymes, and alter the way in which nervous impulses are transmitted. The effects can last for hours, days, or much longer. The action of the enzymes is reestablished after new enzymes are formed. LD_{50} (oral, rat) = 2 mg/kg.

Long-Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. Organophosphates may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May be a neurotoxin; may cause liver damage. Chronic exposure may cause respiratory paralysis and death. Human toxicity (long term)[101]: High—4.20 ppb, Health advisory.

Points of Attack: Respiratory system, central nervous system, cardiovascular system, blood cholinesterase.

Medical Surveillance: Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. Routine biological monitoring of pesticide applicators and field workers includes testing of plasma and red blood cell acetylcholinesterase levels (for enzyme poisoned by this chemical). These tests are normally ac curate only if done within about 2 hours of exposure. If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When acetylcholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate pesticides is recommended until enzyme levels recover. Do not drink any alcoholic beverages before or during use as it promotes absorption of organophosphates.

First Aid: **Treatment for organophosphate poisoning consists of thorough decontamination, cardiorespiratory support, and administration of the antidotes atropine and pralidoxime. In cases of severe poisoning, diazepam, an anticonvulsant, should also be administered. Antidotes should be administered as prevention even if the diagnosis is in doubt**. Speed in removing material from eyes and skin is of extreme importance. *Eyes:* Eye contact can cause dangerous amounts of these chemicals to be quickly absorbed through the mucous membrane into the bloodstream. Immediately and gently flush eyes with plenty of warm or cold water (NO hot water) for at least 15 minutes, occasionally lifting the upper and lower eyelids. Get medical aid immediately. *Skin:* Get medical aid. Dermal contact can cause dangerous amounts of these chemicals to be absorbed into the bloodstream. Wearing the appropriate PPE equipment and respirator for organophosphate/carbamate pesticides, immediately flush skin with plenty of soap and water for at least 15 minutes while removing contaminated clothing and shoes. Shampoo hair promptly if contaminated. The removed, contaminated clothing and shoes should be double-bagged and left in Hot Zone for later disposal by hazardous materials experts. Skin may also be decontaminated with diluted hypochlorite solution. *Inhalation:* Get medical aid. Do not contaminate yourself. Wearing the appropriate PPE equipment and respirator for organophosphate pesticides, immediately remove the victim from the contaminated area to fresh air. If the victim is not breathing, administer artificial respiration. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. If breathing is difficult, administer oxygen through bag/mask apparatus until medical help arrives. Do not leave victim unattended. *Ingestion:* Call poison control. Loosen all clothing. Never give anything by mouth to an unconscious person. If victim is *unconscious or having convulsions*, do nothing except keep victim warm. Get medical aid. Transfer promptly to a medical facility. In cases of ingestion, **do not induce vomiting**. If the victim is alert and asymptomatic, administer a slurry of activated charcoal at a dose of 1 g/kg (infant, child, and adult dose). A soda can and straw may be of assistance when offering charcoal to a child. *In some cases you may be specifically instructed by poison control to induce vomiting by way of 2 tablespoons of syrup of ipecac (adult) washed down with a cup of water.* Do NOT give activated charcoal before or with ipecac syrup.

Note to physician or authorized medical personnel: Treat cases of respiratory compromise, coma, or excessive pulmonary secretions with respiratory support using protocols and techniques available and within the scope of training. Some cases may necessitate procedures such as endotracheal intubation or cricothyrotomy by properly trained and equipped personnel. When possible, atropine (see *Antidotes*, below) should be given under medical supervision. Patients who are comatose, hypotensive, or having seizures or cardiac arrhythmias should be treated according to advanced life support protocols. *Antidotes:* Two antidotes are administered to treat organophosphate poisoning. Atropine is a competitive antagonist of acetylcholine at muscarinic receptors and is used to control the excessive bronchial secretions which are often responsible for death. Pralidoxime relieves both the nicotinic and muscarine effects of organophosphate poisoning by regenerating acetylcholinesterase and can reduce both the bronchial secretions and the muscle weakness associated with poisoning. The initial intravenous dose of atropine in adults should be determined by the severity of symptoms: An initial adult dose of 1.0 to 2.0 mg or pediatric dose of 0.01 mg/kg (minimum 0.01 mg) should be administered intravenously. If intravenous access cannot be established, atropine may also be given intramuscularly, subcutaneously or via endotracheal tube. Doses should be repeated every 15 minutes until excessive secretions and sweating have been controlled. Once bronchial secretion has been controlled, atropine administration should be repeated whenever the secretions begin to recur. In seriously poisoned patients, very large doses may be required. Alterations of pulse rate and pupillary size should not be used as indicators of treatment adequacy. Pralidoxime should be administered as early in poisoning as possible as its efficacy may diminish when given more than 24 to 36 hours after exposure. Doses are as follows: adult 1.0 g; pediatric 25 to 50 mg/kg. The drug should be administered intravenously over 30 to 60 minutes, but in a life-threatening situation, one-half of the total dose can be given per minute for a total administration time of 2 minutes. Treatment should begin to take effect within 40 minutes with a reduction in symptoms and the amount of atropine necessary to control bronchial secretion. The initial dose can be repeated in 1 hour and then every 8 to 12 hours until the patient is clinically well and no longer requires atropine. If intravenous access cannot be established, pralidoxime may also be given intramuscularly. Early administration of diazepam in addition to the combined atropine and pralidoxime treatment may help prevent the onset of seizures and potential brain and cardiac morphologic damage following high-level organophosphate poisoning.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of dermal contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. One recommendation is the use of DuPont Tychem suit fabrics[88] All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls, and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit. *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode).

Storage: Color code—Blue: Health Hazard/Poison. Store in a secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Where possible, automatically transfer material from other storage containers to process containers.

Shipping: UN2783 Organophosphorus pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN3018 Organophosphorus pesticides, liquid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling:

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.3/0.4
Night 0.8/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 600/200
Then: Protect persons downwind (mi/km)
Day 1.4/2.3
Night 2.8/4.5

First remove all sources of ignition. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Stay upwind; keep out of low areas. Ventilate area of spill or leak. Remove and isolate contaminated clothing at the site. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills:* absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills:* dike far ahead of spill for later disposal. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Fire Extinguishing: Thermal decomposition products may include hydrogen chloride and oxides of phosphorus, sulfur, nitrogen, and carbon. May be fatal if inhaled, ingested, or absorbed through skin. Inhalation or contact with some of these materials will irritate or burn skin and eyes. Vapors may cause dizziness or suffocation. *Small fires:* dry chemical, carbon dioxide; water spray; or foam. *Large fires:* water spray, fog, or foam. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Firefighting gear (including SCBA) may not provide adequate protection. If exposure occurs, remove and isolate gear immediately and thoroughly decontaminate personnel. Wear positive pressure breathing apparatus and special protective clothing. Remove and isolate contaminated clothing at the site. Move container from fire area if you can do so without risk. Fight fire from maximum distance. Dike fire control water for later disposal. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Destruction by alkali hydrolysis or incineration. May also be mixed with flammable solvent and sprayed into an incinerator equipped with after burner and scrubber. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office. Afterburner

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Office of Pesticide Programs, "Chlorethoxyfos Facts," (June 2000). http://www.epa.gov/REDs/factsheets/chlorethfact.pdf.

United States Environmental Protection Agency, Office of Pesticide Programs, Pesticide Residue Limits, "Chlorethoxyfos", 40 CFR 180.486. www.epa.gov/pesticides/food/viewtols.htm.

Chlorfenvinphos C:0650

Formula: $C_{12}H_{14}Cl_3O_4P$

Synonyms: Apachlor; Benzyl alcohol,2,4-dichloro-α-(chloromethylene)-, diethyl phosphate; Birlane; Birlane liquid; C-10015; C8949; CFV; CGA 26351; *O*-2-Chlor-1-(2,4-dichlor-phenyl)-vinyl-*O*,*O*-diaethylphosphat (German); Chlorfenvinphos; β-2-Chloro-1-(2′,4′-dichlorophenyl) vinyl diethylphosphate; 2-Chloro-1-(2,4-dichlorophenyl)vinyl diethyl phosphate; Chlorofenvinphos; Chlorp henvinfos; Chlorp henvinphos; Clofenvinfos; Clorfenvinfos (Spanish); Compound 4072; CVP; Diethyl1-(2,4-dichlorophenyl)-2-chlorovinyl phosphate; *O,O*-Diethyl *O*-[2-chloro-1-(2′,4′-dichlorophenyl)vinyl] phosphate; ENT 24969; GC 4072; OMS 1328; Phosphate de *O,O*-diethyle etdeo-2-chloro-1-(2,4-dichlorophenyl) vinyle (French); Phosphoric acid, 2-chloro-1-(2,4-dichlorophenyl)ethenyldiethyl ester; Sapecron; Sapecron 10FGEC; Sapecron 240; Saprecon C; SD 4072; SD 7859; Shell 4072; Supona; Supone; Unitox; Vinylphare; Vinylphate

CAS Registry Number: 470-90-6

HSDB Number: 1540

RTECS Number: TB8750000

UN/NA & ERG Number: (PIH) UN3018 (organophosphorus pesticide, liquid, toxic)/152

EC Number: 207-432-0 [*Annex I Index No.:* 015-071-00-3]

Regulatory Authority and Advisory Information

Hazard Alert: Poison inhalation hazard: exposure can be lethal, Neurotoxin (cumulative), Combustible, Suspected of causing genetic defects, Environmental hazard.

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500 lb (227 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 500 lb (227 kg)

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

United States DOT 49CFR172.101, Inhalation Hazardous Chemical, as organic phosphate, Substance ID: EDF-041.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, N; risk phrases: R24; R28; R33; R50/53; R62; safety phrases: S1/2; S28; S36/37; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Chlorfenvinphos is a nonflammable, yellow or amber liquid with a mild odor. Molecular weight = 359.58; boiling point = 110°C @ 0.001 mmHg; 168−170°C @ 0.5 mmHg; freezing/melting point = −23 − 19°C. Hazard identification (based on NFPA-704 M Rating System): Health 4, flammability 1, reactivity 0. Very slightly soluble in water.

Potential Exposure: Used as a soil insecticide for root maggots, rootworms, and cutworms. Those engaged in the production, formulation, and application of this insecticide.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Strong oxidizers may cause release of toxic phosphorus oxides. Organophosphates, in the presence of strong reducing agents such as hydrides, may form highly toxic and flammable phosphine gas. Keep away from alkaline materials. May be corrosive to metals in the presence of moisture.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 0.91 milligram per cubic meter

PAC-2: 10 milligram per cubic meter

PAC-3: 500 milligram per cubic meter

Poland: MAC (TWA) 0.01 milligram per cubic meter, MAC (STEL) 0.1 milligram per cubic meter

However, it should be recognized that this chemical can be absorbed through the skin, thereby increasing exposure.

Determination in Air: OSHA versatile sampler-2; Toluene/Acetone; GC/Flame photometric detection for sulfur, nitrogen, or phosphorus; NIOSH Analytical Method IV # 5600, Organophosphorus Pesticides.

Permissible Concentration in Water: 0.1 mg/L in drinking water is a recommended drinking water limit.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = > 3.5$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, passes through the unbroken skin.

Harmful Effects and Symptoms

Short-Term Exposure: Highly toxic (LD_{50} for rats is 10 mg/kg). Symptoms exhibited on chlorfenvinphos exposure are typical of cholinesterase poisoning. Nausea is often first symptom, with vomiting; abdominal cramps; diarrhea; and excessive salivation. Headache, giddiness, weakness, tightness in chest; blurring of vision; pinpoint pupils; loss of muscle coordination; and difficulty breathing. Convulsions and coma precede death. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Chlorfenvinphos can cause the heart to beat slower (bradycardia) or irregularly (arrhythmia).

Long-Term Exposure: There is limited evidence that this chemical may damage the developing fetus. Symptoms resembling influenza with headache, nausea; and weakness have been reported. Cholinesterase inhibitor; cumulative effect is possible. Chlorfenvinphos may damage the nervous system with repeated exposure, resulting in impaired memory; depression, anxiety, or irritability, convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, central nervous system; cardiovascular system, skin, eyes, plasma, and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider CBC. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with chlorfenvinphos all handlers should be trained on its proper handling and storage. Should be protected from moisture and stored in glass-lined or polyethylene-lined containers. Keep away from strong bases. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN3018 Organophosphorus pesticides, liquid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Organophosphorus compounds

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.3/0.4
Night 0.8/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 600/200
Then: Protect persons downwind (mi/km)
Day 1.4/2.3
Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Do not touch spilled material. Do not breathe vapors. Stay upwind; keep out of low areas. Remove all ignition sources. Ventilate area of spill or leak. This material is a combustible liquid. For a spill or leak of a combustible liquid, shut off ignition sources; no flares, smoking, or flames in hazard area. Stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: The state of New Jersey has assigned a flammability rating of "2" to chlorfenvinphos. This chemical may burn, but does not readily ignite. Thermal decomposition products may include hydrogen chloride and oxides of phosphorus, sulfur, nitrogen, and carbon. Move container from fire area if you can do it without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Wear positive-pressure breathing apparatus and special protective clothing. Use dry chemical, carbon dioxide; water spray; or alcohol resistant foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Destruction by alkali hydrolysis or incineration[22]. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (80); (100).

Administration (NOAA), Office of Response and Restoration Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 2, No. 4, 63–67, New York, Van Nostrand Reinhold Co. (1982).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Chlorfenvinphos, Washington, DC, Chemical Emergency Preparedness Program (October 31, 1985).

Chlorinated Diphenyl Oxide C:0655

Formula: $C_{12}H_4Cl_6O$; $C_{12}H_{10-n}Cl_nO$ (general, for chlorinated diphenyl oxides)

Synonyms: Benzene, 1,1′-Oxybis, hexachloro derivatives; Chlorinated biphenyl oxide; *o*-Chlorinated diphenyl oxide; Ether, hexachlorophenyl; Hexachlorodiphenyl ether; Hexachlorodiphenyl oxide; Phenyl ether, hexachloro derivative; Trichloro diphenyl ether; Trichloro diphenyl oxide
hexachloro-isomer: see PC Bs.

CAS Registry Number: 31242-93-0; 55720-99-5 (obsolete); 57321-63-8 (trichloro-)

HSDB Number: 7111

RTECS Number: KO4200000 (trichloro-); KO0875000 (hexachloro-)

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171; UN3082 (environmentally hazardous substances, liquid, n.o.s.)/171

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Combustible (*hexachloro diphenyl oxide*), Sensitization hazard (skin).

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: Xi, Xn; risk phrases: R20; R22; R43; safety phrases: S36/37; S41; S45 (see Appendix 4)

Description: Chlorinated diphenyl oxide is a white or yellowish waxy solid or very viscous liquid. Molecular weight = 376.88; boiling point = 230–260°C @ 8 mm Hg; 361.2°C @ 760 mmHg; vapor pressure = 4.37^{-5} mmHg @ 25°C; flash point = 123°C. *Hexachloro Diphenyl Oxide:* autoignition temperature = 620°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 1, reactivity 0.

Potential Exposure: These materials are used as dielectric fluids in the electrical industry; they may be used as organic intermediates to make drugs and other chemicals; and in dry cleaning detergents. Used in the manufacture of flame-inhibiting polymers, as corrosion inhibitors, dry-cleaning detergents, thermal lubricants, additives for soaps and lotions, and in the manufacture of hydraulic fluids, pesticides, wood preservatives, and electric insulators[101].

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. May be able to form unstable peroxides. Reacts with aluminum.

Permissible Exposure Limits in Air

NIOSH IDLH = 5 milligram per cubic meter
OSHA PEL: 0.5 milligram per cubic meter TWA
NIOSH REL: 0.5 milligram per cubic meter TWA
ACGIH TLV[1]: 0.5 milligram per cubic meter TWA
No PAC available.
DFG MAK: [skin], *as chlorinated biphenyl oxide*

Australia: TWA 0.5 milligram per cubic meter; STEL 2 milligram per cubic meter, 1993; Austria: MAK 0.5 milligram per cubic meter [skin], 1999; Belgium: TWA 0.5 milligram per cubic meter; STEL 2 milligram per cubic meter, 1993; Finland: TWA 0.5 milligram per cubic meter; STEL 1.5 milligram per cubic meter [skin], 1999; France: CME 0.5 milligram per cubic meter, 1999; Norway: TWA 0.5 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 0.5 milligram per cubic meter, 2003; Switzerland: MAK-W 0.5 milligram per cubic meter [skin], 1999; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 0.5 milligram per cubic meter

Several states have set guidelines or standards for Chlorinated Diphenyl Oxide in ambient air[60] ranging from 5−20 μ/m^3 (North Dakota) to 8 μ/m^3 (Virginia) to 10 μ/m^3 (Connecticut) to 12 μ/m^3 (Nevada).

Determination in Air: Collect on filter, work up with isooctane, analyze by GC. Use NIOSH Analytical Method IV #5025[18].

Permissible Concentration in Water: Because of the lack of data on both toxicologic effects and environmental contamination, the hazard posed by these compounds cannot be estimated according to the Environmental Protection Agency[6].

Routes of Entry: Inhalation, ingestion, eye and skin contact.

Harmful Effects and Symptoms

Acne-form dermatitis and liver damage.

Short-Term Exposure: Contact can cause skin irritation, rash, burning sensation; chloracne. LD_{50} (oral-rat) => 500 mg/kg. Moderately toxic by ingestion, inhalation, and skin absorption.

Long-Term Exposure: May cause acne-form dermatitis and liver damage. More than light alcohol consumption may increase the liver damage.

Points of Attack: Skin, liver.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Liver function tests. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: OSHA: *5 milligram per cubic meter:* Sa(APF = 10) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); SCBA (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive pressure mode in combination with an auxiliary self-contained positive pressure breathing apparatus). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOvAg100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor and acid gas canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with chlorfenvinphos all handlers should be trained on its proper handling and storage. Should be protected from moisture and stored in glass-lined or polyethylene-lined containers. Keep away from strong bases. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN3082 Environmentally hazardous substances, liquid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required. UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include hydrogen chloride and oxides of carbon. Use dry chemical or carbon dioxide extinguishers. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify

downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: For trichloro phenyl ether, solution in a flammable solvent and incineration in a furnace with afterburner and scrubber is recommended[22].

References

(31); (173); (101); (138); (2).

United States Environmental Protection Agency, Haloethers: Ambient Water Quality Criteria, Washington, DC (1980).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Chlorinated Diphenyl Oxide, Trenton, NJ (August 2000).

Chlorimuron-ethyl C:0658

Formula: $C_{13}H_{11}ClN_4O_6S$

Synonyms: Benzoic acid,2-[((((4-chloro-6-methoxy-2-pyrimidinyl)amino)carbonyl)amino)sulfonyl]-,ethyl ester; Caswell No. 193B; Chlorimuronethyl ester; Chlorimuronethyl [Ethyl-2-[(((4-chloro-6-methoxyprimidin-2-yl)-carbonyl)-amino)sulfonyl]benzoate]; 2-[((((4-Chloro-6-methoxy-2-pyrimidinyl)amino)carbonyl)amino) sulfonyl] benzoic acid, ethyl ester; Ethyl-2-[(((4-chloro-6-methoxy-primidin-2-yl)-carbonyl)-amino)sulfonyl]benzoate; Ethyl 2-[((4-chloro-6-methoxypyrimidine-2-yl)aminocarbonyl)aminosulfonyl]benzoate; Ethyl 2-((((4-chloro-6-methoxy-2-pyrimidinyl)amino)carbonyl)amino)sulfonyl]benzoate; Authority; Canopy (chlorimuron-ethyl + metribuzin); Classic; Concert, canceled; DPX-F6025; Gemini; Lorox; Preview; Reliance; Skermish, canceled; Synchroncy; Synchrony

CAS Registry Number: 90982-32-4

HSDB Number: 6850

RTECS Number: DG5095000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: Not assigned

Regulatory Authority and Advisory Information

Carcinogenicity: Sulfonylurea herbicides were not mutagenic in vitro and most were not carcinogenic in animals. IARC and NTP have not classified the sulfonylurea herbicides with respect to human carcinogenicity. United States Environmental Protection Agency considers the sulfonylureas not classifiable, not rated, or noncarcinogenic, *with the exception of* sulfosulfuron (CAS: 141776-32-1), a likely human carcinogen, and triflusulfuron-methyl (CAS: 126535-15-7) a possible human carcinogen[96].

Hazard Alert: Agricultural chemical.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%

Description: Colorless to off white or pale yellow crystals or powder. Some formulations are listed as "flammable" in the literature. Odorless. Molecular weight = 414.83; specific gravity (H_2O:1) = 1.51 @25°C; freezing/melting point = 181°C; vapor pressure = 4.0×10^{-12} mmHg @25°C[83,USDA]. Henry's Law constant = 4.27×10^{-11} atm m^3/mol @ 25°C (est)[83]. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 0, reactivity 0. Low solubility in water. Physical and toxicological properties may be affected by the carrier solvents used in commercial formulations.

Potential Exposure: A sulfonylurea/pyrimidine derivative herbicide used to control broadleaf weeds and annual morning glory in soybeans and peanuts. Not listed as registered for use in EU countries. Registered for use in the United States and available from more than 25 global suppliers[97].

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, nitrates.

Determination in Water: Method: USGS-NWQL O-2060-01; Procedure: graphitized carbon-based solid-phase extraction and high performance liquid chromatography/mass spectrometry; Analyte: chlorimuron-ethyl; Matrix: water; Detection Limit: 0.0048. Octanol–water coefficient: Log K_{ow} = ranges from 2.50[83] to >3.0. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood. Fish toxicity (threshold): Very low—1308.29960 ppb, MATC.

Routes of Entry: Inhalation, dermal contact, ingestion

Harmful Effects and Symptoms

Human health effects from the sulfonylurea herbicides at low environmental doses or at biomonitored levels from low environmental exposures are unknown. The sulfonylurea herbicides are generally of low toxicity in mammalian studies. Animal studies showed low acute toxicity and little chronic, reproductive, or developmental toxicity or teratogenic effects. Developmental or teratogenic effects tended only to occur at high or maternally toxic doses. At high sublethal, chronic oral doses, such nonspecific effects as weight loss and anemia were observed. Some chemical-specific effects were noted at high doses in animals[96].

Short-Term Exposure: May cause skin and eye irritation. Dermal contact may cause allergic reaction Moderately poisonous if ingested or inhaled. LD_{50} (oral, rat) = > 4000 mg/kg[83]; LD_{50} (dermal, rabbit) = > 2000 mg/kg.

Long-Term Exposure: Repeated or prolonged contact may cause skin and lung sensitization, resulting in allergies. May be a liver toxin. Human toxicity (long term): Very low—140.00 ppb, Health advisory.

Points of Attack: Skin, liver.

Medical Surveillance: Preliminary medical exam to detect chronic diseases of Central nervous system, liver, heart, kidneys, lung, and skin, as well as endocrinological or immunological disturbances, should protect susceptible individuals. Periodical medical exams of internal organs, skin, and eyes are important to avoid chronic occupational intoxications. They should include lab and patch tests when necessary[83]. Urinary levels of the sulfonylurea herbicides reflect recent exposure. There is very limited information on the biomonitoring of sulfonylurea herbicides or their metabolites. Detection of the metabolites may reflect exposure to more than one particular sulfonylurea herbicide or from exposure to environmental degradation products. The urinary metabolites dimethoxypyrimidine and dimethylpyrimidine can be used as nonspecific markers of exposure to the pyrimidinylsulfonylureas, a group that includes bensulfuron-methyl, halosulfuron, primisulfuron-methyl, and sulfosulfon. The urinary metabolite methoxymethyl triazine can be used as a nonspecific marker of exposure to the triazinylsulfonylureas, a group that includes chlorosulfuron, prosulfuron, and triasulfuron[96]. Evaluation by a qualified allergist, including exposure history and testing, may help diagnose lung allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Applicators and other handlers must wear: Coveralls worn over long-sleeved shirt and long pants; Chemical-resistant gloves such as DuPont Tychem suit fabrics, barrier laminate, or Viton; Chemical-resistant footwear plus socks; Protective eye wear; Chemical-resistant headgear for overhead exposure; Chemical-resistant apron when cleaning equipment, mixing, or loading[83]. Agricultural Use/Engineering Controls: When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the WPS for agricultural pesticides, 40 CFR 170.240 (d)(4-6), the handler PPE requirements may be reduced or modified as specified in the WPS. Firefighters should wear NIOSH-approved SCBA and full protective clothing.

Respirator Selection: Wherever and whenever workplace conditions warrant respirator use, a respiratory protection program must be followed that meets one or more of the following requirements: OSHA's 29 CFR 1910.134, ANSIZ88.2, or European Standard EN 149.

Storage: Color code—Blue: Health Hazard/Poison: Store in a tightly closed container in a dry, well-ventilated, and secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Where possible, automatically transfer material from other storage containers to process containers. *Flammable Formula*: Color code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from chlorine compounds, oxidizing agents; and combustible materials. Sources of ignition, such as smoking and open flames, are prohibited where the chemical is handled, used, or stored, Use only nonsparking tools and equipment, especially when opening and closing containers. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Piping should be electrically bonded and grounded.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen spilled material with alcohol to avoid dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen, sulfur, carbon, and hydrogen chloride gas. Use dry chemical, carbon dioxide; water spray; or alcohol-resistant foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA

1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Do not discharge into drains or sewers. Dispose of waste material as hazardous waste using a licensed disposal contractor to an approved landfill. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Incineration with effluent gas scrubbing is recommended. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138).

Pesticide Management Education Program, "Chlorimuron ethyl Herbicide Profile 4/86," Cornell University, Ithaca, NY (April 4, 1986). http://pmep.cce.cornell.edu/profiles/herb-growthreg/cacodylic-cymoxanil/chlorimuron-ethyl/herb-prof-chlorim-ethyl.html.

United States Environmental Protection Agency, Office of Pesticide Programs, Pesticide Residue Limits, "Chlorimuron ethyl," 40 CFR 180.429. http://www.setonresourcecenter.com/40CFR/Docs/wcd0004d/wcd04d68.asp.

Chlorinated Naphthalenes C:0660

Formula: $C_{10}H_{8-x}Cl_x$; $C_{10}H_5Cl_3$ (tri-); $C_{10}H_2Cl_6$ (hexa-)

Synonyms: 1-chloro isomer: α-Chloronaphthalene; 1-Cloronaftaleno (Spanish)

2-Chloro-isomer: β-Chloronaphthalene; 2-Cloronaftaleno (Spanish)

Hexachloro-isomer: Halowax 1014; Hexachloronaphthalene; Hexacloronaftaleno (Spanish); Naphthalene, hexachloro-

Octachloro-isomer: Halowax 1051; Octachloronaphthalene; Perchloronaphthalene; Perna

Pentachloro-isomer: Halowax 1013; Pentachloronaphthalene

Tetrachloro-isomer: Halowax; Nibren wax; Seekay wax; Tetrachloronaphthalene

Trichloro-isomer: Halowax; Nibren wax; Seekay wax; Trichloronaphthalene

CAS Registry Number: 90-13-1 (1-chloro-; α-Chloronaphthalene); 91-58-7 (2-chloro-); 1321-65-9 (trichloro-); 1335-88-2 (tetrachloro-); 1321-64-8 (pentachloro-); 1335-87-1 (hexachloro-); 2234-13-1 (octachloro-)

HSDB Number: 1178 as naphthenic acids

RTECS Number: QJ2100000 (1-chloro-); QJ2275000 (2-chloro-); QK4025000 (trichloro-); QK3700000 (tetrachloro-); QK 0300000 (pentachloro-); QJ7350000 (hexachloro-); QK0250000 (octachloro-)

UN/NA & ERG Number: UN3082 (environmentally hazardous substances, liquid, n.o.s.)/171

EC Number: 201-967-3 (1-chloro-); 202-079-9 (2-chloro); 215-321-3 (trichloro); 1335-88-2 (tetrachloro); 215-320-8 [*Annex I Index No.:* 602-041-00-5] (pentachloro-); 215-641-3 (hexachloro)

Regulatory Authority and Advisory Information

Hazard Alert: Combustible, Suspected of causing genetic defects, Environmental hazard.

Chlorinated naphthalenes:

Clean Water Act: Toxic Pollutant (Section 401.15)

United States DOT Regulated marine pollutant (49CFR172.101, Appendix B) as naphthalenes

RCRA, 40CFR 261, Appendix 8 Hazardous Constituents, waste number not listed

2-Chloronaphthalene:

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants.

EPA ADI: EPA Oral reference dose (RfD) = 0.08 mg/kg/day (UF: 3000, MF: 1)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U047

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.055; Nonwastewater (mg/kg), 5.6

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8120 (10); 8270 (10)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 5000 lb (2270 kg)

Hexachloronaphthalene:

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: [*1321-65-9 (trichloro-)*] Xn, N; risk phrases: R21/22; R36/38; R50/53; R62; safety phrases: S2; S29/35; S41; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to waters (1-chloro-isomer); 3-Severe hazard to water. (*polychlorinated naphthalenes*).

Description: The chlorinated naphthalenes in which one or more hydrogen atoms have been replaced by chlorine to form wax-like substances, beginning with monochloronaphthalene and going on to the octachlor derivatives. Their physical states vary from mobile liquids to waxy-solids depending on the degree of chlorination; freezing/melting points of the pure compounds range from 17°C for 1-chloronaphthalene to 198°C for 1,2,3,4-tetrachloronaphthalene.

1-Chloro-isomer: Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 1, reactivity 0.

2-Chloro-isomer*:* Molecular weight = 162.62; specific gravity (H_2O:1) = 1.138 @ 71°C; boiling point = 259°; freezing/melting point = 58°. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 0, reactivity 0. Insoluble in water.

Hexa-isomer*:* White to light-yellow solid with an aromatic odor. Molecular weight = 334.82; specific gravity

(H_2O:1) = 1.78; boiling point = 343−388°C; freezing/melting point = 137°C. Insoluble in water.

Octa-isomer*:* Waxy, pale yellow solid with an aromatic odor. Molecular weight = 403.73; specific gravity (H_2O:1) = 1.97; boiling point = 410−440°C; freezing/melting point = 197.5°C. Insoluble in water.

Penta-isomer*:* Colorless to white crystalline solid with a benzene-like odor. Molecular weight = 300.40; boiling point = 336°C; freezing/melting point = 120°C. Slightly soluble in water.

Tetra-isomer*:* Colorless to pale yellow solid with an aromatic odor. Molecular weight = 265.96; boiling point = 315−360°C; freezing/melting point = 182°C; flash point = 210°C (oc). Insoluble in water.

Tri-isomer: Colorless to pale-yellow solid with an aromatic odor. Molecular weight = 231.51; specific gravity (H_2O:1) = 1.58; boiling point = 92.78°C; freezing/melting point = 93°C; flash point: 198°C (oc). Insoluble in water.

Potential Exposure: Industrial exposure from individual chlorinated naphthalenes is rarely encountered; rather it usually occurs from mixtures of two or more Chlorinated naphthalenes. Due to their stability, thermoplasticity, and nonflammability, these compounds enjoy wide industrial application. These compounds are used in the production of electric condensers; in the insulation of electric cables and wires; as additives to extreme pressure lubricants; as supports for storage batteries; and as a coating in foundry use. *octachloro-*: Used as a fireproof and waterproof additive and lubricant additive. *Pentachloro-:* Used in electric wire insulation and in additives to special lubricants. *tetrachloro-:* Used in electrical insulating materials and as an additive in cutting oils. *trichloro-:* Used in lubricants and in the manufacture of insulation for electrical wire.

Because of the possible potentiation of the toxicity of higher Chlorinated naphthalenes by ethanol and carbon tetrachloride, individuals who ingest enough alcohol to result in liver dysfunction would be a special group at risk. Individuals, e.g., analytical and synthetic chemists, mechanics and cleaners, who are routinely exposed to carbon tetrachloride or other hepatotoxic chemicals would also be at a greater risk than a population without such exposure. Individuals involved in the manufacture, utilization, or disposal of polychlorinated naphthalenes would be expected to have higher levels of exposure than the general population.

Incompatibilities: All are incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Keep away from heat. Penta- is also incompatible with acids, alkalis.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

90-13-1, 1-chloro-

PAC-1: 4.6 milligram per cubic meter

PAC-2: 51 milligram per cubic meter

PAC-3: 310 milligram per cubic meter

91-58-7, 2-chloro-

PAC-1: 6.2 milligram per cubic meter

PAC-2: 69 milligram per cubic meter

PAC-3: 410 milligram per cubic meter

1335-87-1, hexachloro-

NIOSH IDLH = 2 milligram per cubic meter

OSHA PEL: 0.2 milligram per cubic meter TWA [skin]

NIOSH REL: 0.2 milligram per cubic meter TWA [skin]

ACGIH TLV[1]: 0.2 milligram per cubic meter TWA [skin]

PAC Ver. 29[138]

PAC-1: 0.6 milligram per cubic meter

PAC-2: 6.6 milligram per cubic meter

PAC-3: 40 milligram per cubic meter

Arab Republic of Egypt: TWA 0.2 milligram per cubic meter, 1993; Denmark: TWA 0.2 milligram per cubic meter [skin], 1999; France: VME 0.2 milligram per cubic meter [skin], 1999; the Philippines: TWA 0.2 milligram per cubic meter [skin], 1993; Poland: MAC (TWA) 0.5 milligram per cubic meter, MAC (STEL) 1.5 milligram per cubic meter, 1999; Sweden: NGV 0.2 milligram per cubic meter, KTV 0.6 milligram per cubic meter [skin], 1999; Switzerland: MAK-W 0.2 milligram per cubic meter [skin], 1999; the Netherlands: MAC-TGG 0.2 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TL V: TWA 0.2 milligram per cubic meter [skin]

2234-13-1*, octachloro-*

OSHA PEL: 0.1 milligram per cubic meter TWA [skin]

NIOSH REL: 0.1 milligram per cubic meter TWA; 0.3 milligram per cubic meter STEL [skin]

ACGIH TLV[1]: 0.1 milligram per cubic meter TWA; 0.3 milligram per cubic meter STEL [skin]

PAC Ver. 29[138]

PAC-1: 0.3 milligram per cubic meter

PAC-2: 3.3 milligram per cubic meter

PAC-3: 20 milligram per cubic meter

Denmark: TWA 0.1 milligram per cubic meter [skin], 1999; France: VME 0.1 milligram per cubic meter [skin], 1999; Norway: TWA 0.1 milligram per cubic meter, 1999; the Philippines: TWA 0.1 milligram per cubic meter [skin], 1993; Poland: MAC (TWA) 0.5 milligram per cubic meter, MAC (STEL) 1.5 milligram per cubic meter, 1999; Sweden: NGV 0.2 milligram per cubic meter, KTV 0.6 milligram per cubic meter [skin], 1999; Switzerland: MAK-W 0.1 milligram per cubic meter [skin], 1999; the Netherlands: MAC-TGG 0.1 milligram per cubic meter [skin], 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 0.3 milligram per cubic meter [skin]

1321-64-8, *pentachloro-* (see also separate record at P:0220)

OSHA PEL: 0.5 milligram per cubic meter TWA [skin]

NIOSH REL: 0.5 milligram per cubic meter TWA [skin]

ACGIH TLV[1]: 0.5 milligram per cubic meter TWA [skin]

DFG MAK: 0.5 milligram per cubic meter TWA [skin]

Australia: TWA 0.5 milligram per cubic meter, 1993; Austria: MAK 0.5 milligram per cubic meter [skin], 1999; Belgium: TWA 0.5 milligram per cubic meter, 1993;

Denmark: TWA 0.5 milligram per cubic meter [skin], 1999; France: VME 0.5 milligram per cubic meter, 1999; Norway: TWA 0.5 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 0.5 milligram per cubic meter, 2003; Poland: MAC (TWA) 0.5 milligram per cubic meter, MAC (STEL) 1.5 milligram per cubic meter, 1999; Sweden: NGV 0.2 milligram per cubic meter, KTV 0.3 milligram per cubic meter [skin], 1999; Switzerland: MAK-W 0.5 milligram per cubic meter, KZG-W 2.5 milligram per cubic meter [skin], 1999; Turkey: TWA 0.5 milligram per cubic meter [skin], 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 0.5 milligram per cubic meter [skin]

1335-88-2, tetrachloro-

OSHA PEL: 2 milligram per cubic meter TWA [skin]

NIOSH REL: 2 milligram per cubic meter TWA [skin]

ACGIH TLV[1]: 2 milligram per cubic meter TWA [skin]

Australia: TWA 2 milligram per cubic meter, 1993; Belgium: TWA 2 milligram per cubic meter, 1993; Denmark: TWA 2 milligram per cubic meter [skin], 1999; France: VME 2 milligram per cubic meter, 1999; Norway: TWA 0.01 mg(Ag)/m^3, 1999; the Philippines: TWA 2 milligram per cubic meter [skin], 1993; the Netherlands: MAC-TGG 2 milligram per cubic meter [skin], 2003; Sweden: NGV 0.2 milligram per cubic meter, KTV 0.6 milligram per cubic meter [skin], 1999; Switzerland: MAK-W 2 milligram per cubic meter, 1999; United Kingdom: LTEL 2 milligram per cubic meter; STEL 4 milligram per cubic meter, 1993; United Kingdom: TWA 2 milligram per cubic meter; STEL 4 milligram per cubic meter, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 2 milligram per cubic meter

PAC Ver. 29[138]

1321-65-9, trichloro-

OSHA PEL: 5 milligram per cubic meter TWA [skin]

NIOSH REL: 5 milligram per cubic meter TWA [skin]

ACGIH TLV[1]: 5 milligram per cubic meter TWA [skin]

PAC Ver. 29[138]

PAC-1: 15 milligram per cubic meter

PAC-2: 170 milligram per cubic meter

PAC-3: 990 milligram per cubic meter

DFG MAK: [skin]

Arab Republic of Egypt: TWA 5 milligram per cubic meter, 1993; Australia: TWA 5 milligram per cubic meter [skin], 1993; Austria: MAK 5 milligram per cubic meter [skin], 1999; Belgium: TWA 5 milligram per cubic meter [skin], 1993; Denmark: TWA 5 milligram per cubic meter [skin], 1999; France: VME 5 milligram per cubic meter [skin], 1999; Hungary: TWA 1 milligram per cubic meter; STEL 2 milligram per cubic meter [skin], 1993; the Netherlands: MAC-TGG 5 milligram per cubic meter, 2003; the Philippines: TWA 5 milligram per cubic meter [skin], 1993; Poland: MAC (TWA) 5 milligram per cubic meter, 1999; Russia: STEL 1 milligram per cubic meter [skin], 1993; Sweden: NGV 0.2 milligram per cubic meter, KTV 0.5 milligram per cubic meter [skin], 1999; Switzerland: MAK-W 5 milligram per cubic meter [skin], 1999; Turkey: TWA 5 milligram per cubic meter [skin], 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TL V: 5 milligram per cubic meter [skin]

Determination in Air: *Hexa-isomer:* Filter; Hexane; GC/Electrochemical detection; NIOSH II(2) Method #S100.

Octa-isomer: Filter; Hexane; GC/Flame ionization detection; NIOSH II(2) Method #S97.

Penta-isomer: Filter/Bubbler; Isooctane; GC/Electrochemical detection; NIOSH II(2) Method #S96.

Tetra-isomer: Filter/Bubbler; none; GC/Flame ionization detection; NIOSH II(2) Method #S130 (II-1).

Tri-isomer: Filter/Bubbler; none; GC/Flame ionization detection; NIOSH II(2) Method #S128.

Permissible Concentration in Water: Toxic pollutant designated pursuant to section 307(a)(1) of the Federal Water Pollution Control Act and is subject to effluent limitations. State Drinking Water Guidelines (2-isomer): Florida 560 μg/L.

Determination in Water: 2-Chloronaphthalene may be determined by GC (EPA Method 612) or by GC plus mass spectrometry (EPA Method 625). Octanol−water coefficient: Log K_{ow} = *Tetra-isomer:* about 6.1; *Tri*-isomer: 5.12-7.56; *Penta-isomer:* 8.73-9.13, Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood. Naphthalenes and naphthenic acids are listed as United States DOT marine pollutants and may persist in the environment.

Routes of Entry: Inhalation of fumes and percutaneous absorption of liquid, ingestion; eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Contact can irritate eyes and skin. Cases of systemic poisoning are few in number and they may occur without the development of chloracne. It is believed that chloracne develops from skin contact and inhalation of fumes, while systemic effects result primarily from inhalation of fumes. Symptoms of poisoning may include headaches, fatigue, vertigo, and anorexia. Jaundice may occur from liver damage. Highly chlorinated naphthalenes seem to be more toxic than those chlorinated naphthalenes with a lower degree of substitution.

Long-Term Exposure: May cause acne-like dermatitis. May affect the liver, resulting in jaundice. Can affect the nervous system. Chronic exposure to chlorinated naphthalenes can cause chloracne, which consists of simple erythematous eruptions with pustules, papules, and comedones. Cysts may develop due to plugging of the sebaceous gland orifices.

Points of Attack: Skin, liver, nervous system, reproductive system.

Medical Surveillance: Preplacement and periodic examinations should be concerned particularly with skin lesions, such as chloracne and with liver function. Liver function tests. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Examination of the nervous system. More than light consumption of alcohol may increase liver damage. May be mutagenic.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *hexa-isomer: up to 2 milligram per cubic meter:* SA*: (any supplied-air respirator); or SCBAF: (any SCBA with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full facepiece respirator with an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).*May require eye protection.

Octa-isomer: up to 1 milligram per cubic meter: SA*: (any supplied-air respirator); or SCBAF: (any SCBA with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10, 000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Penta-isomer: up to 5 milligram per cubic meter: SA*: (any supplied-air respirator); or SCBAF: (any SCBA with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).*May require eye protection.

tetra-isomer: up to 20 milligram per cubic meter: SCBAF: (any SCBA with a full facepiece); or SAF: (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

tri-isomer: up to 50 milligram per cubic meter: SCB AF: (any SCBA with a full facepiece); or SAF: (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with chlorfenvinphos all handlers should be trained on its proper handling and storage. Should be protected from moisture and stored in glass-lined or polyethylene-lined containers. Keep away from strong bases. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN3082 Environmentally hazardous substances, liquid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Dampen material with toluene. Collect material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: These chemicals are noncombustible solids. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. Thermal decomposition products may include hydrogen chloride and phosgene. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: High-temperature incineration with flue gas scrubbing. Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced[22].

References

(31); (173); (101); (138); (100).

The references to Sax, N. I., Ed., "Dangerous Properties of Industrial Materials Report," may be tabulated as follows:

(31); Isomer	***Volume***	***No.***	***Pages***	***Year***
1-Chloro-	3	2	77–78	(1983)
2-Chloro-	4	6	85–88	(1984)
Trichloro-	6	6	78–80	(1986)
Tetrachloro-	6	6	76–78	(1986)
Pentachloro-	5	1	84–87	(1985)
Hexachloro-	5	1	81–84	(1985)
Octachloro-	4	5	40–45	(1984)

References

United States Environmental Protection Agency, Chlorinated Naphthalenes: Ambient Water Quality Criteria, Washington, DC (1980).

United States Environmental Protection Agency, Chlorinated Naphthalenes, Health and Environmental Effects Profile No. 38, Office of Solid Waste, Washington, DC (April 30, 1980).

United States Environmental Protection Agency, 2-Chloronaphthalene, Health and Environmental Effects Profile No. 49, Office of Solid Waste, Washington, DC (April 30, 1980).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Hexachloronaphthalene, Trenton, NJ (April 1999).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Octachloronaphthalene, Trenton, NJ (March 2000).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Pentachloronaphthalene, Trenton, NJ (December 1999).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Tetrachloronaphthalene, Trenton, NJ (April 2000).

Chlorine C:0670

Formula: Cl_2

Synonyms: Bertholite; Chlor (German); Chlore (French); Chlorine molecular (C12); CL (military designation); Cloro (Spanish); Diatomic chlorine; Dichlorine; Molecular chlorine; Poly I gas

CAS Registry Number: 7782-50-5

HSDB Number: 206

RTECS Number: FO2100000

UN/NA & ERG Number: (PIH) UN1017/124

EC Number: 231-959-5 [*Annex I Index No.:* 017-001-00-7]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 2500 ($\geq$1.00% concentration); *Theft hazard* 500 ($\geq$9.77% concentration)

Carcinogenicity: NCI: Carcinogenesis Studies (water); equivocal evidence: rat; no evidence: mouse.

Hazard Alert: Poison inhalation hazard, Extremely toxic gas and lung damaging agent, Powerful oxidizer, Corrosive, Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Environmental hazard.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); Accidental Release Prevention/Flammable Substances (Section 112 [r], Table 3), $TQ = 2500$ lb (1135 kg)

United States National Primary Drinking Water Regulations: $MRDL = 4.0$ mg/L; $MRDLG = 4.0$ mg/L; $SMCL = 250$ mg[Cl^-]/L; Priority List (55 FR 1470).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

In 1998 EPA set an MCL for TTHM (total trihalomethane) at MCLs to 0.80 mg/L (down from 0.100 mg/L set in 1976), and Maximum Residual Disinfectant level Goals (MRDG) for chlorine was set @ 4 mg/L.

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%; NPRI.

Hazardous to aquatic life or environment, with possible long-lasting effects[291]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, N, O; risk phrases: R3; R5; R8; R12; R21; R23; R36/37/38; R50; R62; R63; safety phrases: S1/2; S9; S29/35; S33; S38; S41; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Chlorine is a greenish-yellow gas. Pungent, irritating odor. Shipped as a liquefied compressed gas. It is the commonest of the four halogens which are among the most chemically reactive of all the elements. It is not flammable; but it is a strong oxidizer, and contact with other materials may cause fire. Molecular weight = 70.91; specific gravity (H_2O:1) 1.4 @ 20°C, 6.86 atm (liquid); boiling point = −34.6°C; freezing/melting point = −101°C; relative vapor density (air = 1) = 2.47; vapor pressure = 6.8 atm; 5168 mmHg @ 20°C. Slightly soluble in water; solubility = 0.7%. Hazard identification (based on NFPA-704 M Rating System): Health 4, flammability 0, reactivity 0, oxidizer.

Potential Exposure: Environmental danger. Chlorine is a toxic gas with corrosive properties. Gaseous chlorine is widely used as a bleaching agent in the paper, pulp, and textile industries for bleaching cellulose for artificial fibers. It is used in the manufacture of chlorinated lime; inorganic and organic compounds, such as metallic chlorides; chlorinated solvents; refrigerants, pesticides; and polymers, e.g., synthetic rubber and plastics; it is used as a disinfectant, particularly for water and refuse; and in detinning and dezincing iron. CL has been used as a warfare choking/pulmonary agent. *Note*: The lowest level at which humans can detect chlorine through smell and become alert to its irritant properties generally provides sufficient warning of exposure. However, chronic exposure to chlorine causes olfactory fatigue and tolerance to its irritant effects. Those with a history of prolonged exposure to chlorine, may eventually lose their ability to identify incidents of exposure.

Incompatibilities: A powerful oxidizer. Reacts explosively or forms explosive compounds with many organic compounds and common substances, such as acetylene, ether, turpentine, ammonia, fuel gas, hydrogen, and finely divided metals. Keep away from combustible substances and reducing agents. Corrosive to some plastic, rubber, and coating materials. Reacts with water to form hypochlorous acid. Corrosive to many metals in presence of water.

Permissible Exposure Limits in Air

NIOSH IDLH = 10 ppm

Odor threshold = 0.01 ppm in air.

Conversion factor: 1 ppm = 2.90 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 1 ppm/3 milligram per cubic meter Ceiling Concentration

NIOSH REL: 0.5 ppm/1.45 milligram per cubic meter [15 minutes] Ceiling Concentration

ACGIH TLV[1]: 0.5 ppm/1.5 milligram per cubic meter TWA; 1 ppm/2.9 milligram per cubic meter STEL, not classifiable as a human carcinogen

PAC Chlorine*

PAC-1: $\mathbf{0.5_A}$ ppm

PAC-2: $\mathbf{2_A}$ ppm

PAC-3: $\mathbf{20_A}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60-minute values.

DFG MAK: 0.5 ppm/1.5 milligram per cubic meter TWA; Peak Limitation Category I(1); Pregnancy Risk Group C

Arab Republic of Egypt: TWA 1 ppm (3 milligram per cubic meter), 1993; Australia: TWA 1 ppm (3 milligram per cubic meter), 1993; Austria: MAK 0.5 ppm (1.5 milligram per cubic meter), 1999; Belgium: TWA 0.5 ppm (1.5 milligram per cubic meter); STEL 1 ppm, 1993; Denmark: TWA 0.5 ppm (1.5 milligram per cubic meter), 1999; Finland: TWA 0.5 ppm (1.5 milligram per cubic meter); STEL 1 ppm (3 milligram per cubic meter), 1999; France: VLE 1 ppm (3 milligram per cubic meter), 1999; the Netherlands: MAC 3 milligram per cubic meter, 2003; India: TWA 1 ppm (3 milligram per cubic meter); STEL 3 ppm (9 milligram per cubic meter), 1993; Japan: 1 ppm (2.9 milligram per cubic meter), 1999; Norway: TWA 0.5 ppm (1.5 milligram per cubic meter), 1999; the Philippines: TWA 1 ppm (3 milligram per cubic meter), 1993; Poland: MAC (TWA) 1.5 milligram per cubic meter; STEL 9 milligram per cubic meter, 1999; Russia: TWA 1 ppm; STEL 1 milligram per cubic meter, 1993; Sweden: NGV 0.5 ppm (1.5 milligram per cubic meter), TGV 1 ppm (3 milligram per cubic meter), 1999; Switzerland: MAK-W 0.5 ppm (1.5 milligram per cubic meter), KZG-W 1 ppm (3 milligram per cubic meter), 1999; Thailand: TWA 1 ppm (3 milligram per cubic meter), 1993; Turkey: TWA 1 ppm (3 milligram per cubic meter), 1993; United Kingdom: TWA 0.5 ppm (1.5 milligram per cubic meter); STEL 1 ppm (2.9 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 1 ppm.

Russia set a MAC in work-place air of 1.0 milligram per cubic meter and values for ambient air in residential areas of 0.1 milligram per cubic meter on a momentary basis and 0.03 milligram per cubic meter on an average daily basis. Several states have set guidelines or standards for chlorine in ambient air[60] ranging from 0 (North Carolina) to 7.143 μ/m^3 (Kansas) to 10.0 μ/m^3 (New York) to 30.0 μ/m^3 (Florida) to 30−90 μ/m^3 (North Dakota) to 39 μ/m^3 (Massachusetts) to 50 μ/m^3 (Virginia) to 60 μ/m^3 (Connecticut) to 71 μ/m^3 (Nevada) to 75 μ/m^3 (South Carolina).

Determination in Air: Use NIOSH Analytical Method (IV) #6011, OSHA Analytical Method ID-101, ID-126SGX.

Permissible Concentration in Water: EPA has suggested the following limits: Total residual chlorine: 2.0 μg/L for salmonid fish; 10.0 μg/L for other freshwater and marine organisms. Russia[43] recommends an absence of active chlorine (taking into account the absorbing capacity of water) in domestic water supplies and a MAC of zero in water for fishery purposes.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = < 1$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, eye and skin contact.

Harmful Effects and Symptoms

Chlorine reacts with body moisture to form acids. It is itself extremely irritating to skin, eyes, and mucous membranes; and it may cause corrosion of teeth. Prolonged exposure to low concentrations may produce chloracne.

Chlorine in high concentrations acts as an asphyxiant by causing cramps in the muscles of the larynx (choking), swelling of the mucous membranes; nausea, vomiting, anxiety, and syncope. Acute respiratory distress including cough, hemoptysis, chest pain; dyspnea, and cyanosis develop; and later tracheobronchitis, pulmonary edema; and pneumonia may supervene. Exposure to 1.0 ppm may produce irritation of the nose, mouth, and throat; @ 1.3 ppm and above, irritation may be more pronounced with coughing and labored breathing; high concentrations may cause throat muscle spasm leading to suffocation and death; delayed effects may include accumulation of fluid in the lungs, bronchitis, and pneumonia. Death may occur after a few breaths @ 1000 ppm.

Short-Term Exposure: A lacramator. Chlorine is corrosive to the eyes, skin, and respiratory tract. Eye contact can cause permanent damage. Inhalation of the gas can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Rapid evaporation of the liquid may cause frostbite.

Long-Term Exposure: Repeated exposure may permanently damage the lungs, or cause chronic bronchitis. Chlorine may affect the teeth, resulting in erosion; and cause skin rash. A single high exposure may cause similar health effects.

Points of Attack: Lungs, respiratory system.

Medical Surveillance: Special emphasis should be given to the skin, eyes, teeth, and cardiovascular status in placement and periodic examinations. Chest X-rays should be taken and pulmonary function followed.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: *General information*: first responders should use a NIOSH-certified chemical, biological, radio logical, nuclear (CBRN) SCBA with a level a protective suit when entering an area with an unknown contaminant or when entering an area where the concentration of the contaminant is unknown. Level a protection should be used until monitoring results confirm the contaminant and the concentration of the contaminant. *Note:* safe use of protective clothing and equipment requires specific skills developed through training and experience.

LEVEL A: (*RED ZONE*): select when the greatest level of skin, respiratory, and eye protection is required. This is the maximum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than the AEGL-2. A NIOSH-certified CBRN full-facepiece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle. A totally encapsulating chemical protective (TECP) suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, and a hard hat worn under the TECP suit are optional items.

LEVEL B: (RED ZONE): Select when the highest level of respiratory protection is necessary but a lesser level of skin protection is required. This is the minimum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than AEGL-2. It differs from Level A in that it incorporates a nonencapsulating, splash-protective, chemical-resistant splash suit that provides Level A protection against liquids but is not airtight. A NIOSH-certified CBRN full-facepiece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL C: (YELLOW ZONE): Select when the contaminant and concentration of the contaminant are known and the respiratory protection criteria factors for using APRs (APR) or PAPRs are met. This level is appropriate when decontaminating patient/victims. A NIOSH-certified CBRN tight-fitting APR with a canister-type gas mask or CBRN PAPR for air levels greater than AEGL-2. A NIOSH-certified CBRN PAPR with a loose-fitting facepiece, hood, or helmet and a filter or a combination organic vapor, acid gas, and particulate cartridge/filter combination or a continuous flow respirator for air levels greater than AEGL-1. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Escape mask, face shield, coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL D: (GREEN ZONE): Select when the contaminant and concentration of the contaminant are known and the concentration is below the appropriate occupational exposure limit or less than AEGL-1 for the stated duration times. Limited to coveralls or other work clothes, boots, and gloves.

Notes: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Whenever there is likelihood of excessive gas levels, workers should use respiratory protection in the form of full-face gas masks with proper canisters or supplied-air respirators. The skin effects of chlorine can generally be controlled by good personal hygiene practices. Where very high gas concentrations or liquid chlorine may be present, full protective clothing, gloves, and eye protection should be used. Saranex, Butyl rubber/Neoprene, Viton, Neoprene, butyl rubber; and Viton/Neoprene are among the recommended protective materials. Changing work clothes daily and showering following each shift where exposures exist are recommended.

Respirator Selection: *5 ppm:* CcrS (APF = 10) [any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern]; or Sa (APF = 10) (any supplied-air respirator). *12.5 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprS (APF = 25) (any powered, APR with cartridge(s) providing protection against the compound of concern); or CcrFS (APF = 50) [any chemical cartridge respirator with a full facepiece and cartridge(s) providing protection against the compound of concern]; or GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS (APF = 50) (any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern); or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Check oxygen content prior to entering storage area. Poison gas. (1) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. (2) Color code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially organic materials, flammables and combustibles, and other incompatible materials. Oxidizers should be isolated from acids, metals, organic materials, and ammonium nitrate. Oxidizers, including oxidizing gases, should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. (3) Color code—White stripe: Contact Hazard; Store separately; not compatible with materials in solid white category. This gas is toxic and/or corrosive, nonflammable. Outside or detached storage is preferred in an area that is roofed, shaded with the cylinders stored off the ground on nonwooden floors, and away from radiant heat sources and all possible sources of ignition. If indoors or outdoors, store in a well-ventilated noncombustible location temperatures not to exceed 50°C. Automatic monitoring systems are also preferred. Prior to working with chlorine all handlers should be trained on its proper handling and storage. Protect containers against physical damage. Store cylinders and containers in a cool, dry, relatively isolated area, protected from weather and extreme temperature changes. Store in a cool, well-ventilated area away from incompatible materials listed above. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage.

Shipping: UN1017 Chlorine, Hazard Class: 2.3; Labels: 2.3-Poisonous gas, 5.1-Oxidizer, 8-Corrosive material, Inhalation Hazard Zone B. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner. Military driver shall be given full and complete information regarding shipment and conditions in case of emergency. AR 50-6 deals specifically with the shipment of chemical agents. Shipments of agent will be escorted in accordance with AR 740-32.

Spill Handling:.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

UN1017 Chlorine

*Small spills (From a small package or a small leak from a large package)**

First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 1.0/1.5

*Large spills (From a large package or from many small packages)**

First: Isolate in all directions (ft/m) 1500/500
Then: Protect persons downwind (mi/km)
Day 1.9/3.1
Night 4.9/8.0

***Attention:** If dealing with a large spill from the following containers: (1) Rail tank car, (2) Highway tank truck or trailer, (3) Multiple ton cylinders, or (4) Multiple small cylinders or single ton cylinder see the following: "ERG Table 3: Initial Isolation and Protective Action Distances for Different Quantities of Six Common Toxic-by-Inhalation Gases." This chart shows isolation protective distances for the transport containers listed above (numbers 1 through 4) and various wind conditions: Low wind (<6 mph); Moderate wind (6 to 12 mph); High wind (>12 mph).

CL, when used as a weapon

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.3/0.5
Night 1.0/1.5

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 2000/600
Then: Protect persons downwind (mi/km)
Day 2.2/3.6
Night 5.0/8.0

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. If the gas is leaked, stop the flow of gas if it can be done safely. If the source of the leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, and, repair the leak or allow the cylinder to empty. If the leak can be stopped in place, bubble chlorine through a sodium sulfide and excess sodium bicarbonate solution including a trap in the line. For liquid spills, ventilate area and wash down spill with water. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Chlorine is a noncombustible solid, but it will increase the intensity of a fire and cause fire upon contact with combustible materials. Thermal decomposition products may include chlorine. Firefighting gear (including SCBA) does not provide adequate protection. If exposure occurs, remove and isolate gear immediately and thoroughly decontaminate personnel. Vapors are heavier than air and will collect in low areas. Hydrogen and chlorine mixtures (5%–95%) are exploded by almost any form of energy (heat, sunlight, sparks, etc.). May combine with water or steam to produce toxic and corrosive fumes of hydrochloric acid. Use any extinguishing agent suitable for surrounding fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Introduce into large volume and solution of reducing agent (bisulfite, ferrous salts, or hypo), neutralize and flush to sewer with water. Recovery is an option to disposal for chlorine in the case of gases from aluminum chloride electrolysis and chlorine in waste waters. See also "Spill Handling." Nonrefillable cylinders should be disposed of in accordance with local, state, and federal regulations. Allow remaining gas to vent slowly into atmosphere in an unconfined area or exhaust hood. Refillable-type cylinders should be returned to original supplier with any valve caps and outlet plugs secured and valve protection caps in place.

References

(31); (173); (101); (138); (2); (80); (100).

National Institute for Occupational Safety and Health (NIOSH), "Criteria for a Recommended Standard: Occupational Exposure to Chlorine", NIOSH Document Number 76-170, Cincinnati, OH (1976).

National Academy of Sciences, Medical and Biological Effects of Environmental Pollutants: Chlorine and Hydrogen Chloride, Washington, DC (1976).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 3, 41−43 (1981) and 2, No. 4, 67−70, New York, Van Nostrand Reinhold Co. (1982) (Chlorine-36).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Chlorine, Washington, DC, Chemical Emergency Preparedness Program (October 31, 1985).

New York State Department of Health, *Chemical Fact Sheet* Chlorine, Bureau of Toxic Substance Assessment, Albany, NY (January 1986 and Version 2).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Chlorine, Trenton, NJ (August 1998)

Chlorine Dioxide C:0680

Formula: ClO_2

Synonyms: Alcide; Anthium dioxcide; Chlorine oxide; Chlorine (IV) oxide; Chlorine peroxide; Chloroperoxyl; Chloryl radical: "ClO_2"; Dioxido de cloro (Spanish); Doxcide 50; Ez flow; Purogene

CAS Registry Number: 10049-04-4; 70377-94-4

HSDB Number: 517

RTECS Number: FO3000000

UN/NA & ERG Number: (PIH) UN/NA 9191 (hydrate, frozen)/143

EC Number: 233-162-8 [*Annex I Index No.:* 006-089-00-2]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 1000 (≥1.00% concentration).

Carcinogenicity: EPA: Cannot be Determined; Not Classifiable as to human carcinogenicity.

Hazard Alert: Poison inhalation hazard, High acute toxicity, Highly flammable, Suspected reprotoxic hazard, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction).

United States Environmental Protection Agency, FIFRA 1998 Status of Pesticides: Supported

Clean Air Act: Accidental Release Prevention/Flammable Substances (Section 112 [r], Table 3), TQ = 1000 lb (454 kg)

Safe Drinking Water Act (47FR 9352): Priority List (55 FR 1470)

United States National Primary Drinking Water Regulations: MRDL = 0.8 mg/L; MRDLG = 0.8 mg/L

In 1998 EPA set an MCL for TTHM (total trihalomethane) at MCLs to 0.80 mg/L (down from 0.100 mg/L set in 1976), MRDG for chlorine dioxide was set at 0.8 mg/L

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%; C (Oxidizing Material); D1B (Toxic); E (Corrosive Material); F (Dangerously Reactive); NPRI.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, F, O, N; risk phrases: R6; R8; R11; R26; R34; R50; R62; safety phrases: S1/2; S21; S23; S26; S28; S36/37/39; S38; S41; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Chlorine dioxide is a flammable, reddish-yellow gas, or reddish-brown liquid (below 11°C/52°F) with an irritating odor like chlorine or nitric acid. Molecular weight = 67.45; specific gravity (H_2O:1) = 1.6 (liquid @ 0°C); 3.09 @ 11°C; boiling point = 11°C; freezing/melting point = −59°C; relative vapor density (air = 1) = 2.3; vapor pressure = > 1 atm @ 20°C. Explosive Limits in air: >10%. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 3, reactivity 3 (Shock; Oxidizer). Soluble in water (reactive); solubility = 0.3% @ 25°C.

Potential Exposure: Chlorine dioxide is used in bleaching cellulose pulp; bleaching flour; water purification; as a liquid sterilizer in an ultrasonic cleaner.

Incompatibilities: Unstable in light. A powerful oxidizer. Chlorine dioxide gas is explosive at concentrations over 10% and can be ignited by almost any form of energy, including sunlight, heat (explosions can occur in air in temperature above 130°C), or sparks, shock, friction, or concussion. This chemical reacts violently with dust, combustible materials; and reducing agents. Reacts violently with mercury, phosphorus, sulfur, and many compounds, causing fire and explosion hazard. Contact with water forms perchloric and hydrochloric acid. Corrosive to metals.

Permissible Exposure Limits in Air

NIOSH IDLH = 5 ppm

OSHA PEL: 0.1 ppm/0.3 milligram per cubic meter TWA

NIOSH REL: 0.1 ppm/0.3 milligram per cubic meter TWA; 0.3 ppm/0.9 milligram per cubic meter STEL

ACGIH TLV[1]: 0.1 ppm/0.28 milligram per cubic meter TWA; 0.3 ppm/0.83 milligram per cubic meter STEL

PAC* Ver. 29[138]
PAC-1: **0.15**$_{\mathbf{A}}$ ppm
PAC-2: **1.1**$_{\mathbf{A}}$ ppm
PAC-3: **2.4**$_{\mathbf{A}}$ ppm
*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60-minute values.
Emergency Response Planning Guidelines
ERPG-1: inappropriate
ERPG-2: 50 ppm
ERPG-3: 5000 ppm
DFG MAK: 0.1 ppm/0.28 milligram per cubic meter TWA; Peak Limitation Category I(1); Pregnancy Risk Group D
Australia: TWA 0.1 ppm (0.3 milligram per cubic meter); STEL 0.3 ppm, 1993; Austria: MAK 0.1 ppm (0.3 milligram per cubic meter), 1999; Belgium: TWA 0.1 ppm (0.28 milligram per cubic meter); STEL 0.3 ppm, 1993; Denmark: TWA 0.1 ppm (0.3 milligram per cubic meter), 1999; Finland: TWA 0.1 ppm (0.3 milligram per cubic meter); STEL 0.3 ppm (0.9 milligram per cubic meter), 1999; France: VME 0.1 ppm (0.3 milligram per cubic meter), VLE 0.3 ppm (0.8 milligram per cubic meter), 1999; Norway: TWA 0.1 ppm (0.3 milligram per cubic meter), 1999; the Philippines: TWA 0.1 ppm (0.3 milligram per cubic meter), 1993; Poland: MAC (TWA) 0.3 milligram per cubic meter, MAC (STEL) 0.9 milligram per cubic meter, 1999; Russia: STEL 0.1 milligram per cubic meter, 1993; Sweden: NGV 0.1 ppm (0.3 milligram per cubic meter), KTV 0.3 ppm (0.8 milligram per cubic meter), 1999; Switzerland: MAK-W 0.1 ppm (0.3 milligram per cubic meter), KZG-W 0.2 ppm (0.6 milligram per cubic meter), 1999; Thailand: TWA 0.1 ppm (0.3 milligram per cubic meter), 1993; Turkey: TWA 0.1 ppm (0.3 milligram per cubic meter), 1993; United Kingdom: TWA 0.1 ppm (0.28 milligram per cubic meter); STEL 0.3 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 0.3 ppm. Several states have set guidelines or standards for ClO_2 in ambient air[60] ranging from 1.0 μ/m^3 (New York) to 3.0 μ/m^3 (Florida) to 3.0–9.0 μ/m^3 (North Dakota) to 5.0 μ/m^3 (Virginia) to 6.0 μ/m^3 (Connecticut) to 7.0 μ/m^3 (Nevada).

Determination in Air: Collection by bubbler; Potassium iodide; Ion chromatography; OSHA Analytical Method #ID202.

Permissible Concentration in Water: Values in guidelines or standards for chlorine in drinking water[61] have been set by Maine @ 110 μg/L and by the United States Environmental Protection Agency @ 1000 μg/L.

Routes of Entry: Inhalation, ingestion, eye and skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: A lacramator. Chlorine dioxide is corrosive to the eyes, skin, and respiratory tract. Inhalation can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Inhalation at levels above 0.25 ppm may cause slight irritation to the nose, throat, and mouth. Levels above 5 ppm may cause severe irritation to the nose, throat, and mouth. 19 ppm for an unspecified time has caused death.

Long-Term Exposure: Chlorine dioxide may affect the lungs, causing chronic bronchitis to develop with cough, phlegm, and/or shortness of breath. This chemical may affect the teeth, causing erosion. There is limited evidence that Chlorine dioxide may damage the developing fetus.

Points of Attack: Respiratory system, lungs, eyes.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Consider X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. When working with liquid, wear splash-proof chemical goggles and face shield when there is a potential for exposure to gas, unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *1 ppm:* CcrS (APF = 10) (any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern); or Sa (APF = 10) (any supplied-air respirator). *2.5 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprS (APF = 25) [any powered, APR with cartridge(s) providing protection against the compound of concern]. *5 ppm:* CcrFS (APF = 50) [any chemical cartridge respirator with a full facepiece and cartridge(s) providing protection against the compound of concern]; or GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS (APF = 50) (any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern); or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection. Only nonoxidizable sorbents allowed (not charcoal).

Storage: Color code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially organic materials, flammables and combustibles, and other incompatible materials. Oxidizers, including oxidizing gases, should have a boundary separation of 8–10 m or a 1-hour fire wall from flammable or reactive materials. Prior to working with chlorine dioxide all handlers should be trained on its proper handling and storage. This chemical is a powerful oxidizer, and is shock-, light-, and heat-sensitive. It is violently explosive in air at concentrations over 10%. Keep frozen when not in use. Store in tightly closed containers in a cool, dark, well-ventilated area at temperatures well below 130°C. Gas explosions may occur above 130°C. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Use explosion-proof electrical equipment and fittings in storage area. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: UN/NA 9191 Chlorine dioxide, hydrate, frozen, Hazard class: 5.1; Labels: 5.1-Oxidizer, 6.1-Poison Inhalation. Explosive: It may only be shipped in the frozen state and then only by private or contract motor carrier.

Spill Handling:

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

Chlorine dioxide, hydrate, frozen
when spilled in water

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or many small packages)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 0.4/0.6

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of leak or spill. If the gas is leaked, stop the flow of gas if it can be done safely. If the source of the leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, and, repair the leak or allow the cylinder to empty. If the leak can be stopped in place, bubble chlorine dioxide through a solution made up of reducing agent sodium bisulfide and sodium bicarbonate with a trap in the line. For liquid spills, allow chlorine dioxide to evaporate with all available ventilation. Keep chlorine dioxide out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include chlorine gas. A powerful oxidizer, this chemical will increase the intensity of a fire, and can cause fire upon contact with combustibles. This chemical is an explosive at concentrations over 10% and can be ignited by almost any form of energy. Firefighting gear (including SCBA) may not provide adequate protection. If exposure occurs, remove and isolate gear immediately and thoroughly decontaminate personnel. Use water only. *Do not* use dry chemical or carbon dioxide extinguishers. Use water with caution as chlorine dioxide reacts with water, forming hydrogen chloride gas.

Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Use large volume of concentrated solution of ferrous salt or bisulfite solution as reducing agent. Then neutralize and flush to sewer with abundant water[24].

References

(31); (173); (101); (138); (80); (100).

New York State Department of Health, *Chemical Fact Sheet* Chlorine Dioxide, Bureau of Toxic Substance Assessment, Albany, NY (March 1986 and revision).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Chlorine Dioxide, Trenton, NJ (June 1998).

Chlorine Trifluoride C:0690

Formula: ClF_3

Synonyms: Chlorine fluoride; Chlorine trifluoride; Chlorotrifluoride; Trifluorure de chlore (French); Trifluoruro de cloro (Spanish)

CAS Registry Number: 7790-91-2

HSDB Number: 970

RTECS Number: FO2800000

UN/NA & ERG Number: (PIH) UN1749/124

EC Number: 232-230-4

Regulatory Authority and Advisory Information

Department of Home land Security Screening Threshold Quantity (pounds): *Theft hazard* 45 (≥9.97% concentration)

Hazard Alert: Poison inhalation hazard (extremely toxic gas with inadequate warning properties), Corrosive, Powerful oxidizer, Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated, Primary irritant (w/o allergic reaction), Environmental hazard.

United States National Primary Drinking Water Regulations: MCLG = 4 mg[F]/L; MCL = 4 mg[F]/L; SMCL = 2.0 mg[F]/L, as Fluoride.

United States DOT 49CFR172.101, Inhalation Hazardous Chemical (PIH).

Hazardous to aquatic life or environment, with possible long-lasting effects[291]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, O, N; risk phrases: R5; R8; R20; R21; R35; safety phrases: S1; S9; S17; S29/35; S33; S38; S41; S45; S61 (see Appendix 4)

Description: Chlorine trifluoride is a greenish yellow, almost colorless, liquid (below 12°C/53°F), or colorless gas with a sweet, irritating odor. Shipped as a liquefied compressed gas. Molecular weight = 92.45; specific gravity (H_2O:1) = 3.78; boiling point = 11.8°C; freezing/melting point = −76.3°C; vapor pressure = 750 mmHg @ 11.4°C; relative vapor density (air = 1) = 3.21. Hazard identification (based on NFPA-704 M Rating System): Health 4, flammability 0, reactivity 3 (Oxidizer). Reacts with water.

Potential Exposure: Chlorine trifluoride is used as a fluorinating agent. It may be used as an igniter and propellant in rockets. It is used in nuclear fuel processing.

Incompatibilities: A powerful oxidizer. Keep away from acids. Most combustible materials ignite spontaneously on contact with chlorine trifluoride. Explodes on contact with organic materials. The liquid can explode if mixed with halocarbons or hydrocarbons. It reacts violently with oxidizable materials, finely divided metals and metal oxides; sand, glass, asbestos, silicon-containing compounds. Emits highly toxic fumes on contact with acids. Chlorine trifluoride decomposes above 220°C, forming Thermal decomposition products may include hydrogen chloride and HF. Reacts violently with water, forming chlorine gas and hydrofluoric acid. Reacts with most forms of plastics, rubber, coatings, and resins; except the highly fluorinated polymers, such as Teflon and "K el-F."

Permissible Exposure Limits in Air

NIOSH IDLH = 20 ppm

Conversion factor: 1 ppm = 3.78 milligram per cubic meter

OSHA PEL: 0.1 ppm/0.4 milligram per cubic meter Ceiling Concentration

NIOSH REL: 0.1 ppm/0.4 milligram per cubic meter Ceiling Concentration

ACGIH TLV[1]: 0.1 ppm/0.38 milligram per cubic meter, Ceiling Concentration

PAC* Ver. 29[138]

PAC-1: $\mathbf{0.12_A}$ ppm

PAC-2: $\mathbf{2.0_A}$ ppm

PAC-3: $\mathbf{21_A}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60-minute values.

Emergency Response Planning Guidelines (DOE)

ERPG-1:0.1 ppm

ERPG-2: 1 ppm

ERPG-3: 10 ppm

DFG MAK: No numerical value established. Data may be available. (2005)3

Some states have set guidelines or standards for ClF_3 in ambient[60] air, ranging from 3.0 μ/m^3 (Virginia) to 4.0 μ/m^3 (North Dakota) to 10.0 μ/m^3 (Nevada).

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guidelines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg [F]/L. Safe Drinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg[F]/L; SMCL = 2 mg/F/L, as Fluoride.

Routes of Entry: Inhalation, ingestion, eye and skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Chlorine trifluoride is corrosive to the eyes, skin, and respiratory tract. Inhalation can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Contact with the liquefied gas can cause frostbite.

Long-Term Exposure: Can cause lung irritation; bronchitis may develop with cough, phlegm, and shortness of breath.

Points of Attack: Skin, eyes, respiratory tract.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles if working with the liquid and face shield when working with gas, unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *2.5 ppm:* Sa:Cf[£] (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *5 ppm:* SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *20 ppm:* SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern]; or SCBAE (any appropriate escape-type, SCBA). *Note*[£]*:* Substance causes eye irritation or damage; eye protection needed.

Storage: Check oxygen content prior to entering storage area. Poison gas. (1) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. This gas is highly toxic. Even slight exposure to these gasses can cause death. Store outdoors in a secure, restricted area that containing warning signs. This area must be roofed and shaded with the cylinders stored off the ground and away from radiant heat sources on nonwooden floors. If indoors, store in a well-ventilated areas in temperatures not to exceed 50°C. (2) Color code—Yellow Stripe: Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. (3) Color code—White stripe: Contact Hazard; Store separately; not compatible with materials in solid white category. Prior to working with chlorine trifluoride all handlers should be trained on its proper handling and storage. Chlorine trifluoride must be stored to avoid contact with water, sand, glass, silicon-containing compounds, asbestos, and combustible materials, since violent reactions occur. See Incompatibilities.

Store in tightly closed containers in a cool, well-ventilated area away from heat. Store in a cool, well-ventilated area away from incompatible materials listed above. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage.

Shipping: UN1749 Chlorine trifluoride, Hazard class: 2.3; Labels: 2.3-Poisonous gas, 5.1-Oxidizer, 8-Corrosive material, Inhalation Hazard Zone B. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling:

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 0.8/1.3

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 1000/300
Then: Protect persons downwind (mi/km)
Day 0.9/1.5
Night 2.9/4.6

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. If in a building, shut down HVAC systems. Remove all ignition sources. Collect solid chlorine trifluoride in the most convenient and safe manner and deposit in sealed containers. If the gas has leaked, stop the flow of gas if it can be done safely. Ventilate area of leak or spill. If the source of the leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, and, repair the leak or allow the cylinder to empty. Keep chlorine trifluoride out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include HF and hydrogen chloride. This chemical does not burn but it will increase the activity of fire and will cause combustibles to ignite. This gas is under pressure; containers may rupture and explode when heated. *Do not use water* or foam. Use dry chemical, carbon dioxide. Firefighting gear (including SCBA) does not provide adequate protection. If exposure occurs, remove and isolate gear immediately and thoroughly decontaminate personnel. Vapors are heavier than air and will collect in low areas. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier.

References

(31); (173); (101); (138); (122).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Chlorine Trifluoride, Trenton, NJ (November 1998).

Chlormequat Chloride C:0710

Formula: $C_5H_{13}Cl_2N$; $ClCH_2CH_2N(CH_3)_3Cl$

Synonyms: 60-CS-16; AC38555; Ammonium, (2-chloroethyl)trimethyl-, chloride 2-chloro-*N*,*N*,*N*-trimethylethanaminium chloride; Antywylegacz; CCC plant growth regulant; 2-Chloraethyl-trimethylammoniumchlorid (German); Chlorcholinchlorid; Chlorcholine chloride; Chlormequat; Chlorocholine chloride; (β-Chloroethyl) trimethylammonium chloride; (2-Chloroethyl)trimethyl ammonium chloride; 2-Chloroethyl trimethylammonium chloride; (2-Chloro-*N*,*N*,*N*-ethyl)trimethylethanaminium chloride; 2-Chloro-*N*,*N*,*N*-trimethylamm onium chloride; Choline dichloride; Clormecuato de cloroacetilo (Spanish); Cloruro de clormecuat (Spanish); Cyclocel; Cycocel; Cycocel-extra; Cycogan; Cycogan extra; Cyocel; EI 38,555; Ethanaminium, 2-chloro-*N*,*N*,*N*-trimethyl-, chloride; Hico CCC; Hormocel-2CCC; Increcel; Lihocin; NCI-C02960; Retacel; Stabilan; Trimethyl-β-chlorethylammon iumchlorid; Trimethyl-β-chloroethyl ammonium chloride; TUR

CAS Registry Number: 999-81-5

HSDB Number: 1541

RTECS Number: BP5250000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 213-666-4 [*Annex I Index No.:* 007-003-00-6]

Regulatory Authority and Advisory Information

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg)

Superfund/EPCRA 40 CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)

Hazard symbols, risk, & safety statements: Hazard symbol: Xn; risk phrases: R21/22; R51; safety phrases: S2; S36/37; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Chlormequat chloride is a white to yellowish crystalline solid with a fish-like odor. Molecular weight = 158.1; freezing/melting point = 245°C (decomposes); vapor pressure = 7.5×10^{-8} @ 20°C; hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 0. Highly soluble in water. Carrier solvents used in commercial products may alter physical and toxicological properties.

Potential Exposure: People engaged in the manufacture, formulation, and application of this plant growth regulator said to be effective for cereal grains, tomatoes, and peppers.

Incompatibilities: Chlormequat chloride decomposes on heating or in fire forming nitrogen oxides, carbon monoxide, and hydrogen chloride fumes. This chemical decomposes on heating with strong aqueous alkali solutions forming trimethylamine and other gaseous products. Contact with strong oxidizers may cause fire and explosions. Attacks many metals in presence of water.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 0.64 milligram per cubic meter

PAC-2: 7 milligram per cubic meter

PAC-3: 65 milligram per cubic meter

Permissible Concentration in Water: Russia set a MAC in surface water of 0.2 mg/L.

Routes of Entry: Inhalation, passing through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: The LD_{low} oral (human) is 10 mg/kg. It is an irritant and can be absorbed through the skin. Irritates the eyes and the respiratory tract. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Exposure can cause nausea and vomiting. Higher levels can cause slow or irregular heartbeat; tremors, seizures, and coma. This can be fatal. Chlormequat chloride may affect the nervous system.

Long-Term Exposure: May cause liver damage.

Points of Attack: Lungs, liver, nervous system.

Medical Surveillance: Liver function tests. Consider chest X-ray following acute overexposure. EKG examination of the nervous system.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Permeation data indicate that Neoprene gloves may provide protection from exposure to this compound. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: W*here there is a potential for overexposure:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with chlormequat chloride all handlers should be trained on its proper handling and storage. Keep away from strong oxidizers. Store in a cool, dry place and protect from heat and moisture. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/ 75 ft (NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Use dry chemical, carbon dioxide; or water extinguishers. Thermal decomposition products may include oxides of carbon, nitrogen oxide, and hydrogen chloride. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incinerate in a unit with effluent gas scrubbing[22].

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Chlormequat Chloride, Trenton, NJ (April 1999).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Chlormequat Chloride, Washington, DC, Chemical Emergency Preparedness Program (October 31, 1985).

Chlornaphazine C:0720

Formula: $C_{14}H_{15}Cl_2N$; $(ClCH_2CH_2)_2NC_{10}H_7$

Synonyms: 2-Bis(2-chloroethyl)aminonaphthalene; *N*,*N*-Bis (2-chloroethyl)-2-naphthylamine; Bis(2-chloroethyl)-β-naphthylamine; Chlornaftina; Chlornaphazin; Chlornaphthin; Chloronaftina; Chloronaphthine; *N*,*N*-Di(2-chloroethyl)-β-naphthlamine; 2-*N*,*N*-Di(2-chloroethyl)naphthlamine; Di(2-chloroethyl)-β-naphthlamine; Dichloroethyl-β-naphthylamine; Erysan; 2-Naphthalenamine, *N*,*N*-bis(2-chloroethyl)-; Naphthlamine mustard; β-Naphthyl-bis (β-chloroethyl)amine; 2-Naphthl-bis(β-chloroethyl)amine; β-Naphthl-di(2-chloroethyl)amine; NSC-62209; R48

CAS Registry Number: 494-03-1

HSDB Number: 2754

RTECS Number: QM 2450000

UN/NA & ERG Number: UN2810 (toxic liquid, organic, n.o.s.)/153

EC Number: 207-785-0

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human Sufficient Evidence; Animal Limited Evidence, *carcinogenic to humans*, Group 1, 1998

California Proposition 65 Chemical[102]: Cancer 2/27/1987.

Hazard Alert: Poison, Combustible, Explosive[101], Poison, Possible risk of forming tumors, Suspected of causing genetic defects, Environmental hazard; Drug.

Banned or Severely Restricted (Israel) (UN)[13]

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U026

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)

United States DOT Regulated marine pollutant (49CFR172.101, Appendix B) as naphthalenes

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, E, F; risk phrases: R45; R10; R26/27/28; R51; R62; safety phrases: S1/2; S7/9; S27; S29/35; S36/37; S45, S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Chlornaphazine is composed of clear, colorless plates or may be a brown solid. Molecular weight = 268.2; boiling point = 210°C; freezing/melting point = 54–56°C. Slightly soluble in water; solubility =< 1 mg/mL @ 22°C.

Potential Exposure: May be combustible and possibly explosive. Not produced or used commercially in the United States, Chlornaphazine has been used in other countries in the treatment of leukemia and related cancers. Currently, this drug does not have wide therapeutic usage.

Incompatibilities: Keep away from oxidizers, nucleophiles[193], and nitromethanes. Amines may react violently with nitric acid; cellulose nitrate (of high surface area); 1-chloro-2,3-epoxypropane (exothermic reaction may occur). Incompatible with acids, acid halides; alcohols, aldehydes, alkylene oxides; anhydrides, cresols, caprolactam solution; epichlorohydrin, epoxides, isocyanates, glycols, peroxides, phenols. Contact with strong reducing agents may generate flammable hydrogen gas. May attack copper and copper alloys.

Permissible Exposure Limits in Air: No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Determination in Air: Use NIOSH Analytical Method #5518, Naphthylamines; OSHA Analytical method 93

Determination in Water: Log K_{ow} = >4. Values above 3.0 are likely to bioaccumulate in aquatic organisms.

Routes of Entry: Ingestion, inhalation, skin absorption.

Harmful Effects and Symptoms

Short-Term Exposure: This compound is a skin, eye, and mucous membrane irritant. It is toxic by ingestion, inhalation, and skin absorption[101].

Long-Term Exposure: Naphthylamines can affect you when breathed in and by passing through your skin. 1-Naphthylamine should be handled as a carcinogen, with extreme caution. High exposure can cause the skin and lips to turn blue. This reduces the ability of the blood cells to carry oxygen to body organs (methemoglobinemia). Higher levels can cause breathing difficulties, collapse, and possible death.

2-Naphthylamine is a known human bladder carcinogen with a latent period of about 16 years. The symptoms are frequent urination, dysuria, and hematuria. Acute poisoning leads to methemoglobinemia or acute hemorrhagic cystitis. 2-Naphthylamine is carcinogenic, producing urinary bladder carcinomas in hamsters, dogs, and nonhuman primates; and hepatomas in mice, after oral administration. Epidemiological studies have shown that occupational exposure to 2-naphthylamine, either alone or when present as an impurity in other compounds, is causally associated with bladder cancer.

Points of Attack: Bladder, skin. *Cancer site:* bladder cancer.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure. OSHA mandates the following tests or information for 1- and 2-naphthylamine which are related to this chemical: *Increased Risk:* reduced immunologic competence; steroid treatment; pregnancy; cigarette smoking. NIOSH lists the following tests: *Increased Risk:* reduced immunologic competence; steroid treatment; pregnancy; cigarette smoking; cystoscopy; UA (routine).

First Aid: *Eye Contact:* Remove any contact lenses at once. Immediately flush eyes well with copious quantities of water or normal saline for at least 20−30 minutes. Seek medical attention. *Inhalation:* Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing, or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion:* Contact a physician, hospital, or poison center at once. If the victim is unconscious or convulsing, do not induce vomiting or give anything by mouth. Assure that the patient's airway is open and lay him on his side with his head lower than his body and transport immediately to a medical facility. If conscious and not convulsing, give a glass of water to dilute the substance. Vomiting should not be induced without a physician's advice.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in a refrigerator or a cool, dry place. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2810 Toxic liquids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN2588 Pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Dampen spilled material with 60%−70% ethanol to avoid airborne dust, then transfer material to a suitable container. Ventilate the spill area and use absorbent paper dampened with 60%−70% ethanol to pick up remaining material. Wash surfaces well with soap and water. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include hydrogen chloride and oxides of nitrogen and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Disposal of unused product must be undertaken by qualified personnel who are knowledgeable in all applicable regulations and follow all pertinent safety precautions including the use of appropriate protective equipment. For proper handling and disposal, always comply with federal, state, and local regulations.

References

(102); (31); (173); (101); (138); (2); (100).

Chloroacetaldehyde C:0730

Formula: C_2H_3ClO; $ClCH_2CHO$

Synonyms: Acetaldehyde, chloro-; 2-Chloroacetaldehyde; Chloroacetaldehyde monomer; 2-Chloro-1-ethanal; 2-Chloroethanal; Cloroacetaldehido (Spanish); Monochloroacetaldehyde

CAS Registry Number: 107-20-0

HSDB Number: 2521

RTECS Number: AB2450000

UN/NA & ERG Number: (PIH) UN2232/153

EC Number: 203-472-8 [*Annex I Index No.:* 605-025-00-6]

Regulatory Authority and Advisory Information

Hazard Alert: Poison inhalation hazard, Flammable, Possible polymerization hazard, Suspected reprotoxic hazard.

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P023

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1000 lb (454 kg)

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, F, N; risk phrases: R10; R24/25; R26; R34; R40; R50; R61; safety phrases: S1/2; S26; S28; S36/37/39; S41; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Chloroacetaldehyde is a combustible, colorless liquid with a very sharp, irritating odor. Molecular weight = 78.50; specific gravity (H_2O:1) = 1.19 (40% solution); boiling point = 85−100°C; freezing/melting point = 16°C (40% solution); vapor pressure = 100 mmHg @ 20°C; flash point = 87.7°C (40% solutions). Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 2, reactivity 0 (able to polymerize on standing). Soluble in water.

Potential Exposure: Chloroacetaldehyde is used as a fungicide; as an intermediate in 2-aminothiazole manufacture; and in bark removal from tree trunks.

Incompatibilities: Heat and water sensitive; concentrations of >50% form insoluble hemihydrate material on contact with water. Reacts with oxidizers, acids. On heating, chloroacetaldehyde releases chlorine fumes. Polymerizable upon standing.

Permissible Exposure Limits in Air

NIOSH IDLH = 45 ppm

Conversion factor: 1 ppm = 3.21 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 1 ppm/3 milligram per cubic meter Ceiling Concentration

NIOSH REL: 1 ppm/3 milligram per cubic meter Ceiling Concentration

ACGIH TLV[1]: 1 ppm/3.2 milligram per cubic meter Ceiling Concentration

PAC Ver. 29[138]

PAC-1: $\mathbf{1.3_A}$ ppm

PAC-2: $\mathbf{2.2_A}$ ppm

PAC-3: $\mathbf{9.9_A}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60-minute values.

DFG MAK: [skin] Carcinogen Category 3B

Arab Republic of Egypt: TWA 1 ppm (3 milligram per cubic meter), 1993; Australia: TWA 1 ppm (3 milligram per cubic meter), 1993; Austria: MAK 1 ppm (3 milligram per cubic meter), 1999; Belgium: STEL 1 ppm (3.2 milligram per cubic meter), 1993; Denmark: TWA 1 ppm (3 milligram per cubic meter), 1999; Finland: STEL 1 ppm (3 milligram per cubic meter), 1993; France: VLE 1 ppm (3 milligram per cubic meter), 1999; the Netherlands: MAC 3 milligram per cubic meter, 2003; Norway: TWA 1 ppm (3 milligram per cubic meter), 1999; the Philippines: TWA 1 ppm (3 milligram per cubic meter), 1993; Switzerland: MAK-W 1 ppm (3 milligram per cubic meter), KZG-W 2 ppm (6 milligram per cubic meter), 1999; Thailand: TWA 1 ppm (3 milligram per cubic meter), 1993; Turkey: TWA 1 ppm (3 milligram per cubic meter), 1993; United Kingdom: STEL 1 ppm (3.3 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: 1 ppm (Ceiling Concentration). Several states have set guidelines or standards for chloroacetaldehyde in ambient air[60] ranging from 1.0 μ/m^3 (New York) to 25 μ/m^3 (Virginia) to 30 μ/m^3 (North Dakota) to 60 μ/m^3 (Connecticut) to 71 μ/m^3 (Nevada).

Determination in Air: See NIOSH Analytical Method (IV) #2015 and OSHA Analytical Method 76.

Permissible Concentration in Water: No criteria set.

Determination in Water: Octanol−water coefficient: Log K_{ow} = < 0.3. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion, eye and skin contact.

Harmful Effects and Symptoms

Irritation of skin, eyes, and mucous membrane; skin burns; eye damage; pulmonary edema; sensitization of skin and respiratory system. Does have a mutagenic effect. LD_{50} (oral-mouse) = 21 mg/kg.

Short-Term Exposure: Corrosive to the eyes, skin, and respiratory tract Contact can cause burns and permanent damage. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: This chemical may cause mutations. It can cause skin allergy and an asthma-like lung allergy.

Points of Attack: Eyes, skin, respiratory system; lungs.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Lung function tests, Evaluation by a qualified allergist. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin contact with liquids of $>0.1\%$ content or repeated or prolonged contact with liquids of $<0.1\%$ content. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *10 ppm:* CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)]; or Sa (APF = 10) (any supplied-air respirator). *25 ppm:* Sa: Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOv (APF = 25) [any powered, APR with organic vapor cartridge(s)]. *45 ppm:* CcrFOv (APF = 50) [any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s)]; or GmFOv[any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister]; or PaprTOv (APF = 50) [any powered, APR with a tight-fitting facepiece and organic vapor cartridge(s)]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd, Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, SCBA).

Storage: Poison inhalation chemical (PIH); check oxygen content prior to entering storage area. Polymerizable upon standing. Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with chloracetaldehyde all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, dry, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN22322-Chloroethanal, Hazard class: 6.1; Labels: 6.1-Poison Inhalation Hazard, Inhalation Hazard Zone B.

Spill Handling:

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.2/0.3

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)

Day 0.5/0.8
Night 0.8/1.3
Avoid inhalation of vapors. Do not touch spilled material; stop leak; use water spray to reduce vapors. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. *Large spills*: dike far ahead of spill for later disposal Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include hydrogen chloride and oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration, preferably after mixing with another combustible fuel; care must be exercised to assure complete combustion to prevent the formation of phosgene; an acid scrubber is necessary to remove the halo acids produced.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chloroacetaldehyde, Health and Environmental Effects Profile No. 40, Office of Solid Waste, Washington, DC (April 30, 1980)

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 2, No. 4, 70–72, New York, Van Nostrand Reinhold Co. (1982).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Chloroacetaldehyde, Washington, DC, Chemical Emergency Preparedness Program (October 31, 1985).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Chloroacetaldehyde, Trenton, NJ (April 1998).

Chloroacetic Acid C:0740

Formula: $C_2H_3ClO_2$: $ClCH_2COOH$

Synonyms: Acetic acid, chloro-; Acide chloracetique (French); Acide monochloracetique (French); Acido cloroacetico (Spanish); Chloracetic acid; Chloroethanoic acid; MCA; Monochloracetic acid; Monochloressigsaeure (German); Monochloroacetic acid; Monochloroethanoic acid; NCI-C60231

CAS Registry Number: 79-11-8

HSDB Number: 939

RTECS Number: AF8575000

UN/NA & ERG Number: (PIH) UN1750 (liquid)/153; UN1751 (solid)/153

EC Number: 201-178-4 [*Annex I Index No.:* 607-003-00-1]

Regulatory Authority and Advisory Information

Hazard Alert: Poison inhalation hazard, Combustible, Possible risk of forming tumors, Suspected reprotoxic hazard.

United States National Primary Drinking Water Regulations: MCLG = n/a; MCL = 0.060 mg/L, monochloroacetic acid, as a haloacetic acid.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%; NPRI.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R23/24/25; R34; R51; safety phrases: S1/2; S26; S36/37/39; S41; S45; S61; S63 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Chloroacetic acid is a colorless to white crystalline solid. It has a strong vinegar-like odor and an Odor Threshold of 0.15 milligram per cubic meter. Molecular weight = 94.50; boiling point = 188°C; freezing/melting point = 63°C; flash point = 126°C; autoignition temperature => 500°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 2, reactivity 0. Soluble in water.

Potential Exposure: This haloacetic acid can be a byproduct of drinking water disinfection and may increase the risk of cancer. Monochloracetic acid is used primarily as a chemical intermediate in the synthesis of sodium carboxymethyl cellulose; and such other diverse substances as ethyl chloroacetate, glycine, synthetic caffeine, sarcosine, thioglycolic acid, and various dyes. Hence, workers in these areas are affected. It is also used as an herbicide. Therefore, formulators and applicators of such herbicides are affected.

Incompatibilities: Compounds of the carboxyl group react with all bases, both inorganic and organic (i.e., amines) releasing substantial heat, water, and a salt that may be harmful. Incompatible with arsenic compounds (releases hydrogen cyanide gas), diazo compounds, dithiocarbamates, isocyanates, mercaptans, nitrides, sulfides (releasing heat, toxic, and possibly flammable gases), thiosulfates, and dithionites (releasing hydrogen sulfate and oxides of sulfur). The solution in water is a strong acid. Contact with strong oxidizers, strong bases; and strong reducing agents such as hydrides can cause violent reactions. Chloracetic acid decomposes on heating, producing toxic and corrosive hydrogen chloride, phosgene, and carbon monoxide gases. Attacks metals in the presence of moisture.

Permissible Exposure Limits in Air

ACGIH TLV[1]: 0.05 ppm/2 milligram per cubic meter inhalable fraction and vapor.

PAC* Ver. 29[138]

PAC-1: 1.5 ppm

PAC-2: **6.6$_{\mathbf{A}}$** ppm

PAC-3: 15 ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60-minute values.

Poland: MAC (TWA) 2 milligram per cubic meter, MAC (STEL) 4 milligram per cubic meter, 1999; Russia: STEL 1 milligram per cubic meter, 1993; Sweden: TWA 1 ppm (4 milligram per cubic meter); STEL 2 ppm (8 milligram per cubic meter) [skin], 1999; United Kingdom: TWA 0.3 ppm (1.2 milligram per cubic meter) [skin], 2000; the Netherlands: MAC-TGG 4 milligram per cubic meter [skin], 2003. This chemical can be absorbed through the skin, thereby increasing exposure.

Routes of Entry: Inhalation, ingestion, and skin contact. This chemical can be absorbed through the skin, thereby increasing exposure.

Harmful Effects and Symptoms

Short-Term Exposure: Corrosive to the eyes, skin, and respiratory tract. Contact can cause severe irritation and burns. Inhaling this chemical can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Chloracetic acid can cause a feeling of anxiety, restlessness; blurred vision; a feeling of "pins and needles" in the limbs; muscle twitching; and/or hallucinations; may affect the cardiovascular system; central nervous system; and kidneys, resulting in heart problems; convulsions; and kidney damage. These effects may be delayed. Symptoms of exposure include irritation and pain in skin. If chloroacetic acid is inhaled the patient may exhibit difficulty in breathing. Vomiting may occur if the material is ingested. It can burn the skin, cornea, and respiratory tract. This material is very toxic. The probable lethal oral dose is 50−500 mg/kg of body weight, between one teaspoon and 1 oz, for a 150-lb person. Chloroacetic acid is irritating to the skin, cornea, and respiratory tract and causes burns. It may severely damage skin and mucous membranes. Ingestion may interfere with essential enzyme systems and cause perforation and peritonitis. Burns to skin result in marked fluid and electrolyte loss. Death may follow if more than 3% of the skin is exposed to this material. Other health hazards include central nervous system depression, and respiratory system depression.

Long-Term Exposure: Increased risk of cancer. Repeated exposure may cause kidney damage and affect the lungs.

Points of Attack: Lungs, kidneys, central nervous system.

Medical Surveillance: This chemical may increase the risk of cancer. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure. Lung function tests, kidney function tests. Examination of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Saranex is among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. If you are working with dry material wear dust-proof chemical goggles and face shield if you are working with the liquid, unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: W*here there is a potential for overexposure:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with chloroacetic acid all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from metal, combustibles, strong oxidizers; strong bases; and reducing agents. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN1750 (liquid) & UN1751 (solid) Chloroacetic acid, solid or liquid, Hazard class: 6.1; Labels: 6.1-Poison Inhalation Hazard, 8-Corrosive material.

Spill Handling: Stay upwind; keep out of low areas. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Neutralize spilled materials with crushed limestone, soda ash; or lime. Waste water containing chloro acetic acid can be treated with ammonia, ammonium salts; or amines followed by separation of suspended solids. Collect spilled powdered material in the most convenient and safe manner and deposit in sealed containers. Dike *large spills* far ahead of spill for later disposal. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Poisonous decomposition products may include, phosgene, hydrogen chloride, and carbon monoxide. This material is extremely hazardous to health, but fire fighters may enter areas with extreme care. Full protective clothing including a SCBA, coat, pants, gloves, boots and bands around legs, arms, and waist should be provided. No skin surface should be exposed. Move container from fire area if you can do so without risk. Spray cooling water on containers that are exposed to flames until well after fire is out. This chemical may burn but does not readily ignite. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration, preferably after mixing with another combustible fuel; care must be exercised to assure complete combustion to prevent the formation of phosgene; an acid scrubber is necessary to remove the halo acids produced.

References

(31); (173); (101); (138); (100).

National Institute for Occupational Safety and Health (NIOSH), Profiles on Occupational Hazards for Criteria Document Priorities: Monochloroacetic acid, pp 309−311, Report PB-274,073, Rockville, MD (1977).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 3, No. 5, 99−101, New York, Van No strand Reinhold Co. (1983).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Chloroacetic Acid, Washington, DC, Chemical Emergency Preparedness Program (October 31, 1985).

New York State Department of Health, *Chemical Fact Sheet* Chloroacetic Acid, Bureau of Toxic Substance Assessment, Albany, NY (January 1986).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Chloroacetic Acid, Trenton, NJ (July 2002).

Chloroacetonitrile C:0745

Formula: C_2H_2ClN

Synonyms: Acetonitrile, chloro-; Chloracetonitrile; Chloracétonitrile (French); α-Chloroacetonitrile; 2-Chloroacetonitrile; Chlorocyanomethane; Cloroacetonitrilo (Spanish); Chloromethyl cyanide; Monochloroacetonitrile; Monochloromethyl cyanide

CAS Registry Number: 107-14-2

HSDB Number: 6317

RTECS Number: AL8225000
UN/NA & ERG Number: (PIH) UN2668/131
EC Number: 203-467-0
Regulatory Authority and Advisory Information

Carcinogenicity: IARC, Group 3 not classifiable as to its carcinogenicity in humans

Hazard Alert: Poison inhalation hazard, Highly flammable, Water reactive, Possible polymerization hazard (as nitriles), Lacrimator, Possible risk of forming tumors, Suspected of causing genetic defects[138], Suspected reprotoxic hazard, Environmental hazard.

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Hazardous to aquatic life or environment, with possible long-lasting effects[293]. Toxic to aquatic life with long-lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, F, N; risk phrases: R10; R20; R23/24/25; R26; R51/53; R61; R63; safety phrases: S1/2; S28; S29/35; S36/37; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [2-Hazard to waters (est.)]

Description: A clear, colorless liquid. Pungent odor. Molecular weight = 75.5; specific gravity (H_2O:1) = 1.193 @ 20°C; boiling point = 126.5°C; freezing/melting point = 38°C; vapor pressure = 15 mmHg @ 30°C; 8 mmHg @ 20°C; flash point = 48°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 2, reactivity 0 ₩. Henry's Law constant = 1.08×10^{-5} atm m^3/mol @ 25°C (est)[72]. Slightly soluble in water; solubility = 50 to 100 mg/mL @ 21.5°C. Water reactive, releasing hydrogen chloride.

Potential Exposure: A chlorinated haloacetonitrile used as a fumigant and as a manufacturing chemical intermediate for making other chemicals.

Incompatibilities: Highly flammable, forms explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Reacts with water and steam, releasing toxic and corrosive vapors of hydrogen chloride. Nitriles may polymerize in the presence of metals and some metal compounds. They are incompatible with acids; mixing nitriles with strong oxidizing acids can lead to extremely violent reactions. Nitriles are generally incompatible with other oxidizing agents such as peroxides and epoxides. The combination of bases and nitriles can produce hydrogen cyanide. Nitriles are hydrolyzed in both aqueous acid and base to give carboxylic acids (or salts of carboxylic acids). These reactions generate heat. Peroxides convert nitriles to amides. Nitriles can react vigorously with reducing agents. Acetonitrile and propionitrile are soluble in water, but nitriles higher than propionitrile have low aqueous solubility. They are also insoluble in aqueous acids[101].

Permissible Exposure Limits in Air:

NIOSH REL: *Nitriles:* 2 ppm, Ceiling Concentration, not to be exceeded in any 15-minute work period.

PAC* Ver. 29[138]
PAC-1: 0.45 ppm
PAC-2: $\mathbf{5_A}$ ppm
PAC-3: $\mathbf{15_A}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60-minute values.

Determination in Air: #2549 Volatile Organic Compounds[18] (screening), and OSHA Analytical Method 7 Organic Vapors. See NIOSH Criteria Document 78-212 *NITRILES*[18]

Permissible Concentration in Water:

Determination in Water: EPA Method 1624. Isotope dilution purge and trap GC/mass spectrometry. Octanol–water coefficient: Log $K_{\mathrm{ow}} = < 1$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, dermal contact, eye, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Very toxic by ingestion, inhalation, and skin absorption. A lacrimator; severe respiratory irritant LD_{50} (oral-rat) = 220 mg/kg[AIHA].

Long-Term Exposure: Possible risk of forming tumors. Mutagen Respiratory toxin-acute effects other than severe or moderate irritation[138].

Points of Attack: Reproductive system.

Medical Surveillance: Pregnant women should avoid contact. Employees should be notified by a physician that this chemical may affect the reproductive system. In addition to comprehensive initial medical and work histories emphasizing reproductive experience and menstrual history, patient should have physical examination and testing of genitourinary tract, sperm count, motility, and morphology. If required, other tests, such as serum testosterone, serum follicle stimulating hormone (FSH), and serum lutenizing hormone (LH) may be indicated.

First Aid: *Eyes*: First check the victim for contact lenses and remove if present. Flush victim's eyes with water or normal saline solution for 20 to 30 minutes while simultaneously calling a hospital or poison control center. Do not put any ointments, oils, or medication in the victim's eyes without specific instructions from a physician. *Immediately* transport the victim after flushing eyes to a hospital even if no symptoms (such as redness or irritation) develop. *Skin: Immediately* flood affected skin with water while removing and isolating all contaminated clothing. Gently wash all affected skin areas thoroughly with soap and water. If symptoms such as redness or irritation develop, *Immediately* call a physician and be prepared to transport the victim to a hospital for treatment. *Inhalation*: *Immediately* leave the contaminated area; take deep breaths of fresh air. If symptoms (such as wheezing, coughing, shortness of breath, or burning in the mouth, throat, or chest) develop, call a physician and be prepared to transport the victim to a hospital. Provide proper respiratory protection to rescuers entering an unknown atmosphere. Whenever possible, SCBA should be used; if not available, use a level of protection greater than or equal to that advised under Protective Clothing. Ingestion: *do not induce vomiting*. If the victim is conscious and not convulsing, give 1 or 2 glasses of water to dilute the chemical and *Immediately* call a hospital or poison control center. Be prepared to transport the victim to a hospital if advised by a physician. If the victim is convulsing or unconscious, do not give anything by mouth, ensure that the victim's airway is open and lay the victim on his/her side with the head lower than the body. *Do not induce vomiting*. *Immediately* transport the victim to a hospital.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof or splash-proof chemical goggles and face shield when working with liquid unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Nitriles*: NIOSH, *10 ppm:* Sa (APF = 10) (any supplied-air respirator); *25 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); *50 ppm:* SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece); *250 ppm:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd, Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv (APF = 50) (any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister) or SCBAE (any appropriate escape-type, SCBA).

Storage: Poison inhalation chemical (PIH); check oxygen content prior to entering storage area. (1) Color code—Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. (2) Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Store in a cool, dry place, or in a refrigerator.

Shipping: UN2668 Chloroaceto nitrile Hazard class: 6.1, Labels: 6.1-Poison Inhalation Hazard, 3-Flammable liquid Inhalation Hazard Zone B.

Spill Handling:

Chloroacetonitrile

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.1/0.2

As an immediate precautionary measure, isolate spill or leak area for at least 50 m/150 ft in all directions. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources and dampen spilled material with toluene to avoid airborne dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Fully encapsulating, vapor protective clothing should be worn for spills and leaks with no fire. *Eliminate* all ignition sources (no smoking, flares, sparks, or flames in immediate area). All equipment used when handling the product must be grounded. Do not touch or walk through spilled material. Stop leak if you can do it without risk. Prevent entry into waterways, sewers, basements, or confined areas. A vapor suppressing foam may be used to reduce vapors. *Small spill*: Absorb with earth, sand, or other noncombustible material and transfer to containers for later disposal. Use clean nonsparking tools to collect absorbed material. *Large spill*: Dike far ahead of liquid spill for later disposal. Water spray may reduce vapor; but may not prevent ignition in closed spaces.

Fire Extinguishing: Thermal decomposition products may include fumes of poisonous hydrogen cyanide and hydrogen chloride. Highly flammable: Easily ignited by heat, sparks or flames. Vapors may form explosive mixture with air. Vapors may travel to source of ignition and flashback. Most vapors are heavier than air. They will spread along ground and collect in low or confined areas (sewers, basements, tanks). Vapor explosion and poison hazard indoors, outdoors, or in sewers. Those substances designated with a (P) may polymerize explosively when heated or involved in a fire. Runoff to sewer may create fire or explosion hazard. Containers may explode when heated. Liquid is denser than water.

Disposal Method Suggested: Use a licensed professional waste disposal service to dispose of this material. Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Chloroacetonitrile, #0375, Trenton, NJ (January 2003).

2-Chloroacetophenone (Agent CN)

C:0750

Formula: C_8H_7ClO; $C_6H_5COCH_2Cl$

Synonyms: Acetophenone, 2-chloro-; CAF; CAP; Chemical Mace; α-Chloroacetophenone; e-Chloroacetophenone; 1-Chloroacetophenone; Chloroacetophenone (DOT); Chloromethyl phenyl ketone; 2-Chloro-1-phenylethanone; α-Cloroacetofenona (Spanish); CN (military designation); Ethanone, 2-Chloro-1-phenyl-; MACE (lacramator); NCI-C55107; Phenacyl chloride; Phenyl chloromethyl ketone; Tear gas

CAS Registry Number: 532-27-4

HSDB Number: 972

RTECS Number: AM6300000

UN/NA & ERG Number: (PIH) UN1697 (solid)/153; UN3416 (liquid)/153

EC Number: 208-531-1

Regulatory Authority and Advisory Information

Carcinogenicity: NCI: Carcinogenesis Studies (inhalation); equivocal evidence: rat; no evidence: mouse.

Hazard Alert: Poison inhalation hazard, Combustible, Lacrimator (riot control/tear gas), Dangerously water reactive; Sensitization hazard (resp.), Possible risk of forming tumors, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction).

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xn, Xi; risk phrases: R43; R48/23/25; R62; R68/22; safety phrases: S25; S26; S30; S36/37/39; S41; S46; S48/20/22 (see Appendix 4). Safety phrases: (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: 2-Chloroacetophenone (CN) is a combustible, colorless-to-gray solid. CN has a sharp, irritating odor, has been described as smelling like "apple blossoms." It may be dissolved in a solvent. Molecular weight = 154.60; boiling point = 247°C; specific gravity (H_2O:1) = 1.32; freezing/melting point = 56.5°C; vapor pressure = 0.0054 mmHg @ 20°C; flash point = 117.7°C (cc). Hazard identification (based on NFPA-704 M Rating System): Health 3[101]; 2,[77] flammability 1, reactivity 0 ₩. Insoluble in water; reacts forming hydrogen chloride fumes.

Potential Exposure: Chloroacetophenone is used as a chemical warfare agent (Agent CN) and as a principal ingredient in the riot control agent Mace. It is also used as a pharmaceutical intermediate. The United States considers agent CN and its mixtures with various chemicals to be obsolete for military deployment.

Incompatibilities: Keep away from water, steam, strong oxidizers. CN reacts with water, forming hydrochloric acid. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. CN reacts slowly with metals, causing mild corrosion and may evolve flammable hydrogen gas.

Permissible Exposure Limits in Air

NIOSH IDLH; 15 milligram per cubic meter

Odor threshold = 0.015 ppm.

OSHA PEL: 0.05 ppm/0.3 milligram per cubic meter TWA

NIO SH REL: 0.05 ppm/0.3 milligram per cubic meter TWA

ACGIH TLV[1]: 0.05 ppm/0.32 milligram per cubic meter TWA, not classifiable as a human carcinogen

No PAC available

Australia: TWA 0.05 ppm (0.3 milligram per cubic meter), 1993; Austria: MAK 0.05 ppm (0.3 milligram per cubic meter), 1999; Belgium: TWA 0.05 ppm (0.32 milligram per cubic meter), 1993; Denmark: TWA 0.05 ppm (0.3 milligram per cubic meter), 1999; Finland: STEL 0.05 ppm

(0.3 milligram per cubic meter) [skin] 1993; France: VME 0.05 ppm (0.4 milligram per cubic meter), 1999; Norway: TWA 0.05 ppm (0.3 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 0.3 milligram per cubic meter, 2003; Switzerland: MAK-W 0.05 ppm (0.3 milligram per cubic meter), 1999; United Kingdom: TWA 0.05 ppm (0.32 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Several states have set guidelines or standards[60] for chloroacetophenone in ambient air ranging from 1.0 μ/m^3 (New York) to 3.0 μ/m^3 (Florida and North Dakota) to 6.0 μ/m^3 (Connecticut) to 7.0 μ/m^3 (Nevada) to 7.5 μ/m^3 (South Carolina).

Determination in Air: Tenax GC[2]; Thermal desorption; GC/Flame ionization detection; NIOSH II(5) P&CAM Method #291.

Permissible Concentration in Water: No criteria set.

Determination in Water: Octanol–water coefficient: Log $K_{ow} = 1.9$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, skin absorption; ingestion; skin and eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: A lacramator (a "tear gas"). This chemical can be absorbed through the skin, thereby increasing exposure. This chemical irritates the eyes, skin, and respiratory tract. Eye contact can cause severe irritation, burns, and permanent damage. Breathing the vapor can cause lung irritation, coughing, and shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: Repeated or prolonged contact with skin may cause skin sensitization and skin allergy with itching and rash.

Points of Attack: Eyes, skin, respiratory system; lungs.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Consider X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Decontamination: Decontaminate as soon as possible. This is extremely important. If you don't have the equipment and training, don't enter the hot zone to rescue and/or decontaminate victims. If the victim can't move, begin the decontamination process without touching and without entering the hot zone. Use clean water from any source; if possible, use a hose (spray or fog to prevent injury to the victim) or other system so that you won't have to touch the victim; don't even wait for soap or for the victim to remove clothing, begin washing immediately. Immediately flush the eyes with water for at least 15 minutes. Wash—strip—wash—evacuate upwind and uphill: The approach is to immediately wash with water; then have the victim (not the first responder) remove all the victim's clothing; then wash again (with soap if available); and subsequently move away from the hot zone in an upwind and uphill direction. Wash the victim with warm water and soap. Decontaminate with diluted household bleach (10%, or one part bleach to nine parts water), but don't let any of the bleach solution get in the victim's eyes, open wounds, or mouth. Rinse off the diluted bleach solution after 15 minutes. In order to prevent spreading the agent, be certain the victims have been decontaminated as much as possible before they leave the decontamination area. If you get any amount of the agent on yourself, decontaminate immediately. Even if you think you are not contaminated, be sure to thoroughly shower and change clothes as soon as you can after the incident.

Personal Protective Methods:

General information: First responders should use a NIOSH-certified chemical, biological, radiological, nuclear (CBRN) SCBA with a level a protective suit when entering an area with an unknown contaminant or when entering an area where the concentration of the contaminant is unknown. Level a protection should be used until monitoring results confirm the contaminant and the concentration of the contaminant. *Note:* Safe use of protective clothing and equipment requires specific skills developed through training and experience.

LEVEL A: (*RED ZONE*): Select when the greatest level of skin, respiratory, and eye protection is required. This is the maximum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than the AEGL-2. A NIOSH-certified CBRN full-facepiece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle. A TECP suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, and a hard hat worn under the TECP suit are optional items.

LEVEL B: (RED ZONE): Select when the highest level of respiratory protection is necessary but a lesser level of skin protection is required. This is the minimum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than AEGL-2. It differs from Level A in that it incorporates a nonencapsulating, splash-protective, chemical-resistant splash suit that provides Level A protection against liquids but is not airtight. A NIOSH-certified CBRN full-facepiece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL C: (YELLOW ZONE): Select when the contaminant and concentration of the contaminant are known and the respiratory protection criteria factors for using APRs (APR) or PAPRs are met. This level is appropriate when decontaminating patient/victims. A NIOSH-certified CBRN tight-fitting APR with a canister-type gas mask or CBRN PAPR for air levels greater than AEGL-2. A NIOSH-certified CBRN PAPR with a loose-fitting facepiece, hood, or helmet and a filter or a combination organic vapor, acid gas, and particulate cartridge/filter combination or a continuous flow respirator for air levels greater than AEGL-1. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Escape mask, face shield, coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL D: (GREEN ZONE): Select when the contaminant and concentration of the contaminant are known and the concentration is below the appropriate occupational exposure limit or less than AEGL-1 for the stated duration times. Limited to coveralls or other work clothes, boots, and gloves.

Notes: Take all necessary precautions to prevent any reasonable probability of skin or eye contact. **8 hours** (more than 8 hours of resistance to breakthrough >0.1 μg/cm^2/min): Responder suits. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear indirect vent, impact and splash-proof chemical goggles, and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *3 milligram per cubic meter:* Any air-purifying half-mask respirator with organic vapor cartridge(s) in combination with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100. *7.5 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOvHie (APF = 25) (any air-purifying full facepiece respirator equipped with an organic vapor cartridge in combination with a high-efficiency particulate filter). *15 milligram per cubic meter:* Any air-purifying full facepiece respirator equipped with organic vapor cartridge(s) in combination with an N100, R100, or P100 filter; or any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern and having an N100, R100, or P100 filter; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* Any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern and having an N100, R100, or P100 filter; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a refrigerator or cool, well-ventilated area away from oxidizers, heat, water, and steam. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN1697 Chloroacetophenone, solid, (CN), Hazard Class: 6.1; Labels: 6.1-Poison Inhalation. UN3416 Chloroacetophenone, liquid, (CN), Hazard Class: 6.1;

Labels: 6.1-Poisonous materials. Hazard. Military driver shall be given full and complete information regarding shipment and conditions in case of emergency. AR 50-6 deals specifically with the shipment of chemical agents. Shipments of agent will be escorted in accordance with AR 740-32.

Spill Handling:

CN, when used as a weapon

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30

Then: Protect persons downwind (mi/km)

Day 0.1/0.2

Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 200/60

Then: Protect persons downwind (mi/km)

Day 0.2/0.3

Night 0.8/1.3

Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources and dampen spilled material with toluene to avoid airborne dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include hydrogen chloride and oxides of carbon. This chemical is a combustible solid but does not readily ignite. In case of fire, *do not put out the fire*. CN vapor is so bad that the fire is safer than the unburned CN. If there is some reason that you have to put out the fire—for example, there are things you can't let burn nearby—use water or ordinary foam. It's always best to use a spray or fog pattern rather than a solid stream, to avoid spreading the burning liquid around. In the unlikely situation where there is a pile of CN canisters adjacent to a fire, cool the canisters with large amounts of water, but first evacuate the area—if the canisters rupture from heating, toxic gases could kill. CN can give off toxic hydrogen chloride in a fire or when heated. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Tear gas-containing waste is dissolved in an organic solvent and sprayed into an incinerator equipped with an afterburner and alkaline scrubber utilizing reaction with sodium sulfide in an alcohol−water solution. Hydrogen sulfide is liberated and collected by an alkaline scrubber.

References

(31); (173); (101); (138); (85); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 4, No. 1, 48−49 (1984).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* α-Chloroacetophenone, Trenton, NJ (November 1998).

Chloroacetyl Chloride C:0760

Formula: $C_2H_2Cl_2O$; $ClCH_2COCl$

Synonyms: Acetyl chloride, chloro-; Chloroacetic acid chloride; Chloroacetic chloride; Chlorure dechloracetyle (French); Cloruro decloroacetilo (Spanish); Monochloroacetyl chloride

CAS Registry Number: 79-04-9

HSDB Number: 973

RTECS Number: AO6475000

UN/NA & ERG Number: (PIH) UN1752/156

EC Number: 201-171-6 [*Annex I Index No.:* 607-080-00-1]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade).

Hazard Alert: Poison inhalation hazard, Combustible, Violently water reactive, Environmental hazard.

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects[291]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, C, N; risk phrases: R14; R23/24/25; R29; R35; R48/23; R50; safety phrases: S1/2; S7/8; S9; S26; S28; S29/35; S36/37/39; S41; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Chloroacetyl chloride is a colorless to yellowish liquid with a very pungent, extremely irritating, odor. Molecular weight = 112.94; specific gravity (H_2O:1) = 1.42 @ 20°C; boiling point = 106°C; freezing/melting point =

−22°C; vapor pressure = 19 mmHg @ 20°C; 7.5 mmHg @ 5.6°C (NFPA-704 M Rating System): Health 3, flammability 1, reactivity 1 ₩. Reacts violently with water.

Potential Exposure: Highly toxic by inhalation. Chloroacetyl chloride is used in the manufacture of acetophenone. It is used in the manufacture of a number of pesticides including: alachlor, allidochlor, butachlor, dimethachlor, formothion, mecarbam, metolachlor, propachlor. It is also used in the manufacture of pharmaceuticals, such as chlordiazepoxide hydrochloride, diazepam, lidocaine, mianserin.

Incompatibilities: Reacts violently with water, steam-forming chloroacetic acid and hydrogen chloride gas. Reacts with alcohols, powdered metals; sodium amide; combustibles; and many organics, causing toxic fumes, fire, and explosion hazard. On contact with air it emits corrosive gas. Decomposes when heated forming phosgene gas. Corrosive to metals.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 4.62 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: None

NIOSH REL: 0.05 ppm/0.2 milligram per cubic meter TWA

ACGIH TLV[1]: 0.05 ppm/0.23 milligram per cubic meter TWA; 0.15 ppm/0.69 milligram per cubic meter STEL [skin]

PAC* Ver. 29[138]

PAC-1: **$0.040_{\mathbf{A}}$** ppm

PAC-2: **$1.6_{\mathbf{A}}$** ppm

PAC-3: **$52_{\mathbf{A}}$** ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60-minute values.

DFG MAK: No numerical value established. Data may be available.

Australia: TWA 0.05 ppm (0.2 milligram per cubic meter), 1993; Austria: MAK 0.05 ppm (0.2 milligram per cubic meter), 1999; Belgium: TWA 0.05 ppm (0.23 milligram per cubic meter), 1993; Denmark: TWA 0.05 ppm (0.2 milligram per cubic meter), 1999; France: VME 0.05 ppm (0.2 milligram per cubic meter), 1999; Norway: TWA 0.05 ppm (0.2 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 0.2 milligram per cubic meter, 2003; Switzerland: MAK-W 0.05 ppm (0.24 milligram per cubic meter), 1999; United Kingdom: LTEL 0.05 ppm (0.2 milligram per cubic meter), 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 0.15 ppm [skin]. Some states have set guidelines or standards for chloroacetyl chloride in ambient air[60] ranging from 3.0 μ/m^3 (Virginia) to 4.0 μ/m^3 (Connecticut) to 5.0 μ/m^3 (Nevada).

Determination in Air:

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Permissible Concentration in Water: No criteria set. Chloroacetyl chloride decomposes in water.

Routes of Entry: Skin absorption, skin and eye contact, inhalation, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: A tissue corrosive and a lacramator (causes discharge of tears). Chloroacetyl chloride can severely irritate the eyes and cause permanent damage. It is corrosive to the skin and respiratory tract. Corrosive on ingestion. Inhalation of vapor or aerosol can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. The substance may affect the cardiovascular system. Exposure far above the PEL may cause death. Medical reports of the effects of acute exposures include: mild-to-moderate skin burns and erythema; lachrymation and mild eye burns; mild-to-moderate respiratory effects with cough, dyspnea, cyanosis, and mild gastrointestinal effects.

Long-Term Exposure: Repeated or prolonged contact with skin may cause dermatitis. Lungs may be affected by repeated or prolonged exposure.

Points of Attack: Skin, eyes, respiratory system.

Medical Surveillance: Should include attention to skin, eyes, and respiratory system in preplacement and regular physical examinations. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. **4 hours** (At least 4 but <8 hours of resistance to breakthrough >0.1 $\mu g/cm^2/min$): Teflon gloves, suits, boots. Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode).

Storage: Poison inhalation chemical (PIH); check oxygen content prior to entering storage area. Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from water, steam, heat, and combustibles. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN1752 Chloroacetyl chloride, Hazard class: 6.1; Labels: 6.1-Poison Inhalation Hazard, 8-Corrosive material, Inhalation Hazard Zone B.

Spill Handling:

Chloroacetyl chloride

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

when spilled on land

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 0.4/0.6

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 300/90
Then: Protect persons downwind (mi/km)
Day 0.8/1.2
Night 1.4/2.3

When spilled in water

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 0.6/1.0

Stay upwind and uphill. Isolate the area of release or fire and deny entry. Remove all ignition sources. Stop there lease if it can be done safely from a distance. All equipment used to handle this material must be grounded. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. *Small spill*: Cover with *dry* earth, *dry* sand, or other noncombustible material followed with plastic sheet to minimize spreading or contact with water or rain. Use clean nonsparking tools to collect material and place material into loosely covered plastic containers for later disposal. Prevent material and runoff from entering sewers and waterways if it can be done safely well ahead of the release. Use vapor suppressing foam to disperse vapors−contain runoff. Water spray may reduce vapor, but may not prevent ignition in enclosed spaces. Ventilate confined area if it can be done without placing personnel at risk. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a nonflammable liquid. *Do not use water* or water-based extinguishers. This chemical decomposes in heat, producing phosgene, chlorine, and hydrogen chloride. *Small fire*: use *dry* chemical, CO_2, *dry* sand, or alcohol-resistant foam. May react with foams releasing corrosive/toxic gases. *Large fire*: use water spray or alcohol-resistant foam if it is available in sufficient amounts. Under favorable conditions, experienced crews can use coordinated fog streams to sweep the flames off the surface of the burning liquid. Combustible material: may burn but does not ignite readily. Most vapors are heavier than air. They will spread along ground and collect in low or confined areas (sewers, basements, tanks). Vapors may travel to source of ignition and flashback. Containers may explode when heated or if contaminated with water. Keep exposures cool long after fire is out to protect against reignition. Do not direct straight streams into the liquid. Cool exposed containers with large quantities of water from unattended equipment or remove intact containers if it can be done safely. *Do not get water on spilled substance or inside containers*. If cooling streams are ineffective (*venting sound increases in volume and pitch, tank discolors, or shows signs of deforming*), withdraw immediately to a secure location. Always stay away from ends of tanks, especially when engulfed in flames. If material or contaminated runoff from fire control enters waterways, notify downstream users of potentially contaminated water. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156.

Disposal Method Suggested: It may be discharged into sodium bicarbonate solution, then flushed to the sewer with water.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Chloroacetyl Chloride, Trenton, NJ (December 1999).

Chloroanilines C:0770

Formula: $C_6H_4ClNH_2$

Synonyms: *m*-isomer*:* *m*-Aminochlorobenzene; 1-Amino-3-chlorobenzene; 3-Chloroaniline; 3-Chlorobenzeneamine; Orange GC base

mixed isomers: Aminochlorbenzene; Benzeneamine, chloro-; Benzene chloride; Chlorbenzen; Chlorobenzol; MCB; Monochlorbenzene; Monochlorbenzol (German); Monochlorobenzene; NCI-C54886; Phenyl chloride; Phenylchloride

o-isomer: o-Aminochlorobenzene; 1-Amino-2-chlorobenzene; 2-Chloroaminobenzene; 2-Chloroaniline; Fast yellow GC base

p-isomer: p-Aminochlorobenzene; 1-Amino-4-chlorobenzene; Benzeneamine, 4-chloro-; 4-Chloraniline; *p*-Chloroaminobenzene; 4-Chloro-1-aminobenzene; 4-Chloroaniline; 4-Chlorobenzenamine; 4-Chlorobenzeneamine; 4-Chlorophenylamine; *p*-Cloroanilina (Spanish)

CAS Registry Number: 108-42-9 (*m*-isomer); 95-51-2 (*o*-isomer); 106-47-8 (*p*-isomer); 27134-26-5 (mixed isomers); 0265-96-7 (hydrochloride); 101-14-4 [methylene bis(2-chloroaniline), 4,4′-; MBOCA see M;0850]

HSDB Number: 2046 (*m*-isomer); 2045 (*o*-isomer); 2047 (*p*-isomer)

RTECS Number: BX0525000 (*o*-isomer); BX0350000 (*m*-isomer); BX0700000 (*m*-isomer)

UN/NA & ERG Number: (*m*-isomer) UN2018 (solid)/152; UN2019 (liquid)/152

EC Number: 202-426-4 (*o-isomer*); 203-581-0 (*m-isomer*); 203-401-0 [*Annex I Index No.:* 612-137-00-9] (*p-isomer*); 243-656-5 (*hydrochloride*)

Regulatory Authority and Advisory Information

Carcingenicity: See *m- & p-isomer*s, below.

Hazard Alert: (*all isomers*): Poison, Combustible, Possible risk of forming tumors, Suspected reprotoxic hazard, Environmental hazard.

o-isomer

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. (*o-isomer*)

Hazard symbols, risk, & safety statements: (*o-isomer*) Hazard symbol: T, N, Xi; risk phrases: R45; R23/34/25; R43; R51/53; R62; safety phrases: S29/35; S53; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class) (*o-isomer*): 2-Hazard to waters

*m- & p-isomer*s

Carcinogenicity: IARC (*m- & p-isomers*): Animal, limited evidence; Human, inadequate evidence, *not classifiable as carcinogenic to humans*, Group 3.

California Proposition 65 Chemical[102]: Cancer 10/1/94 (*p*-isomer); 5/15/98 (hydrochloride)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P024 (*p*-isomer)

RCRA, 40CFR261, Appendix 8 Hazardous Constituents (*p*-isomer)

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.46; Nonwastewater (mg/kg), 16 (*p*-isomer)

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (20) (*p*-isomer)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1000 lb (454 kg) (*p*-isomer)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0% (*p-isomer*)

Canada, WHMIS, Ingredients Disclosure List 0.1% (*p*-isomer, carcinogen); 1.0% (*m-isomer*).

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: (*p-isomer*) Hazard symbol: T, N, Xi; risk phrases: R45; R23/34/25; R43; R50/53; safety phrases: S29; S41; S45; S53; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to waters (*o-*, *m-*, *isomer*); 3-Severe hazard to water. (*p-isomer*)

Description: The chloroanilines have the following properties:

m-isomer: Colorless to yellow liquid that may turn brown on exposure to air. Molecular weight = 127.57; specific gravity (H_2O:1) = 1.216; boiling point (decomposes) = 230°C; freezing/melting point = −11°C; vapor pressure = < 0.1 mmHg @ 20°C; flash point = 118°C (cc); autoignition temperature = > 540°C. Slight solubility in water; solubility = 0.6%.

o-isomer; Colorless to yellow liquid that may turn brown on exposure to air. Molecular weight = 127.57; specific gravity (H_2O:1) = 1.21; boiling point = 208.7°C; freezing/melting point = −2°C; flash point = 108°C; autoignition temperature = >500°C; solubility in water = 0.5% @ 20°C.

p-isomer see also record No. P:0400

The *p*-isomer is a colorless to pale-yellow crystalline solid. Molecular weight = 127.6; specific gravity (H_2O:1) = 1.43; boiling point = 232°C; freezing/melting point = 69.5−72.5°C; vapor pressure = 0.015 mm Hg @ 20°C; flash point = 120−123°C (oc); autoignition temperature = 685°C. Hazard identification (based on NFPA-704 M Rating System): *p-isomer* Health 3, flammability 1, reactivity 0. Soluble in hot water; solubility (cold) = 0.4% @ 20°C.

Potential Exposure: (*m*- and *o*-isomers): Possible risk of forming tumors, Suspected of causing genetic defects (*p*-isomer): Possible risk of forming tumors, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction). Chloroanilines are used to make dyes, other chemicals; insecticides and many other industrial products.

Incompatibilities: Contact with strong oxidizers may cause fire and explosions. The aqueous solution of the *m*-isomer is a weak base. Incompatible with strong acids; organic anhydrides; isocyanates, aldehydes.

Permissible Exposure Limits in Air

m- and o-isomers

ACGIH TLV[1]: 01 ppm TWA

DFG MAK: [skin]; (*m*- and *p*-isomers) Danger of skin sensitization.

p-isomer see also P:0400

OSHA PEL: 0.1 milligram per cubic meter TWA[skin]

NIOSH REL: 0.1 milligram per cubic meter TWA [skin]

ACGIH TLV[1]: 0.1 milligram per cubic meter TWA; not classifiable as a human carcinogen

PAC Ver. 29[138]

106-47-8

PAC-1: 6.1 ppm

PAC-2: 68 ppm

PAC-3: 100 ppm

DFG MAK: 0.1 milligram per cubic meter, measured as the, inhalable fraction TWA; Peak Limitation Category II (2); [skin], danger of skin sensitization; Carcinogen Category 3; Pregnancy Risk Group C

Austria: [skin], carcinogen, 1999; Poland: TWA 3 milligram per cubic meter; STEL 10 milligram per cubic meter, 1999; Switzerland: [skin], carcinogen, 1999

DFG MAK: [skin] Carcinogen Category 2

The former USSR-UNEP/IRPTC joint project[43] has set MAC limits in work-place air of 0.05 milligram per cubic meter for the *m*-isomer and 0.3 milligram per cubic meter for the *p*-isomer, the MAC is 0.04 milligram per cubic meter on a temporary basis; 0.01 on an average daily basis. No standards were set for the *o*-isomer. This chemical can be absorbed through the skin, thereby increasing exposure. States which have set guidelines or standards for *p*-chloro aniline in ambient air[60] include Connecticut at 0.06 μ/m^3 and New York @ 6.0 μ/m^3.

Permissible Concentration in Water: State Drinking Water Guidelines (106-47-8): Florida 28 μg/L.

Determination in Water: Octanol−water coefficient: Log K_{ow} (all isomers) = range 1.83 to 1.92. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation of vapor, skin absorption; ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Chloroanilines can affect you when breathed in and by passing through your skin. Exposure can lower the ability of the blood to carry oxygen (a condition called methemoglobinemia). This can cause headaches, trouble breathing; weakness; a bluish color to the nose and lips; collapse and death. Contact can severely irritate and may burn the eyes. *o-isomer:* Irritates the eyes, skin, and respiratory tract. *m-isomer:* May affect the liver and kidneys. Exposure may result in death. The effects may be delayed. *p-isomer:* Irritates the eyes, skin, and respiratory tract. May affect the red blood cells, resulting in formation of methemoglobin and hemolysis. Exposure could cause headaches, trouble breathing, weakness, a bluish color to the nose and lips, loss of consciousness; and possible death.

Long-Term Exposure: *o*-isomer: Repeated or prolonged contact with skin may cause dermatitis. The substance may have effects on the liver and kidneys and also the blood system, resulting in forming of methemoglobin. *m*-isomer: The substance may have effects on the blood system, resulting in forming of methemoglobin. *p-isomer:* Repeated or prolonged contact may cause skin sensitization. The substance may have effects on the spleen, liver and kidneys, resulting in organ damage. Tumors have been detected in experimental animals but may not be relevant to humans. The methemoglobinemia described above can occur gradually over weeks instead of all at once.

Points of Attack: Blood, skin.

Medical Surveillance: These chemicals (*m & p isomers*) are suspected human carcinogens. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure. If symptoms develop or overexposure is suspected, the following may be useful: methemoglobin level.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get

medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended.

Note to Physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: *Clothing:* Avoid skin contact with chloroaniline. Wear solvent-resistant gloves and clothing. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove, clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day and put on before work. *Eye Protection:* Wear splash-proof chemical goggles and face shield when working with liquid, unless full facepiece respiratory protection is worn. Wear dust-proof goggles and face shield when working with powders or dust, unless full facepiece respiratory protection is worn.

Respirator Selection: *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA). *Where there is potential exists for exposures to chloroanilines*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode. All respirators selected must be approved by NIOSH under the provisions of 42 CFR 84. The current listing of NIOSH-certified respirators can be found in the NIOSH/NPPTL Certified Equipment List, which is available on the NIOSH website.

Storage: Color code—Blue: Health Hazard/Poison (*p-isomer*): Store in a secure poison location. Prior to working with chloroaniline all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from Oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates), since violent reactions occur. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2018 Chloroanilines, solid, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN2019 Chloroanilines, liquid, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: *Ortho- and metaiomers:* Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. *p-isomer:* Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: *p-isomer:* This chemical is a combustible solid. Thermal decomposition products may include hydrogen chloride and oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode. *o*- and *m*-isomers: These chemicals are combustible liquids. Thermal decomposition products may include nitrous oxides and hydrogen chloride. Use dry chemical, carbon dioxide; or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve in a combustible solvent, such as alcohol or benzene and spray into a furnace equipped with afterburner and scrubber[22]. Alternatively, pour into a mixture of sand and soda ash and burn in a furnace with paper as a fuel. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(102); (31); (173); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 6, No. 5, 64−70 (1986) (2-Chloroaniline).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Chloroaniline, Trenton, NJ (August 2005).

(173); (101); (138).

Chlorobenzene C:0780

Formula: C_6H_5Cl

Synonyms: Abluton T-30; Benzene chloride; Benzene, chloro-; Chlorbenzen; Chlorobenzol; Clorobanceno (Spanish); Clorobenceno (Spanish); KTI PMMA-standard 496 K/950 K; MCB; Monochlorbenzol (German); Monochlorobenzene; NCI-C54886; Phenyl chloride

CAS Registry Number: 108-90-7

HSDB Number: 55

RTECS Number: CZ0175000

UN/NA & ERG Number: UN1134/130

EC Number: 203-628-5 [*Annex I Index No.:* 602-033-00-1]

Regulatory Authority and Advisory Information

Carcinogenicity: EPA: Not Classifiable as to human carcinogenicity; NTP: Carcinogenesis Studies (gavage); some evidence: rat (NTP:TR-261,1985); equivocal evidence: rat; no evidence: mouse.

Hazard Alert: Poison, Highly flammable, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard. Listed for Tier 1 screening as an endocrine disruptor[88].

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

United States National Primary Drinking Water Regulations: MCLG = 0.01 mg/L; MCL = 0.1 mg/L

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U037; Tox # D:021, regulated level = 100 mg/L.

RCRA Toxicity Characteristic (Section 261.24), Maximum Concentration of Contaminants, regulatory level, 100 mg/L

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.057; Nonwastewater (mg/kg), 6.0

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8010 (2); 8020 (2); 8240 (5)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%; NPRI; CEPA Priority Substance List; Drinking Water Quality: 0.08 mg/L MAC.

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xn, N; risk phrases: R11; R20; R51/53; R62; R63; safety phrases: S2; S21; S24/25; S29/35; S41; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Chlorobenzene is a colorless liquid with an almond-like odor. The Odor Threshold is between 0.1 and 3.0 μg/L[35]. Also reported in the literature at 0.68 ppm and 0.741 ppm. Molecular weight = 112.56; specific gravity (H_2O:1) = 1.106 @ 20°C; boiling point = 131−132°C; freezing/melting point = −45.3°C; flash point = 28°C; autoignition temperature = 593°C. Flammable limits are: LEL: 1.3%; UEL: 9.6%. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 3, reactivity 1. Insoluble in water.

Potential Exposure: Chlorobenzene is used in the manufacture of aniline, phenol, and chloronitrobenzene; as an intermediate in the manufacture of dyestuffs and many pesticides, as a solvent; and emulsifier.

Incompatibilities: Reacts violently with strong oxidizers; dimethyl sulfoxide; sodium powder; silver perchlorate; causing fire and explosion hazard. Attacks some plastics, rubber, and coatings. Decomposes on heating, producing phosgene and hydrogen chloride fumes.

Permissible Exposure Limits in Air

NIOSH IDLH = 1000 ppm

OSHA PEL: 75 ppm/350 milligram per cubic meter TWA

NIOSH REL: None

ACGIH TLV[1]: 10 ppm/46 milligram per cubic meter TWA; confirmed animal carcinogen with unknown relevance to humans; BEI: 150 mg [total 4-chlorocatechol]/g creatinine in urine/end-of-shift; 25 mg[total *p*-chloro phenol]/g creatinine in urine/end-of-shift

DFG MAK: 10 ppm/47 milligram per cubic meter TWA; Peak Limitation Category II(2); Pregnancy Rislk Group C; BAT: 70 mg/g [total 4-chlorocatecho l] creatinine in urine at the beginning of the next shift; BAT: 300 mg/g [total 4-chlorocatechol] creatinine in urine at end-of-shift.

PAC* Ver. 29[138]

PAC-1: $\mathbf{10_A}$ ppm

PAC-2: $\mathbf{150_A}$ ppm

PAC-3: $\mathbf{400_A}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60-minute values.

Arab Republic of Egypt: TWA 1 ppm, 1993; Australia: TWA 75 ppm (350 milligram per cubic meter), 1993; Austria: MAK 50 ppm (230 milligram per cubic meter), 1999; Belgium: TWA 75 ppm (345 milligram per cubic meter), 1993; Denmark: TWA 10 ppm (46 milligram per cubic meter), 1999; Finland: TWA 50 ppm (230 milligram per cubic meter); STEL 75 ppm (345 milligram per cubic meter), 1999; France: VME 10 ppm, 1999; the Netherlands: MAC-TGG 46 milligram per cubic meter, 2003; Japan: 10 ppm (46 milligram per cubic meter), 1999; Norway: TWA 25 ppm (115 milligram per cubic meter), 1999; Poland: MAC (TWA) 50 milligram per cubic meter; STEL 150 milligram per cubic meter, 1999; Switzerland: MAK-W 50 ppm (230 milligram per cubic meter), KZG-W 100 ppm (460 milligram per cubic meter), 1999; Turkey: TWA 75 ppm (350 milligram per cubic meter), 1993; United Kingdom: LTEL 50 ppm (230 milligram per cubic meter), 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: confirmed animal carcinogen with unknown relevance to humans. Several states have set guidelines or standards for Chlorobenzene in ambient air[60] ranging from $6.3\ \mu/m^3$ (Massachusetts) to $1167\ \mu/m^3$ (New York) to $2200\ \mu/m^3$ (New York) to $3500\ \mu/m^3$ (Florida and North Dakota) to $6000\ \mu/m^3$ (Virginia) to $7000\ \mu/m^3$ (Connecticut) to $8333\ \mu/m^3$ (Nevada).

Determination in Air: Charcoal absorption followed by workup with CS_2 and analysis by GC. Use NIOSH Analytical Method #1003 for hydrocarbons, halogenated.

Permissible Concentration in Water: Safe Drinking Water Act (47FR 9352): MCL, 0.1 mg/L; MCLG, 0.1 mg/L State Drinking Water Standards: California 70 μg/L; New Jersey 50 μg/L; State Drinking Water Guidelines: Arizona 60 μg/L; Maine 140 μg/L; Minnesota 100 μg/L.

Determination in Water: GC (EPA Methods 601 and 602) or GC plus mass spectrometry (EPA Method 624).

Routes of Entry: Inhalation, ingestion, eye and skin contact. This chemical can be absorbed through the skin, thereby increasing exposure.

Harmful Effects and Symptoms

Short-Term Exposure: The liquid can irritate and burn the skin. The vapor can irritate the eyes, nose, and throat. Chlorobenzene can affect you when breathed in and by passing through your skin. Exposure to high concentrations can cause you to become dizzy, lightheaded, and to pass out. Swallowing the liquid may cause aspiration into the lungs with the risk of chemical pneumonitis. The effects may be delayed. Medical observation is indicated.

Long-Term Exposure: Liver and kidney problems. May cause damage to the lungs, blood, nervous system. Repeated exposure to the liquid may cause skin burns. Similar petroleum-based solvents cause brain damage, with reduced memory and concentration; personality changes; fatigue; sleep disturbances; reduced coordination.

Points of Attack: Respiratory system, eyes, skin, central nervous system; liver.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater, or significant skin contact) the following are recommended before beginning work and at regular times after that: Liver function tests. If symptoms develop or overexposure has occurred, the following may be useful: lung and kidney function tests. Interview for brain effects.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended.

Personal Protective Methods: Wear solvent-resistant gloves and clothing to prevent any reasonable probability of skin or eye contact. **8 hours** (more than 8 hours of resistance to breakthrough $>0.1\ \mu g/cm^2/min$): Viton gloves, suits, Barricade-coated suits; Responder suits, Trellchem HPS suits; Trychem 1000 suits; **4 hours** (At least 4 but <8 hours of resistance to breakthrough $>0.1\ \mu g/cm^2/min$): polyvinyl alcohol gloves; Teflon gloves, suits, boots. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: OSHA: *1000 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOv (APF = 25) [any powered, APR with organic vapor cartridge(s)]; or CcrFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* PD,PP (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance causes eye irritation or damage; eye protection needed.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with chlorobenzene all handlers should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Chlorobenzene must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat, sparks, or flames. Sources of ignition, such as smoking and open flames are prohibited where Chlorobenzene is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gal or more of Chlorobenzene should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of Chlorobenzene.

Shipping: UN1134 Chlorobenzene, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. Keep Chlorobenzene out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include phosgene and hydrogen chloride. Use dry chemical, carbon dioxide; or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration, preferably after mixing with another combustible fuel; care must be exercised to assure complete combustion to prevent the formation of phosgene; an acid scrubber is necessary to remove the halo acids produced[22].

References

(31); (173); (101); (138); (2); (100).

United States Environmental Protection Agency, Chlorinated Benzenes: Ambient Water Quality Criteria, Washington, DC (1980).

United States Environmental Protection Agency, Chlorobenzene, Health and Environmental Effects Profile No. 42, Office of Solid Waste, Washington, DC (April 30, 1980).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 2, No. 4, 72−75, New York, Van Nostrand Reinhold Co. (1982).

New York State Department of Health, *Chemical Fact Sheet* Chlorobenzene, Bureau of Toxic Substance Assessment, Albany, NY (May 1986).

United States Environmental Protection Agency, Health advisory: Chlorobenzene, Washington, DC, Office of Drinking Water (March 31, 1987).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Chlorobenzene, Trenton, NJ (December 1999).

Chlorobenzilate C:0784

Formula: $C_{16}H_{14}C_{12}O_3$

Synonyms: Acar; Acaraben; Acaraben 4E; Akar 338; Benzeneacetic acid, 4-chloro-α-(4-chlorophenyl)-

α-hydroxy-, ethyl ester; Benzilan; Benzilic acid, 4,4′-dichloro-, ethyl ester; Benzilic acid,4,4′-dichloro, ethyl ester; Benz-*o*-chlor; Chlorbenzilate; Chlorbenzilat; 4-Chloro-α-(4-chlorophenyl)-α-hydroxybenzeneacetic acid ethyl ether; 4,4′-Cichlorbenzilsaeureaethylester (German); Compound 338; 4,4′-Dichloro benzilate; 4,4′-Dichlorobenzilic acid ethyl ester; ECB; ENT 18,596; Ethyl 4-chloro-α-(4-chlorophenyl)-α-hydroxybenzene acetate; Ethyl *p,p*′-dichlorobenzilate; Ethyl 4,4′-dichlorobenzilate; Ethyl-4,4′-dichlorodiphenyl glycollate; Ethyl-4,4′-dichlorophenyl glycollate; Ethyl ester of 4,4′-dichlorobenzilic acid; Ethyl 2-hydroxy-2,2-bis(4-chlorophenyl)acetate; Folbex; Folbex smoke strips; G 23992; G 338; Geigy 338; Kop Mite; NCI-C00408; NCI-C60413

CAS Registry Number: 510-15-6

HSDB Number: 1617

RTECS Number: DD2275000

UN/NA & ERG Number: UN2761/151 (solid); UN2996 (liquid)/151

EC Number: 208-110-2 [*Annex I Index No.:* 607-159-00-0]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human No Adequate Evidence; Animal Limited Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1987; NCI: Carcinogenesis Studies (inhalation); clear evidence: mouse; equivocal evidence: rat, 1978. United States Environmental Protection Agency Gene-Tox Program, Negative: In vitro SCE-human lymphocytes; In vitro SCE-human.

California Proposition 65 Chemical[102]: Cancer 1/1/1990.

Hazard Alert: Poison, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction), Environmental hazard, Agricultural chemical.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U038

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.10; Nonwastewater (mg/kg), N/A

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)] (as chlorobenzilate)

Hazard symbols, risk, & safety statements: Hazard symbol: Xn, N; risk phrases: R22; R50/53; safety phrases: S2; S60; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)]

Description: Ethyl 4,4′-dichlorobenzilate is a yellow solid when pure. The technical product is a brownish liquid. Molecular weight = 235.19; specific gravity (water = 1) = 1.282 @ 20°C; boiling point = 146−148°C; freezing/melting point = 35−37.3°C (pure); vapor pressure = 2.2×10^{-6} mmHg @ 20°C; flash point = 40°C. Practically insoluble in water; solubility = <0.1 mg/mL @ 22°C.

Potential Exposure: It is a buffer in many chemical intermediates; an organochlorine miticide; to kill mites, ticks, and other insects; as a synergist for DDT.

Incompatibilities: Strong acids, strong bases; lime.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 8.4 milligram per cubic meter

PAC-2: 92 milligram per cubic meter

PAC-3: 550 milligram per cubic meter

Routes of Entry: Inhalation, ingestion, passing through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Contact irritates the skin causing rash or burning sensation. Exposure can cause headache, loss of appetite; nausea, vomiting, and diarrhea.

Long-Term Exposure: This chemical may damage the male reproductive glands. May cause liver and kidney damage. Repeated or prolonged exposure may affect the nervous system; causing a loss of coordination; muscle weakness; tremors, convulsions, dizziness, and possible coma. This chemical may be a human carcinogen.

Points of Attack: Liver, kidneys, nervous system.

Medical Surveillance: Examination of the nervous system. Liver and kidney function tests. More than light alcohol consumption may exacerbate liver damage.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece

respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong acids, strong bases. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition are prohibited where this chemical is used, handled, or stored. Always store pesticides in their original containers, complete with labels that list ingredients, directions for use, and first aid steps in case of accidental poisoning. Never store pesticides in cabinets with or near food, animal feed, or medical supplies. Do not store pesticides in places where flooding is possible or in places where they might spill or leak into wells, drains, ground water, or surface water[72]. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2996 Organochlorine pesticides, liquid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.UN2761 Organochlorine pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical may burn but does not easily ignite. Thermal decomposition products may include chlorine. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform to EPA regulations governing storage, transportation, treatment, and waste disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(102); (31); (173); (101); (138); (203); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Ethyl-4,4′-Dichlorobenzilate, Trenton, NJ (May 1999).

p-Chlorobenzotrichloride C:0790

Formula: C_7H_4Cl4; $Cl_3C\text{-}C_6H_4\text{-}Cl$

Synonyms: Benzene, 1-chloro-4-(trichloromethyl)-; 4-Chlorobenzotrichloride; *p*-Chlorophenyltrichloromethane; 1-Chloro-4-(trichloromethyl)benzene; PC TC; *p*-α,α,α-Tetrachlorotoluene; *p*-Trichloromethylchlorobenzene

CAS Registry Number: 5216-25-1

RTECS Number: XT8580000

UN/NA & ERG Number: UN1760 (corrosive liquids, n.o.s.)/154

EC Number: 226-009-1 [*Annex I Index No.:* 602-093-00-9]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: (α,α,α-tetrachlorotoluene) Human Limited Evidence; Animal Sufficient Evidence, *probably carcinogenic to humans*, Group 2A; DFG, Carcinogen Category 2.

California Proposition 65 Chemical[102]: Cancer (*as p-a,a, a*-Tetrachlorotoluene) 1/1/1990

Hazard Alert: Combustible, Toxic liquid, Suspected of causing genetic defects, Dangerously water reactive, Possible sensitization hazard (skin).

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xi; risk phrases: R45; R21/22; R37/38; R43; R50/53; R48/23; R62; safety phrases: S1; S41; S45; S53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: *p*-Chlorobenzotrichloride, an organochloride, is a flammable, water-white liquid. Molecular weight = 229.91; specific gravity (H_2O:1) = 1.49; boiling point = 254°C; melting/freezing point = 5 to 6°C; flash point = > 110°C; autoignition temperature = 500−505°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 1₩, reactivity 0. Decomposes in water releasing hydrogen chloride and benzoic acid.

Potential Exposure: Used in agrochemicals manufacture as an intermediate; reaction with HF yields chlorobenzotrifluoride as a major intermediate for several pesticides; for making pharmaceuticals; UV absorbers, and dyestuffs. This chemical is manufactured in high volume (exceeds 1 million pounds per annum) in the United States.

Incompatibilities: A halogenated aromatic compound. Hydrolyzes to hydrochloric acid and benzoic acid in all forms of moisture. Incompatible with strong oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from reducing agents, alkaline materials, strong acids, strong bases, amines, nitrides, azo/diazo compounds, alkali metals, and epoxides.

Permissible Exposure Limits in Air

No PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

DFG MAK: [skin] Carcinogen Category 2

No numerical limits set. However, this chemical can be absorbed through the skin, thereby increasing exposure. Toxic by inhalation. A potential carcinogen: exposure should be kept to lowest feasible level.

Determination in Air: No test listed.

Routes of Entry: Inhalation, ingestion; absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: A corrosive and lacrimator. May cause irritation by any route of exposure. Poisonous by inhalation. LD_{50} (oral-rat) = 820 mg/kg.

Long-Term Exposure: A skin sensitizer; may cause rash. A suspected human carcinogen, neuro-, and respiratory toxicant[129].

Points of Attack: Skin.

Medical Surveillance: Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: (1) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location; keep acids away from bases and red, yellow, and blue-coded chemicals. (2) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Store in tightly closed containers in a refrigerator. Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN1760 Corrosive liquids, n.o.s., Hazard class: 8; Labels: 8-Corrosive material, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include hydrogen chloride and oxides of carbon. Use dry chemical, carbon dioxide; or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(102); (31); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile Draft Report: *p*-Chlorobenzotrichloride, Washington, DC (February 24, 1983).

New York State Department of Health, *Chemical Fact Sheet* para-Chlorobenzotrichloride, Bureau of Toxic Substance Assessment, Albany, NY (January 1986).

Chlorobenzotrifluoride C:0800

Formula: $C_7H_4ClF_3$; $ClC_6H_4CF_3$

Synonyms: (*p*-Chlorophenyl)trifluoromethane; *p*-Chlorotrifluoromethylbenzene; 4-Chlorotrifluoromethylbenzene; 1-Chloro-4-(trimethyl)-benzene; OXSOL 100; α,α,α-Trifluoro-4-chloro toluene; *p*-(Trifluoromethyl)chlorobenzene; *p*-Trifluoromethylphenyl chloride; Trifluoromethylphenyl chloride

CAS Registry Number: 98-56-6; 52181-51-8

HSDB Number: 4251

RTECS Number: XS9145000

UN/NA & ERG Number: UN2234/130

EC Number: 202-681-1

Regulatory Authority and Advisory Bodies

Hazard Alert: Flammable, Possible risk of forming tumors, Suspected of causing genetic defects.

United States National Primary Drinking Water Regulations: MCLG = 4 mg[F]/L; MCL = 4 mg[F]/L; SMCL = 2.0 mg[F]/L, as Fluoride.

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xi, N; risk phrases: R10; R36/37/38; R51; R62; safety phrases: S16; S24/25; S36/37/39; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): (98-56-6) 2-Hazard to waters

Description: Chlorobenzotrifluoride is a colorless, highly flammable liquid. Molecular weight = 180.6; boiling point = 139°C; melting/freezing point = −36°C; flash point = 43°C (cc); autoignition temp => 500°C; flammable limits are: LEL: 0.9%; UEL: 10.5%. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 2, reactivity 0. The pure *o*-isomer: boiling point = 152°C; flash point = 59°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 2, reactivity 1. Slightly soluble in water; solubility =< 1 mg/mL @ 20°C.

Potential Exposure: This material is used in the manufacture of pharmaceuticals; dyes, dielectrics, and insecticides.

Incompatibilities: Vapors may form explosive mixture with air. Violent reaction with strong oxidizers, such as permanganates and dichromates, chlorates, nitrates, peroxides, perchlorates, chlorine, bromine, fluorine, etc.; contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Mixture with sodium dimethyl 5-sulphonatoisophthalate (3965-55-7) may cause explosion.

Permissible Exposure Limits in Air

No standards or PAC available.

Determination in Air: No tests available.

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guide lines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg[F]/L. Safe Drinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg[F]/L; SMCL = 2 mg/F/L, as Fluoride.

Determination in Water: Octanol−water coefficient: Log K_{ow} => 3.5. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Harmful Effects and Symptoms

Short-Term Exposure: Causes local irritation to skin, eyes, and mucous membranes. May cause irritation by any route of exposure. The LD_{50} rat is 13 g/kg (13,000 mg/kg) (insignificantly toxic).

Long-Term Exposure: There is evidence that this chemical is a mutagen.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek

medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear solvent-resistant gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls, and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit. NIOSH: *(fluorides) 12.5 milligram per cubic meter*: Qm (APF = 25) (any quarter-mask respirator). *25 milligram per cubic meter:* 95XQ (APF = 10) (any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators). The following filters may also be used: [N99, R99, P99, N100, R100, P100]; or SA* (any supplied-air respirator). *62.5 milligram per cubic meter:* Sa:Cf (APF = 25)* (any supplied-air respirator operated in a continuous-flow mode); or*$^+$ *if not present as a fume* PaprHie (APF = 25) (any powered, APR with a high-efficiency particulate filter). *125 milligram per cubic meter:* HieF$^+$ (any air-purifying, full facepiece respirator with a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *250 milligram per cubic meter:* Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* HieF$^+$ (any air-purifying, full facepiece respirator with a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA). *Substance reported to cause eye irritation or damage; may require eye protection. *May need acid gas sorbent.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with chlorobenzotrifluoride all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2234 Chlorobenzotrifluorides, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include fluorine and chlorine. Use dry chemical, carbon dioxide; or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA

1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR165 recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (122); (100).

New York State Department of Health, *Chemical Fact Sheet para*-Chlorobenzotrifluoride, Bureau of Toxic Substance Assessment, Albany, NY (January 1986).

o-Chlorobenzylidenemalonitrile (Agent CS) C:0810

Formula: $C_{10}H_5ClN_2$; $ClC_6H_4CH{=}C(CN)_2$

Synonyms: *o*-Chlorobenzalmalononitrile; 2-Chlorobenzalmalononitrile; 2-Chlorobenzylidene malononitrile; CS* (military designation); β,β-Dicyano-*o*-chloro styrene; Propanedinitrile[(2-chlorophenyl)methylene] *Note:* CS1, CS2, CSX all contain *o*-Chlorobenzylidenemalononitrile (CS) as agent

CAS Registry Number: 2698-41-1

HSDB Number: 4346

RTECS Number: OO3675000

UN/NA & ERG Number: (PIH) UN2810 (toxic liquid, organic, n.o.s.)/153

EC Number: 220-278-9

Regulatory Authority and Advisory Information

Hazard Alert: Poison inhalation hazard, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction), Environmental hazard.

As a cyanide compound:

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants as cyanide, total

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as cyanide mixtures.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R28; R32; R50/53; R62; R63; safety phrases: S1/2; S7/8; S23; S36/37; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)]

Description: *o*-Chlorobenzylidene malonitrile is a combustible, white crystalline solid. Pepper-like odor. Molecular weight = 188.62; boiling point = 310−315°C; freezing/melting point = 95°C; vapor pressure = 3×10^{-6} mmHg @ 20°C. Insoluble in water.

Potential Exposure: CS tear gas is used as a riot control agent and is also used as an agent in CS1, CS2, and CSX riot control, and tear gases.

Incompatibilities: Contact with strong oxidizers may cause fire and explosion. May be explosive if dust mixes with air.

Permissible Exposure Limits in Air

NIOSH IDLH = 2 milligram per cubic meter

OSHA PEL: 0.05 ppm/0.4 milligram per cubic meter TWA

NIOSH REL: 0.05 ppm/0.4 milligram per cubic meter Ceiling Concentration [skin]

ACGIH TLV[1]: 0.05 ppm/0.39 milligram per cubic meter Ceiling Concentration [skin]; not classifiable as a human carcinogen

PAC* Ver. 29[138]

PAC-1: **0.005**$_{\mathbf{A}}$ milligram per cubic meter

PAC-2: **0.083**$_{\mathbf{A}}$ milligram per cubic meter

PAC-3: **11**$_{\mathbf{A}}$ milligram per cubic meter

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60-minute values.

Australia: TWA 0.05 ppm (0.4 milligram per cubic meter) [skin], 1993; Belgium: STEL 0.05 ppm (0.4 milligram per cubic meter) [skin], 1993; Denmark: TWA 0.05 ppm (0.4 milligram per cubic meter) [skin], 1999; France: STEL 0.05 ppm (0.4 milligram per cubic meter) [skin], 1999; Norway: TWA 0.05 ppm (0.4 milligram per cubic meter), 1999; the Philippines: TWA 05 ppm (0.4 milligram per cubic meter), 1993; Switzerland: MAK-W 0.05 ppm (0.4 milligram per cubic meter) [skin], 1999; the Netherlands: MAC 0.4 milligram per cubic meter [skin], 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam; ACGIH TLV: Ceiling Concentration 0.05 ppm [skin]. Several states have set guidelines or standards for OCBM in ambient air[60] ranging from 3.0 μ/m^3 (Virginia) to 4.0 μ/m^3 (North Dakota) to 8.0 μ/m^3 (Connecticut) to 10.0 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method #7904; #6010, cyanides.

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 200 μg[CN]/L; State Drinking Water Standards: California 150 μg[CN]/L; State Drinking Water Guidelines: Arizona 220 μg[CN]/L; Maine. 140 μg[CN]/L; Minnesota 100 μg[CN]/L. United States Army field drinking-water standards for cyanide: 2 mg[CN]/L assuming a water consumption of 15 L/day and 6 mg[CN]/L assuming a water consumption of 5 L/day. United States Army field drinking-water standards for cyanide, long-term consumption 0.5 mg [CN]/L; Short-term consumption; Raw water constituents (maximum) 20 mg[CN]/L.

Routes of Entry: Inhalation, ingestion, eye and skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: A lacramator. Irritates the eyes, skin, and respiratory tract. OCBM is extremely irritating and acts on exposed sensory nerve endings (primarily in the eyes and upper respiratory tract). The signs and symptoms from exposure to the vapor are conjunctivitis and pain in the eyes, lacrimation; erythema of the eyelids; blepharospasms; irritation and running of the nose; burning in the throat; coughing and constricted feeling in the chest; and excessive salivation. Vomiting may occur if saliva is swallowed. Most of the symptoms subside after exposure ceases. Burning on the exposed skin is increased by moisture. With heavy exposure, vesiculation and erythema occur. Photophobia has been reported. LD_{50} = (oral-rat).

Long-Term Exposure: Repeated or prolonged contact may cause skin sensitization. Animal experiments indicate that OCBM has a relatively low toxicity. The systemic changes observed in human experiments are nonspecific reactions to stress. OCBM is capable of sensitizing guinea pigs; there also appears to be a cross-reaction in guinea pigs previously sensitized to 1-chloroacetophenone. See NIOSH Criteria Document 212 *Nitriles*.

Points of Attack: Respiratory system, skin, and eyes.

Medical Surveillance: Consideration should be given to the eyes, skin, and respiratory tract in any placement or periodic evaluations.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Decontamination: Decontaminate as soon as possible. This is extremely important. If you don't have the equipment and training, don't enter the hot zone to rescue and/or decontaminate victims. If the victim can't move, begin the decontamination process without touching and without entering the hot zone. Use clean water from any source; if possible, use a hose (spray or fog to prevent injury to the victim) or other system so that you won't have to touch the victim; don't even wait for soap or for the victim to remove clothing, begin washing immediately. Immediately flush the eyes with water for at least 15 minutes. Wash—strip—wash—evacuate upwind and uphill: The approach is to immediately wash with water, then have the victim (not the first responder) remove all the victim's clothing, then wash again (with soap if available); and subsequently move away from the hot zone in an upwind and uphill direction. Wash the victim with warm water and soap. Decontaminate with diluted household bleach (10%, or one part bleach to nine parts water), but don't let any of the bleach solution get in the victim's eyes, open wounds, or mouth. Rinse off the diluted bleach solution after 15 minutes. In order to prevent spreading the agent, be certain the victims have been decontaminated as much as possible before they leave the decontamination area. If you get any amount of the agent on yourself, decontaminate immediately. Even if you think you are not contaminated, be sure to thoroughly shower and change clothes as soon as you can after the incident.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See NIOSH Criteria Document 212 *Nitriles*.

Respirator Selection: OSHA: *2 milligram per cubic meter:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern and having an N100, R100, or P100 filter; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd, Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* Any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern and having an N100, R100, or P100 filter; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a refrigerator or cool, well-ventilated area. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2810 Toxic liquids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. Military driver shall be given full and complete information regarding shipment and conditions in case of emergency. AR 50-6 deals specifically with the shipment of chemical agents. Shipments of agent will be escorted in accordance with AR 740-32.

Spill Handling:
UN2810 Toxic liquids, organic, n.o.s.
Initial isolation and protective action distances
Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).
Small spills (From a small package or a small leak from a large package)
First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 0.7/1.2
Large spills (From a large package or from many small packages)
First: Isolate in all directions (ft/m) 1000/300
Then: Protect persons downwind (mi/km)
Day 1.1/1.8
Night 2.8/4.5
CS when used as a weapon
First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.4/0.6
Large spills (From a large package or from many small packages)
First: Isolate in all directions (ft/m) 300/90
Then: Protect persons downwind (mi/km)
Day 0.3/0.5
Night 1.2/1.9
Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Dampen spilled material with 60%−70% acetone to avoid airborne dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. In case of fire, *do not put out the fire*. CS vapor is so deadly that the fire is safer than the unburned CS. If there is some reason that you have to put out the fire (e.g., there are things you can't let burn nearby) use water or ordinary foam. It's always best to use a spray or fog pattern rather than a solid stream, to avoid spreading the burning liquid around. In the unlikely situation where there is a pile of CS canisters adjacent to a fire, cool the canisters with large amounts of water, but first evacuate the area—if the canisters rupture from heating, toxic gases could kill. CS can give of toxic hydrogen cyanide, chlorine, and nitrogen oxides in a fire or when heated. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References
(31); (173); (101); (138); (85); (2); (100).

Chlorobromomethane C:0820

Formula: CH_2BrCl
Synonyms: Bromochloromethane; Bromoclorometano (Spanish); CB; CBM; Halon 1011; Metane, bromochloro-; Methylene chlorobromide; Mil-B-4394-B; Mono-chloro-mono-bromo-methane
CAS Registry Number: 74-97-5
HSDB Number: 2520
RTECS Number: PA5250000
UN/NA & ERG Number: UN1887/160
EC Number: 200-826-3
Regulatory Authority and Advisory Information
Carcinogenicity: EPA: Not Classifiable as to human carcinogenicity.
Hazard Alert: Poison, Suspected reprotoxic hazard.
Hazard symbols, risk, & safety statements: Hazard symbol: T, F, N, Xi, Xn; risk phrases: R11; R20; R23/24/25; R36/37/38; R39; R41; R51; R59; safety phrases: S7; S16; S26; S36/37; S39; S45; S59; S41 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Chlorobromomethane is a clear, colorless, to pale-yellow liquid with a chloroform-like odor. Molecular weight = 129.39; specific gravity (H_2O:1) = 1.93; boiling point = 67.8°C; freezing/melting point = −88°C; vapor pressure = 115 mmHg @ 20°C. Flammable limits are: LEL:120, 000. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 0, reactivity 0. Insoluble in water.

Potential Exposure: This compound is used in brominated flame retardants; a fire-extinguishing agent; and in organic synthesis.

Incompatibilities: Incompatible with strong oxidizers (possible explosion), reducing agents, bases, carbonates, furyl alcohol, chemically active metals, such as calcium; base metals in the presence of moisture, powdered aluminum; zinc, magnesium. Liquid attacks some plastics, rubber, and coatings.

Permissible Exposure Limits in Air

NIOSH IDLH = 2000 ppm

Odor threshold = 400 ppm.

OSHA PEL: 200 ppm/1050 milligram per cubic meter TWA

NIOSH REL: 200 ppm/1050 milligram per cubic meter TWA

ACGIH TLV[1]: 200 ppm/1060 milligram per cubic meter TWA

PAC Ver. 29[138]

PAC-1: 600 ppm

PAC-2: 830 ppm

PAC-3: 5000 ppm

DFG MAK: [skin] Carcinogen Category 3B

Australia: TWA 200 ppm (1050 milligram per cubic meter); STEL 250 ppm, 1993; Austria: MAK 200 ppm (1050 milligram per cubic meter), 1999; Denmark: TWA 200 ppm (1050 milligram per cubic meter), 1999; Finland: TWA 200 ppm (1050 milligram per cubic meter); STEL 250 ppm (1315 milligram per cubic meter), 1999; France: VME 200 ppm (1050 milligram per cubic meter), 1993; Norway: TWA 100 ppm (525 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 1050 milligram per cubic meter, 2003; Poland: TWA 1000 milligram per cubic meter; STEL 1300 milligram per cubic meter, 1999; Switzerland: MAK-W 200 ppm (1050 milligram per cubic meter), KZG-W 400 ppm (2100 milligram per cubic meter), 1999; Turkey: TWA 200 ppm (1050 milligram per cubic meter), 1993; United Kingdom: TWA 200 ppm (1080 milligram per cubic meter); STEL 250 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 200 ppm. Several states have set guidelines or standards for CBM in ambient air[60] ranging from 10.5−13 milligram per cubic meter (North Dakota) to 17.5 milligram per cubic meter (Virginia) to 21.0 milligram per cubic meter (Connecticut) to 25.0 milligram per cubic meter (Nevada).

Determination in Air: Charcoal adsorption, workup with CS_2, followed by GC. Use NIOSH Analytical Method #1003 for hydrocarbons, halogenated.

Routes of Entry: Inhalation, ingestion, eye and skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Contact can irritate and burn the skin and eyes. This chemical can irritate the lungs. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Symptoms include disorientation, dizziness; irritation of eyes, throat and skin; headaches, anorexia, nausea, vomiting; abdominal pain; weakness, tremors and convulsions; narcosis. LD_{50} (oral-rat) = 5000 mg/kg (slightly toxic).

Long-Term Exposure: May cause liver and kidney damage, which may be progressive; skin irritation and cracking. May affect the lungs and cause bronchitis to develop. May cause weight loss; memory impairment; paralysis. Skin contact can cause drying and cracking.

Points of Attack: Skin, liver, kidneys, respiratory system; lungs, central nervous system.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Serum bromine level. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. **4 hours** (At least 4 but <8 hours of resistance to breakthrough $>0.1\ \mu g/cm^2/min$): Teflon gloves, suits, boots; Responder suits. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *2000 ppm:* Sa:Cf (APF = 25)* (any supplied-air respirator operated in a continuous-flow mode); or PaprOv (APF = 25) [any powered, APR with organic vapor cartridge(s)]; CcrFOv* [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, SCBA).

*Substance can cause eye irritation or damage; eye protection needed.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Chlorobromomethane must be stored to avoid contact with chemically active metals, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat.

Shipping: UN1887 Bromochloromethane, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible liquid. Use any extinguishers suitable for surrounding fire. Thermal decomposition products may include hydrogen chloride and hydrogen bromide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incinerate together with flammable solvent in furnace equipped with afterburner and alkali scrubber.

References

(31); (173); (101); (138); (2); (100).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Chlorobromomethane, Trenton, NJ (November 1998).

p-Chloro-*m*-Cresol C:0824

Formula: C_7H_7ClO; $C_6H_3OHCH_3Cl$

Synonyms: Aptal; Baktol; Baktolan; Candaseptic; Chlorocresol; *p*-Chlorocresol; 4-Chloro-*m*-cresol; 6-Chloro-*m*-cresol; 2-Chloro-hydroxytoluene; 6-Chloro-3-hydroxytoluene; 4-Chloro-3-methylphenol; Clariant (Switzerland); 4-Cloro-3-metilfenol (Spanish); CMK; 3-Methyl-4-chlorophenol; Nipacide PCMC; Parachlorometacresol; PCMC; Ottafact; Parmetol; Parsol; Preventol; Raschit; Raschit K; Rasen-anicon

CAS Registry Number: 59-50-7

HSDB Number: 5198

RTE CS Number: GO7100000

UN/NA & ERG Number: UN2669 (solution)/152; UN3437 (solid)/152

EC Number: 200-431-6 [*Annex I Index No.:* 604-014-00-3]

Regulatory Authority and Advisory Information

Carcinogenicity: EPA Group D, Not classifiable as a human carcinogen.

Hazard Alert: Poison, Combustible, Suspected of causing genetic defects, Environmental hazard, Sensitization hazard (skin).

Clean Water Act: Section 307 Priority Pollutants; Section 313 Priority Chemicals

RCRA Section 261 Hazardous Constituents, U039

RCRA Universal Treatment Standards: Wastewater (mg/L), 0.018; Nonwastewater (mg/kg), 14

RCRA Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8040(5); 8270(20)

EPCRA Section 304 RQ: CERCLA, 5000 lb (2270 kg)

California EPA AB2588-Air Toxics “Hot Spots” Chemicals (CAL)

The “Director’s List” (CAL/OSHA) as chlorophenols

List of priority pollutants (United States Environmental Protection Agency)

EPCRA Section 313 (as chlorophenols) Form R *de minimis* concentration reporting level: 1.0%

Hazardous to aquatic life or environment, with possible long-lasting effects[291]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: Xi, Xn, N; risk phrases: R21/22; R41; R43; R51; safety phrases: S2; S26; S29/35; S36/37/39; S41; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: White (pure) or pink crystalline solid. Crystals turn pink on exposure to air and light. Phenolic odor. Molecular weight = 142.59; specific gravity (H_2O:1) = 1.37; boiling point = 235°C; freezing/melting point = 56°C; 67°C; vapor pressure 5×10^{-2} @25°C. Hygroscopic. Soluble in water; solubility = 3830 mg/L @ 25°C. May be shipped dissolved in a liquid carrier. Physical and toxicological properties may be affected by the carrier solvents used in commercial formulations.

Potential Exposure: Chlorinated phenol fungicide, microbiocide, and germicide used to control bacteria, yeasts, and fungi.

Incompatibilities: Chlorocresols react with boranes, alkalies, aliphatic amines, amides, nitric acid, sulfuric acid. Contact with oxidizing agents may cause a fire and explosion hazard. Heat produces phosgene, hydrogen chloride and chlorine gases. Corrosive to aluminum, copper, tin, and other chemically active metals[101].

Permissible Exposure Limits in Air:

PAC Ver. 29[138]

PAC-1: 5.5 milligram per cubic meter

PAC-2: 60 milligram per cubic meter

PAC-3: 360 milligram per cubic meter

Permissible Concentration in Water: No criteria set for this chemical; however, EPA recommends that drinking water contain not >0.04 mg/L of 2-chlorophenol for a lifetime exposure for an adult, and 0.05 mg/L for a 1-day, 10-day, or longer exposure for a child

Determination in Water: GC (EPA Method 604) or GC plus mass spectrometry (EPA Method 625). Octanol−water coefficient: Log $K_{ow} = > 3$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Skin absorption, inhalation, ingestion, skin and/or eye contact

Harmful Effects and Symptoms

Short-Term Exposure: Inhalation can cause severe irritation, burns to the nose and throat, headache, dizziness, vomiting, lung damage, muscle twitchings, spasms, tremors, weakness, staggering, and collapse. Dermal contact can cause severe irritation and burns. Can be absorbed through the skin to cause or increase the severity of symptoms listed above. Eye contact causes severe irritation. May cause burns. Ingestion can cause irritation, burns to the mouth and throat, low blood pressure, profuse sweating, intense thirst, nausea, abdominal pain, stupor, vomiting, red blood cell damage, and accumulation of fluid in the lungs followed by pneumonia. May also cause restlessness and increased breathing rate followed by rapidly developing muscle weakness. Tremors, convulsions, and coma can promptly set in and will continue until death. Based on animal studies, the estimated lethal dose is between one teaspoon and 1 oz for a 150-lb adult. *p*-isomer: The substance irritates the eyes, the skin and the respiratory tract. The substance may cause effects on the central nervous system and bladder.

Long-Term Exposure: Skin sensitivity may develop. May have effects on the blood, heart, liver, lung, kidney. The state of New Jersey lists the 2-chloro-isomer as probable carcinogen in humans, and that it causes leukemia and soft tissue cancers in humans. Chlorophenols leave the body quickly, so they are not likely to accumulate in the mother's tissues or breast milk. There are no human studies on the effects of chlorophenols on developing fetuses. Studies in rats showed that chlorophenols can pass through the placenta and produce toxic effects to the developing fetuses. The most common problems in children are delayed hardening of the bones of the breastbone, spine, and skull.

Points of Attack: Liver, kidneys. An allergen, may cause skin irritation and sensitization.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: Liver function tests. Kidney function tests. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. EKG. If skin or lung sensitization is suspected, consider evaluation by a qualified allergist, including exposure history and testing, may help diagnose allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. *Do not induce vomiting when formulations containing petroleum solvents are ingested.* Otherwise, give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of dermal contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: SCBA >5.5 milligram per cubic meter. Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a refrigerator or cool, well-ventilated area. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2669 Chlorocresols solution, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN3437 Chlorocresols solid, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: First remove all sources of ignition. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include phosgene, hydrogen chloride, and oxides of carbon. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: A good candidate for rotary kiln incineration at a temperature range of 820 to 1600°C and residence times of seconds for liquids and gases, and hours for solids[179].

References

(31); (173); (101); (138); (204); (100).

United States Environmental Protection Agency, "Reregistration Eligibility Decision (RED), *p*-Chloro-*m*-cresol", Office of Prevention, Pesticides and Toxic Substances, Washington, DC (January 1997). http://www.epa.gov/oppsrrd1/REDs/3046red.pdf.

Agency for Toxic Substances and Disease Registry "Toxicological profile for chlorophenols," 1999, Atlanta, GA.

United States Environmental Protection Agency, Engineering Handbook for Hazardous Waste Incineration, EPA 68-03-3025, p.3-11, Washington, DC (1981).

Chlorodifluorobromomethane C:0830

Formula: $CBrClF_2$

Synonyms: Bromochloro difluoromethane; Chloro difluorobromomethane; Flugex 12 B1; Fluorocarbon 1211; Freon 12B1; Halon 1211; R12B1

CAS Registry Number: 353-59-3

HSDB Number: 6784 as bromochlorodifluoromethane

RTECS Number: PA5270000

UN/NA & ERG Number: UN1974/126

EC Number: 206-537-9

Regulatory Authority and Advisory Information

Hazard Alert: Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated, Suspected of causing genetic defects, Environmental hazard (ozone layer).

Clean Air Act: Stratospheric ozone protection (Title VI, Subpart A, Appendix A), Class I, Ozone Depletion Potential (ODP) = 3.0

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, CEPA Schedule I Toxic Substances (import/export, manufacturing, and processing restrictions).

Harms public health and the environment by destroying ozone in the upper atmosphere.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N, Xi; risk phrases: R5; R21; R36/37/38; R58/59; R62; safety phrases: S9; S23; S33; S36/37; S38; S39, S57; S59; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): Nonhazard to water.

Description: Chlorodifluorobromomethane is a colorless gas or liquid under pressure. Molecular weight = 165.4; boiling point = −4°C; freezing/melting point = −160.5°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 0, reactivity 0. Insoluble in water. The liquefied gas poured into water can be violently explosive.

Potential Exposure: Used as a refrigerant and fire extinguishing agent.

Incompatibilities: The liquefied gas poured into water may be violently explosive. This is due to the phase transition from superheated liquid to vapor[101]. Chlorodifluorobromomethane is generally chemically inert; however, it can react violently with strong reducing agents such as hydrides and highly active metals. It will react with strong oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides strong oxidizing agents. It can also react with weak oxidizers under extreme temperatures[101].

Permissible Exposure Limits in Air

PAC Ver. 29[138]
PAC-1: 13 ppm
PAC-2: 140 ppm
PAC-3: 1400 ppm

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guide lines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg [F]/L. Safe Drinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg[F]/L; SMCL = 2 mg/F/L, as Fluoride.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 2.1$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short-Term Exposure: Chlorodifluorobromomethane can asphyxiate by displacing air. Irritates the eyes and respiratory tract. Contact with the liquid can cause burns and frostbite. Inhalation can cause irregular heartbeat. High exposure can cause dizziness, lightheadedness, and unconsciousness.

Long-Term Exposure: Can affect the heartbeat causing irregular rhythms and skipped beats.

Points of Attack: Heart.

Medical Surveillance: Special 24-hour EKG (Holter monitor) for irregular heartbeat.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/ manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is a potential for overexposure*:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode).

Storage: Check oxygen content prior to entering storage area. Nonflammable gas. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure sufficient oxygen (19%) exists. Store in tightly closed containers in a cool, well-ventilated area away from heat and sparks. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: UN1974 Chlorodifluorobromomethane or Refrigerant gas R-12B1, Hazard Class: 2.2; Labels: 2.2-Nonflammable compressed gas. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: *Gas:* If in a building, evacuate building and confine vapors by closing doors and shutting down HVAC systems. Restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak to disperse the gas. Stop the flow of gas, if it can be done safely from a distance. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place; and repair leak or allow cylinder to empty. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. *Liquid:* Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical may burn, but does not readily ignite. Thermal decomposition products may include bromine, chlorine, and fluoride compounds and oxides of carbon; this may include highly dangerous fumes of hydrogen chloride, hydrogen bromide, and HF. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Container may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier.

References

(31); (173); (101); (138); (122); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Chlorodifluoromonobromomethane, Trenton, NJ (June 1998)

Chlorodifluoroethane C:0840

Formula: C_2H_5Cl; $ClCH_2CH_3$

Synonyms: CFC 142b; Chlofluorocarbon 142b; 1, 1,1-Chlorodifluoroethane; 1-Chloro-1,1-difluoroethane; α-Chloroethylidene fluoride; Chloroethylidene fluoride; 1,1,1-Difluorochloroethane; 1,1-Difluoro-1-chloroethane; Difluoro-1-chloroethane; Difluoromonochloroethane; Ethane, 1-chloro-1,1-difluoro-; FC-142b; Fluorocarbon 142b; Fluorocarbon FC 142b; Freon 142; Freon 142b; Genetron 101; Genetron 142b; Gentron 142B; HCFC-142B; Hydrochlorofluorocarbon 142b; Propellant 142b; R142B

CAS Registry Number: 75-68-3

HSDB Number: 2881

RTECS Number: KH7650000; KH7630000 (chlorodifluoroethanes)

UN/NA & ERG Number: UN2517/115

EC Number: 200-891-8

Regulatory Authority and Advisory Information

Hazard Alert: Extremely flammable gas, Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated, Possible, axphyxiant, Suspected reprotoxic hazard, Suspected of causing genetic defects; Environmental hazard (ozone layer).

Banned or Severely Restricted in aerosol sprays (UN)[13]

Clean Air Act: Stratospheric ozone protection (Title VI, Subpart A, Appendix B), Class II, Ozone Depletion Potential (ODP) = 0.06

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Harms public health and the environment by destroying ozone in the upper atmosphere.

Hazard symbols, risk, & safety statements: Hazard symbol: F+, T, N, Xi; risk phrases: R5; R12; R21; R58/59; R62; 63; safety phrases: S9; S33; S35; S38; S41; S578; S59; 61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Chlorodifluoroethane is a flammable, colorless gas. Nearly odorless. Molecular weight = 100.5; specific gravity (H_2O:1) = 1.21; boiling point = −9.5°C; freezing/melting point = −131°C; flash point = flammable gas; autoignition temperature = 632°C. The explosive limits are: LEL: 6.2%; UEL: 17.9%. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 4, reactivity 0. Practically insoluble in water; solubility = 0.2% @ 5°C. The liquefied gas poured into water can be violently explosive.

Potential Exposure: Chlorodifluoroethane is used in refrigerants; solvents; as a propellant in aerosol sprays; and as an intermediate in the production of highly specialized fluoropolymers[129].

Incompatibilities: The liquefied gas poured into water may be violently explosive. This is due to the phase transition from superheated liquid to vapor[101]. Chlorodifluoroethane is generally chemically inert; however, it can react violently with strong reducing agents such as hydrides and highly active metals. It will react with strong oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides strong oxidizing agents. It can also react with weak oxidizers under extreme temperatures[101]. Decomposes in heat to form phosgene; HF and hydrogen chloride.

Permissible Exposure Limits in Air

PAC* Ver. 29[138]

PAC-1: $\mathbf{10{,}000_E}$ ppm

PAC-2: $\mathbf{15{,}000_E}$ ppm

PAC-3: $\mathbf{25{,}000_E}$ ppm

*ERPG [Emergency Response Planning Guidelines (AIHA)] are marked with a subscript "**E**."

DFG MAK: 1000 ppm/4200 milligram per cubic meter TWA; Peak Limitation II(8); Pregnancy Risk Group D, as 1-Chloro-1,1-difluoroethane (FC-142-b)

Austria: MAK 1000 ppm (4170 milligram per cubic meter), 1999; Hungary: TWA 100 milligram per cubic meter; STEL 200 milligram per cubic meter, 1993; Russia: STEL 3000 milligram per cubic meter, 1993; the Netherlands: MAC-TGG 8380 milligram per cubic meter, 2003

Permissible Concentration in Water: No criteria set.

Determination in Water: Octanol–water coefficient: Log $K_{ow} = 1.6$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Chlorodifluoroethane can affect you when breathed in. Skin contact may cause frostbite. High levels can cause you to feel dizzy, lightheaded, and to pass out. Very high levels could cause death. High exposure could cause irregular heartbeat, which could lead to death.

Short-Term Exposure: Chlorodifluoroethane can affect you when breathed in. High levels can cause you to feel dizzy, lightheaded, and to pass out. Very high levels could cause death. High exposure could cause irregular heartbeat, which could lead to death. Contact with the liquid may cause frostbite.

Long-Term Exposure: Inhalation, rat, lowest published toxic concentration: 1000 ppm/6 hour (3–15 day pregnant) Reproductive: Effects on fertility: Preimplantation mortality (e.g., reduction in number of implants per female; total number of implants per corpora lutea)[165].

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: Special 24 hour EKG (halter monitor) to look for irregular heartbeat. Evaluation by a qualified allergist, including careful exposure history and special testing may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash affected parts in warm water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear nonvented, impact resistant chemical goggles when working with gas Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls, and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit. NIOSH: *(fluorides) 12.5 milligram per cubic meter*: Qm (APF = 25) (any quarter-mask respirator). *25 milligram per cubic meter:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or SA* (any supplied-air respirator). *62.5 milligram per cubic meter:* Sa:Cf (APF = 25)* (any supplied-air respirator operated in a continuous-flow mode); or*$^{+}$ *if not present as a fume* PaprHie (APF = 25) (any powered, APR with a high-efficiency particulate filter). *125 milligram per cubic meter:* HieF^{+} (any air-purifying, full facepiece respirator with a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *250 milligram per cubic meter:* Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* HieF^{+} (any air-purifying, full facepiece respirator with a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

*Substance reported to cause eye irritation or damage; may require eye protection. *May need acid gas sorbent.

Storage: Check oxygen content prior to entering storage area. Flammable gas. Color code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Prior to working with Chlorodifluoroethane all handlers should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Detached or outside storage is preferred. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: UN25171-Chloro-1,1-difluoroethane or Refrigerant gas R-142b, Hazard Class: 2.1; Labels: 2.1-Flammable gas. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from area for leak until clean-up is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Stop flow of gas. If source of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. Keep Chlorodifluoroethane out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable gas. Thermal decomposition products may include phosgene, HF, hydrogen chloride, chlorine, and oxides of carbon. Use dry chemical, carbon dioxide; or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Chlorodifluoroethane, Trenton, NJ (December 1998).

Chlorodifluoromethane C:0850

Formula: $CHClF_2$

Synonyms: Algeon 22; Algofrene 22; Algofrene type 6; Arcton 22; Arcton 4; CFC 22; Chlorofluorocarbon 22; Diaflon 22; Difluorochloromethane; Difluoromonochloromethane; Dymel 22; Electro-CF 22; Eskimon 22; F22; FC 22; Flugene 22; Fluorocarbon 22; Forane 22; Forane 22 B; Freon; Freon 22; Frigen; Frigen 22; Genetron 22; HCFC-22; Hydrochlorofluorocarbon 22; Isceon 22; Isotron 22; Khaladon 22; Khladon 22; Methane, chlorodifluoro-; Monochlorodifluoromethane; Propellant 22; R-22; Refrigerant 22; Ucon 22; Ucon 22/Halocarbon 22

CAS Registry Number: 75-45-6

HSDB Number: 143

RTECS Number: PA6390000

UN/NA & ERG Number: UN1018/126

EC Number: 200-871-9

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Limited Evidence, Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1999[9]

Hazard Alert: Dangerously water reactive (possibly explosive), Possible, axphyxiant, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated, Environmental hazard (ozone layer). Removed from 5/22/2014 list of endocrine dispruptors[88].

Banned or Severely Restricted (in aerosol sprays) (UN)[13]

United States Environmental Protection Agency TSCA Section 8(e) Risk Notification, 8EHQ-0892-9099; 8EHQ-0892-9107; 8EHQ-0892-9108; 8EHQ-0892-9117; 8EHQ-0892-9188

Clean Air Act: Stratospheric ozone protection (Title VI, Subpart A, Appendix B), Class II, Ozone Depletion Potential (ODP) = 0.05

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Harms public health and the environment by destroying ozone in the upper atmosphere.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R40; R5; R21; R59; R62; R63; safety phrases: S9; S23; S33; S38; S57; S59; S41; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Chlorodifluoromethane is a nonflammable, colorless, nearly odorless gas. Molecular weight = 86.47; specific gravity (H_2O:1) = 1.49; boiling point = −40.7°C; freezing/melting point = −157.42°C; vapor pressure = 9.4 atm @ 20°C; 750 mmHg @ −41.1°C; autoignition temperature = 632°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 0, reactivity 0. Soluble in water; solubility = 0.3% @ 25°C. The liquefied gas poured into water can be violently explosive.

Potential Exposure: Chlorodifluoromethane is used as an aerosol propellant, refrigerant, and low-temperature solvent. It is used in the synthesis of polytetrafluoroethylene (PTFE).

Incompatibilities: The liquefied gas poured into water can be violently explosive. This is due to the phase transition from superheated liquid to vapor[101]. Chlorodifluoromethane reacts violently with alkalies and alkaline earth metals; powdered aluminum; sodium, potassium, and zinc; causing fire and explosion hazard. Moisture and rust cause slow decomposition, forming toxic gases. Attacks some plastics, rubber, and coatings. Decomposes in heat forming fumes of chlorine, hydrogen chloride, HF, and phosgene. Attacks magnesium and its alloys.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 3.54 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: None

NIO SH REL: 1000 ppm/3500 milligram per cubic meter TWA; 1250 ppm/4375 milligram per cubic meter STEL.

ACGIH TLV[1]: 1000 ppm/3540 milligram per cubic meter TWA, not classifiable as a human carcinogen

PAC Ver. 29[138]

PAC-1: 1250 ppm

PAC-2: 2400 ppm

PAC-3: 14,000 ppm

DFG MAK: 500 ppm/1800 milligram per cubic meter TWA; Peak Limitation Category II(8); Pregnancy Risk Group C

Australia: TWA 1000 ppm (3500 milligram per cubic meter); STEL 1250 ppm, 1993; Austria: MAK 500 ppm (1800 milligram per cubic meter), 1999; Belgium: TWA 1000 ppm (3540 milligram per cubic meter); STEL 1250 ppm, 1993; Denmark: TWA 500 ppm (1770 milligram per cubic meter), 1999; Finland: TWA 1000 ppm (3500 milligram per cubic meter); STEL 1250 ppm, 1999; France: VME 1000 ppm (3500 milligram per cubic meter), 1999; Hungary: TWA 100 milligram per cubic meter; STEL 200 milligram per cubic meter, 1993; the Netherlands: MAC-TGG 3600 milligram per cubic meter, 2003; Norway: TWA 500 ppm (1750 milligram per cubic meter), 1999; Russia: TWA 1000 ppm; STEL 3000 milligram per cubic meter, 1993; Sweden: NGV 500 ppm (1800 milligram per cubic meter), KTV 750 ppm (2500 milligram per cubic meter), 1999; Switzerland: MAK-W 500 ppm (1800 milligram per cubic meter), 1999; United Kingdom: TWA 1000 ppm (3590 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Several states have set guidelines or standards for FC-22 in ambient air[60] ranging from 35.0−43.75 milligram per cubic meter (North Dakota) to 58 milligram per cubic meter (Virginia) to 70.0 milligram per cubic meter (Connecticut) to 83.3 milligram per cubic meter (Nevada).

Determination in Air: Charcoal tube[2]; Methylene chloride; GC/Flame ionization detection; NIOSH Analytical Method (IV) #1018.

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guidelines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg [F]/L. Safe Drinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg[F]/L; SMCL = 2 mg/F/L, as Fluoride.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 1$. Unlikely to bioaccumulate in marine organisms.

Harmful Effects and Symptoms

Short-Term Exposure: Chlorodifluoromethane can affect you when breathed in. Inhalation can irritate the respiratory tract causing tightness in the chest and trouble breathing. Exposure can cause headache; nausea; dizziness and weakness; sleepiness; tremors; loss of coordination; cardiac arrythmia (irregular heartbeat); coma, and asphyxiation, which could lead to death. Chlorodifluoromethane can irritate the nose, throat, and skin. It can also cause tightening in the chest and trouble breathing. Skin contact with the liquid can cause frostbite.

Long-Term Exposure: Liver, kidney, spleen injury.

Points of Attack: Respiratory system; cardiovascular system; central nervous system; liver, kidneys, spleen.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: Special 24 hour EKG (Holter monitor) to look for irregular heartbeat. Lung, liver, and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Note to physicians: Adrenergic agents are contraindicated.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures over 1000 ppm; Use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode. All respirators selected must be approved by NIOSH under the provisions of 42 CFR 84. The current listing of NIOSH-certified respirators can be found in the NIOSH/NPPTL Certified Equipment List, which is available on the NIOSH website.

Storage: Check oxygen content prior to entering storage area. Nonflammable gas. Keep cylinders cool. Prior to working with chlorodifluoromethane all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN1018 Chlorodifluoromethane, Hazard Class: 2.2; Labels: 2.2-Non-flammable compressed gas. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. *Liquid:* allow to evaporate. *Gas:* Stop flow of gas. If source of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. If liquid or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is nonflammable. The liquefied gas poured into water can be violently explosive. This is due to the phase transition from superheated liquid to vapor[101]. Thermal decomposition products may include HF, hydrogen chloride, phosgene, carbonyl fluoride, chloride and fluoride fumes, and oxides of carbon. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. On contact with fire, this chemical decomposes forming if material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Return to vendor or send to licensed waste disposal company[22].

References

(31); (173); (101); (138); (80); (122); (100).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Chlorodifluoromethane, Trenton, NJ (January 1999).

2-Chloroethyl Vinyl Ether C:0860

Formula: C_4H_7ClO; $ClCH_2CH_2OCH{=}CH_2$

Synonyms: 2-Chlorethylvinyl ether; (2-Chloroethoxy)ethene; 2-Cloroetilo vinileter (Spanish); Vinyl-β-chloroethyl ether; Vinyl-2-chloroethyl ether

CAS Registry Number: 110-75-8

HSDB Number: 1330

RTECS Number: KN6300000

UN/NA & ERG Number: UN1992/131 (P)

EC Number: 203-799-6

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Highly flammable liquid, Possible polymerization hazard (nonstabilized).

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants as 2-chloroethyl vinyl ether (mixed)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U042

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.062; Nonwastewater (mg/kg), N/A

CERCLA: Persons in charge of vessels or facilities are required to notify the National Response Center (NRC) immediately, when there is a release of this designated hazardous substance, in an amount equal to or greater than its RQ of 1000 lb (454 kg).

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1000 lb (454 kg)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, F, Xn; risk phrases: R11; R19; R20/22; R23/24/25; R36/37/38; R39; R41; R50; safety phrases: S7; S16; S21; S26; S36/37/39; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: 2-Chloroethyl vinyl ether is a highly flammable, colorless liquid. Molecular weight = 106.56; specific gravity (H_2O:1) = 1.05 @ 20°C; boiling point = 108.7°C; freezing/melting point = −70.3°C; vapor pressure = 30 mmHg @ 20°C; flash point = 27°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 3, reactivity 2. Slightly soluble in water.

Potential Exposure: 2-Chloroethyl vinyl ether is used in the manufacture of anesthetics, sedatives, and cellulose ethers. The number of potentially exposed individuals is greatest for the following areas: fabricated metal products; wholesale trade; leather, rubber and plastic; and chemical products.

Incompatibilities: Peroxidizable Compound; may form unstable peroxides that can cause explosive polymerization. Stabilizer: 300 ppm triethanolamine and 50 ppm MEHQ (monomethyl ether of hydroquinone). 2-Chloroethyl vinyl ether forms explosive mixture with air. May accumulate static electrical charges, and may cause ignition of its vapors. Contact with oxidizing materials may cause fire or explosion hazard. Stabilizer: 300 ppm triethanolamine & 50 ppm MEHQ (monomethyl ether of hydroquinone).

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 0.16 ppm

PAC-2: 1.8 ppm

PAC-3: 11 ppm

Permissible Concentration in Water: State Drinking Water Standards: Florida 1 μg/L. See also CERCLA RQ above.

Determination in Water: Inert gas purge followed by GC with halide specific detection (EPA Method 601) or GC plus mass spectrometry (EPA Method 624).

Routes of Entry: Eye, skin.

Harmful Effects and Symptoms

Short-Term Exposure: Contact with skin or eyes may cause severe irritation. The oral LD_{50} for 2-Chloroethyl vinyl ether in rats is 250 mg/kg (moderately toxic). Primary skin irritation and eye irritation studies have also been conducted for 2-Chloroethyl vinyl ether. Dermal exposure to undiluted 2-chloroethyl vinyl ether did not cause even slight erythema. Application of undiluted 2-Chloroethyl vinyl ether to the eyes of rabbits resulted in severe eye injury.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working

with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where *there is a potential for overexposure:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode).

Storage: Stabilizer: 300 ppm triethanolamine & 50 ppm MEHQ (monomethyl ether of hydroquinone). Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where 2-chloroethylvinyl ether may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN1992 Flammable liquids, toxic, n.o.s., Hazard Class: 3; Labels: 3-Flammable liquid, 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include hydrogen chloride and oxides of carbon. Use dry chemical or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Residues may be packaged in epoxy-lined drums and disposed of by high temperature incineration with HCl scrubbing of effluent gases.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, 2-Chloroethyl Vinyl Ether, Health and Environmental Effects Profile No. 46, Office of Solid Waste, Washington, DC (April 30, 1980).

United States Environmental Protection Agency, Chloralkyl Ethers: Ambient Water Quality Criteria, Washington, DC (1980).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 7, No. 4, 46–50 (1987).

Chloroform C:0870

Formula: $CHCl_3$

Synonyms: Chloroforme (French); Cloroformo (Spanish); Formyl trichloride; Freon 20; Methane trichloride; Methane, trichloro-; Methenyl trichloride; Methyl trichloride; NCI-C02686; R20 refrigerant; Refrigerant 20; TCM; Trichloroform; Trichloromethane

CAS Registry Number: 67-66-3; *(alt.)* 8013-54-5

HSDB Number: 56

RTECS Number: FS9100000

UN/NA & ERG Number: UN1888/151

EC Number: 200-663-8 [*Annex I Index No.:* 602-006-00-4]

Regulatory Authority and Advisory Information

Department of Home land Security Screening Threshold Quantity (pounds): *Release hazard* 20,000

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen

IARC[9]: Animal Sufficient Evidence, Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B, 1999; NCI: Carcinogenesis Bioassay (gavage); clear evidence: mouse, rat; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies; Likely to produce cancer in humans.

California Proposition 65 Chemical 1/1/87: Cancer; Reproductive toxin, 8/7/2009.

Hazard Alert: Poison, Possible risk of forming tumors, Reproductive toxin: possible risk of gene damage/impaired fertility; Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction).

Banned or Severely Restricted (In Pharmaceuticals) (many countries) (UN)[13]

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); Accidental Release Prevention/Flammable Substances (Section 112 [r], Table 3), TQ = 20,000 lb (9080 kg)

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/1992); Toxic Pollutant (Section 401.15)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U044; D022

RCRA Toxicity Characteristic (Section 261.24), Maximum Concentration of Contaminants, regulatory level, 6.0 mg/L

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.046; Nonwastewater (mg/kg), 6.0

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8010 (0.5); 8240 (5)

United States National Primary Drinking Water Regulations: n/a mg/L; MCL = 0.080 mg/L, as *total* Trihalomethanes (TTHMs)

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 10,000 lb (4540 kg)

Superfund/EPCRA 40 CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%. NPRI

Mexico, Drinking Water Criteria, 0.03 mg/L.

Hazard symbols, risk, & safety statements: Hazard symbol: Xn; risk phrases: R22; R38; R40; R48/20/22; R62; R63; safety phrases: S1; S32; S36/37; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Chloroform is a noncombustible, clear, colorless liquid with a pleasant, sweet odor. The Odor Threshold is 12 ppm. Molecular weight = 119.38; specific gravity (H_2O:1) = 1.47; boiling point = 61.1°C; freezing/melting point = −63.4°C; vapor pressure = 75 mmHg @ 4.3°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 1. Soluble in water; solubility 0.5% @ 25°C.

Potential Exposure: Chloroform was one of the earliest general anesthetics, but its use for this purpose has been abandoned because of toxic effects. Chloroform is widely used as a solvent (especially in the lacquer industry); in the extraction and purification of penicillin and other pharmaceuticals; in the manufacture of artificial silk, propellents, plastics, floor polishes, and fluorocarbons (R-22); and in sterilization of catgut. Chemists and support workers as well as hospital workers are believed to be at a higher risk than the general population. Chloroform is widely distributed in the atmosphere and water (including municipal drinking water primarily as a consequence of chlorination). A survey of 80 American cities by EPA found chloroform in every water system in levels ranging from <0.3 to 311 ppb.

Incompatibilities: Though nonflammable, chloroform decomposes to form hydrogen chloride, phosgene, and chlorine upon contact with a flame. Chloroform decomposes slowly in air and light. Reacts violently with strong caustics (bases), strong oxidants, chemically active metals (especially powders), such as aluminum, lithium, magnesium, potassium, and sodium, causing fire and explosion hazard. Attacks plastic, rubber, and coatings. Corrodes iron and other metals in the presence of moisture.

Permissible Exposure Limits in Air

NIOSH IDLH = 500 ppm

OSHA PEL: 50 ppm/240 milligram per cubic meter Ceiling Concentration

NIOSH REL: Carcinogen 2 ppm/9.78 milligram per cubic meter [60 minutes] STEL. NIOSH considers chloroform to be a potential occupational carcinogen as defined by the OSHA carcinogen policy [29 CFR 1990]. Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A

ACGIH TLV[1]: 10 ppm/49 milligram per cubic meter TWA; confirmed animal carcinogen with unknown relevance to humans.

PAC* Ver. 29[138]

PAC-1: 2 ppm

PAC-2: $\mathbf{64_A}$ ppm

PAC-3: $\mathbf{3200_A}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60-minute values.

Emergency Response Planning Guidelines (AIHA)

ERPG-1: Inappropriate

ERPG-2: 50 ppm

ERPG-3: 5000 ppm

DFG MAK: 0.5 ppm/2.5 milligram per cubic meter Peak Limitation Category II(2) [skin]; Carcinogen Category 4; Pregnancy Risk Group C

Arab Republic of Egypt: TWA 10 ppm (50 milligram per cubic meter), 1993; Australia: TWA 10 ppm (50 milligram per cubic meter), carcinogen, 1993; Austria: MAK 10 ppm (50 milligram per cubic meter), Suspected: carcinogen, 1999; Belgium: TWA 10 ppm (49 milligram per cubic meter), Carcinogen 1993; Denmark: TWA 2 ppm (10 milligram per cubic meter), 1999; Finland: TWA 10 ppm (50 milligram per cubic meter); STEL 20 ppm [skin] carcinogen, 1999; France: VME 5 ppm (25 milligram per cubic meter), VLE 50 ppm (250 milligram per cubic meter), carcinogen, 1999; the Netherlands: MAC-TGG 5 milligram per cubic meter, 2003; India: TWA 10 ppm (50 milligram per cubic meter), carcinogen, 1993; Japan: Occupational Exposure Limit 10 ppm (49 milligram per cubic meter), 2B carcinogen, 1999; Norway: TWA 2 ppm (10 milligram per cubic meter), 1999; the Philippines: TWA 50 ppm (240 milligram per cubic meter), 1993; Poland: MAC (TWA) 50 milligram per cubic meter, MAC (STEL) 225 milligram per cubic meter, 1999; Russia: TWA 50 ppm, 1993; Sweden: NGV 2 ppm (10 milligram per cubic meter), KTV 5 ppm (25 milligram per cubic meter), carcinogen, 1999; Switzerland: MAK-W 10 ppm (50 milligram per cubic meter), KZG-W 20 ppm (100 milligram per cubic meter), 1999; Thailand: TWA 50 ppm (240 milligram per cubic meter), 1993; Turkey: TWA 50 ppm (240 milligram per cubic meter), 1993; United Kingdom: TWA 2 ppm (9.9 milligram per cubic meter) [skin] 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea: ACGIH TLV: confirmed animal carcinogen with unknown relevance to humans.

Russia set a MAC for ambient air in residential areas of 0.3 milligram per cubic meter. Several states have set guidelines or standards for chloroform in ambient air[60] ranging from 0 (North Dakota) to 0.04 μ/m^3 (Michigan and Rhode Island) to 0.43 μ/m^3 (Massachusetts and North Carolina) to 120 μ/m^3 (Pennsylvania) to 167 μ/m^3 (New York) to 250 μ/m^3 (Connecticut and South Carolina) to 500 μ/m^3 (Virginia) to 1190 μ/m^3 (Nevada) to 1200 μ/m^3 (Indiana).

Determination in Air: Charcoal adsorption, workup with CS_2, analysis by GC. See OSHA Analytical Method 5 and NIOSH Analytical Method #1003 for Hydrocarbons, halogenated, or OSHA Analytical Method 7.

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 80 μg/L; Federal Drinking Water Guide lines: 70 μg/L; State Drinking Water Guidelines: Arizona 0.49 μg/L; Florida 6 μg/L; Massachusetts 70 μg/L; Maine 70 μg/L; Minnesota 30 μg/L; New Hampshire 70 μg/L; Wisconsin 6 μg/L.

Determination in Water: GC (EPA Method 601) or GC plus mass spectrometry (EPA Method 624). Octanol–water coefficient: Log $K_{ow} = 2.1$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation of vapors, ingestion; skin and eye contact. This chemical can be absorbed through the skin, thereby increasing exposure.

Harmful Effects and Symptoms

Short-Term Exposure: Chloroform irritates the eyes and contact can cause tearing, conjunctivitis, and permanent eye damage. Symptoms of acute chloroform exposure include fainting sensation; vomiting, dizziness, salivation, nausea, fatigue, and headache. Other symptoms are respiratory depression, coma, kidney damage, and liver damage. Chloroform is classified as moderately toxic. Probable oral lethal dose for humans is 0.5–5 g/kg (between 1 oz and 1 pt) for a 150-lb person. The mean lethal dose is probably near 1 fluid oz (44 g). It is a human suspected carcinogen. Also, it is a central nervous system depressant and a gastrointestinal irritant. It has caused rapid death attributable to cardiac arrest and delayed death from liver and kidney damage. A delayed reaction to high levels of chloroform or from administration of anesthetic to some individuals can develop in 3–5 days, causing drowsiness, nausea, and vomiting; kidney and liver damage; urine may contain acetone and bile pigmentation.

Long-Term Exposure: Symptoms of chronic exposure include loss of appetite; hallucinations, moodiness, and physical and mental sluggishness. Repeated or prolonged contact with skin may cause skin drying, cracking and dermatitis. May cause heart, thyroid, liver, and kidney damage. This substance is possibly carcinogenic to humans. It has been shown to cause liver, kidney, and thyroid cancer in animals. There is evidence that chloroform is a teratogen in animals.

Points of Attack: Liver, kidneys, heart, eyes, skin, central nervous system.

Medical Surveillance: Preplacement and periodic examinations should include appropriate tests for thyroid, liver, and kidney functions, and special attention should be given to the nervous system; the skin, and to any history of alcoholism. Expired air and blood levels may be useful in estimating levels of acute exposure. Special 24 hour (Holter monitor) to detect irregular heartbeat.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended.

Personal Protective Methods: Wear solvent-resistant gloves and clothing to prevent any reasonable probability of skin or eye contact. **8 hours** (more than 8 hours of resistance to breakthrough >0.1 μg/cm^2/min): polyvinyl alcohol gloves; Viton gloves, suits; 4H and Silver Shield gloves; Barricade-coated suits; Responder suits, Trellchem HPS suits; Trychem 1000 suits; **4 hours** (At least 4 but <8 hours of resistance to breakthrough >0.1 μg/cm^2/min): Teflon gloves, suits, boots safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Polyvinyl chloride, Teflon, polyurethane and VITON/chlorobutyl have been recommended as protective materials in the literature. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with chloroform, all handlers should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Store in tightly closed dark bottles or cans in a cool, well-ventilated area.

Shipping: UN1888 Chloroform, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Stay upwind; keep out of low areas. Do not touch spilled material; stop leak if you can do it without risk. Use water spray to reduce vapors. Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. *Small spills*: absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. *Large spills*: dike far ahead of spill for later disposal. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible liquid. Use any extinguishing agents. Thermal decomposition products may include hydrogen chloride, phosgene, and chlorine. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced[22].

Where possible it should be recovered, purified by distillation, and returned to the supplier.

References

(109); (31); (173); (101); (138); (100).

National Institute for Occupational Safety and Health (NIOSH), "Criteria for a Recommended Standard: Occupational Exposure to Chloroform", NIOSH Document Number 75-114, Cincinnati, OH (1975).

National Institute for Occupational Safety and Health (NIOSH), Current Intelligence Bulletin No. 9-Chloroform, Washington, DC (1976).

United States Environmental Protection Agency, Chloroform: Ambient Water Quality Criteria, Washington, DC (1980).

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Chloromethyl Anilines C:0880

Formula: C_7H_8ClN; $C_6H_3Cl(CH_3)NH_2$

Synonyms: *3165-93-3:* Amarthol fast red TR base; Amarthol fast red TR salt; 2-Amino-5-chlorotoluene hydrochloride; Azanil red salt TRD; Azoene fast red TR salt; Azogene fast red TR; Azoic diazo component 11 base; Benzeneamine, 4-chloro-2-methyl-hydrochloride; Brentamine fast red TR salt; Chlorhydrate de 4-chloroorthotoluidine (French); 5-Chloro-2-aminotoluene hydrochloride; 4-Chloro-2-methylaniline hydrochloride; 4-Chloro-6-methylaniline hydrochloride; 4-Chloro-2-methylbenzenamine hydrochloride; 4-Chloro-2-toluidine hydrochloride; C.I. 37085; C.I. azoic diazo component 11; Clorhidrato de 4-cloro-*o*-toluidina (Spanish); Daito red salt TR; Devol red K; Devol red TA salt; Devol red TR; Diazo fast red TR; Diazo fast red TRA; Fast red 5CT salt; Fast red salt TR; Fast red salt TRA; Fast red salt TRN; Fast red TR salt; Hindasol red TR salt; Kromon green B; 2-M ethyl-4-chloroaniline hydrochloride; Natasol fast red TR salt; NCI-C02368; Neutrosel red TRVA; Ofna-Perl salt RRA; Red base ciba IX; Red base IRGA IX; Red salt Ciba IX; Red salt IRGA IX; Red TRS salt; Sanyo fast red salt TR; UN1579

95-69-2: Amarthol fast red TR base; 2-Amino-5-chloro toluene; *asym-m*-Chloro-*o*-toluidine; Asymmetric *m*-chloro-*o*-toluidine; Azoene fast red TR base; Azogene fast red TR; Azoic diazo component 11, base; Benzenamine, 4-chloro-2-methyl; Brentamine fast red TR base; 3-Chloro-6-aminotoluene; 5-Chloro-2-aminotoluene; 4-Chloro-2-methylaniline; 4-Chloro-6-methylaniline; 4-Chloro-2-methylbenzenamine; *p*-Chloro-*o*-toluidine; 4-Chloro-*o*-toluidine; 4-Chloro-2-toluidine; 4-Cloro-*o*-toluidina (Spanish); Daito red base TR; Deval red K; Deval red TR; Diazo fast red TRA; Fast red 5CT base; Fast red base TR; Fast red TR; Fast red TR11; Fast red TR base; Fast red TRO base; Kako red TR base; Kambamine red TR; 2-Methyl-4-chloroaniline; Mitsui red TR base; Red base Ciba IX; Red base IRGA IX; Red base NTR; Red TR base; Sanyo fast red TR base; *o*-Toluidine, 4-chloro-; Tulabase fast red TR

CAS Registry Number: 87-60-5 (3-chloro-*o*-); 95-69-2 (4-chloro-*o*-); 95-79-4 (5-chloro-*o*-); 95-81-8 (2-chloro-5-); 87-63-8 (6-chloro-*o*-); 615-65-6 (2-chloro-*p*-); 95-74-9 (3-chloro-*p*-; CAS: 95-74-9); 3165-93-3 (4-chloro-*o*-, HCl); 7149-75-9 (4 chloro-*m*-); 29027-17-6 (2-chloro-*m*-)

HSDB Number: 5252 (3-chloro-*o*-)

RTECS Number: XU4760000 (3-chloro-*o*-; CAS: 87-60-5); XU5000000 (4-chloro-*o*-; CAS: 95-69-2); XU5075000 (5-chloro-*o*-; CAS: 95-79-4); XU5100000 (6-chloro-*o*-; CAS: 87-63-8); XU5110000 (2-chloro-*p*-; CAS: 615-65-6); XU5111000 (3-chloro-*p*-; CAS: 95-74-9); XU5250000 (4-chloro-*o*-, HCl; CAS: 3165-93-3)

UN/NA & ERG Number: UN2239 (chlorotoluidines, solid)/153; UN3429 (chlorotoluidines, liquid)/153

EC Number: 201-756-6 (3-chloro-*o*-; CAS: 87-60-5); 202-441-6 [*Annex I Index No.:* 612-196-00-0] (4-chloro-*o*-; CAS: 95-69-2); 210-440-7 (2-chloro-*p*-; CAS: 615-65-6); 202-446-3 (3-chloro-*p*-; CAS: 95-74-9); 221-627-8 [*Annex I Index No.:* 612-196-00-0] (4-chloro-*o*-, HCl; CAS: 3165-93-3)

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: (*95-69-2 & 3165-93-3*) Reasonably anticipated to be a human carcinogen: *p*-Chloro-*o*-toluidine and its hydrochloride; IARC: (*95-69-2*) Human Limited Evidence; Animal Sufficient Evidence, *probably carcinogenic to humans*, Group 2A, 2000; IARC: (*95-79-4*) Animal Limited Evidence, Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3.

California Proposition 65 Chemical[102]: Cancer 1/1/1990

Hazard Alert: Poison, Combustible, Suspected of causing genetic defects, Possible risk of forming tumors.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%. (4-chloro-*o*-; CAS: 95-69-2)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U049 (4-Chloro-*o*-HCl only) (3165-93-3)[4]

RCRA, 40CFR261, Appendix 8 Hazardous Constituents. (4-Chloro-*o*-HCl only; CAS:3165-93-3)[4]

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg). (4-chloro-*o*-HCl only; CAS:3165-93-3)[5]

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. as *4-chloro-o-toluidine* (*95-69-2*)

European/International Regulations (4-chloro-o-toluidine; 95-69-2) and (4-chloro-*o*-toluidine HCl*;* 3165-93-3): Hazard symbol: T, N; risk phrases: R45; R23/24/25; R68; R50; R62; safety phrases: S53; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to waters (*87-60-5 and 95-74-9 & 95-69-2*)

Description: The chloromethylanilines are colorless or white crystalline solids or liquids, some have a mild fishy odor. Molecular weight (all isomers) = 141.61. Hazard identification (based on NFPA-704 M Rating System): *(87-60-5)* Health 2, flammability 1, reactivity 0. All are soluble in water; and include the following data:

Isomer	***Melting Point (°C)***	***Boiling Point (°C)***	***Flash Point (°C)***
3-chloro-o-	245	>113	
4-chloro-o-	29	241	100
5-chloro-o-	26	237	160
6-chloro-o-	–	–	99
2-chloro-p-(liq.)	7	257	99
3-chloro-p-	26	238	100
2-chloro-5-	–	–	107

Potential Exposure: Most of the isomers are used in dyestuff manufacture. The 3-chloro-*para* isomer is used to kill birds. It is marketed as pelleted bait for control of bird populations.

Incompatibilities: Incompatible with oxidizers, strong acids; chloroformates, and acid anhydrides, isocyanates, aldehydes forming fire and explosive hazards.

Permissible Exposure Limits in Air

4-chloro-o-toluidine [95-69-2]

No PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

DFG MAK: [skin] Carcinogen Category 1; Germ Cell Mutation Category 3A

5-chloro-o-toluidine [95-79-4]

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

DFG MAK: Carcinogen Category 3B

Routes of Entry: Inhalation, skin contact, ingestion. These chemicals can be absorbed through the skin, thereby increasing exposure.

Harmful Effects and Symptoms

Short-Term Exposure: Chloromethyl anilines can affect you when breathed in and by passing through your skin. Eye contact causes irritation and can lead to permanent damage. Skin contact can cause a rash and produce a burning feeling. Exposure can lower the ability of the blood to carry oxygen (methemoglobinemia) causing a bluish color of the skin, headaches, dizziness, nausea, and even death. They can damage the kidneys and bladder; causing painful, bloody urine.

Long-Term Exposure: The methemoglobinemia condition described above may occur gradually from repeated exposure or all at once. Some of these chemicals like 4-chloro-2-methyl aniline and 5-chloro-2-methyl aniline are probable carcinogens in humans; they cause bladder and liver cancer in animals.

Points of Attack: Eyes, skin, kidneys, bladder, liver.

Medical Surveillance: If symptoms develop or overexposure has occurred, the following may be useful: Blood tests for methemoglobin levels. Kidney function tests. Urine tests for blood, and for *n*-acetyl *p*-amino phenol.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to Physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. When working with liquids or solids wear indirect-vent, impact-resistant chemical goggles, and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposure to chloromethyl anilines, use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece respirator with a high-efficiency particulate filter. Greater protection is provided by a PAPR.

Where there is potential for high exposure to 3-chloro-2-methyl Aniline exists, or to liquid form use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode. All respirators selected must be approved by NIOSH under the provisions of 42 CFR 84. The current listing of NIOSH-certified respirators can be found in the NIOSH/NPPTL Certified Equipment List, which is available on the NIOSH website.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with chloromethyl anilines all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where Choromethyl Anilines are handled, or stored in a manner that could create a potential fire or explosion hazard. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2239 Chlorotoluidines, solid, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN3429 Chlorotoluidines, liquid, Hazard Class: 6.1; Labels: 6.1-Poisonous materials

Spill Handling: *Liquid:* Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Solid: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: These chemicals may burn, but according the state of New Jersey, do not readily ignite. Use dry chemical or carbon dioxide extinguishers. Thermal decomposition products may include chlorine, hydrogen chloride, nitrogen oxides; and carbon monoxide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(109); (102); (31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* 3-Chloro-2-Methyl Aniline, Trenton, NJ (August 2001).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* 4-Chloro-*o*-Methyl Aniline, Trenton, NJ (February 2007).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* 5-Chloro-2-Methyl Aniline, Trenton, NJ (November 1998).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* 6-Chloro-2-Methyl Aniline, Trenton, NJ (August 2001).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* 2-Chloro-4-Methyl Aniline, Trenton, NJ (August 2001).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* 3-Chloro-4-Methyl Aniline, Trenton, NJ (October 1998).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* 2-Chloro-5-Methyl Aniline, Trenton, NJ (August 2001).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* 2-Chloro-3-Methyl Aniline, Trenton, NJ (May 1986).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* 4-Chloro-3-Methyl Aniline, Trenton, NJ (February 2007).

Chloromethyl Methyl Ether C:0890

Formula: C_2H_5ClO; $ClCH_2OCH_3$

Synonyms: Chlorodimethyl ether; Chlorometho xymethane; CMME; α,α-Dichlorodimethyl ether; Dimethylchloroether; Ether, chloro methyl methyl; Ether, dimethyl chloro; Ether methylique monochlore (French); Methane, chloromethoxy-; Methoxychloromethane; Methoxymethyl chloride; Monochlorodimethyl ether; Monochloromethyl methyl ether

CAS Registry Number: 107-30-2

HSDB Number: 908

RTECS Number: KN6650000

UN/NA & ERG Number: (PIH) UN1239/131 (P)

EC Number: 203-480-1 [*Annex I Index No.:* 603-075-00-3]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 5000 (≥1.00% concentration).

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen; Bis(chloromethyl) ether and technical-grade chloromethyl methyl ether; IARC[9]: (technical grade) Human Sufficient Evidence; Animal Sufficient Evidence, *carcinogenic to humans*, Group 1.

California Proposition 65 Chemical[102]: Chloromethyl methyl ether (technical grade) Cancer 2/27/1987.

Hazard Alert: Poison inhalation hazard, Highly flammable, Polymerization hazard, Possible risk of forming tumors, Suspected reprotoxic hazard.

Banned or Severely Restricted (several countries) (UN)[13,35]

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR 1910.1006)

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); Accidental Release Prevention/Flammable Substances (Section 112 [r], Table 3), TQ = 5000 lb (2270 kg)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U046

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%. NPRI

United States DOT 49CFR172.101, Inhalation Hazardous Chemical (PIH).

Hazard symbols, risk, & safety statements: Hazard symbol: F+, T; risk phrases: R45; R11; R19; R20/21/22; R50/53; R63; safety phrases: S1; S21; S41; S45; S53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Chloromethyl methyl ether is a volatile, highly flammable, corrosive liquid with an ethereal odor. Molecular weight = 80.50; specific gravity (H_2O:1) = 1.06; boiling point = 58.8°C; freezing/melting point = −103.3°C; vapor pressure = 192 mmHg @ 20°C; flash point = −17.8°C[ICSC]. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 3, reactivity 2₩. Reacts with water, forming corrosive and toxic hydrochloric acid and formaldehyde. Commercial chloromethyl methyl ether contains from 1% to 7% *bis(chloromethyl)ether*, a known cause of lung cancer in humans.

Potential Exposure: Chloromethyl. methyl ether is a highly reactive methylating agent and is used in the chemical industry for synthesis of organic chemicals. Most industrial operations are carried out in closed process vessels so that exposure is minimized.

Incompatibilities: May form explosive mixture with air. May be able to form unstable and explosive peroxides on contact with oxygen. Contact with (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Decomposes on contact with water, forming hydrochloric acid and formaldehyde. Attacks various metals in presence of water.

Permissible Exposure Limits in Air

OSHA PEL: One of the thirteen OSHA-Regulated Carcinogens. A full OSHA Standard [1910.1006] has been adopted for this substance. See Code of Federal Regulations (CFR) 29,1926.1108

NIOSH REL: Potential Occupational Carcinogen

ACGIH TLV[1]: A2, Suspected Human Carcinogen.

PAC* Ver. 29[138]

PAC-1: 0.043 ppm

PAC-2: $\mathbf{0.47_A}$ ppm

PAC-3: $\mathbf{2.0_A}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60-minute values.

DFG MAK: Carcinogen Category 1, Confirmed Human Carcinogen

Australia: carcinogen, 1993; Austria: carcinogen, 1999; Belgium: carcinogen, 1993; Finland: carcinogen, 1999; France: carcinogen, 1993; Russia: STEL 0.5 milligram per cubic meter [skin], 1993; Sweden: carcinogen, 1999; Switzerland: carcinogen, 1999; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Suspected Human Carcinogen. the Czech Republic has set a TWA of 0.003 milligram per cubic meter[35]. Alberta, Canada set an airborne exposure limit of 0.005 ppm TWA and STEL of 0.015 ppm. Several states have set guidelines or standards for CMME in ambient air[60] ranging from 0 (North Dakota) to 0.02 ppb (Pennsylvania) to 0.03 μ/m^3 (New York) to 3.0 μ/m^3 (Virginia).

Determination in Air: See NIOSH II[1] P&CAM Method #220 or OSHA Analytical Method 10.

Permissible Concentration in Water: No criteria have been set for the protection of freshwater or saltwater aquatic life due to lack of data. For the protection of human health: preferably zero[6].

Routes of Entry: Inhalation of vapor and possibly percutaneous absorption; and ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: This chemical can be absorbed through the skin, thereby increasing exposure. Corrosive to the eyes, skin, and respiratory tract. Inhalation can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Symptoms of exposure include sore throat, coughing; shortness of breath; fever; chills, difficulty in breathing; bronchial secretions from pulmonary edema. The liquid causes severe irritation of eyes and skin; and vapor exposure of 100 ppm is severely irritating to eyes and nose. This level is dangerous to life in 4 hours. Due to an increased death rate from respiratory cancer among exposed victims, it is a regulated carcinogen.

Long-Term Exposure: There is evidence that this chemical caused lung cancer in humans, and has caused skin and lung cancer in animals. Lungs may be affected by repeated or prolonged exposure causing bronchitis with cough, phlegm, and/or shortness of breath.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: Preplacement and periodic medical examinations should include an examination of the skin and respiratory tract, including lung function tests and chest X-ray. Sputum cytology has been suggested as helpful in detecting early malignant changes; and in this connection a detailed smoking history is of importance. Possible effects on the fetus should be considered. Factors of increased risk: reduced immunologic competence, steroid treatment, pregnancy, cigarette smoking.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Those designed to supplement engineering controls and to prevent all skin or respiratory contact. Prevent skin contact. **4 hours** (At least 4 but <8 hours of resistance to breakthrough >0.1 μg/cm²/min): Teflon gloves, suits, boots. Full body protective clothing and gloves should be used on entering areas of partial exposure. Those employed in handling operations should be provided with full-face, supplied-air respirators of continuous-flow or pressure-demand type. On exit from a regulated area, employees should be required to remove and leave protective clothing and equipment at the point of exit, to be placed in impervious containers as the end of the work-shift for decontamination or disposal. Showers should be taken prior to dressing in street clothes.

Respirator Selection: NIOSH: *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, SCBA).

Storage: Poison inhalation chemical (PIH); check oxygen content prior to entering storage area. (1) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. (2) Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with chloromethyl methyl ether, all handlers should be trained on its proper handling and storage. Before entering confined space where chloromethyl methyl ether may be present, check to make sure that an explosive concentration does not exist. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN1239 Methyl chloromethyl ether, Hazard class: 6.1; Labels: 6.1-Poison Inhalation Hazard, 3-Flammable liquid, Inhalation Hazard Zone A. PGI.

Spill Handling:

Methyl chloromethyl ether

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 0.7/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 600/200
Then: Protect persons downwind (mi/km)
Day 1.4/2.3
Night 2.9/4.6

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Small spill: absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Large spill: dike far ahead of *large spills* for later disposal. Flood with water. Rinse with sodium bicarbonate or lime solution. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Chloromethyl methyl ether is a highly flammable liquid. Thermal decomposition products may include hydrogen chloride. *Do not use water* or water based extinguishers. Use dry chemical, carbon dioxide; aFFF. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced[22].

References

(109); (102); (31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chloroalkyl Ethers: Ambient Water Quality Criteria, Washington, DC (1980).

United States Environmental Protection Agency, Chloroalkyl Ethers, Health and Environmental Effects Profile No. 41, Office of Solid Waste, Washington, DC (April 30, 1980).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Chloromethyl Methyl Ether, Washington, DC, Chemical Emergency Preparedness Program (October 31, 1985).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 7, No. 4, 51–54 (1987).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Chloromethyl Methyl Ether, Trenton, NJ (December 1999).

2-(4-Chloro-2-Methyl-Phenoxy) Propionic Acid (MCPP) C:0900

Formula: $C_{10}H_{11}ClO_3$

Synonyms: 2M-4CP; 2M4KHP; Acide 2-(4-chloro-2-methyl-phenoxy)propionique (French); Assassin; Banvel BP; Banvel P; BHM ecoprop; Ceridor; Chipco; Chipco turf herbicide MCPP; 2-(4-Chlor-2-methyl-phenoxy)-propionsaeure (German); 2-(4-Chloro-2-methylphenoxy)propanoic acid; α-(4-Chloro-2-methylphenoxy)propionic acid; (+)-α-(4-Chloro-2-methylphenoxy)propionic acid; (4-Chloro-2-methylphenoxy)propionic acid; 2-(4-Chloro-2-methylphenoxy)propionic acid; 4-Chloro-2-methylphenoxy-α-propionic acid; 2-(4-Chlorophenoxy-2-methyl)propionic acid; 2-(4-Chloro-*o*-tolyl)oxylpropionic acid; 2-(*p*-Chloro-*o*-tolyloxy)propionic acid; Cleaval; Clenecorn; Clovotox; CMPP; Compitox extra; *iso*-Cornox; *iso*-Cornox 64; Cornox plus; CR 205; Crusader; Docklene; EXP 419; Graslam; Harness; Harrier; Hedonal MCPP; Herrisol; Hymec; Hytane extra; Iotox; Kilprop; Liranox; 2-MCPP; MCPP; MCPP 2,4-D; MCPP-D-4; MCPP K-4; Mechlorprop; Mecobrom; Mecomec; Mecopeop; Mecoper; Mecopex; Mecoprop; Mecoturf; Mepro; Methoxone; 2-(2-Methyl-4-chlorophenoxy)propanoic acid; α-(2-Methyl-4-chlorophenoxy)propionic acid; 2-(2′-Methyl-4′-chlorophenoxy)propionic acid; 2-Methyl-4-chlorophenoxy-α-propionic acid; Musketeet; Mylone; N.B. Mecoprop; NSC 60282; Post-Kite; Propal; Propanoic acid, 2-(4-chloro-2-methylphenoxy)-; Propionic acid, 2-(4-chloro-2-methylphenoxy); Propionic acid, 2-(4-chloro-*o*-tolyloxy)-; Propionic acid, 2-(2-methyl-4-chlorophenoxy)-; Proponexplus; Rankotex; RD 4593; Runcatex; Scotlene; Seloxone; Sel-oxone; Super green and weed; Supoertox; Swipe 560 EC; Terset; Tetralen-plus; U46; U46 KV-ester; U46 KV-fluid; Verdone; VI-Par; Vipex; VI-Pex

CAS Registry Number: 93-65-2; *(alt.)* 7085-19-0

HSDB Number: 1738 as mecoprop

RTECS Number: UE9750000

UN/NA & ERG Number: UN3345/153

EC Number: 202-264-4 [*Annex I Index No.:* 607-049-00-2]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human Limited Evidence, animal Inadequate Evidence, possibly carcinogenic to humans, *possibly carcinogenic to humans*, Group 2B, 1987.

Hazard Alert: Poison, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard.

United States Environmental Protection Agency, FIFRA 1998 Status of Pesticides: Unsupported

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Hazard symbols, risk, & safety statements: Hazard symbol: Xn, N; risk phrases: R22; R38; R41; R50/53; R62; R63; safety phrases: S2; S13; S26; S37/39; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)]

Description: Mecoprop is a colorless, crystalline solid. Odorless. Molecular weight = 214.64. melting/freezing point = 93–95°C. Vapor pressure = $< 9.9 \times 10^{-6}$ mmHg @ 20°C. Slightly soluble in water; solubility = < 650 ppm @ 20°C.

Potential Exposure: It is a chlorophenoxy-herbicide, used to control many broadleaf weeds. A derivative of phenoxy aryloxyalkanoic acid.

Incompatibilities: A weak acid. Incompatible with strong bases and oxidizers.

Permissible Exposure Limits in Air This chemical can be absorbed through the skin, thereby increasing exposure.

Routes of Entry: Inhalation, absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: This chemical can be absorbed through the skin, thereby increasing exposure. Contact irritates the eyes and skin. Irritates the respiratory tract. Exposure can cause headache, weakness, convulsions, muscle cramps; loss of coordination; unconsciousness, and death.

Long-Term Exposure: There is limited evidence that the chemical affects human reproduction. Exposure may damage blood cells, causing anemia, and damage the kidneys. Although this chemical has not been identified as a carcinogen, several related compounds have shown limited evidence of cancer.

Points of Attack: Blood, kidney, nervous system.

Medical Surveillance: Examination of the nervous system. CBC. Kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is a potential for overexposure: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers and strong bases.

Shipping: UN3345 Phenoxyacetic acid derivative pesticide, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Use dry chemical, carbon dioxide; alcohol, or polymer foam extinguishers. Thermal decomposition products may include oxides of carbon and hydrogen chloride. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (80); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: 2-(4-Chloro-2-methylphenoxy) propionic acid*, Trenton, NJ (April 1999).

Chloromethyl Phenyl Isocyanate C:0910

Formula: C_8H_6ClNO; $OCN\text{-}C_6H_3AClACH_3$

Synonyms: 3-Chloro-4-methylphenyl isocyanate; Isocyanic acid, 3-chloro-*p*-tolyl ester

CAS Registry Number: 28479-22-3; *(alt.)* 51488-20-1

RTECS Number: NQ8585000

UN/NA & ERG Number: UN2236/156

EC No: 249-050-7

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Water reactive (may be violent), Sensitization hazard (skin, resp.).

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: Xn, Xi; risk phrases: R14/15; R20/21/22; R36/37/38; R42/43; safety phrases: S23; S26; S27; S36/37/39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Chloromethyl phenyl isocyanate is a colorless to yellow liquid or beige, low-melting solid. Acrid odor. Molecular weight = 167.59; freezing/melting point = 143°C; vapor pressure = very low; flash point = > 93°C. Soluble in water; solubility = 33 mg/L @ 25°C. ₩ Insoluble in water, may release flammable gases.

Potential Exposure: This material is used in organic synthesis.

Incompatibilities: May form explosive mixture with air. Isocyanates are highly flammable and reactive with many compounds, even with themselves. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Reaction with moist air, water or alcohols may form amines and insoluble polyureas and react exothermically, releasing toxic, corrosive, or flammable gases, including carbon dioxide; and, at the same time, may generate a violent release of heat increasing the concentration of fumes in the air. Incompatible with amines, aldehydes, alkali metals, ammonia, carboxylic acids, caprolactum, alkaline materials, glycols, ketones, mercaptans, hydrides, organotin catalysts, phenols, strong acids, strong bases, strong reducing agents such as hydrides, urethanes, ureas. Elevated temperatures or contact with acids, bases, tertiary amines, and acyl-chlorides may cause explosive polymerization. Attacks some plastics, rubber, and coatings. Contact with metals may evolve flammable hydrogen gas. May accumulate static electrical charges, and may cause ignition of its vapors. Do not store in temperatures above 30°C/86°F.

Permissible Exposure Limits in Air

PAC Ver. 28, no values in Ver. 29[138]

Isocyanate-bearing waste (as CNs, n.o.s.)

PAC-1: 6 milligram per cubic meter

PAC-2: 8.3 milligram per cubic meter

PAC-3: 50 milligram per cubic meter

cyanate-bearing waste (as CNs, n.o.s.)

PAC-1: 8.3 milligram per cubic meter

PAC-2: 8.3 milligram per cubic meter

PAC-3: 50 milligram per cubic meter

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: 3-Chloro-4-methylphenyl isocyanate can affect you when breathed in. Organic isocyanates can irritate the eyes, skin, and respiratory tract and may cause lung allergies. May cause respiratory irritation. Isocyanate-bearing waste can cause chronic skin effects, including dermatitis and sensitization.

Long-Term Exposure: Although the long-term effects of this chemical are unknown, many isocyanates cause allergic reactions and asthma-like allergy.

Points of Attack: Respiratory system.

Medical Surveillance: For those with frequent or potentially high exposure, the following are recommended before beginning work and at regular times after that. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. These may be normal if the person is not having an attack at the time of the test.

First Aid: If 3-Chloro-4-methylphenyl isocyanate gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. When working with liquids, wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. When working with powders or dusts, wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to 3-Chloro-4-methylphenyl isocyanate, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure demand or other positive-pressure mode. All respirators selected must be approved by NIOSH under the provisions of 42 CFR 84. The current listing of NIOSH-certified respirators can be found in the NIOSH/NPPTL Certified Equipment List, which is available on the NIOSH website.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Do not store in temperatures above 30°C/86°F. Prior to working with 3-chloro-4-methylphenyl isocyanate all handlers should be trained on its proper handling and storage. 3-Chloro-4-methylphenyl isocyanate must be stored to avoid contact with acids (such as hydrochloric and nitric); alkalis (such as sodium hydroxide and potassium hydroxide); and amines (like ammonia), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat, light and moisture. Do not store at temperatures above 30°C/86/F. Sources of ignition, such as smoking and open flames are prohibited where 3-Chloro-4-Methyl Phenyl Isocyanate is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN22363-Chloro-4-methylphenyl isocyanate, liquid, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Stay upwind and uphill. Isolate the area of release or fire and deny entry. Remove all ignition sources. Stop the release if it can be done safely from a distance. All equipment used to handle this material must be grounded. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. *Small spill*: Cover with *dry* earth, *dry* sand, or other noncombustible material followed with plastic sheet to minimize spreading or contact with water or rain. Use clean nonsparking tools to collect material and place material into loosely covered plastic containers for later disposal. Prevent material and runoff from entering sewers and waterways if it can be done safely well ahead of the release. Use vapor suppressing foam to disperse vapors—contain runoff. Water spray may reduce vapor, but may not prevent ignition in enclosed spaces. Ventilate confined area if it can be done without placing personnel at risk. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include hydrogen cyanide, nitrogen oxides, and hydrogen chloride. *Small fire*: use *dry* chemical, CO_2, *dry* sand, or alcohol-resistant foam. May react with foams releasing corrosive/toxic gases. *Large fire*: use water spray or alcohol-resistant foam if it is available in sufficient amounts. Under favorable conditions, experienced crews can use coordinated fog streams to sweep the flames off the surface of the burning liquid. Combustible material: may burn but does not ignite readily. Most vapors are heavier than air. They will spread along ground and collect in low or confined areas (sewers, basements, tanks). Vapors may travel to source of ignition and flashback. Containers may explode when heated or if contaminated with water. Keep exposures cool long after fire is out to protect against re ignition. Do not direct straight streams into the liquid. Cool exposed containers with large quantities of water from unattended equipment or remove intact containers if it can be done safely. *Do not get water on spilled substance or inside containers*. If cooling streams are ineffective (*venting sound increases in volume and pitch, tank discolors, or shows signs of deforming*), withdraw immediately to a secure location. Always stay away from ends of tanks, especially when engulfed in flames. If material or contaminated runoff from fire control enters waterways, notify downstream users of potentially contaminated water. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* 3-Chloro-4-Methyl Phenyl Isocyanate, Trenton, NJ (April 1997).

Chloroneb C:0915

Formula: $C_8H_8Cl_2O_2$

Synonyms: Benzene, 1,4-dichloro-2,5-dimethoxy-; 1,4-Dichloro-2,5-dimethoxybenzene;Chloraxyl seed treater; Delta-coat II; Demosan; Soil fungicide-1823; Tersan SP; Terraneb SP

CAS Number: 2675-77-6

HSDB Number: 1542

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171; UN2761/151 (organochlorine pesticide, solid, toxic)

RTECS Number: CZ4750000

EC Number: 220-222-3

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Suspected reprotoxic hazard, Agricultural chemical.

Description: Colorless crystalline solid. Musty odor. Molecular weight = 207.06; specific gravity (H_2O:1) = 1.66; boiling point = 268°C; freezing/melting point = 133−135°C; vapor pressure = 3×10^{-3} mmHg. @ 20°C. Low solubility in water.

Potential Exposure: An organochlorine/substituted benzene systemic fungicide used to control snow mold on turf grass; used on cotton, sugar beets and bean seeds to control seedling disease. Not approved for use in EU countries.

Incompatibilities: May react with strong oxidizers such as chlorates, peroxides, nitrates, etc.

Permissible Exposure Limits in Air: No standards established.

Determination in Air: Filter; none; Gravimetric; NIOSH IV [Particulates NOR; #0500 (total), #0600 (respirable)][18].

Permissible Concentration in Water: State Drinking Water Guidelines: Florida 91 μg/L. Runoff from spills or fire control may cause water pollution.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = > 3.4$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood. Fish toxicity (threshold)[101]: Very low—530.91122 ppb, MATC.

Harmful Effects and Symptoms

Short-Term Exposure: Overexposure symptoms include apprehension, anxiety, confusion, nervous excitation; dizziness; headache; numbness and weakness in limbs; muscle twitching, tremors; nausea and vomiting; slow, shallow respiration, bluish face; convulsions; loss of consciousness; breathing stops; death. LD_{50} (oral, rat) $= >$ 11 g/kg; LD_{50} (dermal, rat) $= >$ 5 g/kg.

Long-Term Exposure: May cause reproductive and fetal effects. Human toxicity (long term)[101]: Low—91.00 ppb, Health advisory.

Points of Attack: Reproductive system/cells.

Medical Surveillance: In addition to comprehensive initial medical and work histories emphasizing reproductive experience and menstrual history, patient should have physical examination and testing of genito-urinary tract, sperm count, motility, and morphology. If required, other tests, such as serum testosterone, serum FSH, and serum LH may be indicated. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a drug or other inhalation therapy. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure.

First Aid: Speed in removing material from eyes and skin is of extreme importance. *Eyes:* Eye contact can cause dangerous amounts of these chemicals to be quickly absorbed through the mucous membrane into the bloodstream. Directly, irrigate with large amounts of plain, tepid water or saline for 20 minutes, occasionally lifting the lower and upper lids. During this time, remove contact lenses, if easily removable without additional trauma to the eye. Get medical aid immediately. Have physician check for possible delayed damage. *Skin:* Get medical aid. Dermal contact can cause dangerous amounts of these chemicals to be absorbed into the bloodstream. Wearing the appropriate PPE equipment and respirator for organochlorine pesticides, immediately flush exposed skin, hair, and under nails with plain, running, tepid water for 20 minutes, then wash twice with mild soap. Shampoo hair promptly if contaminated; protect eyes. **Do not scrub skin or hair**, since this can increase absorption through the skin. Rinse thoroughly with water. Victims who are able and cooperative may assist with their own decontamination. Remove and double-bag contaminated clothing and personal belongings. Leather absorbs many organochlorines; therefore, items such as leather shoes, gloves, and belts should be discarded. If the skin is swollen or inflamed, cool affected areas with cold compresses. *Ingestion:* Call poison control. Loosen all clothing. Never give anything by mouth to an unconscious person. Get medical aid. *Do not induce vomiting.* * In cases of ingestion, the patient is at risk of central nervous system depression or seizures, which may lead to pulmonary aspiration during vomiting. If the victim is conscious and able to swallow, *administer an aqueous slurry of activated charcoal at 1 g/kg (usual adult dose 60−90 g, child dose 25−50 g). A soda can and straw may be of assistance when offering charcoal to a child. The efficacy of activated charcoal for some organo chlorine poisoning (such as chlordane) is uncertain. If victim is *unconscious or having convulsions*, do nothing except keep victim warm. **In some cases you may be specifically instructed by Poison Control to induce vomiting by way of 2 tablespoons of syrup of ipecac (adult) washed down with a cup of water. Do not give activated charcoal before or with ipecac syrup. Inhalation:* Get medical aid. Do not contaminate yourself. Wearing the appropriate PPE equipment and respirator for organochlorine pesticides, immediately remove the victim from the contaminated area to fresh air. For inhalation exposures, monitor for respiratory distress. If the victim is not breathing, administer artificial respiration. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. If cough or breathing difficulty develops, evaluate for respiratory tract irritation, bronchitis, or pneumonitis. If breathing is difficult, administer 100% humidified supplemental oxygen through bag/mask apparatus until medical help arrives. Do not leave victim unattended.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of dermal contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. At minimum, use Tyvek-type disposable material. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Wherever and whenever workplace conditions warrant respirator use, a respiratory protection program must be followed that meets one or more of the following requirements: OSHA's 29 CFR 1910.134, ANSI Z88.2, or European Standard EN149. Where the neat (undiluted) test chemical is weighed and diluted, wear a NIOSH-approved half face respirator equipped with a combination filter cartridge, i.e., organic vapor/acid gas/HEPA (specific for organic vapors, HCl, acid gas, SO_2 and a high-efficiency particulate filter)[88].

Storage: Color code—Blue: Health Hazard/Poison. Store under ambient temperatures in a tightly closed container in a dry, well-ventilated, and secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Where possible, automatically transfer material from other storage containers to process containers. Keep away from all mineral acids and bases. Always store pesticides in their original containers, complete with labels that list ingredients, directions for use, and first aid steps in case of accidental poisoning. Never store pesticides in cabinets with or near food, animal feed, or medical supplies. Do not store pesticides in places where flooding is possible or in places where they might spill or leak into wells, drains, ground water, or surface water[72].

Shipping: UN2761 Organochlorine pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: For solids, isolate spill or leak area in all directions for at least 25 m/75 ft. Increase, in the downwind direction, as necessary. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Stop leak if you can do it without risk. Prevent entry into waterways, sewers, basements, or confined areas. This chemical is probably combustible. Should a spill occur while you are handling this chemical, *first remove all sources of ignition*, then you should dampen the solid spill material with 60–70% ethanol and transfer the dampened material to a suitable container. Use absorbent paper dampened with 60%–70% ethanol to pick up any remaining material. Seal the absorbent paper, and any of your clothes, which may be contaminated, in a vapor-tight plastic bag for eventual disposal. Solvent wash all contaminated surfaces with 60%–70% ethanol followed by washing with a soap and water solution. Do not reenter the contaminated area until the Safety Officer (or other responsible person) has verified that the area has been properly cleaned.

Fire Extinguishing: Thermal decomposition products may include toxic hydrogen chloride gas. Fires involving this material can be controlled with a dry chemical, carbon dioxide or alcohol-resistant foam extinguisher. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal. Use water spray or fog; do not scatter material using straight water jet streams. *Fire involving storage or vehicular tanks: Isolate* for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Do not allow water to get inside containers. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. *Always* stay away from tanks engulfed in fire. For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn.

Disposal Method Suggested: Do not discharge into drains or sewers. Dispose of waste material as hazardous waste using a licensed disposal contractor to an approved landfill. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Incineration with effluent gas scrubbing is recommended. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (203).

Pesticide Management Education Program, *Chloroneb (Demosan, Tersan-SP) Chemical Profile 1/85*, Cornell University, Ithaca, NY (January 1985). http://pmep.cce.cornell.edu/profiles/fung-nemat/aceticacid-etridiazole/chloroneb/fung-prof-chloroneb.html.

United States Environmental Protection Agency, Office of Pesticide Programs, *Pesticide Residue Limits: Chloroneb*, 40 CFR 180.257, http://www.epa.gov/pesticides/food/viewtols.htm.

1-Chloro-1-Nitropropane C:0920

Formula: $C_3H_6ClNO_2$: $C_2H_5CHClNO_2$

Synonyms: 1,1-Chloronitropropane; Chloronitropropane; 1-Chloro-1-nitropropano (Spanish); Korax; Korax 6; Lanstan; Propane, 1-chloro-1-nitro-

CAS Registry Number: 600-25-9

HSDB Number: 1543

RTECS Number: TX5075000

UN/NA & ERG Number: UN2810 (toxic liquid, organic, n.o.s.)/153

EC Number: 209-990-0 [*Annex I Index No.*: 610-007-00-6]

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Highly flammable, Suspected reprotoxic hazard.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, F, Xn; risk phrases: R11; R22; R23/24/25; R36/37/38; R39; safety phrases: S7; S16; S21; S26; S36/37; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [2-Hazard to water. (est.)]

Description: Chloronitroproane is a flammable, colorless liquid with an unpleasant odor that causes tears (lachrymator). Molecular weight = 123.5; specific gravity (H_2O:1) = 1.2; boiling point = 142.7°C; vapor pressure = 6 mmHg @ 25°C; flash point = 62°C (oc). Hazard identification (based on NFPA-704 M Rating System): Health (unknown), flammability 3, reactivity 2. Slightly soluble in water; solubility = 0.6% @ 20°C.

Potential Exposure: This compound is used in the synthetic rubber industry; as a component in rubber cements; and as a fungicide.

Incompatibilities: May form explosive mixture with air. Strong oxidizers may cause a fire and explosion hazard. May explode when exposed to heat.

Permissible Exposure Limits in Air
NIOSH IDLH = 100 ppm
OSHA PEL: 20 ppm/100 milligram per cubic meter TWA
NIOSH REL: 2 ppm/10 milligram per cubic meter TWA
ACGIH TLV[1]: 2 ppm/10 milligram per cubic meter TWA
No PAC available.

Australia: TWA 2 ppm (10 milligram per cubic meter), 1993; Austria: MAK 20 ppm (100 milligram per cubic meter), 1999; Belgium: TWA 2 ppm (10 milligram per cubic meter), 1993; Denmark: TWA 2 ppm (10 milligram per cubic meter), 1999; Finland: TWA 20 ppm (100 milligram per cubic meter); STEL 30 ppm (150 milligram per cubic meter), 1999; France: VME 2 ppm (10 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 10 milligram per cubic meter, 2003; the Philippines: TWA 20 ppm (100 milligram per cubic meter), 1993; Poland: MAC (TWA) 50 milligram per cubic meter, 1999; Switzerland: MAK-W 2 ppm (10 milligram per cubic meter), 1999; Turkey: TWA 20 ppm (100 milligram per cubic meter), 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 2 ppm. Several states have set guidelines or standards for chloronitropropane in ambient air[60] ranging from 10 μ/m^3 (North Dakota) to 150 μ/m^3 (Virginia) to 200 μ/m^3 (Connecticut) to 238 μ/m^3 (Nevada).

Determination in Air: Chromosorb tube-108; Ethyl acetate; GC/Flame ionization detection; See NIOSH II(5) Method #S-211.

Routes of Entry: Inhalation, ingestion; skin and eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: 1-Chloro-1-nitropropane can affect you when breathed in. Exposure can irritate and burn the eyes, skin, and cause respiratory tract irritation with coughing and/or shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: May cause damage to the heart, liver, and kidneys. Similar irritating substances can cause lung injury and bronchitis.

Points of Attack: In animals: respiratory system, lungs, liver, kidneys, cardiovascular system.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. EKG. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Liver and kidney function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *20 ppm:* Sa* (APF = 10) (any supplied-air respirator); *50 ppm:* Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOv* (APF = 25) [any powered, APR with organic vapor cartridge(s)].* *100 ppm:* CcrFOv (APF = 50) [any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s)]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or PaprTOv* (APF = 50) [any powered, APR with a tight-fitting facepiece and organic vapor cartridge(s)]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, SCBA).

* Substance reported to cause eye irritation or damage; requires eye protection.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with 1-chloro-1-nitropropane all handlers should be trained on its proper handling and storage. Before entering confined space where 1-chloro-1-nitropropane may be present, check to make sure that an explosive concentration does not exist. Store to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2810 Toxic liquids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling:

Toxic liquids, organic, n.o.s.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 0.7/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 1000/300
Then: Protect persons downwind (mi/km)
Day 1.1/1.8
Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is flammable. Thermal decomposition products may include hydrogen chloride and oxides of nitrogen. Use dry chemical, carbon dioxide; or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration (816°C, 0.5-second minimum for primary combustion; 1204°C, 1.0 second for secondary combustion) after mixing with other fuel. The formation of elemental chlorine may be prevented by injection of steam or using methane as a fuel in the process. Alternatively it may be poured over soda ash, neutralized and flushed into the sewer with large volumes of water.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* 1-Chloro-1-Nitropropane, Trenton, NJ (December 1999).

Chloropentafluoroethane C:0930

Formula: C_2ClF_5; ClF_2CCF_3

Synonyms: CFC-115; Chloropentafluoroethane; 1-Chloro-1,1,2,2,2-pentafluoromethane; Ethane, Chloropentafluoro-; F-115; FC 115; Flurocarbon 115; Freon 115; Genetron 115; Halocarbon 115; HCFC-115; Monocloropentafluoetano (Spanish); Pentafluoromonochloroethane; Propellent 115; R115; Refrigerant 115

CAS Registry Number: 76-15-3; *(alt.)* 12770-91-1

HSDB Number: 147

RTECS Number: KH7877500

UN/NA & ERG Number: UN1020/126

EC Number: 200-938-2

Regulatory Authority and Advisory Information

Hazard Alert: Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated, Environmental hazard (atmospheric).

Clean Air Act: Stratospheric ozone protection (Title VI, Subpart A, Appendix A), Class I, Ozone Depletion Potential (ODP) = 0.6

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Harms public health and the environment by destroying ozone in the upper atmosphere.

Hazard symbols, risk, & safety statements: Hazard symbol: Xi, N; risk phrases: R5; R21; R36/37/38; safety phrases: S9; S33; S38; S57; S59; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Chloropentafluoroethane is a colorless, odorless, nonflammable gas. Ethereal odor. Shipped as a liquefied compressed gas. Molecular weight = 154.47; specific gravity (H_2O:1) = 1.57 @ −42°C; boiling point = −37.7°C; freezing/melting point = −106°C; vapor pressure = 7.9 atm @ 21°C; 6035 mmHg @ 21°C; relative vapor density (air = 1) = 5.28. Practically insoluble in water; solubility 0.006% @ 20°C.

Potential Exposure: This material is used as a refrigerant; as a dielectric gas; and as a propellant in aerosol food preparations.

Incompatibilities: Keep away from strong oxidizers, strong bases (alkalis), alkaline earth metals (e.g., aluminum powder, sodium, potassium, zinc), and beryllium. Keep away from open flames; decomposes forming toxic fumes including hydrogen chloride and HF.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 6.32 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: None

NIOSH REL: 1000 ppm/6320 milligram per cubic meter TWA

ACGIH TLV[1]: 1000 ppm/6320 milligram per cubic meter TWA

PAC Ver. 29[138]

PAC-1: 3000 ppm

PAC-2: 5700 ppm

PAC-3: 34,000 ppm

Australia: TWA 1000 ppm (6320 milligram per cubic meter), 1993; Belgium: TWA 1000 ppm (6320 milligram per cubic meter), 1993; Denmark: TWA 1000 ppm (6300 milligram per cubic meter), 1999; France: VME 1000 ppm (6320 milligram per cubic meter), 1999; Hungary: TWA 100 milligram per cubic meter; STEL 200 milligram per cubic meter, 1993; Russia: STEL 3000 milligram per cubic meter, 1993; Switzerland: MAK-W 1000 ppm (6400 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 6460 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 1000 ppm. The former USSR-UNEP/IRPTC joint project[43] set a MAC in work-place air of 3000 milligram per cubic meter. Several states have set guidelines or standards for FC-115 in ambient air[60] ranging from 0.1264 μ/m^3 (Connecticut) to 9999 μ/m^3 (Virginia) to 63,200 μ/m^3 (North Dakota) to 151,000 μ/m^3 (Nevada).

Determination in Air: No method available.

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guide lines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg [F]/L. SafeDrinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg[F]/L; SMCL = 2 mg/F/L, as Fluoride.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 2.4. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Chloropentafluoroethane can affect you when breathed in. Irritates the nose, throat, and lungs, causing coughing, chest tightness, wheezing, and shortness of breath. High levels can cause you to feel dizzy, lightheaded, and to pass out. Very high levels can cause death. Chloropentafluoroethane may irritate the skin causing a rash or burning feeling on contact. Exposure may affect the heart, causing irregular heartbeat, which could lead to death. Rapid evaporation of liquid chloropentafluoroethane may cause frostbite of the eyes and skin.

Long-Term Exposure: Similar very irritating substances can cause lung damage.

Points of Attack: Skin, central nervous system; cardiovascular system.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: Special 24 hour EKG (Holter monitor) to look for irregular heartbeat. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures over 1000 ppm; Use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode. All respirators selected must be approved by NIOSH under the provisions of 42 CFR 84. The current listing of NIOSH-certified respirators can be found in the NIOSH/NPPTL Certified Equipment List, which is available on the NIOSH website.

Storage: Check oxygen content prior to entering storage area. Prior to working with chloropentafluoroethane all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from metals, including aluminum, zinc, and beryllium; and from open flames or temperatures above 52°C/125°F. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: UN1020 Chloropentafluoroethane or Refrigerant gas R-115, Hazard Class: 2.2; Labels: 2.2-Nonflammable compressed gas. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak to disperse the gas. Stop the flow of gas if it can be done safely. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place; and repair leak or allow cylinder to empty. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include fluorides, chlorides, phosgene, and acid gases. Use dry chemical or carbon dioxide extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier.

References

(31); (173); (101); (138); (122); (100).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Chloropentafluoroethane, Trenton, NJ (May 1998).

Chlorophacinone C:0940

Formula: $C_{23}H_{15}ClO_3$

Synonyms: Afnor; Caid; Chlorfacinon (German); 2-(α-*p*-Chlorophenylacetyl)indane-1,3-dione; [(4-Chlorophenyl)-1-phenyl]-acetyl-1,3-indandion (German); 2-[(*p*-Chlorophenyl)phenylacetyl]-1,3-indandione; 2[2-(4-Chlorophenyl)-2-phenylacetyl]indan-1,3-dione; 2[(4-Chlorophenyl)phenylacetyl]-1*H*-indene-1,3(2*H*)-dione; 1-(4-Chlorphenyl)-1-phenyl-acetyl indan-1,3-dion (German); Clorofacinona (Spanish); Delta; Drat; 1,3-Indandione, 2-[(*p*-chlorophenyl) phenylacetyl]-; 1*H*-Indene-1,3(2*H*)-dione, 2-[(4-Chlorophenyl)phenylacetyl]-; Liphadione; LM91; Microzul; Muriol; 2-[2-Phenyl-2-(4-chlorophenyl)acetyl]-1,3-indandione; Quick; Ramucide; Ranac; Ratomet; Raviac; Rozol; Topitox

CAS Registry Number: 3691-35-8

HSDB Number: 6432

RTECS Number: NK5335000

UN/NA & ERG Number: UN3027 (Coumarin derivative pesticides, solid, toxic)/151

EC Number: 223-003-0 [*Annex I Index No.:* 606-014-00-9]

Regulatory Authority and Advisory Information

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)

Hazard symbols, risk, & safety statements: Hazard symbol: T+, N; risk phrases: R23; R27/28; R48/24/25; R50/53; safety phrases: S1/2; S36/37; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to waters.

Description: Chlorophacinone is a highly toxic crystalline solid. Molecular weight = 374.83; freezing/melting point = 140°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 0, reactivity 0.

Potential Exposure: Agricultural Chemical. This material is an anticoagulant rodenticide. A potential danger to those involved in its manufacture, formulation, and application are at risk.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 0.0047 milligram per cubic meter

PAC-2: 0.051 milligram per cubic meter

PAC-3: 0.31 milligram per cubic meter

Permissible Concentration in Water: No criteria set. Fish Tox (ppb): 27.64016000 MATC.

Routes of Entry: Ingestion and skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Contact may cause burns to skin and eyes. Symptoms of exposure are similar to those of warfarin. Symptoms develop after a few days or a few weeks of repeated ingestion and include nosebleed and bleeding gums; pallor and sometimes a rash; massive bruises, especially of the elbow, knees, and buttocks; blood in urine and feces; occasionally paralysis from cerebral hemorrhage; and hemorrhagic shock and death. Chlorophacinone is highly toxicorally and by skin adsorption. The probable oral lethal dose for humans is less than 5 mg/kg to 50 mg/kg, or between a taste (less than 7 drops) and 1 teaspoonful for a 150-lb (70 kg) person. LD_{50} (oral-rat) ≥ 5000 mg/kg; (oral-mouse) 1.06 mg/kg. Human Tox (ppb): 0.03500 (extra high).

Long-Term Exposure: See above.

Points of Attack: Blood, cardiovascular system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode).

Storage: Color code—Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: UN3027 Coumarin derivative pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Small fires: dry chemicals, carbon dioxide; water spray or foam. *Large fires:* water spray, fog, or foam. Move container form fire area if you can do so without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Thermal decomposition products may include hydrogen chloride and oxides of carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration at high temperature with effluent gas scrubbing[22].

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: *Chlorophacinone*, Washington, DC, Chemical Emergency Preparedness Program (October 31, 1985).

Chlorophenols, Mono C:0950

Formula: C_6H_5ClO; C_6H_4ClOH

Synonyms: *m-isomer;* *m*-Chlorophenate; *m*-Chlorophenol; *m*-Clorofenol (Spanish)

o-isomer: *o*-Chlorophenol; *o*-Chlorphenol (German); *o*-Clorofenol (Spanish); Phenol, *o*-chloro-; Phenol, 2-chloro-

p-isomer: *p*-Chlorfenol (Spanish); *p*-Chlorophenate; *p*-Chlorophenol; Parachlorophenol

CAS Registry Number: 95-57-8 (*o*-isomer); 108-43-0 (*m*-isomer); 106-48-9 (*p*-isomer); 25167-80-0 (mixed isomers)

HSDB Number: 1415 (*o*-isomer); 1413 (*m*-isomer); 1414 (*p*-isomer)

RTECS Number: SK2625000 (*o*-isomer); SK2450000 (*m*-isomer); SK2800000 (*p*-isomer)

UN/NA & ERG Number: UN2020 (solid)/153; UN2021 (liquid)/153

EC Number: 202-433-2 (*o*-); 203-582-6 (*m*-); 203-402-6 (*p*-isomer); 246-691-4 (mixed isomers) [*Annex I Index No.:* 604-008-00-0 (all isomers and mixed)]

Regulatory Authority and Advisory Information

Alert (o-isomer): Flammable; (*m* & *p* isomers) Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction), Environmental hazard.

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/1992); Toxic Pollutant (Section 401.15)

Hazard symbols, risk, & safety statements: *all isomers*, Hazard symbol: F, Xn, N; risk phrases: R10; R20/21/22; R36/37/38; R51/53; R62; R63; safety phrases: S2; S28; S41; S61.

WGK[100] (German Aquatic Hazard Class): 2-Hazard to waters (*o-, m-, & p-isomers*)

o-isomer:

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg) (*o*-isomer)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U048 (*o*-isomer)

RCRA, 40CFR261, Appendix 8 Hazardous Constituents (*o*-isomer)

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.44; Nonwastewater (mg/kg), 5.7 (*o*-isomer)

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8040 (5); 8270 (10) (*o*-isomer)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%. (chlorophenols)

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) (chlorophenols)

Canada, WHMIS, Ingredients Disclosure List (*m*-, *o*-, and *p*-isomers) 1%.

Mexico, Drinking Water Criteria: 0.03 mg/L (*o*-isomer).

Description: All isomers have a characteristic odor. Molecular weight (all isomers) = 128.56

m-isomer

Colorless (in pure state) to pink or amber (technical grade, due to impurities) crystalline solid or liquid. Specific gravity (H_2O:1) = 1.245; boiling point = 214°C; freezing/melting point = 32.8°C; vapor pressure = 5 mmHg @ 70°C; 1 mmHg @ 44.2°C; flash point = > 112°C. Solubility in water = 2.6%−2.8.5% @ 20°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 0, reactivity 0.

o-isomer

White crystalline (needle-like) solid. Specific gravity (H_2O:1) = 1.26 @ 20°C; boiling point = 175.6°C; freezing/melting point = 9.4°C; vapor pressure = 7.5 mmHg @ 45.8°C; relative vapor density (air = 1) = 4.4; flash point = 64°C (cc). The explosive limit(s) are: LEL: 17,000 ppm[138]; UEL: unknown. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 2, reactivity 0. Solubility in water = 2.7% @ 20°C.

p-isomer

White to straw-colored, needle-like crystalline solid. Specific gravity (H_2O:1) = 1.27 @ 40°C; boiling point = 218°C; freezing/melting point = 43°C; vapor pressure = 0.75 mmHg @ 45°C; vapor density (air = 1) = 4.44; flash point = 121°C (cc). Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 1, reactivity 0. Solubility in water = 2.71% @ 20°C.

Potential Exposure: Monochlorophenols are used in the manufacture of fungicides, slimicides, bactericides, pesticides, herbicides, disinfectants, wood and glue preservatives; in the production of phenolic resins; in the extraction of certain minerals from coal; as a denaturant for ethanol; as an antiseptic; as a disinfectant, and others.

Incompatibilities: May form explosive mixture with air. Contact with oxidizing agents can cause fire and explosion hazard. Heat produces hydrogen chloride and chlorine. Corrosive to aluminum, copper and other chemically active metals.

Permissible Exposure Limits in Air

Odor threshold = 1.24 ppm (pure), all isomers.

95-57-8, o-isomer

PAC Ver. 29[138]

PAC-1: 2.3 ppm

PAC-2: 25 ppm

PAC-3: 150 ppm

108-43-0, m-isomer

PAC-1: 2.1 milligram per cubic meter

PAC-2: 23 milligram per cubic meter

PAC-3: 140 milligram per cubic meter

o- and m-isomers

Denmark: TWA 0.5 milligram per cubic meter [skin], 1999; Sweden: TWA 0.5 milligram per cubic meter; STEL 1.5 milligram per cubic meter [skin], 1999.

106-48-9, p-isomer

PAC Ver. 29[138]

PAC-1: 1.5 milligram per cubic meter

PAC-2: 17 milligram per cubic meter

PAC-3: 99 milligram per cubic meter

Denmark: TWA 0.5 milligram per cubic meter [skin], 1999; Poland: MAC (TWA) 1 milligram per cubic meter; STEL 3 milligram per cubic meter, 1999; Russia: STEL 1 milligram per cubic meter [skin] 1993; Sweden TWA 0.5 milligram per cubic meter; STEL 1.5 milligram per cubic meter [skin] 1999.

These chemicals can be absorbed through the skin, thereby increasing exposure. Russia set limits in ambient air in residential areas of 0.01 milligram per cubic meter for the *m*- and *p*-chlorphenols and 0.02 milligram per cubic meter for 2-chloro phenol.

Determination in Air: Use NIOSH: (*o*-chlorophenol) P&CAM Method #337.

Permissible Concentration in Water: Federal Drinking Water Guidelines (o-isomer): 40 μg/L; State Drinking Water Guidelines: Florida 35 μg/L; Maine 35 μg/L; Minnesota 30 μg/L. State Drinking Water Guidelines (*p*-isomer): Florida 5.5 μg/L.

Determination in Water: GC (EPA Method 604) or GC plus mass spectrometry (EPA Method 625). Octanol−water coefficient: Log K_{ow} = (*m*-isomer) 2.51; (*o*-isomer) 2.2; (*p*-isomer) 2.4

Routes of Entry: Skin absorption, inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Inhalation can cause severe irritation, burns to the nose and throat; headache, dizziness, vomiting, lung damage; muscle twitchings; spasms, tremors, weakness, staggering, and collapse. Skin contact can cause severe irritation and burns. Can be absorbed through the skin to cause or increase the severity of symptoms listed above. Eye contact causes severe irritation. May cause burns. Ingestion can cause irritation, burns to the mouth and throat; low blood pressure; profuse sweating; intense thirst; nausea, abdominal pain; stupor, vomiting, red blood cell damage, and accumulation of fluid in the lungs followed by pneumonia. May also cause restlessness and increased breathing rate followed by rapidly developing muscle weakness. Tremors, convulsions, and coma can promptly set in and will continue until death. Based on animal studies, the estimated lethal dose is between one teaspoon and 1 oz for a 150-lb adult. *p*-isomer: The substance irritates the eyes, skin, and the respiratory tract. The substance may cause effects on the central nervous system and bladder.

Long-Term Exposure: Skin sensitivity may develop. May have effects on the blood, heart, liver, lung, kidney. The state of New Jersey lists 2-chloro-a probable carcinogen in humans; and that it causes leukemia and soft tissue cancers in humans.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: liver function tests. Kidney function tests. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. EKG.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid, unless full facepiece respiratory protection is worn. Wear dust-proof goggles when working with powders or dust, unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposure to chlorophenols, use a NIOSH/MSHA (US) or

EN149 (Europe)-approved full facepiece respirator with a high-efficiency particulate filter. Greater protection is provided by a PAPR. Where there is potential for high exposure to chlorophenols exists, or to liquid form, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode. All respirators selected must be approved by NIOSH under the provisions of 42 CFR 84. The current listing of NIOSH-certified respirators can be found in the NIOSH/NPPTL Certified Equipment List, which is available on the NIOSH website.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with chlorophenols all handlers should be trained on its proper handling and storage. Before entering confined space where chlorophenols may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN 2020 (solid); UN2021 (liquid) Chlorophenols, solid and liquid, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: *o*-Chlorophenol is a combustible liquid/solid. *m*- and *p*-chlorophenols may burn, but do not readily ignite. Thermal decomposition products may include phenols and chlorides. Use dry chemical, carbon dioxide; or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors from 2-chloro-may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incinerate in admixture with flammable solvent in furnace equipped with afterburner and scrubber[22].

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, 2-Chlorophenol: Ambient Water Quality Criteria, Washington, DC (1980).

United States Environmental Protection Agency, 2-Chloropehnol, Health and Environmental Effects Profile No. 50, Office of Solid Waste, Washington, DC (April 30, 1980).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 2, No. 6, 48−51 (1982) and 4, No. 6, 88−94 (1986) (2-Chlorophenol); 2, No. 6, 46−48 (1982) and 6, No. 5, 70−74 (1986) (3-Chlorophenol); 2, No. 6, 52−55 (1982) and 6, No. 5, 74−81 (1986) (4-Chlorophenol).

New York State Department of Health, *Chemical Fact Sheet* Chlorophenols, Bureau of Toxic Substance Assessment, Albany, NY (May 1986).

New York State Department of Health, *Chemical Fact Sheet* 2-Chloro phenol, Bureau of Toxic Substance Assessment, Albany, NY (March 1986).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* 2-Chlorophenol, Trenton, NJ (December 1999).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* 3-Chlorophenol, Trenton, NJ (December 1999).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* 4-Chloophenol, Trenton, NJ (December 1999).

4-Chloro-*o*-phenylenediamine C:0960

Formula: $C_6H_7ClN_2$; $ClC_6H_3(NH_2)_2$

Synonyms: 2-Amino-4-chloroaniline; 4-Chloro-1,2-benzenediamine; 4-Chloro-1,2-diamino benzene; *p*-Chloro-*o*-phenylenediamine; 4-Chloro-1,2-phenylenediamine; 4-Cl-*o*-Pd; 1,2-Diamino-4-chlorobenzene; 3,4-Diamino-1-chlorobenzene; 3,4-Diaminochlorobenzene; NCI-C03292; Ursol olive 6G

CAS Registry Number: 95-83-0

HSDB Number: 5087 as 4-chloro-1,2-benzenediamine

RTECS Number: SS8850000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154; UN3143 (Dyes, solid, toxic, n.o.s.)/151

EC Number: 202-456-8

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Animal Sufficient Evidence, Human Limited Evidence, *possibly carcinogenic to humans*, Group 2B, 1998; NCI: Clear evidence: mouse, rat[9]; a related chemical, 4-Chloro-*m*-phenylenediamine (5131-60-2)

California Proposition 65 Chemical[102]: Cancer 1/1/1988.

Hazard Alert: Poison, Combustible.

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xn; risk phrases: R45; R36/37/38; R34; R40; R50/53; safety phrases: S22; S26; S36/37/39; S45; S53; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: 4-Chloro-*o*-phenylenediamine is a brown crystalline powder or leaflets from water; freezing/melting point = 67−73°C; also reported in lit. @ 76°C. Slightly soluble in water.

Potential Exposure: This organochlorine material has been patented as a hair dye component. It is believed to be used in production of photographic chemicals. In varying degrees, organochlorines are absorbed from the gut and also by the lung and across the skin[72].

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Light sensitive. It reacts with *alpha*-ketoacids to form quinoxalones or benzopyrazines[101].

Permissible Exposure Limits in Air

No standards or PAC available.

North Dakota has set a guideline for ambient air of zero concentration[60].

Determination in Air: NIOSH Analytical Method #5013, Dyes.

Harmful Effects and Symptoms

Short-Term Exposure: Can cause irritation of eyes, nose, skin, and mucous membranes. In varying degrees, organochlorines are absorbed from the gut and also by the lung and across the skin[72].

Long-Term Exposure: There is sufficient evidence that 4-chloro-*o*-phenylenediamine is carcinogenic in experimental animals. In long-term feeding bioassays with technical grade 4-chloro-*o*-phenylenediamine, rats developed tumors of the urinary bladder and fore-stomach. In mice, the compound induced hepatocellular carcinomas.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 20 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv 100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Store in tightly closed containers in a cool, well-ventilated place or a refrigerator.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN3143 Dyes, solid, toxic, n.o.s. or Dye intermediates, solid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/ 75 ft (NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Ventilate area of spill. Dampen spilled material with alcohol to avoid dust, then transfer material to a suitable container. Use absorbent paper dampened with alcohol to pick up remaining material. Wash surfaces well with soap and water. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide; water spray; or foam extinguishers. Thermal decomposition products may include hydrogen chloride and oxides of nitrogen and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Disposal of unused product must be undertaken by qualified personnel who are knowledgeable in all applicable regulations and follow all pertinent safety precautions including the use of appropriate protective equipment. For proper handling and disposal, always comply with federal, state, and local regulations.

References

(109); (102); (31); (173); (101); (138); (100).

Chlorophenyltrichlorosilane C:0970

Formula: $C_6H_4Cl_4Si$; $ClC_6H_4SiCl_3$

Synonyms: Chlorofeniltriclorosilano (Spanish); Chlorophenyl trichlorosilane; Trichloro (chlorophenyl)silane

CAS Registry Number: 26571-79-9

HSDB Number: 7803

RTECS Number: VV2650000

UN/NA & ERG Number: UN1753/156

EC Number: 247-817-0

Regulatory Authority and Advisory Information

Hazard Alert: Violently water reactive, Corrosive, Environmental hazard.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Canada, WHMIS, Ingredients Disclosure List Concentration 1%.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, C, Xn; risk phrases: R14; R36/37/38; R34; R40; R51; safety phrases: S22; S26; S36/37/39; S41; S45; S53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [2-Hazard to water. (est.)]

Description: Chlorophenyltrichlorosilane is a combustible, colorless to pale yellow liquid. Molecular weight = 245.99; boiling point = 230°C; flash point = 123.8°C. ₩ Reacts violently with water, rapidly releasing corrosive hydrogen chloride gas.

Potential Exposure: Chlorophenyltrichlorosilane is used as an intermediate for silicones manufacture.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Chlorosilanes react vigorously with bases and both organic and inorganic acids generating toxic and/or flammable gases. Chlorosilanes react with water, moist air, or steam to produce heat and toxic, corrosive fumes of hydrogen chloride. They may also produce flammable gaseous hydrogen. Attacks metals in the presence of moisture. Keep chlorophenyltrichlorosilane away from combustible materials, such as wood, paper, and oil. Chlorophenyltrichlorosilane reacts with α-ketoacids, forming heterocyclic compounds of quinoxalones[101].

Permissible Exposure Limits in Air

PAC Ver. 29[138]

based on 15 other trichlorosilanes with identical PACs (for reference only)

PAC-1: $\mathbf{0.6}_{\mathbf{A}}$ ppm

PAC-2: $\mathbf{7.3}_{\mathbf{A}}$ ppm

PAC-3: $\mathbf{33}_{\mathbf{A}}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60-minute values.

Routes of Entry: Skin contact, inhalation.

Harmful Effects and Symptoms

Short-Term Exposure: Chlorophenyltrichlorosilane inhalation, ingestion or skin/eye contact may cause severe injury, burns, or death. Chlorophenyltrichlorosilane is a corrosive chemical. Contact with molten substance may cause severe burns and possibly permanent damage to skin and eyes. Inhalation can cause severe irritation of the lungs, causing coughing and/or shortness of breath. High exposures can cause pulmonary edema, a medical emergency which can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: Can cause lung irritation; bronchitis may develop.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following is recommended. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure exists, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode. All respirators selected must be approved by NIOSH under the provisions of 42CFR84. The current listing of NIOSH-certified respirators can be found in the NIOSH/NPPTL Certified Equipment List, which is available on the NIOSH website.

Storage: Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with chlorophenyltrichlorosilane all handlers should be trained on its proper handling and storage. Chlorophenyltrichlorosilane should be stored to avoid contact with combustible materials, such as wood, paper, and oil. Store in tightly closed containers in a cool, well-ventilated area away from water, steam, and moisture because toxic and corrosive gases, including Hydrogen Chloride can be produced.

Shipping: UN1753 Chlorophenyltrichlorosilane, Hazard class: 8; Labels: 8-Corrosive material.

Spill Handling:

Chlorophenyltrichlorosilane when spilled in water

Initial isolation and protective action distances Chlorosilanes, corrosive, n.o.s.

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 0.7/1.2

Stay upwind and uphill. Isolate the area of release or fire and deny entry. Remove all ignition sources. Stop the release if it can be done safely from a distance. All equipment used to handle this material must be grounded. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. *Small spill*: Cover with *dry* earth, *dry* sand, or other noncombustible material followed with plastic sheet to minimize spreading or contact with water or rain. Use clean nonsparking tools to collect material and place material into loosely covered plastic containers for later disposal. Prevent material and runoff from entering sewers and waterways if it can be done safely well ahead of the release. Use vapor suppressing foam to disperse vapors—contain runoff. Water spray may reduce vapor, but may not prevent ignition in enclosed spaces. Ventilate confined area if it can be done without placing personnel at risk. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Chlorophenyltrichlorosilane may burn, but does not readily ignite. *Do not use water*. Thermal decomposition products may include hydrogen chloride and oxides of carbon and metal. *FOR CHLOROSILANES DO NOT USE WATER. USE AFFF ALCOHOL-RESISTANT, MEDIUM EXPANSION FOAM. Small fire*: use *dry* chemical, CO_2, *dry* sand, or alcohol-resistant foam. May react with foams releasing corrosive/toxic gases. *Large fire*: use water spray or alcohol-resistant foam if it is available in sufficient amounts. Under favorable conditions, experienced crews can use coordinated fog streams to sweep the flames off the surface of the burning liquid. Combustible material: may burn but does not ignite readily. Most vapors are heavier than air. They will spread along ground and collect in low or confined areas (sewers, basements, tanks). Vapors may travel to source of ignition and flashback. Containers may explode when heated or if contaminated with water. Keep exposures cool long after fire is out to protect against reignition. Do not direct straight streams into the liquid. Cool exposed containers with large quantities of water from unattended equipment or remove intact containers if it can be done safely. *Do not get water on spilled substance or inside containers*. If cooling streams are ineffective (*venting sound increases in volume and pitch, tank discolors, or shows signs of deforming*), withdraw immediately to a secure location. Always stay away from ends of tanks, especially when engulfed in flames. If material or contaminated runoff from fire control enters waterways, notify downstream users of potentially contaminated water. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156.

Disposal Method Suggested: Disposal of unused product must be undertaken by qualified personnel who are knowledgeable in all applicable regulations and follow all pertinent safety precautions including the use of appropriate protective equipment. For proper handling and disposal, always comply with federal, state, and local regulations.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Chlorophenyltrichlorosilane, Trenton, NJ (March 2004).

Chloropicrin (Agent PS) C:0980

Formula: CCl_3NO_2

Synonyms: Acquinite; Chlor-O-Pic; Chloropicrine (French); Chlorpikrin (German); Clorpicrina (Spanish); Larvacide 100; Methane, trichloronitro-; Mycrolysin; Nitrochloroform; Nitrotrichloromethane; Pic-Chlor; Picfume; Picride; Profume A; PS (military designation); Trichlor; Trichloronitromethane

CAS Registry Number: 76-06-2

HSDB Number: 977

RTECS Number: PB6300000

UN/NA & ERG Number: UN1580/154; UN1583 (Chloropicrin mixtures, n.o.s.)/154

EC Number: 200-930-9 [*Annex I Index No.*: 610-001-00-3]

Regulatory Authority and Advisory Information

Carcinogenicity: ACGIH A4, not classifiable as a human carcinogen

Hazard Alert: Poison inhalation hazard (extremely toxic gas), Lung dam aging agent, Lacrimator (tear gas), Explosive, Possible risk of forming tumors, Suspected of causing genetic defects.

Banned or Severely Restricted (Various Countries) (UN)[13,35]

United States Environmental Protection Agency, FIFRA 1998 Status of Pesticides: Supported

Carcinogenicity: NCI: Carcinogenesis Bioassay (gavage); no evidence: mouse; inadequate studies: rat.

OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 500 lb (227 kg)

Safe Drinking Water Act (47FR 9352): Priority List (55 FR 1470)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT 49CFR172.101, Inhalation Hazardous Chemical (PIH)

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, E; risk phrases: R22; R26; R36/37/38; R50; R62; safety phrases: S1/2; S36/37; S38; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Chloropicrin is a highly reactive, colorless, oily liquid with a sharp, penetrating odor that causes tears. Molecular weight = 164.38; specific gravity (H_2O:1) = 1.66; boiling point = 112.2°C; freezing/melting point = −69.2°; vapor pressure = 1 mmHg @ 25°C. Hazard identification (based on NFPA-704 M Rating System): Health 4, flammability 0, reactivity 3. Slightly soluble in water; solubility = 0.17% @ 25°C.

Potential Exposure: Chloropicrin is an important insecticide and is used in the manufacture of the dye-stuff methyl violet and in other organic syntheses. It is used as a fumigant insecticide. It is a riot control and tear agent and has been used as a military poison gas. Some forms of tear gas also contain chloropicrin. Since tank trucks, tank cars, and tank vessels carry this throughout the world in large quantities, it is a potential problem.

Incompatibilities: Chloropicrin decomposes explosively when heated above 112°C. It can be dangerously self-reactive; and, may explode when heated under confinement or if shocked. Chloropicrin is stable except when it's heated to a high temperature; it explosively breaks down, releasing other poison gases including nitrogen oxides, nitrosyl chloride, chlorine, phosgene, and carbon monoxide. Liquid chloropicrin (PS) is unstable with high temperatures or severe shock, particularly when involving containers of greater than 30 gal capacity. Chloropicrin reacts violently with aniline, sodium methoxide, and propargyl bromide; 2-bromopropyne and strong oxidizers. Violent reaction with reducing agents; aniline (especially in presence of heat), alcoholic sodium hydroxide. Quickly elevated temperatures, shock, contact with alkali metals or alkaline earth may cause explosions. It is a strong acid and will react violently with bases and alkali materials. Liquid attacks some plastics, rubber, and coatings. Chloropicrin reacts with iron, zinc, light metals including aluminum, magnesium, and alloys containing these metals. It reacts, sometimes violently, with some types of rubbers and plastics, as well as some chemicals including common sulfuric acid; and bases. Contact with metals may evolve explosive hydrogen gas.

Permissible Exposure Limits in Air

NIOSH IDLH = 2 ppm

Conversion factor: 1 ppm = 6.72 milligram per cubic meter @ 25°C & 1 atm

Odor threshold = 1.1 ppm.

OSHA PEL: 0.1 ppm/0.7 milligram per cubic meter TWA

NIOSH REL: 0.1 ppm/0.7 milligram per cubic meter TWA

ACGIH TLV[1]: 0.1 ppm/0.67 milligram per cubic meter TWA; not classifiable as a human carcinogen

PAC PS*

PAC Ver. 29[138]

PAC-1: **0.050**$_{\mathbf{A}}$ ppm

PAC-2: **0.15**$_{\mathbf{A}}$ ppm

PAC-3: **1.4**$_{\mathbf{A}}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60-minute values.

Emergency Response Planning Guidelines

ERPG-1: 0.1 ppm

ERPG-2: 0.3 ppm

ERPG-3: 1.5 ppm

DFG MAK: 0.1 ppm/0.68 milligram per cubic meter TWA; Peak Limitation Category I(1)

Australia: TWA 0.1 ppm (0.7 milligram per cubic meter); STEL 0.3 ppm (2 milligram per cubic meter), 1993; Austria: MAK 0.1 ppm (0.7 milligram per cubic meter), 1999; Belgium: TWA 0.1 ppm (0.67 milligram per cubic meter); STEL 0.3 ppm, 1993; Denmark: TWA 0.1 ppm (0.7 milligram per cubic meter), 1999; Finland: TWA 0.1 ppm (0.7 milligram per cubic meter); STEL 0.3 ppm (2.1 milligram per cubic meter), 1999; France: VME 0.1 ppm (0.7 milligram per cubic meter), 1999; Japan: 0.1 ppm (0.67 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 0.7 milligram per cubic meter, 2003; Norway: TWA 0.1 ppm (0.7 milligram per cubic meter), 1999; the Philippines: TWA 0.1 ppm (0.7 milligram per cubic meter), 1993; Poland: MAC (TWA) 0.5 milligram per cubic meter, MAC (STEL) 1.5 milligram per cubic meter, 1999; Russia: TWA 0.1 ppm, 1993; Switzerland: MAK-W 0.1 ppm (0.7 milligram per cubic meter), KZG-W 0.2 ppm, 1999; Turkey: TWA 0.1 ppm (0.7 milligram per cubic meter), 1993; United Kingdom: TWA 0.1 ppm (0.68 milligram per cubic meter); STEL 0.3 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Several states have set guidelines or standards for chloropicrin in ambient air[60] ranging from 7–20 μ/m^3 (North Dakota) to 11.7 μ/m^3 (Virginia) to 14 μ/m^3 (Connecticut) to 17 μ/m^3 (Nevada).

Permissible Concentration in Water: California[61] has set guidelines for Chloropicrin in drinking water of 50 μg/L on a taste basis and 37 μg/L on an odor basis. When liquid chloropicrin enters water, it mixes very slowly, falling to the bottom, where it breaks down in less than 24 hours. Chloropicrin may be very poisonous to fish. Warn pollution control authorities and advise shutting water intakes.

Determination in Water: Octanol–water coefficient: $\log K_{ow} = 2.1$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion, eye and skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Chlorpicrin was used as poison gas in WW 1. Exposure causes intense tearing of the eyes, headache, nausea and vomiting, diarrhea, and cough. Contact can severely irritate the skin causing rash or burning sensation. Higher exposures can irritate and burn the lungs, causing a build-up of fluid (pulmonary edema); a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. LD_{50} (oral-rat) = 250 mg/kg (moderately toxic).

Long-Term Exposure: Repeated exposure can damage the lungs, causing bronchitis. It may also damage the liver and kidneys.

Points of Attack: Eyes, skin, respiratory system; liver, kidneys.

Medical Surveillance: Before beginning employment and at regular times after that, the following is recommended. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. If symptoms develop or overexposure has occurred, the following may be useful: liver and kidney function tests. Consider chest X-ray following acute overexposure. NIOSH suggests the following tests: electrocardiogram, expired air, pulmonary function tests: forced vital capacity and forced expiratory volume (1 second), sputum cytology, and white blood cell count/differential.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not Use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Decontamination: Decontaminate as soon as possible. This is extremely important. If you don't have the equipment and training, don't enter the hot zone to rescue and/or decontaminate victims. If the victim can't move, begin the decontamination process without touching and without entering the hot zone. Use clean water from any source; if possible, use a hose (spray or fog to prevent injury to the victim) or other system so that you won't have to touch the victim; don't even wait for soap or for the victim to remove clothing, begin washing immediately. Immediately flush the eyes with water for at least 15 minutes. Wash—strip—wash—evacuate upwind and uphill: The approach is to immediately wash with water, then have the victim (not the first responder) remove all the victim's clothing, then wash again (with soap if available); and subsequently move away from the hot zone in an upwind and uphill direction. Wash the victim with warm water and soap. Decontaminate with diluted household bleach (10%, or one part bleach to nine parts water), but don't let any of the bleach solution get in the victim's eyes, open wounds, or mouth. Rinse off the diluted bleach solution after 15 minutes. In order to prevent spreading the agent, be certain the victims have been decontaminated as much as possible before they leave the decontamination area. If you get any amount of the agent on yourself, decontaminate immediately. Even if you think you are not contaminated, be sure to thoroughly shower and change clothes as soon as you can after the incident.

Personal Protective Methods:

General information: First responders should use a NIOSH-certified chemical, biological, radiological, nuclear (CBRN) SCBA with a level a protective suit when entering an area with an unknown contaminant or when entering an area where the concentration of the contaminant is unknown. Level a protection should be used until monitoring results confirm the contaminant and the concentration of the contaminant. *Note:* safe use of protective clothing and equipment requires specific skills developed through training and experience.

LEVEL A: (*RED ZONE*): Select when the greatest level of skin, respiratory, and eye protection is required. This is the maximum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than the AEGL-2. A NIOSH-certified CBRN full-facepiece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle. A TECP suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, and a hard hat worn under the TECP suit are optional items.

LEVEL B: (RED ZONE): Select when the highest level of respiratory protection is necessary but a lesser level of skin protection is required. This is the minimum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than AEGL-2. It differs from Level A in that it incorporates a nonencapsulating, splash-protective, chemical-resistant splash suit that provides Level A protection against liquids but is not airtight. A NIOSH-certified CBRN full-facepiece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL C: (YELLOW ZONE): Select when the contaminant and concentration of the contaminant are known and the respiratory protection criteria factors for using APR or PAPRs are met. This level is appropriate when decontaminating patient/victims. A NIOSH-certified CBRN tight-fitting APR with a canister-type gas mask or CBRN PAPR for air levels greater than AEGL-2. A NIOSH-certified CBRN PAPR with a loose-fitting facepiece, hood, or helmet and a filter or a combination organic vapor, acid gas, and particulate cartridge/filter combination or a continuous flow respirator for air levels greater than AEGL-1. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Escape mask, face shield, coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL D: (GREEN ZONE): Select when the contaminant and concentration of the contaminant are known and the concentration is below the appropriate occupational exposure limit or less than AEGL-1 for the stated duration times. Limited to coveralls or other work clothes, boots, and gloves.

Notes: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. The International Technical Information Institute recommends wearing Neoprene gloves. All protective clothing (suits, gloves, footwear, head gear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *2 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOv (APF = 25) [any powered, APR with organic vapor cartridge(s)]; or CcrFOv (APF = 50) [any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s)]; or GmFOv (APF = 50) (any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance causes eye irritation or damage; eye protection needed.

Storage: Poison inhalation chemical (PIH); check oxygen content prior to entering storage area. Poison gas. (1) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. This gas is highly toxic. Even slight exposure to these gasses can cause death. Store outdoors in a secure, restricted area that containing warning signs. This area must be roofed and shaded with the cylinders stored off the ground and separated from all other products assigned to other hazard categories and radiant heat sources on non-wooden floors. If indoors, store in a well-ventilated areas in temperatures not to exceed 50°C. (2) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with chloropicrin all handlers should be trained on its proper handling and storage. Before entering confined space where chloropicrin may be present, check to make sure that an explosive concentration does not exist. Chloropicrin must be stored to avoid contact with strong oxidizers, such as chlorine or chlorine dioxide, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. High temperatures or severe shock may cause an explosion, particularly with containers having capacities of greater than 30 gal. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN1580 Chloropicrin, Hazard Class: 6.1; Labels: 6.1-Poison Inhalation Hazard, Inhalation Hazard Zone B.

Spill Handling:

Chloropicrin

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package) Note: there is no specific information for "PS" Chloropicrin, used as a weapon in the current DOT tables.

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.3/0.5
Night 0.6/1.0

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 500/150
Then: Protect persons downwind (mi/km)
Day 1.0/1.5
Night 1.9/3.1

Restrict persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Ventilate the area of spill or leak. Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Chloropicrin is a noncombustible liquid. However, in the case where a chloropicrin tank is adjacent to a fire, the tank will heat causing extremely high pressurization, rupture, and explosion. Evacuate area. Even if the tank doesn't fail, the safety valve may open releasing chloropicrin, so evacuate. If necessary, fight fire from an explosion-resistant location. When heated, chloropicrin breaks down to poison gases like phosgene (another good reason to evacuate); and, at high temperature it can violently break down into several Thermal decomposition products may include hydrogen chloride and nitrous vapors. The danger from a heated chloropicrin tank is too great to risk a manned firefighting effort; if possible, an unattended fire monitor aimed at the upper part of the chloropicrin tank will cool the tank and may prevent tank failure. In general, it's best to use a spray or fog pattern rather than a solid stream, to avoid spreading the burning fuel around. If there is a reason that you have to extinguish a fire near a chloropicrin tank, use a firefighting agent (water, ordinary foam, alcohol foam, or dry chemical) appropriate for that fuel. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. When liquid chloropicrin enters water, it mixes very slowly, falling to the bottom, where it breaks down in less than 24 hours. Nevertheless, warn pollution control authorities and advise shutting water intakes. Chloropicrin is very poisonous to fish. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration (816°C, 0.5 seconds minimum for primary combustion; 1204°C, 1.0 second for secondary combustion) after mixing with other fuel. The formation of elemental chlorine may be prevented by injection of steam or using methane as a fuel in the process. Chloropicrin reacts readily with alcoholic sodium sulfite solutions to produce methanetrisulfonic acid (which is relatively nonvolatile and less harmful). This reaction has been recommended for treating spills and cleaning equipment. Although not specifically suggested as a decontamination procedure, the rapid reaction of chloropicrin with ammonia to produce guanidine ($LD_{50} = 500$ mg/kg) could be used for detoxification. The Chemical Manufacturers' Association has suggested two procedures for disposal of Chloropicrin: (1) Pour or sift over soda ash. Mix and wash slowly into large tank. Neutralize and pass to sewer with excess water. (2) Absorb on vermiculite. Mix and shovel into paper boxes. Drop into incinerator with afterburner and scrubber[22]. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (80); (85); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 2, No. 2, 17–19, New York, Van Nostrand Reinhold Co. (1982).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Chloropicrin, Trenton, NJ (April 1998).

Chloroplatinic Acid C:0990

Formula: Cl_6H_2Pt; H_2PtCl_6

Synonyms: Dihydrogen hexachloroplatinate; Dihydrogenhexachloroplatinate (2−); Hexachloro dyhydrogen platinate; Hexachloroplatinic acid; Hexachloroplatinic(IV) acid; Hexachloro platinic(4+) acid, hydrogen-; Hydrogen hexachloroplatinate(4+); Platinate, hexachloro-; Platinic chloride

CAS Registry Number: 16941-12-1

RTECS Number: TP1500000

UN/NA & ERG Number: UN2507/154

EC Number: 241-010-7 [*Annex I Index No.*: 078-009-00-4]

Regulatory Authority and Advisory Information

Hazard Alert: Oxidizing acid, Corrosive, Sensitization hazard (skin, resp.), Suspected of causing genetic defects, Environmental hazard

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazardous to aquatic life or environment, with possible long-lasting effects[291]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, C, N; risk phrases: R8; R25; R34; R35; R42/43; R62; safety phrases: S1/2; S17; S22; S26; S29/35; S36/37/39; S41; S45; S61 (see Appendix 4).

Description: Chloroplatinic acid is a reddish-brown deliquescent solid. Molecular weight = 409.8; specific gravity (H_2O:1) = 2.43; freezing/melting point = 60°C. The explosive limit(s) are: LEL: 14,000 ppm; hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 0, reactivity 0. Soluble in water; aqueous solution is a strong acid.

Potential Exposure: Chloroplatinic acid has many uses, among them are platinum plating, photography, and catalysis.

Incompatibilities: Oxidizing acids are generally soluble in water with the release of hydrogen ions. The resulting solutions have pH's of <7.0. Materials in this group react with chemical bases (e.g., amines and inorganic hydroxides) to form salts. These neutralization reactions occur as the base accepts hydrogen ions that the acid donates. Neutralizations can generate dangerously large amounts of heat in small spaces. The dissolution of acids in water or the dilution of their concentrated solutions with water may generate significant heat. The addition of water acids often generates sufficient heat in the small region of mixing to boil some of the water explosively. The resulting "bumping" spatters acid widely. These materials have significant ability as oxidizing agents. but that ability varies (e.g., from high for nitric acid to low for sulfuric acid and most sulfonic acids). They can react with active metals, including iron and aluminum, and also many less active metals, to dissolve the metal and liberate hydrogen and/or toxic gases. Like other acids, materials in this group can initiate polymerization in certain classes of organic compounds. Their reactions with cyanide salts and compounds release gaseous hydrogen cyanide. Flammable and/or toxic gases are also often generated by their reactions with dithiocarbamates, isocyanates, mercaptans, nitrides, nitriles, sulfides, and weak or strong reducing agents. Additional gas-generating reactions occur with sulfites, nitrites, thiosulfates (to give H_2S and SO_3), dithionites (SO_2), and even carbonates: the carbon dioxide gas from the last is nontoxic but the heat and spattering from the reaction can be troublesome. Acids often catalyze (increase the rate) of chemical reactions[101].

Permissible Exposure Limits in Air

NIOSH IDLH = 4 mg [Pt]/m^3

ACGIH TLV[1]: 0.002 mg[Pt]/m^3 TWA, soluble salts

OSHA PEL: 0.002 mg[Pt]/m^3 TWA, soluble salts

NIOSH REL: 0.002 mg[Pt]/m^3 TWA, soluble salts

PAC Ver. 29[138]

PAC-1: 0.013 milligram per cubic meter

PAC-2: 3.2 milligram per cubic meter

PAC-3: 19 milligram per cubic meter

DFG MAK: No numerical value established. Data may be available; however, 2 μg[Pt]/m^3 peak should not be exceeded; danger of skin and airway sensitization, as chloroplatinates

Determination in Air: Use NIOSH II(7) Method #S-19 (soluble salts)

Routes of Entry: Skin contact, inhalation of vapors, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Chloroplatinic acid can affect you when breathed in. It is a highly corrosive chemical; contact can severely irritate and burn the eyes. In halation can irritate the respiratory tract. Exposure can cause severe allergies affecting the nose, skin, and lungs. Symptoms include sneezing, coughing, nose and throat irritation, and nasal discharge. Irritation and even ulcers can develop in the nose. Once lung allergy develops, even very small future exposures cause cough, wheezing, chest tightness, and shortness of breath. Skin allergy with a rash and itching can also develop.

Long-Term Exposure: Repeated exposure may lead to permanent lung damage (pulmonary fibrosis), skin and asthma-like allergy.

Points of Attack: Skin, respiratory system.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. These may be normal if the person is not having an attack at the time of the test. If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *up to 0.05 milligram per cubic meter:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode), *up to 0.1 milligram per cubic meter:* 100 F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 4 milligram per cubic meter:* Sa:Pd,Pp (APF = 1000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd, Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter).

Storage: Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: UN2507 Chloroplatinic acid, solid, Hazard class: 8; Labels: 8-Corrosive material.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include hydrogen chloride and oxides of metal. Use dry chemical, CO_2, water spray; or foam extinguishers. Chloroplatinic acid may burn, but does not readily ignite. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Chloroplatinic Acid, Trenton, NJ (April 1998).

Chloroprene C:1000

Formula: C_4H_5Cl; $H_2C{=}CCl{-}CH{=}CH_2$

Synonyms: 1,3-Butadiene, 2-chloro-; 2-Chlor-1,3-butadien (German); 1,3-Chlor-2-butadiene; 2-Chloro-1,3-butadiene; 2-Chlorobuta-1,3-diene; 2-Chlorobutadiene; Chloropren (German); β-Chloroprene; Chloroprène, stabilisé (French); β-Cloropreno (Spanish); Neoprene(polymerized product)

CAS Registry Number: 126-99-8

HSDB Number: 1618

RTECS Number: EI9625000

UN/NA & ERG Number: UN1991 (stabilized)/131 (P)

EC Number: 204-818-0 [*Annex I Index No.:* 602-036-00-8]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal sufficient evidence, human inadequate evidence, *possibly carcinogenic to humans*, Group 2B, 1999; NCI: Carcinogenesis Studies (inhalation); clear evidence: mouse, rat NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen. United States Environmental Protection Agency Gene-Tox Program, Positive: Cell transformation-SA7/SHE; Sperm morphology-rat; Positive: D *melanogaster* sex-linked lethal.

California Proposition 65 Chemical[102]: Cancer 6/2/2000.

Hazard Alert: Highly flammable, Polymerization hazard (nonstabilized), Possible risk of forming tumors, Reproductive toxin: possible risk of gene damage/impaired fertility; Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction).

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.057; Nonwastewater (mg/kg), 0.28

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8010 (50); 8240 (5)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, F, Xn, T; risk phrases: R45; R11; R19; R20/22; R36/37/38; R48/20; R62; R63; safety phrases: S21; S41; S45; S53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Chloroprene is a colorless, flammable liquid possessing a pungent odor. The Odor Threshold is 0.4 milligram per cubic meter[41]. Molecular weight = 88.54; specific gravity (H_2O:1) = 0.96 @ 20°C; boiling point = 59.4°C; freezing/melting point = −130°C; vapor pressure = 188 mmHg @ 20°C; 75 mmHg @ 0.3°C; flash point = −20°C (oc). The explosive limits are: LEL: 1.9%; UEL: 11.3%[17]. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 3, reactivity 1. Slightly soluble in water; solubility = 0.03% @ 20°C.

Potential Exposure: The major use of chloroprene is in the production of artificial rubber (Neoprene, duprene); polychloroprene elastomers. Chloroprene is extremely reactive, e.g., it can polymerize spontaneously at room temperatures; the process being catalyzed by light, peroxides, and other free radical initiators. It can also react with oxygen to form polymeric peroxides and because of its instability, flammability, and toxicity, chloroprene has no end-product uses as such.

Incompatibilities: Can form unstable peroxides; chloroprene may polymerize on standing with fire or explosion hazard. May form explosive mixture with air. Reacts with liquid or gaseous fluorine, alkali metals; metal powders, oxidizers, creating a fire or explosion hazard. Attacks some plastics, rubber, and coatings. May accumulate static electrical charges, and may cause ignition of its vapors.

Permissible Exposure Limits in Air

NIOSH IDLH = 300 ppm, *beta*-chloroprene

Conversion factor: 1 ppm = 3.62 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 25 ppm/90 milligram per cubic meter TWA [skin]

NIOSH REL: 1 ppm/3.6 milligram per cubic meter [15-minute] Ceiling Concentration; Limit exposure to lowest feasible concentration. NIOSH considers this chemical to be a potential occupational carcinogen as defined by the OSHA carcinogen policy [29 CFR 1990]. See *NIOSH Pocket Guide*, Appendix A

ACGIH TLV[1]: 10 ppm/36 milligram per cubic meter TWA [skin]

PAC Ver. 29[138]

PAC-1: 30 ppm

PAC-2: 67 ppm

PAC-3: 400 ppm

DFG MAK: [skin] Carcinogen Category 2

Australia: TWA 10 ppm (35 milligram per cubic meter) [skin], 1993; Austria: MAK 10 ppm (36 milligram per cubic meter), 1999; Belgium: TWA 10 ppm (36 milligram per cubic meter) [skin], 1993; Denmark: TWA 1 ppm (3.6 milligram per cubic meter) [skin], 1999; Finland: TWA 10 ppm (36 milligram per cubic meter); STEL 20 ppm (72 milligram per cubic meter) [skin], 1999; France: VME 10 ppm (36 milligram per cubic meter), 1999; Hungary: TWA 10 milligram per cubic meter; STEL 30 milligram per cubic meter, 1993; the Netherlands: MAC-TGG 18 milligram per cubic meter [skin], 2003; Norway: TWA 1 ppm (3.6 milligram per cubic meter), 1999; Poland: MAC (TWA) 2 milligram per cubic meter; STEL, 16 milligram per cubic meter, 1999; Russia: STEL 0.05 milligram per cubic meter, 1993; Sweden: NGV 10 ppm (35 milligram per cubic meter), KTV 15 ppm (60 milligram per cubic meter) [skin], 1999; Switzerland: MAK-W 10 ppm (36 milligram per cubic meter), KZG-W 20 ppm (72 milligram per cubic meter) [skin], 1999; United Kingdom: TWA 10 ppm (37 milligram per cubic meter) [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 10 ppm [skin]. Russia set a MAC in ambient air in residential areas of 0.02 milligram per cubic meter on a momentary basis and 0.002 milligram per cubic meter on a daily average basis[35]. Several states have set guidelines or standards for chloroprene in ambient air[60] ranging from 2.5 μ/m^3 (Massachusetts) to 175 μ/m^3 (South Carolina) to 350 μ/m^3 (North Dakota) to 420−3500 μ/m^3 (North Carolina) to 800 μ/m^3 (Virginia) to 900 μ/m^3 (Connecticut) to 1070 μ/m^3 (Nevada).

Determination in Air: Charcoal adsorption, workup with CS_2 and analysis by GC. Use NIOSH Analytical Method #1002 or OSHA Analytical Method 112[18].

Permissible Concentration in Water: A MAC in water bodies used for domestic purposes of 0.01 mg/L has been set by Russia[35].

Determination in Water: Octanol−water coefficient: Log K_{ow} = 2.1. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation of vapor, skin absorption; ingestion, and eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Chloroprene irritates the eyes, skin, and respiratory tract. Chloroprene acts as a Primary irritant (w/o allergic reaction) on contact with skin, conjunctiva, and mucous membranes; and may result in dermatitis, conjunctivitis, and circumscribed necrosis of the cornea. Inhalation of high concentrations may result in dizziness, lightheadedness and unconsciousness; anesthesia and respiratory paralysis. Chloroprene may affect the central nervous system; kidneys and liver. The LD_{50} oral rat is only 900 mg/kg (slightly toxic).

Long-Term Exposure: Chronic exposure may produce damage to the lungs, nervous system; liver, kidneys, spleen, and myocardium. Because this is a potential mutagen, handle it as a possible cancer-causing substance-with extreme caution. It may also damage the developing fetus, cause spontaneous abortions; and interfere with sperm production. Repeated or prolonged contact with skin may cause dermatitis. Chronic exposure may cause alopecia. Chloroprene is a potential occupational carcinogen. Temporary hair loss has been reported during the manufacture of polymers.

Points of Attack: Eyes, skin, respiratory system; liver, kidneys.

Medical Surveillance: Preplacement and periodic examinations should include an evaluation of the skin, eyes, respiratory tract, and central nervous system. Liver and kidney function should be evaluated.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Prevent skin contact. **8 hours** (more than 8 hours of resistance to breakthrough >0.1 μg/cm^2/min): polyvinyl alcohol gloves; Viton gloves, suits; Responder suits. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should Wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Engineering controls are recommended in NIOSH Criteria Document: 77-1210.

Respirator Selection: NIOSH *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with chloroprene all handlers should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Chloroprene must be stored to avoid contact with peroxides and other oxidizers, such as permanganates, nitrates, chlorates, and perchlorates, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area at temperatures below 10°C/50°F. Sources of ignition, such as smoking and open flames are prohibited where chloroprene is handled, used, or stored. Metal containers involving the transfer of 5 gal or more of chloroprene should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of chloroprene. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN1991 Chloroprene, stabilized, Hazard Class: 3; Labels: 3-Flammable liquid, 6.1-Poisonous material.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Chloroprene is a flammable liquid. Thermal decomposition products may include hydrogen chloride and phosgene. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. May react with itself without warning, blocking relief valves, and leading to container explosions. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced[22].

References
(109); (102); (31); (2); (173); (101); (138); (100).
National Institute for Occupational Safety and Health (NIOSH), *Criteria for a Recommended Standard: Occupational. Exposure to Chloroprene*, NIOSH Document Number 77-210, Cincinnati, OH (1977).
Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 4, 47–49, New York, Van Nostrand Reinhold Co. (1981).
New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet: Chloroprene*, Trenton, NJ (January 2004).

3-Chloropropionitrile C:1010

Formula: C_3H_4ClN; $ClCH_2CH_2CN$
Synonyms: A13-28526; 1-Chloro-2-cyanoethane; 3-Chloropropanenitrile; 3-Chloropropanonitrile; β-Chloropropionitrile; 3-Chloropropionitrile; Propanenitrile, 3-chloro-; Propionitrile, 3-chloro-
CAS Registry Number: 542-76-7
HSDB Number: 6042
RTECS Number: UG1400000
UN/NA & ERG Number: UN3276 (Nitriles, toxic, n.o.s.)/151
EC Number: 208-827-0
Regulatory Authority and Advisory Information
Hazard Alert: Poison, Flammable, Possible polymerization hazard (nitriles)
Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg).
United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P027
RCRA, 40CFR261, Appendix 8 Hazardous Constituents
Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg)
Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1000 lb (454 kg)
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
Hazard symbols, risk, & safety statements: Hazard symbol: T+; risk phrases: R10; R23; R27/28; R50; safety phrases: S13; S28; S36/37/39; S41; S45 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]
Description: 3-Chloropropionitrile is a combustible, colorless liquid with an acrid odor. Molecular weight = 89.53; specific gravity (H_2O:1) = 1.136 @ 25°C; boiling point = (decomposes) 175–176°C; freezing/melting point = −51°C; vapor pressure = 2.5 mmHg @ 25°C; flash point = 76°C. The explosive limits are: LEL: 19,000; UEL: unknown. Hazard identification (based on NFPA-704 M Rating System): Flammability 2, reactivity 1.
Potential Exposure: This material is used in pharmaceutical manufacture and in polymer synthesis.
Incompatibilities: Contact with strong oxidizers may cause a fire and explosion hazard.
Permissible Exposure Limits in Air
NIOSH REL: (nitriles) 2 ppm, Ceiling Concentration, not to be exceeded in any 15-minute work period.
PAC Ver. 29[138]
PAC-1: 0.23 ppm
PAC-2: 2.5 ppm
PAC-3: 5.4 ppm
Determination in Air: See NIOSH Criteria Document 78-212 *NITRILES*[18]
Permissible Concentration in Water:
Determination in Water: Octanol–water coefficient: Log $K_{ow} = < 2$. Unlikely to bioaccumulate in marine organisms.
Routes of Entry: Inhalation, ingestion, skin contact. This chemical can be absorbed through the skin, thereby increasing exposure.
Harmful Effects and Symptoms
Short-Term Exposure: Symptoms of exposure include rapid and irregular breathing; anxiety, confusion; odor of bitter almonds (on breath or vomitus), nausea; vomiting (if oral exposure), irregular heartbeat; a feeling of tightness in the chest; bright pink coloration of the skin; sweating, protruding eyeballs; dilated pupils; unconsciousness followed by convulsions; involuntary urination and defecation; paralysis and respiratory arrest (heart will beat after breathing stops).

Toxic effects are a result of systemic cyanide poisoning. Few poisons are more rapidly lethal. Average oral lethal dose for hydrogen cyanide is approximately 60–90 mg (corresponds to 200 mg of potassium cyanide). Cause of death is lack of oxygen to the body's cells (especially the brain and heart) as a result of the chemical inhibiting cell enzymes.
Medical Surveillance: Blood cyanide level.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a Medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Use amyl nitrate capsules if symptoms develop. All area employees should be trained regularly in emergency measures for cyanide poisoning and in CPR. A cyanide antidote kit should be kept in the immediate work area and must be rapidly available. Kit ingredients should be replaced every 1–2 years to ensure freshness. Persons trained in the use of this kit; oxygen use, and CPR must be quickly available.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See NIOSH Criteria Document 212 *Nitriles*.

Respirator Selection: *up to 25 milligram per cubic meter:* Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern and having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where 3-Chloropropionitrile may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN3276 Nitriles, liquid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required, Potential Inhalation Hazard (Special Provision 5).

Spill Handling:

Nitrile spill

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.3/0.5
Night 0.5/0.8

Stay upwind. Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Dike far ahead of spill for later disposal. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include cyanides. Use alcohol foam extinguishers and water spray. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full

facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: 3-Chloropropionitrile, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* 3-Chloropropanonitrile, #2711, Trenton, NJ (July 2000).

o-Chlorostyrene C:1020

Formula: C_8H_7Cl; $ClC_6H_4CH{=}CH_2$

Synonyms: Benzene, 1-chloro-2-ethenyl-; 1-Chloro-2-ethenylbenzene; *o*-Chlorostyrene; 2-Chlorostyrene; Chlorostyrene

CAS Registry Number: 2039-87-4

HSDB Number: 3450

RTECS Number: WL4150000

UN/NA & ERG Number: UN1993 (Flammable liquids, n.o.s.)/128

EC Number: 218-026-8

Regulatory Authority and Advisory Information

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xi; risk phrases: R20/22; R36/37/38; R45; R50; safety phrases: S23; S36/37/39; S45; R53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: *o*-Chlorostyrene is a flammable, colorless liquid. Molecular weight = 138.60; specific gravity (H_2O:1) = 1.1; boiling point = 188.8°C; freezing/melting point = −63.3°C; vapor pressure = 0.96 mmHg @ 25°C; flash point = 58.8°C. Practically insoluble in water.

Potential Exposure: In organic synthesis; in the preparation of specialty polymers.

Incompatibilities: Contact with elevated temperatures, strong oxidizers, strong bases; or acids may cause fire or explosion. May form peroxides; explosive polymerization may occur.

Permissible Exposure Limits in Air

OSHA PEL: None

NIOSH REL: 50 ppm/285 milligram per cubic meter TWA; 75 ppm/428 milligram per cubic meter STEL

ACGIH TLV[1]: 50 ppm/283 milligram per cubic meter TWA; 75 ppm/425 milligram per cubic meter STEL

No PAC available

Australia: TWA 50 ppm (285 milligram per cubic meter); STEL 75 ppm (430 milligram per cubic meter), 1993; Austria: MAK 50 ppm (285 milligram per cubic meter), 1999; Belgium: TWA 50 ppm; STEL 75 ppm, 1993; France: VME 50 ppm (285 milligram per cubic meter), 1999; Norway: TWA 25 ppm (140 milligram per cubic meter), 1999; Switzerland: MAK-W 50 ppm (215 milligram per cubic meter), KZG-W 100 ppm (430 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 285 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 75 ppm. Several states have set guidelines or standards for chlorostyrene in ambient air[60] ranging from 2.85−4.30 milligram per cubic meter (North Dakota) to 4.8 milligram per cubic meter (Virginia) to 5.7 milligram per cubic meter (Connecticut) to 6.79 milligram per cubic meter (Nevada).

Determination in Air: No Method listed by NIOSH.

Permissible Concentration in Water: No criteria set.

Determination in Water: Octanol−water coefficient: Log K_{ow} = > 3.5. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: *o*-Chlorostyrene can affect you when breathed in and by passing through your skin. Exposure can irritate the eyes and skin. LD_{50} (50% kill) = 3810 μL/kg, oral, rat.

Long-Term Exposure: Repeated exposures may damage the liver and kidneys. Animal studies show hematuria (blood in the urine), proteinuria, acidosis; enlarged liver, jaundice.

Points of Attack: Eyes, skin, liver, kidneys, central nervous system; peripheral nervous system.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function tests. Nervous system tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece

respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures *over 50* ppm; Use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with *o*-chlorostyrene all handlers should be trained on its proper handling and storage. Before entering confined space where *o*-chlorostyrene may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN1993 Flammable liquids, n.o.s., Hazard Class: 3; Labels: 3-Flammable liquid, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. The heat of fire produces Thermal decomposition products may include hydrogen chloride, chlorine, and phosgene. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet: o*-Chlorostyrene, Trenton, NJ (February 2000).

Chlorosulfonic Acid C:1030

Formula: $ClHO_3S$

Synonyms: Acido clorosulfonico (Spanish); Chlorosulfuric acid; Chlorosulphonic Acid; *p*-Chloro-*o*-toluidine hydrochloride; 4-Chloro-*o*-toluidine, hydrochloride; Monochlorosulfuric acid; Sulfonic acid, monochloride; Sulfuric chlorohydrin

CAS Registry Number: 7790-94-5

HSDB Number: 909

RTECS Number: FX5730000

UN/NA & ERG Number: (PIH) UN1754/137

EC Number: 232-234-6 [*Annex I Index No.:* 016-017-00-1]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade).

Hazard Alert: Poison inhalation hazard: exposure can be lethal, Violently water reactive, Corrosive, Strong oxidizer, Known catalytic activity.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1000 lb (454 kg)

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, C, O, risk phrases: R8; R14; R26; R34; R35; R37; safety phrases: S1/2; S17; S26; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Chlorosulfonic acid is a highly corrosive, colorless to yellow, slightly cloudy, fuming liquid with a sharp odor. Molecular weight = 115.52; boiling point = 155°C;

freezing/melting point = −80°C. Hazard identification (based on NFPA-704 M Rating System): Health 4, flammability 0, reactivity 2 ₩, OX. Reactive with water releasing dense fumes and producing corrosive sulfuric and hydrochloric acid.

Potential Exposure: Used to make pesticides, detergents, pharmaceuticals, dyes, resins, sulfonated oils; intermediate for dyes and pharmaceuticals; and pesticides. Although no military designation has been assigned chlorosulfonic acid may have been used as a choking/pulmonary agent.

Incompatibilities: Explosively reacts with water, forming sulfuric and hydrochloric acid and dense fumes. Dangerously reactive, avoid contact with all other material. Violent reaction with many compounds, including reducing agents; alcohols, chemically active metals; combustible materials, strong acids, alkaline earth sulfides, aluminum carbides, aluminum, amines, calcium sulfide, carbides, chlorine trifluoride, glycerin, hydrides, hydrochloric acid, hydrogen peroxide, hydrogen sulfide, hydroxylamine, magnesium, metal powders, metal sulfides, molybdenum, phenylhydrazine, phosphorous red/friction, phosphorous trichloride, silicon, sulfides, sulfur, sulfur dioxide, sulfur/friction, sulfuric acid, tungsten, hydrogen trisulfide, diphenyl ether, finely divided metals, silver nitrate. Contact with phosphorous may cause fire and explosions. Forms explosive material with ethyl alcohol. Attacks many metals; reaction with steel drums forms explosive hydrogen gas, which must be periodically relieved.

Permissible Exposure Limits in Air

PAC* Ver. 29[138]

PAC-1: **0.10**$_{\mathrm{A}}$ milligram per cubic meter

PAC-2: **4.4**$_{\mathrm{A}}$ milligram per cubic meter

PAC-3: **25**$_{\mathrm{A}}$ milligram per cubic meter

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60-minute values.

United Kingdom: 1 milligram per cubic meter TWA, 2000. Due to its highly corrosive nature, all contact with this material should be reduced to the lowest possible level.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short-Term Exposure: Skin or eye contact can cause severe irritation, burns, and permanent eye damage. Irritates the respiratory tract causing coughing, wheezing, and/or shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. LD$_{50}$ (50% kill): 4779 milligram per cubic meter/4 hour, inhalation, rat.

Long-Term Exposure: Can cause bronchitis with cough, phlegm, and/or shortness of breath.

Points of Attack: Lungs.

Medical Surveillance. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Consider X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Saranex and polyethylene are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is a potential for overexposure: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode).

Storage: Poison inhalation chemical (PIH); check oxygen content prior to entering storage area. (1) Color code—White stripe: Contact Hazard; Store separately; not compatible with materials in solid white category. (2) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location; keep acids away from bases and red, yellow, and blue-coded chemicals. (3) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with chlorosulphonic acid all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from water, acids, bases, alcohols, metal powders; and organic combustible materials. It is preferable to store this chemical under nitrogen.

Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: UN1754 Chlorosulfonic acid (with or without sulfur trioxide), Hazard class: 8; Labels: 8-Corrosive material, 6.1-Poison Inhalation Hazard, Inhalation Hazard Zone B.

Spill Handling:

Chlorosulfonic acid (with or without sulfur trioxide) when spilled on land

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 0.2/0.3

when spilled in water

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.2/0.3

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.5/0.8
Night 1.5/2.4

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Chlorosulphonic acid does not burn but can readily ignite combustible materials on contact and will increase fire activity. Thermal decomposition products may include hydrogen chloride and oxides of sulfur. Decomposes explosively on contact with water. Use dry chemical, carbon dioxide; or foam extinguishers. *Do not use water*. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Chlorosulfonic acid Trenton, NJ (1998).

Chlorothalonil C:1040

Formula: $C_8Cl_4N_2$; $C_6Cl_4(CN)_2$

Synonyms: BB Chlorothalonil; 1,3-Benzenedicarbonitrile,2,4,6,6-tetrachloro-; Bombardier; Bravo; Bravo 500; Bravo 6 F; Bravo-W-75; Chiltern Ole; Chlorothalonil; Chlorthalonil (German); Contact 75; DAC 2787; Daconil; Daconil 2787 fungicide; Daconil 2787 W; Daconil F; Daconil M; Daconil Turf; Dacosoil; 1,3-Dicyanotetrachlorobenzene; Exotherm; Exotherm termil; Forturf; Grouticide 75; Impact Excel; Isophthalonitrile, tetrachloro; Jupital; Metatetrachlorophthalodinitrile; NCI-C00102; Nopcocide; Nopcocide 54DB; Nopcocide *n*-96; Nopocide *n*-40-D; Nopocide *n*-96-S; Nuocide; Power chlorothalonil 50; Repulse; Siclor; Sipcam UK Rover 5000; Sweep; Ter-Mil; 2,4,5,6-Tetrachloro-1,3-benzenedicarbonitrile; 2,4,5,6-Tetrachloro-1,3-dicyanobenzene; Tetrachloroisophthalonitrile; *m*-Tetrachlorophthalodinitrile; Tetrachlorophthalodinitrile, *m*-; Thalonil; TPN; TPN (Pesticide); Tripart Faber; Tripart Ultrafaber

CAS Registry Number: 1897-45-6

HSDB Number: 1546

RTECS Number: NT2600000

UN/NA & ERG Number: UN3276/151; UN2588 (pesticides, solid, toxic, n.o.s.)/155

EC Number: 217-588-1 [*Annex I Index No.:* 608-014-00-4]

Regulatory Authority and Advisory Information

Carcinogenicity: EPA: IARC: Animal Sufficient Evidence, Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B, 1999; NCI: Carcinogenesis Bioassay (feed); clear evidence: rat; no evidence: mouse

California Proposition 65 Chemical[102]: Cancer 1/1/1989.

Hazard Alert: Poison, Combustible, Possible polymerization hazard (nitriles), Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Sensitization hazard (skin), Environmental hazard.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) as cyanide compound

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants as cyanide, total

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as cyanide mixtures

United States Environmental Protection Agency, FIFRA 1998 Status of Pesticides: Supported

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xi, N; risk phrases: R26; R37; R40; R41; R43; R50/53; R62; R63; safety phrases: S1/2; S28; S36/37/39; S45; S60; S61.

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Chlorothalonil is a combustible, white, odorless, crystalline solid. Molecular weight = 265.9; specific gravity (H_2O:1) = 1.8; boiling point = 350°C; freezing/melting point = 260°C; vapor pressure = 1×10^{-3} mmHg @ 20°C. Based on the NFPA-704 M Rating System: Health 3, flammability 1, reactivity 0. Insoluble in water.

Potential Exposure: Chlorothalonil is a broad spectrum fungicide; used as fungicide in coatings; caulk, wood preservative, and antifouling systems. Therefore, people involved in its manufacture, formulation, and application can be exposed.

Incompatibilities: Contact with strong oxidizers may cause a fire and explosion hazard. Thermal decomposition may include fumes of hydrogen cyanide. Nitriles may polymerize in the presence of metals and some metal compounds. They are incompatible with acids; mixing nitriles with strong oxidizing acids can lead to extremely violent reactions. Nitriles are generally incompatible with other oxidizing agents such as peroxides and epoxides. The combination of bases and nitriles can produce hydrogen cyanide. Nitriles are hydrolyzed in both aqueous acid and base to give carboxylic acids (or salts of carboxylic acids). These reactions generate heat. Peroxides convert nitriles to amides. Nitriles can react vigorously with reducing agents. Acetonitrile and propionitrile are soluble in water, but nitriles higher than propionitrile have low aqueous solubility. They are also insoluble in aqueous acids[101].

Permissible Exposure Limits in Air

NIOSH REL: Danger of sensitization of the skin; Carcinogen level 3B

NIOSH REL: *Nitriles:* 2 ppm, Ceiling Concentration, not to be exceeded in any 15-minute work period.

PAC Ver. 29[138]

PAC-1: 0.13 milligram per cubic meter

PAC-2: 1.4 milligram per cubic meter

PAC-3: 8.6 milligram per cubic meter

DFG MAK: Danger of sensitization of the skin; Carcinogen level 3B

Austria: Suspected: carcinogen, 1999

Determination in Air: See NIOSH Criteria Document 78-212 *Nitriles*[18]

Permissible Concentration in Water: Because nitriles do not release cyanide ions, they are generally less toxic.

Determination in Water: Analysis of chlorothalonil is by a GC method applicable to the determination of certain chlorinated pesticides in water samples. In this method, approximately 1 L of sample is extracted with methylene chloride. The extract is concentrated and the compounds are separated using capillary column GC. Measurement is made using an electron capture detector. The method detection limit has not been determined for chlorothalonil, but it is estimated that the detection limits for analytes included in this method are in the range of 0.01−0.1 μg/L. Octanol−water coefficient: Log K_{ow} = > 4. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood. Fish Tox = 4.41591000 ppb MATC (HIGH).

Routes of Entry: Inhalation, skin contact.

Harmful Effects and Symptoms

Wilson et al. (1985) gave chlorothalonil (98.1% pure with less than 0.03% hexachlorobenzene) to Fischer 344 rats (60/sex/dose) in their diet at dose levels of 0, 40, 80 or 175 mg/kg/day. Males were treated for 116 weeks, while females received the chemical for 129 weeks. Survival among the various groups was comparable. In both sexes, at the high dose level, there were significant decreases in body weights. In addition, there were also significant increases in blood urea nitrogen and creatinine, while there were decreases in serum glucose and albumin levels. In both sexes, there were dose-dependent increases in kidney carcinomas and adenomas at doses above 40 mg/kg/day. In the high-dose females, there was also a significant increase in stomach papillomas. The data show that, in the Fischer 344 rat, chlorothalonil is a carcinogen[208]. The oral LD_{50} (oral-rat) = 10 g/kg. LC_{50} (inhal-rat) = 310 milligram per cubic meter/1 hour.

Short-Term Exposure: Irritates the eyes, skin, respiratory tract. Inhalation can cause coughing, phlegm, and/or tightness in the chest. Human Tox = 45.69190 ppb CHCL (Chronic Human Carcinogen Level) (INTERMEDIATE).

Long-Term Exposure: Repeated or prolonged contact with skin may cause nose bleeding, skin sensitization, and dermatitis with skin rash. May affect the kidneys and gastrointestinal tract. This chemical causes cancer of the kidneys in animals. See NIOSH Criteria Document 212 *Nitriles*.

Points of Attack: Skin, lungs, kidneys.

Medical Surveillance: CBC. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 20−30 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See NIOSH Criteria Document 212 *Nitriles*.

Respirator Selection: *Where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with chlorothalonil all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping:. UN3276 Nitriles, liquid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required, Potential Inhalation Hazard (Special Provision 5). UN2588 Pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required

Spill Handling:

Nitriles spill

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.3/0.5
Night 0.5/0.8

Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Dampen spilled material with toluene to avoid dust collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Soil Adsorption Index (K_{oc}) = 1380.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include hydrogen cyanide, hydrogen chloride, and nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters.

Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration in a unit operating @ 850°C equipped with off-gas scrubbing equipment.

References

(102); (31); (173); (101); (138); (80); (100); (207); (208).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Chlorothalonil, Trenton, NJ (April 1998).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Chlorothalonil, Washington, DC, Office of Drinking Water (August 1987).

o-Chlorotoluene C:1050

Formula: C_7H_7Cl; $CH_3C_6H_4Cl$

Synonyms: Benzene, 1-chloro-2-methyl-; 2-Chloro-1-methylbenzene; 2-Chlorotoluene; 1-Methyl-2-chlorobenzene; 2-Methylchlorobenzene; Toluene, *o*-chloro-; *o*-Tolylchloride

m-isomer: 1-Chloro-3-methylbenzene; 3-Chloro-1-methylbenzene; 3-Chlorotoluene; *m*-Methylchlorobenzene; 1-Methyl-3-chlorobenzene; 3-Methylchlorobenzene; *m*-Tolylchloride; *meta*-Chlorotoluene; *meta*-Tolylchloride; Toluene, *m*-chloro-

p-isomer: 1-Chloro-4-methylbenzene; 4-Chloro-1-methylbenzene; 4-Chlorotoluene; *p*-Methylchlorobenzene; 1-Methyl-4-chlorobenzene; 4-Methylchlorobenzene; *p*-Tolyl chloride; *para*-Chlorotoluene; *para*-Tolyl chloride; Toluene, *p*-chloro-

CAS Registry Number: 95-49-8 (*o*-);108-41-8 (*m*-); 106-43-4 (*p*-)

HSDB Number: 5291 (*o*-); 5291 (*m*-); 1343 (*p*-)

RTECS Number: XS9000000

UN/NA & ERG Number: UN2238 (Chlorotoluenes)/129

EC Number: 202-424-3 (2-, 3-, and 4-chlorotoluene) [*Annex I Index No.:* 602-040-00-X]

Regulatory Authority and Advisory Information

Hazard Alert: Flammable, Primary irritant (w/o allergic reaction), Environmental hazard.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) (*m- & p*-isomers removed 2015)

Hazard symbols, risk, & safety statements: (2-, 3-, and 4-chlorotoluene) Hazard symbol: F, Xn, N; risk phrases: R10; R20; R23/24/25; R51/53; safety phrases: S2; S24/25; S41; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: *o*-Chlorotoluene is a flammable, colorless liquid with an aromatic odor. Molecular weight = 126.59; boiling point = 160°C; freezing/melting point = −35°C; vapor pressure = 4 mmHg @ 25°C; flash point = 52°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 2, reactivity 1. Practically insoluble in water; solubility = 0.009% @ 25°C.

Potential Exposure: *o*-Chlorotoluene is widely used as a solvent and intermediate in the synthesis of dyes, synthetic rubber; pharmaceuticals; and other organic chemicals. Used as an insecticide, bactericide.

Incompatibilities: Incompatible with acids, alkalis, oxidizers, reducing materials; water.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 5.18 milligram per cubic meter @ 25°C & 1 atm

Odor Threshold = 0.32 ppm.

OSHA PEL: None

NIOSH REL: 50 ppm/250 milligram per cubic meter TWA; 75 ppm/375 milligram per cubic meter STEL

ACGIH TLV[1]: 50 ppm TWA

(o-)

PAC Ver. 29[138]

PAC-1: 75 ppm

PAC-2: 310 ppm

PAC-3: 1800 ppm

This chemical can be absorbed through the skin, thereby increasing exposure.

Australia: TWA 50 ppm (250 milligram per cubic meter); STEL 75 ppm, 1993; Austria: MAK 50 ppm (250 milligram per cubic meter), 1999; Belgium: TWA 50 ppm (259 milligram per cubic meter); STEL 75 ppm (388 milligram per cubic meter), 1993; Denmark: TWA 50 ppm (285 milligram per cubic meter) [skin], 1999; Finland: TWA 50 ppm (260 milligram per cubic meter); STEL 75 ppm (390 milligram per cubic meter) [skin], 1999; France: VME 50 ppm (250 milligram per cubic meter), 1999; Norway: TWA 25 ppm (125 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 250 milligram per cubic meter [skin], 2003; Russia: STEL 10 milligram per cubic meter [skin], 1993; Sweden: carcinogen, 1999; Switzerland: MAK-W 50 ppm (250 milligram per cubic meter) [skin], 1999; United Kingdom: TWA 50 ppm (264 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, KORE, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 50 ppm. Several states have set guidelines or standards for chlorotoluene in ambient air[60] ranging from 2.5−3.75 milligram per cubic meter (North Dakota) to 4.0 milligram per cubic meter (Virginia) to 5.0 milligram per cubic meter (Connecticut) to 5.95 milligram per cubic meter (Nevada).

106-43-4, (*p*-)

PAC Ver. 29[138]
PAC-1: 1.2 ppm
PAC-2: 13 ppm
PAC-3: 80 ppm

Determination in Air: No Methods listed by NIOSH or OSHA.

Permissible Concentration in Water: No criteria set, but EPA[32] has suggested a permissible ambient goal of 3450 μg/L based on health effects.

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Contact can irritate and burn the eyes and skin. Inhalation can irritate the respiratory tract, causing coughing, and/or shortness of breath. High exposure can cause dizziness, loss of coordination; convulsions and coma. Vasodilatation, labored respiration; and narcosis have been observed in test animals.

Long-Term Exposure: May affect the liver and kidneys.

Points of Attack: Eyes, skin, respiratory system; central nervous system; liver, kidneys. Prolonged or repeated contact may cause dermatitis.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: liver function tests. Kidney function tests. Examination by a dermatologist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek Medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear solvent-resistant gloves and clothing to prevent any reasonable probability of skin or eye contact. Prevent skin contact. **8 hours** (more than 8 hours of resistance to breakthrough >0.1 μg/cm^2/min): Barricade-coated suits; **4 hours** (At least 4 but <8 hours of resistance to breakthrough >0.1 μg/cm^2/min): Viton gloves, suits. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures *over 50* ppm; Use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece respirator with an organic vapor cartridge/canister. Increased protection is obtained from full facepiece PAPRs.

Where there is potential for high exposures exists, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with *o*-Chlorotoluene all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2238 Chlorotoluenes, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include chlorine. Use dry chemical, carbon dioxide; alcohol foam; or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify

downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR165 recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet: o*-Chlorotoluene, Trenton, NJ (November 1998).

Chloroxuron C:1060

Formula: $C_{15}H_{15}ClN_2O_2$: $(CH_3)_2NCONHC_6H_4OC_6H_4Cl$

Synonyms: C1983; *N*′-[4-(4-Chlorophenoxy)phenyl]-*N*,*N*-dimethylurea; 3-[*p*-(*p*-Chlorophenoxy)phenyl-1,1]-dimethylurea; 3-[4-(4-Chlorophenoxy)phenyl]-1,1-dimethylurea; Chloroxifenidum; Ciba 1983; Cloroxuron (Spanish); Norex; Tenoran; Urea, 3-[*p*-(*p*-chlorophenoxy)phenyl]-1,1-dimethyl-; Urea, *N*′-[4-(4-chlorophenoxy)phenyl]-*N*,*N*-dimethyl-

CAS Registry Number: 1982-47-4

HSDB Number: 980

RTECS Number: YS6125000

UN/NA & ERG Number: UN2767 (Phenyl urea pesticides, solid, toxic)/151

EC Number: 217-843-7

Regulatory Authority and Advisory Information

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 500 lb (227 kg).

Hazard symbols, risk, & safety statements: Hazard symbol: N; risk phrases: R50/53; safety phrases: S22; S26; S45; S60/61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Chloroxuron is a combustible, colorless crystalline solid. Molecular weight = 290.77; freezing/melting point = 15.5°C; vapor pressure = 3.9×10^{-9} mmHg @ 20°C. Practically insoluble in water.

Potential Exposure: A potential danger to those involved in the manufacture, formulation, and application of chloroxuron for use as a selective pre- and early postemergency herbicide in soybeans, strawberries; various vegetable crops, and ornamentals. It is a root- and foliage-absorbed herbicide selective in leek, celery, onion, carrot, and strawberry.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 0.91 milligram per cubic meter

PAC-2: 10 milligram per cubic meter

PAC-3: 68 milligram per cubic meter

Determination in Water: Octanol−water coefficient: Log K_{ow} = ~4. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood. Fish Tox: 49.75254000 ppb MATC (INTERMEDIATE).

Routes of Entry: Ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Slightly irritating to eyes and skin. The LD_{50} oral (dog) is 10 mg/kg (highly toxic). The LD_{50} oral (rat) is 3700 mg/kg. Chloroxuron is stated to be highly toxic to humans by ingestion and under certain conditions, it can form carcinogenic dimethylnitrosamine. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Long-Term Exposure: No data available. Human Tox: 35.00000 ppb Health advisory: (INTERMEDIATE).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a Medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and

face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator:

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with Chloroxuron all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: UN2767 Phenylurea pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Do not touch spilled material; stop leak if you can do it without risk. Use water spray to reduce vapors. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. *Large spills:* dike far ahead of spill for later disposal. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Soil Adsorption Index (K_{oc}) = 3000.

Fire Extinguishing: This chemical is a combustible solid. Thermal decomposition products may include oxides of nitrogen and carbon, and corrosive fumes of hydrogen chloride (HCl). Use dry chemical, carbon dioxide; water spray; or standard foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incinerate in a unit with effluent gas scrubbing[22]. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Chloroxuron, Washington, DC, Chemical Emergency Preparedness Program (October 31, 1985).

Chlorpyrifos C:1070

Formula: $C_9H_{11}Cl_3NO_3PS$

Synonyms: Brodan; α-Chlorpyrifos 48EC (a); Chlorpyrifos-ethyl; Clorpirifos (Spanish); Detmol U.A.; *O*,*O*-Diaethyl-*O*-3,5,6-trichlor-2-pyridylmonothiophosphat (German); *O*,*O*-Diethyl; *O*,*O*-Dimethyl *O*-(3,5,6-trichloro-2-pyridinyl) phosphorothioate; Dowco 179; Dursban; Dursban 4; Dursban 5G; Dursban F; EF 121; ENT 27311; Eradex; Global Crawling insect bait; Lorsban; Murphy Super Root Guard; Phosphorothioic acid, *O*,*O*-diethyl *O*-(3,5,6-trichloro-2-pyridinyl) ester; 2-Pyridinol, 3,5,6-trichloro-, *O*-ester with *O*,*O*-diethyl phosphorothioate; Pyrinex; Spannit; Talon; *O*-3,5,6-Trichloro-2-pyridyl phosphorothioate; Twinspan

CAS Registry Number: 2921-88-2

HSDB Number: 389

RTECS Number: TF6300000

UN/NA & ERG Number: (PIH) UN2783 (organophosphorus pesticides, solid, toxic)/152; UN3018 (organophosphorus pesticide, liquid, n.o.s.)/152

EC Number: 220-864-4 [*Annex I Index No.:* 015-084-00-4]

Regulatory Authority and Advisory Information

Hazard Alert: Poison inhalation hazard, Neurotoxin (cumulative), Suspected of causing genetic defects, Suspected reprotoxic hazard, Environmental hazard.

United States Environmental Protection Agency, FIFRA 1998 Status of Pesticides: Supported

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg)

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), severe pollutant

United States DOT 49CFR172.101, Inhalation Hazardous Chemical, as organic phosphate, Substance ID: EDF-041

Canada, Drinking Water Quality MAC = 0.09 mg/L.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R24/25; R33; R50/53; R62; R63; safety phrases: S1/2; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Chlorpyrifos is a colorless crystalline compound (liquid @ 43°C and commercial formulations may be combined with combustible liquids) with a mild mercaptan odor. The odor is also described as like natural gas. Boiling point = (decomposes) 160°C; molecular weight = 350.59; specific gravity (H_2O:1) = 1.40 (liquid @ 43°C); freezing/melting point = 42.2°C; vapor pressure = 0.00003 mmHg @ 25°C. Insoluble in water. Reacts with water and most reactive hydrogen compounds.

Potential Exposure: A potential danger to those involved in the manufacture, formulation, and application of this insecticide.

Incompatibilities: Above 130°C this chemical may undergo violent exothermic decomposition. The substance decomposes on heating at approximately 160°C and on burning, producing toxic and corrosive fumes including hydrogen chloride, nitrogen oxides; phosphorous oxides, sulfur oxides. Reacts with strong acids; strong bases; causing hydrolysis. Attacks copper and brass. Contact with oxidizers may cause the release of phosphorous oxides. Contact with strong reducing agents, such as hydrides, may cause the formation of flammable and toxic phosphine gas.

Permissible Exposure Limits in Air

OSHA PEL: None

NIOSH REL: 0.2 milligram per cubic meter TWA; 0.6 milligram per cubic meter STEL

ACGIH TLV[1]: 0.1 milligram per cubic meter TWA inhalable fraction and vapor [skin]; not classifiable as a human carcinogen; BEI issued. (2000)

PAC Ver. 29[138]

PAC-1: 0.6 milligram per cubic meter

PAC-2: 15 milligram per cubic meter

PAC-3: 44 milligram per cubic meter

Australia: TWA 0.2 milligram per cubic meter; STEL 0.6 milligram per cubic meter [skin], 1993; Belgium: TWA 0.2 milligram per cubic meter; STEL 0.6 milligram per cubic meter [skin], 1993; Denmark: TWA 0.2 milligram per cubic meter [skin], 1999; Finland: TWA 0.2 milligram per cubic meter; STEL 0.6 milligram per cubic meter [skin], 1999; France: VME 0.2 milligram per cubic meter [skin], 1999; Norway: TWA 0.2 milligram per cubic meter, 1999; Poland: TWA 0.2 milligram per cubic meter; STEL 0.6 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 0.2 milligram per cubic meter [skin], 2003; United Kingdom: TWA 0.2 milligram per cubic meter; STEL 0.6 milligram per cubic meter [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Several states have set guidelines or standards for chlorpyrifos in ambient air[60] ranging from 2−6 μ/m^3 (North Dakota) to 3.0 μ/m^3 (Virginia) to 4.0 μ/m^3 (Connecticut) to 5 μ/m^3 (Nevada).

Determination in Air: OSHA versatile sampler-2; Toluene/Acetone; GC/Flame photometric detection for sulfur, nitrogen, or phosphorus; NIOSH Analytical Method (IV) #5600, Organophosphorus Pesticides, or OSHA Analytical Method 62.

Permissible Concentration in Water: Mexico[35] has set a limit of 3.0 μg/L in coastal waters and 0.03 mg/L in estuaries. Russia set a MAC in water bodies used for fishery purposes of 5.0 μg/L.

Determination in Water: Fish Tox = 0.3666 ppb MATC (Low); Octanol−water coefficient: Log $K_{ow} = \sim 5$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Skin absorption, inhalation of dust, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: May cause eye and skin irritation. Cholinesterase inhibitor. Exposure at high levels may result in death. The effects may be delayed. The LD_{50} rat is 82 mg/kg (moderately toxic). Chlorpyrifos can affect you when breathed in and quickly enters the body be passing through the skin. Severe poisoning can occur from skin contact. It is a moderately toxic organophosphate chemical. Exposure can cause rapid severe poisoning with headache, sweating, nausea and vomiting, diarrhea, loss of coordination; and possible death.

Long-Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. Chlorpyrifos may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage. Human Tox = 20 ppb; Health advisory: (INTERMEDIATE).

Points of Attack: Respiratory system; central nervous system; peripheral nervous system; plasma cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When Cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of “normal.” Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider CBC. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended.

Personal Protective Methods: *Clothing:* Avoid skin contact with chlorpyrifos. Wear protective gloves and clothing. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. *Eye Protection:* Wear splash-proof chemical goggles and face shield when working with liquid, unless full facepiece respiratory protection is worn. Wear dust-proof goggles and face shield when working with powders or dust, unless full facepiece respiratory protection is worn.

Respirator Selection: Where there is potential exists for Exposures over *0.2 milligram per cubic meter*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece respirator with a pesticide cartridge. Greater protection is provided by a powered-APR. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with chlorpyrifos all handlers should be trained on its proper handling and storage. Chlorpyrifos must be stored to avoid contact with strong bases; or acids, or acid fumes, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from sources of heat.

Shipping: UN2783 Organo phosphorus pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN3018 Organophosphorus pesticides, liquid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling:

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.3/0.4
Night 0.8/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 600/200
Then: Protect persons downwind (mi/km)
Day 1.4/2.3
Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Do not touch spilled material. Do not breathe vapors. Stay upwind; keep out of low areas. Remove all ignition sources. Ventilate area of spill or leak. This material is a combustible liquid. For a spill or leak of a combustible liquid, shut off ignition sources; no flares, smoking, or flames in hazard area. Stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Chlorpyrifos may burn, but does not readily ignite. Thermal decomposition products may include oxides of phosphorus, sulfur, nitrogen, and carbon. Use dry chemical, carbon dioxide; water spray; or standard foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Heat above 130°C may cause violent exothermic reaction. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: This compound is 50% hydrolyzed in aqueous MeOH solution at pH 6 in 1930 days; and in 7.2 days at pH 9.96. Spray mixtures of $<1\%$ concentration are destroyed with an excess of 5.25% sodium hypochlorite in <30 minutes @ 100°C; and in 24 hours @ 30°C. Concentrated (61.5%) mixtures are essentially destroyed by treatment with 100:1 volumes of the above sodium hypochlorite solution and steam in 10 minutes[22]. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References
(31); (173); (101); (138); (80); (100).
New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet: Chlorpyrifos*, Trenton, NJ (July 2002).

Chlorpyrifos-methyl C:1073

Formula: $C_7H_7Cl_3NO_3PS$
Synonyms: Chorpirifosmetil (Spanish); Chlormethylfos; *O,O*-Dimethyl O-(3,5,6-trichloro-2-pyridyl)phosophorothioate; DOWCO-217; Dursban methyl; ENT 27,520; Methyl chlorpyrifos; Methyl dursban; Noltran; NSC-60380; OMS 1155; Phosphorothioic acid, *O,O*-dimethyl *O*-(3,5,6-trichloro-2-pyridyl)ester; Reldan; Reldane; Storcide; Trichlormethylfos; Zertell
CAS Registry Number: 5598-13-0
HSDB Number: 6981
RTE CS Number: TG0700000
UN/NA & ERG Number: UN2783 (organophosphorus pesticide, solid, n.o.s.)/152; UN3018 (organophosphorus pesticide, liquid, n.o.s.)/152
EC Number: 227-011-5 [*Annex I Index No.:* 015-186-00-9]
Regulatory Authority and Advisory Information
Hazard Alert: Poison inhalation hazard, Neurotoxin (cumulative), Possible sensitization hazard (skin).
United States DOT 49CFR172.101, Inhalation Hazard Chemical as organophosphates
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%
Hazard symbols, risk, & safety statements: Hazard symbol: Xi, N; risk phrases: R33; R43; R50/53; safety phrases: S2; S36/37; S60; S61; S41 (see Appendix 4).
WGK[100] (Germ an Aquatic Hazard Class): 3-Severe hazard to waters *as Chlorpyrifos*
Description: White or amber crystalline solid. May be dissolved in a flammable or combustible carrier solvent. Molecular weight = 327.5; specific gravity (H_2O:1) = 1.64; freezing/melting point = 46°C; vapor pressure = 4.2×10^{-5} mmHg @ 25°C; specific gravity (H_2O:1) = 1.39 @ 50°C. Low solubility in water; solubility = 5 mg/L. Physical and toxicological properties may be affected by the carrier solvents used in commercial formulations.
Potential Exposure: Chlorpyrifos-methyl is a general use organophosphate insecticide for use on stored grain (for protection of stored food, feed oil, and seed grains against injury from stored grain weevils, moths, borers, beetles, and mealworms including granary weevil, rice weevil, red flour beetle, confused flour beetle, saw-toothed grain beetle, Indian meal moth, and Angoumois grain moth, lessor grain borers), seed treatment, grain bin, and warehouse[14].
Incompatibilities: Strong oxidizers, strong acids, and alkalies. In the presence of strong reducing agents such as hydrides, organophosphates form highly toxic and flammable phosphine gas. Contact with oxidizers can cause the release of toxic oxides of phosphorus. Corrosive to copper, brass, iron, and tin plate[88].
Permissible Exposure Limits in Air: No standards established.
Determination in Air: OSHA versatile sampler-2; Toluene/Acetone; GC/Flame ionization detection; NIOSH IV, Method #5600, Organophosphorus Pesticides[18].
Determination in Water: Octanol–water coefficient: Log K_{ow} = > 4.0. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood. Fish toxicity (threshold)[101]: High—1.02425 ppb, MATC.
Harmful Effects and Symptoms
Organophosphates are highly toxic. Symptoms may develop rapidly, or there may be a delay of several hours following exposure before they become noticeable. The delay tends to be longer in the case of some compounds that dissolve fats, lipids, oils, and nonpolar solvents such as toluene. Symptoms may increase in severity for more than a single day and last for several days. In severe cases of organophosphate intoxication, respiratory failure may occur.
Short-Term Exposure: Eye pupils are small; blurred vision; eye watering; runny nose; cough; shortness of breath; salivation; dizziness; nausea, stomach cramps, diarrhea, and vomiting; increased blood pressure; profuse sweating; hypermotility, hallucinations; irritability; tingling of the skin; drowsiness; slow heartbeat; convulsions; fluid in lungs; loss of consciousness; incontinence; breathing stops; death. Organophosphates inhibit the action of acetylcholinesterase enzymes and alter the way in which nervous impulses are transmitted. The effects can last for hours, days, or much longer. The action of the enzymes is reestablished after new enzymes are formed. LD_{50} (oral, rat) = 1500–18508 mg/kg; LD_{50} (dermal, rat) = > 3500 mg/kg.
Long-Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. Organophosphates may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver, cardiovascular, and blood damage. Skin sensitizer. Some studies findings support the hypothesis that organophosphates, including chlorpyrifos and its metabolites may contribute to ADHD and learning disabilities in children. Human toxicity (long term)[101]: Low—70.00 ppb, Health advisory.
Points of Attack: Skin. Respiratory system, central nervous system, cardiovascular system, blood cholinesterase.
Medical Surveillance: Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. Routine biological monitoring of pesticide applicators and field workers includes testing of plasma and red blood cell acetylcholinesterase levels (for enzyme poisoned by this chemical). These tests are normally accurate only if done within about 2 hours of exposure. If Exposure stops, plasma levels return

to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When acetylcholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate pesticides is recommended until enzyme levels recover. Do not drink any alcoholic beverages before or during use as it promotes absorption of organophosphates. Evaluation by a qualified allergist, including exposure history and testing, may help diagnose allergy.

First Aid: **Treatment for organophosphate poisoning consists of thorough decontamination, cardiorespiratory support, and administration of the antidotes atropine and pralidoxime. In cases of severe poisoning, diazepam, an anticonvulsant, should also be administered. Antidotes should be administered as prevention even if the diagnosis is in doubt**. Speed in removing material from eyes and skin is of extreme importance. *Eyes:* Eye contact can cause dangerous amounts of these chemicals to be quickly absorbed through the mucous membrane into the bloodstream. Immediately and gently flush eyes with plenty of warm or cold water (NO hot water) for at least 15 minutes, occasionally lifting the upper and lower eyelids. Get medical aid immediately. *Skin:* Get medical aid. Dermal contact can cause dangerous amounts of these chemicals to be absorbed into the bloodstream. Wearing the appropriate PPE equipment and respirator for organophosphate/carbamate pesticides, immediately flush skin with plenty of soap and water for at least 15 minutes while removing contaminated clothing and shoes. Shampoo hair promptly if contaminated. The removed, contaminated clothing and shoes should be double-bagged and left in Hot Zone for later disposal by hazardous materials experts. Skin may also be decontaminated with diluted hypochlorite solution. *Inhalation:* Get medical aid. Do not contaminate yourself. Wearing the appropriate PPE equipment and respirator for organophosphate pesticides, immediately remove the victim from the contaminated area to fresh air. If the victim is not breathing, administer artificial respiration. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. If breathing is difficult, administer oxygen through bag/mask apparatus until medical help arrives. Do not leave victim unattended. *Ingestion:* Call poison control. Loosen all clothing. Never give anything by mouth to an unconscious person. If victim is *unconscious or having convulsions*, do nothing except keep victim warm. Get medical aid. Transfer promptly to a medical facility. In cases of ingestion, **do not induce vomiting**. If the victim is alert and asymptomatic, administer a slurry of activated charcoal at a dose of 1 g/kg (infant, child, and adult dose). A soda can and straw may be of assistance when offering charcoal to a child. *In some cases you may be specifically instructed by poison control to induce vomiting by way of 2 tablespoons of syrup of ipecac (adult) washed down with a cup of water*. Do NOT give activated charcoal before or with ipecac syrup.

Note to physician or authorized medical personnel: Treat cases of respiratory compromise, coma, or excessive pulmonary secretions with respiratory support using protocols and techniques available and within the scope of training. Some cases may necessitate procedures such as endotracheal intubation or cricothyrotomy by properly trained and equipped personnel. When possible, atropine (see *Antidotes*, below) should be given under medical supervision. Patients who are comatose, hypotensive, or having seizures or cardiac arrhythmias should be treated according to advanced life support protocols. *Antidotes:* Two antidotes are administered to treat organophosphate poisoning. Atropine is a competitive antagonist of acetylcholine at muscarinic receptors and is used to control the excessive bronchial secretions which are often responsible for death. Pralidoxime relieves both the nicotinic and muscarine effects of organophosphate poisoning by regenerating acetylcholinesterase and can reduce both the bronchial secretions and the muscle weakness associated with poisoning. The initial intravenous dose of atropine in adults should be determined by the severity of symptoms: An initial adult dose of 1.0 to 2.0 mg or pediatric dose of 0.01 mg/kg (minimum 0.01 mg) should be administered intravenously. If intravenous access cannot be established, atropine may also be given intramuscularly, subcutaneously or via endotracheal tube. Doses should be repeated every 15 minutes until excessive secretions and sweating have been controlled. Once bronchial secretion has been controlled, atropine administration should be repeated whenever the secretions begin to recur. In seriously poisoned patients, very large doses may be required. Alterations of pulse rate and pupillary size should not be used as indicators of treatment adequacy. Pralidoxime should be administered as early in poisoning as possible as its efficacy may diminish when given more than 24 to 36 hours after exposure. Doses are as follows: adult 1.0 g; pediatric 25 to 50 mg/kg. The drug should be administered intravenously over 30 to 60 minutes, but in a life-threatening situation, one-half of the total dose can be given per minute for a total administration time of 2 minutes. Treatment should begin to take effect within 40 minutes with a reduction in symptoms and the amount of atropine necessary to control bronchial secretion. The initial dose can be repeated in 1 hour and then every 8 to 12 hours until the patient is clinically well and no longer requires atropine. If intravenous access cannot be established, pralidoxime may also be given intramuscularly. Early administration of diazepam in addition to the combined atropine and pralidoxime treatment may help prevent the onset of seizures and potential brain and cardiac morphologic damage following high-level organophosphate poisoning.

Personal Protective Methods: *Clothing:* Avoid dermal contact with chlorpyrifos. Wear protective gloves and clothing.

Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. *Eye Protection:* Wear splash-proof chemical goggles and face shield when working with liquid, unless full facepiece respiratory protection is worn. Wear dust-proof goggles and face shield when working with powders or dust, unless full facepiece respiratory protection is worn.

Respirator Selection: Where there is potential exists for Exposures over *0.2 milligram per cubic meter*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece respirator with a pesticide cartridge. Greater protection is provided by a powered-APR. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison. Store in a secure poison location. Prior to working with chlorpyrifos all handlers should be trained on its proper handling and storage. Chlorpyrifos must be stored to avoid contact with strong bases; or acids, or acid fumes, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from sources of heat.

Shipping: UN2783 Organophosphorus pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN3018 Organophosphorus pesticides, liquid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling:

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.3/0.4
Night 0.8/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 600/200
Then: Protect persons downwind (mi/km)
Day 1.4/2.3
Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Do not touch spilled material. Do not breathe vapors. Stay upwind; keep out of low areas. Remove all ignition sources. Ventilate area of spill or leak. This material is a combustible liquid. For a spill or leak of a combustible liquid, shut off ignition sources; no flares, smoking, or flames in hazard area. Stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include hydrogen chloride and oxides of phosphorus, sulfur, nitrogen, and carbon. This chemical may burn, but does not readily ignite. Use dry chemical, carbon dioxide; water spray; or standard foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Heat above 130°C may cause violent exothermic reaction. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: This compound is 50% hydrolyzed in aqueous methanol solution @ pH 6 in 1930 days; and in 7.2 days at pH 9.96. Spray mixtures of $<1\%$ concentration are destroyed with an excess of 5.25% sodium hypochlorite in <30 minutes @ 100°C; and in 24 hours @ 30°C. Concentrated (61.5%) mixtures are essentially destroyed by treatment with 100:1 volumes of the above sodium hypochlorite solution and steam in 10 minutes. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, "Reregistration Chlorpyrifos-methyl Facts," Office of Prevention, Pesticides and Toxic Substances, Washington, DC (October 2000). http://www.epa.gov/REDs/factsheets/cpm_fs.htm.

Chlorsulfuron C:1077

Formula: $C_{12}H_{12}ClN_5O_4S$

Synonyms: Benzenesulfonamide, 2-Chloro-*N*-[((4-methoxy-6-methyl-1,3,5-triazin-2-yl)amino)carbonyl]-; **Chlorsulfuron**; 2-Chloro-*N*-[((4-methoxy-6-methyl-1,3,5-triazin-2-yl)amino) carbonyl]benzenesulfonamide; 2-Chloro-*N*-[(4-methoxy-6-methyl-1,3,5-triazin-2-yl)aminocarbonyl]-benzenesulfonamide; 1-[(*O*-Chlorophenyl)sulfonyl]-3-(4-methoxy-6-methyl-*S*-triazin-2-yl)urea; DPX 4189; Finesse; Glean; Glean 20df; Landmark MP; Lasher; Riverdale Corsair; Telar DF; Urea, 1-[(O-chlorophenyl)sulfonyl]-3-(4-methoxy-6-methyl-*S*-triazin-2-yl)-

CAS Registry Number: 64902-72-3

HSDB Number: 6847

RTECS Number: YS6640000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 265-268-5 [*Annex I Index No.:* 613-121-00-4]

Regulatory Authority and Advisory Information

Carcinogenicity: EPA Group E, Evidence of noncarcinogenicity for humans.

California Proposition 65 Chemical[102]: Developmental, male, female, 5/14/1999; *delisted 6/6/2014*

Hazard Alert: Environmental hazard, Agricultural chemical.

Potential Ground water Pollutant [California FAC Section 13145(d)/12811, active]

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: N; risk phrases: R50/53; safety phrases: S29/35; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Colorless, odorless crystals. Molecular weight = 357.79; freezing/melting point = 176°C; decomposes @ 192°C; vapor pressure = 4.6×10^{-6} mmHg @ 20°C Soluble in water; solubility = 113 mg/L @ 25°C. Slowly hydrolyzes in water, releasing ammonia fumes and forming acetate salts.

Potential Exposure: A selective systemic sulfonylurea herbicide used to control most broadleaf weeds and some annual grasses in wheat, barley, oats, duram, rye, triticale, and flax. Applied to noncrop sites such as rights-of-way, fence rows, and roadsides.

Incompatibilities: Slowly hydrolyzes in water, releasing ammonia and forming acetate salts. May bencompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air:

PAC Ver. 29[138]

PAC-1: 3.9 milligram per cubic meter

PAC-2: 43 milligram per cubic meter

PAC-3: 260 milligram per cubic meter

Determination in Water: Fish toxicity (threshold)[101]: Very low—45107.62902 ppb, MATC.

Routes of Entry: Inhalation, dermal contact, ingestion

Harmful Effects and Symptoms

Human health effects from the sulfonylurea herbicides at low environmental doses or at biomonitored levels from low environmental exposures are unknown. The sulfonylurea herbicides are generally of low toxicity in mammalian studies. Animal studies showed low acute toxicity and little chronic, reproductive, or developmental toxicity or teratogenic effects. Developmental or teratogenic effects tended only to occur at high or maternally toxic doses. At high sublethal, chronic oral doses, such nonspecific effects as weight loss and anemia were observed. Some chemical-specific effects were noted at high doses in animals[96].

Short-Term Exposure: May cause skin and eye irritation. Moderately poisonous if ingested or inhaled. LD_{50} (oral, rat) = > 5000 mg/kg; LD_{50} (dermal, rabbit) = > 3000 mg/kg.

Long-Term Exposure: May cause developmental problems. Human toxicity (long term)[101]: Very low—350.00 ppb, Health advisory.

Medical Surveillance: Preliminary medical exam to detect chronic diseases of Central nervous system, liver, heart, kidneys, lung, and skin, as well as endocrinological, or immunological disturbances, should protect susceptible individuals. Periodical medical exams of internal organs, skin, and eyes are important to avoid chronic occupational intoxications. They should include lab and patch tests when necessary[83]. In addition to comprehensive initial medical and work histories emphasizing reproductive experience and menstrual history, patient should have physical examination and testing of genito-urinary tract, sperm count, motility, and morphology. If required, other tests, such as serum testosterone, serum FSH, and serum LH may be indicated. Urinary levels of the sulfonylurea herbicides reflect recent exposure. The urinary metabolites dimethoxypyrimidine and dimethylpyrimidine can be used as nonspecific markers of exposure to the pyrimidinylsulfonylureas, a group that includes bensulfuron-methyl, halosulfuron, primisulfuron-methyl, and sulfosulfon. The urinary metabolite methoxymethyl triazine can be used as a nonspecific marker of exposure to the triazinylsulfonylureas, a group that includes chlorosulfuron, prosulfuron, and triasulfuron[96].

Routes of Entry: Inhalation, passing through the skin, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Contact with eyes or skin may cause irritation or burns. Inhalation of dust should be avoided; use NIOSH- or CEN (UK)-approved APRs for pesticides. Because this material has a low vapor pressure, significant inhalation of vapors is unlikely at ordinary temperatures. May be harmful if swallowed. Dermal contact may cause allergic reaction. LD_{50} (oral, rat) = > 5 g/kg; LD_{50} (dermal, rabbit) = > 3 g/kg.

Long-Term Exposure: Repeated or prolonged contact may cause skin and lung sensitization, resulting in allergies.

Points of Attack: Skin

Medical Surveillance: Evaluation by a qualified allergist, including exposure history and testing, may help diagnose allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of dermal contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Wherever and whenever workplace conditions warrant respirator use, a respiratory protection program must be followed that meets one or more of the following requirements: OSHA's 29 CFR 1910.134, ANSI Z88.2, or European Standard EN 149.

Storage: Color code—Blue: Health Hazard/Poison. Store in a secure poison location. Store in a refrigerator and protect from exposure to oxidizers or moisture[52]. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen spilled material with alcohol to avoid dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide; water spray; or alcohol-resistant foam extinguishers. Thermal decomposition products may include sulfur oxides. Prevent water from entering containers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: It is the responsibility of chemical waste generators to determine the toxicity and physical properties and of a discarded chemical and to properly identify its classification and certification as a hazardous waste and to determine the disposal method. United States Environmental Protection Agency guidelines for the classification determination are listed in 40 CFR Parts 261.3. In addition, waste generators must consult and follow all regional, national, state, and local hazardous waste laws to ensure complete and accurate classification and disposal methods. Recycle any unused portion of the material for its approved use or return it to the manufacturer or supplier. Ultimate disposal of the chemical must consider: the material's impact on air quality; potential migration in soil or water; effects on animal, aquatic, and plant life; and conformance with environmental and public health regulations[83].

References

(102); (31); (173); (101); (138); (100).

United States Environmental Protection Agency, Office of Pesticide Programs, Pesticide Residue Limits, "Chlorsulfuron," 40 CFR 180.405. www.epa.gov/pesticides/food/viewtols.htm.

Chlorthiophos C:1080

Formula: $C_{11}H_{15}Cl_2O_3PS_2$

Synonyms: Celamerck S-2957; Cela S-2957; Celathion; CMS 2957; *O*-[Dichloro(methylthio)phenyl] *O*,*O*-diethyl phosphorothioate (3 isomers); *O*,*O*-[Diethyl-*O*-2,4,5-

dichloro(methylthio)phenyl]thionophosphate; ENT 27,635; NSC 195164; OMS 1342

CAS Registry Number: 21923-23-9; 60238-56-4

HSDB Number: 6452

RTECS Number: TF1590000

UN/NA & ERG Number: (PIH) UN3018 (organophosphorus pesticides, liquid, toxic)/152

EC Number: 244-663-6 [015-115-00-1]

Regulatory Authority and Advisory Information

Hazard Alert: Poison inhalation hazard, Neurotoxin (cumulative), Combustible, Environmental hazard, Agricultural chemical.

Banned or Severely Restricted (in agriculture: Germany, Malaysia) (UN)[13]

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500 lb (227 kg)

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

United States DOT 49CFR172.101, Inhalation Hazardous Chemical, as organic phosphate, Substance ID: EDF-041.

Hazardous to aquatic life or environment, with possible long-lasting effects[291]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, N; risk phrases: R27/28; R33; R50; safety phrases: S1/2; S28; S36/37; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to waters (CAS: 21923-23-9).

Description: Chlorthiophos is a yellowish-brown liquid. boiling point = 153−158°C @ 13 mmHg, and crystallizes at less than 25°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 1, reactivity 0.

Potential Exposure: A potential danger to those involved in the manufacture, formulation, and application of this insecticide and acaricide.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Strong oxidizers may cause release of toxic phosphorus oxides. Organophosphates, in the presence of strong reducing agents such as hydrides, may form highly toxic and flammable phosphine gas. Keep away from alkaline materials.

Permissible Exposure Limits in Air:

21923-23-9

PAC Ver. 29[138]

PAC-1: 0.71 milligram per cubic meter

PAC-2: 7.8 milligram per cubic meter

PAC-3: 9.9 milligram per cubic meter

Determination in Air: OSHA versatile sampler-2; Toluene/Acetone; GC/Flame photometric detection for sulfur, nitrogen, or phosphorus; NIOSH Analytical Method (IV) Method #5600, Organophosphorus Pesticides.

Routes of Entry: Inhalation, ingestion, skin contact. This chemical can be absorbed through the skin, thereby increasing exposure.

Harmful Effects and Symptoms

Short-Term Exposure: Symptoms of chlorthiophos exposure include headache, giddiness; blurred vision; nervousness, weakness, nausea, cramps, diarrhea, and discomfort in the chest. Signs include sweating, tearing, salivation, vomiting, cyanosis, convulsions, coma, loss of reflexes, and loss of sphincter control. Organic phosphorus insecticides are absorbed by the skin, as well as by the respiratory and gastrointestinal tracts. They are cholinesterase inhibitors. The LD_{50} oral (rabbit) is 20 mg/kg which is in the highly toxic class.

Long-Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. Chlorthiophos may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system; central nervous system; peripheral nervous system; plasma cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider CBC. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Effects may be delayed; keep victim under observation.

Personal Protective Methods: *Clothing:* Avoid skin contact with this chemical. Wear protective gloves and clothing. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work.

Eye Protection: Wear splash-proof chemical goggles and face shield when working with liquid, unless full facepiece respiratory protection is worn. Wear dust-proof goggles and face shield when working with powders or dust, unless full facepiece respiratory protection is worn.

Respirator Selection: Where there is potential exists for exposures, use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece respirator with a pesticide cartridge. Greater protection is provided by a powered-APR. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with Chlorthiophos all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from incompatible materials. Always store pesticides in their original containers, complete with labels that list ingredients, directions for use, and first aid steps in case of accidental poisoning. Never store pesticides in cabinets with or near food, animal feed, or medical supplies. Do not store pesticides in places where flooding is possible or in places where they might spill or leak into wells, drains, ground water, or surface water[72].

Shipping: UN3018 Organophosphorus pesticides, liquid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Organophosphorus compounds

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.3/0.4
Night 0.8/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 600/200
Then: Protect persons downwind (mi/km)
Day 1.4/2.3
Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Do not touch spilled material. Do not breathe vapors. Stay upwind; keep out of low areas. Remove all ignition sources. Ventilate area of spill or leak. This material is a combustible liquid. For a spill or leak of a combustible liquid, shut off ignition sources; no flares, smoking, or flames in hazard area. Stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material may burn, but does not ignite readily. Thermal decomposition products may include hydrogen chloride and oxides of phosphorus, sulfur, nitrogen, and carbon. For small fires, use dry chemical, carbon dioxide; water spray; or foam. For large fires, use water spray, fog, or foam. Stay upwind; keep out of low areas. Move containers from fire area if you can do so without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR165 recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (203); (96); (204); (100).

United States Environmental Protection Agency, "Chemical Profile: Chlorthiophos," Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

Cholecalciferol C:1086

Formula: $C_{27}H_{44}O$
Synonyms: Colecalciferol; 7-Dehydrochloesterol; Delsterol; Deparal; D3-Vigantol; Oleovitamin D_3; Quintox; Rampage; Ricketon; 9,10-Secocholesta-5,7,10(19)-trien-3-β-ol; 9,10-Secocholesta-5,7,10(19)-trien-3-ol, (3.β,5Z,7E)-; Trivitan; Vigorsan; Vitamin D_3; Vitinc DAN-DEE-3
CAS Registry Number: 67-97-0
HSDB Number: 820
RTE CS Number: VS2900000
UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154
EC Number: 200-673-2 [*Annex I Index No.:* 604-140-00-4]
Regulatory Authority and Advisory Information
Hazard symbols, risk, & safety statements: Hazard symbol: T + ; risk phrases: R24/25; R26; R48/25; safety phrases: S1/2; S28; S36/37; S45 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.
Description: White or colorless crystalline solid. Odorless; molecular weight = 384.62; specific gravity (H_2O:1) = 0.963; freezing/melting point = 84−85°C; 87°C; vapor pressure = 2.4×10^{-9} mmHg @ 25°C (est.)[83]; Henry's Law constant = 2.3×10^{-4} atm m^3/mole @ 25° (est.)[83]. Practically insoluble in water.
Potential Exposure: Sterol rodenticide used in bait for vermin control. Vitamin D is a steroid hormone that has an important role in regulating body levels of calcium and phosphorus, and in mineralization of bone. Not approved for use in EU countries.
Incompatibilities: Sensitive to air, light, and moisture. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.
Permissible Exposure Limits in Air: No standards established.
Determination in Air: Liquid chromatography with ultraviolet detection.
Determination in Water: Octanol−water coefficient: Log K_{ow} = 10.2 (est.)[83]. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.
Routes of Entry: Inhalation, ingestion, dermal contact.
Harmful Effects and Symptoms
Short-Term Exposure: Massive doses are highly toxic to humans; may cause irritability, weakness, fatigue, sleepiness, headache, dry mouth, nausea, abdominal cramps, vomiting, constipation, diarrhea. LD_{50} (oral, rat) = 1426 mg/kg.
Long-Term Exposure: May cause hypertension, kidney effects, anorexia, tinnitus.
Medical Surveillance: Tests for urinary calcium, phosphate, and albumin; Blood urea nitrogen (BUN) levels; serum cholesterol. There may be a decrease in serum alkaline phosphatase concentrations[83].
First Aid Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.
Personal Protective Methods: Applicators and other handlers must wear: Coveralls worn over long-sleeved shirt and long pants; Chemical-resistant gloves such as DuPont Tychem suit fabrics, barrier laminate, or Viton; Chemical-resistant footwear plus socks; Protective eye wear; Chemical-resistant headgear for overhead exposure; Chemical-resistant apron when cleaning equipment, mixing, or loading[83]. Agricultural Use/Engineering Controls: When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the WPS for agricultural pesticides, 40 CFR 170.240(d)(4-6), the handler PPE requirements may be reduced or modified as specified in the WPS. Firefighters should wear NIOSH-approved SCBA and full protective clothing.
Respirator Selection: Wherever and whenever workplace conditions warrant respirator use, a respiratory protection program must be followed that meets one or more of the following requirements: OSHA's 29 CFR 1910.134, ANSI Z88.2, or European Standard EN 149.
Storage: Color code—Blue: Health Hazard/Poison: Store in a tightly closed container in a dry, well-ventilated, and secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Where possible, automatically transfer material from other storage containers to process containers.
Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.
Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft (NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. As

an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 m/150 ft for liquids and at least 25 m/75 ft for solids. Increase, in the downwind direction, as necessary, the isolation distance shown above. Eliminate all ignition sources (no smoking, flares, sparks, or flames in immediate area). Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Stop leak if you can do it without risk. Prevent entry into waterways, sewers, basements, or confined areas. Absorb or cover with dry earth, sand, or other noncombustible material and transfer to containers. Do not get water inside containers.

Fire Extinguishing: Thermal decomposition products may include oxides of carbon. *Fire involving storage or vehicular tanks:* Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. *Small fire:* Dry chemical, carbon dioxide, or water spray. *Large fire:* Dry chemical, carbon dioxide, alcohol-resistant foam, or water spray. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal; do not scatter the material. *Fire involving tanks or car/trailer loads:* Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Do not get water inside containers. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. Always stay away from tanks engulfed in fire. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Recycle any unused portion of the material for its approved use or return it to the manufacturer or supplier. Ultimate disposal of the chemical must consider: the material's impact on air quality; potential migration in soil or water; effects on animal, aquatic, and plant life; and conformance with environmental and public health regulations[83].

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, "Reregistration Eligibility Decision (RED), Rodenticide Cluster," Office of Prevention, Pesticides and Toxic Substances, Washington, DC (July 1998). http://www.epa.gov/REDs/2100red.pdf.

Chromic Acetate C:1090

Formula: $C_6H_9CrO_6$; $Cr(C_2H_3O_2)_3$

Synonyms: Acetato cromico (Spanish); Acetic acid, chromium(3+) salt; Chromic acetate(III); Chromium acetate; Chromium(III) acetate; Chromium triacetate

CAS Registry Number: 1066-30-4

HSDB Number: 985

RTECS Number: AG2975000

UN/NA & ERG Number: UN3288 (Toxic solid, inorganic, n.o.s.)/151

EC Number: 213-909-4

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human Inadequate Evidence; Animal Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1997

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) as total chromium

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992); 40CFR 401.15 Section 307 Toxic Pollutants

EPA ADI: Chromium(III) = 125 mg/day/man. EPA EASI levels for chromium: **Infants:** age 0.0−0.5 year: 0.01−0.04 mg/day; age 0.5−1.0 year: 0.02−0.06 mg/day. **Children:** age 1−3 years: 0.02−0.08 mg/day; age 4−6 years: 0.03−0.12 mg/day; age 7−10 years: 0.05−0.20 mg/day; age > or = 11 years: 0.05−0.20 mg/day. **Adults**: 0.05−0.20 mg/day.

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1000 lb (454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: Chromium III compounds: 1.0%. *Also must be reported as a chromium compound:* "Includes any unique chemical substance that contains chromium as part of that *chemical*'s infrastructure." Form R *de minimis* concentration reporting level: Chromium(VI) compounds: 0.1%. Form R Toxic Chemical Category Code: N090

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: Xi; risk phrases: R36/37/38; R51; safety phrases: S16; S26; S36/37/39; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Chromic acetate is a gray-green powder or blue-green pasty mass. Molecular weight = 229.15 (anhydrous), 247.16 (hydrate); specific gravity (H_2O:1) = 1.30; boiling point = 100°C (aqueous solution). Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 0, reactivity 0. Soluble in water.

Potential Exposure: Chromic acetate is used to fix certain textile dyes; to harden photographic emulsions in tanning, and as a catalyst.

Incompatibilities: Contact with strong oxidizers may cause fire and explosion hazard.

Permissible Exposure Limits in Air

NIOSH IDLH = 25 mg[Cr(III)]/m^3

OSHA PEL: 0.5 mg[Cr]/m^3 TWA

NIOSH REL: 0.5 mg[Cr]/m^3 TWA limit exposures to lowest feasible concentration.

ACGIH TLV[1]: 0.5 mg[Cr]/m^3 TWA; not classifiable as a human carcinogen

PAC Ver. 29[138]
PAC-1: 6.6 milligram per cubic meter
PAC-2: 78 milligram per cubic meter
PAC-3: 470 milligram per cubic meter
DFG MAK: [skin] danger of skin sensitization

Determination in Air: Use NIOSH Analytical Methods #7024, 7300, 7301, 7303, 9102 and OSHA Analytical Methods ID-121 and ID-125G[58].

Permissible Concentration in Water: EPA ADI:125 mg[Cr (III)]/day/man, as chromium(III). The states of Maine and Minnesota have set guidelines for chromium in drinking water[61] of 50 μg/L for Maine and 120 μg/L for Minnesota.

Determination in Water: Total chromium may be determined by digestion followed by AA, or by colorimetry (diphenylcarbazide); or by ICP optical emission spectrometry. Dissolved total Cr or Cr(VI) may be determined by 0.45 μ filtration followed by the above-cited methods[49].

Routes of Entry: Inhalation, ingestion; skin and/or eye contact

Harmful Effects and Symptoms

Short-Term Exposure: Inhalation may cause irritation of the eyes, nose, and throat. Eye contact may cause irritation, redness, and tearing. Skin contact may cause irritation, redness, and tearing. Skin allergy sometimes occurs, with itching, redness, and/or an eczema-like rash. If this happens, future contact can trigger symptoms.

Long-Term Exposure: Repeated or prolonged skin contact may cause skin sensitization, irritation, and dermatitis. Some chromium compounds can cause a sore or hole in the septum dividing the nose. Chromic acetate is a carcinogen-handle with extreme caution. May cause lung or throat cancer; birth defects; miscarriage; skin allergy with redness, itching, and rash.

Points of Attack: Eyes, skin.

Medical Surveillance: If illness occurs or overexposure is suspected, medical attention is recommended. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. NIOSH lists the following tests [chromium(III) compounds]: whole blood (chemical/metabolite); biologic tissue/biopsy; chest X-ray; pulmonary function tests; red blood cells/count; urine (chemical/metabolite) [end-of-shift] [end-of-shift at end-of-work-week] [end-of-work-week] [pre- & postshift].

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *up to 2.5 milligram per cubic meter*: Qm* (APF = 25) (any quarter-mask respirator). *Up to 5 milligram per cubic meter:* 95XQ* (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa* (APF = 10) (any supplied-air respirator). *Up to 12.5 milligram per cubic meter:* Sa:Cf* (any supplied-air respirator operated in a continuous-flow mode); or PaprHie* (any PAPR with a high-efficiency particulate filter). *Up to 25 milligram per cubic meter:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or PaprTHie* (any powered, APR with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (any SCBA with a full facepiece); or SaF (any supplied-air respirator with a full facepiece) *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with Chromic Acetate all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. A regulated, marked area should be established where Chromic Acetate is handled, used, or stored. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN3288 Toxic solids, inorganic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Chromic acetate may burn, but does not readily ignite. Use dry chemical, CO_2, water spray; or foam extinguishers. Thermal decomposition products may include oxides of metal and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested:

Dilute and stir in excess soda ash. Let stand, neutralize liquid and flush to sewer. Dispose of sludge in landfill.

References

(31); (173); (101); (138); (2); (122); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 3, 43−45 (1981) and 5, No. 6, 43−45 (1985).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Chromic Acetate, Trenton, NJ (December 1999).

United States Environmental Protection Agency, *Health Assessment Document: Chromium*, EPA 600/8-83-014F, Washington, DC (1984).

Chromic(VI) Acid C:1100

Formula: $H_2Cr_2O_7$; H_2CrO_4 ($CrO_3 \cdot H_2O$)

Synonyms: Acide chromique (French); Acido cromico (Spanish); Chromic(6+) acid; Chromic(VI) acid; Chromic anhydride; Chromium anhydride; Chromium trioxide. ***ester:*** Acido cromico (Spanish); Chromic(VI) acid; Chromic acid ester; Chromic acid, solid; Chromic acid, solution, chromic anhydride; Chromic trioxide; Chromium oxide; Chromium (VI) oxidemonochromium oxide; Chromium trioxide; Chromium(6+) trioxide; Chromium trioxide, anhydrous; Monochromium trioxide; Puratronic chromium trioxide

CAS Registry Number: 7738-94-5; 11115-74-5 (ester)

HSDB Number: 6769

RTECS Number: GB2450000; GB6650000

UN/NA & ERG Number: UN1463 (solid)/141; UN1755 (solution)/154

EC Number: 231-801-5

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human Sufficient Evidence; Animal Sufficient Evidence, *carcinogenic to humans*, Group 1, 1997; NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen; EPA *(inhalation)*: Known human carcinogen; EPA *(oral)*: Not Classifiable as to human carcinogenicity; NTP: Known to be a human carcinogen.

California Proposition 65 Chemical[102]: (*hexavalent chromium*) Cancer 2/27/1987; Developmental/Reproductive toxin (male, female) 12/19/2008

Hazard Alert: Poison, Powerful oxidizer, Environmental hazard, Sensitization hazard (skin, resp.), Corrosive, Reproductive toxin: Suspected of causing genetic defects.

Clean Water Act: 40CFR116.4 Hazardous Substances; RQ 40CFR117.3 (same as CERCLA); 40CFR423, Appendix A, Priority Pollutants; 40CFR401.15 Section 307 Toxic Pollutants as chromium and compounds.

EPA ADI: Chromium(VI) = 0.175 mg/day/man. EPA EASI levels for chromium: **Infants:** age 0.0−0.5 year: 0.01−0.04 mg/day; age 0.5−1.0 year: 0.02−0.06 mg/day. **Children:** age 1−3 years: 0.02−0.08 mg/day; age 4−6 years: 0.03−0.12 mg/day; age 7−10 years: 0.05−0.20 mg/day; age > or = 11 years: 0.05−0.20 mg/day.

Adults: 0.05−0.20 mg/day.

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: Chromium VI compounds: 0.1%.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112). As chromium compounds. (ester)

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992); 40CFR401.15 Section 307 Toxic Pollutants (ester)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg) (ester)

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, C, O, N, Xi; risk phrases: R45; R8; R9; R43; R48/24/25; R50/53; R62; safety phrases: S8; S16; S17; S23; S26; S29; 36/37/39; S41; S43; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water. (est.)

Description: Chromic acid is a dark purplish-red odorless flakes or crystalline powder. Molecular weight = 100.00 mg[CrO_3]; boiling point = 250°C (decomposes); freezing/melting point = 197°C (decomposes). Often used in aqueous solution. Hazard identification (based on NFPA-

704 M Rating System): Health 3, flammability 0, reactivity 0, oxidizer. Highly soluble in water. It may also be formulated as $H_2CrO_4(CrO_3 \cdot H_2O)$.

Potential Exposure: Chromic acid is used in chromium plating; medicine, ceramic glazers, and paints.

Incompatibilities: A strong oxidizer. Aqueous solution is strongly acidic. Reacts with acetic acid, acetic anhydride, acetone, anthracene, chromous sulfide; diethyl ether; dimethyl formamide; ethanol, hydrogen sulfide; methanol, naphthalene, camphor, glycerol, potassium ferricyanide, pyridine, turpentine, combustibles; organics, and other easily oxidized materials (such as paper, wood, sulfur, aluminum, and plastics). Attacks metals in presence of moisture.

Permissible Exposure Limits in Air

NIOSH IDLH = 15 mg[Cr(VI)]/m^3, potential human carcinogen

as chromium(VI) inorganic soluble compounds

OSHA PEL: 0.005 mg[Cr(VI)]/m^3 TWA Concentration. See 29CFR1910.1026

NIOSH REL: 0.001 mg[Cr]/m^3 TWA, potential carcinogen, limit exposure to lowest feasible level. NIOSH considers all Cr(VI) compounds (including chromic acid, *tert*-butyl chromate, zinc chromate, and chromyl chloride) to be potential occupational carcinogens. See *NIOSH Pocket Guide*, Appendices A and C.

ACGIH TLV[1]: 0.05 mg[Cr]/m^3 TWA, Confirmed Human Carcinogen; BEI issued

DFG MAK: [skin] Danger of skin sensitization; Carcinogen Category 1; TRK: 0.05 mg[Cr]/m^3; 20 μg/L [Cr] in urine at end-of-shift

Several states have set guidelines or standards for chromic acid in ambient air[60] ranging from 0 (North Carolina) to 0.001 μ/m^3 (Massachusetts) to 1.0 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Methods #7600, 7604, 7605, 7703, 9101 and OSHA Analytical Methods ID-103, ID-215, W-4001.

Permissible Concentration in Water: State Drinking Water Guidelines: California 10 μg[Cr(VI)]/L; Maine 35 μg[Cr (VI)]/L. United States National Primary Drinking Water Regulations: MCLG = 0.01 mg[Cr]/L; MCL = 0.1 mg[Cr]/L as chromium. Chromium may cause allergic dermatitis. For the protection of freshwater aquatic life: Hexavalent chromium: 0.29 μg/L as a 24-hour average, never to exceed 21.0 μg/L. for the protection of saltwater aquatic life: Hexavalent chromium: 18 μg/L as a 24-hour average, never to exceed 1260 μg/L. To protect human health: hexavalent chromium 50 μg/L according to EPA[6].

Determination in Water: Total chromium may be determined by digestion followed by AA, or by colorimetry (diphenylcarbazide); or by ICP optical emission spectrometry. Chromium(VI) may be determined by extraction and AA, or colorimetry (using diphenylhydrazide). Dissolved total Cr or Cr(VI) may be determined by 0.45 μ filtration followed by the above-cited methods[49].

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Chromic acid can affect you when breathed in. It can also pass into inner layers of the skin. Chromic acid should be handled as a carcinogen with extreme caution. *Inhalation:* May be poisonous. Dust may cause severe irritation to the nose, throat, and lungs, causing coughing; shortness of breath. May cause flu-like symptoms including chills, muscle ache; headache, fever. High exposure may cause nausea, salivation, vomiting, cramps, diarrhea, chest pains; cough; a build-up of fluids in the lungs (pulmonary edema), and possible death. Pulmonary edema is a medical emergency and may be delayed from 1 to 2 days following exposure. *Skin:* May cause severe irritation and thermal and acid burns, especially if skin is wet. *Eyes:* May cause severe irritation, burns, pain, and possible blindness. *Swallowed:* May be poisonous. May cause severe burns of the mouth, throat, and stomach; vomiting; watery or bloody diarrhea. Damage to kidneys and liver; collapse and convulsions can result.

Long-Term Exposure: May cause lung cancer; birth defects; miscarriage, kidney and liver damage; skin allergy and ulcers; injury to the nasal septum (may cause a hole in the nose); discoloration of teeth; bronchitis, lung allergy.

Points of Attack: Blood, respiratory system; liver, kidneys, eyes, skin.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure. NIOSH lists the following tests: Blood gas analysis, CBC; chest X-ray, electrocardiogram, liver function tests; pulmonary function tests, sputum cytology, urine (chemical/metabolite), UA (routine), white blood cell count/differential. Before beginning employment and at regular times after that, the following are recommended: exam of the mouth and larynx. If symptoms develop or overexposure is suspected, the following may also be useful: kidney function tests. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Specific engineering controls are recommended in NIOSH criteria documents: #73-11021 (chromic acid) and #76-129 [chromium(VI)].

First Aid: Move victim to fresh air. Call 911 or emergency Medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, Avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. (chromic acid) **8 hours** (more than 8 hours of resistance to breakthrough $>0.1\ \mu g/cm^2/min$): polyethylene gloves, suits, boots; polyvinyl chloride gloves, suits, boots; Saranex-coated suits; **4 hours** (At least 4 but <8 hours of resistance to breakthrough $>0.1\ \mu g/cm^2/min$): butyl rubber gloves, suits, boots; Viton gloves, suits. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. When working with liquids, wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. When working with powders or dusts, wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH, as chromates: *at any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Check oxygen content prior to entering storage area. Oxidizers should be isolated from acids, metals, organic materials, and ammonium nitrate. (1) Color code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially organic materials, flammables and combustibles, and other incompatible materials. Oxidizers, including oxidizing gases, should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. *Note:* Store corrosives in this group in chemical resistant secondary containers and/or in corrosion proof cabinets. (2) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with chromic acid all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from acetone, combustible, organic, or other readily oxidizable material (such as paper, wood, sulfur, aluminum, and plastics). Sources of ignition, such as smoking and open flames, are prohibited where Chromic acid is used, handled, or stored in a manner that could create a potential fire or explosion hazard. A storage hazard; sealed containers may burst from carbon dioxide release. Store in tightly closed containers in a dry, cool, well-ventilated place with nonwood floors. Keep away from combustible materials; alcohols and acetone. Where possible, automatically transfer chromic acid from drums or other storage containers to process containers. Containers may explode in fire. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage.

Shipping: UN1463 Chromium trioxide, anhydrous, Hazard Class: 5.1; Labels: 5.1-Oxidizer, 6.1-Poisonous materials, 8-Corrosive material. UN1755 (solution) Chromic acid, solid, Hazard class: 8; Labels: 8-Corrosive material.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of metal. Use dry chemical, soda ash; CO_2, water spray; or foam extinguishers. Chromic acid may ignite other combustible materials, such as paper and wood. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Chemical reduction to chromium(III) can be followed by land fill disposal of the sludge[22].

References

(109); (102); (31); (173); (101); (138); (2); (122); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 2, 21–22 (1982) and 3, No. 3, 60–62 (1983).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Chromic Acid, Trenton, NJ (July 2002).

United States Environmental Protection Agency, *Health Assessment Document: Chromium*, EPA 600/8-83-014F, Washington, DC (1984).

Chromic Chloride C:1110

Formula: Cl_3Cr; $CrCl_3$

Synonyms: Chromium chloride; Chromium(III) chloride (1:3); Chromium chloride (III) anhydrous; Chromium chloride, anhydrous; Chromium sesquichloride; Chromium trichloride; C.I. 77295; Cloruro cromico (Spanish); Puratronic chromium chloride; Trichlorochromium

CAS Registry Number: 10025-73-7

HSDB Number: 6341

RTECS Number: GB5425000

UN/NA & ERG Number: UN1759 (solid)/154; UN1760 (liquid)/154

EC Number: 233-038-3

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human Inadequate Evidence; Animal Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1997; EPA (*insoluble salts*): Not Classifiable as to human carcinogenicity; Cannot be Determined

Carcinogenicity: IARC: Human Inadequate Evidence; Animal Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3.

Hazard Alert: Corrosive, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) as chromium compounds

United States National Primary Drinking Water Regulations: MCLG = 0.01 mg[Cr]/L; MCL = 0.1 mg[Cr]/L as chromium; SMCL = 250 mg[Cl^-]/L as Chloride.

Clean Water Act: 40CFR116.4 Hazardous Substances; RQ 40CFR117.3 (same as CERCLA); 40CFR423, Appendix A, Priority Pollutants; 40CFR401.15 Section 307 Toxic Pollutants as chromium and compounds.

EPA ADI: Chromium(III) = 125 mg/day/man. EPA EASI levels for chromium: **Infants:** age 0.0–0.5 year: 0.01–0.04 mg/day; age 0.5–1.0 year: 0.02–0.06 mg/day. **Children:** age 1–3 years: 0.02–0.08 mg/day; age 4–6 years: 0.03–0.12 mg/day; age 7–10 years: 0.05–0.20 mg/day; age > or = 11 years: 0.05–0.20 mg/day. **Adults**: 0.05–0.20 mg/day.

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 1/10,000 lb (0.454/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: Chromium III compounds: 1.0%. *Also must be reported as a chromium compound:* "Includes any unique chemical substance that contains chromium as part of that *chemical*'s infrastructure." Form R *de minimis* concentration reporting level: Chromium(VI) compounds: 0.1%. Form R Toxic Chemical Category Code: N090

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: C, Xn; risk phrases: R21/22; R36/38; R62; R63; safety phrases: S24/25; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Chromic chloride is a highly corrosive, Blue or greenish to black crystalline solid. Molecular weight = 158.35; specific gravity (H_2O:1) = 1.76; boiling point = (decomposes) 1300°C; freezing/melting point = 1152°C (dissociates above 1300°C). Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 0. Insoluble in water (reaction).

Potential Exposure: Chromic chloride is used for production of solutions of basic chlorides and as a catalyst for polymerization of olefins and other organic reactions; in chromizing; in the manufacture of chromium metal and compounds; as a textile mordant; in tanning; in corrosion inhibitors; and as a waterproofing agent. A nutritional supplement.

Incompatibilities: Reacts with water and strong oxidizers. Contact with strong acids or acid fumes may produce highly toxic chloride fumes. May attack certain steels, causing pitting attack and stress corrosion.

Permissible Exposure Limits in Air

NIOSH IDLH = 25 mg[Cr(III)]/m^3

OSHA PEL: 0.5 mg[Cr]/m^3 TWA

NIOSH REL: 0.5 mg[Cr]/m^3 TWA limit exposures to lowest feasible concentration.

ACGIH TLV[1]: 0.5 mg[Cr]/m^3 TWA; not classifiable as a human carcinogen

PAC Ver. 29[138]

PAC-1: 4.6 milligram per cubic meter

PAC-2: 15 milligram per cubic meter

PAC-3: 87 milligram per cubic meter

DFG MAK: [skin] danger of skin sensitization

Determination in Air: Use NIOSH Analytical Methods #7024, 7300, 7301, 7303, 9102 and OSHA Analytical Methods ID-121 and ID-125G[58].

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 100 μg[Cr]/L.

For the protection of freshwater aquatic life: Trivalent chromium: not to exceed [1.08 In (hardness) + 3.48] μg/L. For the protection of saltwater aquatic life: Trivalent chromium: 10,300 μg/L on an acute toxicity basis. *To protect human health:* Trivalent chromium: 170 μg/L[6].

Determination in Water: Total chromium may be determined by digestion followed by AA, or by colorimetry (diphenylcarbazide); or by ICP optical emission spectrometry. Dissolved total Cr or Cr(VI) may be determined by 0.45 μ filtration followed by the above-cited methods[49].

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Chromic chloride is highly corrosive. Irritates and burns the eyes and skin. Inhalation can irritate the respiratory tract, causing coughing and wheezing. It displays high dermal toxicity, and moderate oral toxicity. The oral toxicity-rat is given as 1870 mg/kg.

Long-Term Exposure: Chromium may cause allergic dermatitis. This chemical may cause histologic fibrosis of the lungs. Signs for exposure to chromic chloride as for other chromium compounds include dermatitis; ulcers of the upper respiratory tract and inflammation of the larynx, lungs, gastrointestinal tract; and nasal passages. Repeated skin contact can cause sensitization and dermatitis.

Points of Attack: Eyes, skin, lungs.

Medical Surveillance: Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. NIOSH lists the following tests [chromium(III) compounds]: whole blood (chemical/metabolite); biologic tissue/biopsy; chest X-ray; pulmonary function tests; red blood cells/count; urine (chemical/metabolite) [end-of-shift] [end-of-shift at end-of-work-week] [end-of-work-week] [pre- & postshift].

First Aid: Move victim to fresh air. Call 911 or emergency Medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 2.5 milligram per cubic meter*: Qm* (APF = 25) (any quarter-mask respirator). *Up to 5 milligram per cubic meter:* 95XQ* (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa* (APF = 10) (any supplied-air respirator). *Up to 12.5 milligram per cubic meter:* Sa:Cf* (any supplied-air respirator operated in a continuous-flow mode); or PaprHie* (any PAPR with a high-efficiency particulate filter). *Up to 25 milligram per cubic meter:* 100 F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or PaprTHie* (any powered, APR with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (any SCBA with a full facepiece); or SaF (any supplied-air respirator with a full facepiece) *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizing agents and water.

Shipping: UN1759 Corrosive solids, n.o.s., Hazard class: 8; Labels: 8-Corrosive material, Technical Name Required. UN1760 Corrosive liquids, n.o.s., Hazard class: 8; Labels: 8-Corrosive material, Technical Name Required.

Spill Handling: Do not touch spilled material. Avoid inhalation. Wear full protective clothing and proper respiratory protection. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Chromic chloride itself does not burn. It reacts with water, so use in flooding quantities only. Thermal decomposition products may include hydrogen chloride and oxides of metal. Use extinguishing agents suitable for surrounding fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Precipitate as chromium hydroxide. Dewater the sludge and dispose of the compacted sludge in single-purpose dumps[22].

References

(31); (173); (101); (138); (2); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Chromic Chloride, Washington, DC, Chemical Emergency Preparedness Program (September 1998).

United States Environmental Protection Agency, *Health Assessment Document: Chromium*, EPA 600/8-83-014F, Washington, DC (1984).

Chromic Sulfate C:1120

Formula: $Cr_2O_{12}S_3$; $Cr_2(SO_4)_3$

Synonyms: Chromic sulfate; Chromium sulfate; Chromium (3+) sulfate; Chromium(III) sulfate; Chromium sulfate; C.I.77305; Dichromium sulfate; Dichromium sulfate; Dichromium trisulfate; Dichromium trisulfate; Sulfato cromico (Spanish); Sulfuric acid, chromium(3+) salt

CAS Registry Number: 10101-53-8

HSDB Number: 2543

RTECS Number: GB7200000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 233-253-2

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human Inadequate Evidence; Animal Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1997; EPA (insoluble salts): Not Classifiable as to human carcinogenicity; Cannot be Determined.

Hazard Alert: Environmental hazard,[101] Possible sensitization hazard.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112). as chromium compounds

Clean Water Act: Section 311 Hazardous Substances/ 40CFR116.4 Hazardous Substances; RQ 40CFR117.3 (same as CERCLA); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992); 40CFR401.15 Section 307 Toxic Pollutants as chromium and compounds. 40CFR423, Appendix A, Priority Pollutants

EPA ADI: Chromium(III) = 125 mg/day/man. EPA EASI levels for chromium: **Infants:** age 0.0–0.5 year: 0.01–0.04 mg/day; age 0.5–1.0 year: 0.02–0.06 mg/day. **Children:** age 1–3 years: 0.02–0.08 mg/day; age 4–6 years: 0.03–0.12 mg/day; age 7–10 years: 0.05–0.20 mg/day; age > or = 11 years: 0.05–0.20 mg/day.

Adults: 0.05–0.20 mg/day.

United States National Primary Drinking Water Regulations: MCLG = 0.01 mg[Cr]/L; MCL = 0.1 mg[Cr]/L as Chromium; SMCL = 250 mg[SO_4^{-2}]/L as Sulfate

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1000 lb (454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: Chromium III compounds: 1.0%. *Also must be reported as a chromium compound:* "Includes any unique chemical substance that contains chromium as part of that chemical's infrastructure." Form R *de minimis* concentration reporting level: Chromium(VI) compounds: 0.1%. Form R Toxic Chemical Category Code: N090

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: N, Xi; risk phrases: R43; safety phrases: S29/35; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Chromic sulfate is a peach colored solid or red to violet, odorless powder. Molecular weight = 392.18. Specific gravity (H_2O:1) = 3.01; hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 0, reactivity 0. Insoluble in water.

Potential Exposure: This compound is used in green paints, inks, dyes, and ceramics.

Incompatibilities: This chemical has weak oxidizing and reducing properties. Keep away from strong oxidizers (perchlorates, peroxides, permanganates, chlorates, nitrates, chlorine, bromine, and fluorine). When heated this chemical decomposes to chromic acid.

Permissible Exposure Limits in Air

NIOSH IDLH = 25 mg[Cr(III)]/m^3

OSHA PEL: 0.5 mg[Cr]/m^3 TWA

NIOSH REL: 0.5 mg[Cr]/m^3 TWA limit exposures to lowest feasible concentration.

ACGIH TLV[1]: 0.5 mg[Cr]/m^3 TWA; not classifiable as a human carcinogen

PAC Ver. 29[138]

PAC-1: 5.7 milligram per cubic meter

PAC-2: 6.3 milligram per cubic meter

PAC-3: 380 milligram per cubic meter

DFG MAK: [skin] danger of skin sensitization

Determination in Air: Use NIOSH Analytical Methods #7024, 7300, 7301, 7303, 9102 and OSHA Analytical Methods ID-121 and ID-125G[58].

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 100 μg[Cr]/L. For the protection of freshwater aquatic life: Trivalent chromium: not to exceed [1.08 In (hardness) + 3.48]μg/L. For the protection of saltwater aquatic life: Trivalent chromium: 10,300 μg/L on an acute toxicity basis. *To protect human health:* Trivalent chromium: 170 μg/L.

Determination in Water: Total chromium may be determined by digestion followed by AA; or by colorimetry (diphenylcarbazide); or by ICP optical emission spectrometry. Dissolved total Cr or Cr(VI) may be determined by 0.45 μ filtration followed by the above-cited methods[49].

Routes of Entry: Inhalation of dust or mist, skin; contact, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Chromic Sulfate can affect you when breathed in. Skin contact may cause irritation, especially if repeated or prolonged. Skin allergy sometimes occurs with itching, redness, and/or an eczema-like rash. If this happens future contact can trigger symptoms. Eye contact may cause irritation and burns.

Long-Term Exposure: Chromium may cause allergic dermatitis. Some chromium compounds can cause an ulcer in the septum separating the nose. It is uncertain whether this chemical has this effect.

Points of Attack: Eyes, skin.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. NIOSH lists the following tests [chromium(III) compounds]: whole blood (chemical/metabolite); biologic tissue/biopsy; chest X-ray; pulmonary function tests; red blood cells/count; urine (chemical/metabolite) [end-of-shift] [end-of-shift at end-of-work-week] [end-of-work-week] [Pre- & postshift].

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a Medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 2.5 milligram per cubic meter*: Qm* (APF = 25) (any quarter-mask respirator). *Up to 5 milligram per cubic meter:* 95XQ* (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa* (APF = 10) (any supplied-air respirator). *Up to 12.5 milligram per cubic meter:* Sa:Cf* (any supplied-air respirator operated in a continuous-flow mode); or PaprHie* (any PAPR with a high-efficiency particulate filter). *Up to 25 milligram per cubic meter:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or PaprTHie* (any powered, APR with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (any SCBA with a full facepiece); or SaF (any supplied-air respirator with a full facepiece) *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection. *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with chromic acid all handlers should be trained on its proper handling and storage. Prior to working with chromic sulfate all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers and sources of heat.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Chromic sulfate may burn, but does not readily ignite. Thermal decomposition products may include oxides of metal and sulfur. Use dry chemical, CO_2, water spray; or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return to supplier where possible. Where this is not practical, the material should be encapsulated and buried in a specially designated chemical landfill.

References

(31); (173); (101); (138); (2); (122); (100).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Chromic Sulfate, Trenton, NJ (May 2002).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 3, No. 3, 62−65 (1983); (122).

United States Environmental Protection Agency, *Health Assessment Document: Chromium*, EPA 600/8-83-014F, Washington, DC (1984).

Chromium C:1130

Formula: Cr

Synonyms: Chrome; Chromium, elemental; Chromium metal; Cromo (Spanish); Elemental chromium

CAS Registry Number: 7440-47-3 (elemental)

HSDB Number: 910

RTECS Number: GB4200000 (elemental)

UN/NA & ERG Number: UN3089 (Metal powder, flammable, n.o.s.)/170; UN1759 (corrosive solids, n.o.s.)/154

EC Number: 231-157-5

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: (metallic chromium and chromium[III] compounds) Human Inadequate Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3; [chromium(VI)], *carcinogenic to humans*, Group 1, 1997; NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen; EPA *(inhalation)*: Human Carcinogen; Known human carcinogen; EPA *(oral)*: Cannot be Determined; NTP: Known to be a human carcinogen. Chromium, elemental, chromic acid, chromium(VI) oxide, and chromium(III) chromate are listed as carcinogens in Canada (WHMIS). United States Environmental Protection Agency Genetox Program, Inconclusive: Carcinogenicity-mouse/rat.

California Proposition 65 Chemical[102]: (*hexavalent chromium*) Cancer 2/27/1987; Developmental/Reproductive toxin (male, female) 12/19/2008.

Hazard Alert: Combustible (dust), Pyrophoric (dust), Possible risk of forming tumors, Suspected reprotoxic hazard.

Banned or Severely Restricted (Many countries, many categories) (UN)[35]

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112). as chromium compounds

United States National Primary Drinking Water Regulations: MCLG = 0.01 mg[Cr]/L; MCL = 0.1 mg[Cr]/L as Chromium

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/1992); Toxic Pollutant (Section 401.15)

EPA ADI: Chromium(VI) = 0.175 mg/day/man; Chromium (III) = 125 mg/day/man. EPA EASI levels for chromium: **Infants:** age 0.0−0.5 year: 0.01−0.04 mg/day; age 0.5−1.0 year: 0.02−0.06 mg/day. **Children:** age 1−3 years: 0.02−0.08 mg/day; age 4−6 years: 0.03−0.12 mg/day; age 7−10 years: 0.05−0.20 mg/day; age > or = 11 years: 0.05−0.20 mg/day. **Adults:** 0.05−0.20 mg/day.

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): D007

RCRA Toxicity Characteristic (Section 261.24), Maximum Concentration of Contaminants, regulatory level, 5.0 mg/L

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 2.77; Nonwastewater (mg/kg), 0.86 as chromium, total dust

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): total dust 6010 (70); 7190 (500); 7191 (10)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 5000 lb (2270 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1% (chromium, elemental, chromic acid, chromium(VI) oxide, and chromium(III) chromate, carcinogen). NPRI; CEPA Priority Substance List; Drinking Water Quality, 0.05 mg/L MAC.

Hazard symbols, risk, & safety statements: Hazard symbol: F, C, Xi, Xn, N (dust/powder); risk phrases: R45; R10; R17; R20/21/22; R23; R34; R36; R40; R67; safety phrases: S16; S26; S27; S29/35 (dust); S36/37/39; S45; S61 (dust); S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): Nonhazard to water, solid particles, size >1 mm.

Description: Chromium may exist in one of three valence states in compounds, [II (+2)], [III (+3)], and [VI (+6)]. The most stable oxidation state is trivalent chromium; Hexavalent chromium is a less stable state. Chromium (element) blue-white to steel-gray, lustrous, brittle, hard, odorless solid. Elemental: Molecular weight = 52.00; specific gravity (H_2O:1) = 7.15; boiling point = 2642°C; freezing/melting point = 1907°C. Hazard identification (based on Ignition temperature of dust cloud = unknown; minimum explosive concentration = 0.23 oz/ft^3[209]. NFPA-704 M Rating System): [dust] Health 0, flammability 1, reactivity 0. Insoluble in water. Noncombustible Solid in bulk form, but finely divided dust burns rapidly if heated in a flame. Relative explosion hazard of dust: Strong.

Potential Exposure: Chromium metal is used in stainless and other alloy steels to impart resistance to corrosion, oxidation, and for greatly increasing the durability of metals; for chrome plating of other metals.

Incompatibilities: Dust may be pyrophoric in air. Chromium metal (especially in finely divided or powder form) and insoluble salts reacts violently with strong oxidants, such as hydrogen peroxide, causing fire and explosion hazard. Reacts with diluted hydrochloric and sulfuric acids. Incompatible with alkalis and alkali carbonates.

Permissible Exposure Limits in Air

Chromium metal

NIOSH IDLH = 250 mg[Cr]/m^3

OSHA PEL: 1 mg[Cr]/m^3 TWA

NIOSH REL: 0.5 mg[Cr]/m^3 TWA

ACGIH TLV[1]: 0.5 mg[Cr]/m^3 TWA; not classifiable as a human carcinogen

PAC Ver. 29[138]

PAC-1: 1.5 milligram per cubic meter

PAC-2: 17 milligram per cubic meter

PAC-3: 99 milligram per cubic meter

Arab Republic of Egypt: TWA 0.05 milligram per cubic meter, 1993; Australia: TWA 0.05 milligram per cubic meter, 1993; Belgium: TWA 0.5 milligram per cubic meter, 1993; Denmark: TWA 0.5 mg[Cr]/m^3, 1999; Finland: TWA 0.01 milligram per cubic meter, 1999; France: VME 0.5 milligram per cubic meter, 1999; Japan: 0.5 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 0.5 milligram per cubic meter, 2003; the Philippines: TWA 1 milligram per cubic meter, 1993; Poland: TWA 0.5 milligram per cubic meter, 1999; Sweden: NGV 0.5 milligram per cubic meter, 1999; United Kingdom: TWA 0.5 milligram per cubic meter, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Several states have set guidelines or standards for chromium in ambient air[60] ranging from 0 (North Carolina) to 0.00009 μ/m^3 (Rhode Island) to 0.068 μ/m^3 (Massachusetts) to 0.07−0.39 μ/m^3 (Montana) to 0.12 μ/m^3 (Pennsylvania) to 0.167 μ/m^3 (Virginia) to 2.5 μ/m^3 (Connecticut) to 5.0 μ/m^3 (North Dakota) to 12.0 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Methods #7024, 7300, 7301, 7303, 9102 and OSHA Analytical Methods ID-121 and ID-125G[58].

Permissible Concentration in Water: State Drinking Water Guidelines: California 10 μg[Cr(VI)]/L; Maine 35 μg [Cr(VI)]/L. Federal Drinking Water Guidelines: EPA 100 μg[Cr]/L. Safe Drinking Water Act (47FR 9352): MCL, 0.1 mg/L; MCLG, 0.1 mg/L. For the protection of freshwater aquatic life: Trivalent chromium: not to exceed [1.08 In (hardness) + 3.48] μg/L. Hexavalent chromium: 0.29 μg/L as a 24-hour average, never to exceed 21.0 μg/L. For the protection of saltwater aquatic life: Trivalent chromium: 10,300 μg/L on an acute toxicity basis. Hexavalent chromium: 18 μg/L as a 24-hour average, never to exceed 1260 μg/L. *To protect human health:* Trivalent chromium: 170 μg/L; Hexavalent chromium 50 μg/L according to EPA[6]. EPA[49] has set a long-term Health advisory: for adults of 0.84 mg/L and a lifetime Health advisory: of 0.12 mg/L (120 μg/L) for chromium. EPA's maximum drinking water level (MCL) is 0.1 mg/L[62]. The states of Maine and Minnesota have set guidelines for chromium in drinking water[61] of 50 [Cr]:g/L for Maine and 120 [Cr] μg/L for Minnesota.

Determination in Water: Total chromium may be determined by digestion followed by AA; or by colorimetry (diphenylcarbazide); or by ICP optical emission spectrometry. Chromium(VI) may be determined by extraction and AA or colorimetry (using diphenylhydrazide). Dissolved total Cr or Cr(VI) may be determined by 0.45 μ filtration followed by the above-cited methods[49].

Routes of Entry: Inhalation, ingestion, eye and skin contact.

Harmful Effects and Symptoms

Chromium can affect you when breathed in. Chromium metal ore has been reported to cause lung allergy. Chromium fumes can cause "metal fume fever," a flu-like illness lasting about 24 hours with chills, aches, cough, and fever. Chromium particles can irritate the eyes. The above cautions apply to chromium metal. Since chromium is a reasonably reactive metal, thought must be given to the actions of combined chromium and particularly to the presence or absence of carcinogenic effects in various chromium compounds. A table of differentiation between noncarcinogenic and carcinogenic chromium(VI) compounds has been presented by NIOSH as shown below. NIOSH has not conducted an in-depth study of the toxicity of chromium metal or compounds containing chromium in an oxidation state other than chromium(VI) compounds be reduced to 0.001 milligram per cubic meter, and that these compounds be regulated as occupational carcinogens. NIOSH also recommends that the permissible exposure limit for noncarcinogenic chromium(VI) be reduced to 0.025 milligram per cubic meter averaged over a work-shift of up to 10 hours per day, 40 hours per week, with a ceiling level of 0.05 milligram per cubic meter averaged over a 15-minute period. It is recommended further that chromium (VI) in the work-place be considered carcinogenic, unless it has been demonstrated that only the noncarcinogenic chromium(VI) compounds mentioned below are present. The NIOSH Criteria Documents for Chromic acid and Chromium(VI) should be consulted for more detailed information.

Short-Term Exposure: Chromium particles can irritate the eyes. Chromium fumes can cause “metal fume fever” a flu-like illness, lasting about 24−36 hours with chills, aches, cough, and fever.

Long-Term Exposure: Repeated or prolonged contact may cause skin sensitization. Chromium metal ore has been reported to cause lung allergy.

Points of Attack: Chromium metal and insoluble salts: respiratory system and lungs.

Medical Surveillance: Preemployment physical examinations should include: a work history to determine past exposure to chromic acid and hexavalent chromium compounds; exposure to other carcinogens; smoking history; history of skin or pulmonary sensitization to chromium, history, or presence of dermatitis; skin ulcers; or lesions of the nasal mucosa and/or perforation of the septum; and a chest X-ray. Periodic examinations and evaluation should be made of skin and respiratory complaints especially in workers who demonstrate allergic reactions. Chest X-rays should be taken yearly for workers over age 40, and every 5 years for younger workers. Blood, liver, lungs, and kidney function should be evaluated periodically. Urine test for chromates. This test is most accurate shortly after exposure. Regulatory exams are required for carcinogens by OSHA 1910.1002-1016.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Note to Physician: In case of fume inhalation, treat for pulmonary edema. Give prednisone or other corticosteroid orally to reduce tissue response to fume. Positive-pressure ventilation may be necessary. Treat metal fume fever with bed rest, analgesics, and antipyretics. The symptoms of metal fume fever may be delayed for 4−12 hours following exposure: it may last less than 36 hours.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Respirators should be used in areas where dust, fumes, or mist exposure exceeds Federal standards of where brief concentrations exceed the TWA, and for emergencies. Dust, fumes, and mist filter-type respirators or supplied-air respirators should be supplied all workers exposed, depending on concentration of exposure. Specific engineering controls are recommended in NIOSH criteria document #76-129, chromium(VI).

Respirator Selection: *Up to 2.5 milligram per cubic meter*: Qm (APF = 25) (any quarter-mask respirator). *Up to 5 milligram per cubic meter:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa* (APF = 10) (any supplied-air respirator) *up to 12.5 milligram per cubic meter:* Sa:Cf* (any supplied-air respirator operated in a continuous-flow mode); or PaprHie* (APF = 25) (any powered, APR with a high-efficiency particulate filter). *Up to 25 milligram per cubic meter:* 100 F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or any powered, APR with a tight-fitting facepiece and a high-efficiency particulate filter*; or any SCBA with a full facepiece; or any supplied-air respirator with a full facepiece. *Up to 250 milligram per cubic meter:* Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode. *Emergency or planned entry into un known concentrations or IDLH conditions:* Any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode; or any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive pressure breathing apparatus. *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—White: Corrosive or Contact Hazard (powder); Store separately in a corrosion resistant location. Store in tightly closed containers in a cool, well-ventilated area. Prior to working with chromium all handlers should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Store in tightly closed containers in a cool, well-ventilated area. Chromium must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine), since violent reactions occur. Sources of ignition, such as smoking and open flames are prohibited where chromium is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN3089 Metal powders, flammable, n.o.s., Hazard Class: 4.1; Labels: 4.1-Flammable solid. UN1759 Corrosive solids, n.o.s., Hazard class: 8; Labels: 8-Corrosive material, Technical Name required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Chromium metal as dust/powder is combustible and may explode in air. Thermal decomposition products may include metal oxides. Use special mixtures of dry chemicals appropriate for extinguishing metal fires. *Do not use water*. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Recovery and recycling is a viable alternative to disposal for chromium in plating wastes; tannery wastes; cooling tower blowdown water and chemical plant wastes.

References

(109); (102); (31); (173); (101); (138); (2); (170); (122); (100).

National Institute for Occupational Safety and Health (NIOSH), Criteria for a Recommended Standard: Occupational.

Exposure to Chromic acid, NIOSH Publication No. 73-11021, Cincinnati OH (1973).

National Institute for Occupational Safety and Health (NIOSH), “Criteria for a Recommended Standard: Occupational Exposure to Chromium(VI)”, NIOSH Document Number 76-129, Cincinnati, OH (1976).

National Institute for Occupational Safety and Health (NIOSH), Information Profiles on Potential Occupational Hazards: Inorganic Chromium Compounds, Report PB-276,678, pp 136−142, Rockville, MD (October 1977).

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United States Environmental Protection Agency, Chromium, Health and Environmental Effects Profile No. 51, Office of Solid Waste, Washington, DC (April 30, 1980).

Sax, N.I., Ed., “*Dangerous Properties of Industrial Materials Report*,” 1, No. 1, 40−41 (1980) and 3, No. 3, 65−68 (1983).

New York State Department of Health, *Chemical Fact Sheet* Chromium Metal, Bureau of Toxic Substance Assessment, Albany, NY (January 1986).

United States Public Health Service, “Toxicological Profile for Chromium,” Atlanta, Georgia, agency for Toxic Substances and Disease Registry (October 1987).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Chromium, Trenton, NJ (January 2000).

United States Environmental Protection Agency, *Health Assessment Document: Chromium*, EPA 600/8-83-014F, Washington, DC (1984).

Chromium Carbonyl C:1140

Formula: C_6CrO_6; $Cr(CO)_6$

Synonyms: Chromium hexacarbonyl; Hexacarbonyl chromium; Hexacarbonylchromium

CAS Registry Number: 13007-92-6

RTECS Number: GB5075000

UN/NA & ERG Number: UN3466 (solid)/151; UN3281 (liquid)/151

EC Number: 235-852-4

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: [chromium(VI)], *carcinogenic to humans*, Group 1; NTP: [chromium(VI) compounds] Known to be a human carcinogen; The German MAK value is 3B. This value is for In vitro animal studies yielding evidence of carcinogenic effects. These effects are not sufficient for classification if this material in one of the other categories.

California Proposition 65 Chemical[102]: (*hexavalent chromium*) Cancer 2/27/1987

Hazard Alert: Combustible, Explosive when heated, Possible risk of forming tumors, Suspected of causing genetic defects.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

United States National Primary Drinking Water Regulations: MCLG = 0.01 mg[Cr]/L; MCL = 0.1 mg[Cr]/L as Chromium

Clean Water Act: Toxic Pollutant (Section 401.15); 40CFR401.15 Section 307 Toxic Pollutants as chromium and compounds.

EPA ADI: Chromium(VI) = 0.175 mg/day/man. EPA EASI levels for chromium: **Infants:** age 0.0−0.5 year: 0.01−0.04 mg/day; age 0.5−1.0 year: 0.02−0.06 mg/day. **Children**: age 1−3 years: 0.02−0.08 mg/day; age 4−6 years: 0.03−0.12 mg/day; age 7−10 years: 0.05−0.20 mg/day; age > or = 11 years: 0.05−0.20 mg/day.

Adults: 0.05−0.20 mg/day.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, D007 (chromium compounds)

EPCRA (Section 313): Includes any unique chemical substance that contains chromium as part of that chemical's infrastructure.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N, Xn; risk phrases: R45; R5; R20/21/22; R44; R49; R50/53; R62; safety phrases: S36/37/39; S41; S45; S53; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Chromium carbonyl is a colorless crystalline substance which sinters (forms a coherent mass without melting) @ 90°C. Molecular weight = 220.06; freezing/melting point = (decomposes) 110°C. boiling point = explodes in lieu of boiling @ 210°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 1, reactivity 0. Insoluble in water; possible reaction.

Potential Exposure: Chromium carbonyl is used as a catalyst for hydrogenation, isomerization, water−gas shift reaction and alkylation of aromatic hydrocarbons; gasoline additive to increase octane number; preparation of chromous oxide, CrO.

Incompatibilities: Violent reaction on contact with oxidizers. Decomposed by chlorine and fuming nitric acid; sensitive to heat and light (undergoes photochemical decomposition). Many carbonyls react with water, forming toxic and flammable vapors.

Permissible Exposure Limits in Air

OSHA PEL: None

NIOSH REL: None

ACGIH TLV[1]: None for *organic* chromium compounds. However, based on its formula and synonym (chromium *hexa*carbonyl): 0.01 mg(Cr)/m^3 TWA [listed under "certain water insoluble forms" hexavalent chromium inorganic compounds]. A1: Confirmed Human Carcinogen *as hexavalent chromium compounds* (*certain water insoluble forms*).

DFG MAK: Carcinogen Category 3B

PAC Ver. 29[138]

PAC-1: 0.13 milligram per cubic meter

PAC-2: 11 milligram per cubic meter

PAC-3: 66 milligram per cubic meter

Determination in Air: Use NIOSH Analytical Methods #7600, 7604, 7605, 7703, 9101 and OSHA Analytical Methods ID-103, ID-215, W-4001.

Permissible Concentration in Water: State Drinking Water Guidelines: California 10μg[Cr(VI)]/L; Maine 35 μg [Cr(VI)]/L.

For the protection of freshwater aquatic life: Trivalent chromium: not to exceed [1.08 In (hardness) + 3.48] μg/L. Hexavalent chromium: 0.29 μg/L as a 24-hour average, never to exceed 21.0 μg/L. For the protection of saltwater aquatic life: Hexavalent chromium: 18 μg/L as a 24-hour average, never to exceed 1260 μg/L. *To protect human health:* hexavalent chromium 50 μg/L (United States Environmental Protection Agency)[6]. EPA[49] has set a long-term Health advisory: for adults of 0.84 mg/L and a lifetime Health advisory: of 0.12 mg/L (120 μg/L) for chromium. EPA has recently proposed a maximum drinking water level of 0.1 mg/L[62]. The states of Maine and Minnesota have set guidelines for chromium in drinking water[61] of 50 μg/L for Maine and 120 μg/L for Minnesota.

Determination in Water: Total chromium may be determined by digestion followed by AA; or by colorimetry (diphenylcarbazide); or by ICP optical emission spectrometry. Chromium(VI) may be determined by extraction and AA or colorimetry (using diphenylhydrazide). Dissolved total Cr or Cr(VI) may be determined by 0.45 μ filtration followed by the above-cited methods[49].

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Highly toxic. Emits toxic fumes of CO when heated. Thought to be carcinogenic.

Short-Term Exposure: Poisonous if ingested; tiny amounts may also cause digestive tract irritation. May cause eye and skin irritation. May cause skin sensitization. May cause chrome ulcers, deep lesions of the skin, usually on breaks in the skin, often found hand and lower forearm. Inhalation may cause irritation of the respiratory tract. LD_{50} (oral-rat) = 230 mg/kg (moderately toxic).

Long-Term Exposure: Chromium may cause allergic dermatitis. May cause cancer in humans. May cause lung damage. Chronic exposure to water insoluble hexavalent chromium compounds has been shown to be associated with lung cancer and gastrointestinal tract tumors.

Medical Surveillance: Preemployment physical examinations should include: a work history to determine past exposure to chromic acid and hexavalent chromium compounds; exposure to other carcinogens; smoking history; history of skin or pulmonary sensitization to chromium, history or presence of dermatitis; skin ulcers; or lesions of the nasal mucosa and/or perforation of the septum; and a chest X-ray. Periodic examinations and evaluation should be made of skin and respiratory complaints especially in workers who demonstrate allergic reactions. Chest X-rays should be taken yearly for workers over age 40, and every 5 years for younger workers. Blood, liver, lungs, and kidney function should be evaluated periodically. Urine test for chromates. This test is most accurate shortly after exposure. Regulatory exams are required for carcinogens by OSHA 1910.1002-1016.

First Aid: *Skin Contact:* Flood all areas of body that have contacted the substance with water. Don't wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others. *Eye Contact:* Remove any contact lenses at once. Immediately flush eyes well with copious quantities of water or normal saline for at least 20−30 minutes. Seek Medical attention. *Inhalation:* Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing, or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion:* Contact a physician, hospital, or poison center at once. If the victim is unconscious or convulsing, do not induce vomiting or give anything by mouth. Assure that the patient's airway is open and lay him on his side with his head lower than his body and transport immediately to a medical facility. If conscious and not convulsing, give a glass of water to dilute the substance. Vomiting should not be induced without a physician's advice.

Respirator Selection: NIOSH, as chromates: *at any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure, locked, poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area or in a refrigerator. Protect from light. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN3466 Metal carbonyls, solid n.o.s. Hazard class 6.1. Technical name required. UN3281 Metal carbonyls, liquid n.o.s. Hazard class 6.1. Technical name required, Potential Inhalation Hazard (Special Provision 5). UN3466 Metal carbonyls, solid n.o.s. Hazard class 6.1. Technical name required.

Spill Handling:

Metal carbonyls, liquid n.o.s.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 300/90
Then: Protect persons downwind (mi/km)
Day 0.9/1.5
Night 3.4/5.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 3000/900
Then: Protect persons downwind (mi/km)
Day 7.1 + /11 +
Night 7.0 + /11 + *

" + " means distance can be larger in certain atmospheric conditions.

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Large spills can be cleaned up using JP-4L or JP-5 (jet engine fuels). Isopropyl alcohol may be used to cleanup moderate spills, while methyl ethyl ketone should be used for cleaning *small spills* and quick disconnects. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Chromium carbonyl is a flammable compound and extreme care should be used in firefighting both due to the carcinogenic nature of the material and the emission of CO as a decomposition product. Thermal decomposition products may include oxides of metal and carbon. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Use a licensed professional waste disposal service to dispose of this material. All federal, state, and local environmental regulations must be observed. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform to EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(102); (31); (101); (138); (2); (122); (100).

Chromium Nitrate C:1150

Formula: CrN_3O_9; $Cr(NO_3)_3$

Synonyms: Chromic nitrate; Chromium(III) nitrate; Chromium (3+) nitrate; Chromium trinitrate; Nitric acid, chromium(3+) salt; Nitrato cromico (Spanish)

Nonahydrate: Chromium nitrate nonahydrate; Chromic nitrate nonahydrate; Chromium trinitrate nonahydrate; Nitric acid, chromium (3+) salt, nonahydrate

CAS Registry Number: 10103-47-6; 13548-38-4 (III); 7789-02-8 (nonahydrate); 17135-66-9

RTECS Number: GB6280000; GB3600000

UN/NA & ERG Number: UN2720/141

EC Number: 236-921-1 (trinitrate)

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human Inadequate Evidence; Animal Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1997.

Hazard Alert: Strong oxidizer, Unstable, possibly shock-sensitive, Suspected reprotoxic hazard, as nonhydrate (CAS: 7789-02-8); Environmental hazard.

United States National Primary Drinking Water Regulations: MCLG = 0.01 mg[Cr]/L; MCL = 0.1 mg[Cr]/L as Chromium: 0.01 mg/L; MCL = 0.1 mg/L as chromium; 10 mg[N]/L; MCL = 10 mg/L as nitrates

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Clean Water Act: Toxic Pollutant (Section 401.15); 40CFR401.15 Section 307 Toxic Pollutants as chromium and compounds

EPA ADI: Chromium(III) = 125 mg/day/man. EPA EASI levels for chromium: **Infants:** age 0.0−0.5 year: 0.01−0.04 mg/day; age 0.5−1.0 year: 0.02−0.06 mg/day. **Children:** age 1−3 years: 0.02−0.08 mg/day; age 4−6 years: 0.03−0.12 mg/day; age 7−10 years: 0.05−0.20 mg/day; age > or = 11 years: 0.05−0.20 mg/day.

Adults: 0.05−0.20 mg/day.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, D007 (chromium compounds)

EPCRA (Section 313): Includes any unique chemical substance that contains chromium as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: Chromium(III) compounds: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. as Chromium(III) compounds, NPRI; CEPA Priority Substance List (as chromium compounds).

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

European/International Regulations: Hazard symbol: T, O, Xi, N; risk phrases: R45; R8; R38; R41; R43; R49; R50/53; S63; safety phrases: S8; S17; S29/25; S36/38; S41; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to waters.

Description: Chromium nitrate is a crystalline substance, variously stated to be green brown or purple and existing in various hydrated forms. Molecular weight = 238.03; 400.21 (nonahydrate); freezing/melting point = 60−100°C, depending on the degree of hydration. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 0, reactivity 0. Soluble in water.

Potential Exposure: Chromium nitrate is used in the preparation of chrome catalysts, in textile printing operations; and as a corrosion inhibitor. Used to make other chemicals.

Incompatibilities: This chemical is a strong oxidizer. Contact with reducing agents; fuels, ethers, and other flammable and combustible materials cause a fire and explosion hazard. Violent reaction with many compounds, including reducing agents; alcohols, chemically active metals; combustible materials, strong acids, alkaline earth sulfides, aluminum carbides, aluminum, amines, calcium sulfide, carbides, chlorine trifluoride, glycerin, hydrides, hydrochloric acid, hydrogen peroxide, hydrogen sulfide, hydroxylamine, magnesium, metal powders, metal sulfides, molybdenum, phenylhydrazine, phosphorous red/friction, phosphorous trichloride, silicon, sulfides, sulfur, sulfur dioxide, sulfur/friction, sulfuric acid, tungsten, hydrogen trisulfide.

Permissible Exposure Limits in Air
NIOSH IDLH = 25 mg[Cr(III)]/m^3
OSHA PEL: 0.5 mg[Cr]/m^3 TWA
NIOSH REL: 0.5 mg[Cr]/m^3 TWA limit exposures to lowest feasible concentration.
ACGIH TLV[1]: 0.5 mg[Cr]/m^3 TWA; not classifiable as a human carcinogen
DFG MAK: [skin] danger of skin sensitization
PAC Ver. 29[138]
10103-47-6
PAC-1: 33 milligram per cubic meter
PAC-2: 36 milligram per cubic meter
PAC-3: 220 milligram per cubic meter
13548-38-4
PAC-1: 6.9 milligram per cubic meter
PAC-2: 110 milligram per cubic meter
PAC-3: 640 milligram per cubic meter

Determination in Air: Use NIOSH Analytical Methods #7024, 7300, 7301, 7303, 9102 and OSHA Analytical Methods ID-121 and ID-125G[58].

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 100 μg[Cr]/L. For the protection of freshwater aquatic life: Trivalent chromium: not to exceed [1.08 In (hardness) + 3.48]μg/L. Trivalent chromium: 10,300 μg/L on an acute toxicity basis. *To protect human health:* Trivalent chromium: 170 μg/L; Hexavalent chromium 50 μg/L according to EPA[6]. EPA[49] has set a long-term Health advisory: for adults of 0.84 mg/L and a lifetime Health advisory: of 0.12 mg/L (120 μg/L) for chromium. EPA has recently proposed a maximum drinking water level of 0.1 mg/L.

Determination in Water: Total chromium may be determined by digestion followed by AA, or by colorimetry; (diphenylcarbazide); or by ICP optical emission spectrometry. Dissolved total Cr or Cr(VI) may be determined by 0.45 μ filtration followed by the above-cited methods[49].

Routes of Entry: Skin contact, inhalation, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Chromium nitrate can affect you when breathed in. Chromium nitrate may cause mutations. Handle with extreme caution. Skin contact may cause irritation, especially if repeated or prolonged. Skin allergy sometimes occurs, with itching, redness, and/or an eczema-like rash. If this happens, future contact can trigger symptoms. Eye contact may cause irritation.

Long-Term Exposure: Chromium may cause allergic dermatitis. May cause genetic changes; birth defects; skin allergy with rash and itching.

Points of Attack: Irritation of eyes; sensitization dermatitis.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. NIOSH lists the following tests [chromium(III) compounds]: whole blood (chemical/metabolite); biologic tissue/biopsy; chest X-ray; pulmonary function tests; red blood cells/count; urine (chemical/metabolite) [end-of-shift] [end-of-shift at end-of-work-week] [end-of-work-week] [pre- & postshift].

First Aid: If chromium nitrate gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek Medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear-splash or dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 2.5 milligram per cubic meter*: Qm* (APF = 25) (any quarter-mask respirator). *Up to 5 milligram per cubic meter:* 95XQ* (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa* (APF = 10) (any supplied-air respirator). *Up to 12.5 milligram per cubic meter:* Sa:Cf* (any supplied-air respirator operated in a continuous-flow mode); or PaprHie* (any PAPR with a high-efficiency particulate filter). *Up to 25 milligram per cubic meter:* 100 F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or PaprTHie* (any powered, APR with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (any SCBA with a full facepiece); or SaF (any supplied-air respirator with a full facepiece) *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Oxidizers should be isolated from acids, metals, organic materials, and ammonium nitrate. (1) Color code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially organic materials, flammables and combustibles, and other incompatible materials. Oxidizers, including oxidizing gases, should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. (2) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Chromium Nitrate must be stored to avoid contact with strong reducing agents such as hydrides; fuels, and ether, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from flammable and combustible materials. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage regulations.

Shipping: UN2720 Chromium nitrate, Hazard Class: 5.1; Labels: 5.1-Oxidizer.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. Keep chromium nitrate out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Chromium nitrate itself does not burn but it will increase the intensity of a fire since it is an oxidizer. Thermal decomposition products may include nitrogen oxides and chromium oxide fumes. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Precipitate chromium as the hydroxide. Dewater the sludge and dispose of in single-purpose dumps[22].

References

(31); (173); (101); (138); (2); (122); (100).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Chromium nitrate, Trenton, NJ (May 2001, 1987).

United States Environmental Protection Agency, *Health Assessment Document: Chromium*, EPA 600/8-83-014F, Washington, DC (1984).

Chromium(III) Oxide C:1160

Formula: Cr_2O_3

Synonyms: Anadomis green; Anidride cromique (French); Casalis green; Chrome green; Chrome oxide; Chromia; Chromic acid; Chromic oxide; Chromium(3+) oxide; Chromium(III) oxide; Chromium sesquioxide; Chromium (3+) trioxide; C.I. 77288; C.I. Pigment green; Dichromium trioxide; Green chromic oxide; Green cinnabar; Green GA; Green rouge; Leaf green; Levanox; Oil green; Oxido de cromo (Spanish); Ultramarine green

CAS Registry Number: 1308-38-9; 20770-05-2 (hydroxide)

HSDB Number: 1619

RTECS Number: GB6475000

UN/NA & ERG Number: UN3086 (toxic solids, oxidizing, n.o.s.)/141

EC Number: 215-160-9

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human Inadequate Evidence; Animal Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1997; EPA (insoluble salts): Not Classifiable as to human carcinogenicity; Cannot be Determined.

Carcinogenicity: IARC: Human Inadequate Evidence; Animal Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3.

Hazard Alert: Poison, Possible risk of forming tumors, Suspected reprotoxic hazard.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

United States National Primary Drinking Water Regulations: MCLG = 0.01 mg[Cr]/L; MCL = 0.1 mg[Cr]/L as Chromium

Clean Water Act: Toxic Pollutant (Section 401.15); 40CFR 401.15 Section 307 Toxic Pollutants as chromium and compounds.

EPA ADI: Chromium(III) = 125 mg/day/man.

EPA EASI levels for chromium: **Infants:** age 0.0−0.5 year: 0.01−0.04 mg/day; age 0.5−1.0 year: 0.02−0.06 mg/day. **Children:** age 1−3 years:

0.02−0.08 mg/day; age 4−6 years: 0.03−0.12 mg/day; age 7−10 years: 0.05−0.20 mg/day; age > or = 11 years: 0.05−0.20 mg/day. **Adults:** 0.05−0.20 mg/day.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, D007 (chromium compounds)

EPCRA (Section 313): Includes any unique chemical substance that contains chromium as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: Chromium(III) compounds: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. as Chromium(III) compounds, n.o.s.; NPRI; CEPA Priority Substance List.

WGK[100] (German Aquatic Hazard Class): Nonhazard to water.

Description: Chromium oxide is a bright green, odorless powder. Molecular weight = 151.99; 85 (*20770-05-2, chromium (III) oxide hydroxide*); specific gravity (H_2O:1) = 5.22; freezing/melting point = 2266°C (± 25°C); 2320°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 0. Insoluble in water.

Potential Exposure: Chromium(III) oxide is used as a paint pigment, a fixative for certain textile dyes; in the manufacture of chromium; and a catalyst.

Incompatibilities: A strong oxidizer. Contact with reducing agents; organics, and combustibles may be violent.

Permissible Exposure Limits in Air

NIOSH IDLH = 25 mg[Cr(III)]/m^3

OSHA PEL: 0.5 mg[Cr]/m^3 TWA

NIOSH REL: 0.5 mg[Cr]/m^3 TWA limit exposures to lowest feasible concentration.

ACGIH TLV[1]: 0.5 mg[Cr]/m^3 TWA; not classifiable as a human carcinogen

PAC Ver. 29[138]

1308-38-9

PAC-1: 2.2 milligram per cubic meter

PAC-2: 24 milligram per cubic meter

PAC-3: 140 milligram per cubic meter

20770-05-2, chromium(III) oxide hydroxide

PAC-1: 2.5 milligram per cubic meter

PAC-2: 27 milligram per cubic meter

PAC-3: 160 milligram per cubic meter

DFG MAK: [skin] danger of skin sensitization

Determination in Air: Use NIOSH Analytical Methods #7024, 7300, 7301, 7303, 9102 and OSHA Analytical Methods ID-121 and ID-125G[58].

Permissible Concentration in Water: For the protection of freshwater aquatic life: Trivalent chromium: not to exceed [1.08 In (hardness) + 3.48]μg/L. For the protection of saltwater aquatic life: Trivalent chromium: 10,300 μg/L on an acute toxicity basis. *To protect human health:* Trivalent chromium: 170 μg/L (EPA)[6]. EPA[49] has set a long-term Health advisory: for adults of 0.84 mg/L and a lifetime Health advisory: of 0.12 mg/L (120 μg/L) for chromium. EPA's maximum drinking water level (MCL) is 0.1 mg/L[62]. The states of Maine and Minnesota have set guidelines for chromium in drinking water[61] of 50 g/L for Maine and 120 μg/L for Minnesota.

Determination in Water: Total chromium may be determined by digestion followed by AA, or by colorimetry (diphenylcarbazide); or by ICP optical emission spectrometry.

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 100 μg[Cr]/L.

Routes of Entry: Inhalation of dust or mist, skin contact, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Eye contact can cause irritation. Skin allergy may occur with itching, redness, and/or an eczema-like rash. Persons allergic to other chromium compounds may be more likely to develop skin allergy to this chemical.

Long-Term Exposure: Chromium may cause allergic dermatitis. There is limited evidence that chromium(III) oxide is a teratogen in animals, and until further testing is done, it should be treated as a possible teratogen in humans. Chromium(III) oxide has been tested and has *not* been shown to cause cancer in animals (NJ Department of Health, 5/1988). Skin allergy may develop from repeated exposure to this chemical.

Points of Attack: Irritation of eyes; sensitization dermatitis.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. NIOSH lists the following tests [chromium(III) compounds]: whole blood (chemical/metabolite); biologic tissue/biopsy; chest X-ray; pulmonary function tests; red blood cells/count; urine (chemical/metabolite) [end-of-shift] [end-of-shift at end-of-work-week] [end-of-work-week] [pre- & postshift].

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a Medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: *Clothing:* Avoid skin contact with Chromium(III) oxide. Wear protective gloves and clothing. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day and put on before work. *Eye Protection:* Eye protection is included in the recommended respiratory protection.

Respirator Selection: *Up to 2.5 milligram per cubic meter*: Qm* (APF = 25) (any quarter-mask respirator). *Up to 5 milligram per cubic meter:* 95XQ* (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa* (APF = 10) (any supplied-air respirator). *Up to 12.5 milligram per cubic meter:* Sa:Cf* (any supplied-air respirator operated in a continuous-flow mode); or PaprHie* (any PAPR with a high-efficiency particulate filter). *Up to 25 milligram per cubic meter:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or PaprTHie* (any powered, APR with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (any SCBA with a full facepiece); or SaF (any supplied-air respirator with a full facepiece) *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: (1) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. (2) Color code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Oxidizers should be isolated from acids, metals, organic materials, and ammonium nitrate. Chromium(III) oxide must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine), glycerol and oxygen difluoride, since violent reactions occur. A regulated, marked area should be established where chromium(III) oxide is handled, used, or stored. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: UN3086 Toxic solids, oxidizing, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, 5.1-Oxidizer. Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Chromium(III) oxide itself does not burn. Thermal decomposition products may include oxides of chromium metal. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (2); (122); (100).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Chromium(III) Oxide, Trenton, NJ (May 1998).

New York State Department of Health, *Chemical Fact Sheet* Chromium(III) Oxide, Bureau of Toxic Substance Assessment, Albany, NY (March 1986 and Revised Version #2).

United States Environmental Protection Agency, *Health Assessment Document: Chromium*, EPA 600/8-83-014 F, Washington, DC (1984).

Chromium Potassium Sulfate C:1170

Formula: $CrKO_8S_2$; $CrK(SO_4)_2$

Synonyms: Chrome alum; Chrome potash alum; Chromic potassium sulfate; Chromic potassium sulfate; Chromium potassium sulfate; Chromium potassium sulfate; Crystal chrome alum; Potash alum; Potassium chromic sulfate; Potassium chromium alum; Potassium disulphatochromate (III); Sulfuric acid, chromium(3+) potassium salt

CAS Registry Number: 10141-00-1 (anhydrous)

RTECS Number: GB6845000 (anhydrous); GB6850000 (dodecahydrate)

UN/NA & ERG Number: UN3288 (Toxic solid, inorganic, n.o.s.)/151

EC Number: 233-401-6 [chromium potassium bis(sulfate)]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human Inadequate Evidence; Animal Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1997; EPA: Not Classifiable as to human carcinogenicity; Cannot be Determined.

Hazard Alert: Possible risk of forming tumors, Suspected of causing genetic defects, Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

United States National Primary Drinking Water Regulations: MCLG = 0.01 mg[Cr]/L; MCL = 0.1 mg[Cr]/L as Chromium; MCLG = 0.01 mg[Cr]/L; MCL = 0.1 mg[Cr]/L as Chromium; SMCL = 250 mg[SO_4^{-2}]/L as Sulfate.

Clean Water Act: Toxic Pollutant (Section 401.15); 40CFR401.15 Section 307 Toxic Pollutants as chromium and compounds.

EPA ADI: Chromium(III) = 125 mg/day/man.

EPA EASI levels for chromium: **Infants:** age 0.0–0.5 year: 0.01–0.04 mg/day; age 0.5–1.0 year: 0.02–0.06 mg/day. **Children:** age 1–3 years: 0.02–0.08 mg/day; age 4–6 years: 0.03–0.12 mg/day; age 7–10 years: 0.05–0.20 mg/day; age > or = 11 years: 0.05–0.20 mg/day. **Adults:** 0.05–0.20 mg/day.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, D007 (chromium compounds)

EPCRA (Section 313): Includes any unique chemical substance that contains chromium as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: Chromium(III) compounds: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. as Chromium(III) compounds, n.o.s.; NPRI; CEPA Priority Substance List.

Hazard symbols, risk, & safety statements: Hazard symbol: Xi; risk phrases: R36/38; R41; R51; safety phrases: S16; S26; S36/37/39; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Chromium potassium sulfate is a crystalline compound whose color may range from violet-red to black. Molecular weight = 287.3; 499.41 (*dodecahydrate*); specific gravity (H_2O:1) = 1.83 (*dodecahydrate*); freezing/melting point = 89°C; soluble in water.

Potential Exposure: This material is used in tanning of leather; dyeing of fabrics; manufacture of glues and gums, chromium salts; ink, photographic emulsions, and ceramics.

Incompatibilities: Contact with magnesium, aluminum may cause fire and explosion hazard.

Permissible Exposure Limits in Air

NIOSH IDLH = 25 mg[Cr(III)]/m^3

OSHA PEL: 0.5 mg[Cr]/m^3 TWA

NIOSH REL: 0.5 mg[Cr]/m^3 TWA limit exposures to lowest feasible concentration.

ACGIH TLV[1]: 0.5 mg[Cr]/m^3 TWA; not classifiable as a human carcinogen

Determination in Air: Use NIOSH Analytical Methods #7024, 7300, 7301, 7303, 9102 and OSHA Analytical Methods ID-121 and ID-125G[58].

Permissible Concentration in Water: For the protection of freshwater aquatic life: Trivalent chromium: not to exceed [1.08 In (hardness) + 3.48]μg/L. For the protection of saltwater aquatic life: Trivalent chromium: 10,300 μg/L on an acute toxicity basis. *To protect human health:* Trivalent chromium: 170 μg/L; Hexavalent chromium 50 μg/L according to EPA[6]. United States Environmental Protection Agency[49] has set a long-term Health advisory: for adults of 0.84 mg/L and a lifetime Health advisory: of 0.12 mg/L (120 μg/L) for chromium. EPA's maximum drinking water level (MCL) is 0.1 mg/L[62]. The states of Maine and Minnesota have set guidelines for chromium in drinking water[61] of 50 μg/L for Maine and 120 μg/L for Minnesota.

Determination in Water: Total chromium may be determined by digestion followed by AA, or by colorimetry (diphenylcarbazide); or by ICP optical emission spectrometry. Dissolved total Cr or Cr(VI) may be determined by 0.45 μ filtration followed by the above-cited methods[49].

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 100 μg[Cr]/L.

Routes of Entry: Inhalation, eyes, skin.

Harmful Effects and Symptoms

Short-Term Exposure: *Inhalation:* May cause irritation to mouth, nose, throat, and lungs. *Skin:* May cause irritation, redness, and sores. Allergic reaction may occur in sensitive individuals. *Eyes:* May cause irritation. *Ingestion:* Large quantities may cause stomach irritation and nausea.

Long-Term Exposure: Chromium may cause allergic dermatitis.

Points of Attack: Skin.

Medical Surveillance: Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. NIOSH lists the following tests [chromium(III) compounds]: whole blood (chemical/metabolite); biologic tissue/biopsy; chest X-ray; pulmonary function tests; red blood cells/count; urine (chemical/metabolite) [end-of-shift] [end-of-shift at end-of-work-week] [end-of-work-week] [pre- & postshift].

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash or dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *up to 2.5 milligram per cubic meter*: Qm* (APF = 25) (any quarter-mask respirator). *Up to 5 milligram per cubic meter:* 95XQ* (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa*

(APF = 10) (any supplied-air respirator). *Up to 12.5 milligram per cubic meter:* Sa:Cf* (any supplied-air respirator operated in a continuous-flow mode); or PaprHie* (any PAPR with a high-efficiency particulate filter). *Up to 25 milligram per cubic meter:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or PaprTHie* (any powered, APR with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd, Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Keep away from heat.

Shipping: UN3288 Toxic solids, inorganic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material is not flammable. Use extinguisher appropriate for surrounding fire. Thermal decomposition products may include oxides of chromium metal and potassium sulfate. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (122); (100).

New York State Department of Health, *Chemical Fact Sheet*: Chromium potassium sulfate, Bureau of Toxic Substance (2). Assessment, Albany, NY (January 1986).

United States Environmental Protection Agency, *Health Assessment Document: Chromium*, EPA 600/8-83-014 F, Washington, DC (1984).

Chromium Trioxide C:1180

Formula: CrO_3

Synonyms: Anhydride chromique (French); Chrome (trioxyde de) (French); Chromic acid mg[CrO_3]; Chromic(VI) acid; Chromic anhydride; Chromic trioxide; Chromium oxide; Chromium(VI) oxide; Chromium trioxide; Chromium(6+) trioxide; Chromsaeureanhydrid (German); Chromtrioxid (German); Monochromium oxide; Monochromium trioxide; Puratronic chromium trioxide

CAS Registry Number: 1333-82-0; *(alt.)* 12324-05-9; *(alt.)* 12324-08-2

HSDB Number: 518

RTECS Number: GB6650000

UN/NA & ERG Number: UN1463 (anhydrous)/141

EC Number: 215-607-8 [*Annex I Index No.:* 024-001-00-0]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human Sufficient Evidence; Animal Sufficient Evidence, *carcinogenic to humans*, Group 1, 1997; NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen; EPA *(inhalation)*: Known human carcinogen; EPA *(oral)*: Not Classifiable as to human carcinogenicity; NTP: Known to be a human carcinogen

California Proposition 65 Chemical[102]: (*hexavalent chromium*) Cancer 2/27/1987; Developmental/Reproductive toxin (male, female) 12/19/2008.

Hazard Alert: Exposure can be lethal, Strong oxidizer, Sensitization hazard (skin, resp.), Possible risk of forming tumors, Reproductive toxin: possible risk of gene damage/impaired fertility; Suspected reprotoxic hazard, Environmental hazard.

OSHA Table Z-1-A Air Contaminant as chromic acid and chromates mg[CrO_3]

Banned or Severely Restricted (Some countries) (UN)[35]

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

United States National Primary Drinking Water Regulations: MCLG = 0.01 mg[Cr]/L; MCL = 0.1 mg[Cr]/L as Chromium

Clean Water Act: Toxic Pollutant (Section 401.15); 40CFR401.15 Section 307 Toxic Pollutants as chromium and compounds.

EPA ADI: Chromium(VI) = 0.175 mg/day/man. EPA EASI levels for chromium: **Infants:** age 0.0−0.5 year: 0.01−0.04 mg/day; age 0.5−1.0 year: 0.02−0.06 mg/day. **Children:** age 1−3 years: 0.02−0.08 mg/day; age 4−6 years: 0.03−0.12 mg/day; age 7−10 years: 0.05−0.20 mg/day; age > or = 11 years: 0.05−0.20 mg/day. **Adults**: 0.05−0.20 mg/day.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, D007 (chromium compounds)

EPCRA (Section 313): Includes any unique chemical substance that contains chromium as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: Chromium(VI) compounds: 0.1%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%. NPRI; CEPA Priority Substance List.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: O, T+, N; risk phrases: R45; R8; R9; R24/25; R26; R35; R42/43; R50/53; R62; R63; safety phrases: S17; S29/35; S41; S45; S53; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Chromium trioxide is a dark-red crystalline substance. It is odorless. Molecular weight = 100.00; specific gravity (H_2O:1) = 2.70; boiling point = (decomposes below BP) @ 250°C; freezing/melting point = 197°C. Hazard identification (based on NFPA-704 M Rating System): Health 4, flammability 0, reactivity 3 (Oxidizer). It is deliquescent. Soluble in water.

Potential Exposure: Chromium trioxide is used in plating and metal treatment, as a corrosion inhibitor; and as an oxidant; in aluminum anodizing, dye; ink, and paint manufacturing, tanning, engraving; and photography.

Incompatibilities: Chromium trioxide is a strong oxidizer. The solution in water is a strong acid. Reacts violently with bases and is corrosive. Contact with reducing agents; fuels, organic chemicals, flammable and combustible materials, causing fire and explosion hazard. This chemical decomposes above 250°C to chromic oxide and oxygen with increased fire hazard. Attacks metals in the presence of moisture.

Permissible Exposure Limits in Air

as chromium(VI) inorganic soluble compounds

NIOSH IDLH = 15 mg[Cr(VI)]/m^3

OSHA PEL: 0.005 mg[Cr(VI)]/m^3 TWA Concentration. See 29CFR1910.1026

NIOSH REL: 0.001 mg[Cr]/m^3 TWA, potential carcinogen, limit exposure to lowest feasible level. NIOSH considers all Cr(VI) compounds (including chromic acid, *tert*-butyl chromate, zinc chromate, and chromyl chloride) to be potential occupational carcinogens. See *NIOSH Pocket Guide*, Appendices A and C.

ACGIH TLV[1]: 0.05 mg[Cr]/m^3 TWA, Confirmed Human Carcinogen; BEI issued

PAC Ver. 29[138]

PAC-1: 0.29 milligram per cubic meter

PAC-2: 5 milligram per cubic meter

PAC-3: 30 milligram per cubic meter

DFG MAK: [skin] Danger of skin sensitization; Carcinogen Category 1; TRK: 0.05 mg[Cr]/m^3; 20 μg/L [Cr] in urine at end-of-shift

Austria: carcinogen, 1999; Denmark: TWA 0.02 mg[Cr]/m^3, 1999; Finland: carcinogen, 1993; France: VME 0.05 milligram per cubic meter, VLE 0.1 milligram per cubic meter, carcinogen, 1999; Japan: EOL 0.05 mg[Cr]/m^3, 1999; Norway: TWA 0.02 milligram per cubic meter, 1999; Poland: TWA 0.1 mg[Cr]/m^3; STEL 0.3 mg[Cr]/m^3, 1999; Russia: STEL 0.01 milligram per cubic meter [skin] 1993; Switzerland: TWA 0.02 milligram per cubic meter, carcinogen, 1999; United Kingdom: TWA 0.05 mg[Cr]/m^3, carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Confirmed human carcinogen. Connecticut[60] has set a guideline for chromium trioxide in ambient air of 0.25 μ/m^3.

Determination in Air: Use NIOSH Analytical Methods #7600, 7604, 7605, 7703, 9101 and OSHA Analytical Methods ID-103, ID-215, W-4001.

Permissible Concentration in Water: Permissible concentration in Water: State Drinking Water Guidelines: California 10 μg[Cr(VI)]/L; Maine 35 μg[Cr(VI)]/L. For the protection of freshwater aquatic life: Hexavalent chromium: 0.29 μg/L as a 24-hour average, never to exceed 21.0 μg/L. For the protection of saltwater aquatic life: Hexavalent chromium: 18 μg/L as a 24-hour average, never to exceed 1260 μg/L. *To protect human health:* hexavalent chromium 50 μg/L according to EPA[6]. EPA[49] has set a long-term Health advisory: for adults of 0.84 mg/L and a lifetime Health advisory: of 0.12 mg/L (120 μg/L) for chromium. EPA's maximum drinking water level (MCL) is 0.1 mg/L[62]. The states of Maine and Minnesota have set guidelines for chromium in drinking water[61] of 50 μg/L for Maine and 120 μg/L for Minnesota.

Determination in Water: Total chromium may be determined by digestion followed by AA, or by colorimetry (diphenylcarbazide); or by ICP optical emission spectrometry. Chromium(VI) may be determined by extraction and AA or colorimetry (using diphenylhydrazide). Dissolved total Cr or Cr(VI) may be determined by 0.45 μ filtration followed by the above-cited methods[49].

Routes of Entry: Inhalation, skin contact, ingestion.

Harmful Effects and Symptoms

Extremely corrosive to skin.

Short-Term Exposure: *Inhalation:* Human exposure to concentrations between 0.18−1.4 milligram per cubic meter of acid mist for 2 weeks produced irritation of the nose; after 4 weeks, ulcers of the nose developed; and after 8 weeks, holes formed in the tissue separating the nostrils with bleeding, discharge or formation of a crust in the inner nose. Additional effects noted in humans exposed to unknown concentrations are irritation of the throat, voicebox, lungs; asthmatic attacks, headache, wheezing, coughing, shortness of breath; and painful breathing. Chromic trioxide can cause severe allergic lung reaction. *Skin:* Direct contact will produce severe irritation of the skin. Sensitization from such contact can occur and result in severe dermatitis from very small exposures at a later time. *Eyes:* Can cause severe irritation, burns, and possible loss of vision. *Ingestion:* Swallowing of chromic acid solutions can result in severe irritation and damage to the mouth, throat, and stomach.

Long-Term Exposure: Chromium may cause allergic dermatitis. Prolonged Exposure to chromic acid mist can result in perorations (holes) of the nasal septum (tissue separating the nostrils); lung irritation with symptoms similar to asthma and liver damage. Repeated or prolonged contact with skin may cause dermatitis and chrome ulcers, or "chrome holes." May cause skin sensitization, allergy, irritation, and rashes. Repeated or prolonged inhalation exposure may cause asthma-like reactions. Wearing away of the surfaces of teeth has been noted in workers exposed to chromic acid mist for a prolonged time. This substance is carcinogenic to humans. It has been shown to cause lung and throat cancers. There is limited evidence that this chemical is a teratogen in animals. May cause kidney and liver damage.

Points of Attack: Skin, lungs, kidney, liver.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for Medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure. NIOSH lists the following tests: Blood gas analysis, CBC; chest X-ray, electrocardiogram, liver function tests; pulmonary Function tests, sputum cytology, urine (chemical/metabolite), UA (routine), white blood cell count/differential. Before first exposure and every 6−12 months, a medical history and exam is recommended, with very careful attention to the nose, skin, lungs, and voice box. If you notice skin, nose, or lung effects, seek prompt medical attention. Also check your skin daily for little bumps or blisters, the first sign of "chrome ulcers." If not treated early, these can last for years after exposure. If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear acid resistant gloves and clothing to prevent any reasonable probability of skin or eye contact. (as chromic acid and chromates) **8 hours** (more than 8 hours of resistance to breakthrough $>0.1\ \mu g/cm^2/min$): polyethylene gloves, suits, boots; polyvinyl chloride gloves, suits, boots; Saranex-coated suits; **4 hours** (At least 4 but <8 hours of resistance to breakthrough $>0.1\ \mu g/cm^2/min$): butyl rubber gloves, suits, boots; Viton gloves, suits Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. AIHA recommends polyvinyl chloride for solutions of Chromium(VI) oxide in water as a protective material. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Specific engineering controls are recommended in NIOSH criteria document #76-129, chromium(VI).

Respirator Selection: NIOSH, as chromates: *at any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Check oxygen content prior to entering storage area. UN1463 (1) Color code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially organic materials, flammables and combustibles, and other incompatible materials. Oxidizers, including oxidizing gases, should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. *Note*: Store corrosives in this group in chemical resistant secondary containers or in corrosion proof cabinets. UN1755 (2) Color code—White: Corrosive or contact Hazard; Store separately in a corrosion resistant location. *Note:* Store corrosives in this group in chemical resistant secondary containers and/or in corrosion proof cabinets. (3) Color code—Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. Prior to working with chromium(VI) oxide all handlers should be trained on its proper handling and storage. Chromium(VI) oxide must be stored to avoid contact with reducing agents and organic chemicals, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from fuels and other flammable and combustible materials. Do not store chromium(VI) oxide on wood floors, because prolonged contact with wood can produce a fire hazard. Protect from excess moisture to minimize rusting of containers. A regulated, marked area should be established where chromium(VI) oxide is handled, used, or stored. Store in a cool, well-ventilated area away from incompatible materials listed above. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN1463 (anhydrous), Chromium trioxide, anhydrous, Chromium trioxide, anhydrous, Hazard Class: 5.1; Labels: 5.1-Oxidizer, 6.1-Poisonous materials, 8-Corrosive material. UN1755 (solution), Hazard class: 8; Labels: 8-Corrosive material.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. Keep chromium(VI) oxide out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of metal. Extinguish fire using an agent suitable for type of surrounding fire. Chromium(VI) oxide itself does not burn but it will increase the intensity of a fire since it is an oxidizer. The substance decomposes above 250°C to chromic oxide and oxygen with increased fire hazard. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Reduce to Cr(III). If material cannot be recovered and recycled, dispose of sludge in a chemical waste landfill[22].

References

(109); (102); (31); (173); (101); (138); (2); (122); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 7, 47–49 (1981).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Chromium(VI) Oxide, Trenton, NJ (April 1998).

New York State Department of Health, *Chemical Fact Sheet* Chromic Acid, Bureau of Toxic Substance Assessment, Albany, NY (January 1986).

United States Environmental Protection Agency, *Health Assessment Document: Chromium*, EPA 600/8-83-014F, Washington, DC (1984).

Chromous Chloride C:1200

Formula: Cl_2Cr

Synonyms: Chromium chloride; Chromium(2+) chloride; Chromium(II) chloride; Chromium dichloride; Cloruro cromoso (Spanish)

CAS Registry Number: 10049-05-5

HSDB Number: 988

RTECS Number: GB5250000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171; UN3260 (solid)/154

EC Number: 233-163-3

Regulatory Authority and Advisory Information

Hazard Alert: Suspected reprotoxic hazard.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112). as chromium compounds

United States National Primary Drinking Water Regulations: MCLG = 0.01 mg[Cr]/L; MCL = 0.1 mg[Cr]/L as Chromium; 0.01 mg[Cr]/L; MCL = 0.1 mg[Cr]/L as chromium; SMCL = 250 mg[Cl^-]/L as Chloride.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992); 40CFR401.15 Section 307 Toxic Pollutants

EPA EASI levels for chromium: **Infants:** age 0.0–0.5 year: 0.01–0.04 mg/day; age 0.5–1.0 year:

0.02−0.06 mg/day. **Children:** age 1−3 years: 0.02−0.08 mg/day; age 4−6 years: 0.03−0.12 mg/day; age 7−10 years: 0.05−0.20 mg/day; age > or = 11 years: 0.05−0.20 mg/day. **Adults:** 0.05−0.20 mg/day.

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1000 lb (454 kg)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. as Chromium(II) compounds, n.o.s.

Hazard symbols, risk, & safety statements: Hazard symbol: N, Xn; risk phrases: R22; R36/37/38; R51/53; safety phrases: S16; S26; S36; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Chromous chloride is a white-to-bluish solid or lustrous needles which turn Blue in water. Molecular weight = 122.90; specific gravity (H_2O:1) = 2.75 @ 14°C; boiling point = 1300°C; freezing/melting point = 824°C. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 0, reactivity 0. Soluble in water.

Potential Exposure: It is used in metal alloys and metal finishing; textile treatment including mothproofing, waterproofing, printing; and dying, leather tanning; making photographic chemicals; and green pigments for various uses.

Incompatibilities: Very hygroscopic. The substance is a strong reducing agent. Reacts with oxidizers. Reacts with water, forming flammable hydrogen gas.

Permissible Exposure Limits in Air

Chromous chloride may reduce the oxygen content of air in confined spaces.

OSHA PEL: 0.5 mg[Cr]/m^3 TWA

NIOSH: 0.5 mg[Cr]/m^3 TWA; Limit exposures to lowest feasible concentration; See *NIOSH Pocket Guide*, Appendix C

PAC Ver. 29[138]

PAC-1: 3.5 milligram per cubic meter

PAC-2: 62 milligram per cubic meter

PAC-3: 370 milligram per cubic meter

Determination in Air: Use NIOSH Analytical Methods #7024, 7300, 7301, 7303, 9102 and OSHA Analytical Methods ID-121 and ID-125G[58].

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 100 μg[Cr]/L.

Routes of Entry: Inhalation, eyes and/or skin.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin, and respiratory tract. Eye contact may cause damage. Inhalation can cause coughing and/or shortness of breath. May cause pulmonary irritation. Moderately toxic to humans. Between 1 oz, and 1 lb may be fatal. LD_{50} (oral-rat) = 1870 mg/kg.

Long-Term Exposure: Chromium may cause allergic dermatitis. Chrome ulcers or sores of the skin or nasal septum; hole in the nasal septum, sometimes with bleeding may result. May cause lung damage.

Points of Attack: Skin, lungs.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a Medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to Physician: In case of fume inhalation, treat pulmonary edema. Consider administering prednisone or other corticosteroid to reduce tissue response to fume. Positive-pressure ventilation may be necessary. Treat metal fume fever with bed rest, analgesics, and antipyretics.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Up to 2.5 milligram per cubic meter: Qm* (APF = 25) (any quarter-mask respirator). *Up to 5 milligram per cubic meter:* 95XQ* (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa* (APF = 10) (any supplied-air respirator). *Up to 12.5 milligram per cubic meter:* Sa:Cf* (any supplied-air respirator operated in a continuous-flow mode); or PaprHie* (any PAPR with a high-efficiency particulate filter). *Up to 25 milligram per cubic meter:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or PaprTHie* (any powered, APR with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Prior to working with chromous chloride all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from water and moisture. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: UN3260 Corrosive solid, acidic, inorganic, n.o.s., Hazard class: 8; Labels: 8-Corrosive material, Technical Name Required.

Spill Handling: *Solid:* Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Liquid solution: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Chromous chloride may burn, but does not readily ignite. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. Thermal decomposition products may include chromous salts, chromic salts; and fumes of chromium. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (2); (122); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Chromous chloride. Trenton, NJ (September 1998).

United States Environmental Protection Agency, *Health Assessment Document: Chromium*, EPA 600/8-83-014F, Washington, DC (1984).

Chromyl Chloride C:1210

Formula: Cl_2CrO_2: CrO_2Cl_2

Synonyms: Chlorure de chromyle (French); Chromic oxychloride; Chromium chloride oxide; Chromium, dichlorodioxo-; Chromium(VI) dioxychloride; Chromium dioxychloride dioxide; Chromium oxychloride; Chromylchlorid (German); Chromyl chloride; Dioxodichlorochromium; Oxychlorure chromique (French)

CAS Registry Number: 14977-61-8

HSDB Number: 990

RTECS Number: GB5775000

UN/NA & ERG Number: UN1758 (chromium oxychloride)/137

EC Number: 239-056-8 [*Annex I Index No.:* 024-005-00-2]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade).

Carcinogenicity: IARC: Human Sufficient Evidence; Animal Sufficient Evidence *carcinogenic to humans*, Group 1, 1997; NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen, as hexavalent chromium.

California Proposition 65 Chemical[102]: (*hexavalent chromium*) Cancer 2/27/1987; Developmental/Reproductive toxin (male, female) 12/19/2008.

Hazard Alert: Oxidizer, Violently water reactive, Corrosive, Air reactive, Possible risk of forming tumors, Suspected reprotoxic hazard, Environmental hazard.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

United States National Primary Drinking Water Regulations: MCLG = 0.01 mg[Cr]/L; MCL = 0.1 mg[Cr]/L as chromium; SMCL = 250 mg[Cl^-]/L as Chloride.

Clean Water Act: Toxic Pollutant (Section 401.15); 40CFR401.15 Section 307 Toxic Pollutants as chromium and compounds

EPA ADI: Chromium(VI) = 0.175 mg/day/man. EPA EASI levels for chromium: **Infants:** age 0.0−0.5 year: 0.01−0.04 mg/day; age 0.5−1.0 year: 0.02−0.06 mg/day. **Children:** age 1−3 years: 0.02−0.08 mg/day; age 4−6 years: 0.03−0.12 mg/day; age 7−10 years: 0.05−0.20 mg/day;

age > or = 11 years: 0.05−0.20 mg/day. **Adults**: 0.05−0.20 mg/day.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, D007 (chromium compounds)

EPCRA (Section 313): Includes any unique chemical substance that contains chromium as part of that chemical's infrastructure.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: O, T, C, N, Xi; risk phrases: R8; R14/15; R29; R34; R35; R43; R46; R49; R50/53; safety phrases: S1; S17; S29/35; S45; S53; S60; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Chromyl chloride is a dark red fuming liquid with a musty, burning odor. Molecular weight = 154.90; specific gravity (H_2O:1) = 1.91 @ 25°C; boiling point = 117°C; freezing/melting point = −96.5°C; vapor pressure = 20 mmHg @ 25°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 2 ₩. Soluble in water; violent reaction, releasing hydrochloric and chromic acids and chlorine gas.

Potential Exposure: Chromium oxychloride is used in making chromium complexes and dyes; and used in various organic oxidation and chlorination reactions.

Incompatibilities: Contact with water is violent and forms hydrochloric and chromic acids, and chlorine gas. A powerful oxidizer. Reacts violently with acetone, alcohol, ammonia, ether, fuels, organic solvents, moist phosphorus, phosphorus trichloride; sodium azide; sulfur, reducing agents; turpentine. Contact with nonmetal halides, such as disulfur dichloride, phosphorus trichloride; and phosphorus tribromide; nonmetal hydrides, such as hydrogen sulfide; hydrogen phosphide, and urea, causes a danger fire and explosion hazard.

Permissible Exposure Limits in Air

as chromium(VI) inorganic soluble compounds

NIOSH IDLH = 15 mg[Cr(VI)]/m^3

OSHA PEL: 0.005 mg[Cr(VI)]/m^3 TWA Concentration. See 29CFR1910.1026

NIOSH REL: 0.001 mg[Cr]/m^3 TWA, potential carcinogen, limit exposure to lowest feasible level. NIOSH considers all Cr(VI) compounds (including chromic acid, *tert*-butyl chromate, zinc chromate, and chromyl chloride) to be potential occupational carcinogens. See *NIOSH Pocket Guide*, Appendices A and C.

ACGIH TLV[1]: 0.05 mg[Cr]/m^3 TWA, Confirmed Human Carcinogen; BEI issued

DFG MAK: [skin] Danger of skin sensitization; Carcinogen Category 1; TRK: 0.05 mg[Cr]/m^3; 20 μg/L [Cr] in urine at end-of-shift

Austria: carcinogen, 1999; Denmark: TWA 0.02 mg[Cr]/m^3, 1999; Finland: carcinogen, 1993; France: VME 0.05 milligram per cubic meter, VLE 0.1 milligram per cubic meter, carcinogen, 1999; Japan: EOL 0.05 mg[Cr]/m^3, 1999; Norway: TWA 0.02 milligram per cubic meter, 1999; Poland: TWA 0.1 mg[Cr]/m^3; STEL 0.3 mg[Cr]/m^3, 1999; Russia: STEL 0.01 milligram per cubic meter [skin] 1993; Switzerland: TWA 0.02 milligram per cubic meter, carcinogen, 1999; United Kingdom: TWA 0.05 mg [Cr]/m^3, carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Confirmed human carcinogen. Connecticut[60] has set a guideline for chromium trioxide in ambient air of 0.25 μ/m^3.

Determination in Air: Use NIOSH Analytical Methods #7600, 7604, 7605, 7703, 9101 and OSHA Analytical Methods ID-103, ID-215, W-4001.

Permissible Concentration in Water: State Drinking Water Guidelines: California 10 μg[Cr(VI)]/L; Maine 35 μg[Cr(VI)]/L. For the protection of freshwater aquatic life: Hexavalent chromium: 0.29 μg/L as a 24-hour average, never to exceed 21.0 μg/L. For the protection of saltwater aquatic life: Hexavalent chromium: 18 μg/L as a 24-hour average, never to exceed 1260 μg/L. *To protect human health:* hexavalent chromium 50 μg/L according to EPA[6]. EPA[49] has set a long-term Health advisory: for adults of 0.84 mg/L and a lifetime Health advisory: of 0.12 mg/L (120 μg/L) for chromium. EPA's maximum drinking water level (MCL) is 0.1 mg/L[62].

Determination in Water: Total chromium may be determined by digestion followed by AA, or by colorimetry (diphenylcarbazide); or by ICP optical emission spectrometry. Chromium(VI) may be determined by extraction and AA or colorimetry (using diphenylhydrazide). Dissolved total Cr or Cr(VI) may be determined by 0.45 μ filtration followed by the above-cited methods[49].

Routes of Entry: Inhalation, skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Chromium oxychloride can affect you when breathed in and by passing through your skin. Chromium oxychloride should be handled as a carcinogen, with extreme caution. Eye contact can cause severe damage with this corrosive chemical. Skin contact can cause deep ulcers or an allergic rash or severe irritation.

Long-Term Exposure: Chromium may cause allergic dermatitis. May cause cancer of the lungs and throat; birth defects, fetus damage, possible miscarriage; skin allergy, with itching and rash; lung allergy with cough, wheezing, and difficult breathing; kidney damage; damage to the bone (septum) in the nose.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended:

urine test for chromates. This test is most accurate shortly after exposure. Exam of the nose and skin. Lung function tests. These may be normal if the person is not having an attack at the time of the test. Kidney function tests. If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. If any skin bumps or blisters develop, seek medical attention promptly. If not treated early, "chrome ulcers" can develop which can last for years. NIOSH lists the following tests [chromium(III) compounds]: whole blood (chemical/metabolite); biologic tissue/biopsy; chest X-ray; pulmonary function tests; red blood cells/count; urine (chemical/metabolite) [end-of-shift] [end-of-shift at end-of-work-week] [end-of-work-week] [pre- & postshift].

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a Medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. (as chromic acid and chromates) **8 hours** (more than 8 hours of resistance to breakthrough $>0.1\ \mu g/cm^2/min$): polyethylene gloves, suits, boots; polyvinyl chloride gloves, suits, boots; Saranex-coated suits; **4 hours** (At least 4 but <8 hours of resistance to breakthrough $>0.1\ \mu g/cm^2/min$): butyl rubber gloves, suits, boots; Viton gloves, suits Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Specific engineering controls are recommended in NIOSH criteria document #76-129, chromium(VI).

Respirator Selection: NIOSH, as chromates: *at any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—White: Corrosive or contact Hazard; Store separately in a corrosion resistant location. Prior to working with Chromium Oxychloride all handlers should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Chromium Oxychloride must be stored to avoid contact with water, since violent reactions occur, releasing poisonous materials including chromic acid, hydrogen chloride, chromic chloride, and chlorine. Store in tightly closed containers in a cool, well-ventilated area away from flammable and combustible materials; ammonia, alcohol and turpentine, and other incompatible materials listed above.

Shipping: UN1758 Chromium oxychloride, Hazard class: 8; Labels: 8-Corrosive material.

Spill Handling:

Chromium oxychloride when spilled in water.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 0.5/0.8

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of confined spaces, such as a sewer, because of the potential for an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Chromium oxychloride does not burn, but it will increase the intensity of a fire since it is an oxidizer. Extinguish surrounding fire with dry chemicals or CO_2. *Do not use water* to control a small fire. Thermal decomposition products may include chromic acid, hydrogen chloride, chromic chloride, chlorine. Vapors may travel to a source of ignition and flashback. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire especially if water gets in them. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(109); (102); (31); (173); (101); (138); (2) (202); (122); (100).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Chromium oxychloride, Trenton, NJ (January 2001).

United States Environmental Protection Agency, *Health Assessment Document: Chromium*, EPA 600/8-83-014F, Washington, DC (1984).

Chrysene C:1220

Formula: $C_{18}H_{12}$

Synonyms: A13-00867; 1,2-Benzofenantreno (Spanish); 1,2-Benzophenanthrene; Benzo(*a*)phenanthrene; 1,2-Benzphenanthrene; Benz(*a*)phenanthrene; Criseno (Spanish); 1,2,5,6-Dibenzonaphthalene

CAS Registry Number: 218-01-9

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

HSDB Number: 2810

RTECS Number: GC0700000

EC Number: 205-923-4 [*Annex I Index No.:* 601-048-00-0]

Regulatory Authority and Advisory Information

Carcinogenicty: EPA, classification: B2; probable human carcinogen. ACGIH: A3: Confirmed animal carcinogen with unknown relevance to humans. Carcinogenicity: IARC: Human Inadequate Evidence; Animal Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3. NIOSH has recommended that coal tar pitch volatiles, including polycyclic aromatic hydrocarbons (PAHs) be treated as potential human carcinogen. ACGIH: Confirmed Human Carcinogen *Polycyclic Aromatic Compounds (PAHs)*. *Note*: Coal-tar, polycyclic aromatic compounds, and other materials which are known to be a human carcinogens; may contain chrysene.

California Proposition 65 Chemical[102]: Cancer 1/1/1990

Hazard Alert: Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Environmental hazard.

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR 1910.1002) as coal tar pitch volatiles.

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; Section 307 (a)(1) Toxic pollutant designated, pursuant to of the and is subject to effluent limitations as polycyclic aromatic hydrocarbons (PAHs)

United States National Primary Drinking Water Regulations: MCLG = 0 mg/L; MCL = 0.0002 mg/L as polycyclic aromatic hydrocarbons (PAHs).

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U050

United States DOT Regulated marine pollutant (49CFR172.101, Appendix B) as naphthalenes

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.059; Nonwastewater (mg/kg), 3.4

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8100 (200); 8270 (10)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%. Form R Toxic Chemical Category Code: N590 as polycyclic aromatic compounds.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%. as chrysene and coal tar pitch volatiles

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, F, N, Xn; risk phrases: R45; R11; R40; R36/37/38; R50/53; R62; R68; R66; R67; safety phrases: S16; S23; S24/25; S26; S29; S36/37/39; S53; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)]

Description: Chrysene is a combustible, white[2] (when pure), red, or blue, fluorescent crystalline solid. Odorless.

Polycyclic aromatic hydrocarbons (PAHs) are compounds containing multiple benzene rings and are also called polynuclear aromatic hydrocarbons. Molecular weight = 228.29[2]; specific gravity (H_2O:1) = 1.27 @ 24°C; boiling point = 448°C @ 760 mmHg[2]; freezing/melting point = 254°C[2]. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 1, reactivity 0. Insoluble in water.

Potential Exposure: Almost never found by itself, chrysene is found in gasoline and diesel exhaust as well as in cigarette smoke; and in coal tar; coal tar pitch; creosote. It is used in organic synthesis.

Incompatibilities: Contact with strong oxidizers may cause fire and explosion hazard.

Permissible Exposure Limits in Air: As coal tar pitch volatiles

NIOSH IDLH = 80 milligram per cubic meter as coal tar pitch volatiles

OSHA PEL: 0.2 milligram per cubic meter TWA [1910.1002] (benzene-soluble fraction). OSHA defines "coal tar pitch volatiles" in 29 CFR 1910.1002 as the fused polycyclic hydrocarbons that volatilize from the distillation residues of coal, petroleum (excluding asphalt), wood, and other organic matter.

NIOSH REL: 0.1 milligram per cubic meter (cyclohexane-extractable fraction). NIOSH considers coal tar products (i.e., coal tar, coal tar pitch, or creosote) to be potential occupational carcinogens

ACGIH TLV[1]: 0.2 milligram per cubic meter TWA (as benzene soluble aerosol); Confirmed Human Carcinogen

PAC Ver. 29[138]

PAC-1: 0.6 milligram per cubic meter

PAC-2: 12 milligram per cubic meter

PAC-3: 69 milligram per cubic meter

DFG MAK: Category 1, human carcinogen

Guidelines for chrysene concentration in ambient air[60] have been set at zero by North Dakota and @ 3.0 μ/m^3 by Virginia.

Determination in Air: Use NIOSH Analytical Method #5506 polycyclic aromatic hydrocarbons by HPLC; NIOSH Analytical Method #5515, Polycyclic aromatic hydrocarbons by GC; OSHA Analytical Method ID-58.

Permissible Concentration in Water: For the maximum protection of human health from the potential carcinogenic effects due to exposure of polynuclear aromatic hydrocarbons through ingestion of contaminated water and contaminated aquatic organisms, therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 1×10^{-5}, 1×10^{-6}, and 1×10^{-7}. The corresponding criteria are 28.0, 2.8, and 0.28 ng/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 311.0, 31.1, and 3.11 ng/L, respectively.

Determination in Water: Extraction with methylene chloride may be followed by measurement by ultraviolet or by HPLC/flame spectrometry or by GC and mass spectrometry as reviewed in the ATSDR document referenced below. Octanol−water coefficient: Log $K_{ow} = -6$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, skin contact, ingestion. This chemical can be absorbed through the skin, thereby increasing exposure.

Harmful Effects and Symptoms

Short-Term Exposure: Chrysene can affect you when breathed in and by passing through your skin. Chrysene should be handled as a carcinogen-with extreme caution. Skin contact may cause a rash. If skin in exposed to sunlight, a "sunburn" can occur. Sunlight Exposure on skin contaminated with coal tar chemicals, such as Chrysene can cause rash and later, pigment changes. Persons who smoke cigarettes may be at increased lung cancer risk with this chemical. This can be significantly reduced by stopping smoking, as well as by reducing exposures.

Long-Term Exposure: May cause cancer of the skin and kidneys; birth defects; miscarriage; dermatitis, changes in skin pigment. May cause bronchitis with phlegm and/or shortness of breath. The DFG[3] states that PAHs are present at particularly high levels in coal tar oils and related pyrolysis products of organic materials; and are carcinogenic (category 1) in animal studies.

Points of Attack: Skin, respiratory system; bladder, liver, kidneys.

Medical Surveillance: NIOSH lists the following tests: CBC; chest X-ray; pulmonary function tests: forced vital capacity; forced expiratory volume (1 second); photopatch testing; sputum cytology; UA (routine); cytology, hematuria; liver, kidney, and bladder function tests recommended for coal tar pitch volatiles[2]. Monthly, carefully look at any skin areas that are exposed. Any growth (like a mole) that increases in size or shows changes in color should be examined by a physician. Skin cancer is curable when detected early. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable

probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with chrysene all handlers should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN3077 Environmentally Hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Coal tar pitch volatiles are combustible, but may not readily ignite. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include oxides of carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Chrysene may be destroyed by permanganate oxidation, by high-temperature incinerator with scrubbing equipment; or by microwave plasma treatment.

References

(102); (31); (173); (101); (138); (2); (18); (202); (100).

United States Public Health Service, *Toxicological Profile for Chrysene*, Atlanta, Georgia, agency for Toxic Substances and Disease Registry (October 1987).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 4, No. 4, 83−101 (1984).

United States Environmental Protection Agency, "identification *of Organic Compounds in Effluents from Industrial Sources*," EPA-560/3-75-002, April 1975.

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet: Chrysene*, Trenton, NJ (December 1999).

C.I. Basic Green 1 C:1230

Formula: $C_{27}H_{34}N_2O_4S$; $C_{27}H_{33}N_2AHSO_4$

Synonyms: Brilliant Green; C.I. 42040; Ethyl Green; Emerald Green; Malachite Green G

CAS Registry Number: 633-03-4

HSDB Number: 6403

RTECS Number: BP6825000

UN/NA & ERG Number: UN3143 (Dyes, solid, toxic, n.o.s.)/151; UN2811 (toxic solid, organic, n.o.s.)/154

Regulatory Authority and Advisory Information

Hazard symbols, risk, & safety statements: Hazard symbol: N; risk phrases: R20/21/22; 22; R36/37/38; R51/53; safety phrases: S16; S26; S36/37/39; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: C.I. Basic Green 1 is a metallic green, odorless crystal or powder. Molecular weight = 482.69; freezing/melting point = 210°C. Soluble in water.

Potential Exposure: C.I. Basic Green 1 is used in dyeing silk, wool, leather, jute, and cotton yellowish-green; manufacturing green ink; as staining constituent of bacteriological media; indicator, an intestinal anthelmintic; a wound antiseptic; treatment of mycotic infections; agricultural fungicide (Not registered as a pesticide in the United States).

Incompatibilities: Oxidizing agents, reducing agents; anionics, and aqueous solutions of bentonite. Keep away from moisture.

Permissible Exposure Limits in Air

No standards or PAC available.

Routes of Entry: Ingestion.

Harmful Effects and Symptoms

It is classified as very toxic; probable lethal dose is 50−500 mg/kg in humans (between 1 teaspoon and 1 oz for a 150-lb person). It is a skin irritant. Ingestion causes diarrhea and abdominal pain.

Short-Term Exposure: C.I. Basic green can irritate and burn the skin and eyes. Ingestion causes nausea, vomiting, diarrhea, and abdominal pain. It is classified as very toxic; probable lethal dose is 50−500 mg/kg in humans (between 1 teaspoon and 1 oz for a 150-lb person).

Long-Term Exposure: Skin contact can cause drying and cracking.

Points of Attack: Skin.

Medical Surveillance: There is no special tests for this substance.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is a potential for overexposure: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: UN3143 Dyes, solid, toxic, n.o.s. or Dye intermediates, solid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft (NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen, sulfur, and carbon. This chemical may burn but does not easily ignite. For small fires use dry chemical, carbon dioxide; water spray; or foam. For large fires use water spray, fog, or foam. Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Wear self-contained (positive pressure if available) breathing apparatus and full protective clothing. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: C.I. Basic Green 1, Washington, DC, Chemical Emergency Preparedness Program (October 31, 1985).

(173); (101); (138).

C.I. Direct Red 28 C:1240

Formula: $C_{32}H_{24}N_6O_6S_2 \cdot 2Na$
Synonyms: Atlantic Congo red; Atul Congo red; Azocard red Congo; Benzo Congo red; Brasilamina Congo 4B; C.I. 22120; C.I. Direct red 28; C.I. Direct red 28, disodium salt; Congo red; Cotton red L; Diacotton Congo red; Direct red 28; Erie Congo 4B; Hispamin Congo 4B; Kayaku Congo red; Mitsui Congo red; Peeramine congo red; Sugai congo red; Tertrodirect red C; Trisulfon congo red; Vondacel red Cl
CAS Registry Number: 573-58-0
HSDB Number: 4225
UN/NA & ERG Number: UN3143/151
EC Number: 209-358-4 [*Annex I Index No.:* 611-027-00-8]
Regulatory Authority and Advisory Information
Hazard symbols, risk, & safety statements: Hazard symbol: T; risk phrases: R50/53; R63; safety phrases: S53; S45 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.
Description: C.I. Direct red 28(Congo Red) is an odorless, brownish-red powder. Molecular weight = 698.72. Melting point = 359°C. Soluble in water; solubility = 25 g/L @ 25°C.
Potential Exposure: It is used as an indicator dye, a biological stain; a diagnostic aid in medicine; and a dye for fabric and paper.
Incompatibilities: Contact with oxidizers may cause fire and explosion hazard. Incompatible with strong acids; reducing agents.
Permissible Exposure Limits in Air
No standards or PAC available.
Determination in Air: Use NIOSH Analytical Method #5013, Dyes.
Routes of Entry: Inhalation.
Harmful Effects and Symptoms
Short-Term Exposure: Skin and eye contact may cause irritation. Exposure can cause nausea, vomiting, and diarrhea; and increase the formation of platelets; and increasing the ability of the blood to clot.
Long-Term Exposure: While this chemical has not been designated a carcinogen, the parent compound, benzidine, causes bladder cancer. May decrease the fertility in males. May cause skin allergy with itching and rash. *EC Labeling:* Restricted to professionals. Toxic; (R45) May cause cancer; (R63) Suspected reprotoxic hazard; (S53) Avoid exposure: obtain special instructions before use; (S45) In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).
Points of Attack: Skin, blood.
Medical Surveillance: CBC. Evaluation by a qualified allergist.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting.
Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: Where there is a potential for overexposure: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode).
Storage: (1) Color code—Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. (2) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, strong acids; reducing agents and heat. Where possible, automatically pump liquid from drums or other storage containers to process containers.
Shipping: UN3143 Dyes, solid, toxic, n.o.s. or Dye intermediates, solid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.
Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or

federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical may burn, but does not easily ignite. Use dry chemical, carbon dioxide; water spray; alcohol foam or polymer foam extinguishers. Thermal decomposition products may include ammonia, carbon monoxide, nitrogen, and sulfur oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* C.I Direct red 28, Trenton, NJ (May 1999).

C.I. Food Red 15 C:1250

Formula: $C_{28}H_{31}N_2O_3 \cdot Cl$

Synonyms: 11411 Red; Acid brilliant pink B; ADC Rhodamine B; Aizen Rhodamine BH; Aizen Rhodamine BHC; Akiriku rhodamine B; Ammonium, [9(*o*-Carboxyphenyl)-6-(diethylamino)-3*H*-xanthen-3-ylidene] diethyl-, chloride; Basic violet 10; Calcozine red BX; Calcozine rhodamine BXP; 9-*o*-Carboxyphenyl-6-diethylamino-3-ethylimino-3-isoxanthrene, 3-ethochloride; [9-(*o*-Carboxyphenyl)-6-(diethylamino)-3-xanthen-3-ylidene]diethylammonium chloride; Cerise toner X1127; C.I. 45170; C.I. Basic Violet 10; Cosmetic brilliant pink bluish D concentrate; D and C red No. 19; Diabasic rhodamine B; Edicol supra rose B; Edicol Supra Rose BS; Eriosin rhodamine B; Ethanaminium *n*-[9-(2-carboxyphenyl)-6-(diethylamino)-3*H*-xanthern-3-ylidene]-*N*-ethyl-, chloride; FD and C red No. 19; Flexco red 540; Hexacol rhodamine B extra; Ikada rhodamine B; Japan red 213; Japan red No. 213; Mitsui rhodamine BX; Red No. 213; Rheonine B; Rhodamine B; Rhodamine B 500; Rhodamine B 500 hydrochloride; Rhodamine BA; Rhodamine BA export; Rhodamine B extra; Rhodamine B extra M 310; Rhodamine B extra S; Rhodamine BN; Rhodamine BS; Rhodamine BX; Rhodamine BXL; Rhodamine BXP; Rhodamine FB; Rhodamine lake red B; Rhodamine O; Rhodamine S; Rhodamine, tetraethyl-; Sicilian Cerise toner A 7127; Symulex magenta F; Symulex rhodamine B toner F; Takaoka rhodamine B; Tetraethyldiamino-*o*-carboxyphenyl-xanthenyl chloride; Tetraethylrhodamine; Xanthylium, 9-(2-carboxyphenyl)-3,6-bis(diethylamino)-, chloride

CAS Registry Number: 81-88-9

HSDB Number: 5244 ***as*** rhodamine B

RTECS Number: BP3675000

UN/NA & ERG Number: UN3143 (Dyes, solid, toxic, n.o.s.)/151

Regulatory Authority and Advisory Information

Carcinogenicity: Carcinogenicity: IARC: Human Inadequate Evidence; Animal Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1998

California Proposition 65 Chemical[102]: Cancer 7/1/1990

Hazard Alert: Poison, Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, On DSL List; WHMIS Classification D2A, D2B

Hazardous to aquatic life or environment, with possible long-lasting effects[194]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xn, Xi; risk phrases: R45; R11; R20/21/22; R36; R40; R51/53; R62; R63; R67; R68; safety phrases: S7; S16; S22; S24/25; S/36/37/39; S/45; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: C.I. Food red 15 is a green crystalline or red-violet powdered solid. Molecular weight = 479.1. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 1, reactivity 0. Highly soluble in water.

Potential Exposure: It is used as a color additive in drugs, foods, cosmetics, and fabric dyes. It is also used as a tracing agent in water pollution studies. May be used as an agricultural chemical.

Incompatibilities: Dust may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, strong reducing agents.

Permissible Exposure Limits in Air

PAC Ver. 26; No data in Ver. 29[138]

989-38-8 (Basic Red 1)

PAC-1: 0.0081 milligram per cubic meter

PAC-2: 0.089 milligram per cubic meter

PAC-3: 1.3 milligram per cubic meter

Determination in Air: Use NIOSH Analytical Method #5013, Dyes.

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the skin, eyes, and respiratory tract. Eye or skin contact can cause burns and permanent damage. Can cause headaches, difficult breathing and chest tightness.

Long-Term Exposure: May cause liver damage.

Points of Attack: Liver.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for Medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure. Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek Medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a Medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with C.I. Food dye 15 all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers and reducing agents. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: UN3143 Dyes, solid, toxic, n.o.s. or Dye intermediates, solid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Use dry chemical, carbon dioxide; water spray; alcohol foam, or polymer foam extinguishers. Thermal decomposition products may include oxides of carbon, nitrogen oxides; hydrogen chloride; and ammonia. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(102); (31); (173); (101); (138); (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* C.I. Food Red, Trenton, NJ (April 1999).

(173); (101); (138).

Cinnamaldehyde C:1284

Formula: C_9H_8O

Synonyms: Adios; Benzylideneacetaldehyde; Cassia aldehyde; Cinnamal; (*E*)-Cinnamaldehyde; *trans*-Cinnamaldehyde; *trans*-Cinnamicaldehyde; Cinnamyl aldehyde; *trans*-Cinnamylaldehyde; Cinnimic aldehyde; NCI-C56111; Phenylacrolein; β-Phenylacrolein; 3-Phenylacrolein; 3-Phenylpropenal; 3-Phenyl-2-propenal; Mixture of cinnamaldehyde, cinnamyl alcohol, 4-methoxycinnamaldehyde, 3-phenyl-1-propanol, 4-methoxyphenethyl alcohol, indole, and 1,2,4-trimethoxybenzene.

trans-isomer: (*E*)-Cinnamaldehyde; (*E*)-3-Phenylpropenal; (*E*)-3-Phenyl-2-propenal; 2-Propenal, 3-phenyl-, (*E*)-; Zimtaldehyde; Zimtaldehyde light

CAS Registry Number: 104-55-2; 14371-10-9 (*trans-*)

HSDB Number: 209 (104-55-2)

RTE CS Number: GD6475000; GD6476000 (*trans*-isomer)

UN/NA & ERG Number: UN1989 (aldehydes, n.o.s)/ 129 (P)

EC Number: 203-213-9

Regulatory Authority and Advisory Information

Hazard Alert: Combustible, Polymerization hazard, Possible risk of forming tumors, Suspected of causing genetic defects, Sensitization hazard.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xi; risk phrases: R19; R36/37/38; R43; R62; safety phrases: S26; S36/37; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water. (104-55-2)

Description: Combustible, yellowish, oily liquid (thickens on exposure to air). Strong pungent, spicy, cinnamon odor. Molecular weight = 132.15; 132.17 (*trans*); specific gravity (H_2O:1) = 1.048−1.052 @ 25°C; freezing/melting point = −7.5°C; boiling point = 253°C; 252°C (*trans*); flash point = 120°C (cc); vapor pressure = 1 mmHg @ 76.1°C, 40 mmHg @ 152°C. Soluble in water.

Potential Exposure: Botanical fungicide and insecticide. Used as an antifungal agent, corn rootworm attractant, and dog and cat repellent. Can be used on soil casing for mushrooms, row crops, turf, and all food commodities. Not listed for use in EU countries.

Incompatibilities: Aldehydes are frequently involved in self-condensation or polymerization reactions. These reactions are exothermic; they are often catalyzed by acid. Aldehydes are readily oxidized to give carboxylic acids. Flammable and/or toxic gases are generated by the combination of aldehydes with azo, diazo compounds, dithiocarbamates, nitrides, and strong reducing agents. Aldehydes can react with air to give first peroxo acids, and ultimately carboxylic acids. These autoxidation reactions are activated by light, catalyzed by salts of transition metals, and are autocatalytic (catalyzed by the products of the reaction). The addition of stabilizers (antioxidants) to shipments of aldehydes retards autoxidation[101].

Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, ketones, azo dyes, caustics, boranes, hydrazines.

Permissible Exposure Limits in Air:

PAC Ver. 27; No values found in Ver. 29[138]

104-55-2

PAC-1: 14 milligram per cubic meter

PAC-2: 150 milligram per cubic meter

PAC-3: 670 milligram per cubic meter

14371-10-9, trans-isomer

PAC-1: 5.5 ppm (30 milligram per cubic meter)

PAC-2: 60 ppm (330 milligram per cubic meter)

PAC-3: 120 ppm (660 milligram per cubic meter)

Determination in Water: Octanol−water coefficient: Log K_{ow} (CAS: 104-55-2) = 1.9. Unlikely to bioaccumulate in aquatic organisms.

Harmful Effects and Symptoms

Short-Term Exposure: Contact with eyes or skin may cause severe irritation or injury. Skin sensitization may occur. Inhalation should be avoided; use NIOSH- or CEN (UK)-approved APRs for pesticides. May be harmful if swallowed. Has anesthetic properties. Fatal dose is between 1 oz and 1 lb/pt for a 150-lb person. LD_{50} (oral, rat) => 3000 mg/kg; LD_{50} (dermal, rat) => 1200 mg/kg.

Long-Term Exposure: May cause tumors. Potential mutagen, may cause reproductive and fetal effects.

Points of Attack: Inhalation, dermal contact, ingestion. Reproductive cells.

Medical Surveillance: In addition to comprehensive initial medical and work histories emphasizing reproductive experience and menstrual history, patient should have physical examination and testing of genito-urinary tract, sperm count, motility, and morphology. If required, other tests, such as serum testosterone, serum FSH, and serum LH may be indicated. Evaluation by a qualified allergist, including exposure history and testing, may help diagnose allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Applicators and other handlers must wear: Coveralls worn over long-sleeved shirt and long pants; Chemical-resistant gloves such as DuPont Tychem suit fabrics, barrier laminate, or Viton; Chemical-resistant footwear plus socks; Protective eye wear; Chemical-resistant headgear for overhead exposure; Chemical-resistant apron when cleaning equipment, mixing, or loading[83]. Agricultural Use/Engineering Controls: When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the WPS for agricultural pesticides, 40 CFR 170.240(d)(4-6), the handler PPE requirements may be reduced or modified as specified in the WPS. Firefighters should wear NIOSH-approved SCBA and full protective clothing.

Respirator Selection: SCBA >14 milligram per cubic meter (CAS: 104-55-2); 5.5 ppm (30 milligram per cubic meter) [14371-10-9 (*trans*-isomer)]. Wherever and whenever workplace conditions warrant respirator use, a respiratory protection program must be followed that meets one or more of the following requirements: OSHA's 29 CFR 1910.134, ANSI Z88.2, or European Standard EN149.

Storage: Color code—Red: Flammability Hazard: Store in a flammable (liquid or solid materials) storage area or approved cabinet away from sources if ignition.

Shipping: UN1989 Aldehydes, n.o.s., Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Wastewater from contaminant suppression, cleaning of protective clothing/equipment, or contaminated sites should be contained and evaluated for subject chemical or decomposition product concentrations. Concentrations shall be lower than applicable environmental discharge or disposal criteria. Alternatively, pretreatment and/or discharge to a POTW is acceptable only after review by the governing authority. Due consideration shall be given to remediation worker exposure (inhalation, dermal, and ingestion) as well as fate during treatment, transfer and disposal. If it is not practicable to manage the chemical in this fashion, it must meet Hazardous Material Criteria for disposal.

Fire Extinguishing: Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol-resistant foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Office of Pesticide Programs, Cinnamaldehyde Fact Sheet (040506), Washington, DC (December 2000). http://www.epa.gov/oppbppd1/biopesticides/ingredients/factsheets/factsheet_040506.htm.

United States Environmental Protection Agency, Office of Pesticide Programs, Pesticide Residue Limits, "Cinnamaldehyde", 40 CFR 180.1127, 1156. www.epa.gov/pesticides/food/viewtols.htm.

Cisplatin C:1260

Formula: $Cl_2H_6N_2Pt$; $Pt(NH_3)_2Cl_2$

Synonyms: CDDP; DDP; *cis*-Diamminedichloro platinum; *cis*-Diamminedichloro platinum (II); *cis*-Platinous diaminodichloride; *cis*-Platinum

CAS Registry Number: 15663-27-1

HSDB Number: 3939 as *cis*-diamminedichloroplatinum

RTECS Number: TP2450000

UN/NA & ERG Number: UN2928 (Toxic solids, corrosive, organic, n.o.s.)/154; UN3290 (toxic solid, corrosive, inorganic, n.o.s.),/154; UN3249 (Medicine, solid, toxic, n.o.s.)/151; UN3288 (Toxic solid, inorganic, n.o.s.)/151

EC Number: 239-733-8

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Animal Sufficient Evidence; Human Inadequate Evidence, probably carcinogenic to humans, *probably carcinogenic to humans*, Group 2A, 1998

California Proposition 65 Chemical[102]: Cancer 10/1/1988

Hazard Alert: Poison, Combustible, Corrosive, Sensitization hazard (skin).

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, C; risk phrases: R45; R25; R36/37/38; R41; R42/43; R50/53; safety phrases: S22; S26; S36/37/39; S41; S45; S53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Cisplatin is a white powder or yellow crystalline solid; freezing/melting point = 270°C (decomposes). Soluble in water.

Potential Exposure: A potential danger to those involved in the manufacture, formulation and administration of this anticancer chemotherapy agent. Contact with water causes decomposition.

Incompatibilities: Aluminum reacts with cisplatin and decreases the drug's effectiveness. Do not use any aluminum equipment to prepare or administer cisplatin.

Permissible Exposure Limits in Air

platinum, soluble salts

NIOSH IDLH = 4 mg [Pt]/m^3

ACGIH TLV[1]: 1 milligram per cubic meter (metal); 0.002 mg[Pt]/m^3 TWA, soluble salts, as Pt

OSHA PEL: None (metal); 0.002 mg[Pt]/m^3 TWA, soluble salts, as Pt

NIOSH REL: 1 milligram per cubic meter (metal); 0.002 mg[Pt]/m^3 TWA, soluble salts, as Pt

No PAC available.

DFG MAK: No numerical value established. Data may be available; however, 2 μg[Pt]/m^3 peak should not be exceeded; danger of skin and airway sensitization, as chloroplatinates

Determination in Air: Use NIOSH II[72] Method #S191, (IV) #7300, Elements.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Contact with the skin or eyes can cause irritation with possible loss of vision. Inhalation can irritate the nose and throat. Exposure to high levels can cause tintinus (ringing in the ears) and possible hearing loss. LD_{50} (oral-rat) = 25.8 mg/kg (highly toxic).

Long-Term Exposure: Cisplatin is a probable carcinogen in humans-handle with extreme caution. It has been shown to cause lung and skin cancer in animals. It may damage the developing fetus and may damage the testes (male reproductive glands). Repeated exposure to high levels can cause the same side effects seen in patients. These include kidney damage, hearing loss; low blood cell count and nausea and committing. Exposure may cause anemia. May damage the nervous system causing numbness and weakness in the hands and feet. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Points of Attack: Skin, lungs, nervous system; bone marrow, kidneys.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure. Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: examination of the nervous system. Audiogram (hearing test). CBC. Kidney function tests. If symptoms develop or overexposure is suspected, the following may be useful: blood levels of cisplatin.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek Medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Based on potential carcinogenicity the following is recommended by NIOSH: *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: (1) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. (2) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with cisplatin all handlers should be trained on its proper handling and storage. A regulated, marked area should be established where cisplatin is handled, used, or stored in manufacturing and packaging operations. Store cisplatin in sealed vials or tightly closed containers in a cool, well-ventilated area away from aluminum.

Shipping: UN2928 Toxic solids, corrosive, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, 8-Corrosive material, Technical Name Required. UN3290 Toxic solid, corrosive, inorganic, n.o.s., Hazard class: 6.1; Labels: 6.1-Poisonous materials, 8-Corrosive material. UN3288 Toxic solids, inorganic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN3249 Medicine, solid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include hydrogen chloride and oxides of nitrogen, metal, and carbon. If tank, rail car, or tank truck is involved in a fire, *isolate* for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. *Small Fire*: Dry chemical, CO_2, or water spray. *Large Fire*: Dry chemical, CO_2, alcohol-resistant foam or water spray. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal; do not scatter the material. Fire involving Tanks or Car/Trailer Loads Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. *Do not get water inside containers*. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. *Always* stay away from tanks engulfed in fire. Keep exposures cool to protect against reignition. Do not direct straight streams into the liquid. Cool exposed containers with large quantities of water from unattended equipment or remove intact containers if it can be done safely. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156.

Disposal Method Suggested: Disposal of unused product must be undertaken by qualified personnel who are knowledgeable in all applicable regulations and follow all pertinent safety precautions including the use of appropriate protective equipment. For proper handling and disposal, always comply with federal, state, and local regulations.

References

(109); (102); (31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Cisplatin, Trenton, NJ (October 1998).

Clethodim C:1263

Formula: $C_{17}H_{26}ClNO_3S$

Synonyms: 2-Cyclohexen-1-one, 2-[1-(((3-chloro-2-propenyl)oxy)imino)propyl]-5-[2-(ethylthio)propyl]-3-hydroxy-; *(E)*-2-[1-(((3-Chloro-2-propenyl)oxy)imino)propyl]-5-[2-(ethylthio)propyl]-3-hydroxy-2-cyclohexen-1-one; Cletodime; Prism; RE45601; Select

CAS Registry Number: 110429-62-4; 104233-53-6; 99129-21-2

HSDB Number: 7960

RTECS Number: GW7184000

UN/NA & ERG Number: UN3082 (environmentally hazardous substances, liquid, n.o.s.)/171

Regulatory Authority and Advisory Information

Hazard Alert: Combustible, Agricultural chemical. Listed for Tier 1 screening as an endocrine disruptor[88].

WGK[100] (German Aquatic Hazard Class): No value found.

Description: Depending on purity, clethodim can range from amber to green-yellow viscous liquid. Commercial product may be in a flammable solvent*. Molecular weight = 359.94; specific gravity (H_2O:1) = 0.965; boiling point = (decomposes); freezing/melting point = −80°C; vapor pressure = 3×10^{-9} mmHg @ 25°C (est); flash point = >60°C; 72°C*. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 1, reactivity 0. Soluble in water; solubility = 12 mg/L @ 25°C (est.). *Physical and toxicological properties may be affected by the carrier solvents used in commercial formulations.

Potential Exposure: A selective postemergence cyclohexanedione/cyclohexanone derivative herbicide used to control annual and perennial grasses to a range of crops including cotton, flax, peanuts, soybeans, sugarbeets, potatoes, alfalfa, sunflowers, and most vegetables. Not approved for use in EU countries.

Incompatibilities: A weak acid, keep away from bases and alkalies. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Decomposes at about 100°C.

Determination in Air: Use high performance liquid chromotography (HPLC).

Permissible Concentration in Water:

Determination in Water: Octanol−water coefficient: Log K_{ow} = >4. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood. Fish toxicity (threshold)[101]: Very low—3210.91612 ppb, MATC.

Routes of Entry: Inhalation, dermal contact.

Harmful Effects and Symptoms

Short-Term Exposure: Contact with eyes or skin may cause irritation or injury. Inhalation should be avoided; use NIOSH- or CEN (UK)-approved APRs for pesticides. May be harmful if swallowed. LD_{50} (oral, rat) = > 1100 mg/kg;1630 mg/kg.

Medical Surveillance: Preliminary medical exam to detect chronic diseases of Central nervous system, liver, heart, kidneys, lung, and skin, as well as endocrinological or immunological disturbances, should protect susceptible individuals. Periodical medical exams of internal organs, skin, and eyes are important to avoid chronic occupational intoxications. They should include lab and patch tests when necessary[83].

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Applicators and other handlers must wear: Coveralls worn over long-sleeved shirt and long pants; Chemical-resistant gloves such as DuPont Tychem suit fabrics, barrier laminate, or Viton; Chemical-resistant footwear plus socks; Protective eye wear; Chemical-resistant headgear for overhead exposure; Chemical-resistant apron when cleaning equipment, mixing, or loading[83]. Agricultural Use/Engineering Controls: When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the WPS for agricultural pesticides, 40 CFR 170.240(d)(4-6), the handler PPE requirements may be reduced or modified as specified in the WPS. Firefighters should wear NIOSH-approved SCBA and full protective clothing.

Respirator Selection: Wherever and whenever workplace conditions warrant respirator use, a respiratory protection program must be followed that meets one or more of the following requirements: OSHA's 29 CFR 1910.134, ANSI Z88.2, or European Standard EN 149.

Storage: Color code—Blue: Health Hazard/Poison. Store in a secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Where possible, automatically transfer material from other storage containers to process containers.

Shipping: UN3082 Environmentally hazardous substances, liquid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required

Spill Handling: Wearing protective equipment, cleanup with dampened absorbent paper and transfer material to a suitable trash container. Seal the absorbent paper and your clothing in a vapor-tight plastic bag for eventual disposal. Wash all contaminated surfaces with a soap and water solution. Do not reenter the contaminated area until and expert verifies that the area has been properly cleaned.

Fire Extinguishing: Thermal decomposition products in fire include toxic hydrogen chloride gas and oxides of nitrogen, sulfur, and carbon. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Recycle any unused portion of the material for its approved use or return it to the manufacturer or supplier. Ultimate disposal of the chemical must consider: the material's impact on air quality; potential migration in soil or water; effects on animal, aquatic, and plant life; and conformance with environmental and public health regulations[83].

References

(31); (173); (101); (138); (100).

EXTOXNET, Extension Toxicology Network, "Pesticide Information Profile, Clethodim," Oregon State University, Corvallis, OR (July 1995). http://ace.orst.edu/cgi-bin/mfs/01/pips/clethodi.htm.

United States Environmental Protection Agency, Office of Pesticide Programs, Pesticide Residue Limits, "Clethodim", 40 CFR 180.458. www.epa.gov/pesticides/food/viewtols.htm.

Clofentezine C:1265

Formula: $C_{14}H_8Cl_2N_4$

Synonyms: 3,6-Bis(2-chlorophenyl)-1,2,4,5-tetrazine; Bisclofentezin; NC-21314; 1,2,4,5-Tetrazine, 3,6-bis(2-chlorophenyl)-; NC; APOLLO; OVATION

CAS Registry Number: 74115-24-5

RTECS Number: XF6860000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 277-228-2

Regulatory Authority and Advisory Information

Hazard Alert: Environmental hazard, Agricultural chemical. Listed for Tier 1 screening as an endocrine disruptor[88].

SARA 311/312: Acute & Chronic health hazard

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: N; risk phrases: R52; R53; safety phrases: S22; S24/25; S60; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Magenta crystalline solid. Molecular weight = 303.15; boiling point = (decomposes); freezing/melting point = 180°C; vapor pressure = 1×10^{-9} mmHg @ 20°C. Low solubility in water.

Potential Exposure: Tetrazine miticide used on a wide variety of crops—fruit, cereals, rangeland, ornamentals, etc. An EPA Restricted Use Pesticide (RUP).

Incompatibilities: Oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); strong acids. Decomposes above 185°C.

Determination in Water: Octanol—water coefficient: Log $K_{ow} = > 3$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood. Fish toxicity (threshold)[101]: High—7.00003 ppb, MATC.

Routes of Entry: Inhalation, ingested, dermal contact.

Harmful Effects and Symptoms

Short-Term Exposure: Contact with eyes or skin may cause irritation or injury. Can be absorbed by the skin. Inhalation should be avoided; use NIOSH- or CEN (UK)-approved APRs for pesticides. May be harmful if swallowed. LD_{50} (oral, rat) = > 3 g/kg; LD_{50} (dermal, rat) = > 1 g/kg.

Long-Term Exposure: May cause liver and/or thyroid damage. Human toxicity (long term)[101]: Low—70.00 ppb, Health advisory. Human toxicity (long term)[101]: High −9.10 ppb, Health advisory.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Applicators and other handlers must wear: Coveralls worn over long-sleeved shirt and long pants; Chemical-resistant gloves such as DuPont Tychem suit fabrics, barrier laminate, or Viton; Chemical-resistant footwear plus socks; Protective eye wear; Chemical-resistant headgear for overhead exposure; Chemical-resistant apron when cleaning equipment, mixing, or loading[83]. Agricultural Use/Engineering Controls: When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the WPS for agricultural pesticides, 40 CFR 170.240(d)(4-6), the handler PPE requirements may be reduced or modified as specified in the WPS. Firefighters should wear NIOSH-approved SCBA and full protective clothing.

Respirator Selection: Wherever and whenever workplace conditions warrant respirator use, a respiratory protection program must be followed that meets one or more of the following requirements: OSHA's 29 CFR 1910.134, ANSI Z88.2, or European Standard EN149.

Storage: Color code—Blue: Health Hazard/Poison. Store in a tightly closed container in a dry, well-ventilated, and secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Where possible, automatically transfer material from other storage containers to process containers. Always store pesticides in their original containers, complete with labels that list ingredients, directions for use, and first aid steps in case of accidental poisoning. Never store pesticides in cabinets with or near food, animal feed, or medical supplies. Do not store pesticides in places where flooding is possible or in places where they might spill or leak into wells, drains, ground water, or surface water[72].

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: For solids, isolate spill or leak area in all directions for at least 25 m/75 ft. Increase, in the downwind direction, as necessary. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Stop leak if you can do it without risk. Prevent entry into waterways, sewers, basements, or confined areas. Cover with plastic sheet to prevent spreading. Absorb or cover with dry earth, sand, or other noncombustible material and transfer to containers. Do not allow water to get inside containers.

Fire Extinguishing: On small fire, use alcohol-resistant foam, dry chemical powder, carbon dioxide, or water spray. On a large fire: use water spray, fog or alcohol-resistant foam. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal. Use water spray or fog; do not scatter material using straight water jet streams. *Fire involving storage or vehicular tanks: Isolate* for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Do not allow water to get inside containers. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. *Always* stay away from tanks engulfed in fire. For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn.

Disposal Method Suggested: Do not discharge into drains or sewers. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (203); (100).

United States Environmental Protection Agency, Office of Pesticide Programs, *Pesticide Residue Limits, Clofentezine*, 40CFR180.446. http://www.epa.gov/pesticides/food/viewtols.htm.

Clomazone C:1266

Formula: $C_{12}H_{14}ClNO_2$

Synonyms: Cerano; Clomazone; 2-[(2-Chlorophenyl) methyl]-4,4-dimethyl-3-isoxazolidinone; 2-(2-Chlorobenzyl)-4,4-dimethyl-1,2-oxazolidin-3-one; Colzor trio; Command; Commence; Dibel; Dimethazone; FMC 57020; Gambit; Magister; Merit; Strategy

CAS Registry Number: 81777-89-1

HSDB Number: 6614 as Dimethazone

RTECS Number: NY2977000

UN/NA & ERG Number: UN2902 (Pesticides, liquid, toxic, n.o.s)/151

Regulatory Authority and Advisory Information

Carcinogenicity: EPA: Not likely to be carcinogenic to humans.

Hazard Alert: Poison, Agricultural chemical, Environmental hazard. Listed for Tier 1 screening as an endocrine disruptor[88].

Potential Ground water Pollutant [California FAC Section 13145(d)/12811, active]

Hazard symbols, risk, & safety statements: Hazard symbol: N, Xn; risk phrases: R20/22; R36/38; R50; safety phrases: S16; S26; S29/35; S36; S41; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Depending purity, it may be clear and colorless to pale yellow or brownish liquid. Commercially available as emulsifiable concentrates that can be dissolved in water. Molecular weight = 239.71; specific gravity (H_2O:1) = 1.19; boiling point = 275−282°C; freezing/melting point = 25−34°C; flash point = 105°C; vapor pressure = 1×10^{-4} mmHg @ 20. Highly soluble in water; solubility = >1000 mg/L. Physical and toxicological properties may be affected by the carrier solvents used in commercial formulations.

Potential Exposure: Clomazone is a oxazolidione broad-spectrum herbicide used on rice, peas, pumpkins, soybeans, sweet potatoes, winter squash, cotton, tobacco, and fallow wheat fields to control annual grasses and broadleaf weeds.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air: No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 2.5. Unlikely to bioaccumulate in marine organisms. Fish toxicity (threshold)[101]: Very low—3156.16718 ppb, MATC

Routes of Entry: Dermal contact, ingestion, inhalation.

Harmful Effects and Symptoms

Short-Term Exposure: Highly toxic, may be fatal if inhaled, swallowed or absorbed through skin. Avoid any skin contact or eye. Contact with eyes or skin may cause irritation or injury. Effects of contact or inhalation may be delayed. Inhalation should be avoided. Human toxicity (long term)[101]: Very low—301.00 ppb, Health advisory. LD_{50} (oral, rat) = <1500 mg/kg; LD_{50} (dermal, rat) = > 2 g/kg.

Points of Attack: Central nervous system, liver, heart, kidneys, lung, and skin.

Medical Surveillance: Preliminary medical exam to detect chronic diseases of Central nervous system, liver, heart, kidneys, lung, and skin, as well as endocrinological or immunological disturbances, should protect susceptible individuals. Periodical medical exams of internal organs, skin, and eyes are important to Avoid chronic occupational intoxications. They should include lab and patch tests when necessary[83].

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method* if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed.

Personal Protective Methods: Applicators and other handlers must wear: Coveralls worn over long-sleeved shirt and long pants; Chemical-resistant gloves such as DuPont Tychem suit fabrics, barrier laminate, or Viton; Chemical-resistant footwear plus socks; Protective eye wear; Chemical-resistant headgear for overhead exposure; Chemical-resistant apron when cleaning equipment, mixing, or loading[83]. Agricultural Use/Engineering Controls: When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the WPS for agricultural pesticides, 40 CFR 170.240(d)(4-6), the handler PPE requirements may be reduced or modified as specified in the WPS. Firefighters should wear NIOSH-approved SCBA and full protective clothing.

Respirator Selection: Wherever and whenever workplace conditions warrant respirator use, a respiratory protection program must be followed that meets one or more of the following requirements: OSHA's 29 CFR1910.134, ANSI Z88.2, or European Standard EN149.

Storage: Color code—Blue: Health Hazard/Poison. Store in a tightly closed container in a dry, well-ventilated, and secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Where possible, automatically transfer material from other storage containers to process containers.

Shipping: UN2902 Pesticide, liquid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 m/150 ft for liquids and at least 25 m/75 ft for solids. Keep unauthorized personnel away. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Stay upwind. Keep out of low areas. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Stop leak if you can do it without risk. Prevent entry into waterways, sewers, basements, or confined areas. Cover with plastic sheet to prevent spreading. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Noncombustible, substance itself does not burn. Thermal decomposition products may include hydrogen chloride, and oxides of nitrogen and carbon. Containers may explode when heated. Runoff from fire control or dilution water may be corrosive and/or toxic and may cause pollution. Runoff may pollute waterways. If tank, rail car, or tank truck is involved in a fire, Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. *Small Fire*: Use dry chemical, CO_2, or water spray. *Large Fire*: Water spray, fog, or regular foam. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal; do not scatter the material. Use water spray or fog; do not use straight streams. *Fire involving Tanks or Car/Trailer Loads:* Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Do not get water inside containers. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. *Always* stay away from tanks engulfed in fire. For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn. *Do not* get water inside containers.

Disposal Method Suggested: Do not discharge into drains or sewers. Dispose of waste material as hazardous waste using a licensed disposal contractor to an approved landfill. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (100).

EXTOXNET, Extension Toxicology Network, "Pesticide Information Profile, Clomazone," Oregon State University, Corvallis, OR (June 1996). http://extoxnet.orst.edu/pips/clomazon.htm.

United States Environmental Protection Agency, Office of Pesticide Programs, Pesticide Residue Limits, "Clomazone", 40 CFR 180.425. www.epa.gov/pesticides/food/viewtols.htm.

Clonitralid C:1268

Formula: $C_{15}H_{15}Cl_2N_3O_5$

Synonyms: 2-Aminoethanol salt of 5-chloro-*N*-(2-chloro-4-nitrophenyl)-2-hydroxybenzamide; 2-Aminoethanol salt of 2′,5-dichloro-4′-nitrosalicylanilide; BAY 73; BAY 6076; Bayer 73; Bayer 25648; Bayluscid; BaylucideM 73; 5-Chloro-*N*-(2-chloro-4-nitrophenyl)-2-hydroxybenzamide with 2-aminoethanol (1:1); 5-Chloro-*N*-(2-chloro-4-nitrophenyl)-2-hydroxybenzamide, 2-aminoethanol salt; 2′,5-Dichloro-4′-nitrosalicylanilide, 2-aminoethanol salt; 5,2′-Dichloro-4′-nitrosalicylanilide ethanolamine salt; 5,2-Dichloro-4-nitrosalicylicanilide-2-aminoethanol salt; 2′,5-Dichloro-4′-nitrosalicyloylanilide ethanolamine salt; Ethanolamine salt of 5,2′-dichloro-4′-nitrosalicyclicanilide; Molluscicide Bayer 73; NCI-C00431; Niclosamide; SR 73

CAS Registry Number: 1420-04-8

HSDB Number: 4045

RTECS Number: VN8575000

UN/NA & ERG Number: UN2588 (Pesticide, solid, poisonous, n.o.s.)/151; UN2902 (Pesticide, liquid, poisonous, n.o.s.)/151

EC Number: 215-811-7; Not classified in Annex I

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Possible risk of forming tumors, Suspected reprotoxic hazard, Environmental hazard.

Hazard symbols, risk, & safety statements: Hazard symbol: Xn, N; risk phrases: R22; R33; R50/53; R63; safety phrases: S29/35; S41; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to waters

Description: Depending on purity, a bright yellow or brownish-yellow crystalline solid or powder. Odorless. Soluble in water. Molecular weight = 388.23; freezing/melting point = 191°C; 216°C; vapor pressure = 8×10^{-8} mmHg @ 20°C; 3×10^{-4} mmHg @ 20°C. Practically insoluble in water; solubility = 0.2 mg/L @ 20°C.

Potential Exposure: Niclosamide, the parent chemical, is a relatively selective, noncumulative chlorinated aromatic amide pesticide. Clonitralid (ethanolamine salt of niclosamide) is used principally against molluscs, especially fresh water snails and to control sea lamprey larvae and also as an antiparasitic drug in human, pets, and livestock. Niclosamide is toxic to all fish species at 0.5 mg/L (48 hours). A restricted use pesticide in the United States. Limited to use by a certified applicator [40 CFR 152.175 (a) (7/1/94)]. Not listed for use in EU countries.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Hydrolyzed by strong acids, and alkalies. Slowly hydrolyzes in water, releasing ammonia and forming acetate salts. Decomposes at ~200−205°C.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 1$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Dermal contact, ingestion

Harmful Effects and Symptoms

Short-Term Exposure: May cause severe eye irritation. Ingestion may result in nausea and abdominal pain. May be absorbed through the mucous membrane. LD_{50} (oral, rat) $= > 5000$ mg/kg; LD_{50} (dermal, rat) $= > 2000$ mg/kg.

Long-Term Exposure: May cause reproductive and fetal effects. May cause tumors, gastrointestinal discomfort, anorexia, and hair loss.

Points of Attack: Gastrointestinal system. Reproductive cells.

Medical Surveillance: In addition to comprehensive initial medical and work histories emphasizing reproductive experience and menstrual history, patient should have physical examination and testing of genito-urinary tract, sperm count, motility, and morphology. If required, other tests, such as serum testosterone, serum FSH, and serum LH may be indicated.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. Give artificial respiration if victim is not breathing. *Do not* use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves.

Respirator Selection: Wherever and whenever workplace conditions warrant respirator use, a respiratory protection program must be followed that meets one or more of the following requirements: OSHA's 29 CFR 1910.134, ANSI Z88.2, or European Standard EN149.

Storage: Color code—Blue: Health Hazard/Poison. Store in a tightly closed container in a dry, well-ventilated, and secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Where possible, automatically transfer material from other storage containers to process containers.

Shipping: UN2588 Pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN2902 Pesticides, liquid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Wearing protective clothing, dampen the spilled material with water. Cleanup with dampened absorbent paper and transfer material to a suitable trash container. Seal the absorbent paper and your clothing in a vapor-tight plastic bag for eventual disposal. Wash all contaminated surfaces with a soap and water solution. Do not reenter the contaminated area until and expert verifies that the area has been properly cleaned.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen and carbon, hydrogen chloride gas, and possibly hydrogen cyanide. *On a small fire:* use dry chemical, CO_2, or water spray. On a large fire, use water spray, fog, or regular foam. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal; do not scatter the material. Use water spray or fog; do not use straight streams. *Fire involving storage or vehicular tanks:* Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Do not get water inside containers. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. ALWAYS stay away from tanks engulfed in fire. For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies.

Disposal Method Suggested: Do not discharge into drains or sewers. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office. Burn in incinerator specifically designed for pesticide disposal or dispose as a hazardous waste in a landfill approved and licensed for the disposal of pesticides. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Ultimate disposal of the chemical must consider: the material's impact on air quality; potential migration in soil or water; effects on animal, aquatic, and plant life; and conformance with environmental and public health regulations[83].

References

(31); (173); (101); (138); (100).

Clopidol C:1270

Formula: $C_7H_7Cl_2NO$

Synonyms: Clopindol; Coccidiostat C; Coyden; 3,5-Dichloro-2,6-dimethyl-4-pyridinol; 3,5-Dichloro-4-pyridnol;

Farmcoccid; Lerbek; Methylchloropindol; Methylchlorpindol; Metilchlorpindol
CAS Registry Number: 2971-90-6
HSDB Number: 7907
RTECS Number: UU7711500
UN/NA & ERG Number: UN3249 (Medicine, solid, toxic, n.o.s.)/151
EC Number: 221-008-2
Regulatory Authority and Advisory Information
Hazard Alert: Poison, Drug.
Hazard symbols, risk, & safety statements: Hazard symbol: Xi; risk phrases: R36/37/38; safety phrases: S16; S26; S36/37/39 (see Appendix 4)
Description: Clopidol is a white to light brown powder. Molecular weight = 192.1; freezing/melting point ≥ 320°C. Insoluble in water.
Potential Exposure: Those engaged in formulation, application or manufacture of this veterinary antibiotic. Used as a pharmaceutical and as feed and food additive.
Incompatibilities: Noncombustible solid, but dust may explode in cloud form. Contact with strong oxidizers may cause a fire or explosion hazard.
Permissible Exposure Limits in Air
OSHA PEL: 15 milligram per cubic meter TWA, total dust; 5 milligram per cubic meter TWA, respirable fraction
NIOSH REL: 10 milligram per cubic meter, total dust; 5 milligram per cubic meter TWA, respirable fraction; 20 milligram per cubic meter, total dust STEL
ACGIH TLV[1]: 10 milligram per cubic meter; Not classified as a human carcinogen
No PAC available.
Several states have set guidelines for clopidol in ambient air[60] ranging from 100 μ/m^3 (North Dakota) to 160 μ/m^3 (Virginia) to 200 μ/m^3 (Connecticut) to 238 μ/m^3 (Nevada).
Determination in Air: Filter; none; Gravimetric; NIOSH IV, Particulates NOR: Method #0500, total dust, Method #0600 (respirable).
Harmful Effects and Symptoms
Short-Term Exposure: Clopidol may cause irritation of eyes, skin, nose, and throat. Clopidol has a low order of toxicity. Rats feed 15 mg/kg/day for 2 years showed no ill effects. LD_{50} (oral-rat) = 18 g/kg (slightly toxic).
Long-Term Exposure: Unknown at this time.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a Medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.
Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: Where there is potential exists for Exposures over *10 milligram per cubic meter*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed.
Where there is potential for high exposures exists, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.
Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with Clopidol all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.
Shipping: UN3249 Medicine, solid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials.
Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.
Fire Extinguishing: This chemical is a noncombustible solid. Thermal decomposition products may include hydrogen chloride and oxides of nitrogen and carbon. Extinguish fire using and agent suitable for the type of surrounding fire; Clopidol itself does not burn. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed

containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dispose of contents and container to an approved waste disposal plant. All federal, state, and local environmental regulations must be observed. It is inappropriate and possibly dangerous to the environment to dispose of expired or waste drugs and pharmaceuticals by flushing them down the toilet or discarding them to the trash. Household quantities of expired or waste pharmaceuticals may be mixed with wet cat litter or coffee grounds, double-bagged in plastic, discard in trash. Larger quantities shall carefully take into consideration applicable DEA, EPA, and FDA regulations. If possible return the pharmaceutical to the manufacturer for proper disposal being careful to properly label and securely package the material. Alternatively, the waste pharmaceutical shall be labeled, securely packaged, and transported by a state licensed medical waste contractor to dispose by burial in a licensed hazardous or toxic waste landfill or incinerator.

References

(31); (173); (101); (138).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Clop idol, Trenton, NJ (September 2000).

Clopyralid C:1274

Formula: $C_7H_3Cl_2NO_2$

Synonyms: Accent; Confront; Curtail; Curtailm; 3,6-DCP; 3,6-Dichloropicolinic acid; 3,6-Dichloro-2-pyridinecarboxylic acid; 2-Pyridinecarboxylic acid, 3,6-dichloro-; 3,6-Dichloro-2-picolinic acid; DOWCO-290; Hornet; Lontrel; Lontrel 3; Lontril F; Lontril T; Matrigon; Millennium; Naf-280; Paradigm; Picolinic acid, 3,6-dichloro-; Reclaim; Redeem; Riverdale; Scorpion; Stinger; Transline; Widematch; XRM-3972

CAS Registry Number: 1702-17-6

HSDB Number: 6593

RTECS Number: TJ7550700

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 216-935-4 [*Annex I Index No.:* 607-231-00-1]

Regulatory Authority and Advisory Information

Carcinogenicity: EPA: Not likely to be a carcinogen to Humans.

Hazard Alert: Combustible, Suspected reprotoxic hazard, Environmental hazard.

California EPA AB2588-Air Toxics "Hot Spots" Chemicals (CAL) as chlorophenoxy pesticides

Hazardous to aquatic life or environment, with possible long-lasting effects[293]. Toxic to aquatic life with long-lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xi, N; risk phrases: R41; R51/53; R63; safety phrases: S2; S26; S29; S30; S35; S39; S41; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [2-Hazard to water. (est.)]

Description: Odorless and colorless crystalline solid. Odorless. Available as a soluble concentrate that is usually mixed with water. Combustible. Molecular weight = 192.00; boiling point = (decomposes); freezing/melting point = 150−152°C; vapor pressure = 1×10^{-5} mmHg @ 25°C; flash point = >100°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 1, reactivity 0. High solubility in water; solubility = 1000 ppm. Physical and toxicological properties may be affected by the carrier solvents used in commercial formulations.

Potential Exposure: Clopyralid is a pyralid herbicide used to control annual and perennial broadleaf weeds on rangeland, pastures, turf, and lawns, rights-of-way and a few agricultural products such as sugarbeets, oats, barley, mint, and wheat.

Incompatibilities: May react violently with strong oxidizers, bromine, 90% hydrogen peroxide, phosphorus trichloride, silver powders, or dust. Incompatible with silver compounds. Mixture with some silver compounds forms explosive salts of silver oxalate. Keep away from oxidizers, sulfuric acid, caustics, ammonia, aliphatic amines, alkanolamines, isocyanates, alkylene oxides, epichlorohydrin. Solutions are strong acids; corrosive to aluminum, iron, and tin. Compounds of the carboxyl group react with all bases, both inorganic and organic (i.e., amines) releasing substantial heat, water, and a salt that may be harmful. Incompatible with arsenic compounds (releases hydrogen cyanide gas), diazo compounds, dithiocarbamates, isocyanates, mercaptans, nitrides, sulfides (releasing heat, toxic, and possibly flammable gases), thiosulfates, and dithionites (releasing hydrogen sulfate and oxides of sulfur)[101].

Determination in Water: Octanol−water coefficient: $\text{Log}\, K_{ow} = -3$. Negative, Unlikely to bioaccumulate in marine organisms. Fish toxicity (threshold)[101]: Very low—20832.27357 ppb, MATC.

Harmful Effects and Symptoms

Short-Term Exposure: Poisonous; may be fatal if inhaled, swallowed, or absorbed through skin. Severely irritates eyes, skin, and respiratory tract, with burning sensation, pain, redness, and swelling. Metabolic stimulant. If inhaled, causes coughing, dilated pupils, headache, profuse perspiration, intense thirst, extreme fatigue, rapid pulse, high fever, clammy, flushed skin, rapid breathing, nausea, vomiting, cyanosis (bluish tint to skin and lips), anxiety and confusion, convulsions, risk of lung edema. If swallowed, face and lips turn bluish. Liver injury with associated jaundice, kidney failure, and cardiac arrhythmias are commonly noted. Nerve damage, which may be delayed, may include swelling of legs and feet, muscle twitch, and stupor. Severe exposure can cause death from heart failure. Dust or liquid left in contact with the skin for several hours may be absorbed. This may result in severe delayed symptoms as listed above. These symptoms may last for months or years. Can cause permanent impairment of vision or irreversible damage. LD_{50} (oral, rat) $= >2500$ mg/kg. Low toxicity.

Long-Term Exposure: Workers exposed to chlorophenoxy compounds (in the manufacturing process) over a 5-to-10-year period at levels above 10 milligram per cubic meter complained of weakness, rapid fatigue, headache, and vertigo. Liver damage, low blood pressure, and slowed heartbeat were also found. Based on animal tests, may affects human reproduction. Human toxicity (long term)[101]: Very low—3500.00 ppb, Health advisory.

Points of Attack: Eyes, skin, respiratory system, central nervous system, cardiovascular system, liver, and kidney.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: Liver and kidney function tests. Exam of the nervous system. Preliminary medical exam to detect chronic diseases of Central nervous system, liver, heart, kidneys, lung, and skin, as well as endocrinological or immunological disturbances, should protect susceptible individuals. Periodical medical exams of internal organs, skin, and eyes are important to avoid chronic occupational intoxications. They should include lab and patch tests when necessary[83].

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek Medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek Medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. *Do not induce vomiting when formulations containing petroleum solvents are ingested*. Otherwise, give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Applicators and other handlers must wear: Coveralls worn over long-sleeved shirt and long pants; Chemical-resistant gloves such as DuPont Tychem suit fabrics, barrier laminate, or Viton; Chemical-resistant footwear plus socks; Protective eye wear; Chemical-resistant headgear for overhead exposure; Chemical-resistant apron when cleaning equipment, mixing, or loading[83]. Agricultural Use/Engineering Controls: When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the WPS for agricultural pesticides, 40 CFR 170.240(d)(4-6), the handler PPE requirements may be reduced or modified as specified in the WPS. Firefighters should wear NIOSH-approved SCBA and full protective clothing.

Respirator Selection: Wherever and whenever workplace conditions warrant respirator use, a respiratory protection program must be followed that meets one or more of the following requirements: OSHA's 29 CFR 1910.134, ANSI Z88.2, or European Standard EN149.

Storage: Color code—Blue: Health Hazard/Poison. Store in a tightly closed container in a dry, well-ventilated, and secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage.

Where possible, automatically transfer material from other storage containers to process containers.

Shipping: UN3077 Environmentally Hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: If a spill occurs, clean it up promptly. Don't wash it away. Instead, sprinkle the liquid spill with saw dust, vermiculite, or kitty litter. Sweep it into a plastic garbage bag, and dispose of it as directed on the pesticide product label. Wash all contaminated surfaces with a soap and water solution.

Fire Extinguishing: Thermal decomposition products may include hydrogen chloride, chlorine, and oxides of nitrogen and carbon. *On a small fire:* use dry chemical, CO_2, or water spray. On a large fire, use water spray, fog, or regular foam. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal; do not scatter the material. Use water spray or fog; do not use straight streams. *Fire involving storage or vehicular tanks:* Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Do not get water inside containers. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. ALWAYS stay away from tanks engulfed in fire. For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies.

Disposal Method Suggested: Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office. Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers.

References

(31); (173); (101); (138); (100).

Caroline Cox, *Journal of Pesticide Reform*, Northwest Coalition for Alternatives to Pesticides, *Clopyralid Herbicide* Fact Sheet: Eugene, OR (1998).

Coal Dust C:1280

Formula: $C_{3n}H_{4n}$; $(C_3H_4)_n$

Synonyms: Anthracite coal dust; Bituminous coal dust; Coal facings; Lignite coal dust; Sea coal

RTECS Number: GF8281000

UN/NA & ERG Number: UN1361/133

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Inadequate Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1997.

Hazard Alert: Possible risk of forming tumors.

Description: Coal dust is a combustible dark brown-black solid dispersed in the air. Properties vary depending on type of coal.

Potential Exposure: A potential danger to those involved in the mining, preparation, delivery, or use of powdered coal.

Incompatibilities: Keep dust away from strong oxidizers. The dust can act as a reducing agent. Slightly explosive when exposed to flame.

Permissible Exposure Limits in Air [SiO_2 = quartz]

OSHA PEL: 2.4 milligram per cubic meter TWA (containing less than 5% SiO_2), respirable fraction; 10 mg/m/(%% SiO_{2+2}) TWA (containing more than 5% SiO_2), respirable fraction

ACGIH TLV[1]: 2 milligram per cubic meter TWA (containing less than 5% SiO_2), respirable fraction; 0.1 milligram per cubic meter TWA (containing more than 5% SiO_2), respirable fraction; 0.9 milligram per cubic meter TWA Bituminous and 0.4 milligram per cubic meter TWA for Anthracite, not classifiable as a human carcinogen.

United Kingdom: LTEL 2 milligram per cubic meter (respirable), 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: 2 mg/m TWA (containing less than 5% SiO_2), respirable fraction

Determination in Air:

Coal dust may be determined gravimetrically: Filter; none; Gravimetric; NIOSH Analytical Method (IV) #0600, Particulates NOR (respirable). See also Method #7500. See also OSHA Analytical Method ID-142.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Long-Term Exposure: The inhalation of coal dust may cause coal workers' pneumoconiosis (CWP), chronic bronchitis; decreased pulmonary function; emphysema. This can result in reduction in ventilatory capacity, pulmonary hypertension, and premature death.

Points of Attack: Respiratory system.

Medical Surveillance: Preplacement and annual physical examinations should be performed with emphasis on the respiratory system including chest X-rays.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear thick working gloves and safety glasses[24].

Respirator Selection: Use NIOSH/MSHA-approved dust respirator.

Storage: (1) Color code—Red Stripe: Flammability Hazard (4.2): Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Store flammable solids (spontaneously combustible) up to maximum allowable quantity per control area in an approved flammable storage area. Do not store in a basement. (2) Color code—Yellow Stripe [*dust* (*strong reducing agent*)]: Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area separated from strong oxidants, strong bases; strong acids. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN1361 Carbon, animal or vegetable origin, Hazard Class: 4.2; Labels: 4.2-Spontaneously combustible material.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-

up is complete. Remove all ignition sources. Remove to containers which are readily disposable to land reclamation or dumps. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste.

Fire Extinguishing: This chemical is a combustible solid. Coal dust is explosive when exposed to flame. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include oxides of carbon. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Use land reclamation or dumps[24].

References

(31); (173); (2); (170).

Coal Tar Pitch C:1290

Synonyms: *8001-58-9:* AWPA No. 1; Brick oil; Coal tar creosote; Coal tar distillate; Coal tar oil; Creosota de alquitran de hulla (Spanish); Creosote, coal tar; Creosote, from coal tar; Creosote oil; Creosote P1; Creosotum; Cresylic creosote; Dead oil; Heavy oil; Liquid pitch oil; Naphthalene oil; Preserv-*o*-Sote; Tar oil; Wash oil. *Note:* Synonyms vary depending upon the specific compound that are covered as separate records (e.g., acridine, anthracene, benzo(*a*)pyrene, chrysene, pyrene, phenanthrene). NIOSH considers coal tar, coal tar pitch, and creosote to be coal tar products.

CAS Registry Number: 65996-93-2 (coal tar pitch); 8007-45-2 (coal tar); 65996-92-1 (coal tar distillate); 8001-58-9 (coal tar creosote); 56-49-5 (3-Methylcholanthrene)

HSDB Number: 5050 as coal tar

RTECS Number: GF8655000 (coal tar pitch); GF8600000 (coal tar); GF8617500 (coal tar distillate); GF8615000 (coal tar creosote); GO5870000 (creosote, wood, same CAS as coal tar creosote)

UN/NA & ERG Number: UN1136/128

EC Number: 266-028-2 [*Annex I Index No.:* 648-055-00-5] (pitch, coal tar, high-temp); 232-361-7 [*Annex I Index No.:*648-081-00-7] (tar, coal); 266-027-7 [*Annex I Index No.:* 648-047-00-1] [distillates (coal tar)]; 232-287-5 [*Annex I Index No.:* 648-101-00-4] (creosote); 232-361-7 [*Annex I Index No.:* 648-081-00-7] (coal tar pitch).

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen; NTP: (coal tar pitch) NTP 13th Report on Carcinogens, 2014, Known to be a human carcinogen; IARC: Human Sufficient Evidence; Animal Sufficient Evidence, *carcinogenic to humans*, Group 1[9].

California Proposition 65 Chemical[102]: (*if present as coke-oven emissions*) Cancer 2/27/1987; (creosotes) 10/1/1988.

Hazard Alert: Poison, Flammable liquid, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Environmental hazard, Agricultural chemical.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N, Xn: risk phrases: R45; R50/53; R62; R63; safety phrases: S (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

creosotes (8001-58-9).

Carcinogenicity: IARC: Animal Sufficient Evidence; Human Inadequate Evidence, probably carcinogenic to humans, *probably carcinogenic to humans*, Group 2 A; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies.

California Proposition 65 Chemical[102]: *(if present as coke-oven emissions*) Cancer 2/27/1987; (creosotes) 10/1/1988

Banned or Severely Restricted (coal tar oils) (UN)[35]

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR 1910.1002)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U051

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

European/International Regulations [*65996-93-2; (The residue from the distillation of high temperature coal tar. A black solid with an approximate softening point from 30°C to 180°C/86°F to 356°F. Composed primarily of a complex mixture of three or more membered condensed ring aromatic hydrocarbons*)]; [*8007-45-2 (The by-product from the destructive distillation of coal. Almost black semisolid. A complex combination of aromatic hydrocarbons, phenolic compounds, nitrogen bases, and thiophene*)]; [*65996-92-1 (The distillate from coal tar having an approximate distillation range of 100 to 450°C/212 to 842°F. Composed primarily of two to four membered condensed ring aromatic hydrocarbons, phenolic compounds, and aromatic nitrogen bases.)*]: Hazard symbol: T; risk phrases: R45; R62; R63; safety phrases: S53; S41; S45 (see Appendix 4).

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

European/International Regulations (creosote): Hazard symbol: T, C; risk phrases: R45; R23/24/25; R34; R48/20/21/22; R68; safety phrases: S26-S36/37/39-S45-S53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water. [Coal tar pitch, softening point >80°C, ground to grain size <1 cm.]; 2 [Coal tar pitch, softening point $>80°$C, molten or pieces (grain size >1 cm.)]

Description: The term "coal tar products," as used by NIOSH, includes coal tar and two of the fractionation products of coal tar, creosote and coal tar pitch, derived from the carbonization of bituminous coal. Coal tar, coal tar pitch, and creosote (coal tar creosote 8001-58-9) derived from bituminous coal often contain identifiable components which by themselves are carcinogenic, such as benzo(*a*) pyrene, benzanthracene, chrysene, and phenanthrene. Other chemicals from coal tar products, such as anthracene, carbazole, fluoranthene, and pyrene may also cause cancer, but these causal relationships have not been adequately documented. Also, the research chemical methylcholanthrene (CAS: 56-49-5), a powerful carcinogen, fits this category. Coal tar pitch is a black viscous liquid. Aromatic solvent odor. Boiling point = $>260°$C; specific gravity (H_2O:1) = 1.07−108; freezing/melting point = 250−180°C; flash point = 207°C (coal tar pitch); 74°C (creosote oil); autoignition temperature = $>510°$C. Insoluble in water. Coal tar creosote (8001-58-9, crosote) is an black oily, tar-like substance. Pungent odor, molecular weight = varies; boiling point = 191.7°C @ 760 mmHg; specific gravity (H_2O:1) = 1.05−109 @ 15°C; free zing/melting point = varioe; flash point = 73.9; autoignition temperature = 336.1°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 2, reactivity 0. Insoluble in water.

Potential Exposure: The coke-oven plant is the principal source of coal tar. The hot gases and vapors produced during the conversion of coal to coke are collected by means of a scrubber, which condenses the effluent into ammonia, water, crude tar, and other by-products. Crude tar is separated from the remainder of the condensate for refining and may undergo further processing. Employees may be exposed to pitch and creosote in metal and foundry operations; when installing electrical equipment; in construction, railway, utility; and briquette manufacturing.

Incompatibilities: Incompatible with strong oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Phenols, such as creosote react as weak organic acids. Phenols and cresols are much weaker as acids than common carboxylic acids (phenol has pKa = 9.88). These materials are incompatible with strong reducing agents such as hydrides, nitrides, alkali metals, and sulfides. Flammable hydrogen gas is often generated, and the heat of the reaction may ignite the gas. Heat is also generated by the acid-base reaction between phenols and bases. Such heating may initiate polymerization of the organic compound. Phenols are sulfonated very readily (e.g., by concentrated sulfuric acid at room temperature). The reactions generate heat. Phenols are also nitrated very rapidly, even by dilute nitric acid[101].

Permissible Exposure Limits in Air

NIOSH IDLH = 80 milligram per cubic meter as coal tar pitch volatiles

OSHA PEL: 0.2 milligram per cubic meter TWA [1910.1002] (benzene-soluble fraction). OSHA defines "coal tar pitch volatiles" in 29 CFR 1910.1002 as the fused polycyclic hydrocarbons that volatilize from the distillation residues of coal, petroleum (excluding asphalt), wood, and other organic matter.

NIOSH REL: 0.1 milligram per cubic meter (cyclohexane-extractable fraction). NIOSH considers coal tar products (i.e., coal tar, coal tar pitch, or creosote) to be potential occupational carcinogens. See *NIOSH Pocket Guide*, Appendices A and C.

ACGIH TLV[1]: 0.2 milligram per cubic meter TWA (as benzene soluble aerosol); Confirmed Human Carcinogen; BEIp issued.

NIOSH IDLH = 80 milligram per cubic meter as coal tar pitch volatiles

65996-93-2, coal tar pitch volatiles; *8001-58-9, coal tar creosote*

PAC-1: 0.6 milligram per cubic meter
PAC-2: 120 milligram per cubic meter
PAC-3: 700 milligram per cubic meter
PAC Ver. 29[138]

8007-45-2, coal tar, aerosol

PAC-1: 2.8 milligram per cubic meter
PAC-2: 31 milligram per cubic meter
PAC-3: 190 milligram per cubic meter

DFG MAK: Category 1, human carcinogen

Denmark: TWA 0.2 milligram per cubic meter, 1999: France: VME 0.2 milligram per cubic meter, 1999: United Kingdom: LTEL 0.14 milligram per cubic meter, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Confirmed Human Carcinogen. Several states have set guidelines or standards for coal tar pitch volatiles in ambient air[60] ranging from 0 (North Carolina) to 0.0161 μ/m^3 (Kansas) to 0.48 μ/m^3 (Pennsylvania) to 2.0 μ/m^3 (Connecticut and Virginia) to 5.0 μ/m^3 (Nevada).

Determination in Air: Collection on a filter, extraction, column chromatography; spectrophotometric measurement. Benzene soluble may be determined by collection of particulates on a filter, ultrasonic extraction with benzene; evaporation and gravimetric determination. Use NIOSH Analytical Method #5506 polycyclic aromatic hydrocarbons by HPLC; NIOSH Analytical Method #5515, Polycyclic aromatic hydrocarbons by GC; OSHA Analytical Method ID-58.

Determination in Water: No Method established. Octanol−water coefficient: Log K_{ow} = about 6.0.

Routes of Entry: Inhalation, skin, and eye contact.

Harmful Effects and Symptoms

Based on a review of the toxicologic and epidemiologic evidence presented, it has been concluded that some materials contained in coal tar pitch, and therefore, in coal tar, can cause lung and skin cancer; and perhaps cancer at other sites. Based on a review of experimental toxicologic evidence, it is also concluded that creosote can cause skin and lung cancer. While the evidence on creosote is not so strong as that on pitch (in part because of difficulties in chemical characterization of such mixtures), the conclusion on the carcinogenic potential of creosote is supported by information on the presence of polycyclic aromatic hydrocarbons, and imputations and evidence of the carcinogenicity of such hydrocarbons. The overwhelming scientific evidence in the record supports the finding that coke-oven emissions are carcinogenic. This finding rests on epidemiological surveys as well as animal studies and chemical analyses of coke-oven emissions. Coke-oven workers have an increased risk of developing cancer of the lung and urinary tract. In addition, observations of animals and of human populations have shown that skin tumors can be induced by the products of coal combustion and distillation. Chemical analyses of coke-oven emissions reveal the presence of a large number of scientifically recognized carcinogens as well as several agents known to enhance the effect of chemical carcinogens, especially on the respiratory tract.

Points of Attack: Respiratory system; lungs, bladder, kidneys, skin.

Medical Surveillance: Medical surveillance shall be made available, as specified below, to all employees occupationally exposed to coal tar products.

Preplacement Medical Examinations: These examinations shall include: comprehensive initial medical and work histories, with special emphasis directed toward identifying preexisting disorders of the skin, respiratory tract, liver, and kidneys. A physical examination giving particular attention to the oral cavity, skin, and respiratory system. This shall include posteroanterior and lateral chest X-rays (35 × 42 cm). Pulmonary function tests, including forced vital capacity (FVC) and forced expiratory volume @ 1 second (FEV 1.0), and a sputum cytology examination shall be offered as part of the medical examination of exposed employees. Other tests, such as liver function and UA, should be performed as considered appropriate by the responsible physician. In addition, the mucous membranes of the oral cavity should be examined. A judgment of the employee's ability to use positive pressure respirators.

Periodic Examinations: These examinations shall be made available at least annually and shall include: Interim medical and work histories. A physical examination as outlined above.

Initial Medical Examinations: These examinations shall be made available to all workers as soon as practicable after the promulgation of a standard based on these recommendations.

Pertinent Medical Records: These records shall be maintained for at least 30 years after termination of employment. They shall be made available to medical representatives of the government, the employer or the employee.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Employers shall use engineering controls when needed to keep the concentration of airborne coal tar products at, or below, the specified limit. Employers shall provide protective clothing and equipment impervious to coal tar products to employees whenever liquid coal tar products may contact the skin or eyes. Emergency equipment shall be located at well-marked and clearly identified stations and shall be adequate to permit all personnel to escape from the area or to cope safely with the emergency on reentry. Protective equipment shall include: eye and face protection; protective clothing; and respiratory protection as spelled out in detail by NIOSH.

Respirator Selection: NIOSH: *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: (1) Color code—Red: Flammability Hazard: store in a flammable (liquid or solid materials) storage area or approved cabinet away from sources if ignition. (2) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area separated from strong oxidants, strong bases; strong acids. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Entry into areas containing coal tar creosote is to be controlled by permit only.

Shipping: UN1136 Coal tar distillates, flammable, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Restrict persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Keep coal tar creosote out of a confined space, such as a sewer because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations.

Fire Extinguishing: *For combustible solids*. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include harmful and irritating gases. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode. *For combustible liquids*. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode. Coal tar creosote is a combustible liquid. Use dry chemical, CO_2, water spray; or foam extinguishers.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed[22].

References

(109); (102); (31); (173); (101); (138); (2); (80); (100).

National Institute for Occupational Safety and Health (NIOSH), “Criteria for a Recommended Standard: Occupational Exposure to Coal Tar Products”, NIOSH Document Number 78-107, Cincinnati, OH (September 1977).

United States Environmental Protection Agency, Creosote, Health and Environmental Effects Profile No. 53, Office of Solid Waste, Washington, DC (April 30, 1980).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Creosote, Trenton, NJ (January 2007).

Cobalt and Oxides C:1300

Formula: Co; CoO [Cobalt (II) oxide]; Co_3O_4 [Cobaltic oxide]

Synonyms: *cobalt metal:* Aquacat; C.I. 77320; Cobalt-59; Cobalto (Spanish); Kobalt (German); NCI-C60311; Super cobalt

CAS Registry Number: 7440-48-4 (cobalt metal); 1307-96-6 [cobalt(II)]; 1308-06-1 (cobaltic oxide)

HSDB Number: 519 (cobalt elemental)

RTECS Number: GF8750000 (cobalt metal); GG2800000 [cobalt(II)]; GG2900000 (cobalt oxide)

UN/NA & ERG Number: UN1325 (flammable solids, organic, n.o.s.)/133; UN3189 (metal powder, self-heating, n.o.s.)/135

EC Number: 231-158-0 (cobalt metal)

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human Inadequate Evidence, animal Inadequate Evidence, possibly carcinogenic to humans, Group 2B, 1991; DFG: Carcinogen Category 2.

California Proposition 65 Chemical[102]: Cancer (cobalt metal powder) 7/1/1992; (cobalt oxide) 7/1/1992

Hazard Alert: Highly flammable (powder/dust), Possible risk of forming tumors, Suspected of causing genetic defects, Sensitization hazard (resp. dust).

Banned or Severely Restricted (In Pharmaceuticals) (USA)[13]

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) as cobalt compounds

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): total dust 6010 (70); 7200 (500); 7201 (10) (cobalt metal)

EPCRA (Section 313): Form R *de minimis* concentration reporting level: 1.0% (cobalt metal)

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) Note: Includes any unique chemical substance that contains cobalt as part of that chemical's infrastructure (cobalt compounds)

EPCRA (Section 313): Includes any unique chemical substance that contains cobalt as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: 1.0% (cobalt compounds)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%. (cobalt, cobalt(II) chloride, carcinogens); NPRI

Mexico, Wastewater, Toxic Pollutant.

Hazardous to aquatic life or environment, with possible long-lasting effects[195]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xn: risk phrases: R11; R22 (oxide); R42/43; R50 (particle size ≤ 1 mm); R62; safety phrases: S21; S22; R24; R37; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water (particle size ≤ 1 mm); 1-Low hazard to water. (particle size ≥ 1 mm).

Description: Cobalt is a silver-gray to black, hard, brittle, magnetic metal. It is relatively rare; the important mineral sources are the arsenides, sulfides, and oxidized forms. It is generally obtained as a by-product of other metals, particularly copper. Molecular weight = 58.93 (cobalt); specific gravity (H_2O:1) = 8.86; boiling point = 2927°C; freezing/melting point = 1495°C. Hazard identification (based on NFPA-704 M Rating System): (dust) Health 2, flammability 3, reactivity 2. Cobalt is insoluble in water. Cobalt fume and dust have the composition $Co/CoO/Co_2O_2/Co_2O_4$. Cobaltic oxide: freezing/melting point = (decomposes) 895°C. Insoluble in water.

Cobalt(II) oxide: Molecular weight = 74.93 [cobalt(II) oxide]; specific gravity (H_2O:1) = 6.45; freezing/melting point = 1935°C; cobaltic oxide: Molecular weight = 240.79.

Potential Exposure: (cobalt): Possible risk of forming tumors, Suspected reprotoxic hazard. Nickel-aluminum-cobalt alloys are used for permanent magnets. Alloys with nickel, aluminum, copper, beryllium, chromium, and molybdenum are used in the electrical, automobile, and aircraft industries. Cobalt is added to tool steels to improve their cutting qualities and is used as a binder in the manufacture of tungsten carbide tools. Various cobalt compounds are used as pigments in enamels, glazes, and paints; as catalysts in afterburners; and in the glass, pottery, photographic, electroplating industries. Radioactive cobalt (^{60}Co) is used in the treatment of cancer. Cobalt has been added to beer to promote formation of foam but cobalt acts with alcohol to produce severe cardiac effects at concentrations as low as 1.2–1.5 mg/L of beer. Cobalt is part of the vitamin B_{12} molecule and as such is an essential nutrient. The requirement of humans for cobalt in the form of vitamin B_{12} is about 0.13 μg/day.

Incompatibilities: Cobalt metal dust/powder may spontaneously ignite on contact with air, when finely divided. Reacts with acids, strong oxidizers; ammonium nitrate causing fire and explosion hazard. Can promote decomposition of various organic substances. Cobaltic oxide reacts with reducing agents; and violently with hydrogen peroxide.

Permissible Exposure Limits in Air

NIOSH IDLH = 20 mg[Co]/m^3

OSHA PEL: 0.1 mg[Co]/m^3 TWA as metal dust and fume.

NIOSH REL: 0.05 mg[Co]/m^3 TWA as metal dust and fume.

ACGIH TLV[1]: 0.02 mg[Co]/m^3 TWA, animal carcinogen; BEI: 15 μg/L [Co] in urine at end-of-shift at end of workweek; 1 μg/L [Co] in blood at end-of-shift at end of workweek. Hard metals containing Tungsten carbide & Cobalt as Cobalt[Co]: 0.005 milligram per cubic meter.

PAC Ver. 29[138]

7440-48-4 (cobalt metal)

PAC-1: 0.18 milligram per cubic meter

PAC-2: 2 milligram per cubic meter

PAC-3: 20 milligram per cubic meter

DFG MAK: (*as inhalable fraction*) [skin] Danger of airway sensitization; Carcinogen Category 2 (includes cobalt-containing hard metals); Germ Cell Mutation Category 3A; TRK: 5 μg/L [Co] in whole blood; 60 μg/L [Co] in urine

Arab Republic of Egypt: TWA 0.1 milligram per cubic meter, 1993; Australia: TWA 0.05 milligram per cubic meter, 1993; Austria: carcinogen, 1999; Belgium: TWA 0.05 milligram per cubic meter, 1999; Denmark: TWA 0.05 milligram per cubic meter, 1999; Finland: TWA 0.05 milligram per cubic meter [skin] 1999; Hungary: TWA 0.1 milligram per cubic meter; STEL 0.2 milligram per cubic meter, 1993; the Netherlands: MAC-TGG 0.02 mg[Co]/m^3; MAC-TGG 0.02 milligram per cubic meter, 2003; Norway: TWA 0.05 milligram per cubic meter, 1999; the Philippines: TWA 0.1 milligram per cubic meter, 1993; Poland: MAC (TWA) 0.05 milligram per cubic meter, MAC (STEL) 0.2 milligram per cubic meter, 1999; Russia: STEL 0.5 milligram per cubic meter, 1993; Sweden: NGV 0.05 milligram per cubic meter, 1999; Switzerland: MAK-W 0.1 milligram per cubic meter, carcinogen, 1999; United Kingdom: TWA 0.1 milligram per cubic meter, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH

TLV: confirmed animal carcinogen with unknown relevance to humans. Russia, for ambient air in residential areas: 0.001 milligram per cubic meter is the MAC on an average daily basis for cobalt metal. Several states have set guidelines or standards for cobalt in ambient air[60] ranging from 0.33 μ/m^3 (New York) to 0.8 μ/m^3 (Virginia) to 1.0 μ/m^3 (Florida and North Dakota) to 2.0 μ/m^3 (Connecticut and Nevada).

PAC Ver. 29[138]

1307-96-6 [cobalt(II) oxide]

PAC-1: 0.076 milligram per cubic meter
PAC-2: 4.2 milligram per cubic meter
PAC-3: 25 milligram per cubic meter

1308-06-1 (cobaltic oxide)

PAC-1: 0.082 milligram per cubic meter
PAC-2: 4.5 milligram per cubic meter
PAC-3: 27 milligram per cubic meter

Determination in Air: Cobalt metal, dust, and fume may be determined by filter collection, acid dissolution; digestion and measurement by AA spectrophotometry. See NIOSH Analytical Method (IV)s #NIOSH 7027, #7300, #7301, #7303, #9102 and OSHA Analytical Methods ID-121, ID-125G, and ID-213.

Permissible Concentration in Water: The EPA[32] has suggested a permissible ambient goal of 0.7 μg/L based on health effects. State Drinking Water Guidelines: Arizona 0.70 μg[Co]/L; Wisconsin 40 μg[Co]/L. Russia[43] set a MAC of 1 mg/L in water bodies used for domestic purposes. Limits in water bodies for fishery purposes have been set at 0.01 mg/L for fresh water and 0.05 mg/L for sea water.

Determination in Water: AA spectroscopy gives a detection limit of 0.05 mg/L in water. Neutron activation can detect cobalt in urine below 0.5 μg/L.

Routes of Entry: Inhalation of dust or fume, ingestion, skin or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Cobalt dust is mildly irritating to the eyes and to a lesser extent to the skin. It is an allergen and has caused allergic sensitivity type dermatitis in some industries where only minute quantities of cobalt are used. The eruptions appear in the flexure creases of the elbow, knee ankle, and neck. Cross sensitization occurs between cobalt and nickel; and to chromium when cobalt and chromium are combined. Inhalation of dust and fume may cause irritation of the lungs with coughing and/or shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Ingestion of cobalt or cobalt compounds is rare in industry. Vomiting, diarrhea, and a sensation of hotness may occur after ingestion; or after the inhalation of excessive amounts of cobalt dust.

Long-Term Exposure: Repeated or prolonged inhalation exposure may affect lungs and cause an asthma-like disease with cough and dyspnea. This situation may progress to interstitial pneumonia with marked fibrosis. Pneumoconiosis may develop which is believed to be reversible. Since cobalt dust is usually combined with other dusts, the role cobalt plays in causing the pneumoconiosis is not entirely clear. Cobalt may decrease fertility in males. Repeated or prolonged contact may cause skin sensitization. The substance may have effects on the heart, resulting in cardiomyopathy. Cobalt may affect the thyroid and kidneys. Cobalt is possibly carcinogenic and mutagenic to humans. Some isotopes of cobalt emit ionizing radiation; such exposure is associated with an increased risk of developing cancer.

Points of Attack: Respiratory system, skin.

Medical Surveillance: In preemployment examinations, special attention should be given to a history of skin diseases; allergic dermatitis; baseline allergic respiratory diseases; and smoking history. A baseline chest X-ray should be taken and chest X-ray for scarring should be done every 2−3 years following 5 or more years of exposure. Periodic examinations should be directed toward skin and respiratory symptoms and lung function. Evaluation for heart failure. Kidney and thyroid function tests. Evaluation by a qualified allergist. Consider chest X-ray following acute overexposure. NIOSH lists (cobalt): Whole Blood (chemical/metabolite) End-Of-Shift/end-of-shift at end-of-work-week/end-of-work-week, Blood Serum, Chest X-ray; pulmonary function tests: Forced Vital Capacity; Forced Expiratory Volume (1 second), urine (chemical/metabolite), urine (chemical/metabolite) End-Of-Shift/end-of-shift at end-of-work-week/end-of-work-week.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working

with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Where dust levels are excessive, dust respirators should be used by all workers. Protective clothing should be issued to all workers and changed on a daily basis. Showering after each shift is encouraged prior to change to street clothes. Gloves and barrier creams may be helpful in preventing dermatitis. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA, for cobalt metal dust and fume: *0.25 milligram per cubic meter: if not present as a fume* Qm* (APF = 25) (any quarter-mask respirator). *0.5 milligram per cubic meter*: 95XQ* (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa* (APF = 10) (any supplied-air respirator). *1.25 milligram per cubic meter:* Sa:Cf (APF = 25)* (any supplied-air respirator operated in a continuous-flow mode); or PaprHie* (APF = 25) (any powered, APR with a high-efficiency particulate filter). *2.5 milligram per cubic meter:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *20 milligram per cubic meter:* SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA). *Note**:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: (1) Color code—Red Stripe: Flammability Hazard (4.2): Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Store flammable solids (spontaneously combustible) up to maximum allowable quantity per control area in an approved flammable storage area. Do not store in a basement. (2) Color code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Cobalt must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine), acids and ammonium nitrate, since violent reactions occur. It should be stored in a cool place under an inert atmosphere. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN3189 Metal powder, self-heating, n.o.s., Hazard Class: 4.2; Labels: 4.2-Spontaneously combustible material.

UN1325 Flammable solids, organic, n.o.s., Hazard Class: 4.1; Labels: 4.1-Flammable solid.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. If spill involves radioactive cobalt, evacuate area and delay cleanup until properly instructed by qualified radiation authorities. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid, however powdered cobalt will ignite. Thermal decomposition products may include oxides of metal. Use dry chemical, such as sand, dolomite, and graphite powder for extinguishing powdered metal fires. *Do not use water*. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: For cobalt chloride: chemical reaction with water, caustic soda, and slaked lime, resulting in precipitation of the metal sludge, which may be landfilled. Cobalt metal may be recovered from scrap and cobalt compounds from spent catalysts as alternatives to disposal[22].

References

(102); (31); (173); (101); (138); (100).

United States Environmental Protection Agency, Toxicology of Metals, Vol. II: Cobalt, pp 188−205, Report EPA-600/1-77-022, Research Triangle Park, NC (May 1977).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 3, 47–48, New York, Van Nostrand Reinhold Co. (1981). (Cobalt).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Cobalt, Washington, DC, Chemical Emergency Preparedness Program (October 31, 1985).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Cobalt, Trenton, NJ (June 2005).

Cobalt Carbonyl C:1310

Formula: $C_8Co_2O_8$; $Co_2(CO)_8$

Synonyms: Cobalt octacarbonyl; Cobalto tetracarbonilo (Spanish); Cobalt tetracarbonyl; Cobalt tetracarbonyl dimer; Di-μ-carbonylhexacarbonyldicobalt; Dicobalt carbonyl; Dicobalt octacarbonyl; Octacarbonyldicobalt

CAS Registry Number: 10210-68-1; 37264-96-3; *(alt.)* 90043-99-5

HSDB Number: 6345

RTECS Number: GG0300000

UN/NA & ERG Number: UN3124/136; UN3190/135; UN1325 (flammable solid, organic)/133

EC Number: 233-514-0

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human Inadequate Evidence, animal Inadequate Evidence, possibly carcinogenic to humans, *possibly carcinogenic to humans*, Group 2B, 1991; IARC: Human Inadequate Evidence, group 2B, 1991.

Hazard Alert: Poison, Highly flammable, Pyrophoric hazard, Possible risk of forming tumors, Sensitization hazard, Environmental hazard.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) as cobalt compounds

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 10/10,000 lb (4.54/4540 kg)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects[194]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, F, Xn, Xi, N; risk phrases: R11, R17; R22; R26; R40; R43; R48/20; R50/53; R62; safety phrases: S1; S21; S28; S29/35; S36/37/39; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Cobalt carbonyl is a pyrophoric (spontaneously flammable in air), red-orange (when pure) to dark-brown crystalline solid. Molecular weight = 341.94; specific gravity (H_2O:1) = 1.87; boiling point = (decomposes) 52°C; freezing/melting point = (decomposes) 50.9°C; vapor pressure = 0.7 mmHg @ 25°C; 0.07 mmHg @ 15°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 3, reactivity 2 ₩. Insoluble in water.

Potential Exposure: This material is used as a catalyst for a number of reactions. It is also used in antiknock gasoline and for high-purity cobalt salts.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Decomposes on exposure to air or heat (@ ~52°C) producing toxic fumes of cobalt and oxides of carbon.

Permissible Exposure Limits in Air

NIOSH IDLH = 20 mg[Co]/m^3

OSHA PEL: None

NIOSH REL: 0.1 milligram per cubic meter TWA

ACGIH TLV[1]: 0.1 milligram per cubic meter TWA

PAC Ver. 29[138]

PAC-1: 0.3 milligram per cubic meter

PAC-2: 3.3 milligram per cubic meter

PAC-3: 20 milligram per cubic meter

DFG MAK: Not established; TRK: 5 μg/L [Co] in whole blood; 60 μg/L [Co] in urine; Carcinogen Category 2

Australia: TWA 0.01 milligram per cubic meter, 1993; Belgium: TWA 0.1 milligram per cubic meter, 1993; Denmark: TWA 0.1 mg[Co]/m^3, 1999; France: VME 0.1 milligram per cubic meter, 1999; Hungary: TWA 0.01 milligram per cubic meter; STEL 0.02 milligram per cubic meter, 1993; Japan: 0.05 mg[Co]/m^3, 2B carcinogen, 1999; United Kingdom: TWA 0.1 mg[Co]/m^3, 2000; the Netherlands: MAC-TGG 0.1 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 0.1 mg[Co]/m^3. Several states have set guidelines or standards for cobalt in ambient air[60] ranging from 1.0 μ/m^3 (North Dakota) to 1.6 μ/m^3 (Virginia) to 2.0 μ/m^3 (Connecticut and Nevada).

Determination in Air: OSHA ID-125G.

Permissible Concentration in Water: State Drinking Water Guidelines: Arizona 0.70 μg[Co]/L; Wisconsin 40 μg[Co]/L. Russia[43] set a MAC in water for fishery purposes of 0.5 mg/L.

Routes of Entry: Inhalation, ingestion, skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: May cause sensitization and allergic reaction by skin contact and inhalation. The carbonyls are direct irritants. Carbon monoxide causes breathlessness, headache, weakness; and fatigue, nausea and vomiting; dimness of vision; collapse and coma. Cobalt carbonyl is corrosive to the eyes, skin, and severely irritates the respiratory tract. Inhalation of the aerosols can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Cobalt carbonyls share the general high toxicity of carbonyls because of the direct irritant and systemic action of the compound coupled with the effects of carbon monoxide, which is released from their decomposition. The oral LD_{50} (oral, rat) = 754 mg/kg (slightly toxic).

Long-Term Exposure: May cause lung irritation and decreased pulmonary function, wheezing, dyspnea (breathing difficulty). Animal tests produce liver and kidney injury.

Points of Attack: Eyes, skin, respiratory system; blood, central nervous system.

Medical Surveillance. Cobalt carbonyls may be among the most toxic materials. This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Liver and kidney function tests. CBC.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek Medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a Medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Where there is a potential for overexposure*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode).

Storage: (1) Color code—Red Stripe: Flammability Hazard (4.2): Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Store flammable solids (spontaneously combustible) up to maximum allowable quantity per control area in an approved flammable storage area. Do not store in a basement. (2) Color code—Blue: Health Hazard/Poison. Store in a tightly closed container in a dry, well-ventilated, and secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Decomposes on exposure to air or heat; stable in atmosphere of hydrogen and carbon monoxide. Store in airtight, unbreakable containers in a cool, well-ventilated area away from strong oxidizers and acids.

Shipping: UN3124 Toxic solids, self-heating, n.o.s., Hazard Class: 6.1; 6.1-Poisonous materials, 4.2-Spontaneously combustible material. Technical Name Required. UN3190 Self-heating solid, inorganic, Hazard Class: 4.2; Labels: 4.2-Spontaneously combustible material, Technical Name Required. UN1325 Flammable solid, organic, n.o.s. Hazard Class: 4.1; Labels: 4.1-Flammable solid.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. If appropriate, moisten spilled material to prevent dust. Collect powdered material in the most convenient and safe manner and deposit in airtight, sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Noncombustible solid. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include oxides of metal and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (170); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: *Cobalt Carbonyl*, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Cobalt Carbonyl, #0521,* Trenton, NJ (June 2000).

Cobalt Hydrocarbonyl C:1320

Formula: C_5HO_5; $HCO(CO)_4$

Synonyms: Hydrocobalt tetracarbonyl; Tetracarbonylhydridocobalt; Tetracarbonylhydrocobalt

CAS Registry Number: 16842-03-8

HSDB Number: 7141 as cobalt compounds

RTECS Number: GG0900000

UN/NA & ERG Number: UN3281/151; UN2927/154

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human Inadequate Evidence, animal Inadequate Evidence, possibly carcinogenic to humans, *possibly carcinogenic to humans*, Group 2B, 1991

Hazard Alert: Poison, Extremely flammable gas or liquid, Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated, Chemically unstable, Strong reducing agent.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112). *Note*: Includes any unique chemical substance that contains cobalt as part of that chemical's infrastructure

EPCRA (Section 313): Includes any unique chemical substance that contains cobalt as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T+; risk phrases: R40; R5; R12; R21; R27/28; R50; safety phrases: S9; S13; S28; S33; S38; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Cobalt hydrocarbonyl is an unstable, highly flammable and toxic gas or liquid which decomposes rapidly at room temperature to toxic cobalt carbonyl. It has an offensive odor, molecular weight = 171.98; boiling point = 10°C; freezing/melting point = −33°C; flash point = flammable gas. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 4, reactivity 1. Very slightly soluble in water; solution is a strong acid.

Potential Exposure: A potential danger to those involved in manufacture and use of this material as a catalyst for organic reactions.

Incompatibilities: Unstable gas; decomposes rapidly in air at room temperature to toxic cobalt carbonyl and explosive hydrogen gas. A strong metal hydride reducing agent; violent reaction with oxidizers and acids. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Aqueous solution is highly acidic. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

NIOSH IDLH = 20 mg[Co]/m^3

OSHA PEL: None

NIOSH REL: 0.1 milligram per cubic meter TWA

ACGIH TLV[1]: 0.1 milligram per cubic meter TWA

PAC* Ver. 29[138]

PAC-1: 0.3 milligram per cubic meter

PAC-2: $\mathbf{0.9_A}$ milligram per cubic meter

PAC-3: $\mathbf{3_A}$ milligram per cubic meter

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60-minute values.

DFG MAK: 0.1 m g[Co]/m^3; TRK: 5 μg/L [Co] in whole blood; 60 μg/L [Co] in urine; Carcinogen Category 2

Australia: TWA 0.1 milligram per cubic meter, 1993; Belgium: TWA 0.1 milligram per cubic meter, 1993; Denmark: TWA 0.1 mg[Co]/m^3, 1999; France: VME 0.1 milligram per cubic meter, 1999; Japan: 0.05 mg[Co]/m^3, 2B carcinogen, 1999; Norway: TWA 0.1 mg[Co]/m^3, 1999; Russia: STEL 0.01 milligram per cubic meter [skin], 1993; the Netherlands: MAC-TGG 0.1 milligram per cubic meter, 2003; United Kingdom: TWA 0.1 mg[Co]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 0.1 mg[Co]/m^3. Some states have set guidelines or standards for cobalt in ambient air[60] ranging from 1.0 μ/m^3 (North Dakota) to 1.6 μ/m^3 (Virginia) to 2.0 μ/m^3 (Connecticut and Nevada).

Determination in Air: Use OSHA: Method #ID-125 G.

Permissible Concentration in Water: State Drinking Water Guidelines: Arizona 0.70 μg[Co]/L; Wisconsin 40 μg[Co]/L.

Routes of Entry: Inhalation, skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates eyes, skin, and respiratory tract. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. The 30-minute LD_{50} (inh-rats) = 165 milligram per cubic meter. The clinical effects are similar to nickel carbonyl and iron pentacarbonyl, but it has about one-half the toxicity of nickel carbonyl. In animals: irritation respiratory system; dyspnea (breathing difficulty), cough.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: Cobalt carbonyls may be among the most toxic materials. This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure. Preemployment physical examinations should give particular attention to the respiratory tract and skin. Periodic examinations should include the respiratory tract and nasal sinuses, smoking history as well as general health. A baseline chest X-ray should be available and pulmonary function followed.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a Medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Where the danger of splash or spill of liquids exists, impervious protective clothing should be used. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Where there is a potential for overexposure:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode).

Storage: Check oxygen content prior to entering storage area. (1) Color code—Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. (2) Color code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in a cool, well-ventilated area. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: UN3281 Metal carbonyls, liquid, n.o.s., Hazard class: 6.1; Labels: 6.1 Technical Name Required, Potential Inhalation Hazard (Special Provision 5). Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner. UN2927 Toxic liquids, corrosive, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, 8-Corrosive material, Technical Name Required.

Spill Handling:

Metal carbonyls, liquid, n.o.s.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 300/90
Then: Protect persons downwind (mi/km)
Day 0.9/1.5

Night 3.4/5.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 3000/900

Then: Protect persons downwind (mi/km)

Day 7.1 + /11+

Night 7.0 + /11+*

" + " means distance can be larger in certain atmospheric conditions.

If in a building, evacuate building and confine vapors by closing doors and shutting down HVAC systems. Restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit and to disperse the gas. Stop the flow of gas, if it can be done safely from a distance. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place; and repair leak or allow cylinder to empty. Keep this chemical out of confined spaces, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable gas. Thermal decomposition products may include oxides of metal and carbon. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Cobalt Hydrocarbonyl, #0522, Trenton, NJ (November 2002).

Cobalt Naphthenate C:1330

Formula: $C_{12}H_{18}CoO_4$; $(C_5H_9COO)_2Co$

Synonyms: Cobalt naphtha; Cobalt naphthenate powder; Cobaltous naphthenate; Naphtenate de cobalt (French); Naphthenate de cobalt (French); Naphthenic acid, cobalt salt

CAS Registry Number: 61789-51-3

HSDB Number: 1178 as naphthenic acids

RTECS Number: QK8925000

UN/NA & ERG Number: UN2001 (powder)/133; UN1993 (solution)/128

EC Number: 263-064-0

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human Inadequate Evidence, animal Inadequate Evidence, possibly carcinogenic to humans, *possibly carcinogenic to humans*, Group 2B, 1991.

Hazard Alert: Flammable solid, Possible risk of forming tumors, Sensitization hazard (skin), Primary irritant (w/o allergic reaction), Environmental hazard.

United States DOT Regulated marine pollutant (49CFR172.101, Appendix B) as naphthenic acids

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) *Note:* Includes any unique chemical substance that contains cobalt as part of that chemical's infrastructure

EPCRA (Section 313): Includes any unique chemical substance that contains cobalt as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N, Xn, Xi; risk phrases: R40; R10, R23/24/25; R36/38; R42/; R49; R50/53; R65; safety phrases: S23; S36/37/39; S41; S45; S53; S60; S61; S62 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Cobalt naphthenate is a flammable brown powder or bluish-red solid; freezing/melting point = 140°C; flash point = 49°C; autoignition temperature = 276°C. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 2, reactivity 0. Insoluble in water.

Potential Exposure: Cobalt naphthenate is used as a drying agent in paints, varnishes; inks, and for curing plastics.

Incompatibilities: Highly flammable; powder or dust can form an explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

cobalt and compounds
NIOSH IDLH = 20 mg[Co]/m^3
No PAC available.
DFG MAK: Carcinogen Category 2, as inhalable fraction; [skin] danger of sensitization of the skin and airways; Germ Cell Mutation Category 3A

Determination in Air: Cobalt metal, dust, and fume may be determined by filter collection, acid dissolution, digestion, and measurement by AA spectrophotometry. See NIOSH Analytical Method (IV) #7027. See also Method #7300, Elements, and OSHA Analytical Methods ID121 and ID125.

Permissible Concentration in Water: State Drinking Water Guidelines: Arizona 0.70 μg[Co]/L; Wisconsin 40 μg[Co]/L.

Determination in Water: Naphthalenes and naphthenic acids are listed as United States DOT marine pollutants and may persist in the environment.

Permissible Concentration in Water: State Drinking Water Guidelines: Arizona 0.70 μg[Co]/L; Wisconsin 40 μg[Co]/L.

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Cobalt naphthenate can affect you when breathed in. Breathing the dust or fumes can cause lung allergy (asthma) to develop. Repeated exposures can cause lung scarring. High exposure can damage the heart and/or cause a large thyroid (goiter). Exposure can irritate the nose, throat, and lungs. Higher levels can cause a build-up of fluid (pulmonary edema). This can cause death. Repeated exposure can cause a loss of the sense of smell. Contact can cause a skin allergy to develop. LD$_{50}$ (oral-rat) = 3900 mg/kg (slightly toxic).

Long-Term Exposure: Repeated or prolonged contact may cause skin sensitization and allergy. Repeated exposure to cobalt naphthenate can cause lung irritation, bronchitis, lung scarring with shortness of breath; coughing. This chemical can cause kidney damage.

Points of Attack: Skin, lungs, kidneys.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure. For those with frequent or potentially high exposure (half the TLV or greater) the following are recommended before beginning work and at regular times after that. Lung function tests. Chest X-ray (every 5 years) beginning 10 years after exposure. If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. GTT and serum lipid studies (to check for blood sugar and fat changes). CBC exam of the cardiovascular system. Kidney function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA, for cobalt metal dust and fume: *0.25 milligram per cubic meter: if not present as a fume* Qm* (APF = 25) (any quarter-mask respirator). *0.5 milligram per cubic meter*: 95XQ* (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa * (APF = 10) (any supplied-air respirator). *1.25 milligram per cubic meter:* Sa:Cf (APF = 25)* (any supplied-air respirator operated in a continuous-flow mode); or PaprHie* (APF = 25) (any powered, APR with a high-efficiency particulate filter). *2.5 milligram per cubic meter:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *20 milligram per cubic meter:* SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA). *Note**:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—Red Stripe: Flammability Hazard: Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Store flammable solids up to maximum allowable quantity per control area in an approved flammable storage area. Do not store in a basement. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers (such as chlorine, bromine, and fluorine). Sources of ignition, such as smoking and open flames are prohibited where cobalt naphthenate is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2001 Cobalt naphthenate powder, Hazard Class: 4.1; Labels: 4.1-Flammable solid. UN1993 Flammable liquids, n.o.s., Hazard Class: 3; Labels: 3-Flammable liquid, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Cobalt Naphthenate is a combustible solid. Use dry chemical, sand, water spray; or alcohol foam extinguishers. Thermal decomposition products may include oxides of metal and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Cobalt Naphthenate, Trenton, NJ (September 1998).

Cobalt Sulfate C:1335

Formula: $CoSO_4$; $CoSO_4 \cdot 7H_2O$ (heptahydrate)

Synonyms: Bieberite; Cobaltous sulfate heptahydrate; Cobalt monosulfate; Cobaltous sulfate; Cobalt(II) sulfate; Cobalt (2+) sulfate; Cobalt(II) sulfate; Sulfuric acid, cobalt (2+) salt (1:1)

CAS Registry Number: 10124-43-3; 10026-24-1 (heptahydrate)

HSDB Number: 204 (10124-43-3)

RTECS Number: GG3100000; GG3200000 (heptahydrate)

UN/NA & ERG Number: UN3288/155

EC Number: 233-334-2 [*Annex I Index No.:* 027-005-00-0]

Regulatory Authority and Advisory Information

Carcinogenicty: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen

California Proposition 65 Chemical[102]: Cancer, 5/20/2005

Hazard Alert: Poison, Sensitization hazard (skin, resp.), Possible risk of forming tumors, Suspected reprotoxic hazard, Environmental hazard.

United States National Primary Drinking Water Regulations: SMCL = 250 mg[SO_4^{-2}]/L as Sulfate

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N, Xi; risk phrases: R40; R43; R48/23; R52/53; safety phrases: S2; S36/37/39; S41; S45; S61 (see Appendix 4); (*powder*): T, N, Xi; risk phrases: R22; R42/43; R49; R50; R51/53; R52/53; safety phrases: S22; S23; S29/35; S36/37; S41; S45; S53; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Red powder or rose pink crystalline solid. Odorless. Molecular weight = 155[138]; 281(heptahydrate)[136]; specific gravity (H_2O:1) = 3.71[138]; 1.95[136] @ 20°C; 2.03 @ 20°C (heptahydrate); freezing/melting point = 735°C; heat of Solution = 23 Btu/lb = 13 cal/g = 0.54×10^5/kg. Soluble in water and forms an acidic solution.

Potential Exposure: Many be used to catalyze organic reactions.
Incompatibilities: Aqueous solution reacts with bases, generating some heat. May react as either oxidizing agents or reducing agents.
Permissible Exposure Limits in Air:
NIOSH IDLH = 20 mg[Co]/m^3
OSHA PEL: 0.1 mg[Co]/m^3 TWA as metal dust and fume.
NIOSH REL: 0.05 mg[Co]/m^3 TWA as metal dust and fume.
ACGIH TLV[1]: 0.02 mg[Co]/m^3 TWA, animal carcinogen; BEI: 15 μg/L [Co] in urine at end-of-shift at end of workweek; 1 μg/L [Co] in blood at end-of-shift at end of workweek
PAC Ver. 29[138]
PAC-1: 0.16 milligram per cubic meter
PAC-2: 14 milligram per cubic meter
PAC-3: 84 milligram per cubic meter
10026-24-1, heptahydrate
PAC-1: 0.29 milligram per cubic meter
PAC-2: 19 milligram per cubic meter
PAC-3: 120 milligram per cubic meter
Determination in Air: Use OSHA: Method #ID-125G.
Permissible Concentration in Water: State Drinking Water Guidelines: Arizona 0.70 μg[Co]/L; Wisconsin 40 μg[Co]/L.
Routes of Entry: Inhalation, ingestion.
Harmful Effects and Symptoms
Short-Term Exposure: Contact with eyes or skin causes irritation. Inhalation causes shortness of breath and coughing; permanent disability may occur. Ingestion causes pain and vomiting[136]. LD_{50} (oral-rat) = 425 mg/kg.
Long-Term Exposure: May be carcinogenic. May cause tumors and may affect the unborn fetus.
Points of Attack: Eye irritant-moderate; respiratory irritant-acute, severe, or moderate but not mild; skin-moderate; Heart cardiovascular system-acute effects; Central nervous system-acute effects; Respiratory toxin-acute effects other than severe or moderate irritation; Hematological effects-acute, unspecified; Gastrointestinal tract-acute effects; Narcotic; Kidney-acute effects[138].
Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure. In addition to comprehensive initial medical and work histories emphasizing reproductive experience and menstrual history, patient should have physical examination and testing of genito-urinary tract, sperm count, motility, and morphology. If required, other tests, such as serum testosterone, serum FSH, and serum LH may be indicated.
First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves.
Personal Protective Methods:
Respirator Selection: *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA)
Storage: Color code—Blue: Health Hazard/Toxics/Poisons: Potential carcinogen. Store in a secure poison location.
Shipping: UN3288 Toxic solids, inorganic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.
Spill Handling: Stay upwind and uphill. Remove all ignition sources. All equipment used to handle this material must be grounded. If material or contaminated runoff from fire control enters waterways, notify downstream users of potentially contaminated water. Wear positive-pressure, SCBA. Wear chemical protective clothing which is specifically recommended by the manufacturer. Structural firefighter's protective clothing provides only limited protection. Small spill: Cover with *dry* earth, *dry* sand, or other noncombustible material followed with plastic sheet to minimize spreading or contact with water or rain. Use clean nonsparking tools to collect material and place material into loosely covered plastic containers for later disposal. Stop the release if it can be done safely from a distance. Prevent material and runoff from entering sewers and waterways if it can be done safely well ahead of the release. Use vapor suppressing foam to disperse vapors−contain runoff. Water spray may reduce vapor, but may not prevent ignition in enclosed spaces. Consider application of alcohol-resistant (AFFF) foam to large areas of spilled liquid to control vapors. Ventilate confined area if it can be done without placing personnel at risk.
Fire Extinguishing: Thermal decomposition products may include oxides of sulfur and cobalt metal. *Small fire:* Extinguish with *dry* chemical, CO_2, *dry* sand, or alcohol-resistant foam. May react with foams releasing corrosive/toxic gases. *Large fire:* Use water spray or alcohol-resistant foam if it is available in sufficient amounts. Under favorable conditions, experienced crews can use coordinated fog streams to sweep the flames off the surface of the burning

liquid. Keep exposures cool to protect against reignition. Do not direct straight streams into the liquid. Cool exposed containers with large quantities of water from unattended equipment or remove intact containers if it can be done safely. *Do not get water on spilled substance or inside containers*. If cooling streams are ineffective (*venting sound increases in volume and pitch, tank discolors, or shows signs of deforming*), withdraw immediately to a secure location. Always stay away from ends of tanks, especially when engulfed in flames. Always stay away from ends of tanks, especially when engulfed in flames. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156.

Disposal Method Suggested: Use a licensed professional waste disposal service to dispose of this material. All federal, state, and local environmental regulations must be observed.

References

(109); (102); (31); (85); (173); (101); (136); (138); (100).

Colchicine C:1340

Formula: $C_{22}H_{25}NO_6$

Synonyms: Acetamide, *N*-(5,6,7,9-Tetrahydro-1,2,3,10-tetramethoxy-9-oxobenzo[*a*]heptalen-7-yl); 7-Acetamido-6,7-dihydro-1,2,3,10-tetramethoxybenzo(*a*)heptalen-9(5*H*)-one; *N*-Acetyltrimethylcolchicinic acid methyl ether; Benzo[*a*] heptalen-9(5*H*)-one; 7-α-H-Colchicine; Colchineos; Colchisol; Colcin; Colquicina (Spanish); Colsaloid; Condylon; NSC 757; *N*-(5,6,7,9)-Tetrahydro-1,2,3,10-tetramethoxy-9-oxobenzo(*a*)heptalen-7-yl-acetamide

CAS Registry Number: 64-86-8

HSDB Number: 3044

RTECS Number: GH0700000

UN/NA & ERG Number: UN1544 (alkaloids, n.o.s.)/151; UN3249 (Medicine, solid, toxic, n.o.s.)/151

EC Number: 200-598-5 [*Annex I Index No.:* 614-005-00-6]

Regulatory Authority and Advisory Information

California Proposition 65 Chemical[102]: Developmental/Reproductive toxin (male) 10/1/1992.

Hazard Alert: Poison, Biotoxin, Combustible, Reproductive toxin: possible risk of gene damage/impaired fertility; Suspected reprotoxic hazard, Human, Primary irritant (w/o allergic reaction), Drug (alkaloid).

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 10/10,000 lb (4.54/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg)

Hazard symbols, risk, & safety statements: Hazard symbol: T+, N; risk phrases: R46; R28; R62; R63; safety phrases: S53; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Colchicine is a pale yellow powder. It has little or no odor. It darkens on contact with light. Molecular weight = 399.48; boiling point = 407°C; freezing/melting point = 142−157°C; vapor pressure = $1 \times 10{-}5$ mmHg @ 25°C; hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 1, reactivity 0. Slightly soluble in water.

Potential Exposure: Colchicine is a drug used to treat gouty arthritis, pseudogout, sarcoidal arthritis; and calcific tendonitis.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, mineral acids. Keep away from light.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 0.082 milligram per cubic meter

PAC-2: 0.9 milligram per cubic meter

PAC-3: 5.1 milligram per cubic meter

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Colchicine can irritate and burn the eyes, skin nose, and throat. Exposure can cause nausea, vomiting, diarrhea, loss of appetite; and abdominal pain may occur several hours after exposure. Inhalation can cause lung irritation with coughing and shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Colchicine can affect the heart causing arrhythmia. Shock occurs because of extensive vascular damage. Kidney damage resulting in bloody urine and diminished urine output may occur. It is classified as super toxic. The LD_{low} oral (dog, cat) is 0.125 mg/kg. Probable oral lethal dose in humans is less than 5 mg/kg i.e., less than 7 drops for a 70-kg (150 lb) person. Death results from respiratory arrest. The fatal dose varies considerably; as little as 7 mg of colchicine has proved fatal.

Long-Term Exposure: May cause genetic changes; liver and kidney damage. High exposure can cause headache, confusion, muscle weakness; coma and death.

Points of Attack: Heart, liver, kidneys, lungs.

Medical Surveillance: CBC. Liver and kidney function tests. EKG. Lung function tests. Consider chest X-ray following acute overexposure.

First Aid: This material is an alkaloid. If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods:

General information: first responders should use a NIOSH-certified chemical, biological, radiological, nuclear (CBRN) SCBA with a level a protective suit when entering an area with an unknown contaminant or when entering an area where the concentration of the contaminant is unknown. Level a protection should be used until monitoring results confirm the contaminant and the concentration of the contaminant. *Note:* safe use of protective clothing and equipment requires specific skills developed through training and experience.

LEVEL A: (*RED ZONE*): Select when the greatest level of skin, respiratory, and eye protection is required. This is the maximum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than the AEGL-2. A NIOSH-certified CBRN full-facepiece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle. A TECP suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, and a hard hat worn under the TECP suit are optional items.

LEVEL B: (RED ZONE): Select when the highest level of respiratory protection is necessary but a lesser level of skin protection is required. This is the minimum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than AEGL-2. It differs from Level A in that it incorporates a nonencapsulating, splash-protective, chemical-resistant splash suit that provides Level A protection against liquids but is not airtight. A NIOSH-certified CBRN full-facepiece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL C: (YELLOW ZONE): Select when the contaminant and concentration of the contaminant are known and the respiratory protection criteria factors for using APRs (APR) or PAPRs are met. This level is appropriate when decontaminating patient/victims. A NIOSH-certified CBRN tight-fitting APR with a canister-type gas mask or CBRN PAPR for air levels greater than AEGL-2. A NIOSH-certified CBRN PAPR with a loose-fitting facepiece, hood, or helmet and a filter or a combination organic vapor, acid gas, and particulate cartridge/filter combination or a continuous flow respirator for air levels greater than AEGL-1. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Escape mask, face shield, coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL D: (GREEN ZONE): Select when the contaminant and concentration of the contaminant are known and the concentration is below the appropriate occupational exposure limit or less than AEGL-1 for the stated duration times. Limited to coveralls or other work clothes, boots, and gloves.

Notes: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Where there is a potential for overexposure:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, dry place or a refrigerator. Protect from Exposure to light, and keep away from mineral acids and oxidizers.

Shipping: UN1544 Alkaloids, solid, n.o.s. or Alkaloid salts, solid, n.o.s. poisonous, Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN3249 Medicine, solid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is

complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using dry chemical, carbon dioxide; or water spray extinguishers. Thermal decomposition products may include oxides of nitrogen and carbon. Avoid breathing dusts and fumes from burning material. Keep upwind. Wear full protective clothing. Wear SCBA. Avoid bodily contact with the material. Wash away any material which may have contacted the body with copious amounts of water or soap and water. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(102); (31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Colchicine, Washington, DC, Chemical Emergency Preparedness Program (March 1999).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Colchicine, Trenton, NJ (March 1999).

Conjugated Estrogens C:1350

Formula: $C_{18}H_{19}NaO_5S$

Synonyms: Amnestrogen; Ces; Climestrone; Co-Estro; Conest; Conestron; Conjes; Conjugated estrogenic hormones; Equigyne (sodiume strone sulfate and sodium equilin sulfate, or synthetic estrogen piperazine estrone sulfate); Estratab; Estrifol; Estroate; Estrocon; Estromed; Estropan; Evex; Femacoid; Femest; Fem H; Femogen; Formatrix; Ganeake; Genisis; Glyestrin; Kestrin; Menest; Menogen; Menotab; Menotrol; Milprem; MsMed; Neo-Estrone; Novoconestron; Oestrilin; Oestro-Feminal; Oestropak; Morning; Ovest; Palopause; Par; Estro; Piperazine oestrone sulfate; PMB; Premarin; Presomen; Promarit; SK-Estrogens; Sodestrin-H; Sodium equilin sulfate; Tag-39; Transannon; Trocosone; Zeste

CAS Registry Number: 12126-59-9

HSDB Number: 3076 as Estrogenic substances, conjugated

RTECS Number: GL1224000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171; UN3249 (Medicine, solid, toxic, n.o.s.)/151

EC Number: 235-199-5

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human Sufficient Evidence; Animal Limited Evidence (Equigyne), *carcinogenic to humans*, Group 1, 1998; NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen, as estrogens, steroidial

California Proposition 65 Chemical[102]: Cancer 1/27/87; Developmental/Reproductive toxin 4/1/90.

Hazard Alert: Poison, Possible risk of forming tumors, Reproductive toxin: Suspected of causing genetic defects, Human Hormone.

Description: Conjugated estrogens generally occur as butter-colored powders. Molecular weight = 370.4. The sodium equilin sulfate component is unstable to light and air. Piperazine estrone sulfate occurs as a white to yellowish white crystalline powder that is slightly soluble in water. Piperazine estrone sulfate decomposes (melts) @ 245°C.

Potential Exposure: Conjugated estrogens are naturally occurring substances excreted in the urine of pregnant mares; piperazine estrone sulfate is not known to occur naturally. Conjugated estrogens are used to treat symptoms of the climacteric, vulvae dystrophies; female hypogonadism; and dysfunctional uterine bleeding. They also are used for treatment following: ovariectomy, for chemotherapy of mammary cancer and prostate carcinogema; and for prevention of postpartum breast engorgement. In addition, conjugated estrogens have been found in cosmetic preparations.

Incompatibilities: Estrogens are Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, acid chlorides, and acid anhydrides.

Permissible Exposure Limits in Air

No standards or PAC available.

Permissible Concentration in Water: No criteria set. Because conjugated estrogens are used as pharmaceuticals and in low quantities relative to other chemicals, they are not regulated by EPA. There may be a small pollution problem relative to hospital wastes.

Harmful Effects and Symptoms

Long-Term Exposure: There is sufficient evidence that conjugated estrogens are carcinogenic in humans. Liver and vascular tumors, endometrial cancer; ovarian cancer; breast cancer; vascular system; and testicular cancer are associated with the use of conjugated estrogens in humans. A large number of studies of cancer of the endometrium suggest that use of conjugated estrogens causes the disease.

Several studies reported on the relative risk of breast cancer from use of conjugated estrogens; the evidence is conflicting, both overall and within subgroups.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Commercially available conjugated estrogens USP tablets, synthetic conjugated estrogens A tablets, synthetic conjugated estrogens B tablets, and conjugated estrogens USP vaginal cream should be stored at controlled room temperature (20−25°C). Conjugated estrogens, USP powder for injection should be stored at a temperature of 2−8°C prior to reconstitution. Following reconstitution, solutions of the drug should be used immediately [AHFS].

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required. UN3249 Medicine, solid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials. PGIII.

Spill Handling: As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 m/150 ft for liquids and at least 25 m/75 ft for solids. Keep unauthorized personnel away. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Stay upwind. Keep out of low areas. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Stop leak if you can do it without risk. Prevent entry into waterways, sewers, basements, or confined areas. Cover with plastic sheet to prevent spreading. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen, sodium, sulfur, and carbon. Noncombustible, substance itself does not burn but may decompose upon heating to produce corrosive and/or toxic fumes. Containers may explode when heated. Runoff from fire control or dilution water may be corrosive and/or toxic and may cause pollution. Runoff may pollute waterways. If tank, rail car, or tank truck is involved in a fire, ISOLATE for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. Small Fire: Use dry chemical, CO_2, or water spray. *Large Fire*: Water spray, fog, or regular foam. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal; do not scatter the material. Use water spray or fog; do not use straight streams. *Fire involving Tanks or Car/Trailer Loads:* Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Do not get water inside containers. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. *Always* stay away from tanks engulfed in fire. For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn. *Do not* get water inside containers.

Disposal Method Suggested: It is inappropriate and possibly dangerous to the environment to dispose of expired or waste drugs and pharmaceuticals by flushing them down the toilet or discarding them to the trash. Household quantities of expired or waste pharmaceuticals may be mixed with wet cat litter or coffee grounds, double-bagged in plastic, discard in trash. Larger quantities shall carefully take into consideration applicable DEA, EPA, and FDA regulations. If possible return the pharmaceutical to the manufacturer for proper disposal being careful to properly label and securely package the material. Alternatively, the waste pharmaceutical shall be labeled, securely packaged, and transported by a state licensed medical waste contractor to dispose by burial in a licensed hazardous or toxic waste landfill or incinerator.

References

(109); (102); (31); (173); (101); (138).

American Society of Health System Pharmacists, AHFS Drug Information, p. 3137, Bethesda, MD (2010).

Copper & Oxides C:1360

Formula: Cu

Synonyms: 1721 gold; Allbri natural copper; Anac 110; Arwood copper; Bronze powder; CDA 101; CDA 102; CDA 110; CDA 122; C.I. 77400; C.I. Pigment metal 2; Cobre (Spanish); Copper bronze; Elemental copper; Gold bronze; Kafar copper; M2 copper; MI (copper); OFHC Cu; Raney copper

CAS Registry Number: 7440-50-8; *(alt.)* 72514-83-1 (1317-38-0); 1317-38-0 (CuO, copper oxide fume); 1317-39-1 (copper oxide)

HSDB Number: 1622 (7440-50-8); 266; 1549 (copper oxide)

RTECS Number: GL5325000; GL7900000 (CuO, copper oxide fume)

UN/NA & ERG Number: UN3089 (Metal powders, flammable, n.o.s.)/170

EC Number: 231-159-6

Regulatory Authority and Advisory Information

Hazard Alert: Highly flammable (dust), Pyrophoric hazard, Possible risk of forming tumors, Suspected of causing genetic defects, FDA-proprietary drug.

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/1992); Toxic Pollutant (Section 401.15)

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): total dust 6010 (60); 7210 (200)

United States National Primary Drinking Water Regulations: MCLG = 1.3 mg[Cu]/L; MCL = TT action Level: 1.3 mg[Cu]/L. Copper is regulated by a Treatment Technique (TT) that requires systems to control the corrosiveness of their water. If more than 10% of tap water samples exceed the action level, water systems must take additional steps; SMCL = 1 mg[Cu]/L as Copper; MCLG = 0 mg/L; MCL = 4 millirems/year, as *beta*-proton emitter, as (Cu_{66}).

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 5000 lb (2270 kg) (no reporting of releases of this hazardous substance is required if the diameter of the pieces of solid metal released is equal to 0.004 in)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%; NPRI; CEPA Priority Substance List, Ocean dumping prohibited; Drinking Water Quality ≤ 1.0 mg/L

EPA ADI: 1.3 mg[Cu]/L. As copper.

Hazard symbols, risk, & safety statements: Hazard symbol: F, N, Xi, Xn (Cu powder/dust); risk phrases: R11; R17; R36/38; R39; R48/20; R51/53; R48/20; R59; R62; safety phrases: S7; S16; S21; S26; S36/37; S45; S61; S62; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water]. (*copper oxide*)

Description: Copper is a reddish-brown metal which occurs free or in ores, such as malachite, cuprite, and chalcopyrite. Copper: Molecular weight = 63.55; specific gravity (H_2O:1) = 8.89; boiling point = 2562°C; freezing/melting point = 1084.62°C. It may form both mono- and divalent compounds. Ignition temperature of dust cloud = 900°C; minimum explosive concentration = unknown oz/ft^3[209]. Hazard identification (based on NFPA-704 M Rating System) *copper powder*: Health 1, flammability 3, reactivity 0. Copper is insoluble in water, but soluble in nitric acid and hot sulfuric acid. Relative explosion hazard of dust: Fire.

Cupric oxide (CuO): Molecular weight = 79.54; specific gravity (H_2O:1) = 6.4; freezing/melting point = 1326°C.

Copper fume is a finely divided black particulate dispersed in air. Copper dusts and mists have been assigned the formula $CuSO_4 \cdot 5H_2O/CuCl$ by NIOSH. Copper fume has been designated as $Cu/CuO/Cu_2O$ by NIOSH.

Potential Exposure: Exposure to fume may occur in copper and brass plants; and during the welding of copper alloys; Metallic copper is an excellent conductor of electricity and is widely used in the electrical industry in all gauges of wire for circuitry, coil, and armature windings; high conductivity tubes; commutator bars, etc. It is made into castings, sheets, rods, tubing, and wire and is used in water and gas piping; roofing materials; cooking utensils; chemical and pharmaceutical equipment and coinage. Copper forms many important alloys: Be−Cu alloy, brass, bronze; gunmetal, bell metal; German silver; aluminum bronze, silicon bronze; phosphor bronze; and manganese bronze. Copper compounds are used as insecticides, algicides, molluscicides, plant fungicides, mordants, pigments, catalysts; as a copper supplement for pastures; and in the manufacture of powdered bronze paint and percussion caps. They are also utilized in analytical reagents, in paints for ships' bottoms; in electroplating; and in the solvent for cellulose in rayon manufacture.

Incompatibilities: Copper dust, fume, and mists form shock-sensitive compounds with acetylene gas, acetylenic compounds, azides, and ethylene oxides. Incompatible with acids, chemically active metals, such as potassium; sodium, magnesium, zinc, zirconium, strong bases. Violent reaction, possibly explosive, if finely divided material come in contact with strong oxidizers.

Permissible Exposure Limits in Air

NIOSH IDLH = 100 mg[Cu]/m^3 (dust, mists and fume)

OSHA PEL: 1 mg[Cu]/m^3 (dust, mist) TWA; 0.1 milligram per cubic meter (fume) TWA

NIOSH: 1 mg[Cu]/m^3 (dust, mist) TWA; 0.1 milligram per cubic meter (fume) TWA

ACGIH TLV[1]: 1 mg[Cu]/m^3 (dust, mist) TWA; 0.2 milligram per cubic meter (fume) TWA

PAC Ver. 29[138]

7440-50-8, copper metal, dusts, and fumes

PAC-1: 3 milligram per cubic meter

PAC-2: 33 milligram per cubic meter

PAC-3: 200 milligram per cubic meter

1317-38-0, CuO, cupric oxide

PAC-1: 0.75 milligram per cubic meter

PAC-2: 11 milligram per cubic meter

PAC-3: 93 milligram per cubic meter

1317-39-1, copper oxide

PAC-1: 0.68 milligram per cubic meter

PAC-2: 16 milligram per cubic meter

PAC-3: 93 milligram per cubic meter

Copper and its inorganic compounds

DFG MAK: 0.1 milligram per cubic meter measured as the inhalable fraction of the aerosol; Peak Limitation Category II(2); Pregnancy Risk Group C

Arab Republic of Egypt: TWA 0.1 milligram per cubic meter (fume), 1993; Australia: TWA 0.2 milligram per cubic meter (fume), TWA 1 milligram per cubic meter (*dust*), 1993; Austria: MAK 1 milligram per cubic meter, MAK 0.1 milligram per cubic meter (fume), 1999; Belgium: TWA 0.2 milligram per cubic meter (fume), 1993; Denmark: TWA 0.1 milligram per cubic meter, 1999; Belgium: TWA 1 milligram per cubic meter (*dust*), 1993; the Netherlands: MAC-TGG 0.2 milligram per cubic meter (fume), MAC-TGG 1 milligram per cubic meter (*dust*), 2003; Finland: TWA 1 milligram per cubic meter (*dust*), 1999; France: VME (fume) 0.2 milligram per cubic meter, VME (*dust*): 1 milligram per cubic meter, 1999, VME 1 milligram per cubic meter; STEL 2 milligram per cubic meter (*dust*), 1993; Hungary: TWA 0.2 milligram per cubic meter; STEL 0.4 milligram per cubic meter (*dust*), 1993; India: TWA 0.2 milligram per cubic meter (fume), 1993; Norway: TWA 0.05 mg[Co]/m^3, TWA 0.1 milligram per cubic meter, fume, 1999; the Philippines: TWA 1.0 milligram per cubic meter (fume), 1993; Poland: MAC (TWA) fume 0.1 milligram per cubic meter, MAC (STEL) fume 0.3 milligram per cubic meter, MAC (TWA) dust 1 milligram per cubic meter, MAC (STEL) dust 2 milligram per cubic meter, 1999; Russia: STEL 0.5 ppm (1 milligram per cubic meter) (*dust*), 1993; Sweden: NGV 0.2 milligram per cubic meter (respirable dust), NGV 1 milligram per cubic meter (total dust), 1999; Switzerland: MAK-W 0.1 milligram per cubic meter, KZG-W 0.2 milligram per cubic meter (fume), MAK-W 1 milligram per cubic meter, KZG-W 1 milligram per cubic meter, 1999; Thailand: TWA 0.1 milligram per cubic meter (fume), TWA 1 milligram per cubic meter, 1993; United Kingdom: TWA 0.2 milligram per cubic meter, fume, TWA 1 milligram per cubic meter; STEL 2 milligram per cubic meter, dusts and mists as Cu, TWA 1 mg (week)/m^3; STEL 3 mg (week)/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 1 mg [Cu]/m^3. Several states have set guidelines or standards for copper in ambient air[60] ranging from 0.26−1.57 μ/m^3 (Montana) to 2.0 μ/m^3 (North Dakota) to 2.0−20.0 μ/m^3 (Connecticut) to 4.0−20.0 μ/m^3 (Florida) to 5.0 μ/m^3 (Nevada) to 16.0 μ/m^3 (Virginia) to 20.0 μ/m^3 (New York).

Determination in Air: Use NIOSH Analytical Methods (dusts and mist) #7029, #7300, #7301, #7303, #9102 and OSHA Analytical Methods ID-121, ID-125G; NIOSH Analytical Methods (fume) #7029, #7300, #7301, #7303 and OSHA Analytical Methods ID-121, ID-125G, ID-206

Permissible Concentration in Water: The permissible concentration of total recoverable copper in water to protect freshwater aquatic life is 5.6 μg[Cu]/L as a 24-hour average. The log of this concentration should not exceed the numerical value of log [0.94 In (hardness)-1.23]. The corresponding value to protect saltwater aquatic life is 4.0 μg[Cu]/L as a 24-hour average, and should not exceed 23 μg[Cu]/L at any time. Federal Drinking Water Guidelines: Action Level = 1300 μg[Cu]/L; EPA = 1000 μg [Cu]/L; State Drinking Water Guidelines: Arizona 1300 μg [Cu]/L; Kansas 1000 μg/L, and Minnesota 1300 μg/L[61].

Determination in Water: Total copper may be determined by digestion followed by AA, or by colorimetry (using neocuproine), or by ICP or optical emission spectrometry. Dissolved copper may be determined by 0.45 μ filtration followed by the preceding methods.

Routes of Entry: Inhalation of dust or fume, ingestion, or skin or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Short-term exposure to copper causes gastrointestinal distress. Copper salts act as irritants to the intact skin causing itching, erythema, and dermatitis. In the eyes, copper salts may cause conjunctivitis and even ulceration and turbidity of the cornea. Metallic copper may cause keratinization of the hands and soles of the feet, but it is not commonly associated with industrial dermatitis. The fumes and dust cause irritation of the upper respiratory tract; metallic taste in the mouth; nausea, metal fume fever. Inhalation of dusts, fumes, and mists of copper salts may cause congestion of the nasal mucous membranes. If the salts reach the gastrointestinal tract; they act as irritants producing salivation, nausea, vomiting, gastric pain; hemorrhagic gastritis; and diarrhea. It is unlikely that poisoning by ingestion in industry would progress to a serious point as small amounts induce vomiting, emptying the stomach of copper salts. Chronic human intoxication occurs rarely and then only in individuals with Wilson's disease (hepatolenticular degeneration). This is a genetic condition caused by the pairing of abnormal autosomal recessive genes in which there is abnormally high absorption, retention, and storage of copper by the body. The disease is progressive and fatal if untreated.

Long-Term Exposure: Long-term exposure causes liver and/or kidney damage. People with Wilson's Disease should consult their personal doctor if the amount of copper in their water exceeds the action level. Copper may decrease fertility in both males and females. Repeated or prolonged contact may cause skin sensitization and allergy; thickening of the skin, and greenish color to the skin, teeth, and hair. Repeated exposure can cause chronic irritation of the nose; and cause ulcers and hole in the septum dividing the inner nose. Repeated high exposure to copper can cause liver damage. There is evidence that workers in copper smelting plants have an increased risk of lung cancer, but this is thought to be due to arsenic trioxide and not copper.

Points of Attack: For copper dusts and mists: respiratory system, lungs, skin, liver, including risk with Wilson's disease; kidneys. For copper fume: respiratory system, skin, eyes, and risk with Wilson's disease.

Medical Surveillance: Serum and urine copper levels. Evaluation by a qualified allergist. Liver function tests.

Copper often contains arsenic as an impurity. Wilson's disease is a rare hereditary condition which interferes with the body's ability to get rid of copper. If you have this condition, consult your doctor about copper exposure. NIOSH lists the following tests: whole blood (chemical/metabolite), blood serum, biologic tissue/biopsy, urine (chemical/metabolite), urine (chemical/metabolite) 24 hours.

First Aid: If copper dust or powder gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If copper dusts or powder contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to Physician: In case of fume inhalation, treat pulmonary edema. Give prednisone or other corticosteroid orally to reduce tissue response to fume. Positive-pressure ventilation may be necessary. Treat metal fume fever with bed rest, analgesics, and antipyretics. The symptoms of metal fume fever may be delayed for 4–12 hours following exposure: it may last less than 36 hours.

Personal Protective Methods: For copper dusts, powder, or mists: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, head gear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Copper dusts and mists: 5 milligram per cubic meter*: Qm (APF = 25) (any quarter-mask respirator). *10 milligram per cubic meter:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *25 milligram per cubic meter:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); PaprHie (APF = 25) (any powered, APR with a high-efficiency particulate filter). *50 milligram per cubic meter*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or PaprTHie (APF = 50) (any powered, APR with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *100 milligram per cubic meter:* SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Copper fume: Up to 1 milligram per cubic meter: Any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100; or, Sa (APF = 10) (any supplied-air respirator). *Up to 2.5 milligram per cubic meter:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25) (any powered, APR with a high-efficiency particulate filter). *Up to 5 milligram per cubic meter:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTHie (APF = 50) (any powered, APR with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 100 milligram per cubic meter:* SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned en try into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Red Stripe (*copper powder*) flammability Hazard: Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8–10 m or a 1-hour fire wall from flammable or reactive materials. Prior to working with copper all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from acetylene gas, oxidizers, and other incompatible materials listed above. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. Copper powder: sources of ignition, such as smoking and open flames, are prohibited where copper powder is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Store to avoid conditions which create fumes or fine dusts.

Shipping: UN3089 Metal powders, flammable, n.o.s., Hazard Class: 4.1; Labels: 4.1-Flammable solid. Copper, elemental is not specifically cited in DOT's Performance-Oriented Packaging Standards[19].

Spill Handling: Warn other workers of spill. Put on proper protective equipment and clothing. Sweep or vacuum up solids being careful not to raise dust levels. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of copper dust and powder as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Copper powder can be a combustible solid. Thermal decomposition products may include metal oxides. Other poisonous gases may be produced in fire; copper may contain arsenic. Use special mixtures of dry chemicals appropriate for extinguishing metal fires: powdered dolomite, sodium chloride (common salt) or graphite. *Do not use water*. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Copper-containing wastes can be concentrated through the use of ion exchange, reverse osmosis, or evaporators to the point where copper can be electrolytically removed and sent to a reclaiming firm. If recovery is not feasible, the copper can be precipitated through the use of caustics and the sludge deposited in a chemical waste landfill[22]. Copper-containing soluble wastes can be concentrated through the use of ion exchange, reverse osmosis, or evaporators to the point where copper can be electrolytically removed and sent to a reclaiming firm. If recovery is not feasible, the copper can be precipitated through the use of caustics and the sludge deposited in a chemical waste landfill.

References

(31); (173); (101); (138); (2); (80); (170); (100).

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United States Environmental Protection Agency; Drinking Water Criteria Document for Copper, p.I-2 (EPA-600/X-84-190-1), Washington, DC, 1985.

United States Environmental Protection Agency, Recognition and Management of Pesticide Poisoning, 5th edition, Chapter 15, p. 145−147, Copper Compounds Washington DC, 2009.

Copper Arsenite C:1361

Formula: $CuHAsO_3$

Synonyms: Acid orthoarsenite; Arsenito de cobre (Spanish); Air-flo green; Arsonic acid, copper(2+) salt (1:1); Arsenious acid, copper(2+) salt (1:1); Cupric arsenite; Cupric green; Copper arsonate; Copper orthoarsenite; KOCIDE 2000; Scheele's green; Scheele's mineral; Swedish green

CAS Registry Number: 10290-12-7

HSDB Number: 4071

RTECS Number: CG3385000

UN/NA & ERG Number: UN1586/151

EC Number: 033-002-00-5

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen: Arsenic and inorganic arsenic compounds; IARC: Human Sufficient Evidence, 1980; Animal Limited Evidence, *carcinogenic to humans*, Group 1, 1987

California Proposition 65 Chemical[102]: Carcinogen (as arsenic) 2/27/1987

Hazard Alert: Poison, Suspected reprotoxic hazard, Environmental hazard, Agricultural chemical.

California EPA AB2588-Air Toxics "Hot Spots" Chemicals (CAL)
Clean Water Act: Toxic Pollutant (Section 401.15) as copper and compounds
WHO ADI = 0.002 mg[As]/kg as inorganic arsenic
EPA ADI: 1.3 mg[Cu]/L. As copper.
RCRA Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 6010(60); 7210(200) Note: All species in the ground water that contain copper are included
Carcinogen User Register Chemical (CAL/OSHA)
AB 1803-Well Monitoring Chemical (CAL)
EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%
CAL Air Resources Board/AB 1807 Toxic Air Contaminants Specific chemicals (EPA/NESHAP)
Permissible Exposure Limits for Chemical Contaminants (CAL/OSHA) as arsenic compounds
Clean Air Act: List of high risk pollutants (Section 63.74) as arsenic compounds
United States National Primary Drinking Water Regulations: MCLG = 1.3 mg[Cu]/L; MCL = TT action Level: 1.3 mg[Cu]/L. Copper is regulated by a Treatment Technique (TT) that requires systems to control the corrosiveness of their water. If more than 10% of tap water samples exceed the action level, water systems must take additional steps; SMCL = 1 mg[Cu]/L as Copper; MCLG = 0 mg[As]/L; MCL = 0.010 mg[As]/L as Arsenic.
Clean Water Act: Section 311 Hazardous Substances/RQ (same as CERCLA); Section 313 Priority Chemicals; Toxic Pollutant (Section 401.15) as arsenic and compounds
RCRA Section 261 Hazardous Constituents, waste number D004 (arsenic compounds)
EPCRA Section 304 RQ: CERCLA, 1 lb (0.454 kg)
United States DOT Regulated marine pollutant (49CFR172.101, Appendix B). As arsenates, liquid, n.o.s; arsenates, solid, n.o.s; arsenical pesticides liquid, toxic, flammable, n.o.s
Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%., as copper compounds; NPRI; CEPA Priority Substance List, Ocean dumping prohibited.
WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: An odorless, yellow-green powder. Low vapor pressure.

Potential Exposure: Formerly used in agriculture as insecticide, rodenticide, and fungicide. Also used in pigments and animal medications. Not currently registered for use in the United States.

Permissible Exposure Limits in Air:
OSHA(2): 0.01 milligram per cubic meter
NIOSH(2): Ceiling 0.002 milligram per cubic meter/15 min; carcinogen
ACGIH(1): 0.01 milligram per cubic meter; carcinogen

Determination in Air: Collection on a filter and analysis by AA spectrometry. See NIOSH Methods #7900 and #73000, Elements[18]. See also OSHA Method ID 105[58].

Permissible Concentration in Water: The permissible concentration of total recoverable copper in water to protect freshwater aquatic life is 5.6 μg[Cu]/L as a 24-hour average. The log of this concentration should not exceed the numerical value of log [0.94 In (hardness)-1.23]. The corresponding value to protect saltwater aquatic life is 4.0 μg[Cu]/L as a 24-hour average, and should not exceed 23 μg[Cu]/L at any time. Federal Drinking Water Guidelines: EPA 10 μg[As]/L; State Drinking Water Guidelines: Arizona 10 μg[As]/L; Connecticut 10 μg[As]/L. Runoff from spills or fire control may cause water pollution. Federal Drinking Water Guidelines: Action Level = 1300 μg[Cu]/L; EPA = 1000 μg[Cu]/L; State Drinking Water Guidelines: Arizona 1300 μg[Cu]/L; Kansas 1000 μg/L, and Minnesota 1300 μg/L[61].

Determination in Water: See OSHA Analytical Method ID-105 for arsenic. The AA graphite furnace technique is often used for measurement of total arsenic in water. It also has been standardized by EPA. Total arsenic may be determined by digestion followed by silver diethyldithiocarbamate; an alternative is AA; another is ICP optical emission spectrometry. Total copper may be determined by digestion followed by AA or by colorimetry (using neocuproine) or by ICP Optical Emission Spectrometry. Dissolved Copper may be determined by 0.45 μ filtration followed by the preceding methods.

Routes of Entry: Inhalation, skin, eyes, and ingestion

Harmful Effects and Symptoms

Short-Term Exposure: *Inhalation:* Dust is readily absorbed from the lungs, but inhaled quantities are usually insufficient to cause acute systemic toxicity. Can cause cough with foamy sputum and rales. *Skin/Eye Contact:* Dust can cause localized skin irritation, but systemic absorption through the skin is negligible. Dermal contact is unlikely to cause systemic effects unless the dermal barrier is compromised. Eye exposure may produce burns and ulcerations. *Ingestion:* The most important route of acute exposure. Arsenicals are quickly absorbed and can be extremely hazardous. Significant tissue and organ damage and death may result. *Symptoms of exposure include*: Headache (lethargy, delirium, hallucinations, seizures, or coma can occur); dizziness; acute nausea and occasional vomiting; labored breathing; restlessness; cyanosis (pale or bluish lips, face, and fingernails); perspiration; difficult breathing; abdominal pain with diarrhea; trembling and feeling of "pins and needles" or electrical shock like pains in the lower extremities; convulsions; unconsciousness; possible pulmonary edema, a Medical emergency. Very acute poisoning: extreme headache; muscular paralysis, and liver and kidney dysfunction, loss of consciousness; death.

Long-Term Exposure: Arsenic can cause skin damage or problems with circulatory systems, and may have increased risk of cancer. Chronic exposure is characterized by malaise, peripheral sensorimotor neuropathy, anemia, jaundice, gastrointestinal complaints, and characteristic skin lesions including hyperkeratosis (small corn-like elevations) and hyperpigmentation. Hyperkeratosis usually appears on the palms or soles. Pigmentation changes and hyperkeratosis can take 3 to 7 years to appear. Chronic inhalation can also lead to conjunctivitis, irritation of the throat and respiratory tract, and perforation of the nasal septum. Chronic exposure can cause allergic contact dermatitis. Chronic exposure may be more serious for children because of their potential longer latency period. *Carcinogenicity:* The Department of Health and Human Services, IARC, United States Environmental Protection Agency, and NTP have classified arsenic as a human carcinogen based on sufficient evidence from human data. Arsenic trioxide causes skin and lung cancer, and may cause internal cancers such as liver, bladder, kidney, colon, and prostate cancers. Arsenic ions released from arsenic trioxide within the body can cross the placenta and affect the developing fetus; arsenic is also excreted in breast milk. Experimental animal studies support an association between high ingested arsenic dose and fetal toxicity. Long-term exposure to copper causes liver and/or kidney damage. People with Wilson's Disease should consult their personal doctor to determine if the amount of copper in their water exceeds 1.3 mg[Cu]/L.

Points of Attack: Muscles, liver, and kidney

Medical Surveillance: Test for urine arsenic. Levels should not be greater than 100 μg/g of creatinine in the urine. Examine the skin for abnormal growths. Liver and kidney function tests. In acutely ill patients, the agent most frequently recommended is dimercaprol, also known as BAL (British Anti-Lewisite). The standard dosage regimen is 3 to 5 mg/kg IM every 4–6 hours until the 24-hour urinary arsenic level falls below 50 μg/L, unless an orally administered chelating agent (e. g., DMSA, see below) is substituted. This regimen may be adjusted depending upon the severity of the exposure and the symptoms. Do not chelate asymptomatic patients without the guidance of a 24-hour urinary arsenic level. Contraindications to BAL include preexisting renal disease, pregnancy (except in life-threatening circumstances) and concurrent use of medicinal iron (BAL and iron together form a complex that is very toxic).

First Aid: Do not contaminate yourself. Positive-pressure, SCBA is recommended in response situations that involve exposure to potentially unsafe levels of arsenicals or combustion products which may include arsine and arsenic trioxide fumes. *Eyes:* Immediately and gently flush eyes with plenty of warm or cold water (NO hot water) for at least 15 minutes, occasionally lifting the upper and lower eye lids. Get Medical aid immediately. *Skin:* Although it is poorly absorbed dermally, dermal contact should be avoided because arsenicals may irritate the skin. Wearing the appropriate PPE equipment and respirator for arsenicals. Immediately flush skin with plenty of soap and water for at least 15 minutes while removing contaminated clothing and shoes. *Ingestion:* Call poison control. Loosen all clothing. Never give anything by mouth to an unconscious person. Get medical aid. Do NOT induce vomiting. If conscious, alert, and able to swallow, aggressive decontamination with gastric lavage is recommended within 1 hour of ingestion of a life-threatening amount of poison. The effectiveness of activated charcoal in binding arsenic trioxide is questionable, but administration of a charcoal slurry is recommended pending further evaluation in cases of ingestion of unknown quantities (at 1 g/kg, usual adult dose 60–90 g, child dose 25–50 g). A soda can and straw may be of assistance when offering charcoal to a child. If victim is *UNCONSCIO United States OR HAVING CONVULSIONS*, do nothing except keep victim warm. *Inhalation:* Get medical aid. Wearing the appropriate PPE equipment and respirator for arsenicals, immediately remove the victim from the contaminated area to fresh air. If the victim is not breathing, administer artificial respiration. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. If breathing is difficult, administer oxygen through bag/mask apparatus until medical help arrives. Do not leave victim unattended.

Respirator Selection: *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN1586 copper arsenite, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Spill Handling: As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 m/150 ft for liquids and at least 25 m/75 ft for solids. Keep unauthorized personnel away. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Stay upwind. Keep out of low areas. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Stop leak if you can do it without risk. Prevent entry into waterways, sewers, basements, or confined areas. Cover with plastic sheet to prevent spreading. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decompodition includes oxides of copper and arsenic.

Disposal Method Suggested: Copper-containing soluble wastes can be concentrated through the use of ion exchange, reverse osmosis, or evaporators to the point where copper can be electrolytically removed and sent to a reclaiming firm. If recovery is not feasible, the copper can be precipitated through the use of caustics and the sludge deposited in a chemical waste landfill

References

(109); (102); (31); (173); (101); (138); (204); (100).

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United States Environmental Protection Agency; Drinking Water Criteria Document for Copper, p.I-2 (EPA-600/X-84-190-1), Washington, DC, 1985.

United States Environmental Protection Agency, Recognition and Management of Pesticide Poisoning, 5th edition, Chapter 15, page 146, Washington, DC, 2009.

Copper Chloride C:1370

Formula: Cl_2Cu

Synonyms: Copper bichloride; Copper(2 +) chloride; Copper(II) chloride; Copper dichloride; Cupric chloride; Cupric chloride dihydrate; Cupric dichloride; Dicopper dichloride; Dikupferdichlorid (German); Kupferchlorid (CuCl) (German)

CAS Registry Number: 7758-89-6 (I); 7447-39-4 (II)

HSDB Number: 259 (I & II)

RTECS Number: GL7237000

UN/NA & ERG Number: UN2802/154

EC Number: 231-210-2 (II); 231-842-9 (I)

Regulatory Authority and Advisory Information

Hazard Alert: Corrosive, Environmental hazard.

EPA ADI:1.3 mg[Cu]/L. As copper.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992); Section 307 Toxic Pollutants, 40CFR401.15 (effluent limitations); as copper and compounds

United States National Primary Drinking Water Regulations: MCLG = 1.3 mg[Cu]/L; MCL = TT action Level: 1.3 mg[Cu]/L. Copper is regulated by a Treatment Technique (TT) that requires systems to control the corrosiveness of their water. If more than 10% of tap water samples exceed the action level, water systems must take additional steps; SMCL = 1 mg[Cu]/L as Copper; United States National Primary Drinking Water Regulations: SMCL = 250 mg$[Cl^-]$/L as Chloride

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 6010 (60); 7210 (200) Note: All species in the ground water that contain copper are included

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%, as copper compounds; NPRI; CEPA Priority Substance List, Ocean dumping prohibited.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

European/International Regulations (*dichloride*): Hazard symbol: T, C, N, Xi, Xn; risk phrases: R21/22; R23/24/25; R32; R35; R36/37/38; R38; R41; R50/53 (*dichloride*); R51/53 (*monochloride*); safety phrases: S25; S26; S28; S29/35; S36/37/39; S36; S37/39; S39; S44; S45; S57; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water. (*dichloride*); 2-Hazard to waters (*monochloride*).

Description: Copper chloride is a brownish-yellow powder. Molecular weight = 134.45 (II); specific gravity (H_2O:1) = 3.4 (II); boiling point = (decomposes below this point) 993°C (II); freezing/melting point = 598 C (II); 498°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 0, reactivity 0. Soluble in water; solution is acidic.

Potential Exposure: Copper chloride is used in petroleum, textiles, metallurgy, photography, agricultural products;

feed additives; and wood preservation. It is also used in light sensitive paper manufacturing; glass pigments; ceramics; and in making cyclonitrile.

Incompatibilities: Contact with strong acids forms monovalent copper salts and toxic hydrogen chloride gas. Forms shock-sensitive and explosive compounds with potassium, sodium, sodium hypobromite, nitromethane, acetylene. Keep away from moisture and alkali metals. Attacks metals in the presence of moisture. Reacts with moist air to form cupric chloride dihydrate. May attack some metals, paints, and coatings. May be able to ignite combustible materials.

Permissible Exposure Limits in Air

NIOSH IDLH = 100 mg[Cu]/m^3 (dust, mists and fume)

PAC Ver. 29[138]

7758-89-6 (I)

PAC-1: 4.7 milligram per cubic meter

PAC-2: 53 milligram per cubic meter

PAC-3: 320 milligram per cubic meter

7447-39-4 (II)

PAC-1: 6.3 milligram per cubic meter

PAC-2: 69 milligram per cubic meter

PAC-3: 420 milligram per cubic meter

Copper and its inorganic compounds

DFG MAK: 0.1 milligram per cubic meter measured as the inhalable fraction of the aerosol; Peak Limitation Category I(1); Pregnancy Risk Group C

Determination in Air: Use NIOSH Analytical Methods (dusts and mist) #7029, #7300, #7301, #7303, #9102 and OSHA Analytical Methods ID-121, ID-125G, ID-206

Permissible Concentration in Water: The permissible concentration of total recoverable copper in water to protect freshwater aquatic life is 5.6 μg[Cu]/L as a 24-hour average. The log of this concentration should not exceed the numerical value of log [0.94 In (hardness)-1.23]. The corresponding value to protect saltwater aquatic life is 4.0 μg[Cu]/L as a 24-hour average, and should not exceed 23 μg[Cu]/L at any time. Federal Drinking Water Guidelines: Action Level = 1300 μg[Cu]/L; EPA = 1000 μg [Cu]/L; State Drinking Water Guidelines: Arizona 1300 μg [Cu]/L; Kansas 1000 μg/L, and Minnesota 1300 μg/L[61]. Runoff from spills or fire control may cause water pollution.

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Long-term exposure to copper causes liver and/or kidney damage. Irritates the eyes, skin, and respiratory tract. Skin or eye contact can cause corrosive burns and permanent damage. Irritates the stomach causing salivation, nausea, vomiting, stomach pain; and diarrhea.

Long-Term Exposure: Repeated exposure may cause skin thickening and allergy. May cause a greenish color to the skin and hair. May damage the liver and kidneys. Repeated Exposure can cause ulcers or a hole in the nasal septum with possible bleeding. May affect the blood. People with Wilson's Disease should consult their personal doctor to determine if the amount of copper in their water exceeds 1.3 mg[Cu]/L.

Points of Attack: Kidneys, liver, skin, blood.

Medical Surveillance: Serum and urine copper levels. Liver and kidney function tests. Evaluation by a qualified allergist. CBC. Wilson's disease is a rare hereditary condition which interferes with the body's ability to get rid of copper. If you have this condition, consult your doctor about copper exposure.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Specific engineering controls are required under OSHA 1910.1018, *Inorganic Arsenic*. See also NIOSH Criteria Document #75-149, *Inorganic Arsenic*.

Respirator Selection: *Copper dusts and mists: 5 milligram per cubic meter*: Qm (APF = 25) (any quarter-mask respirator). *10 milligram per cubic meter:* Any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100; or Sa (APF = 10) (any supplied-air respirator). *25 milligram per cubic meter:* Sa: Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); PaprHie (APF = 25) (any powered, APR with a high-efficiency particulate filter). *50 milligram per cubic meter*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or PaprTHie (APF = 50) (any powered, APR with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *100 milligram per cubic meter:* SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd, Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from incompatible materials listed above, moisture, and heat.

Shipping: UN2802 Copper chloride, Hazard class: 8; Labels: 8-Corrosive material.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical does not burn. Thermal decomposition products may include hydrogen chloride and oxides of metal. Use any extinguisher suitable for surrounding fires. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Copper Chloride, Trenton, NJ (February 2007).

United States Environmental Protection Agency, Ambient Water Quality Criteria Document: Copper, p.B-14 (440/5-80-036), Washington, DC, 1980.

United States Environmental Protection Agency; Drinking Water Criteria Document for Copper, p.I-2 (EPA-600/X-84-190-1), Washington, DC, 1985.

United States Environmental Protection Agency, Recognition and Management of Pesticide Poisoning, 5th edition, Chapter 15, page 146, Washington, DC, 2009.

Copper Cyanide C:1380

Formula: CCuN, C_2CuN_2; CuCN, $Cu(CN)_2$

Synonyms: *cupric cyanide:* Copper(II) cyanide; Copper cynanamide; Cyanure de cuivre (French)

cuprous cyanide: Cianuro de cobre (Spanish); Copper(1+) cyanide; Copper(I) cyanide; Cupricin

CAS Registry Number: 544-92-3 (cuprous cyanide); 14763-77-0 (cupric cyanide)

HSDB Number: 1438

RTECS Number: GL7150000 (cuprous cyanide); GL7175000 (cupric cyanide)

UN/NA & ERG Number: UN1587/151

EC Number: 238-826-0

Regulatory Authority and Advisory Information

EPA ADI: 1.3 mg[Cu]/L. As copper.

Hazard Alert: Poison, Dangerously water reactive, Air reactive (moisture releases poisonous gas), Environmental hazard.

as cuprous cyanide

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) as cyanide compounds

Clean Water Act: Toxic Pollutant (Section 401.15)

United States National Primary Drinking Water Regulations: MCLG = 1.3 mg[Cu]/L; MCL = TT action Level: 1.3 mg[Cu]/L. Copper is regulated by a Treatment Technique (TT) that requires systems to control the corrosiveness of their water. If more than 10% of tap water samples exceed the action level, water systems must take additional steps; SMCL = 1 mg[Cu]/L as Copper; MCLG = 0.2 mg[CN^-]/L; MCL = 0.2 mg[CN^-]/L as cyanide.

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P029

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg)

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 6010 (60); 7210 (200) Note: All species in the ground water that contain copper are included

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%. (copper)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%. (cyanide)

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. (cupric cyanide); NPRI; CEPA Priority Substance List, Ocean dumping prohibited, as copper compounds, n.o.s.; Drinking Water Quality = 0.2 mg (CN)/l MAC as cyanide compounds.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R14/15; R26; R29; R37; R40; R41; R50/53; safety phrases: S1/2; S28; S23; S29/35; S36/37; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Cuprous cyanide is a white crystalline substance. Cupric cyanide, $Cu(CN)_2$ is a yellowish-green powder which decomposes on heating. Molecular weight = 89.56 (cuprous); 115.55 (cupric); specific gravity (H_2O:1) = 2.92; freezing/melting point = 474°C (in nitrogen, cuprous cyanide). Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 0 ₩. Insoluble in water; reaction may release hydrogen cyanide gas.

Potential Exposure: Copper cyanide is used in electroplating copper on iron; and as an insecticide and a catalyst.

Incompatibilities: Contact with heat, strong acids (HCl, H_2SO_4, HNO_3) forms deadly hydrogen cyanide gas. May release hydrogen cyanide on contact with moisture. Incompatible with strong oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, acetylene gas, and chemically active metals, such as potassium, sodium, magnesium, and zinc.

Permissible Exposure Limits in Air

As cyanides, CN

OSHA PEL: 5 mg[CN]/m^3 TWA

NIOSH REL: 4.7 ppm/5 mg[CN]/m^3 [10 minutes] Ceiling Concentration

ACGIH TLV[1]: 5 mg[CN]/m^3 [skin] Ceiling Concentration (1993−1994)

PAC Ver. 29[138]

544-92-3, copper (I) cyanide

PAC-1: 21 milligram per cubic meter

PAC-2: 29 milligram per cubic meter

PAC-3: 170 milligram per cubic meter

Copper and its inorganic compounds

NIOSH IDLH = 100 mg[Cu]/m^3 (dust, mists and fume)

DFG MAK: 0.1 milligram per cubic meter measured as the inhalable fraction of the aerosol; Peak Limitation Category II(1) [skin]; Pregnancy Risk Group C

The limit set by Russia[43] is 0.3 milligram per cubic meter as a MAC in work-place air and 0.009 milligram per cubic meter as a momentary value in ambient air of residential areas; the daily average MAC allowable in residential areas is 0.004 milligram per cubic meter.

Determination in Air: Use NIOSH Analytical Method #7904; # 6010, cyanides. For copper Use NIOSH Analytical Methods (dusts and mist) #7029, #7300, #7301, #7303, #9102 and OSHA Analytical Methods ID-121, ID-125G

Permissible Concentration in Water: The permissible concentration of total recoverable copper in water to protect freshwater aquatic life is 5.6 μg[Cu]/L as a 24-hour average. The log of this concentration should not exceed the numerical value of log [0.94 In (hardness)-1.23]. The corresponding value to protect saltwater aquatic life is 4.0 μg [Cu]/L as a 24-hour average and should not exceed 23 μg [Cu]/L at any time. *Copper:* Federal Drinking Water Guidelines: Action Level = 1300 μg[Cu]/L; EPA = 1000 μg [Cu]/L; State Drinking Water Guidelines: Arizona 1300 μg [Cu]/L; Kansas 1000 μg/L, and Minnesota 1300 μg/L[61]. United States Army field drinking-water standards for cyanide: 2 mg/L assuming a water consumption of 15 L/day and 6 mg/L assuming a water consumption of 5 L/day. United States Army field drinking-water standards for cyanide, long-term consumption 0.5 mg/L; Short-term consumption; Raw water constituents (maximum) 20 mg/L.

Inorganic cyanide standards: Bulgaria 0.3 milligram per cubic meter; Czechoslovakia 3−15 milligram per cubic meter; Finland 7 milligram per cubic meter; Federal Republic of Germany 5 milligram per cubic meter; Hungary 0.3 milligram per cubic meter; Poland 0.3 milligram per cubic meter; Romania 0.3 milligram per cubic meter; Yugoslavia 5 milligram per cubic meter[77].

Determination in Water: Use NIOSH Analytical Method #7904; #6010, cyanides. Cyanide may be determined titrimetrically by EPA Methods 335.2 and 9010 which give total cyanide. Total copper may be determined by digestion followed by AA or by colorimetry (using neocuproine) or by ICP Optical Emission Spectrometry. Dissolved Copper may be determined by 0.45 μ filtration followed by the preceding methods.

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Copper cyanide can affect you when breathed in. Eye contact can cause severe burns with loss of vision. Skin contact can cause irritation or burns. Breathing copper cyanide causes irritation of respiratory tract and may cause nose bleeds or sores in the nose.

Long-Term Exposure: Long-term exposure to copper causes liver and/or kidney damage. People with Wilson's Disease should consult their personal doctor to determine if the amount of copper in their water exceeds 1.3 mg[Cu]/L.

Repeated exposure can cause copper to deposit in the liver and other body organs, causing damage, atrophy of the inner lining of the nose, with a watery discharge. Metallic taste may also occur. Repeated skin exposure can cause skin allergy and possibly a green discoloration of the skin and hair. May be able to affect the lungs.

Points of Attack: Skin, lungs, possibly other body organs.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful. Urine copper test.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek Medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH (***as cyanides***): *25 milligram per cubic meter*: Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern and having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA). ***Copper dusts and mists:*** *5 milligram per cubic meter*: Qm (APF = 25) (any quarter-mask respirator). *10 milligram per cubic meter:* Any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100; or Sa (APF = 10) (any supplied-air respirator). *25 milligram per cubic meter:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); PaprHie (APF = 25) (any powered, APR with a high-efficiency particulate filter). *50 milligram per cubic meter*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or PaprTHie (APF = 50) (any powered, APR with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *100 milligram per cubic meter:* SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd, Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with copper cyanide all handlers should be trained on its proper handling and storage. Copper cyanide must be stored to avoid contact with chemically active metals (such as potassium, sodium, magnesium, and zinc), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from acetylene gas.

Shipping: UN1587 Copper cyanide, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Thermal decomposition products may include cyanide gas and nitrous oxides. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Copper-containing soluble wastes can be concentrated through the use of ion exchange, reverse osmosis, or evaporators to the point where copper can be electrolytically removed and sent to a reclaiming firm. If recovery is not feasible, the copper can be precipitated through the use of caustics and the sludge deposited in a chemical waste landfill. Copper-containing wastes can be concentrated to the point where copper can be electrolytically removed and reclaimed. If recovery is not feasible, the copper can be precipitated by alkali; the cyanide destroyed by alkaline oxidation yielding a sludge which can be sent to a chemical waste landfill[22]. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (2); (100).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Copper cyanide, Trenton, NJ (February 2007).

United States Environmental Protection Agency, Ambient Water Quality Criteria Document: Copper, p.B-14 (440/5-80-036), Washington, DC, 1980.

United States Environmental Protection Agency; Drinking Water Criteria Document for Copper, p.I-2 (EPA-600/X-84-190-1), Washington, DC, 1985.

United States Environmental Protection Agency, Recognition and Management of Pesticide Poisoning, 5th edition, Chapter 15, p. 145−147, Copper Compounds Washington, DC, 2009.

Copper Hydroxide C:1382

Formula: $Cu(OH)_2$

Synonyms: Champion; Chiltern kocide 101; Comac parasol; Copper dihydroxide; Copper hydrate; Copper(II) hydroxide; Copper oxide hydrated; Criscobre; Cupravit blue; Cupric hydroxide; Kocide 101; Kozinc; Mefenoxam/copper; Nu-cop; Parasol; Spin-out

CAS Registry Number: 20427-59-2

HSDB Number: 262

RTECS Number: GL7600000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 243-815-9.

Regulatory Authority and Advisory Information

Hazard Alert: Environmental hazard.

EPA ADI:1.3 mg[Cu]/L. As copper.

Clean Water Act: Toxic Pollutant (Section 401.15) as copper and compounds

United States National Primary Drinking Water Regulations: MCLG = 1.3 mg[Cu]/L; MCL = TT action Level: 1.3 mg[Cu]/L. Copper is regulated by a Treatment Technique (TT) that requires systems to control the corrosiveness of their water. If more than 10% of tap water samples exceed the action level, water systems must take additional steps; SMCL = 1 mg[Cu]/L as Copper.

RCRA Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 6010(60); 7210(200) Note: All species in the ground water that contain copper are included

EPCRA (Section 313): Includes any unique chemical substance that contains copper as part of that chemical's infrastructure

Form R *de minimis* concentration reporting level: 1.0%

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R26; R37; R40; R41; R50/53; safety phrases: S1/2; S28; S29/35; S23; S36/37; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Blue, gelatinous or amorphous powder. Insoluble in water. Molecular weight = 97.56; density 3.368; freezing/melting point (decomposes)

Potential Exposure: Inorganic copper fungicide, nematicide, and microbiocide.

Incompatibilities: Reacts with calcium (metal hydroxides), nitroethane, nitromethane, 1-nitropropane, zirconium

Permissible Exposure Limits in Air:

As copper

NIOSH IDLH = 100 mg[Cu]/m^3

OSHA PEL: 1 mg[Cu]/m^3 (dust, mist) TWA; 0.1 milligram per cubic meter (fume) TWA

NIOSH: 1 mg[Cu]/m^3 (dust, mist) TWA; 0.1 milligram per cubic meter (fume) TWA

ACGIH TLV[1]: 1 mg[Cu]/m^3 (dust, mist) TWA; 0.2 milligram per cubic meter (fume) TWA

PAC Ver. 29[138]

PAC-1: 4.6 milligram per cubic meter

PAC-2: 33 milligram per cubic meter

PAC-3: 200 milligram per cubic meter

Copper and its inorganic compounds

DFG MAK: 0.1 milligram per cubic meter measured as the inhalable fraction of the aerosol; Peak Limitation Category II(2); Pregnancy Risk Group C

Determination in Air: Copper dusts and mists are collected on a filter, worked up with acid, measured by AA. See

NIOSH Method #7029 for copper. For copper fume: filter collection, acid digestion, measurement by AA.

Permissible Concentration in Water: The permissible concentration of total recoverable copper in water to protect freshwater aquatic life is 5.6 μg[Cu]/L as a 24-hour average. The log of this concentration should not exceed the numerical value of log [0.94 In (hardness)-1.23]. The corresponding value to protect saltwater aquatic life is 4.0 μg [Cu]/L as a 24-hour average, and should not exceed 23 μg [Cu]/L at any time. Federal Drinking Water Guidelines: Action Level = 1300 μg[Cu]/L; EPA = 1000 μg[Cu]/L; State Drinking Water Guidelines: Arizona 1300 μg[Cu]/L; Kansas 1000 μg/L, and Minnesota 1300 μg/L[61].

Harmful Effects and Symptoms

Short-Term Exposure: Contact with eyes or skin may cause irritation or injury. Inhalation should be avoided; use NIOSH- or CEN (UK)-approved APRs for pesticides. May be harmful if swallowed.

Long-Term Exposure: Long-term Exposure to copper causes liver and/or kidney damage. People with Wilson's Disease should consult their personal doctor to determine if the amount of copper in their water exceeds 1.3 mg[Cu]/L. May cause skin sensitization.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious and able to swallow, have victim drink 4 to 8 oz of water. Do not induce vomiting. *Note to physician or authorized medical personnel*: Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a drug or other inhalation therapy. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. Evaluation by a qualified allergist, including exposure history and testing, may help diagnose allergy.

Respirator Selection: *Copper dusts and mists: 5 milligram per cubic meter*: Qm (APF = 25) (any quarter-mask respirator). *10 milligram per cubic meter:* Any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100; or Sa (APF = 10) (any supplied-air respirator). *25 milligram per cubic meter:* Sa: Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); PaprHie (APF = 25) (any powered, APR with a high-efficiency particulate filter). *50 milligram per cubic meter*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or PaprTHie (APF = 50) (any powered, APR with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *100 milligram per cubic meter:* SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd, Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp: ASC BA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—Blue: Health Hazard/Poison: Store in a tightly closed container in a dry, well-ventilated, and secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Where possible, automatically transfer material from other storage containers to process containers.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Do not touch or walk through spilled material. Stop leak if you can do it without risk. Prevent dust cloud. Avoid inhalation of asbestos dust. *Small Dry Spill:* With clean shovel place material into clean, dry container and cover loosely; move containers from spill area. Small Spill: Take up with sand or other noncombustible absorbent material and place into containers for later disposal. *Large Spill*: Dike far ahead of liquid spill for later disposal. Cover powder spill with plastic sheet or tarp to minimize spreading. Prevent entry into waterways, sewers, basements, or confined areas.

Fire Extinguishing: As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 m/150 ft for liquids and at least 25 m/75 ft for solids. *Fire involving storage or vehicular tanks:* Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m (1/2 mi) in all directions. *On a Small fire:* use dry chemical, CO_2, water spray, or regular *foam. On a large fire:* use water spray, fog, or regular foam. Do not scatter spilled material with high pressure streams of water. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal. *Fire involving tanks:* From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. Always stay away from tanks engulfed in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Copper-containing soluble wastes can be concentrated through the use of ion exchange, reverse osmosis, or evaporators to the point where copper can be electrolytically removed and sent to a reclaiming firm. If recovery is not feasible, the copper can be precipitated through the use of caustics and the sludge deposited in a chemical waste landfill Copper-containing wastes can be concentrated through the use of ion exchange, reverse osmosis, or evaporators to the point where copper can be electrolytically removed and sent to a reclaiming firm. Details of copper recovery from a variety of industrial wastes have been published. If recovery is not feasible, the copper can be precipitated by the use of caustics and the sludge deposited in a chemical waste landfill. Recommendable methods: Precipitation, solidification, landfill, discharge to sewer, & incineration. Peer-review: Precipitate copper with alkali, filter, solidify precipitate. (Do not use ammonia as alkali). Cation exchange will allow recovery of copper. Eluate from cation exchanger can be passed through anion exchanger to remove (or reduce) naphthenic acid content. Exhausted ion exchange resins can be landfilled. (Peer-review conclusions of an IRPTC expert consultation)[UN].

References

(31); (173); (101); (138); (204); (100).

United States Environmental Protection Agency, Office of Pesticide Programs, Pesticide Residue Limits, (40CFR180.1021). www.epa.gov/pesticides/food/viewtols.htm.

United States Environmental Protection Agency, Ambient Water Quality Criteria Document: Copper, EPA 440/5-80-036, p. B-14 Washington, DC (1980).

United States Environmental Protection Agency, Ambient Water Quality Criteria Document: Copper, p.B-14 (440/5-80-036), Washington, DC, 1980.

United States Environmental Protection Agency; Drinking Water Criteria Document for Copper, p.I-2 (EPA-600/X-84-190-1), Washington, DC, 1985.

United States Environmental Protection Agency, Recognition and Management of Pesticide Poisoning, 5th edition, Chapter 15, p. 145−147, Copper Compounds Washington, DC, 2009.

Copper(II)-8-Hydroxyquinoline C:1383

Formula: $C_{18}H_{12}CuN_2O_2$

Synonyms: Bioquin; Bioquin-1; Bis(8-quinolinato)copper; Bis(8-quinolinolato)copper; Bis(8-quinolinolato-N1,O8)-copper; Bis(8-oxyquinoline)copper; Blue control; Cellu-quin; Champman PQ-8; Copper-8; Copper hydroxyquinolate; Copper-8-hydroxyquinolate; Copper-8-hydroxyquinolinate; Copper-8-hydroxyquinoline; Copper oxinate; Copper (II) oxinate; Copper oxine; Copper oxyquinolate; Copper oxyquinoline; Copper quinolate; Copper-8-quinolate; Copper-8-quinolinol; Copper quinolinolate; Copper-8-quinolinolate; Cunilate; Cunilate-2472; Cupric-8-hydroxyquinolate; Cupric-8-quinolinolate; Dokirin; Fruitdo; 8-Hydroxyquinoline copper complex; Milmer; Nytek; Oxime-copper; Oxine-copper; Quinondo

CAS Registry Number: 10380-28-6

HSDB Number: 6944 (copper compounds)

RTE CS Number: VC5250000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 233-841-9

Regulatory Authority and Advisory Information

Carcinogenicity: IARC, Group 3 not classifiable as to its carcinogenicity in humans

Hazard Alert: Poison, May be flammable,[77] Sensitization hazard, Possible risk of forming tumors, Suspected of causing genetic defects, Agricultural chemical, Environmental hazard.

EPA ADI:1.3 mg[Cu]/L. As copper.

California EPA AB2588-Air Toxics “Hot Spots” Chemicals (CAL) as copper compounds

The “Director’s List” (CAL/OSHA) as copper compounds

Clean Water Act: Toxic Pollutant (Section 401.15) as copper and compounds

United States National Primary Drinking Water Regulations: MCLG = 1.3 mg[Cu]/L; MCL = TT action Level: 1.3 mg[Cu]/L. Copper is regulated by a Treatment Technique (TT) that requires systems to control the corrosiveness of their water. If more than 10% of tap water samples exceed the action level, water systems must take additional steps; SMCL = 1 mg[Cu]/L as Copper.

RCRA Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 6010(60); 7210(200) Note: All species in the ground water that contain copper are included

EPCRA (Section 313): Includes any unique chemical substance that contains copper as part of that chemical’s infrastructure; Form R *de minimis* concentration reporting level: 1.0%

Hazard symbols, risk, & safety statements: Hazard symbol: T, N, Xi; risk phrases: R36/37/38; R43; R50/53; safety phrases: S2; S26; S36; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Yellow-green crystalline solid or powder. Odorless. Molecular weight = 351.9; specific gravity (H_2O:1) = 1.69 @ 20°C; freezing/melting point = 239.8°C. Decomposition temperature = 270°C. Insoluble in water.

Potential Exposure: Fungicide and microbiocide.

Incompatibilities: May form highly unstable acetylides. Decomposes on burning producing toxic and corrosive fumes including copper and nitrogen oxides.

Permissible Exposure Limits in Air:

as inorganic copper

NIOSH IDLH = 100 mg[Cu]/m^3

OSHA PEL: 1 mg[Cu]/m^3 (dust, mist) TWA; 0.1 milligram per cubic meter (fume) TWA

NIOSH: 1 mg[Cu]/m^3 (dust, mist) TWA; 0.1 milligram per cubic meter (fume) TWA

ACGIH TLV[1]: 1 mg[Cu]/m^3 (dust, mist) TWA; 0.2 milligram per cubic meter (fume) TWA

Determination in Air: Copper dusts and mists are collected on a filter, worked up with acid, measured by AA. See NIOSH Method #7029 for copper. For copper fume: filter collection, acid digestion, measurement by AA.

Permissible Concentration in Water: The permissible concentration of total recoverable copper in water to protect freshwater aquatic life is 5.6 μg[Cu]/L as a 24-hour average. The log of this concentration should not exceed the numerical value of log [0.94 In (hardness)-1.23]. The corresponding value to protect saltwater aquatic life is 4.0 μg [Cu]/L as a 24-hour average, and should not exceed 23 μg [Cu]/L at any time. Federal Drinking Water Guidelines: Action Level = 1300 μg[Cu]/L; EPA = 1000 μg[Cu]/L; State Drinking Water Guidelines: Arizona 1300 μg[Cu]/L; Kansas 1000 μg/L, and Minnesota 1300 μg/L[61].

Determination in Water: Total copper may be determined by digestion followed by AA or by colorimetry (using neocuproine) or by ICP Optical Emission Spectrometry. Dissolved Copper may be determined by 0.45 μ filtration followed by the preceding methods.

Determination in Water: Log K_{ow} = 2.46 Values above 3.0 are likely to bioaccumulate in aquatic organisms.

Harmful Effects and Symptoms

Short-Term Exposure: Organic copper compounds are more absorbable and exhibit greater systemic toxicity than inorganic compounds. Soluble copper salts are corrosive to mucous membranes and the cornea. Contact with eyes or skin may cause irritation or injury. Inhalation should be avoided. Harmful if swallowed. Metallic taste, nausea, vomiting, and stomach pain. In more severe cases, there may be blood in vomit or black/tarry stools, jaundice, and enlarged liver. Blood cells rupture resulting in circulatory collapse and shock[72].

Long-Term Exposure: Long-term exposure to copper causes liver and/or kidney damage. People with Wilson's Disease should consult their personal doctor to determine if the amount of copper in their water exceeds 1.3 mg[Cu]/L. Repeated or prolonged inhalation exposure may cause asthma. May cause skin allergy and thickening of the skin; copper deposits can cause discoloration in the skin and hair, leaving a green color. Repeated exposure can cause shrinking of the lining of the inner nose with watery discharge, liver damage. Individuals with Wilson's disease absorb, retain, and store copper excessively. May cause mutations in humans. May damage the testes and decrease fertility in both males and females

Points of Attack: Skin, reproductive system, liver

Medical Surveillance: Serum and urine copper level. Liver and kidney tests. Examination by a qualified allergist. More than light alcohol consumption may exacerbate the liver damage caused by copper sulfate

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Applicators and other handlers must wear: Coveralls worn over long-sleeved shirt and long pants; Chemical-resistant gloves such as DuPont Tychem suit fabrics, barrier laminate, or Viton; Chemical-resistant footwear plus socks; Protective eye wear; Chemical-resistant headgear for overhead exposure; Chemical-resistant apron when cleaning equipment, mixing, or loading[83]. Agricultural Use/Engineering Controls: When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the WPS for agricultural pesticides, 40 CFR170.240 (d)(4-6), the handler PPE requirements may be reduced or modified as specified in the WPS. Firefighters should wear NIOSH-approved SCBA and full protective clothing.

Respirator Selection: Wherever and whenever workplace conditions warrant respirator use, a respiratory protection program must be followed that meets one or more of the following requirements: OSHA's 29 CFR1910.134, ANSI Z88.2, or European Standard EN149.

Storage: Color code—Blue: Health Hazard/Poison: Store in a tightly closed container in a dry, well-ventilated, and secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Where possible, automatically transfer material from other storage containers to process containers.

Shipping: UN3077 Environmentally Hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling:

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen, meta (copper), and carbon. As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 m/150 ft for liquids and at least 25 m/75 ft for solids. *Fire involving storage or vehicular tanks:* Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m (1/2 mi) in all directions. *On a small fire:* use dry chemical, CO_2, water spray, or regular *foam. On a large fire:* use water spray, fog, or regular foam. Do not scatter spilled material with high pressure streams of water. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal. *Fire involving tanks:* from a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. Always stay away from tanks engulfed in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Copper-containing soluble wastes can be concentrated through the use of ion exchange, reverse osmosis, or evaporators to the point where copper can be electrolytically removed and sent to a reclaiming firm. If recovery is not feasible, the copper can be precipitated through the use of caustics and the sludge deposited in a chemical waste landfill Copper-containing wastes can be concentrated through the use of ion exchange, reverse osmosis, or evaporators to the point where copper can be electrolytically removed and sent to a reclaiming firm. Details of copper recovery from a variety of industrial wastes have been published. If recovery is not feasible, the copper can be precipitated by the use of caustics and the sludge deposited in a chemical waste landfill. Recommendable Methods: Precipitation, solidification, landfill, discharge to sewer, & incineration. Peer-review: Precipitate copper with alkali, filter, solidify precipitate. (Do not use ammonia as alkali). Cation exchange will allow recovery of copper. Eluate from cation exchanger can be passed through anion exchanger to remove (or reduce) naphthenic acid content. Exhausted ion exchange resins can be landfilled. (Peer-review conclusions of an IRPTC expert consultation)[UN].

References

(31); (173); (101); (138); (204); (100).

United States Environmental Protection Agency, Toxicology of Metals, Vo l. II: Copper, Report EPA-600/1-77-022, pp 206–221, Research Triangle Park, NC (May 1977).

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United States Environmental Protection Agency; Drinking Water Criteria Document for Copper, p.I-2 (EPA-600/X-84-190-1), Washington, DC, 1985.

United States Environmental Protection Agency, Recognition and Management of Pesticide Poisoning, 5th edition, Chapter 15, p. 145–147, Copper Compounds Washington, DC, 2009.

Copper Octanoate C:1386

Formula: $C_{16}H_{30}CuO_4$

Synonyms: Concern; Copper caprylate; Copper(2+) dioctanate; Copper soap fungicide; Kupferoktanoat (German); NE U 1140F; Octanoic acid, copper salt; Ortho Disease B Gon Copper Fungicide Concentrate

CAS Registry Number: 20543-04-8; 3890-89-9

HSDB Number: 6944, as copper compounds

RTECS Number: Not found

UN/NA & ERG Number: UN3082/177

EC Number: 223-433-9; 243-866-7

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Sensitization hazard, Agricultural chemical (fungicide), Environmental hazard

B2588-Air Toxics “Hot Spots” Chemicals (CAL)

Clean Water Act: Toxic Pollutant (Section 401.15) as copper and compounds

EPA ADI:1.3 mg[Cu]/L. As copper.

United States National Primary Drinking Water Regulations: MCLG = 1.3 mg[Cu]/L; MCL = TT action Level: 1.3 mg[Cu]/L. Copper is regulated by a Treatment Technique (TT) that requires systems to control the corrosiveness of their water. If more than 10% of tap water samples exceed the action level, water systems must take additional steps; SMCL = 1 mg[Cu]/L as Copper.

RCRA Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 6010 (60); 7210(200) Note: All species in the ground water that contain copper are included.

EPCRA (Section 313): Includes any unique chemical substance that contains copper as part of that chemical’s infrastructure Form R *de minimis* concentration reporting level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N, Xi; risk phrases: R20/21/22; R36/37/38; R43; safety phrases: S29/35; S61; S41 (see Appendix 4)

Description: Blue liquid. Acidic odor; Lardy/fatty odor. Molecular weight = 349.95; specific gravity (H_2O:1) = ~1.0–1.06 @ 20°C; boiling point = ~100°C. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 0, reactivity 0. Soluble in water.

Potential Exposure: A copper soap fungicide that controls many common diseases on vegetables, fruits and ornamentals, both indoors and outdoors. Treats mildew, including powdery mildew, fruit rots, blue mold, downy mildew, leaf spots, blights, white rust, apple scab, and anthracnose.

Incompatibilities: Esters are generally incompatible with nitrates. Moisture may cause hydrolysis or other forms of decomposition. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Concentration in Water: The permissible concentration of total recoverable copper in water to protect freshwater aquatic life is 5.6 μg[Cu]/L as a 24-hour average. The log of this concentration should not exceed the numerical value of log [0.94 In (hardness)-1.23]. The corresponding value to protect saltwater aquatic life is 4.0 μg [Cu]/L as a 24-hour average, and should not exceed 23 μg [Cu]/L at any time. Federal Drinking Water Guidelines: Action Level = 1300 μg[Cu]/L; EPA = 1000 μg[Cu]/L; State Drinking Water Guidelines: Arizona 1300 μg[Cu]/L; Kansas 1000 μg/L, and Minnesota 1300 μg/L[61].

Determination in Water: Total copper may be determined by digestion followed by AA or by colorimetry (using neocuproine) or by ICP Optical Emission Spectrometry. Dissolved Copper may be determined by 0.45 μ filtration followed by the preceding methods.

Routes of Entry: Ingestion, dermal contact, inhalation

Harmful Effects and Symptoms

Short-Term Exposure: Organic copper compounds are more absorbable and exhibit greater systemic toxicity than inorganic compounds. Soluble copper salts are corrosive to mucous membranes and the cornea. Contact with eyes or skin may cause irritation or injury. Inhalation should be avoided. Harmful if swallowed. Metallic taste, nausea, vomiting, and stomach pain. In more severe cases, there may be blood in vomit or black/tarry stools, jaundice, and enlarged liver. Blood cells rupture resulting in circulatory collapse and shock[72].

Long-Term Exposure: Long-term exposure to copper causes liver and/or kidney damage. People with Wilson's Disease should consult their personal doctor to determine if the amount of copper in their water exceeds 1.3 mg[Cu]/L. Copper salts may cause sensitization in certain individuals.

Points of Attack: Eyes, kidneys, liver, skin.

Medical Surveillance: Evaluation by a qualified allergist. Medical observation and rest is recommended for 24 to 48 hours after breathing overexposure, as symptoms may be delayed. If signs of allergy are detected, the exposed person(s) should avoid all further contact with this chemical. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure.

First Aid: Management of poisonings by ingestion of copper-containing fungicides depends entirely on the chemical nature of the compound: the strongly ionized salts present the greatest hazard; the oxides, hydroxides, oxychloride, and oxysulfate are less likely to cause severe systemic poisoning. If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. *Do not make an unconscious person vomit.* Give water or milk as an anticorrosive as soon as possible to dilute the toxicant and mitigate corrosive action on the mouth, esophagus, and gut. Charcoal has not been widely studied in metal poisonings as an effective adsorbant[72].

Personal Protective Methods: Applicators and other handlers must wear: Coveralls worn over long-sleeved shirt and long pants; Chemical-resistant gloves such as DuPont Tychem suit fabrics, barrier laminate, or Viton; Chemical-resistant footwear plus socks; Protective eye wear; Chemical-resistant headgear for overhead exposure; Chemical-resistant apron when cleaning equipment, mixing, or loading[72]. Agricultural Use/Engineering Controls: When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the WPS for agricultural pesticides, 40 CFR170.240(d)(4-6), the handler PPE requirements may be reduced or modified as specified in the WPS. Firefighters should wear NIOSH-approved SCBA and full protective clothing.

Respirator Selection: Use NIOSH- or CEN (UK)-approved APRs for pesticides. Wherever and whenever workplace conditions warrant respirator use, a respiratory protection program must be followed that meets one or more of the following requirements: OSHA's 29 CFR 1910.134, ANSI Z88.2, or European Standard EN 149.

Shipping: UN3082 Environmentally hazardous substances, liquid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Wearing protective equipment, cleanup with dampened absorbent paper and transfer material to a suitable trash container. Seal the absorbent paper and your clothing in a vapor-tight plastic bag for eventual disposal. Wash all contaminated surfaces with a soap and water solution. Do not reenter the contaminated area until and expert verifies that the area has been properly cleaned.

Fire Extinguishing: Thermal decomposition releases poisonous fumes including oxides of metal (copper) and carbon. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers.

If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Copper-containing soluble wastes can be concentrated through the use of ion exchange, reverse osmosis, or evaporators to the point where copper can be electrolytically removed and sent to a reclaiming firm. If recovery is not feasible, the copper can be precipitated through the use of caustics and the sludge deposited in a chemical waste landfill.

References

(31); (173); (101); (138); (204).

Pesticide Management Education Program, "Copper Octanoate Pesticide Tolerance Petition Filing 1/97," Cornell University, Ithaca, NY (January 1997). http://pmep.cce.cornell.edu/profiles/fung-nemat/aceticacid-etridiazole/copper-octanoate/copper-octanoate-tol.html.

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United States Environmental Protection Agency; Drinking Water Criteria Document for Copper, p.I-2 (EPA-600/X-84-190-1), Washington, DC, 1985.-600/X-84-190-1.

United States Environmental Protection Agency, Recognition and Management of Pesticide Poisoning, 5th edition, Chapter 15, p. 145−147, Copper Compounds Washington DC, 2009.

Copper Oxychloride C:1388

Formula: $Cl_2Cu_4H_6O_6$

Synonyms: BASF Grunkupfer (German); Basic cupric chloride; Basic copper chloride; Blitox 50; Blitox; Blue copper-50; Blue copper; Chemocin; Chempar; Cobox blue; Cobox; Colloidox; Cop-Tox; Copper OC fungicide; Copper chloroxide; Copper chloride oxide, hydrate; Copper chloride oxide; Copper chloride, mixed with copper oxide, hydrate; Copper chloride, basic; Coppersan; Coppesan blue; Coppesan; Coprantol; Coprex; Coprosan blue; Coxysan; Cu-56; Cupral 45; Cupramar; Cupramer; Cuprantol; Cupravet; Cupravit green; Cupravit forte; Cupravit; Cupric oxide chloride; Cupricol; Cupritox; Cuprokylt; Cuprol; Cuprosan blue; Cuprosana; Cuprosan; Cuprovinol; Cuproxol; Cuprox; Devicopper; Faligruen; Fycol 8; Fytolan; Kauritil; Kilex; Kt 35; Kupricol; Kuprikol; Microcop; Miedzian 50; Miedzian; Neoramblu; Oxicob; Oxivor; Oxyclor; Oxycur; Parrycop; Peprosan; Recop; Rhodiacuivre; Sutox; Tamraghol; Tricop 50; Viricuivre; Vitigran blue; Vitigran

CAS Registry Number: 1332-40-7; 1332-65-6 (tetrahysrate); 1344-71-4; 74315-47-2

RTECS Number: GL7020000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 215-572-9

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Sensitization hazard, Environmental hazard, Agricultural chemical.

EPA ADI:1.3 mg[Cu]/L. As copper.

United States National Primary Drinking Water Regulations: MCLG = 1.3 mg[Cu]/L; MCL = TT action Level: 1.3 mg[Cu]/L. Copper is regulated by a Treatment Technique (TT) that requires systems to control the corrosiveness of their water. If more than 10% of tap water samples exceed the action level, water systems must take additional steps; SMCL = 1 mg[Cu]/L as Copper.

Clean Water Act: Toxic Pollutant (Section 401.15) as copper and compounds

RCRA Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 6010(60); 7210(200) Note: All species in the ground water that contain copper are included

EPCRA (Section 313): Includes any unique chemical substance that contains copper as part of that chemical's infrastructure

Form R de minimis concentration reporting level: 1.0%

Hazardous to aquatic life or environment, with possible long-lasting effects[291]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: N, Xn; risk phrases: R22; R36/37/38; R51; safety phrases: S16; S26; S29/35; S45; S60; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [2-Hazard to water. (est.)]

Description: Bluish-green powder. Odorless. Molecular weight = 427.12. Insoluble in water.

Potential Exposure: Used to control fungi on beets, fruit crops, grapes, olive trees, potatoes, vegetables, tomatoes, ornamental plants, and many more. Used as a bird repellant.

Incompatibilities: When heated to decomposition or on contact with acids or acid fumes, may produce highly toxic chloride fumes and deadly phosgene gas. May cause pitting of some metals.

Permissible Exposure Limits in Air:

No United States Standards or PAC available.

DFG MAK: 0.01 milligram per cubic meter, inhalable fraction TWA; Peak limitation Category II(8); Pregnancy Risk Group C.

Permissible Concentration in Water: The permissible concentration of total recoverable copper in water to protect freshwater aquatic life is 5.6 μg[Cu]/L as a 24-hour average. The log of this concentration should not exceed the numerical value of log [0.94 In (hardness)-1.23]. The corresponding value to protect saltwater aquatic life is 4.0 μg

[Cu]/L as a 24-hour average, and should not exceed 23 μg [Cu]/L at any time. Federal Drinking Water Guidelines: Action Level = 1300 μg[Cu]/L; EPA = 1000 μg[Cu]/L; State Drinking Water Guidelines: Arizona 1300 μg[Cu]/L; Kansas 1000 μg/L, and Minnesota 1300 μg/L[61].

Determination in Water: Total copper may be determined by digestion followed by AA or by colorimetry (using neocuproine) or by ICP Optical Emission Spectrometry. Dissolved Copper may be determined by 0.45 μ filtration followed by the preceding methods.

Harmful Effects and Symptoms

Short-Term Exposure: Contact with eyes or skin may cause irritation or injury. Inhalation should be avoided; use NIOSH- or CEN (UK)-approved APRs for pesticides. May be poisonous if swallowed. Contact poison control center. LD_{50} (oral, human) = 200 mg/kg.

Long-Term Exposure: Long-term exposure to copper causes liver and/or kidney damage. Anyone having hereditary Wilson's disease should avoid contact with the material. These persons are born with an abnormally high level of copper in their system and exposure may increase levels of copper, causing overdose, liver problems which can be fatal. People with Wilson's Disease should consult their personal doctor to determine if the amount of copper in their water exceeds 1.3 mg[Cu]/L.

Points of Attack: Liver

Medical Surveillance: Tests for copper level and Wilson's disease.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek Medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Applicators and other handlers must wear: Coveralls worn over long-sleeved shirt and long pants; Chemical-resistant gloves such as DuPont Tychem suit fabrics, barrier laminate, or Viton; Chemical-resistant footwear plus socks; Protective eye wear; Chemical-resistant headgear for overhead exposure; Chemical-resistant apron when cleaning equipment, mixing, or loading[83]. Agricultural Use/Engineering Controls: When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the WPS for agricultural pesticides, 40 CFR 170.240(d)(4-6), the handler PPE requirements may be reduced or modified as specified in the WPS. Firefighters should wear NIOSH-approved SCBA and full protective clothing.

Respirator Selection: Wherever and whenever workplace conditions warrant respirator use, a respiratory protection program must be followed that meets one or more of the following requirements: OSHA's 29 CFR 1910.134, ANSI Z88.2, or European Standard EN149.

Storage: Color code—Blue: Health Hazard/Poison: Store in a tightly closed container in a dry, well-ventilated, and secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Where possible, automatically transfer material from other storage containers to process containers.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Do not touch or walk through spilled material. Stop leak if you can do it without risk. Prevent dust cloud. Avoid inhalation of asbestos dust. *Small Dry Spill:* With clean shovel place material into clean, dry container and cover loosely; move containers from spill area. Small Spill: Take up with sand or other noncombustible absorbent material and place into containers for later disposal. *Large Spill*: Dike far ahead of liquid spill for later disposal. Cover powder spill with plastic sheet or tarp to minimize spreading. Prevent entry into waterways, sewers, basements, or confined areas.

Fire Extinguishing: Thermal decomposition products may include deadly phosgene gas, hydrogen chloride gas, and oxides of metal. As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 m/150 ft for liquids and at least 25 m/75 ft for solids. *Fire involving storage or vehicular tanks:* Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m (1/2 mi) in all directions. *On a small fire:* use dry chemical, CO_2, water spray, or regular *foam. On a large fire:* use water spray, fog, or regular foam. Do not scatter spilled material with high pressure streams of water. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal. *Fire involving tanks:* From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. Always stay away from tanks engulfed in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Copper-containing wastes can be concentrated through the use of ion exchange, reverse osmosis, or evaporators to the point where copper can be electrolytically removed and sent to a reclaiming firm.

Details of copper recovery from a variety of industrial wastes have been published. If recovery is not feasible, the copper can be precipitated by the use of caustics and the sludge de posited in a chemical waste landfill. Recommendable methods: Precipitation, solidification, landfill, discharge to sewer, & incineration. Peer-review: Precipitate copper with alkali, filter, solidify precipitate. (Do not use ammonia as alkali). Cation exchange will allow recovery of copper. Eluate from cation exchanger can be passed through anion exchanger to remove (or reduce) naphthenic acid content. Exhausted ion exchange resins can be landfilled. (Peer-review conclusions of an IRPTC expert consultation)[UN].

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Office of Pesticide Programs, Pesticide Residue Limits, “Copper Oxychloride,” 40 CFR 180.1001 (b), 180.1021. www.epa.gov/pesticides/food/viewtols.htm.

United States Environmental Protection Agency, Ambient Water Quality Criteria Document: Copper, p.B-14 (440/5-80-036), Washington, DC, 1980.

United States Environmental Protection Agency; Drinking Water Criteria Document for Copper, p.I-2 (EPA-600/X-84-190-1), Washington, DC, 1985.

United States Environmental Protection Agency, Recognition and Management of Pesticide Poisoning, 5th edition, Chapter 15, p. 145−147, Copper Compounds Washington, DC, 2009.

Copper Sulfate C:1390

Formula: CuO_4S; $CuSO_4$

Synonyms: Basicop; BCS copper fungicide; Blue copper; Blue stone; Blue vitriol; Copper monosulfate; Copper sulfate (1:1); Copper(2+) sulfate; Copper(2+) sulfate (1:1); Copper(II) sulfate; Copper sulfate pentahydrate; CP basic sulfate; Cupric sulfate anhydrous; Cupric sulfate; Griffin super Cu; Kupfersulfat (German); Phyto-Bordeaux; Roman vitriol; Sulfate of copper; Sulfate de cuivre (French); Sulfato de cobre (Spanish); Sulfuric acid, copper(2+) salt (1:1); TNCS 53; Triangle *pentahydrate:* Blue copper AS; Copper sulfate pentahydrate; Copper(2+) sulfate pentahydrate; Copper(II) sulfate pentahydrate; Cupric sulfate pentahydrate; Kupfersulfat−pentahydrat (German); Kupfervitriol (German); Salzburg vitriol; Sulfuric acid copper(2+) salt (1:1), pentahydrate; Sulfuric acid, copper(2+) salt, pentahydrate; Vencedor

CAS Registry Number: 7758-98-7; 7758-99-8 (pentahydrate)

HSDB Number: 916 (7758-98-7); 2968 (pentahydrate)

RTECS Number: GL8800000; GL8900000 (pentahydrate)

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171; UN3288/155

EC Number: 231-847-6

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Inadequate Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3; EPA: Cannot be Determined; Not Classifiable as to human carcinogenicity.

Hazard Alert: Poison, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard; *pentahydrate*: Possible risk of forming tumors, Suspected of causing genetic defects.

United States National Primary Drinking Water Regulations: MCLG = 1.3 mg[Cu]/L; MCL = TT action Level: 1.3 mg[Cu]/L. Copper is regulated by a Treatment Technique (TT) that requires systems to control the corrosiveness of their water. If more than 10% of tap water samples exceed the action level, water systems must take additional steps; SMCL = 1 mg[Cu]/L as Copper; SMCL = 250 mg[SO_4^{-2}]/L as Sulfate.

As copper compounds:

EPA ADI:1.3 mg[Cu]/L. As copper.

Clean Water Act: Toxic Pollutant (Section 401.15)

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 6010 (60); 7210 (200). *Note:* All species in the ground water that contain copper are included

EPCRA (Section 313): Includes any unique chemical substance that contains copper as part of that chemical’s infrastructure. This category does not include copper phthalocyanide compounds that are substituted with only hydrogen; and/or chlorine; and/or bromine. Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%; NPRI; CEPA Priority Substance List, Ocean dumping prohibited.

Hazard symbols, risk, & safety statements: Hazard symbol: N, Xi, Xn; risk phrases: R22; R36/37/38; R51/53; R62; safety phrases: S16; S22; S24/25; S26; S36; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Copper sulfate is a greenish-white crystalline solid; the pentahydrate is Blue powder or granules, or ultramarine crystalline solid. Molecular weight = 159.60; 249.70 (pentahydrate). Boiling point = 150°C (pentahydrate) with-5H_2O; freezing/melting point = (decomposes) >200°C; decomposes >110°C (pentahydrate) with-4H_2O; copper sulfate decomposes to CuO @ 650°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 0, reactivity 0. Highly soluble in water; forms a bright Blue solution.

Potential Exposure: Copper sulfate is used as intermediate and wood preservative; also used in production of copper compounds; to detect and to remove trace amounts of water from alcohols and organic compounds; as a fungicide and algicide; in veterinary medicine and others.

Incompatibilities: Aqueous solution is an acid. May form explosive materials on contact with acetylene and nitromethane. Incompatible with strong bases; hydroxylamine, magnesium; zirconium, sodium hypobromite, hydrazine.

Permissible Exposure Limits in Air

NIOSH IDLH = 100 mg[Cu]/m^3 (dust, mists and fume)

PAC Ver. 29[138]

7758-98-7

PAC-1: 7.5 milligram per cubic meter

PAC-2: 10 milligram per cubic meter

PAC-3: 59 milligram per cubic meter

7758-99-8, pentahydrate

PAC-1: 12 milligram per cubic meter

PAC-2: 32 milligram per cubic meter

PAC-3: 190 milligram per cubic meter

copper and its inorganic compounds

DFG MAK: 0.1 milligram per cubic meter measured as the inhalable fraction of the aerosol; Peak Limitation Category II(2); Pregnancy Risk Group C

Arab Republic of Egypt: TWA 0.1 mg[Cu]/m^3 (fume), 1993; Australia: TWA 0.2 mg[Cu]/m^3 (fume), 1993; Australia: TWA 1 mg[Cu]/m^3 (*dust*), 1993; Belgium: TWA 0.2 mg[Cu]/m^3; TWA 1 mg[Cu]/m^3 (*dust*), 1993; Finland: TWA 0.2 mg[Cu]/m^3; TWA 1 mg[Cu]/m^3 (*dust*), 1999; France: VME 0.2 mg[Cu]/m^3 (fume); VME 1 mg[Cu]/m^3; STEL 2 mg[Cu]/m^3 (*dust*), 1993; Hungary: TWA 0.2 mg [Cu]/m^3; STEL 0.4 mg[Cu]/m^3 (*dust*), 1993; India: TWA 0.2 mg[Cu]/m^3 (fume), 1993; the Philippines: TWA 1.0 mg [Cu]/m^3 (fume), 1993; Russia: STEL 0.5 milligram per cubic meter; STEL 0.5 ppm (1 mg[Cu]/m^3) (*dust*), 1993; Sweden: NGV 0.2 mg[Cu]/m^3 (resp. dust); NGV 1 mg[Cu]/m^3 (total dust), 1999; Switzerland: TWA 0.1 mg[Cu]/m^3; STEL 0.2 mg[Cu]/m^3 (fume); TWA 1 mg[Cu]/m^3; STEL 1 mg[Cu]/m^3, 1999; Thailand: TWA 0.1 mg[Cu]/m^3 (fume); TWA 1 mg[Cu]/m^3, 1993; United Kingdom: LTEL 0.2 mg [Cu]/m^3 (fume); LTEL 1 mg[Cu]/m^3, 1993. Russia[43] has set limits in the ambient air of residential areas of 0.009 milligram per cubic meter on a momentary basis and 0.004 milligram per cubic meter on a daily average basis. the Czech Republic[35]: MAC 0.1 milligram per cubic meter, daily average basis; MAC 0.3 milligram per cubic meter, 30-minute basis.

Determination in Air: Use NIOSH Analytical Methods (dusts and mist) #7029, #7300, #7301, #7303, #9102 and OSHA Analytical Methods ID-121, ID-125G

Permissible Concentration in Water: The permissible concentration of total recoverable copper in water to protect freshwater aquatic life is 5.6 μg[Cu]/L as a 24-hour average. The log of this concentration should not exceed the numerical value of log [0.94 In (hardness)-1.23]. The corresponding value to protect saltwater aquatic life is 4.0 μg[Cu]/L as a 24-hour average, and should not exceed 23 μg[Cu]/L at any time. Federal Drinking Water Guidelines: Action Level = 1300 μg[Cu]/L; EPA = 1000 μg [Cu]/L; State Drinking Water Guidelines: Arizona 1300 μg [Cu]/L; Kansas 1000 μg/L, and Minnesota 1300 μg/L[61].

Determination in Water: Total copper may be determined by digestion followed by AA or by colorimetry (using neocuproine) or by ICP Optical Emission Spectrometry. Dissolved Copper may be determined by 0.45 μ filtration followed by the preceding methods.

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: *Inhalation:* May cause irritation to nose, throat, and lungs, causing coughing and wheezing. *Skin:* May cause irritation of skin, localized coloration, itching, and burns. *Eyes:* May cause severe irritation, inflammation, burns, excessive tissue fluid, and a cloudy cornea; possible permanent damage. *Ingestion:* Poisonous if swallowed. May cause burning and metallic taste in mouth; Blue skin coloration; intense inflammation of the stomach and intestines, abdominal pain; vomiting, diarrhea, blood in feces; headache, cold sweat; weak pulse; salivation, nausea, dehydration, low blood pressure; jaundice, and kidney failure. Death may result from a dose of a little as 1 teaspoon for a 150-lb person.

Long-Term Exposure: Long-term exposure to copper causes liver and/or kidney damage. People with Wilson's Disease should consult their personal doctor to determine if the amount of copper in their water exceeds 1.3 mg[Cu]/L. This chemical may cause mutations in humans. May damage the testes and decrease fertility in both males and females. May cause skin allergy and thickening of the skin; copper deposits can cause discoloration in the skin and hair, leaving a green color. Repeated exposure can cause shrinking of the lining of the inner nose with watery discharge; liver damage. Individuals with Wilson's disease absorb, retain, and store copper excessively.

Points of Attack: Skin, reproductive system; liver.

Medical Surveillance: Serum and urine copper level. Liver and kidney tests. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. More than light alcohol consumption may exacerbate the liver damage caused by copper sulfate.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek Medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to Physician: Empty stomach by lavage with 0.1% solution of potassium ferrocyanide or milk. Liver or kidney function tests may be indicated. May result in methaemoglobinemia.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Neoprene and polyvinyl chloride are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. When working with liquids, wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. When working with powders or dusts, wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Copper dusts and mists: 5 milligram per cubic meter*: Qm (APF = 25) (any quarter-mask respirator). *10 milligram per cubic meter:* Any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100; or Sa (APF = 10) (any supplied-air respirator). *25 milligram per cubic meter:* Sa: Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); PaprHie (APF = 25) (any powered, APR with a high-efficiency particulate filter). *50 milligram per cubic meter*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or PaprTHie (APF = 50) (any powered, APR with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *100 milligram per cubic meter:* SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with cacodylic acid you should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN3288 Toxic solids, inorganic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. Thermal decomposition products may include oxides of sulfur. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Copper-containing soluble wastes can be concentrated through the use of ion exchange, reverse osmosis, or evaporators to the point where copper can be electrolytically removed and sent to a reclaiming firm. If recovery is not feasible, the copper can be precipitated through the use of caustics and the sludge deposited in a chemical waste landfill Add soda ash to waste $CuSO_4$ solution; let stand 24 hours. Decant and neutralize solution before flushing to sewer. Landfill sludge[22].

References

(31); (173); (101); (138); (2); (80); (100).

New York State Department of Health, *Chemical Fact Sheet* Copper Sulfate, Bureau of Toxic Substance Assessment, Albany, NY (January 1986 and Version 3).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Cupric Sulfate, Trenton, NJ (January 1999).

United States Environmental Protection Agency, Ambient Water Quality Criteria Document: Copper, p.B-14 (440/5-80-036), Washington, DC 1980.

United States Environmental Protection Agency; Drinking Water Criteria Document for Copper, p.I-2 (EPA-600/X-84-190-1), Washington, DC, 1985.

United States Environmental Protection Agency, Recognition and Management of Pesticide Poisoning, 5th edition, Chapter 15, p. 145−147, Copper Compounds Washington, DC, 2009.

Cotton Dust (Raw) C:1400

Formula: $C_{6n}H_{10n}O5n$; $(C_6H_{10}O_5)_n$
Synonyms: Cotton fiber (raw)
CAS Registry Number: None
RTECS Number: GN2275000
UN/NA & ERG Number: None assigned.
Regulatory Authority and Advisory Information
Hazard Alert: Combustible.
OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR 1910.1043).

Description: Cotton dust is defined as dust generated into the atmosphere as a result of the processing of cotton fibers combined with any naturally occurring materials, such as stems, leaves, bracts; and inorganic matter which may have accumulated on the cotton fibers during the growing or harvesting period. Any dust generated from processing of cotton through the weaving of fabric in textile mills; and dust generated in other operations or manufacturing processes using new or waste cotton fibers or cotton fiber by-products from textile mills is considered cotton dust. Hazard identification (based on NFPA-704 M Rating System): Health 0, flammability 1, reactivity 0.

Potential Exposure: The Occupational Safety and Health Administration has estimated that nearly a million workers are involved in work with cotton fibers and thus are potentially exposed to cotton dust in the work place.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Dust forms an explosive mixture with air.

Permissible Exposure Limits in Air
NIOSH IDLH = 100 milligram per cubic meter
No PAC available
OSHA PEL: [Z-1-A & 1910.1043*] 1 milligram per cubic meter TWA (waste processing during waste recycling [sorting, blending, cleaning, and willowing (and garnetting)]) 0.200 milligram per cubic meter TWA (textile yarn manufacturing, and cotton washing operations) 0.750 milligram per cubic meter TWA (textile slashing and weaving operations) 0.500 milligram per cubic meter TWA [all other operations (for textile mill waste house operations or for dust from "lower grade washed cotton" used during yarn manufacturing)]. All PELs for cotton dust are mean concentrations of lint-free, respirable cotton dust collected by the vertical elutriator or an equivalent method and averaged over an 8-hour period.
**Note:* The OSHA Standard in 29 CFR 1910.1043 does not apply to cotton harvesting, ginning, or the handling and processing of woven or knitted materials and washed cotton.
NIOSH REL: <0.200 milligram per cubic meter TWA (as lint-free cotton dust); Reduce exposures to cotton dust to the lowest feasible concentration to reduce the prevalence and severity of byssinosis.
ACGIH TLV[1]: 0.2 milligram per cubic meter TWA, 5 × PEL maximum for disposables, per OSHA cotton dust standard. If oil aero sol is present, use R or P95.
DFG MAK: 1.5 milligram per cubic meter (measured as the, inhalable fraction); Pregnancy Risk Group C
Finland: TWA 1 milligram per cubic meter, 1999; France: VME 0.2 milligram per cubic meter, fiber, 1999; India: TWA 0.2 milligram per cubic meter, 1993; the Philippines: TWA 1 milligram per cubic meter, 1993; Sweden: NGV 0.5 milligram per cubic meter, 1999; Switzerland: MAK-W 0.32 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 0.2 milligram per cubic meter, 2003; United Kingdom: LTEL 0.5 milligram per cubic meter, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TL V: TWA 0.2 milligram per cubic meter (G).

Determination in Air: Vertical elutriator; none; Gravimetric; OSHA (1910.1043).

Routes of Entry: Inhalation of dust, ingestion, eye and skin contact.

Harmful Effects and Symptoms
Short-Term Exposure: Human pulmonary effects. Breathing raw cotton fiber can cause coughing, fever (resembling metal fume fever), chills; and may cause nausea and vomiting, when first exposed. Allergens or fungi in the cotton or dust can cause illness.

Long-Term Exposure: Repeated exposures can cause serious permanent lung damage ("brown lung" or byssinosis). The first symptoms are chest tightness and trouble breathing that occur a few hours after first starting work for the week. At first, the symptoms go away after a day or two, but with continued Exposure they can become constant.

Points of Attack: Cardiovascular system; respiratory system.

Medical Surveillance: NIOSH lists the following tests: pulmonary function tests; forced vital capacity; forced expiratory volume (1 second); forced expiratory volume (1 second)/forced vital capacity (ratio); the percentage that the measured values of the forced expiratory volume (1 second) and forced vital capacity differ from the predicted values, using the standard tables in 29CFR1910.1043, Appendix C. Chest X-ray; pulmonary function tests: forced vital capacity; forced expiratory volume (1 second); pulmonary function tests: pre- and postshift.

1. *Preplacement*: A comprehensive physical examination shall be made available to include as a minimum medical history, baseline forced vital capacity (FVC); and forced vital expiratory volume @ 1 second (FEV_1).

The history shall include administration of a questionnaire designed to elicit information regarding symptoms of chronic bronchitis, byssinosis, and dyspnea. If a positive personal history of respiratory allergy, chronic obstructive lung disease; or other diseases of the cardiopulmonary system are elicited; or where there is a positive history of smoking, the applicant shall be counseled on his increased risk from occupational exposure to cotton dust. At the time of this examination, the advisability of the workers using negative or positive pressure respirators shall be evaluated.

2. *Each newly employed person:* shall be retested for ventilatory capacity (FVC and FEV_1) within 6 weeks of employment. This retest shall be performed on the first day at work after at least 40 hours' absence from exposure to cotton dust and shall be performed before and after at least 6 hours of exposure on the same day.
3. *Each current employee exposed to cotton dust*: shall be offered a medical examination at least yearly that shall include administration of a questionnaire designed to elicit information regarding symptoms of chronic bronchitis, byssinosis, and dyspnea.
4. Each current employee exposed to cotton dust shall have measurement of forced vital capacity (FVC) and of forced expiratory volume @ 1 second (FEV_2). These tests of ventilatory function should be performed on the first day of work following at least 40 hours of absence from exposure to cotton dust, and shall be performed before and after at least 6 hours of exposure on the same day.
5. Ideally, the judgment of the employee's pulmonary function should be based on preplacement values (values taken before exposure to cotton dust). When preplacement values are not available, then reference to standard pulmonary function value tables may be necessary. Note that these tables may not reflect normal values for different ethnic groups. For example, the average healthy black male may have an approximately 15% lower FVC than a Caucasian male of the same body build. A physician shall consider, in cases of significantly decreased pulmonary function, the impact of further exposure to cotton dust and evaluate the relative merits of a transfer to areas of less exposure or protective measures. A suggested plan for the management of cotton workers was proposed as a result of a conference on cotton workers' health.
6. Medical records, including information on all required medical examinations, shall be maintained for persons employed in work involving exposure to cotton dust. Medical records with pertinent supporting documents shall be maintained at least 20 years after the individual's termination of employment. These records shall be available to the medical representatives of the Secretary of Health, Education, and Welfare; of the Secretary of Labor; of the employee or former employee; and of the employer.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Engineering control shall be used wherever feasible to maintain cotton dust concentrations below the prescribed limit. Administrative controls can also be used to reduce exposure. Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof goggles and face shield unless full facepiece respiratory protection is worn. Respirators shall also be provided and used for nonroutine operations (occasional brief exposures above the environmental limit and for emergencies) and shall be considered for use by employees who have symptoms even when exposed to concentrations below the established environmental limit. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *up to 1 milligram per cubic meter:* Qm* (APF = 25) (any quarter-mask respirator). *Up to 2 milligram per cubic meter*: 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *Up to 5 milligram per cubic meter:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25) (any powered, APR with a high-efficiency particulate filter). *Up to 10 milligram per cubic meter:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SaT:Cf

(APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTHie (APF = 50) (any powered, APR with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 100 milligram per cubic meter:* Sa:Pd, Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Cotton fiber must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat or flame.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect cotton dust in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Cotton fiber and dust is flammable. Use water only. Do not use chemical or carbon dioxide extinguishers. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Cotton dust may be used as a cheap filling in quilt blankets. It contains a large organic fraction which can be digested anaerobically to produce manure plus biogas fuel[22].

References

(31).

National Institute for Occupational Safety and Health (NIOSH), "Criteria for a Recommended Standard: Occupational Exposure to Cotton Dust", NIOSH Document Number 75-118, Cincinnati, OH (1975).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Cotton Dust (Raw), Trenton, NJ (October 2001).

Coumafuryl C:1410

Formula: $C_{17}H_{14}O_5$

Synonyms: 3-(α-Acetonylfurfuryl)-4-hydroxycoumarin; Cumafuryl (German); Foumarin; Fumarin; 3-(α-Furyl-β-acetylaethyl)-4-hydroxycumarin (German); 3-(1-Furyl-3-acetylethyl)-4-hydroxycoumarin; Krumkil; Ratafin; Rat-A-Way; Tomarin

CAS Registry Number: 117-52-2

EC Number: 204-195-5 [*Annex I Index No.:* 607-058-00-1]

HSDB Number: 7117

RTECS Number: GN4850000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154; UN3027 (Coumarin derivative pesticides, solid, toxic)/151

EC Number: 204-195-5 [607-058-00-1]

Regulatory Authority and Advisory Information

Superfund/EPCRA 302, Extremely Hazardous Substances: Dropped from listing in 1988.

Hazard symbols, risk, & safety statements: Hazard symbol: T; risk phrases: R/25; R48/25; R51/53; safety phrases: S22; S26; S37; S45; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [2-Hazard to water. (est.)].

Description: Coumafuryl is a colorless, white, crystalline solid or powder. Molecular weight = 298.29; specific gravity (H_2O:1) = 1.36; freezing/melting point = 124°C; vapor pressure = 3×10^{-6} @ 25°C. Hazard identification (based on NFPA-704M Rating System): Health 3, flammability 0, reactivity 0. Highly soluble in water.

Potential Exposure: This material is an anticoagulant rodenticide. Therefore, those involved in its manufacture, formulation, and application are at risk.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. At room temperature this material can decompose rapidly to cobalt carbonyl and hydrogen gas; at 52°C cobalt carbonyl decomposes, producing toxic fumes of cobalt and oxides of carbon.

Permissible Exposure Limits in Air

No standards or PAC available.

Routes of Entry: Ingestion, skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Coumafuryl is very similar to warfarin, a hemorrhagic agent. Inhalation may cause symptoms described in long-term exposure. A single large ingested dose may cause hemorrhagic shock. The LD_{50} oral (mouse) is 14.7 mg/kg (highly toxic). This chemical can be absorbed through the skin, thereby increasing exposure or hemorrhagic effect. High exposure can cause death.

Long-Term Exposure: Chronic exposure may cause death by hemorrhagic shock. Absorption by the lungs or after a few days or few weeks of repeated ingestion, may cause inhibition of prothrombin synthesis, nose bleeds and bleeding gums, hematoma; small reddish spots like a rash; bruises of the elbows, knees and buttocks; blood in urine and stools; anemia, occasional paralysis due to a stroke.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Speed in removing material from skin is of extreme importance. Remove and isolate contaminated clothing and shoes at the site. Keep victim quiet and maintain normal body temperature. Effects may be delayed. Keep victim under observation.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Specific respirator(s) have not been recommended by NIOSH.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN3027 Coumarin derivative pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft (NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. For *small spills*, absorb with sand or other noncombustible absorbent material and place into containers for later disposal. For *small dry spills*, with clean shovel place material into clean, dry container and cover; move containers from spill area. For *large spills*, dike far ahead of spill for later disposal. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. *Small fires:* dry chemical, carbon dioxide; water spray or foam. *Large fires:* water spray, fog, or foam. Move container from fire area if you can do so without risk. Wear positive pressure breathing apparatus and special protective clothing. Remove an isolate contaminated clothing at the site. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Thermal decomposition products may include oxides of carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Coumafuryl, Washington, DC, Chemical Emergency Preparedness Program (October 31, 1985).

Coumaphos C:1420

Formula: $C_{14}H_{16}ClO_5PS$

Synonyms: Asuntol; Azunthol; Bay 21/199; Bayer 21/199; Baymix; Baymix 50; 3-Chloro-7-hydroxy-4-methyl-coumarin *O*,*O*-diethyl phosphorothioate; 3-Chloro-7-hydroxy-4-methyl-coumarin *O*,*O*-diethyl phosphorothionate; 3-Chloro-7-hydroxy-4-methyl-coumarin *O*-ester with *O*,*O*-diethyl phosphorothioate; *O*-3-Chloro-4-methyl-7-coumarinyl *O*,*O*-diethyl phosphorothioate; 3-Chloro-4-methyl-7-coumarinyl-diethyl phosphorothioate; 3-Chloro-4-methyl-7-hydroxy-coumarindiethyl thiophosphoric acid ester; 3-Chloro-4-methylumbelliferone *O*-ester with *O*,*O*-diethyl phosphorothioate; Co-Ral; Coumafos; Cumafos (Spanish); *O*,*O*-Diaethyl-*O*-(3-chlor-4-methyl-cumarin-7-yl)-monothiophosphat (German); *O*,*O*-Diethyl 3-chloro-4-methyl-7-umbelliferone thiophosphate; Diethyl 3-chloro-4-methylumbelliferyl thionophosphate; *O*,*O*-Diethyl *O*-(3-chloro-4-methyl-7-coumarinyl) phosphorothioate; *O*,*O*-Diethylo (3-chloro-4-methylcoumarinyl-7) thiophosphate; *O*,*O*-Diethyl *O*-(3-chloro-4-methyl-2-*oxo*-2*H*-benzopyran-7-yl) phosphorothioate; *O*,*O*-Diethyl *O*-(3-chloro-4-methylumbelliferyl) phosphorothioate; Diethylthiophosphoric acid ester of 3-chloro-4-methyl-7-hydroxycoumarin; Diolice; ENT 17,957; Meldane; Meldone; Muscatox; NCI-C08662; Negashunt; Phosphorothioic acid, *O*-(3-chloro-4-methyl-2-*oxo*-2*H*-1-benzopyran-7-yl) *O*,*O*-diethyl ester; Phosphorothioic acid, *O*,*O*-diethyl ester, *O*-ester with 3-chloro-7-hydroxy-4-methylcoumarin; Resitox; Suntol; Thiophosphate de *O*,*O*-diethyle etde *O*-(3-chloro-4-methyl-7-coumarinyle) (French); Umbethion

CAS Registry Number: 56-72-4

HSDB Number: 249

RTECS Number: GN6300000

UN/NA & ERG Number: UN2783 (organophosphorus pesticide, solid, n.o.s.)/152; UN3018 (organophosphorus pesticide, liquid, n.o.s.)/152

EC Number: 200-285-3 [*Annex I Index No.:* 015-038-00-3]

Regulatory Authority and Advisory Information

Carcinogenicity: NCI: Carcinogenesis Bioassay (feed); no evidence: mouse, rat.

Hazard Alert: Poison, Neurotoxin (cumulative), Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Environmental hazard. Listed for Tier 1 screening as an endocrine disruptor[88].

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 100/10,000 lb (455/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg)

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), severe pollutant.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, N; risk phrases: R21; R28; R33; R50/53; R62; R63; safety phrases: S1/2; S28; S36/37; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)]

Description: Coumaphos is a white to brownish crystalline solid with a slight sulfurous odor. Molecular weight = 362.78; freezing/melting point = 91°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 1, reactivity 0. Insoluble in water.

Potential Exposure: A potential danger to those involved in the manufacture, formulation, and application of this material which is used for control of a wide variety of livestock insects including cattle grubs, lice scabies, flies, and ticks; the common ectoparasites of sheep, goats, horse, swine, and poultry; as well as for screw worms in all these animals.

Incompatibilities: Organophosphates are susceptible to formation of highly toxic and flammable phosphine gas in the presence of strong reducing agents such as hydrideds and active metals. Partial oxidation by oxidizing agents may result in the release of toxic phosphorus oxides[101]. Keep away from piperonyl butoxide, oxidizers, strong bases, water, and heat.

Permissible Exposure Limits in Air

Odor threshold = 0.02 ppm.

ACGIH TLV: 0.05 milligram per cubic meter TWA, inhalable fraction and vapor [skin]; not classifiable as a human carcinogen; BEI issued (2005)

PAC Ver. 29[138]

PAC-1: 0.27 milligram per cubic meter

PAC-2: 3 milligram per cubic meter

PAC-3: 13 milligram per cubic meter

Determination in Air: OSHA versatile sampler-2; Toluene/Acetone; GC/Flame photometric detection for sulfur, nitrogen, or phosphorus; NIOSH Analytical Method (IV) Method #5600, Organophosphorus Pesticides.

Permissible Concentration in Water: Mexico has set a maximum permissible concentration in estuaries of 0.02 mg/L.

Determination in Water: No Method available. Octanol−water coefficient: Log $K_{ow} = >4$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood. Fish Tox: 16.96524000 ppb MATC (INTERMEDIATE).

Routes of Entry: Inhalation, ingestion, skin contact. This chemical can be absorbed through the skin, thereby increasing exposure.

Harmful Effects and Symptoms

Short-Term Exposure: Contact may cause burns to skin and eyes. Fatal skin absorption can occur even if there is no feeling of irritation after contact. Cholinesterase inhibitor. Exposure can cause rapid, fatal organophosphate poisoning: with headache, sweating, nausea and vomiting, diarrhea, salivation, abdominal cramps; difficult breathing; stiffness of legs; blurring of vision; followed by loss of muscle coordination; muscle twitching; convulsions, coma, and death. LD_{50} (oral-rat) = 13 mg/kg (highly toxic). The probable oral lethal dose is 50−500 mg/kg; or between 1 teaspoonful and 1 oz. For a 70-kg (150 lb) person. May be fatal if inhaled, swallowed, or absorbed through skin. The effects may be delayed.

Long-Term Exposure: High or repeated exposure may cause nerve damage causing weakness, poor coordination in the arms and legs. May cause personality changes; depression, memory loss; or irritability. Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage. Human Tox: 1.75000 ppb Health advisory: (HIGH).

Points of Attack: Respiratory system; central nervous system; peripheral nervous system; plasma cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider CBC. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water, followed by alcohol. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a Medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Effects may be delayed. Keep victim under observation.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. In case of poisoning with this substance specific treatment is required; the appropriate means, including instructions, should be available.

Respirator Selection: Where there is potential exists for exposure to coumaphos, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. store in tightly closed containers in a cool, well-ventilated area.

Shipping: UN2783 Organo phosphorus pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous material. UN3018 Organophosphorus pesticides, liquid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling:

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m)	100/30
Then: Protect persons downwind (mi/km)	
Day	0.3/0.4
Night	0.8/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m)	600/200
Then: Protect persons downwind (mi/km)	
Day	1.4/2.3
Night	2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Do not touch spilled material. Do not breathe vapors. Stay upwind; keep out of low areas. Remove all ignition sources. Ventilate area of spill or leak. This material is a combustible liquid. For a spill or leak of a combustible liquid, shut off ignition sources; no flares, smoking, or flames in hazard area. Stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Soil Adsorption Index (K_{oc}) = 18,000.

Fire Extinguishing: This material may burn but does not ignite easily. Thermal decomposition products may include hydrogen chloride and oxides of phosphorous, sulfur and carbon. Extinguish with water, foam, carbon dioxide; or dry chemicals. This chemical is a combustible solid. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Coumaphos can be decomposed by heating with concentrated alkali. Large amounts should be incinerated in a unit equipped with effluent gas scrubbing[22]. Do not discharge into drains or sewers. Dispose of waste material as hazardous waste using a licensed disposal contractor to an approved landfill. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform to EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration with effluent gas scrubbing is recommended[22]. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (80); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Coumaphos, Washington, DC, Chemical Emergency Preparedness Program (October 31, 1985).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 4, No. 1, 53−56 (1984) and 9, No. 1, 19−29 (1989).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Coumaphos, Trenton, NJ (December 1998).

Coumatetralyl C:1430

Formula: $C_{19}H_{16}O_3$

Synonyms: Bay 25634; Bay ENE 11183B; Bayer 25,634; 2*H*-1-Benzopyran-2-one, 4-Hydroxy-3-(1,2,3,4-tetrahydro-1-naphthalenyl)-; Coumarin, 4-hydroxy-3-(1,2,3,4-tetrahydro-1-naphthyl)-; Cumatetralyl (German); Endox; Endrocid; Endrocide; ENE 11183; 4-Hydroxy-3-(1,2,3,4-tetrahydro-1-napthalenyl)-2*H*-1-benzopyran-2-one; 4-Hydroxy-3-(1,2,3,4-tetrahydro-1-napthyl)cumarin; Racumin; Raucumin 57; Rodentin; 3-(α-Tetral)-4-oxycoumarin; 3-(α-Tetrayl)-4-hydroxycoumarin; 3-(D-Tetrayl)-4-hydroxycoumarin

CAS Registry Number: 5836-29-3

HSDB Number: 1725

RTECS Number: GN7630000

UN/NA & ERG Number: UN3027 (Coumarin derivative pesticides, solid, toxic)/151

EC Number: 227-424-0 [*Annex I Index No.:* 607-059-00-7]

Regulatory Authority and Advisory Information

Hazard Alert: Exposure can be lethal, Combustible, Animal poison

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 500 lb (227 kg).

Hazardous to aquatic life or environment, with possible long-lasting effects[194]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, N; risk phrases: R27/28; R48/24/25; R52/53; safety phrases: S1/2; S28; S36/37; S45; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Coumatetralyl is a yellowish-white, crystalline solid. Molecular weight = 292.35. Boiling point = 290°C; freezing/melting point = 69−70°C. Hazard identification (based on NFPA-704 M Rating System): Health 4, flammability 1, reactivity 0. Soluble in hot water.

Potential Exposure: Coumatetralyl is used as a rodenticide, functioning as an anticoagulant that does not induce bait-shyness.

Incompatibilities: Contact with oxidizers may cause fire and explosion hazard. Keep away from metals.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 0.0064 milligram per cubic meter

PAC-2: 0.071 milligram per cubic meter

PAC-3: 17 milligram per cubic meter

Permissible Concentration in Water: No criteria set. Fish Tox = 16.96524000 ppb MATC (INTERMEDIATE); STV (Sediment Toxicity Value): VERY LOW

Routes of Entry: Inhalation, ingestion, skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Inhalation may cause symptoms described in long-term exposure. A single large ingested dose may cause hemorrhagic shock. This chemical can be absorbed through the skin, thereby increasing exposure or hemorrhagic effect. High exposure can cause death. The LD_{50} oral (rat) is 16.5 mg/kg (highly toxic). Human Tox (ppb): 1.75000 (HIGH).

Long-Term Exposure: Prolonged or repeated exposure can cause serious organ damage. Chronic exposure may cause death by hemorrhagic shock. Absorption by the lungs, or after a few days or few weeks of repeated ingestion, may cause inhibition of prothrombin synthesis; nose bleeds and bleeding gums; hematoma, small reddish spots like a rash; bruises of the elbows, knees and buttocks; blood in urine and stools; anemia, occasional paralysis due to a stroke. Preexisting blood clotting disease or liver disease are aggravated by coumatetralyl exposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−36 hours following overexposure, as effects may be delayed.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash or dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Specific respirator(s) have not been recommended by NIOSH. The following might be considered in and emergency: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full facepiece respirator with an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers.

Shipping: UN3027 Coumarin derivative pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Wear positive pressure breathing apparatus and special protective clothing. Remove and isolate contaminated clothing at the site. Do not touch spilled material. Use water spray to reduce vapors. With clean shovel place material into clean, dry container and cover. Dike far ahead of *large spills* for later disposal. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. *Small fires:* dry chemical, carbon dioxide; water spray or foam. *Large fires:* water spray, fog, or foam. Stay upwind, keep out of low areas. Wear positive pressure breathing apparatus and special protective clothing. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Thermal decomposition products may include oxides of carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve in a solvent and burn in a furnace by spraying in the solution[22].

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Coumatetralyl, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Coumatetralyl, #2297, Trenton, NJ (February 2003).

p-Cresidine C:1440

Formula: $C_8H_{11}NO$; $C_6H_3(NH_2)(OCH_3)(CH_3)$

Synonyms: *m*-Amino-*p*-cresol, methyl ester; 3-Amino-*p*-cresol methyl ester; 1-Amino-2-methoxy-5-methylbenzene; 3-Amino-4-methoxytoluene; 2-Amino-4-methylanisole; *o*-Anisidine,5-methyl-; Azoic red 36; Benzeneamine, 2-methoxy-5-methyl-; C.I. azoic red 83; *p*-Cresidina (Spanish); Cresidine; Kresidine; Krezidin (German); Krezidine; 2-Methoxy-5-methylaniline; 2-Methoxy-5-methyl-benzenamine; 4-M ethoxy-*m*-toluidine; 4-Methyl-2-aminoanisole; 5-Methyl-*o*-anisidine; NCI-C02982; Paracresol

CAS Registry Number: 120-71-8

HSDB Number: 4107

RTECS Number: BZ6720000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 204-419-0 [*Annex I Index No.:* 612-209-00-X]

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Animal Sufficient Evidence; Human No Adequate Data, *possibly carcinogenic to humans*, Group 2B, 1982; NCI: Carcinogenesis Bio assay (feed); clear evidence: mouse, rat.

California Proposition 65 Chemical[102]: Cancer 1/1/1988.

Hazard Alert: Poison, Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazard symbols, risk, & safety statements: Hazard symbol: T; risk phrases: R22; R45; R50/53; R62; safety phrases: S53; R45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: *p*-Cresidine is a white crystalline solid. Molecular weight = 137.20. Boiling point = 235°C; freezing/melting point = 52°C; flash point ≥ 112°C; autoignition temperature = 450°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 1, reactivity 0. Practically insoluble in water.

Potential Exposure: *p*-Cresidine is used as an intermediate in the production of various azodyes, printing inks, and pigments; including 11 dyes that are produced commercially in the United States. Human exposure to *p*-Cresidine occurs primarily through inhalation of vapors or skin absorption of the liquid. Exposure to *p*-cresidine is believed to be limited to workers in dye-production facilities. The Consumer Product Safety Commission staff believes it is possible that residual levels or trace impurities of *p*-cresidine may be present in some dyes based on this chemical, and it may be present in the final consumer product. The presence of *p*-cresidine, even as a trace contaminant, may be a cause for concern. However, data describing the actual levels of impurities in the final product and the potential for consumer exposure and uptake are currently lacking.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

No PAC available

DFG MAK: Carcinogen Category 2

Austria: carcinogen, 1999; Finland: carcinogen, 1993; France: carcinogen, 1993; Switzerland: carcinogen, 1999. Zero in ambient air set by North Dakota[60].

Determination in Water: Octanol−water coefficient: $\text{Log}\,K_{\text{ow}} = 1.7$. Unlikely to bioaccumulate in marine organisms.

Harmful Effects and Symptoms

Short-Term Exposure: Symptoms of exposure include skin andeye irritation; nausea, vomiting, liver damage; cyanosis, methemoglobinemia, weakness, drowsiness, somnolence, and loss of consciousness. LD_{50} (oral-rat) = 1450 mg/kg (slightly toxic).

Long-Term Exposure: May cause cancer in humans. When administered in the diet, *p*-cresidine was carcinogenic to rats, causing increased incidences of carcinomas and papillomas of the urinary bladder in both sexes; increased incidences of olfactory neuroblastomas in both sexes; increased incidences of olfactory neuroblastomas in both sexes; and of liver tumors in males. *p*-Cresidine was also carcinogenic in mice, causing carcinomas of the urinary bladders in both sexes, and hepatocellular carcinomas in females. May cause anemia.

Points of Attack: Blood.

Medical Surveillance: Blood hemoglobin level. CBC.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, Avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Note to Physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Specific respirator(s) have not been recommended by NIOSH. The following might be considered in an emergency: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full facepiece respirator with an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue (*potential carcinogen*): Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Store in a refrigerator under an inert atmosphere for prolonged storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft (NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(109); (102); (31); (173); (101); (138); (100).

National Cancer Institute, Bioassay of *p*-Cresidine for Possible Carcinogenicity, DHHS Publication No. (NIH) 78-1394, National Technical Information Service, Springfield, Virginia (1979).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* *p*-Cresidine Trenton, NJ (June 2001).

Cresols C:1450

Formula: C_7H_8O; $CH_3C_6H_4OH$

Synonyms: *m-isomer:* Benzene, 3-methyl-; *m*-Cresol; 3-Cresol; Cresol-*m*; *m*-Cresylic acid; 1-Hydroxy-3-methylbenzene; *m*-Hydroxytoluene; 3-Hydroxytoluene; *m*-Kresol (German); Metacresol; *m*-Methylphenol; 3-Methylphenol; Phenol, 3-methyl-; *m*-Toluol

mixed isomers: Acede cresylique (French); *ar*-Toluenol; Bacillol; Cresol isomers; Cresols (*o*-; *m*-; *p*-); Cresols (all isomers); Cresols and cresylic acids, mixed; Cresylic acid; Hydroxytoluole (German); Kresole (German); Methylphenol; Phenol, methyl-; Tekresol; Tricresol

o-isomer: Benzene, 2-methyl-; *o*-Creso l; 2-Cresol; Cresol-*o*; cresol-*o*-; *o*-Cresylic acid; 1-Hydroxy-2-methylbenzene; *o*-Hydroxytoluene; 2-Hydroxytoluene; *o*-Kresol (German); *o*-Methylphenol; 2-Methylphenol; Orthocresol; Phenol, 2-methyl; *o*-Toluol

p-isomer: Benzene, 4-methyl; *p*-Creso l; 4-Cresol; Cresol-*p*; *p*-Cresylic acid; 1-Hydroxy-4-methylbenzene; *p*-Hydroxytoluene; 4-Hydroxytoluene; *p*-Kresol (German); *p*-Methylphenol; 4-Methylphenol; Phenol, 4-methyl; *p*-Toluol

CAS Registry Number: 1319-77-3 (mixed isomers, cresylic acid); 95-48-7 (*o*-isomer); 108-39-4 (*m*-isomer); 106-44-5 (*p*-isomer)

HSDB Number: 250 (1319-77-3) as cresol

RTECS Number: GO5950000 (mixed isomers); GO6300000 (*o*-isomer); GO6125000 (*m*-isomer); GO6475000 (*p*-isomer)

UN/NA & ERG Number: UN2076 (cresols, liquid)/153; UN3455 (cresols, solid)/153

EC Number: 203-577-9 (*m*-isomer); 202-432-8 (*o*-isomer); 203-398-6 [*Annex I Index No.:* 604-004-00-9] (*p*-isomer)

Regulatory Authority and Advisory Information

Carcinogenicity: EPA (*o-, m-, & p-isomers*): Possible Human Carcinogen; ACGIH A4, not classifiable as a human carcinogen

Hazard Alert: Poison, Flammable, Corrosive (skin). (mixed isomers) Possible risk of forming tumors. Agricultural Chemical. (*m*-isomer) Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction). (*o*-isomer): Possible risk of forming tumors, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction). (*p*-isomer): Possible risk of forming tumors, Primary irritant (w/o allergic reaction), Environmental hazard.

mixed isomers:

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Clean Water Act: Section 311 Hazardous Substances/RQ 100 lb (4.54 kg); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U052

RCRA Toxicity Characteristic (Section 261.24), Maximum Concentration of Contaminants, regulatory level, 200 mg/L. *Note*: if *o-, m-* and *p*-cresol concentrations cannot be differentiated, the total cresol (D026) concentration is used. The regulatory level of total cresol is 200 mg/L

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1000 lb (454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, appendix B) as cresols (*o-, m, and p-isomers*)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%., all isomers; NPRI.

WGK[100] (German Aquatic Hazard Class): 2-Hazard to waters (*o-, m, and p-isomers*)

Description: Cresol is a mixture of the three isomeric cresols, *o-, m-*, and *p*-cresol. Cresols are slightly soluble in water.

m-Isomer: Colorless or yellow liquid with characteristic odor. Molecular weight = 108.14; specific gravity (H_2O:1) = 1.030 to 1.038; boiling point = 202.7°C; freezing/melting point = 12.2°C; vapor pressure = 0.14 mmHg @ 25°C; flash point = 86°C (cc); autoignition point = 558°C. Explosive limits: LEL: 1.1% @ 149°C. Hazard identification (based on NFPA-704 M Rating System): (cresols) Health 3, flammability 2, reactivity 0. Solubility in water = 2%.

o-Isomer: Colorless or yellow liquid or crystals that turn dark on exposure to air and light, with characteristic phenolic odor. Molecular weight = 108.15; specific gravity (H_2O:1) = 1.05; boiling point = 191.1°C; freezing/melting point = 31.1°C; vapor pressure = 0.29 mmHg @ 25°C; flash point = 81°C (cc); autoignition point = 599°C. Explosive limits: LEL: 1.4% @ 149°C. Hazard identification (based on NFPA-704 M Rating System): (cresols) Health 3, flammability 2, reactivity 0. Solubility in water = 2%.

p-Isomer: Colorless to yellow crystals that turn dark on exposure to air and light, with characteristic odor. Molecular weight = 108.15; specific gravity (H_2O:1) = 1.04; boiling point = 201.8°C; freezing/melting point = 36°C; flash point = 86°C (cc); autoignition point = 558−560°C. Explosive limits: LEL: 1.1%; UEL: %. Hazard identification (based on NFPA-704 M Rating System): (cresols) Health 3, flammability 2, reactivity 0. Solubility in water = 2%.

Mixed isomers: Molecular weight = 108.15; boiling point = 202°C; freezing/melting point = 35°C; vapor pressure = 0.11 mmHg @ 25°C; flash point = 43−82°C; autoignition point = about 560°C. Explosive limits: LEL: 1.1%. Hazard identification (based on NFPA-704 M Rating System): (cresols) Health 3, flammability 2, reactivity 0. Solubility in water = 2%.

Potential Exposure: Cresol is used as a disinfectant and fumigant; as an ore flotation agent, and as an intermediate in the manufacture of chemicals, dyes, plastics, and antioxidants. A mixture of isomers is generally used; the concentrations of the components are determined by the source of the cresol.

Incompatibilities: Vapors may form explosive mixture with air. Incompatible with strong acids; oxidizers, alkalies, aliphatic amines; amides, chlorosulfonic acid; oleum. Decomposes on heating, producing strong acids and bases, causing fire and explosion hazard. Liquid attacks some plastics and rubber. Attacks many metals.

Permissible Exposure Limits in Air

NIOSH IDLH = 250 ppm all isomers (o-, m-, p-)

Conversion factor: 1 ppm = 4.43 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 5 ppm/22 milligram per cubic meter TWA [skin]

NIOSH REL: 2.3 ppm/10 milligram per cubic meter TWA

ACGIH TLV[1]: 20 ppm TWA, inhalable fraction and vapor [skin]; not classifiable as a human carcinogen

PAC Ver. 29[138]

All isomers

PAC-1: 14 ppm

PAC-2: 25 ppm

PAC-3: 250 ppm

DFG MAK *(all isomers)*: [skin]; Germ Cell Mutation Category 3 A

Austria: MAK 5 ppm (22 milligram per cubic meter) [skin], 1999; Denmark: TWA 5 ppm (22 milligram per cubic meter) [skin], 1999; France: VME 5 ppm (22 milligram per cubic meter), 1999; Japan: 5 ppm (22 milligram per cubic meter), 1999; Norway: TWA 5 ppm (22 milligram per cubic meter), 1999; United Kingdom: TWA 5 ppm (22 milligram per cubic meter) [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 5 ppm [skin]. Russia set a MAC in work-place air of 0.5 milligram per cubic meter[35]. They have also set a MAC in ambient air in residential areas of 0.005 milligram per cubic meter both on a momentary and on a daily average basis. Several states have set guidelines or standards for cresols in ambient air[60] ranging from 12.0 μ/m^3 (Massachusetts) to 73.0 μ/m^3 (New York) to 110 μ/m^3 (Indiana) to 200 μ/m^3 (Connecticut) to 220 μ/m^3 (Florida, North Dakota, South Carolina) to 370 μ/m^3 (Virginia) to 524 μ/m^3 (Nevada) to 2200 μ/m^3 (North Carolina).

Determination in Air: XAD-7 (tube); Methanol; GC/Flame ionization detection; NIOSH Analytical Method (IV) #2546, Cresols and Phenol, or OSHA Analytical Method 32.

Permissible Concentration in Water: No criteria set, but EPA has suggested a permissible ambient concentration, based on health effects, of 304 μg/L. Russia[43] set a MAC in water used for domestic purposes of 0.004 μg/L of *m*- and *p*-isomers. A limit of 0.003 mg/L of *o*-isomer is set for water bodies used for fishery purposes. Mexico[35] set a MAC of 1.5 mg/L of cresols in the waters in estuaries.

Routes of Entry: Inhalation of percutaneous absorption of liquid or vapor, ingestion, eye and skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Corrosive to the eyes, skin, and respiratory tract. Inhalation can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Corrosive on ingestion. May affect the central nervous system. Exposure may result in death. The effects may be delayed. *Inhalation:* A level of 4 ppm was reported not to cause symptoms. Exposure to 48 ppm for 5−10 minutes may cause irritation to the nose, throat, and lungs, nausea, vomiting, and general muscle weakness. High blood pressure, tremors, and convulsions have been reported in people exposed to Cresol at unspecified levels. Due to irritating effects, the inhalation of appreciable amounts of cresol vapor in the work-place under normal conditions is unlikely. *Skin:* This is a major route of exposure and the one which causes most work-related cresol injuries. Contact with 20 mL of 90% cresol resulted in burns, swelling, internal bleeding, and kidney damage, and has caused death in children; 10% cresol left on the skin for 2 hours has caused inflammation, blistering and scarring; 6% for 5−6 hours has caused drying and peeling, inflammation, facial tremors and tearing. A 4% solution tested on human skin produced no sensitization reaction. *Ingestion:* 250 mL of 50% Cresol has caused pneumonia, irritation of the pancreas, kidney failure, and unconsciousness. Symptoms reported from swallowing an unspecified amount of cresol include an immediate burning of the tissues, sweating, headache, dizziness; muscle weakness; ringing in the ears and pale skin appearance. Death has occurred from as little as 1 g (about 1/4 teaspoon). Exposure may result in a burning pain in the mouth and throat; white necrotic lesions in the mouth, esophagus and stomach; abdominal pain; vomiting, diarrhea, paleness, sweating; weakness, headache, dizziness; ringing in ears; shallow respiration with "phenol" odor on the breath; scanty, dark-colored or "smoky" urine; and possible delirium followed by unconsciousness. Convulsions are rarely seen, except in children. Hypersensitivity develops in certain individuals. The chemical is rated as a very toxic compound with a probable oral lethal dose in humans of 50−500 mg/kg, or between 1 teaspoon and 1 oz for a 70-kg (150 lb) person.

Long-Term Exposure: Repeated or prolonged contact with skin may cause dermatitis. May cause lung damage. Repeated or prolonged exposure may affect the central nervous system; kidneys, and liver. *p-isomer:* Repeated or prolonged skin contact with the *p*-isomer may cause dermatitis.

Points of Attack: Central nervous system; respiratory system; liver, kidneys, skin, eyes.

Medical Surveillance: Cresols are suspected human carcinogens. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure. Consider the skin, eyes, respiratory system; liver, and kidney functions in placement or periodic examinations. Liver and kidney function tests. Evaluation by a qualified allergist. Consumption of alcohol may increase liver damage. NIOSH lists the following tests: Liver function tests; pulmonary function tests; urine (chemical/metabolite); urine (chemical/metabolite) Pre- and Postshift.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. *m-Cresol 108-39-4* **4 hours**: (At least 4 but <8 hours of resistance to breakthrough $>0.1\ \mu g/cm^2/min$): Neoprene rubber gloves, suits, boots; Teflon gloves, suits, boots. *p-Cresol 106-44-5* **4 hours** (At least 4 but <8 hours of resistance to breakthrough $>0.1\ \mu g/cm^2/min$): 4H and Silver Shield gloves. Also, Saranex has been recommended as a protective material for cresols. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. When working with liquids, wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. When working with powders or dusts, wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH as cresol: *23 ppm:* Any air-purifying half-mask respirator with organic vapor cartridge(s) in combination with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100; Sa (APF = 10) (any supplied-air respirator). *57.5 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOvHie (APF = 25) (any air-purifying full facepiece respirator equipped with an organic vapor cartridge in combination with a high-efficiency particulate filter). *115 ppm:* GmFOv100 (APF = 50) [any air-purifying full facepiece respirator equipped with organic vapor cartridge(s) in combination with an N100, R100, or P100 filter]; or [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or PaprTHie (APF = 50) (any powered, APR with a tight-fitting facepiece and a high-efficiency particulate filter); or SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *250 ppm:* SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Color code—White: Corrosive or Contact Hazard: Store separately in a corrosion-resistant location. Prior to working with cresols all handlers should be trained on its proper handling and storage. Before entering confined space where cresols may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area. Away from strong acids or oxidizers. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2076 Cresols, liquid, Hazard class: 6.1; Labels: 6.1-Poisonous materials, 8-Corrosive material. UN3455 Cresols, solid, Hazard class: 6.1; Labels: 6.1-Poisonous materials, 8-Corrosive material.

Spill Handling: Avoid inhalation. Wear proper respiratory protection and eye protection. Wear protective clothing. Do not touch spilled material. Stop leak if you can do so without risk. Use water spray to reduce vapors. For *small spills*: absorb the material with sand or other noncombustible absorbent material and place into containers for later disposal. For *small dry spills*, shovel up and place into clean, dry containers and cover. For *large spills*, dike far ahead of spill for later disposal. If clothing becomes contaminated remove immediately and isolate at the site. If a leak or spill has not ignited, use water spray to disperse the vapors and to provide protection for personnel attempting to stop a leak. Water spray may be used to flush spills away from exposures. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Cresols are combustible. Thermal decomposition products may include oxides of carbon. Stay upwind, keep out of low areas. Ventilate closed spaces before entering them. Use water to blanket the fire and dry chemical, foam, or carbon dioxide to extinguish the flames. Extinguish small fires with dry chemical, carbon dioxide; water spray; or foam. For large fires use water spray, fog, or foam. Move container from fire area if you can do so without risk. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. Dike fire control water for later disposal; don't scatter the material. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Wastewaters may be subjected to biological treatment. Concentrations may be further reduced by ozone treatment. High concentration wastes may be destroyed in special waste incinerators[22].

References

(31); (173); (101); (138); (100).

National Institute for Occupational Safety and Health (NIOSH), "Criteria for a Recommended Standard: Occupational Exposure to Cresol", NIOSH Document Number 78-133, Cincinnati, OH (1978).

United States Environmental Protection Agency, a Study of Industrial Data on Candidate Chemicals for Testing (Alkyl Phthalates and Cresols), Report EPA-560/5-78-002, Washington, DC (June 1978).

United States Environmental Protection Agency, Cresols and Cresylic Acid, Health and Environmental Effects Profile No. 54, Office of Solid Waste, Washington, DC (April 30, 1980).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Cresylic Acid, Washington, DC, Chemical Emergency Preparedness Program (October 31, 1985).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Cresylic Acid, Trenton, NJ (April 1985).

New York State Department of Health, *Chemical Fact Sheet* Cresol (Mixture), Bureau of Toxic Substance Assessment, Albany, NY (March 1986). Also separate fact sheets on "ortho-Creso l," "meta-Cresol" and "para-Cresol."

Sax, N. I., Ed., "*Dangerous properties of Industrial Materials Report*, for *o*-cresol: 5," No. 3, 30–34 (1985), for *m*-cresol: 1, No. 6, 44–46 (1981), and 6, No. 1, 41–46 (1986).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Cresols (mixed isomers), Trenton, NJ (March 2007).

Crimidine C:1460

Formula: $C_7H_{10}ClN_3$; $C_7H_{10}N_3Cl$

Synonyms: Castrix; 2-Chloro-4-methyl-6-dimethylamino-pyrimidine; Crimidin (German); Pyrimidine, 2-chloro-4-(dimethylamino)-6-methyl-; W491

CAS Registry Number: 535-89-7

HSDB Number: 2812

RTECS Number: UV8050000

UN/NA & ERG Number: UN2588 (Pesticides, solid, toxic, n.o.s.)/151

EC Number: 208-622-6 [*Annex I Index No.:* 613-004-00-8]

Regulatory Authority and Advisory Information

Hazard Alert: Exposure can be lethal, Combustible, Animal poison

Banned or Severely Restricted (in agriculture) (Germany) (UN)[13]

Substances and Quantity Potential Likely to Cause Major Accidents (ILO): 100 kg

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 100/10,000 lb (4.54/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg).

Hazard symbols, risk, & safety statements: Hazard symbol: T+, N; risk phrases: R28; R52; safety phrases: S1/2; S36/37; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [2-Hazard to water. (est.)]

Description: Crimidine is a brown, waxy solid. Molecular weight = 171.65; boiling point = about 145°C; freezing/melting point = 87°C. Hazard identification (based on NFPA-704 M Rating System): Health 4, flammability 1, reactivity 0. Slightly soluble in water.

Potential Exposure: Crimidine is used as a rodenticide. Not registered for use in the United States as a pesticide.

Incompatibilities: Acids and acid fumes, strong bases.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 0.0063 milligram per cubic meter

PAC-2: 0.069 milligram per cubic meter

PAC-3: 0.41 milligram per cubic meter

Routes of Entry: Ingestion, absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Contact can cause eye and skin irritation and burns. Inhalation can irritate the nose and throat. Exposure may result in serious central nervous system damage with anxiety, restlessness, muscle stiffness, light sensitivity; noise sensitivity; touch sensitive; cold sweat; and leading to convulsions that may be fatal. If patient survives 5−6 hours there may not be serious problems. Extremely toxic; the LD_{50} oral (rat) is 1.25 mg/kg; probable oral lethal dose in humans is less than 5 mg/kg or less than 7 drops for a 70-kg (150 lb) person.

Long-Term Exposure: Chronic health effects are unknown at this time.

Points of Attack: Central nervous system.

Medical Surveillance: There is no special test for this chemical. However, if illness occurs or overexposure is suspected, medical attention is recommended.

First Aid: *Eye Contact:* Immediately remove any contact lenses and flush with large amounts of water for at least 15 minutes, occasionally lifting upper and lower lids. Seek Medical attention immediately. *Skin Contact:* Quickly remove contaminated clothing. Immediately wash area with large amounts of water. Seek medical attention immediately. *Inhalation:* Remove the person from exposure, trying to avoid rapid, jerky motions or noise. Begin (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. If seizures occur, begin seizure first aid measures. Call for immediate medical attention to visit the patient prior to transfer if possible. Any facility using this chemical should have 24 hour rapid access to medical personnel with training and equipment for emergency treatment. All area employees should be trained in first aid measures for castrix, including seizure management and CPR.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: SCBA >0.11 milligram per cubic meter. Where there is potential exists for exposure to Castrix, use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece respirator with a pesticide cartridge. Increased protection is obtained from full facepiece APRs. If while wearing a filter, cartridge or canister respirator, you can smell, taste, or otherwise detect castrix, or in the case of a full facepiece respirator you experience eye irritation, leave the area immediately. Check to make sure the respirator-to-face seal is still good. If it is, replace the filter, cartridge, or canister. If the seal is no longer good, you may need a new respirator.

Where there is potential for high exposures exists, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with castrix all handlers should be trained on its proper handling and storage. Castrix must be stored to avoid contact with strong acids (such as hydrochloric, sulfuric, and nitric) and acid fumes, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: UN2588 Pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Use organic vapor respiratory protection. Stay upwind; keep out of low areas. Wear self-contained (positive pressure if available) breathing apparatus and full protective clothing. Do not touch spilled material; stop leak if you can do so without risk. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills*: with clean shovel place material into clean, dry container and cover; move containers from spill area. *Large spills*: dike far ahead of spill for later disposal. If water pollution occurs, notify appropriate authorities. Ventilate area of spill or leak. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Thermal decomposition products may include hydrogen chloride fumes and oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR165 recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Crimidine, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Castrix, Trenton, NJ (September 1998).

Crotonaldehyde C:1470

Formula: C_4H_6O; $CH_3CH = CHCHO$

Synonyms: *cis-Isomer:* Aldehido crotonico (Spanish); Aldehyde crotonique (French); 2-Butenal; Crotonic aldehyde; β-methylacrolein; Propylene aldehyde; Topenel

trans-Isomer: Aldehido crotonico, (*E*)-(Spanish); Aldehyde crotonique (*E*)-(French); (*E*)-2-Butenal; *trans*-2-Butenal; 2-Butenal, (*E*)-; Crotonal; Crotonaldehyde; Crotonaldehyde, (*E*)-; Crotonaldehyde

trans-Isomer: Crotonic aldehyde; Ethylene dipropionate (8CI); 3-Methylacroleine; NCI-C56279; Propylene aldehyde, (*E*)-; Propylene aldehyde, *trans*-; Propylene aldehyde-*trans*

CAS Registry Number: 4170-30-3 (*cis*-); 123-73-9 (*trans*-)

HSDB Number: 252

RTECS Number: GP9499000 (*cis*-); GP9625000 (*trans*-)

UN/NA & ERG Number: (PIH) UN1143/131 (P)

EC Number: 224-030-0 [*Annex I Index No.:* 605-009-00-9]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Carcinogenicity: IARC: Human Inadequate Evidence; Animal Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1995; EPA: Classification C, Possible Human Carcinogen, ACGIH A3 Confirmed animal carcinogen with unknown relevance to humans.

cis-Isomer:

Hazard Alert: Poison inhalation hazard, Exposure may be lethal, Highly flammable liquid, Polymerization hazard (unstabilized), Possible risk of forming tumors, Suspected of causing genetic defects, Environmental hazard.

Clean Air Act: Accidental Release Prevention/Flammable Substances (Section 112 [r], Table 3), TQ = 20,000 lb (9080 kg)

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U053

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. (*cis*- and *trans*-).

Hazardous to aquatic life or environment, with possible long-lasting effects[291]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, F, N, Xn; risk phrases: R11, R19; R24/25; R26; R36/37/38; R40; R41; R48/22; R50; R62; R68; safety phrases: S1; S21; S26; S28; S29/35; S36/37/39; S41; S45; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water (*cis*- and *trans-isomers*).

trans-Isomer:

Hazard Alert: Poison inhalation hazard, Exposure may be lethal, Highly flammable liquid, Polymerization hazard (unstabilized), Suspected of causing genetic defects, Primary irritant (w/o allergic reaction), Environmental hazard.

Clean Air Act: Accidental Release Prevention/Flammable Substances (Section 112 [r], Table 3), TQ = 20,000 lb (9080 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg)

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Hazard symbols, risk, & safety statements: Hazard symbol: T+, F, N, Xn; risk phrases: R11, R19; R24/25; R26; R36/37/38; R40; R41; R48/22; R50; R62; R68; safety phrases: S1; S21; S26; S28; S29/35; S36/37/39; S41; S45; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water (*cis*- and *trans-isomers*).

Description: Crotonaldehyde is water-white (turns pale-yellow on contact with air) with an irritating, pungent, suffocating odor. Molecular weight = 70.09; 70.1 (*trans*-); specific gravity (H_2O:1) = 0.85 @ 20°C; boiling point = 102.2°C; freezing/melting point = (*trans*-) −73.8; (*cis*-) −69°C; vapor pressure = 30 mmHg @ 25°C; flash point = 13°C (oc); autoignition temperature = 232°C. explosive limits (*trans*-): LEL: 2.1%; UEL: 15.5%. NFPA 704 M Hazard identification (*trans*-): Health 4, flammability 3, reactivity 2. Highly soluble in water; solubility = 18%.

Potential Exposure: Crotonaldehyde is used as a warning agent in fuel gases and gas line leaks; as solvent; in chemical warfare; as an intermediate in the manufacture of *n*-butanol and crotonic and sorbic acids; in resin and rubber antioxidant manufacture; also used as a solvent in mineral oil purification; as an alcohol denaturant.

Incompatibilities: Vapors may form explosive mixture with air. A strong reducing agent. Readily converted by oxygen to peroxides and acids; heat or contact with alkalis and many other substances may cause polymerization. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, nonoxidizing mineral acids; ammonia, organic amines; aliphatic amines; aromatic amines; 1,3-butadiene, strong bases. Liquid attacks some plastics, rubber, and coatings.

Permissible Exposure Limits in Air

NIOSH IDLH = 50 ppm

Conversion factor: 1 ppm = 2.87 milligram per cubic meter @ 25°C & 1 atm

Odor threshold = 0.11 ppm.

OSHA PEL: 2 ppm/6 milligram per cubic meter TWA

NIOSH REL: 2 ppm/6 milligram per cubic meter TWA; See *NIOSH Pocket Guide*, Appendix C

ACGIH TLV[1]: 0.3 ppm/0.86 milligram per cubic meter, Ceiling Concentration [skin] confirmed animal carcinogen with unknown relevance to humans

Crotonaldehyde (cis- & *trans*-)

PAC* Ver. 29[138]

PAC-1: $\mathbf{0.19_A}$ ppm

PAC-2: $\mathbf{4.4_A}$ ppm

PAC-3: $\mathbf{14_A}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a sub script "**A**" and correspond to 60-minute values.

DFG MAK: [skin] Carcinogen Category 3B; Germ Cell Mutation Category 3B

Australia: TWA 2 ppm (6 milligram per cubic meter), 1993; Belgium: TWA 2 ppm (5.7 milligram per cubic meter), 1993; Denmark: TWA 2 ppm (6 milligram per cubic meter) [skin], 1999; Finland: TWA 2 ppm (6 milligram per cubic meter); STEL 6 ppm (17 milligram per cubic meter) [skin], 1999; France: VME 2 ppm (6 milligram per cubic meter), 1993; the Philippines: TWA 2 ppm (6 milligram per cubic meter), 1993; Poland: TWA 6 milligram per cubic meter; STEL 12 milligram per cubic meter, 1999; Switzerland: MAK-W 2 ppm (6 milligram per cubic meter) [skin], 1999; United Kingdom: LTEL 2 ppm (6 milligram per cubic meter); STEL 6 ppm (18 milligram per cubic meter), 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: ceiling 0.3 ppm [skin]. Several states have set guidelines or standards for Crotonaldehyde in ambient air[60] ranging from 60−180 μ/m^3 (North Dakota) to 100 μ/m^3 (Virginia) to 120 μ/m^3 (Connecticut) to 143 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #3516 or OSHA Analytical Method 81.

Permissible Concentration in Water: No criteria set. Regulated by Clean Water Act.

Determination in Water: Octanol−water coefficient: Log K_{ow} = <0.7. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion, eye and skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: A lacramator (causing tearing). Contact or vapor can cause severe and painful irritation and burn eyes (can cause corneal damage) and skin. The vapor can irritate the respiratory tract causing cough and shortness of breath. The substance may affect the lungs, resulting in impaired function, coughing, and shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Medical observation is indicated. Although slightly less toxic, crotonaldehyde is similar chemically and toxicologically to acrolein which is rated as extremely toxic. LD_{50} (oral-rat) = 206 mg/kg (moderately toxic). A 15-minute exposure @ 4.1 ppm is highly irritating to the nose and upper respiratory tract and causes tearing. Brief exposure @ 45 ppm proved very disagreeable, with prominent eye irritation. Toxic concentrations for human inhalation have been reported @ 12 milligram per cubic meter/10 minutes As with acrolein, vapor exposures cause gastrointestinal distress when ingested.

Long-Term Exposure: Crotonaldehyde causes mutations; such chemicals may have a cancer risk. There is limited evidence that this chemical causes cancer in animals, and may cause liver cancer. May cause skin allergy. Testing has not been completed to determine the carcinogenicity of low-molecular-weight aldehydes. However, the limited studies to date indicate that some aldehydes may have chemical reactivity and mutagenicity similar to potential occupational carcinogens, such as acetaldehyde and malonaldehyde. Therefore, NIOSH recommends that careful consideration should be given to reducing exposures to this aldehyde. Further information can be found in the *NIOSH Current Intelligence Bulletin 55: Carcinogenicity of Acetaldehyde and Malonaldehyde, and Mutagenicity of Related Low-Molecular-Weight Aldehydes* [DHHS (NIOSH), Publication No. 91-112].

Points of Attack: Respiratory system, eyes, skin.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure. Consider the skin, eyes, and respiratory system in placement or periodic examinations. Evaluation by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least

15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a Medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. **8 hours** (more than 8 hours of resistance to breakthrough $>0.1\ \mu g/cm^2/min$): butyl rubber gloves, suits, boots; Responder suits; **4 hours** (At least 4 but <8 hours of resistance to breakthrough $>0.1\ \mu g/cm^2/min$): Teflon gloves, suits, boots. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *20 ppm:* CcrFOv (APF = 50) (any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister); or Sa (APF = 10) (any supplied-air respirator). *50 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOv (APF = 25) [any powered, APR with organic vapor cartridge(s)]; or CcrFOv (APF = 50) (any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister); or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece) *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Poison inhalation chemical (PIH); check oxygen content prior to entering storage area. (1) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. (2) Color code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Prior to working with crotonaldehyde all handlers should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from heat, caustics, ammonia, amines, oxidizing material; mineral acids and 1,3-butadiene, since violent reactions occur. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN1143 Crotonaldehyde or Crotonaldehyde, stabilized, Hazard class: 6.1; Labels: 6.1-Poison Inhalation Hazard, 3-Flammable liquid, Inhalation Hazard Zone B.

Spill Handling:

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.3/0.5

Night 0.6/1.0
Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Establish forced ventilation to keep levels below explosive limit. Wear positive-pressure breathing apparatus and special protective clothing. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: dike far ahead of spill for later disposal. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged Exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed. May be absorbed on vermiculite and burned in open incinerator or dissolved in solvent and sprayed into incinerator.

References

(31); (173); (101); (138); (2); (100).

United States Environmental Protection Agency, Crotonaldehyde, Health and Environmental Effects Profile No. 55, Office of Solid Waste, Washington, DC (April 30, 1980).

Sax, N. I., E d., "*Dangerous properties of Industrial Materials Report*," 4, No. 1, 56–59, New York, Van Nostrand Reinhold Co. (Jan./Feb. 1984).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Crotonaldehyde, Washington, DC, Chemical Emergency Preparedness Program (Nov. 30, 1987).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Crotonaldehyde, (E), Trenton, NJ (March 2007).

Crotonic Acid C:1480

Formula: $C_4H_6O_2$

Synonyms: α-Butenoic acid; 2-Butenoic acid; α-Crotonic acid; β-Methylacrylic acid; 3-Methylacrylic acid

CAS Registry Number: 3724-65-0

HSDB Number: 2814

UN/NA & ERG Number: UN2823/153

EC Number: 203-533-9

Regulatory Authority and Advisory Information

Hazard Alert: Serious or permanent injury hazard, Reducing agent, Combustible, Corrosive, Polymerization hazard (in fire), Primary irritant (w/o allergic reaction).

Hazard symbols, risk, & safety statements: Hazard symbol: T, C, F, Xi, Xn; risk phrases: R10; R21/22; R34; R35; R36/37/378; safety phrases: S26; S36/37/39; S45; (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Crotonic acid is a white or colorless, crystalline solid with a pungent odor. May be transported as a molten liquid. Molecular weight = 86.1; specific gravity (H_2O:1) = 1.02 @ 15°C; boiling point = 187–189°C; freezing/melting point = 72°C; vapor pressure = 0.19 mmHg @ 20°C; flash point = 88°C (oc); autoignition temperature = 396°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 2, reactivity 0. Soluble in water; solubility = 9% @ 25°C. This chemical is the commercially used *trans*-isomer. The *cis*-isomer is less stable and melts at 15°C.

Potential Exposure: Used to make plastics, resins, plasticizers, lacquers, and medicines; other chemicals as a chemical intermediate.

Incompatibilities: May form explosive mixture with air. A strong reducing agent. The aqueous solution is a weak acid. Violent reaction with oxidizers, combustibles, strong bases; peroxides. Moisture or strong sunlight (UV) may cause explosive polymerization. May accumulate static electrical charges, and may cause ignition of its vapors. Combustible when exposed to heat or flame. Compounds of the carboxyl group react with all bases, both inorganic and organic (i.e., amines) releasing substantial heat, water, and a salt that may be harmful. Incompatible with arsenic compounds (releases hydrogen cyanide gas), diazo compounds, dithiocarbamates, isocyanates, mercaptans, nitrides, sulfides (releasing heat, toxic, and possibly flammable gases), thiosulfates, and dithionites (releasing hydrogen sulfate and oxides of sulfur).

Permissible Exposure Limits in Air
PAC Ver. 29[138]
PAC-1: 3 milligram per cubic meter
PAC-2: 33 milligram per cubic meter
PAC-3: 200 milligram per cubic meter

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin, and respiratory tract. Corrosive: contact with the skin or eyes can cause burns and permanent damage. Inhalation can cause coughing and shortness of breath. Higher exposures can cause pulmonary edema, a Medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. moderately toxic by ingestion, skin contact, and subcutaneous routes.

Long-Term Exposure: Irritates the lungs; may cause bronchitis with coughing, phlegm, and/or shortness of breath.

Points of Attack: Lungs.

Medical Surveillance. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Where there is a potential for overexposure*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode).

Storage: (1) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. (2) Color code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. (3) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with crotonic acid, all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, strong bases; and reducing agents. Where possible, automatically pump liquid from drums or other storage containers to process containers

Shipping: UN2823 Crotonic acid, solid, Hazard class: 8; Labels: 8-Corrosive material.

Spill Handling: *Solid:* Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Liquid: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Thermal decomposition products may include oxides of carbon. May polymerize in heat of fire. Use dry chemical, carbon dioxide; alcohol or polymer foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Crotonic Acid, Trenton NJ (January 1999).

Crufomate C:1490

Formula: $C_{12}H_{19}ClNO_3P$

Synonyms: 4-*t*-Butyl-2-chlorophenyl methyl methylphosphoramidate; 4-*tert*. Butyl 2-chlorophenyl methylphosphoramidate demethyle (French); *O*-(4-*tert*-Butyl-2-chlor-phenyl)-*O*-methyl-phosphorsaeure-*N*-methylamid (German); Dowco 132; ENT 25,602-X; *O*-Methyl *O*-2-chloro-4-*tert*-butylphenyl *n*-methylamidophosphate; Methylphosphoramidic acid, 4-*t*-butyl-2-chlorophenyl methyl ester; Montrel; Phenol,4-*t*-butyl-2-chloro-, ester with methyl methylphosphoramidate; Phosphoramidic acid, 4-*tert*-butyl-2-chlorophenylphosphor amidate; Phosphoramidic acid, methyl-,4-*tert*-butyl-2-chlorophenyl; Phosphoramidic acid, methyl-,2-chloro-4-(1,1-dimethylethyl)phenyl methyl ester; Ruelene; Ruelene Drench; Rulene

CAS Registry Number: 299-86-5

HSDB Number: 1547 as ruelene

RTECS Number: TB3850000

UN/NA & ERG Number: (PIH) UN2783 (organophosphorus pesticides, solid, toxic)/152; UN3018 (organophosphorus pesticide, liquid, toxic)/152

EC Number: 015-074-00-X

Regulatory Authority and Advisory Information

Hazard Alert: Poison inhalation hazard, Neurotoxin (cumulative), Suspected of causing genetic defects.

United States DOT 49CFR172.101, Inhalation Hazardous Chemical, as organic phosphate, Substance ID: EDF-041

Hazard symbols, risk, & safety statements: Hazard symbol: N, Xn; risk phrases: R22; R33; R36/37/38; R50/53; R61; safety phrases: S16; S26; S41; S45; S60; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Crufomate is a white crystalline solid; the commercial product is a yellow oil. Molecular weight = 291.71; boiling point = (decomposes); freezing/melting point = (decomposes) 63°C. Insoluble in water.

Potential Exposure: A potential danger to those involved in the manufacture, formulation, and application of this insecticide and anthelmintic for cattle.

Incompatibilities: Contact with oxidizers may cause the release of phosphorous oxides. Contact with strong reducing agents, such as hydrides, may cause the formation of flammable and toxic phosphine gas. Decomposes on heating, forming corrosive and toxic fumes of hydrogen chloride and nitrogen and phosphorous oxides. Incompatible with strongly alkaline and strongly acidic media. Unstable over long periods in aqueous preparations or above 60°C.

Permissible Exposure Limits in Air

OSHA PEL: None

NIOSH REL: 5 milligram per cubic meter TWA; 20 milligram per cubic meter STEL

ACGIH TLV[1]: 5 milligram per cubic meter TWA; not classifiable as a human carcinogen; BEI_A issued: Acetylcholinesterase inhibiting pesticides

No PAC available

Australia: TWA 5 milligram per cubic meter; STEL 20 milligram per cubic meter, 1993; Belgium: TWA 5 milligram per cubic meter; STEL 20 milligram per cubic meter, 1993; Denmark: TWA 5 milligram per cubic meter, 1999; France: VME 5 milligram per cubic meter, 1999; Russia: STEL 0.5 milligram per cubic meter [skin], 1993; Switzerland: MAK-W 5 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 5 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Several states have set guidelines or standards for crufomate in ambient air[60] ranging from 50−200 μ/m^3 (North Dakota) to 80 μ/m^3 (Virginia) to 100 μ/m^3 (Connecticut) to 119 μm^3 (Nevada).

Determination in Air: Filter; none; Gravimetric; NIOSH Analytical Method (IV) #0500, Particulates NOR, total dust. OSHA versatile sampler-2; Toluene/Acetone; GC/Flame photometric detection for sulfur, nitrogen, or phosphorus; NIOSH Analytical Method (IV) Method #5600, Organophosphorus Pesticides.

Routes of Entry: Skin absorption, inhalation of dust, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: A cholinesterase inhibitor. Crufomate irritates the eyes, skin, and respiratory tract. Crufomate can affect you when breathed in and quickly enters the body by passing through the skin. Severe poisoning can occur from skin contact. It is a moderately toxic organophosphate chemical. Exposure can cause effects on the nervous system; rapid severe poisoning with headache, sweating, nausea and vomiting; diarrhea, loss of coordination; convulsions, respiratory failure; and death. The LD_{50} (oral-rat) = 460 mg/kg (slightly toxic). The health effects may be delayed.

Long-Term Exposure: Exposure may affect the developing fetus. Crufomate may damage the testes. High or repeated exposure may cause nerve damage and poor coordination in arms and legs. Repeated exposure may cause personality changes of depression, anxiety, or irritability.

Points of Attack: Respiratory system; central nervous system; peripheral nervous system; plasma cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of “normal.” Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider CBC. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek Medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−36 hours.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles when working with liquid or wear dust-proof goggles when working with powders or dusts unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Where there is potential exists for exposures over 5 milligram per cubic meter*, use a NIOSH/MSHA or European Standard EN149-approved full facepiece respirator with a pesticide cartridge. Greater protection is provided by a PAPR. *Where there is potential for high exposures exists*, use a NIOSH/MSHA or European Standard EN 149-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA or European Standard EN149-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool well-ventilated area away from heat. Also, avoid contact with oxidizers (such as peroxides, permanganates, chlorates, perchlorates, and nitrates).

Shipping: UN2783 Organophosphorus pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN3018 Organophosphorus pesticides, liquid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling:

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.3/0.4
Night 0.8/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 600/200
Then: Protect persons downwind (mi/km)
Day 1.4/2.3
Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Do not touch spilled material. Do not breathe vapors. Stay upwind; keep out of low areas. Remove all ignition sources. Ventilate area of spill or leak. This material is a combustible liquid. For a spill or leak of a combustible liquid, shut off ignition sources; no flares, smoking, or flames in hazard area. Stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include hydrogen chloride and oxides of phosphorus, sulfur, nitrogen, and carbon. If crufomate is in dry form, extinguish fire using an agent suitable for the type of surrounding fire; crufomate itself does not burn. If an oily or liquid form is used, consider the flammability of the solvent in determining appropriate procedures. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire-fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Crufomate decomposes above pH 7.0 in alkaline media. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Crufomate, Trenton, NJ (June 2005).

Cumene C:1500

Formula: C_9H_{12}; $C_6H_5CH(CH_3)_2$

Synonyms: Benzene isopropyl; Benzene, (1-methylethyl-)-; Cum; Cumeno (Spanish); Cumol; Isopropilbenceno (Spanish); Isopropylbenzene; Isopropylbenzène (French) Isopropylbenzol; Isopropyl-benzol (German); 1-Methylethyl benzene; 2-Phenylpropane

CAS Registry Number: 98-82-8

HSDB Number: 172

RTECS Number: GR8575000

UN/NA & ERG Number: UN1918/130

EC Number: 202-704-5 [Annex I Index No.: 601-024-00-X]

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen.

California Proposition 65 Chemical[102]: Cancer: 4/6/2010.

Hazard Alert: Highly flammable liquid, Narcotic hazard, Possible risk of forming tumors, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction), Possible electrostatic hazard, Environmental hazard.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U055

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 5000 lb (2270 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%; NPRI.

Hazardous to aquatic life or environment, with possible long-lasting effects[293]. Toxic to aquatic life with long la sting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, F, N; risk phrases: R11; R33; R62; R63; safety phrases: S16; S21; S29/35; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Cumene is a colorless liquid. Sharp, penetrating, aromatic odor, like gasoline. Molecular weight = 120.2; specific gravity (H_2O:1) = 0.86 @ 20°C; boiling point = 152.4°C; freezing/melting point = −96°C; vapor pressure = 7.5 mmHg @ 33°C; flash point = 36°C; autoignition temperature = 420°C. Explosive limits are: LEL: 0.9%; UEL: 6.5%. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 3, reactivity 1. Insoluble in water.

Potential Exposure: Cumene is used primarily in the manufacture acetone and phenol which are widely used as solvents for paints, laquers, and varnishes and to make plastics. Cumene is used in gasoline blending and as a high-octane gasoline component. It is also found as a component in tobacco smoke.

Incompatibilities: Vapor may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Air contact forms cumene hydroperoxide. Attacks rubber. May accumulate static electrical charges, and may cause ignition of its vapors.

Permissible Exposure Limits in Air

NIOSH IDLH = 900 ppm [LEL]

Odor threshold = 0.008−0.132 ppm

Conversion factor: 1 ppm = 4.92 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 50 ppm/245 milligram per cubic meter TWA [skin]

NIOSH REL: 50 ppm/245 milligram per cubic meter TWA [skin]

ACGIH TLV[1]: 50 ppm/246 milligram per cubic meter TWA

PAC* Ver. 29[138]

PAC-1: $\mathbf{50}_{\mathbf{A}}$ ppm

PAC-2: $\mathbf{300}_{\mathbf{A}}$ ppm

PAC-3: $\mathbf{730}_{\mathbf{A}}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a sub script "**A**" and correspond to 60-minute values.

DFG MAK: 50 ppm/250 milligram per cubic meter [skin]; Peak Limitation Category II(4); Pregnancy Risk Group C

Australia: TWA 50 ppm (245 milligram per cubic meter) [skin], 1993; Austria: MAK 50 ppm (245 milligram per cubic meter) [skin], 1999; Belgium: TWA 50 ppm (246 milligram per cubic meter) [skin], 1993; Denmark: TWA 25 ppm (120 milligram per cubic meter) [skin], 1999; Finland: TWA 50 ppm (245 milligram per cubic meter); STEL 75 ppm (370 milligram per cubic meter) [skin], 1999; France: VME 50 ppm (245 milligram per cubic meter) [skin], 1999; Hungary: TWA 80 milligram per cubic meter; STEL 100 milligram per cubic meter, 1993; the Netherlands: MAC-TGG 100 milligram per cubic meter [skin], 2003; Norway: TWA 25 ppm (125 milligram per cubic meter), 1999; the Philippines: TWA 50 ppm (245 milligram per cubic meter) [skin], 1993; Poland: MAC (TWA) 100 milligram per cubic meter, MAC (STEL) 350 milligram per cubic meter, 1999; Russia: STEL 50 milligram per cubic meter, 1993; Sweden: NGV 25 ppm (120 milligram per cubic meter), KTV 35 ppm (170 milligram per cubic meter) [skin], 1999; Switzerland: MAK-W 50 ppm (245 milligram per cubic meter) [skin], 1999; United Kingdom: TWA 25 ppm (125 milligram per cubic meter); STEL 75 ppm [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 50 ppm. Several states have set guidelines or standards for Cumene in ambient air[60] ranging from 2.45−3.65 milligram per cubic meter (North Dakota) to 4.0 milligram per cubic meter (Virginia) to 4.9 milligram per cubic meter (Connecticut) to 5.83 milligram per cubic meter (Nevada).

Determination in Air: Charcoal adsorption, workup with CS_2, analysis by GC. Use NIOSH Analytical Method #1501 for hydrocarbons, aromatic.

Determination in Water: No method listed. Octanol−water coefficient: Log $K_{ow} \geq 3.5$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, ingestion; skin and eye contact. Passes through the unbroken skin.

Harmful Effects and Symptoms

Short-Term Exposure: Narcotic action with long-lasting effects; depressant to central nervous system[136]. Irritates the eyes, skin, and respiratory tract. Skin contact may cause a burning sensation and/or rash. Higher levels can cause dizziness, lightheadedness, headaches, unconsciousness, narcosis, coma. Levels of 4000 ppm may cause unconsciousness. LD_{50} (oral-rat) = 1400 mg/kg.

Long-Term Exposure: Inhalation exposure to cumene caused lung tumors in male and female mice, and liver tumors in female mice[193]. Can cause drying and cracking of the skin. May cause lung, liver, and kidney damage. Although cumene has not been adequately tested to determine whether brain or nerve damage could occur with repeated exposure, many solvents and other petroleum-based chemicals have been shown to cause such damage.

Points of Attack: Eyes, skin, respiratory system; central nervous system.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Interview for brain effects, including recent memory, mood, concentration, altered sleep patterns; and nervous system evaluation. NIOSH lists the following tests: whole blood (chemical/metabolite); Expired air; urine (chemical/metabolite): last 2 hours of 8-hour exposure; urine (chemical/metabolite).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. *Do not* induce vomiting.

Personal Protective Methods: Wear appropriate clothing to prevent repeated or prolonged skin contact Tychem 1000 suits: **8 hours** (more than 8 hours of resistance to breakthrough $>0.1\ \mu g/cm^2/min$) Teflon gloves, suits, boots: **4 hours** (At least 4 but <8 hours of resistance to breakthrough $>0.1\ \mu g/cm^2/min$). Also, chlorinated polyethylene (CPE) may offer protection and is among the recommended protective materials. Wear eye protection to prevent any reasonable probability of eye contact. Employees should wash promptly when skin is wet or contaminated. Remove nonimpervious clothing promptly if contaminated or wet.

Respirator Selection: *500 ppm:* CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)]; or Sa (APF = 10) (any supplied-air respirator). *1000 ppm:*

Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOv (APF = 25) [any powered, APR with organic vapor cartridge(s)]; or CcrFOv (APF = 50) [any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s)]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister]; or SCBAF (APF = 50) (any SCBA with a full facepiece) or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. May form peroxides in storage. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Cumene must be stored to avoid contact with oxidizers, such as permanganates, nitrites, peroxides, chlorates, and perchlorates, since violent reactions occur. Store in tightly closed containers in a cool well-ventilated area away from heat. Sources of ignition, such as smoking and open flames are prohibited where Cumene is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Sources of ignition, such as smoking and open flames are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gal or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical.

Shipping: UN1918 Cumene, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(109); (102); (31); (173); (101); (138); (2); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 4, No. 1, 59−62, New York, Van Nostrand Reinhold Co. (Jan./Feb. 1984).

New York State Department of Health, *Chemical Fact Sheet* Cumene, Bureau of Toxic Substance Assessment, Albany, NY (March 1986).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Cumene, Trenton, NJ (December 1999).

Cumene Hydroperoxide C:1510

Formula: $C_9H_{12}O_2$: $C_6H_5C(CH_3)_2OOH$

Synonyms: Cument hydroperoxide; Cumenyl hydroperoxide; Cumolhydroperoxid (German); α-Cumylhydroperoxide; Cumyl hydroperoxide; α,α-Dimethylbenzyl hydroperoxide; Hidroperoxido de cumeno (Spanish); Hydroperoxide, 1-methyl-1-phenylethyl-; Hydroperoxyde de cumene

(French); Hydroperoxyde de cumyle (French); Hyperiz; Isopropylbenzene hydroperoxide; Trigorox K80

CAS Registry Number: 80-15-9

HSDB Number: 254

RTECS Number: MX2450000

UN/NA & ERG Number: UN3109 (Organic peroxide type F, liquid)/145

EC Number: 201-254-7 [*Annex I Index No.:* 617-002-00-8]

Regulatory Authority and Advisory Information

Hazard Alert: Flammable, Possible risk of forming tumors, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction).

OSH A: Considered Highly Hazardous

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U096

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%; on DSL List; NPRI.

Hazard symbols, risk, & safety statements: Hazard symbol: O, F, T, N; risk phrases: R7; R10; R20/22; R23; R34; R48/20/22; R51/53; R61; R62; safety phrases: S1/2; S3/7; S14; S36/37/39; S45; S50; S41; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Cumene hydroperoxide, an organic peroxide, is a colorless to pale yellow to green liquid. Mild odor. Molecular weight = 152.21; specific gravity (H_2O:1) = 1.05; boiling point = 153°C; freezing/melting point = −10°C. It explodes on heating; flash point = 79°C. Its explosive limits are: LEL: 0.9%; UEL: 6.5%. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 2, reactivity 4 (Oxidizer). Slightly soluble in water.

Potential Exposure: Cumene hydroperoxide is used as polymerization initiator, curing agent for unsaturated polyester resins and cross-linking agent; as an intermediate in the process for making phenol plus acetone from cumene.

Incompatibilities: The pure material is reported to explode on heating at elevated temperatures (various values given are 50°, 109,[75] 150°C[11]) or in strong sunlight. The substance is a strong oxidizer; reacts violently with combustible and reducing agents, causing fire and explosion hazard. Contact with metallic salts of cobalt, copper or lead alloys; mineral acids; bases; and amines may lead to violent decomposition. Vapor forms an explosive mixture with air. May accumulate static electrical charges, and may cause ignition of its vapors.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 0.15 ppm

PAC-2: 1.6 ppm

PAC-3: 9.7 ppm

DFG MAK: Organic peroxide (Section Xa)

Routes of Entry: Inhalation, eyes, passing through the unbroken skin.

Harmful Effects and Symptoms

Short-Term Exposure: Cumene hydroperoxide is corrosive to the eyes, skin, and respiratory tract. Eye contact can cause burns and permanent damage. Corrosive on ingestion. Inhalation may include nosebleeds, sore throat; hoarseness, cough with phlegm; increased saliva; and shortness of breath. Higher exposures can cause a build-up of fluid in the lungs (pulmonary edema), a medical emergency, which can cause death. Other exposure symptoms may include headache, dizziness, poor coordination, and even unconsciousness. LD_{50} (oral-rat) = 382 mg/kg (moderately toxic).

Long-Term Exposure: Cumene hydroperoxide may cause mutations. Handle with extreme caution. May cause skin allergy. High or repeated overexposure may damage lungs, kidneys and liver.

Points of Attack: Lungs, skin, kidneys, liver.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. If symptoms develop or overexposure is suspected, the following also may be useful: consider chest X-ray after acute overexposure. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Tests for kidney and liver function. CBC.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable

probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures to cumene hydroperoxide exists, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Yellow Stripe: Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Prior to working with cumene hydroperoxide all handlers should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Cumene hydroperoxide must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine), strong acids (such as hydrochloric, sulfuric, and nitric) and organic materials; reducing agents; copper, copper or lead alloys, cobalt and mineral acids, since violent reactions occur. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN3109 Organic peroxide type F, liquid, Hazard Class: 5.2; Labels: 5.2-Organic peroxide, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep cumene hydroperoxide out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is an unstable, flammable liquid. Thermal decomposition products may include phenol. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

(173); (101); (138).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Cumene Hydroperoxide, Trenton, NJ (September 1996).

Cupferron C:1520

Formula: $C_6H_9N_3O_2$: $C_6H_5N(NO)ONH_4$

Synonyms: Ammonium-*N*-nitrosophenylhydroxylamine; Benzeneamine, *n*-Hydroxy-*N*-nitroso, ammonium salt; Hydroxylamine, *n*-nitroso-*N*-phenyl-, ammonium salt; Kupferron; NCI-C03258; *n*-Nitrosophenylhydroxylamin ammonium salz (German); *n*-Nitroso-*N*-phenylhydroxylamine ammonium salt; *n*-Nitrosophenylhydroxylamine ammonium salt

CAS Registry Number: 135-20-6

HSDB Number: 4109

RTECS Number: NC4725000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 205-183-2

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; NCI: Carcinogenesis Bioassay (feed); clear evidence: rat; mouse.

California Proposition 65 Chemical[102]: Cancer 1/1/1988

Hazard Alert: Poison, Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazard symbols, risk, & safety statements: Hazard symbol: T; risk phrases: R45; R26; R36/37; R50/53; R62; safety phrases: S25; S23; 24/25; S36/37/38; S40; S43 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Cupferron is a creamy-white crystalline compound. Molecular weight = 155.19; freezing/melting point = 163°C. Explosive limits: LEL: 9000 ppm; UEL: unknown. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 2, reactivity 1. Soluble in water.

Potential Exposure: Cupferron is used to separate tin from zinc, and copper and iron from other metals in the laboratory. Cupferron also finds application as a quantitative reagent for vanadates and titanium; and for the colorimetric determination of aluminum. The potential for exposure appears to be greatest for those engaged in analytical or research studies involving use of the chemical. Workers may also be exposed to the compound during manufacturing processes.

Incompatibilities: Forms unstable and possibly explosive compounds with thorium salts; titanium, zirconium.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 0.6 milligram per cubic meter

PAC-2: 6.6 milligram per cubic meter

PAC-3: 39 milligram per cubic meter

Routes of Entry: Human Exposure to cupferron occurs mainly through ingestion or inhalation of the dust from the dry salt. Skin absorption is a secondary route of exposure.

Harmful Effects and Symptoms

Long-Term Exposure: Cupferron, given in the diet, was carcinogenic to Fisher 344 rats, causing hemangiosarcomas, hepatocellular carcinomas; and squamous-cell carcinomas of the fore-stomach in males and females; as well as carcinomas of the auditory sebaceous gland in females. The chemical was also carcinogenic to B6C3F1 mice, causing hemangiosarcomas in males; and hepatocellular carcinomas, carcinomas of the auditory sebaceous gland, a combination of hemangiosarcom as and hemangiomas; and adenomas of the Harderian gland in females. LD_{50} = (oral-rat) 257 mg/kg (moderately toxic).

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure.

First Aid: Move victim to fresh air. Call 911 or emergency Medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with cupferron all handlers should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Cupferron should be stored in a refrigerator or in a cool dry place and protected from exposure to moisture.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft (NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide; water spray; or foam extinguishers. Thermal decomposition products may include ammonia and nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(109); (102); (31); (173); (101); (138); (100).

National Cancer Institute, Bio assay of Cupferron for Possible Carcinogenicity, Technical Report Series No. 100, DHEW Publication No. (NIH) 78-1350, Bethesda, MD (1978).

Cupric Acetate C:1530

Formula: $C_4H_6CuO_4$; $Cu(OOCCH_3)_2$

Synonyms: Acetate de cuivre (French); Acetato de cobre (Spanish); Acetic acid, copper(2+) salt; Acetic acid, copper(II) salt; Acetic acid, cupric salt; Copper acetate; Copper (2+) acetate; Copper(II) acetate; Copper diacetate; Copper (2+) diacetate; Copper(II) diacetate; Crystallized verdigris; Crystals of venus; Cupric diacetate; Neutral verdigris

CAS Registry Number: 142-71-2; 6046-93-1 (monohydrate)

HSDB Number: 915

RTECS Number: AG3480000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 205-553-3

Regulatory Authority and Advisory Information

Hazard Alert: Combustible, Environmental hazard, Suspected reprotoxic hazard. Suspected reprotoxic hazard

United States National Primary Drinking Water Regulations: MCLG = 1.3 mg[Cu]/L; MCL = TT action Level: 1.3 mg[Cu]/L. Copper is regulated by a Treatment Technique (TT) that requires systems to control the corrosiveness of their water. If more than 10% of tap water samples exceed the action level, water systems must take additional steps; SMCL = 1 mg[Cu]/L as Copper.

EPA ADI:1.3 mg[Cu]/L. As copper.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992); Toxic Pollutant (Section 401.15). as copper and compounds

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 6010 (60); 7210 (200) Note: All species in the ground water that contain copper are included

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. as copper compounds, n.o.s.; NPRI; CEPA Priority Substance List, Ocean dumping prohibited.

Hazardous to aquatic life or environment, with possible long-lasting effects[291]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: N, Xn; risk phrases: R22; R36/37/38; R50/53; R63; safety phrases: S16; S26; S29/35; S45; S60; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Cupric acetate is a greenish Blue powder or small crystals. Molecular weight = 181.64; boiling point = 240°C (decomposes); freezing/melting point = 115°C. Explosive limits: LEL: 8000 ppm; UEL: unknown. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 2, reactivity 0. Soluble in water.

Potential Exposure: Cupric acetate is used as a fungicide, as a catalyst for organic reactions; in textile dyeing and as a pigment for ceramics.

Incompatibilities: Forms explosive materials with acetylene gas, ammonia, caustic solutions; sodium hypobromite; notromethane. Keep away from chemically active metals; strong acids; nitrates. Decomposes above 240°C forming acetic acid fumes.

Permissible Exposure Limits in Air

NIOSH IDLH = 100 mg[Cu]/m^3 (dust & mist)
OSHA PEL: 1 mg[Cu]/m^3 (dust & mist) TWA; 0.1 milligram per cubic meter (fume) TWA
NIOSH: 1 mg[Cu]/m^3 (dust & mist) TWA; 0.1 milligram per cubic meter (fume) TWA
ACGIH TLV[1]: 1 mg[Cu]/m^3 (dust & mist) TWA; 0.2 milligram per cubic meter (fume) TWA
PAC Ver. 29[138]
142-71-2, anhydrous
PAC-1: 8.6 milligram per cubic meter
PAC-2: 20 milligram per cubic meter
PAC-3: 120 milligram per cubic meter

Determination in Air: Use NIOSH Analytical Methods (dusts and mist) #7029, #7300, #7301, #7303, #9102 and OSHA Analytical Methods ID-121, ID-125G

Permissible Concentration in Water: The permissible concentration of total recoverable copper in water to protect freshwater aquatic life is 5.6 μg[Cu]/L as a 24-hour average. The log of this concentration should not exceed the numerical value of log [0.94 In (hardness)-1.23]. The corresponding value to protect saltwater aquatic life is 4.0 μg [Cu]/L as a 24-hour average, and should not exceed 23 μg [Cu]/L at any time. Federal Drinking Water Guidelines: Action Level = 1300 μg[Cu]/L; EPA = 1000 μg[Cu]/L; State Drinking Water Guidelines: Arizona 1300 μg[Cu]/L; Kansas 1000 μg/L, and Minnesota 1300 μg/L[61].

Determination in Water: Total copper may be determined by digestion followed by AA or by colorimetry (using neocuproine) or by ICP Optical Emission Spectrometry. Dissolved Copper may be determined by 0.45 μ filtration followed by the preceding methods.

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Inhaling cupric acetate dust and vapors can irritate the respiratory tract causing coughing and wheezing. High levels may cause fluid to build up in the lungs (pulmonary edema), This can cause death. Corrosive: contact can irritate and may burn the skin and eyes. LD$_{50}$ (oral-rat) = 595 mg/kg (slightly toxic).

Long-Term Exposure: Long-term exposure to copper causes liver and/or kidney damage. Repeated exposure to this chemical can cause skin allergy, thickening of the skin, and/or a green discoloration of the skin and hair. Repeated Exposure can cause shrinking (atrophy) of the inner lining of the nose; and may cause sores in the nose. Can cause liver and kidney damage.

Points of Attack: Skin, lung, liver, and kidney damage.

Medical Surveillance: People with Wilson's Disease should consult their personal doctor to determine if the amount of copper in their water exceeds 1.3 mg[Cu]/L. For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Serum and urine tests for copper can measure recent exposure. Liver and kidney function tests. Evaluation by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a Medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. When working with liquids, wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. When working with powders or dusts, wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Copper dusts and mists: 5 milligram per cubic meter*: Qm (APF = 25) (any quarter-mask respirator). *10 milligram per cubic meter:* Any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100; or Sa (APF = 10) (any supplied-air respirator). *25 milligram per cubic meter:* Sa: Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); PaprHie (APF = 25) (any powered, APR with a high-efficiency particulate filter). *50 milligram per cubic meter*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or PaprTHie (APF = 50) (any powered, APR with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *100 milligram per cubic meter:* SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd, Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp: ASC BA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—Green: General storage may be used. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Cupric acetate must be stored to avoid contact with acetylene gas, chemically active metals (such as potassium, sodium, magnesium, and zinc), since violent reactions occur.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Thermal decomposition products may include acetic acid. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Copper-containing soluble wastes can be concentrated through the use of ion exchange, reverse osmosis, or evaporators to the point where copper can be electrolytically removed and sent to a reclaiming firm. If recovery is not feasible, the copper can be precipitated through the use of caustics and the sludge deposited in a chemical waste landfill.

References

(31); (173); (101); (138); (2); (100).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Cupric Acetate, Trenton, NJ (February 1999).

United States Environmental Protection Agency, Ambient Water Quality Criteria Document: Copper, p.B-14 (440/5-80-036), Washington, DC, 1980.

United States Environmental Protection Agency; Drinking Water Criteria Document for Copper, p.I-2 (EPA-600/X-84-190-1), Washington, DC, 1985.

United States Environmental Protection Agency, Recognition and Management of Pesticide Poisoning, 5th edition, Chapter 15, p. 145-147, Copper Compounds Washington DC, 2009.

Cupric Nitrate C:1540

Formula: CuN_2O_6; $Cu(NO_3)_2$

Synonyms: Copper dinitrate; Copper(2+) nitrate; Copper (II) nitrate; Cupric dinitrate; Nitrato de cobre (Spanish); Nitric acid, copper(2+) salt; Nitric acid, copper(II) salt

CAS Registry Number: 3251-23-8

HSDB Number: 264

RTECS Number: WU 7400000

UN/NA & ERG Number: UN1479/140

EC Number: 221-838-5

Regulatory Authority and Advisory Information

Hazard Alert: Strong oxidizer, Corrosive, Environmental hazard, Primary irritant (w/o allergic reaction).

United States National Primary Drinking Water Regulations: MCLG = 1.3 mg[Cu]/L; MCL = TT action Level: 1.3 mg[Cu]/L. Copper is regulated by a Treatment Technique (TT) that requires systems to control the corrosiveness of their water. If more than 10% of tap water samples exceed the action level, water systems must take additional steps; SMCL = 1 mg[Cu]/L as Copper/L; MCL = 10 mg/L as nitrates.

EPA ADI:1.3 mg[Cu]/L. As copper.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992); Toxic Pollutant (Section 401.15). as copper and compounds

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 6010 (60); 7210 (200) Note: All species in the ground water that contain copper are included

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%; NPRI; CEPA Priority Substance List, Ocean dumping prohibited.

Hazardous to aquatic life or environment, with possible long-lasting effects[192]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: O, C, Xi, N; risk phrases: R45; R8; R20/21/22; R34; R22; R36/38; safety phrases: S17; S20; S26; S29; S36/37/39; S45; S61 (see Appendix 4).

WGK[100] (Germ an Aquatic Hazard Class): 3-Severe hazard to waters.

Description: Cupric nitrate is a Blue crystalline solid. Molecular weight = 187.56; specific gravity (H_2O:1) = 2.05; boiling point = 170°C (decomposes below this point); freezing/melting point = 255°C. Soluble in water. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 0, reactivity 3 ₩ (Oxidizer). Soluble in water; solubility = 135 g/100 mL (trihydrate).

Potential Exposure: Cupric nitrate is used as an insecticide, in paint, varnish, enamel, and in wood preservatives. Metal compounds are often used in "hot" operations in the work-place. These may include, but are not limited to, welding, brazing, soldering, plating, cutting, and metallizing. At the high temperatures reached in these operations, metals often form metal fumes which have different health effects and exposure standards than the original metal compound and require specialized controls.

Incompatibilities: A strong oxidizer. Aqueous solution is acidic; incompatible with bases. Violent reaction with potassium hexacyanoferrate; ammonia and potassium amide mixtures; acetic anhydrides, cyanides, ethers. Forms explosive materials with nitromethanes, sodium hypobromite; acetylene; chemically active metals, such as potassium, sodium, etc. May ignite on contact with aluminum foil or tin. Risk of spontaneous combustion with combustibles (wood, cloth, etc.) organics, or reducing agents and readily oxidizable materials. Attacks metals in the presence of moisture.

Permissible Exposure Limits in Air

NIOSH IDLH = 100 mg[Cu]/m^3 (dust & mist)

OSHA PEL: 1 mg[Cu]/m^3 (dust & mist) TWA; 0.1 milligram per cubic meter (fume) TWA

NIOSH: 1 mg[Cu]/m^3 (dust & mist) TWA; 0.1 milligram per cubic meter (fume) TWA

ACGIH TLV[1]: 1 mg[Cu]/m^3 (dust & mist) TWA; 0.2 milligram per cubic meter (fume) TWA

PAC Ver. 29[138]

PAC-1:8.9 milligram per cubic meter

PAC-2: 31 milligram per cubic meter

PAC-3: 190 milligram per cubic meter

copper and its inorganic compounds

DFG MAK: 0.1 milligram per cubic meter measured as the inhalable fraction of the aerosol; Peak Limitation Category II(2); Pregnancy Risk Group C

Determination in Air: Use NIOSH Analytical Methods (dusts and mist) #7029, #7300, #7301, #7303, #9102 and OSHA Analytical Methods ID-121, ID-125G

Permissible Concentration in Water: The permissible concentration of total recoverable copper in water to protect freshwater aquatic life is 5.6 μg[Cu]/L as a 24-hour average. The log of this concentration should not exceed the numerical value of log [0.94 In (hardness)-1.23]. The corresponding value to protect saltwater aquatic life is 4.0 μg [Cu]/L as a 24-hour average, and should not exceed 23 μg [Cu]/L at any time. Federal Drinking Water Guidelines: Action Level = 1300 μg[Cu]/L; EPA = 1000 μg[Cu]/L; State Drinking Water Guidelines: Arizona 1300 μg[Cu]/L; Kansas 1000 μg/L, and Minnesota 1300 μg/L[61].

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Short-term exposure to copper causes gastrointestinal distress. Skin and eye contact can cause irritation and burns. Inhalation can irritate the nose and throat, causing coughing and wheezing. Cupric nitrate may produce fumes that can cause "metal fume fever." Ingestion cause salivation, nausea, vomiting, stomach pain. May cause blood effects if swallowed. High exposure can cause unconsciousness. LD_{50} (oral-rat) = 940 mg/kg (slightly toxic).

Long-Term Exposure: Long-term exposure to copper causes liver and/or kidney damage. Repeated exposure can cause copper to deposit in various parts of the body. Large deposits can make the skin and hair a green color. Repeated exposure can cause shrinking of the inner lining of the nose, and may cause runny nose and sores. Excess deposits in the liver can cause liver damage. Metallic taste may also occur. Skin allergy with rash sometimes occurs. If allergy develops, even small future exposures can trigger rash. Repeated exposures can also cause thickening of the skin not caused by allergy.

Points of Attack: Skin, liver.

Medical Surveillance: People with Wilson's Disease should consult their personal doctor to determine if the amount of copper in their water exceeds 1.3 mg[Cu]/L. For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: Urine test for copper can measure recent exposure. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least

15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to Physician: In case of fume inhalation, treat for pulmonary edema. Give prednisone or other corticosteroid orally to reduce tissue response to fume. Positive-pressure ventilation may be necessary. Treat metal fume fever with bed rest, analgesics, and antipyretics. The symptoms of metal fume fever may be delayed for 4−12 hours following exposure: it may last less than 36 hours.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Copper dusts and mists: 5 milligram per cubic meter*: Qm (APF = 25) (any quarter-mask respirator). *10 milligram per cubic meter:* Any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100; or Sa (APF = 10) (any supplied-air respirator). *25 milligram per cubic meter:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); PaprHie (APF = 25) (any powered, APR with a high-efficiency particulate filter). *50 milligram per cubic meter*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or PaprTHie (APF = 50) (any powered, APR with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *100 milligram per cubic meter:* SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd, Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Check oxygen content prior to entering storage area. Color code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially organic materials, flammables and combustibles, and other incompatible materials. Oxidizers, including oxidizing gases, should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Cupric nitrate must be stored to avoid contact with combustible, organic, or other readily oxidizable materials; and chemically active metals (such as potassium, sodium, magnesium, and zinc), since violent reactions occur. Store in tightly closed containers in a cool well-ventilated area away from acetylene gas. Protect storage containers from physical damage. Store in a cool, well-ventilated area away from incompatible materials listed above. Store in a cool, well-ventilated area away from incompatible materials listed above. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage.

Shipping: UN1479 Oxidizing solid, n.o.s., Hazard Class: 5.1; Labels: 5.1-Oxidizer, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. Keep cupric nitrate out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Copper nitrate itself is noncombustible, but it will increase the intensity of fire and may ignite combustible materials. Decomposes below 170°C. Thermal decomposition products may include metal fumes and oxides of nitrogen and carbon. Flooding amounts of water may be used to minimize its oxidizing effect on other materials. Caution: when large quantities are involved, application of water may cause scattering of molten material. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Copper-containing soluble wastes can be concentrated through the use of ion exchange, reverse osmosis, or evaporators to the point where copper can be electrolytically removed and sent to a reclaiming firm. If recovery is not feasible, the copper can be precipitated through the use of caustics and the sludge deposited in a chemical waste landfill. Add slowly to water; stir in excess soda ash. Let stand, then neutralize. Decant solution and flush to sewer; landfill sludge.

References

(31); (173); (101); (138); (2); (100).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Cupric Nitrate, Trenton, NJ (February 1999).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 2, No. 5, 35–38 (1982) and 5, No. 6, 45–49 (1985).

United States Environmental Protection Agency, Ambient Water Quality Criteria Document: Copper, p.B-14 (440/5-80-036), Washington, DC 1980.

United States Environmental Protection Agency; Drinking Water Criteria Document for Copper, p.I-2 (EPA-600/X-84-190-1), Washington, DC, 1985.

United States Environmental Protection Agency, Recognition and Management of Pesticide Poisoning, 5th edition, Chapter 15, p. 145–147, Copper Compounds Washington, DC, 2009.

Cupric Oxalate C:1550

Formula: $C_2H_2O_4 \cdot Cu$

Synonyms: Copper oxalate; Copper(II) oxalate; Ethanedioic acid, copper(2+) salt; Oxalic acid, copper(2+) salt

CAS Registry Number: 814-91-5; 55671-32-4 (hemihydrate)

HSD B Number: 265

UN/NA & ERG Number: UN2775/151

RTECS Number: RO2670000

EC Number: 212-411-4

Regulatory Authority and Advisory Information

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992); Section 307 Toxic Pollutants, 40CFR401.15 (effluent limitations); as copper and compounds

United States National Primary Drinking Water Regulations: MCLG = 1.3 mg[Cu]/L; MCL = TT action Level: 1.3 mg[Cu]/L. Copper is regulated by a Treatment Technique (TT) that requires systems to control the corrosiveness of their water. If more than 10% of tap water samples exceed the action level, water systems must take additional steps; SMCL = 1 mg[Cu]/L as Copper.

EPA ADI:1.3 mg[Cu]/L. As copper.

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 6010 (60); 7210 (200) *Note:* All species in the ground water that contain copper are included

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. as copper compounds, n.o.s.; NPRI; CEPA Priority Substance List, Ocean dumping prohibited

Hazard symbols, risk, & safety statements: Hazard symbol: T, N, Xn; risk phrases: R21/22; R27/28; safety phrases: S29/35; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Cupric oxalate is a bluish-white, odorless powder. Molecular weight = 153.58. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 0, reactivity 1. Insoluble in water.

Potential Exposure: Used as a catalyst for organic reactions and in seed treatment as a repellent for birds and rodents.

Incompatibilities: Explosive materials are formed on contact with acetylene gas, ammonia, caustic solutions; sodium hypobromite, nitromethane. Slight heating can cause a weak explosion. Cupric oxalate dissolves in aqueous ammonia and reacts as an acid to neutralize other bases as well. Can serve as a reducing agent in reactions that generate carbon dioxide. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

NIOSH IDLH = 100 mg[Cu]/m^3 (dust & mist)

OSHA PEL: 1 mg[Cu]/m^3 (dust & mist) TWA; 0.1 milligram per cubic meter (fume) TWA

NIOSH: 1 mg[Cu]/m^3 (dust & mist) TWA; 0.1 milligram per cubic meter (fume) TWA

ACGIH TLV[1]: 1 mg[Cu]/m^3 (dust & mist) TWA; 0.2 milligram per cubic meter (fume) TWA
PAC Ver. 29[138]
PAC-1: 7.3 milligram per cubic meter
PAC-2: 79 milligram per cubic meter
PAC-3: 480 milligram per cubic meter

Determination in Air: Use NIOSH Analytical Methods (dusts and mist) #7029, #7300, #7301, #7303, #9102 and OSHA Analytical Methods ID-121, ID-125G

Permissible Concentration in Water: The permissible concentration of total recoverable copper in water to protect freshwater aquatic life is 5.6 μg[Cu]/L as a 24-hour average. The log of this concentration should not exceed the numerical value of log [0.94 In (hardness)-1.23]. The corresponding value to protect saltwater aquatic life is 4.0 μg [Cu]/L as a 24-hour average, and should not exceed 23 μg [Cu]/L at any time. Federal Drinking Water Guidelines: Action Level = 1300 μg[Cu]/L; EPA = 1000 μg[Cu]/L; State Drinking Water Guidelines: Arizona 1300 μg[Cu]/L; Kansas 1000 μg/L, and Minnesota 1300 μg/L[61].

Determination in Water: Total copper may be determined by digestion followed by AA, or by colorimetry (using neocuproine) or by ICP optical emission spectrometry. Dissolved copper may be determined by 0.45 μ filtration followed by the preceding methods.

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Powerful irritant. Contact with skin and/or eyes causes severe irritation, burns, and can cause permanent damage. Inhalation irritates the respiratory tract causing coughing and wheezing. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. If swallowed, cupric oxalate has a caustic effect on the mouth, esophagus, and stomach; causing salivation, nausea, vomiting, diarrhea, and may cause damage to the kidneys. Short-term exposure to copper causes gastrointestinal distress.

Long-Term Exposure: Long-term exposure to copper causes liver and/or kidney damage. People with Wilson's Disease should consult their personal doctor to determine if the amount of copper in their water exceeds 1.3 mg[Cu]/L. Repeated exposure to this chemical may cause thickening of the skin; greenish color to the skin and hair; shrinking and perforation of the nasal septum with possible bleeding. May cause skin allergy and liver damage.

Points of Attack: Skin, liver.

Medical Surveillance: Liver function tests. Evaluation by a qualified allergist. Wilson's disease is a rare hereditary condition which interferes with the body's ability to get rid of copper. If you have this condition, consult your doctor about copper exposure. People with Wilson's Disease should consult their personal doctor to determine if the amount of copper in their water exceeds 1.3 mg [Cu]/L.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Copper dusts and mists: 5 milligram per cubic meter*: Qm (APF = 25) (any quarter-mask respirator). *10 milligram per cubic meter:* Any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100; or Sa (APF = 10) (any supplied-air respirator). *25 milligram per cubic meter:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); PaprHie (APF = 25) (any powered, APR with a high-efficiency particulate filter). *50 milligram per cubic meter*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or PaprTHie (APF = 50) (any powered, APR with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *100 milligram per cubic meter:* SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd, Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Prior to working with cupric oxalate all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from acetylene gas, ammonia, caustic solutions, and nitromethane.

Shipping: UN2775, Copper based pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Thermal decomposition products may include oxides of metal and carbon. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Cupric Oxalate, Trenton, NJ (February 1999).

United States Environmental Protection Agency, Ambient Water Quality Criteria Document: Copper, p.B-14 (440/5-80-036), Washington, DC, 1980.

United States Environmental Protection Agency; Drinking Water Criteria Document for Copper, p.I-2 (EPA-600/X-84-190-1), Washington, DC, 1985.

United States Environmental Protection Agency, Recognition and Management of Pesticide Poisoning, 5th edition, Chapter 15, p. 145−147, Copper Compounds Washington DC, 2009.

Cupriethylenediamine C:1560

Formula: $C_2H_{10}CuN_2$; $Cu(C_2N_2H_{10})$

Synonyms: Complex; Copper−ethylenediamine complex; Cupriethylene diamine; Ethane, 1,2-diamino-, copper; Komeen; Koplex aquatic herbicide

CAS Registry Number: 13426-91-0

HSD B Number: 2767

RTECS Number: KH8660000

UN/NA & ERG Number: UN1761/154

Regulatory Authority and Advisory Information

Hazard Alert: powerful reducing agent, Environmental hazard.

Clean Water Act: Toxic Pollutant (Section 401.15) as copper and compounds

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 6010 (60); 7210 (200) Note: All species in the ground water that contain copper are included

EPCRA (Section 313): Includes any unique chemical substance that contains copper as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%; NPRI; CEPA Priority Substance List, Ocean dumping prohibited.

Description: Cupriethylenediamine is a purple liquid (may contain red or Blue sediment), with an ammoniacal odor. Also described as a fishy odor. Molecular weight = 506.91; boiling point = 100°C. Reacts with water.

Potential Exposure: Cupriethylenediamine is used to dissolve cellulose products to give a cuprammonium-type solution.

Incompatibilities: Violent reaction with water. A powerful reducing agent. Violent reaction with oxidizers, organic materials; and many other substances. Forms unstable peroxides under normal conditions of temperature and storage. Dissolves wood, cotton and other cellulosic material.

Permissible Exposure Limits in Air

NIOSH IDLH = 100 mg[Cu]/m^3 (dust & mist)

OSHA PEL: 1 mg[Cu]/m^3 (dust & mist) TWA; 0.1 milligram per cubic meter (fume) TWA

NIOSH: 1 mg[Cu]/m^3 (dust & mist) TWA; 0.1 milligram per cubic meter (fume) TWA

ACGIH TLV[1]: 1 mg[Cu]/m^3 (dust & mist) TWA; 0.2 milligram per cubic meter (fume) TWA

Determination in Air: Use NIOSH Analytical Methods (dusts and mist) #7029, #7300, #7301, #7303, #9102 and OSHA Analytical Methods ID-121, ID-125G

Permissible Concentration in Water: The permissible concentration of total recoverable copper in water to protect freshwater aquatic life is 5.6 μg[Cu]/L as a 24-hour average. The log of this concentration should not exceed the numerical value of log [0.94 In (hardness)-1.23]. The corresponding value to protect saltwater aquatic life is 4.0 μg [Cu]/L as a 24-hour average, and should not exceed 23 μg [Cu]/L at any time. Federal Drinking Water Guidelines: Action Level = 1300 μg[Cu]/L; EPA = 1000 μg[Cu]/L; State Drinking Water Guidelines: Arizona 1300 μg[Cu]/L; Kansas 1000 μg/L, and Minnesota 1300 μg/L[61].

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short-Term Exposure: Cupriethylene diamine is a corrosive chemical that can cause severe irritation and burns of the skin and eyes on contact. Exposure to Cupriethylene diamine can irritate the throat and air passages. May cause asthma-like symptoms with wheezing, cough, and tightness in the chest.

Long-Term Exposure: Repeated exposure can cause thickening of the skin or a green color to form on the skin and hair. Repeated exposure can cause shrinking (atrophy) of the inner lining of the nose and may cause sores in the nose and watery discharge. Excessive buildup of copper can cause liver damage.

Points of Attack: Skin, lungs, liver.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Urine Copper test. Liver function tests.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of Exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that Medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear solvent-resistant gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Copper dusts and mists: 5 milligram per cubic meter*: Qm (APF = 25) (any quarter-mask respirator). *10 milligram per cubic meter:* Any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100; or Sa (APF = 10) (any supplied-air respirator). *25 milligram per cubic meter:* Sa: Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); PaprHie (APF = 25) (any powered, APR with a high-efficiency particulate filter). *50 milligram per cubic meter*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or PaprTHie (APF = 50) (any powered, APR with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *100 milligram per cubic meter:* SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd, Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: (1) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. (2) Color code—Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from incompatible materials listed above. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN1761 Cupriethylene diamine solution, Hazard class: 8; Labels: 8-Corrosive material, 6.1-Poisonous materials.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Cupriethylene diamine may burn, but does not readily ignite. Use dry chemical, carbon dioxide; or foam extinguishers. Thermal decomposition products may include nitrous oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (2).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Cupriethylenediamine, Trenton, NJ (July 2002).

United States Environmental Protection Agency, Ambient Water Quality Criteria Document: Copper, p.B-14 (440/5-80-036), Washington, DC, 1980.

United States Environmental Protection Agency; Drinking Water Criteria Document for Copper, p.I-2 (EPA-600/X-84-190-1), Washington, DC, 1985.

United States Environmental Protection Agency, Recognition and Management of Pesticide Poisoning, 5th edition, Chapter 15, p. 145—147, Copper Compounds Washington, DC, 2009.

Cuprous Thiocyanate C:1565

Formula: CuSCN; CcuNS; CHNS · Cu

Synonyms: Bardike; Copper(I) thiocyanate; Cuprous sulfocyanate; Cuprous sulfocyanide; Micron; OSP 3506-35; Superyacht; Tri-Lux

CAS Registry Number: 1111-67-7

RTECS Number: GL8955000

UN/NA & ERG Number: UN3439/151; UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 284-183-1 [*Annex I Index No.:* 615-032-00-6]

Regulatory Authority and Advisory Information

Hazard Alert: Environmental hazard.

California EPA AB2588-Air Toxics “Hot Spots” Chemicals (CAL) (as copper compounds)

The “Director’s List” (CAL/OSHA) (as copper compounds)

RCRA Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 6010(60); 7210(200) Note: All species in the ground water that contain copper are included

California EPA AB2588-Air Toxics “Hot Spots” Chemicals (CAL)

CAL Air Resources Board/AB 1807 Toxic Air Contaminants

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Clean Water Act: Toxic Pollutant (Section 401.15) as copper and compounds; Section 307 Priority Pollutants as cyanide, total; Toxic Pollutant (Section 401.15)

United States National Primary Drinking Water Regulations: MCLG = 1.3 mg[Cu]/L; MCL = TT action Level: 1.3 mg[Cu]/L. Copper is regulated by a Treatment Technique (TT) that requires systems to control the corrosiveness of their water. If more than 10% of tap water samples exceed the action level, water systems must take additional steps; SMCL = 1 mg[Cu]/L as Copper.

EPA ADI:1.3 mg[Cu]/L. As copper.

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P030 as cyanides Soluble salts and complexes, n.o.s.

RCRA Section 261 Hazardous Constituents

RCRA Universal Treatment Standards: Wastewater (mg/L), 1.2 (total); 0.86 (amenable); Nonwastewater (mg/kg), 590 (total); 30 (amenable)

RCRA Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 9010(40)

EPC RA Section 304 RQ: CE RCLA, 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%

United States DOT Regulated marine pollutant (49CFR172.101, Appendix B) as cyanides, mixtures or solutions

Canada, WHMIS, Ingredients Disclosure List (cyanide compounds, inorganic, n.o.s)

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: Xn, N; risk phrases: R20/21/22; R32; R50/53; safety phrases: S13; S60; S41; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: White to yellowish powder. Practically insoluble in water. Molecular weight = 121.64. Specific gravity (H_2O:1) = 2.84 @ 20°C. Low solubility in water.

Potential Exposure: Used as a microbiocide and algaecide in antifouling paints. Used as a laboratory chemical and for making other chemicals. Some formulations may be designated Restricted Use Pesticide (RUP).

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air:

The NIOSH[2] IDLH level = 25 milligram per cubic meter.

NIOSH REL: *Nitriles:* 2 ppm, Ceiling Concentration, not to be exceeded in any 15-minute work period.

Determination in Air: Use NIOSH Analytical Method #7904; # 6010, cyanides. Use NIOSH Analytical Methods (dusts and mist) #7029, #7300, #7301, #7303, #9102 and OSHA Analytical Methods ID-121, ID-125G.

Permissible Concentration in Water: United States National Primary Drinking Water Regulations: MCLG = 1.3 mg[Cu]/L; MCL = TT action Level: 1.3 mg [Cu]/L. Copper is regulated by a Treatment Technique (TT) that requires systems to control the corrosiveness of their water. If more than 10% of tap water samples exceed the action level, water systems must take additional steps; SMCL = 1 mg[Cu]/L as Copper. Federal Drinking Water Standards: EPA 1300 μg[Cu]/L; Federal Drinking Water Guidelines: EPA 1000 μg[Cu]/L; State Drinking Water Guidelines: Arizona 1300 μg[Cu]/L. Safe Drinking Water Act (47FR 9352): MCL, 0.01 mg/L; MCLG, 0.01 mg/L. Because nitriles do not release cyanide ions, they are generally less toxic.

Determination in Water: Total copper may be determined by digestion followed by AA or by colorimetry (using neocuproine) or by ICP Optical Emission Spectrometry. Dissolved Copper may be determined by 0.45 μ filtration followed by the preceding methods.

Routes of Entry: Inhalation, skin absorption, ingestion

Harmful Effects and Symptoms

Short-Term Exposure: Highly toxic, may be fatal if inhaled, swallowed or absorbed through skin. Avoid any skin contact or eye. Effects of contact or inhalation may be delayed. Short-term exposure to copper causes gastrointestinal distress.

Long-Term Exposure: Long-term exposure to copper causes liver and/or kidney damage.

Points of Attack: Liver, kidneys, gastrointestinal system.

Medical Surveillance: Anyone having hereditary Wilson's disease should avoid contact with the material. These persons are born with an abnormally high level of copper in their system and exposure may increase levels of copper, causing overdose, liver problems which can be fatal. People with Wilson's Disease should consult their personal doctor to determine if the amount of copper in their water exceeds 1.3 mg[Cu]/L.

Personal Protective Methods: Wear positive pressure SCBA. Wear chemical protective clothing that is specifically recommended by the manufacturer. It may provide little or no thermal protection. Structural firefighters' protective clothing provides limited protection in fire situations ONLY; it is not effective in spill situations where direct contact with the substance is possible.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method* if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed.

Respirator Selection: Wherever and whenever workplace conditions warrant respirator use, a respiratory protection program must be followed that meets one or more of the following requirements: OSHA's 29 CFR 1910.134, ANSI Z88.2, or European Standard EN149. NIOSH (*as cyanides*): *25 milligram per cubic meter*: Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd, Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern and having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Shipping: UN3439 Nitriles, solid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Nitriles spill

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United

States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).
First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.1/0.2
Large spills (From a large package or from many small packages)
First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.3/0.5
Night 0.5/0.8
Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of copper, sulfur, and cyanides. Noncombustible, substance itself does not burn but may decompose upon heating to produce corrosive and/or toxic fumes. Containers may explode when heated. Runoff from fire control or dilution water may be corrosive and/or toxic and may cause pollution. Runoff may pollute waterways. If tank, rail car, or tank truck is involved in a fire, ISOLATE for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. Small Fire: Use dry chemical, CO_2, or water spray. *Large Fire*: Water spray, fog, or regular foam. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal; do not scatter the material. Use water spray or fog; do not use straight streams. *Fire involving Tanks or Car/Trailer Loads:* Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Do not get water inside containers. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. *Always* stay away from tanks engulfed in fire. For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn. *Do not* get water inside containers.

Disposal Method Suggested: Copper-containing soluble wastes can be concentrated through the use of ion exchange, reverse osmosis, or evaporators to the point where copper can be electrolytically removed and sent to a reclaiming firm. If recovery is not feasible, the copper can be precipitated through the use of caustics and the sludge deposited in a chemical waste landfill. Copper-containing wastes can be concentrated to the point where copper can be electrolytically removed and reclaimed. If recovery is not feasible, the copper can be precipitated by alkali; the cyanide destroyed by alkaline oxidation yielding a sludge which can be sent to a chemical waste landfill[22]. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (204); (100).

United States Environmental Protection Agency, Cyanides: Ambient Water Quality Criteria, Washington, DC (1980) (2).

United States Environmental Protection Agency, Reviews of the Environmental Effects of Pollutants; V: Cyanide, Report No. EPA-600/1-78-027, Washington, DC (1978).

United States Environmental Protection Agency, Cyanides, Health and Environmental Effects Profile No. 56, Office of Solid Waste, Washington, DC (April 30, 1980).

United States Public Health Service, "ToxFAQs for Cyanide," Atlanta, Georgia, Agency for Toxic Substances and Disease Registry (September 1997). http://www.atsdr.cdc.gov/tfacts8.html.

United States Environmental Protection Agency, Ambient Water Quality Criteria Document: Copper, p.B-14 (440/5-80-036), Washington, DC, 1980.

United States Environmental Protection Agency; Drinking Water Criteria Document for Copper, p.I-2 (EPA-600/X-84-190-1), Washington, DC, 1985.

United States Environmental Protection Agency, Recognition and Management of Pesticide Poisoning, 5th edition, Chapter 15, p. 145−147, Copper Compounds Washington, DC, 2009.

Cyanamide C:1570

Formula: CH_2N_2; H_2NCN
Synonyms: Amidocyanogen; Carbamonitrile; Carbimide; Carbodiimide; Cyanogenamide; Cyanogen nitride
CAS Registry Number: 420-04-2; *(alt.)* 65931-45-5
HSDB Number: 1550
RTECS Number: GS5950000
UN/NA & ERG Number: UN3276 (nitriles, toxic, n.o.s.)/151 (P)
EC Number: 206-992-3 [*Annex I Index No.:* 615-013-00-2]

Regulatory Authority and Advisory Information

Hazard Alert: Exposure can be lethal, Combustible, Polymerization hazard, Corrosive, Suspected of causing genetic defects, Environmental hazard, Drug. Listed for Tier 1 screening as an endocrine disruptor[88].

United States Environmental Protection Agency, FIFRA, 1998 Status of Pesticides: Active registration

Hazardous to aquatic life or environment, with possible long-lasting effects[194]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, C, N; risk phrases: R19; R21; R25; R34; R36/38; R51/53; R62; safety phrases: S1/2; S3; S22; S36/37; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

As cyanide compounds:

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants as cyanide, total

EPCRA (Section 313): X+CN-where X = H+ or any other group where a formal dissociation may occur. For example, KCN or $Ca(CN)_2$. Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as cyanide mixtures, cyanide solutions

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects[194]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, N; risk phrases: R27/28; R50/53; R62; safety phrases: S13; S28; S29/35; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Cyanamide is a combustible crystalline solid, but it is usually found as a 25% liquid solution. Molecular weight = 42.05; specific gravity (H_2O:1) = 1.28; boiling point = decomposes @ 260°C; freezing/melting point = 45°C; flash point = 141°C. Hazard identification (based on NFPA-704 M Rating System): Health 4, flammability 1, reactivity 3. Highly soluble in water; solubility = 78% @ 15°C.

Potential Exposure: Cyanamide may be melted to give a dimer, dicyandiamide or cyanoguanidine. At higher temperatures it gives the trimer, melamine; a raw material for melamine-form aldehyde resins.

Incompatibilities: Cyanamide may polymerize at temperatures above 122°C, or on evaporation of aqueous solutions. Reacts with acids, strong oxidants, strong reducing agents such as hydrides and water, causing explosion and toxic hazard. Attacks various metals. Decomposes when heated above 49°C, on contact with acids, bases, 1,2-phenylene diamine salts; and moisture; producing toxic fumes including nitrogen oxides and cyanides. Nitriles may polymerize in the presence of metals and some metal compounds. They are incompatible with acids; mixing nitriles with strong oxidizing acids can lead to extremely violent reactions. Nitriles are generally incompatible with other oxidizing agents such as peroxides and epoxides. The combination of bases and nitriles can produce hydrogen cyanide. Nitriles are hydrolyzed in both aqueous acid and base to give carboxylic acids (or salts of carboxylic acids). These reactions generate heat. Peroxides convert nitriles to amides. Nitriles can react vigorously with reducing agents. Acetonitrile and propionitrile are soluble in water, but nitriles higher than propionitrile have low aqueous solubility. They are also insoluble in aqueous acids[101].

Permissible Exposure Limits in Air

OSHA PEL: None

NIOSH REL: 2 milligram per cubic meter TWA; NIOSH REL: *Nitriles:* 2 ppm, Ceiling Concentration, not to be exceeded in any 15-minute work period.

ACGIH TLV[1]: 2 milligram per cubic meter TWA

PAC Ver. 29[138]

PAC-1: 6 milligram per cubic meter

PAC-2: 66 milligram per cubic meter

PAC-3: 400 milligram per cubic meter

DFG MAK: 1 milligram per cubic meter, inhalable fraction TWA; Peak Limitation Category II(2) [skin] Danger of skin sensitization; Pregnancy Risk Group C

Australia: TWA 2 milligram per cubic meter, 1993; Austria: MAK 2 milligram per cubic meter [skin], 1999; Belgium: TWA 2 milligram per cubic meter, 1993; Denmark: TWA 2 milligram per cubic meter, 1999; Finland: TWA 2 milligram per cubic meter; STEL 4 milligram per cubic meter [skin], 1999; France: VME 2 milligram per cubic meter, 1999; Norway: TWA 2 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 2 milligram per cubic meter, 2003; Russia: STEL 0.5 milligram per cubic meter [skin], 1993; Switzerland: MAK-W 2 milligram per cubic meter, 1999; United Kingdom: TWA 2 milligram per cubic meter, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 2 milligram per cubic meter. Russia[43] has limits for ambient air in residential areas of 0.01 milligram per cubic meter on an average daily basis. Several states have set guidelines or standards for Cyanamide in ambient air[60] ranging from 6.7 μ/m^3 (New York) to 20.0 μ/m^3 (Florida and North Dakota) to 35 μ/m^3 (Virginia) to 40 μ/m^3 (Connecticut) to 50 μ/m^3 (South Carolina).

Determination in Air: Filter; none; Gravimetric; NIOSH Analytical Method (IV) #0500, Particulates NOR, total dust. See NIOSH Criteria Document 212 *Nitriles*.

Permissible Concentration in Water: Because nitriles do not release cyanide ions, they are generally less toxic.

Routes of Entry: Inhalation, ingestion; skin absorption

Harmful Effects and Symptoms

Short-Term Exposure: Cyanamide is caustic and severely irritates the eyes, skin, and respiratory tract; and may affect the liver. Ingestion or inhalation may cause transitory intense redness of the face, headache, vertigo, increased respiration; tachycardia and hypotensions. The adverse effects of cyanamide are potentiated by the ingestion of alcohol (beer, wine, or liquor) within 1–2 days before or after exposure. Cyanamide is a highly reactive chemical and is a dangerous explosion hazard.

Long-Term Exposure: Repeated or prolonged contact may cause skin sensitization and allergy. Exposure may cause liver and nervous system damage. See NIOSH Criteria Document 212 *Nitriles*.

Points of Attack: Liver, skin.

Medical Surveillance: If overexposure occurs or if illness is suspected, the following are recommended: liver function tests. Exam of the nervous system. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. When working with liquids, wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. When working with powders or dusts, wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See NIOSH Criteria Document 212 *Nitriles*.

Respirator Selection: Where there is potential exists for exposures over 2 milligram per cubic meter, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: (1) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. (2) Color code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Oxidizers should be isolated from acids, metals, organic materials, and ammonium nitrate. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool well-ventilated area away from acids or acid fumes. Cyanamide can be stored in glass containers if it is stabilized with phosphoric, acetic, sulfuric, or boric acid; it attacks iron and steel, copper and brass. Sources of ignition, such as smoking and open flames are prohibited where cyanamide is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever cyanamide is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN3276 Nitriles, liquid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required, Potential Inhalation Hazard (Special Provision 5).

Spill Handling: Nitriles spill

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.3/0.5
Night 0.5/0.8

Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Ventilate area of spill or leak. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. Keep cyanamide out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase

with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)
First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)
First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.3/0.5
Night 0.5/0.8

Fire Extinguishing: Cyanamide may burn, but does not readily ignite. Poisonous gas is produced in fire, including nitrogen oxides and cyanides. Use dry chemical or CO_2 extinguishers. Containers may explode in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Add excess alkaline calcium hypochlorite with agitation. Flush to sewer after 24 hours. Cyanamide can also be destroyed in an incinerator equipped with afterburner and scrubber.

References

(31); (173); (101); (138); (80); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 8, No. 5, 65−68 (1988).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet: Cyanamide*, Trenton, NJ (February 2001).

Cyanazine C:1580

Formula: $C_9H_{13}ClN_6$

Synonyms: Bladex; Bladex 80WP; 2-Chloro-4-(1-cyano-1-methylethylamino)-6-ethylamino-1,3,5-triazine; 2-Chloro-4-ethylamino-6-(1-cyano-1-methyl)ethylamino-*s*-triazine; 2-([4-Chloro-6-(ethylamino)-*s*-triazin-2-yl]amino)-2-methylpropanenitrile; 2-([4-Chloro-6-(ethylamino)-1,3,5-triazin-2-yl]amino)-2-methylpropanenitrile; 2-([4-Chloro-6-(ethylamino)-*s*-triazin-2-yl]amino)-2-methylpropionitrile; 2-(4-Chloro-6-ethylamino-1,3,5-triazin-2-ylamino)-2-methylpropionitrile; Cyanazine triazine pesticide; [(1-Cyano-1-methylethyl) amino]-6-(ethylamino)-*s*-triazine; DW 3418; EPA pesticide chemical code 100101; Fortrol; Payze; Propanenitrile, 2-([4-chloro-6-(ethylamino)-*s*-triazin-2-yl]amino)-2-methyl-; Propanenitrile, 2-([4-Chloro-6-(ethylamino)-1,3,5-triazin-2-yl] amino)-2-methyl-; SD 15418; *s*-Triazine, 2-chloro-4-ethylamino-6-(1-cyano-1-methyl)ethylamino-; WL 19805

CAS Registry Number: 21725-46-2

HSDB Number: 6842

RTECS Number: UG1490000

UN/NA & ERG Number: UN2763 (Triazine pesticides, solid, toxic)/151; UN3439 (Nitriles, solid)/151

EC Number: 244-544-9 [*Annex I Index No.:* 613-013-00-7]

Regulatory Authority and Advisory Information

California Proposition 65 Chemical[102]: Cancer; Developmental/Reproductive toxin 4/1/1990.

Hazard Alert: Poison, Combustible, Possible risk of forming tumors, Reproductive toxin: possible risk of gene damage/impaired fertility; Suspected reprotoxic hazard, Environmental hazard.

Safe Drinking Water Act (47FR 9352): Priority List (55 FR 1470)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants as cyanide, total

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P030 as cyanides soluble salts and complexes, n.o.s.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents. as cyanides, soluble salts, and complexes, n.o.s.

EPCRA (Section 313): X + CN-where X = H + or any other group where a formal dissociation may occur. For example, KCN or Ca(CN)2. Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as cyanide mixtures, cyanide solutions or cyanides, inorganic, n.o.s.

Canada, Drinking Water Quality, IMAC = 0.01 mg/L.

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xn, N; risk phrases: R22; R50/53; R62; R63; safety phrases: S2; S37; S41; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)]

Description: Cyanazine is an off-white to tan crystalline solid. Molecular weight = 240.73; freezing/melting point = 167−169°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 1, reactivity 0. Soluble in water. Physical properties may be altered by carrier solvents used in commercial formulations.

Potential Exposure: A potential danger to those involved in the manufacture, formulation, and application of this herbicide used for preemergence or postemergence weed control in field corn.

Incompatibilities: Cyanazine decomposes in heat producing very toxic fumes and gases of hydrogen cyanide, hydrogen chloride; ethyl chloride; ammonia; acetone; and ethylene. Nitriles may polymerize in the presence of metals and some metal compounds. They are incompatible with acids; mixing nitriles with strong oxidizing acids can lead to extremely violent reactions. Nitriles are generally incompatible with other oxidizing agents such as peroxides and epoxides. The combination of bases and nitriles can produce hydrogen cyanide. Nitriles are hydrolyzed in both aqueous acid and base to give carboxylic acids (or salts of carboxylic acids). These reactions generate heat. Peroxides convert nitriles to amides. Nitriles can react vigorously with reducing agents. Acetonitrile and propionitrile are Soluble in water, but nitriles higher than propionitrile have low aqueous solubility. They are also insoluble in aqueous acids[101]. Attacks metals in the presence of heat and moisture.

Permissible Exposure Limits in Air

NIOSH IDLH = 25 mg[CN]/m^3

NIOSH REL: (nitriles) 2 ppm, Ceiling Concentration, not to be exceeded in any 15-minute work period.

No standards or PAC available.

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 200 μg[CN]/L; State Drinking Water Standards: California 150 μg[CN]/L; State Drinking Water Guidelines: Arizona 220 μg[CN]/L; Maine. 140 μg [CN]/L; Minnesota 100 μg[CN]/L. United States Army field drinking-water standards for cyanide: 2 mg[CN]/L assuming a water consumption of 15 L/day and 6 mg[CN]/L assuming a water consumption of 5 L/day. United States Army field drinking-water standards for cyanide, long-term consumption 0.5 mg[CN]/L; Short-term consumption; Raw water constituents (maximum) 20 mg[CN]/L.

Determination in Water: High-performance liquid chromatography is applicable to the determination of cyanazine in water according to EPA.

Routes of Entry: Inhalation, ingestion, absorption through the unbroken skin.

Harmful Effects and Symptoms

Short-Term Exposure: This chemical can be absorbed through the skin, thereby increasing exposure. Exposure can irritate the nose, throat, and bronchial tubes. Contact can irritate the skin or eyes. Overexposure can cause weakness, nausea and difficulty breathing. LD$_{50}$ (oral-rat) = 149 mg/kg (moderately toxic). Toxicological properties may be altered by carrier solvents used in commercial formulations.

Long-Term Exposure: Long-term effects are unknown. Related chemicals in the triazin chemical groups can cause liver damage; reduce thyroid function and/or cause skin allergy. May cause reproductive toxicity in humans. See NIOSH Criteria Document 212 *Nitriles*.

Medical Surveillance: Liver function tests. Thyroid function tests. Evaluation by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See NIOSH Criteria Document 212 *Nitriles*.

Respirator Selection: Engineering control must be effective to ensure that exposure to cyanazine does not occur. Where there is potential exists for exposures to cyanazine use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece respirator with a pesticide cartridge. Increased protection is obtained from full facepiece APRs.

Where there is potential for high exposures exists, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air-respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with cyanazine all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from heat. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: UN2763 Triazine pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN3439 Nitriles, solid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling:

Nitriles spill

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.3/0.5
Night 0.5/0.8

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Cyanazine may burn, but does not readily ignite. Use dry chemical, CO_2, water spray; or foam extinguishers. Thermal decomposition products may include hydrogen cyanide, hydrogen chloride; ethyl chloride; ammonia, acetone, and ethylene. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(102); (31); (173); (101); (138); (80); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 3, No. 1, 47−50, New York, Van Nostrand Reinhold Co. (1983).

United States Environmental Protection Agency, Chemical Hazard Information Profile: *Cyanazine*, Washington, DC, Office of Drinking Water (August 1987).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet: Bladex*, Trenton, NJ (October 2000).

Cyanides C:1590

Formula: CKN, CNNa, KCN (see P:0910), NaCN (see S:0450)

Synonyms: Carbon nitride ion (CN); Cianuro (Spanish); Cyanide anion; Cyanure (French); Isocyanide

CAS Registry Number: 57-12-5 (cyanide ion); 151-50-8 (potassium cyanide); 592-01-8 (calcium cyanide); 506-78-5 (iodine cyanide)

RTECS Number: GS7175000 (cyanide ion); TS8750000 (potassium cyanide); VZ7520000 (sodium cyanide); NN1750000 (iodine cyanide); EW0700000 (calcium cyanide)

UN/NA & ERG Number: UN1588 (Cyanides, inorganic, solid, n.o.s.)/157; UN1680 (potassium cyanide)/157; UN1689 (sodium cyanide)/157; UN1575 (calcium cyanide)/157

Other cyanide compounds:

UN1051/117 Hydrogen cyanide, anhydrous, stabilized
UN1565/157 Barium cyanide
UN1694/159 Bromobenzyl cyanides
UN1575/157 Calcium cyanide
UN1587/151 Copper cyanide
UN1613/154 Hydrocyanic acid, aqueous solution, with <5% Hydrogen cyanide
UN1613/154 Hydrogen cyanide, aqueous solution, with not >20% Hydrogen cyanide
UN1614/152 Hydrogen cyanide, stabilized (absorbed)
UN1620/151 Lead cyanide
UN1626/157 Mercuric potassium cyanide
UN1636/154 Mercuric cyanide
UN1642/151 Mercuric oxycyanide
UN1648/127 Methyl cyanide
UN1653/151 Nickel cyanide
UN1679/157 Potassium cuprocyanide
Potassium cyanide see P:0910
UN1684/151 Silver cyanide
UN2316/157 Sodium cuprocyanide, solid
UN2317/157 Sodium cuprocyanide, solution

UN1713/151 Zinc cyanide

EC Number: 006-007-00-5

Regulatory Authority and Advisory Information

Carcinogenicity: EPA (cyanide, free): Not Classifiable as to human carcinogenicity.

Hazard Alert: Poison, Exposure can be lethal, Water reactive, Environmental hazard.

Banned or Severely Restricted (in agriculture) (Germany) (in Consumer Products) (US)[13]

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, N; risk phrases: R2627/28; R50/53; safety phrases: S13; S28; S29/35; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Cyanide compounds:

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

United States National Primary Drinking Water Regulations: MCLG = 0.2 mg$[CN^-]$/L; MCL = 0.2 mg $[CN^-]$/L as cyanide.

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants as cyanide, total

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P030 as cyanides Soluble salts and complexes, n.o.s.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents. as cyanides, soluble salts, and complexes, n.o.s.

EPCRA (Section 313): X + CN-where X = H + or any other group where a formal dissociation may occur. For example, KCN or Ca(CN)2. Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as cyanide mixtures, cyanide solutions or cyanides, inorganic, n.o.s.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%; NPRI; CEPA Priority Substance List, Ocean dumping prohibited

Cyanides, soluble salts and compounds:

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

United States National Primary Drinking Water Regulations: MCLG = 0.2 mg$[CN^-]$/L; MCL = 0.2 mg $[CN^-]$/L as cyanide.

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants as cyanide, total; Toxic Pollutant (Section 401.15)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P030

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR 268.48; 61F R15654, Universal Treatment Standards: Wastewater (mg/L), 1.2, total dust; 0.86 (amenable); Nonwastewater (mg/kg), 590, total dust; 30 (amenable)

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 9010 (40)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, append ix B) as cyanides, inorganic, n.o.s.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%; NPRI; CEPA Priority Substance List, Ocean dumping prohibited.

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water. Highly water *polluting (potassium cyanide and calcium cyanide*)

Description: KCN and NaCN are white crystalline solids with a faint almond odor. Sodium cyanide also has a slight odor of hydrocyanic acid when damp. *KCN:* boiling point = 1625°C; freezing/melting point = 634°C. *NaCN:* boiling point = 1496°C; freezing/melting point = 564°C. NFPA 704 M Hazard identification (KCN and NaCN): Health 3, flammability 0 [(4) gas], reactivity 1[(2) gas]₩. Soluble in water; slow decomposition releases highly toxic and flammable hydrogen cyanide gas.

Potential Exposure: *Sodium and potassium cyanides* are used primarily in the extraction of ores, electroplating, metal treatment, and various manufacturing processes. *Iodine cyanide:* Used generally for destroying all lower forms of life; in taxidermy to preserve insects, etc.

Incompatibilities: Soluble in water; slow decomposition releases highly toxic and flammable hydrogen cyanide gas. The aqueous solution of potassium and sodium cyanide are highly corrosive, and strong bases. KCN and NaCN react violently with acids, releasing highly flammable hydrogen cyanide. Potassium and sodium cyanide are incompatible with strong oxidizers (such as acids, acid salts; chlorates, nitrates), organic anhydrides; isocyanates, alkylene oxides; epichlorohydrin, aldehydes, alcohols, glycols, phenols, cresols, caprolactum. Attacks aluminum, copper, zinc in the presence of moisture. KCN and NaCN absorb moisture from the air forming a corrosive syrup.

Permissible Exposure Limits in Air

NIOSH IDLH = 25 mg[CN]/m^3

57-12-5 (cyanide ion)

PAC Ver. 29[138]

PAC-1: 6 mg[CN]/m^3

PAC-2: 8.3 mg[CN]/m^3

PAC-3: 50 mg[CN]/m^3

DFG MAK: 2 mg[CN]/m^3, inhalable fraction TWA; Peak Limitation Category II(1) [skin]; Pregnancy Risk Group: C

Australia: TWA 5 milligram per cubic meter [skin], 1993; Austria: MAK 5 mg[CN]/m^3 [skin], 1999; Denmark: TWA

5 milligram per cubic meter [skin], 1999; France: VME 5 mg[C N]/m^3 [skin], 1999; Poland: TWA 0.3 mg[CN]/m^3, ceiling 10 mg[CN]/m^3, 1999; Switzerland: MAK-W 5 milligram per cubic meter, KZG-W 10 milligram per cubic meter [skin], 1999; United Kingdom: TWA 5 mg[CN]/m^3 [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Ceiling Concentration 5 milligram per cubic meter [skin]. Russia[43] has set MAC values for ambient air in residential areas of 0.009 milligram per cubic meter on a momentary basis and 0.004 milligram per cubic meter on an average daily basis. Several states have set guidelines or standards for cyanides in ambient air[60] ranging from 16.7 μ/m^3 (New York) to 50.0 μ/m^3 (Florida and North Dakota) to 80.0 μ/m^3 (Virginia) to 100 μ/m^3 (Connecticut and South Dakota) to 125 μ/m^3 (South Carolina) to 119.0 μ/m^3 (Nevada).

151-50-8 (potassium cyanide)

PAC-1: $\mathbf{5.3}_\mathbf{A}$ milligram per cubic meter

PAC-2: $\mathbf{19}_\mathbf{A}$ milligram per cubic meter

PAC-3: $\mathbf{40}_\mathbf{A}$ milligram per cubic meter

592-01-8 (calcium cyanide)

PAC-1: $\mathbf{3.8}_\mathbf{A}$ milligram per cubic meter

PAC-2: $\mathbf{13}_\mathbf{A}$ milligram per cubic meter

PAC-3: $\mathbf{28}_\mathbf{A}$ milligram per cubic meter

*AEGLs (Acute Emergency Guideline Levels) are marked with a sub script "**A**" and correspond to 60-minute values.

As cyanides

OSHA PEL: 5 mg[CN]/m^3 TWA

NIOSH REL: 4.7 ppm/5 mg[CN]/m^3 [10 minutes] Ceiling Concentration

ACGIH TLV[1]: 5 mg[CN]/m^3 [skin] Ceiling Concentration (1993−1994)

Determination in Air: Use NIOSH Analytical Method (IV) #7904, Cyanides. See also Method #6010, Hydrogen Cyanide[18].

Permissible Concentration in Water: Safe Drinking Water Act (47FR 9352): MCL, 0.2 mg/L; MCLG, 0.2 mg/L. Federal Drinking Water Guidelines: EPA 200 μg[CN]/L; State Drinking Water Standards: California 150 μg[CN]/L; State Drinking Water Guidelines: Arizona 220 μg[CN]/L; Maine. 140 μg[CN]/L; Minnesota 100 μg[CN]/L. United States Army field drinking-water standards for cyanide: 2 mg[CN]/L assuming a water consumption of 15 L/day and 6 mg[CN]/L assuming a water consumption of 5 L/day. The United States Environmental Protection Agency[49]. has determined a no-observed-adverse-effect-level (NOAEL) of 10.8 mg/kg/day which yields a lifetime Health advisory: of 154 μg/L. States which have set guidelines for cyanides in drinking water[61] include Arizona @ 160 μg/L and Kansas @ 220 μg/L.

Determination in Water: Distillation followed by silver nitrate titration or colorimetric analysis using pyridine pyrazolone (or barbituric acid).

Routes of Entry: Potassium cyanide can be absorbed through the skin; inhalation, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Potassium and sodium cyanide are corrosive to the eyes, skin, and the respiratory tract. Contact can cause eye and skin burns; may cause permanent damage to the eyes. Corrosive if swallowed. These substances may affect the central nervous system. Symptoms include headaches, confusion, nausea, pounding heart, weakness, unconsciousness, and death.

Long-Term Exposure: Repeated or prolonged contact with potassium or sodium cyanide may cause thyroid gland enlargement. May cause nosebleed and sores in the nose; changes in blood cell count. May cause central nervous system damage with headache, dizziness, confusion, nausea, vomiting, pounding heart; weakness in the arms and legs; unconsciousness and death. May affect liver and kidney function.

Points of Attack: Liver, kidneys, skin, cardiovascular system; central nervous system; thyroid.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Urine thiocyanate levels. Blood cyanide levels. CBC. Evaluation of thyroid function. Liver function tests. Kidney function tests. Central nervous system tests. EKG.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy. *Note:* Use amyl nitrate capsules if symptoms develop. All area employees should be trained regularly in emergency measures for cyanide poisoning and in CPR. A cyanide antidote kit should be kept in the immediate work area and MUST be rapidly available. Kit ingredients should be replaced every 1−2 years to ensure freshness. Persons trained in the use of this kit; oxygen use, and CPR must be quickly available. *Note to Physician:* Consider the administration of Ketocya nor (cobalt edetate) in dose of 300−600 mg i.v. initially. If recovery does not occur quickly (in 1−2 minutes) give a second dose of 300 mg, followed by i.v. glucose 5%. Alternatively, administer sodium nitrite (3%) in an i.v. dose of 10 mL over 3 minutes.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable

probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid, unless full facepiece respiratory protection is worn. Wear dust-proof goggles and face shield when working with powders or dust, unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *up to 25 milligram per cubic meter:* Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern and having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with cyanides all handlers should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Protect against physical damage. Store in cool dry place. Separate from other storage and protect from acids and oxidizing materials.

Shipping: UN1588 Cyanides, inorganic, solid, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN1935

Cyanides solutions, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Avoid contact with solids, dusts, or solutions. Wear chemical protective suit with SCBA. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. Do not allow this chemical to enter the environment. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include highly toxic and flammable hydrogen cyanide gas and oxides of nitrogen. Reacts with water releasing highly toxic and flammable hydrogen cyanide gas. NO hydrous agents. NO water. NO carbon dioxide. Use dry chemical and foam on surrounding fires. Vapors are heavier than air and may collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform to EPA regulations governing storage, transportation, treatment, and waste disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office. Add strong alkaline hypochlorite and react for 24 hours. Then flush to sewer with large volumes of water[22].

References

(31); (173); (101); (138); (2); (100).

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National Institute for Occupational Safety and Health (NIOSH), "Criteria for a Recommended Standard: Occupational Exposure to Hydrogen Cyanide and Cyanide Salts", NIOSH Document Number 77-108, Cincinnati, OH (1977).

United States Environmental Protection Agency, Reviews of the Environmental Effects of Pollutants; V: Cyanide, Report No. EPA-600/1-78-027, Washington, DC (1978).

United States Environmental Protection Agency, Cyanides, Health and Environmental Effects Profile No. 56, Office of Solid Waste, Washington, DC (April 30, 1980).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 3, No. 6, 56−60 (1983) (Potassium Cyanide).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 3, No. 6, 60−63 (1983) (Sodium Cyanide).

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United States Environmental Protection Agency, Chemical Hazard Information Profile: Potassium Cyanide, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).
United States Environmental Protection Agency, Chemical Hazard Information Profile: Sodium Cyanide, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).
New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Potassium Cyanide, Trenton, NJ (June 1998).
New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Sodium Cyanide, Trenton, NJ (February 2007).

Cyanogen C:1600

Formula: C_2N_2; $(CN)_2$
Synonyms: Carbon nitride; Cyanogene (French); Cyanogen gas; Dicyan; Dicyanogen; Ethanedinitrile; Monocyanogen; Nitriloacetonitrile; Oxalic acid dinitrile; Oxalic nitrile; Oxalonitrile; Oxalyl cyanide; Prussite
CAS Registry Number: 460-19-5
HSDB Number: 2130
RTECS Number: GT1925000
UN/NA & ERG Number: (PIH) UN1026/119
EC Number: 207-306-5 [*Annex I Index No.:* 608-011-00-8]
Regulatory Authority and Advisory Information
Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration); *Theft hazard* 45 (≥11.67% concentration).
Hazard Alert: Poison inhalation hazard: exposure can be lethal, Extremely flammable gas, Highly toxic gas with inadequate warning properties, Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated, Primary irritant (w/o allergic reaction), Environmental hazard.
Clean Air Act: Accidental Release Prevention/Flammable Substances (Section 112 [r], Table 3), TQ = 10,000 lb (4540 kg)
United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P031
RCRA, 40CFR261, Appendix 8 Hazardous Constituents
Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)
United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as cyanides, inorganic, n.o.s.
United States DOT 49CFR172.101, Inhalation Hazardous Chemical
Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%; NPRI; CEPA Priority Substance List, Ocean dumping prohibited.
Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.
Hazard symbols, risk, & safety statements: Hazard symbol: F+, T+, N; risk phrases: R5; R12; R21; R23; R36/37/38; R50/53; safety phrases: S1/2; S9; S16; S23; S33; S38; S41; S45; S60; S61 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)]
Description: Cyanogen is a colorless, flammable, compressed liquefied gas at room temperature. At deadly levels only, it has a pungent, almond-like odor. Molecular weight = 52.04; boiling point = −21°C; Relative density (gas) = 1.82; freezing/melting point = −28°C; vapor pressure = 5.1 atm @ 25°C; relative vapor density (air = 1) = 1.82. Explosive limits: LEL: 6.6%; UEL: 32.0%. Hazard identification (based on NFPA-704 M Rating System): Health 4, flammability 4, reactivity 2 ₩. Soluble in water; solubility = 1%.
**Note:* The irritant properties of cyanogen have been tested using both human male and female subjects, 21−65 years of age. The distinctive bitter almond smell of cyanogen could not be detected at concentrations of 50, 100, and 250 ppm. When exposed to 8 ppm for 6 minutes or 16 ppm for 6−8 minutes, immediate eye and nose irritation occurred.
Potential Exposure: Cyanogen is currently used as an intermediate in organic syntheses; at one time, it was used in poison gas warfare.
Incompatibilities: Chemically unstable in rising temperatures. May form explosive mixture with air. Explosive reaction with strong oxidizers (e.g., dichlorine oxide, fluorine). Forms toxic gases on contact with acids, including hydrogen cyanide. Slowly hydrolyzed in water to form hydrogen cyanide, oxalic acid, and ammonia.
Permissible Exposure Limits in Air
Conversion factor: 1 ppm = 2.13 milligram per cubic meter @ 25°C & 1 atm
OSHA PEL: None
NIOSH REL: 10 ppm/20 milligram per cubic meter TWA; *Nitriles:* 2 ppm, Ceiling Concentration, not to be exceeded in any 15-minute work period.
ACGIH TLV[1]: 5 ppm/10.6 milligram per cubic meter STEL, Ceiling Concentration.
PAC* Ver. 29[138]
PAC-1: **2.0**$_{\mathbf{A}}$ ppm
PAC-2: **8.3**$_{\mathbf{A}}$ ppm
PAC-3: **25**$_{\mathbf{A}}$ ppm
*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript “**A**” and correspond to 60-minute values.
DFG MAK: 5 ppm/11 milligram per cubic meter TWA; Peak Limitation Category II(2) [skin]; Pregnancy Group D
Arab Republic of Egypt: TWA 10 ppm (20 milligram per cubic meter), 1993; Australia: TWA 10 ppm (20 milligram per cubic meter), 1993; Austria: MAK 10 ppm (22 milligram per cubic meter) [skin], 1999; Belgium: TWA

10 ppm (21 milligram per cubic meter), 1993; Denmark: TWA 10 ppm (20 milligram per cubic meter), 1999; Finland: STEL 10 ppm (22 milligram per cubic meter) [skin], 1999; France: VME 2 ppm (4 milligram per cubic meter), VLE 10 ppm (20 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 20 milligram per cubic meter, 2003; Norway: TWA 10 ppm (22 milligram per cubic meter), 1999; Switzerland: MAK-W 10 ppm (22 milligram per cubic meter), KZG-W 50 ppm (110 milligram per cubic meter) [skin], 1999; United Kingdom: TWA 10 ppm (22 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 10 ppm. Several states have set guidelines or standards for Cyanogen in ambient air[60] ranging from 66.7 μ/m^3 (New York) to 200 μ/m^3 (Florida and North Dakota) to 350 μ/m^3 (Virginia) to 400 μ/m^3 (Connecticut) to 476 μ/m^3 (Nevada) to 500 μ/m^3 (South Carolina).

Determination in Air: Use NIOSH Analytical Method #7904; #6010, cyanides.

Permissible Concentration in Water: Because nitriles do not release cyanide ions, they are generally less toxic.

Routes of Entry: Inhalation, passing through the skin; and eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Can be fatal if inhaled. A lacrimator (causing tearing). This chemical can be absorbed through the skin, thereby increasing exposure. Irritates eyes, nose, upper respiratory system. Skin contact with the liquid caused frostbite. Vision loss can occur following a high exposure. Cyanogen hydrolyzes to yield one molecule of hydrogen cyanide and one of cyanate; based on this, the toxic effects of $(CN)_2$ are thought to be comparable to HCN. The cyanide ion when released in the body causes a form of asphyxia by inhibiting many enzymes-especially those concerned with cellular respiration. Although the blood is saturated with oxygen, the tissues are not able to use it. Symptoms appear within a few seconds or minutes of ingesting or breathing vapors. Symptoms include cherry red lips, tachypnea, hypernea, bradycardia, headache, vertigo (an illusion of movement), convulsions, dizziness. The victims experience constriction of the chest, giddiness, confusion, headache, hypernea, palpitation, unconsciousness, convulsions; feeble and rapid respiration; and an extremely weak pulse. Death occurs within a few minutes after a large dose. LD_{50} (rat, inhalation) ≤ 400 ppm.

Long-Term Exposure: Enlargement of the thyroid gland. There is some Evidence that long-term exposure can cause damage to the nervous system. Victims experience loss of appetite; weight loss. See NIOSH Criteria Document 212 *Nitriles*.

Points of Attack: Eyes, respiratory system; central nervous system; cardiovascular system.

Medical Surveillance: Before beginning employment and at regular times after that, the following is recommended: serum and urine thiocyanate levels. If symptoms develop or overexposure is suspected, the following may be useful: exam of the thyroid.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is advised for 24 to 48 hours. If frostbite has occurred, seek medical attention immediately; do NOT rub the affected areas or flush them with water. In order to prevent further tissue damage, do NOT attempt to remove frozen clothing from frostbitten areas. If frostbite has NOT occurred, immediately and thoroughly wash contaminated skin with soap and water.

If cyanide poisoning is suspected: Use amyl nitrate capsules if symptoms develop. All area employees should be trained regularly in emergency measures for cyanide poisoning and in CPR. A cyanide antidote kit should be kept in the immediate work area and must be rapidly available. Kit ingredients should be replaced every 1−2 years to ensure freshness. Persons trained in the use of this kit; oxygen use, and CPR must be quickly available.

Personal Protective Methods: Lower exposure can cause irritation of the eyes, nose, and throat. If these symptoms are noticed, immediately leave the work area. Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. *Clothing:* Avoid skin contact with cyanogen. Wear protective gloves and clothing. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. *Eye Protection:* Wear air-tight gas-proof goggles, unless full facepiece respiratory protection is worn. See NIOSH Criteria Document 212 *Nitriles*.

Respirator Selection: Where there is potential exists for exposures *over 10* ppm; Use a NIOSH/MSHA or European Standard EN149-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA or European Standard EN149-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Poison inhalation chemical (PIH); check oxygen content prior to entering storage area. (1) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. This gas is highly toxic. Even slight exposure to these gasses can cause death. Store outdoors in a secure, restricted area that containing warning signs. This area must be roofed and shaded with the cylinders stored off the ground and separated from all other products assigned to other hazard categories and radiant heat sources on nonwooden floors. If indoors, store in a well-ventilated areas in temperatures not to exceed 50°C.(2) Color code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Prior to working with cyanogen all handlers should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool well-ventilated area away from heat and light. Cyanogen must be stored to avoid contact with fluorine and oxygen, water or steam, acid or acid fumes, since violent reactions occur. Sources of ignition, such as smoking and open flames are prohibited where cyanogen is handled, used, or stored. Outside storage or storage in an area of noncombustible construction, is preferable. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Where cyanogen is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: UN1026 Cyanogen, Hazard Class: 2.3; Labels: 2.3-Poisonous gas, 2.1-Flammable gas, Inhalation Hazard Zone B. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling:

Cyanogen

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.3/0.5

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 1.0/1.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Stop the flow of gas if it can be done safely. If source of leak is a cylinder and the leak cannot be stopped in place, remove leaking cylinder to a safe place in the open air; repair leak or allow cylinder to empty. Keep cyanogen out of confined space, such as a sewer because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of cyanogen as a hazardous waste. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a highly flammable gas; it burns with a purple-tinged flame. Thermal decomposition products may include hydrogen cyanide. This gas is under pressure; containers may rupture and explode when heated. Stop the flow of gas if it can be done safely. *Do not use water.* Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Incineration; oxides, or nitrogen are removed from the effluent gas by scrubbers and/or thermal devices.

References

(31); (173); (101); (138); (2); (100).

National Institute for Occupational Safety and Health (NIOSH), Information Profiles on Potential Occupational Hazards-Single Chemicals: Cyanogen, Report TR 79-607, pp 39−44, Rockville, MD (December 1979).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 2, No. 1, 103−105, New York, Van Nostrand Reinhold Co. (1982).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Cyanogen, Trenton, NJ (January 2000).

Cyanogen Bromide C:1610

Formula: BrCN

Synonyms: Bromine cyanide; Bromocyan; Bromocyanogen; Bromure de cyanogen (French); Bromuro de cianogeno (Spanish); Campilit; Cyanobromide; Cyanogen monobromide

CAS Registry Number: 506-68-3

HSDB Number: 708

RTECS Number: GT2100000

UN/NA & ERG Number: (PIH) UN1889/157

EC Number: 208-051-2

Regulatory Authority and Advisory Information

Hazard Alert: Poison inhalation hazard, Exposure may be lethal, Corrosive, Dangerous water reaction, United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U246

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1000 lb (454 kg)

MARINE POLLUTANT (49CFR, Subchapter 172.10)

United States DOT 49CF R172.101, Inhalation Hazardous Chemical, dangerously water reactive, Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%; NPRI; CEPA Priority Substance List, Canada, Ocean dumping prohibited.

Hazardous to aquatic life or environment, with possible long-lasting effects[291]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, C, N; risk phrases: R26/27/28; R29; R31; R34; R35; R36/37; R50/53; safety phrases: S7/9; S29/35; S28; S30; S36/37/39; S41; S45; S53; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Cyanogen bromide is a colorless or white, volatile, crystalline solid with a penetrating odor. Molecular weight = 105.93; boiling point = 61−62°C; freezing/melting point = 52°C. Hazard identification (based on NFPA-704 M Rating System): Health 4, flammability 0, reactivity 1 ₩. Soluble in water; slow, dangerous reaction, releasing poisonous gas, hydrogen bromide.

Potential Exposure: Used as an activating reagent for insoluble supports for affinity absorption. In danger are those manufacturing this compound or using it in organic synthesis or as a fumigant; in textile treatment; in gold cyaniding. It may have been used as a military poison gas.

Incompatibilities: May be unstable unless dry and pure; impure cyanogen bromide decomposes rapidly and tends to explode. Cyanogen bromide decomposes violently on heating or on contact with water, acids, or acid vapors; producing highly toxic and flammable hydrogen cyanide and corrosive hydrogen bromide. Avoid physical damage, contact with acids or water, and store away from a location where water may be needed for fire control[101]. Violent reaction with ammonia, amines.

Permissible Exposure Limits in Air

NIOSH IDLH = 25 mg[CN]/m^3

PAC Ver. 29[138]

PAC-1: 24 milligram per cubic meter

PAC-2: 44 milligram per cubic meter

PAC-3: 200 milligram per cubic meter

*as cyanides, **inorganic***

OSHA PEL: 5 mg[CN]/m^3/4.7 ppm TWA

NIOSH REL: 5 mg[CN]/m^3/4.7 ppm/10 minutes, Ceiling Concentration

ACGIH TLV[1]: 5 mg[CN]/m^3 [skin] Ceiling Concentration

DFG MAK: 2 mg[CN]/m^3, inhalable fraction TWA; Peak Limitation Category II(1) [skin]; Pregnancy Risk Group: C.

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 200 µg[CN]/L; State Drinking Water Standards: California 150 µg[CN]/L; State Drinking Water Guidelines: Arizona 220 µg[CN]/L; Maine. 140 µg[CN]/L; Minnesota 100 µg[CN]/L. United States Army field drinking-water standards for cyanide: 2 mg[CN]/L assuming a water consumption of 15 L/day and 6 mg[CN]/L assuming a water consumption of 5 L/day. United States Army field drinking-water standards for cyanide, long-term consumption 0.5 mg [CN]/L; Short-term consumption; Raw water constituents (maximum) 20 mg[CN]/L.

Routes of Entry: Inhalation, ingestion, skin absorption.

Harmful Effects and Symptoms

Short-Term Exposure: Cyanogen bromide's toxic action resembles that of hydrocyanic acid. Cyanogen bromide is corrosive to the eyes, skin, and respiratory tract. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Exposure may result in death. Super toxic; probable oral lethal dose in humans in less than 5 mg/kg or a taste (less than 7 drops) for a 70-kg (150 lb) person. Vapors are highly irritant and very poisonous. High concentrations produce excessive respiration (causing increased uptake of cyanide), then labored breathing, paralysis, unconsciousness, convulsions and respiratory arrest.

Headache, dizziness, nausea, and vomiting may occur with lesser concentrations.

Patients may experience confusion, anxiety, and an initial rise in blood pressure with a decreased heartbeat followed by an increased heartbeat; cyanosis is not a consistent finding, in fact, the patient may be reddish. An odor of bitter almonds on the patient's breath may be present. Individuals with chronic diseases of the kidneys; respiratory tract; skin, or thyroid are at greater risk of developing toxic cyanide effects.

Long-Term Exposure: Repeated or prolonged exposure to cyanogen bromide may cause thyroid gland enlargement. Chronic exposure may cause fatigue and weakness.

Points of Attack: Eyes, respiratory system; thyroid gland.

Medical Surveillance: Thyroid gland examination.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek Medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. Do not perform direct mouth to mouth resuscitation; use bag/mask apparatus. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Use amyl nitrate capsules if symptoms of cyanide poisoning develop. All area employees should be trained regularly in emergency measures for cyanide poisoning and in CPR. A cyanide antidote kit should be kept in the immediate work area and must be rapidly available. Kit ingredients should be replaced every 1−2 years to ensure freshness. Persons trained in the use of this kit; oxygen use, and CPR must be quickly available.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Where there is a potential for overexposure*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode).

Storage: Avoid p7hysical damage, contact with acids or water, and store away from a location where water may be needed for fire control[101]. (1) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. (2) Color code—White stripe: Contact Hazard; Store separately; not compatible with materials in solid white category. If dried over sodium, pure material may be stored in a desiccator for several months. Impure material decomposes and may explode. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from moisture, acids, ammonia, amines; and incompatible materials listed above.

Shipping: UN1889 Cyanogen bromide, Hazard class: 6.1; Labels: 6.1-Poisonous materials, 8-Corrosive material. A DOT regulated marine pollutant.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Protective clothing including impervious hand protection should be worn. Wear positive pressure breathing apparatus. Do not touch spilled material; stop leak if you can do it without risk. Use water spray to reduce vapors. *Small spills*: take up with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: dike far ahead of spill for later disposal. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include hydrogen cyanide, hydrogen bromide, and oxides of nitrogen and carbon. This gas is under pressure; containers may rupture and explode when heated. Firefighting gear (including SCBA) does not provide adequate protection. If exposure occurs, remove and isolate gear immediately and thoroughly decontaminate personnel. If conditions permit, do not extinguish. Cool exposures using unattended monitors. (FEMA). If fire must be extinguished, use agent suitable for type of surrounding fire. Material itself does not burn or burns with difficulty. *Do not use water* on material itself. If large quantities of combustibles are involved, use water in flooding quantities as spray and fog.

Use water spray to absorb vapors. Keep material out of water sources and sewers. Use water spray to knock down vapors. Vapors are heavier than air and will collect in low areas. Wear full protective clothing. Avoid direct water contact as it will cause cyanogen bromide to decompose, releasing toxic gases. Avoid breathing vapors; keep upwind; wear SCBA. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: May be added to strong alkaline solution of calcium hypochlorite, let stand for 24 hours and flush to sewer. May also be dissolved in flammable solvent and sprayed into an incinerator equipped with afterburner and scrubber.

References

(31); (173); (101); (138); (100).

Sax, N. I., E d., "*Dangerous Properties of Industrial Materials Report*," 1, No. 8, 60−62, New York, Van Nostrand Reinhold Co. (1981).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Cyanogen Bromide, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Cyanogen bromide, Trenton, NJ (April 2004).

Cyanogen Chloride (Agent CK)

C:1620

Formula: CClN; CNCl

Synonyms: Chlorcyan; Chlorine cyanide; Chlorocyan; Chlorocyanide; Chlorocyanogen; Chlorure de cyanogene (French); CK (military designation); Cloruro de cianogeno (Spanish); Cyanogen chloride, containing less than 0.9% water

CAS Registry Number: 506-77-4

HSDB Number: 917

RTECS Number: GT2275000

UN/NA & ERG Number: (PIH) UN1589/125 (P)

EC Number: 208-052-8

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration); *Theft hazard* 15 (≥2.67% concentration)

Carcinogenicity: NTP: Carcinogenesis studies; selected, October 2000

Hazard Alert: Poison inhalation hazard: exposure can be lethal, Systemic agent, High acute toxicity: highly poisonous gas and lacrimator with dangerously inadequate warning properties, Corrosive, Chemically unstable, Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated, Polymerization hazard; Dangerously water reactive, Possible risk of forming tumors, Environmental hazard.

OSHA Process Safety Management of Highly Hazardous Chemicals (29CFR, Part 1910.119, Appendix A): Threshold Quantity: 500 lb.

Clean Air Act: Accidental Release Prevention/Flammable Substances (Section 112 [r], Table 3), TQ = 10,000 lb (4540 kg)

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P033

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Safe Drinking Water Act (47FR 9352): Priority List (55 FR 1470)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg)

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%; NPRI; CEPA Priority Substance List, Ocean dumping prohibited.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, C; risk phrases: R5; R15; R19; R21; R26; R27/28; R29; R34; R39/23/24/25; R50/53; safety phrases: S1; S9; S13; S28; S33; S38; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Cyanogen chloride is a colorless gas or liquid (below 55°F/13°C) with a pungent, irritating odor. Shipped as a liquefied gas. A solid below—6°C. Molecular weight = 61.47; boiling point = 13.7°C; freezing/melting point = −6°C; vapor pressure = 1010 mmHg @ 20°C; relative vapor density (air = 1) = 2.16; flash point = 51°C. Hazard identification (based on NFPA-704 M Rating System): Health 4, flammability 0, reactivity 3₩. Soluble in water; solubility = 7%. Cyanogen chloride (CK) reacts slowly with water or water vapor to form toxic hydrogen cyanide and hydrogen chloride.

Potential Exposure: Cyanaogen chloride is used as a fumigant, metal cleaner; in ore refining; production of synthetic rubber and in chemical synthesis. CK is used as a military poison gas (blood agent). It forms cyanide in the body.

Incompatibilities: CK is incompatible with; or, may react with most basic and acidic solvents. CK reacts slowly with water or water vapor forming toxic hydrogen cyanide and hydrogen chloride. Cyanogen chloride may polymerize violently if contaminated with chlorine. CK is unstable; it may be stabilized (i.e., inhibited) to prevent polymerization. In crude form CK trimerizes violently if catalyzed by traces of hydrogen chloride or ammonium chloride. Contact with alcohols, acids, acid salts; amines, strong alkalis; olefins, and strong oxidizers may cause fire and explosion. Heat causes decomposition producing toxic and corrosive fumes of hydrogen cyanide, hydrochloric acid, nitrogen oxides. Reacts slowly with water or water vapor, forming hydrogen chloride. Attacks copper, brass, and bronze in the presence of moisture.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 2.52 milligram per cubic meter

OSHA PEL: None

NIOSH REL: 0.3 ppm/0.6 milligram per cubic meter Ceiling Concentration

ACGIH TLV[1]: 0.3 ppm Ceiling Concentration

PAC CK* Ver. 29[138]

PAC-1: 0.0045 ppm

PAC-2: $\mathbf{0.05_A}$ ppm

PAC-3: $\mathbf{4_A}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript “**A**” and correspond to 60-minute values.

Emergency Response Planning Guidelines (DOE)

ER PG-1:inappropriate

ERPG-2: 0.4 ppm

ERPG-3: 4 ppm

DFG MAK: No numerical value established. Data may be available.

Australia: TWA 0.3 ppm (0.6 milligram per cubic meter), 1993; Belgium: STEL 0.3 ppm (0.75 milligram per cubic meter), 1993; Denmark: TWA 0.1 ppm (0.3 milligram per cubic meter), 1999; Finland: STEL 0.1 ppm (0.3 milligram per cubic meter) [skin] 1999; France: VLE 0.3 ppm (0.6 milligram per cubic meter), 1999; Norway: TWA 0.25 ppm (0.6 milligram per cubic meter), 1999; the Netherlands: MAC 0.6 milligram per cubic meter, 2003; Switzerland: MAK-W 0.3 ppm (0.8 milligram per cubic meter), 1999; United Kingdom: STEL 0.3 ppm (0.77 milligram per cubic meter), 2000: Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Ceiling Concentration 0.3 ppm. Israel: STEL 0.3 ppm (0.6 milligram per cubic meter). Some states have set guidelines and standards for cyanogen chloride in ambient air[60] ranging from 5.0 μ/m^3 (Virginia) to 6.0 μ/m^3 (North Dakota) to 14.0 μ/m^3 (Nevada).

Determination in Air: No method available.

Routes of Entry: Inhalation, skin absorption (liquid); ingestion (liquid); skin and/or eye contact (liquid).

Harmful Effects and Symptoms

Short-Term Exposure: Cyanogen chloride is converted to cyanide in the body. A lacrimator. Cyanogen chloride severely irritates the eyes, skin, and respiratory tract. Inhalation can cause weakness, headache, giddiness, dizziness, confusion, nausea, vomiting; irregular heartbeat; and pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Skin contact with the liquid may cause frostbite and irritation. The toxicity of cyanogen chloride resides very largely on its pharmacokinetic property of yielding readily to hydrocyanic acid in vivo. Inhaling small amounts of cyanogen chloride causes dizziness, weakness, congestion of the lungs; hoarseness, conjunctivitis, loss of appetite; weight loss; and mental deterioration. These effects are similar to those found from inhalation of cyanide. Ingestion or inhalation of a lethal dose of cyanogen chloride ($LD_{50} = 13$ mg/kg). Cyanide or other cyanogenic compounds causes dizziness; rapid respiration; vomiting, flushing, headache, drowsiness, drop in blood pressure; rapid pulse; unconsciousness, convulsions; with death occurring within 4 hours.

Points of Attack: Eyes, skin, respiratory system; central nervous system; cardiovascular system.

Medical Surveillance. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. EKG.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a Medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy. If frostbite has occurred, seek medical attention immediately; do NOT rub the affected areas or flush them with water. In order to prevent further tissue damage, do NOT attempt to remove frozen clothing from frostbitten areas. If frostbite has NOT occurred, immediately and thoroughly wash contaminated skin with soap and water. *If cyanide poisoning is suspected*: Use amyl nitrate capsules if symptoms develop. All area employees should be trained regularly in emergency measures for cyanide poisoning and in CPR. A cyanide antidote kit should be kept in the immediate work area and must be rapidly available. Kit ingredients should be replaced every 1−2 years to ensure freshness. Persons trained in the use of this kit; oxygen use, and CPR must be quickly available.

Decontamination: CK is a gas at normal temperature; the liquid will quickly evaporate. When it mixes with water it forms hydrochloric acid. Since the more concentrated the acid, the more dangerous it is; consequently, the acid must be diluted as much as possible. Decontamination must be started quickly before it has time to do much damage. Extra minutes before decontamination can make a big difference. Although CK is a gas the victim can't spread the agent to others. But, if the victim is wet, or the victim's clothes are wet, hydrochloric acid may be spread to others outside the hot and warm zones. So, wash a victim thoroughly so that he can't spread the acid to others. If you don't have the equipment and training, don't enter the hot zone to rescue and decontaminate victims. If the victim can't move, decontaminate without touching and without entering the hot zone. Use clean water from any source; if possible, use a hose (spray or fog to prevent injury to the victim) or other system so that you won't have to touch the victim; don't even wait for soap or for the victim to remove clothing, begin washing immediately. Immediately flush the eyes with water for at least 15 minutes. Wash−strip−wash−evacuate upwind and uphill: The approach is to immediately wash with water, then have the victim (not the first responder) remove all the victim's clothing, then wash again (with soap if available). Subsequently move away from the hot zone in an upwind and uphill direction. *Don't use household or other bleach products* to decontaminate the victim. Wash the victim with warm water and soap. After decontamination, treat the acid burns as you would with burns from a fire. Decontaminate with water or with soap and water. Be sure you've decontaminated the victims as much as you can before they leave the area. If you get any of the acid on yourself, decontaminate immediately. Even if you think you are not contaminated, be sure to thoroughly shower and change clothes as soon as you can following the incident.

Person al Protective Methods:

General information: First responders should use a NIOSH-certified chemical, biological, radiological, nuclear (CBRN) SCBA with a level a protective suit when entering an area with an unknown contaminant or when entering an area where the concentration of the contaminant is unknown. Level a protection should be used until monitoring results confirm the contaminant and the concentration of the contaminant. *Note:* safe use of protective clothing and equipment requires specific skills developed through training and experience.

LEVEL A: (*RED ZONE*): Select when the greatest level of skin, respiratory, and eye protection is required. This is the maximum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than the AEG L-2. A NIOSH-certified CBRN full-facepiece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle. A TECP suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, and a hard hat worn under the TECP suit are optional items.

LEVEL B: (RED ZONE): Select when the highest level of respiratory protection is necessary but a lesser level of skin protection is required. This is the minimum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than AEGL-2. It differs from Level A in that it incorporates a nonencapsulating, splash-protective, chemical-resistant splash suit that provides Level A protection against liquids but is not airtight. A NIOSH-certified CBRN full-facepiece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL C: (YELLOW ZONE): Select when the contaminant and concentration of the contaminant are known and the respiratory protection criteria factors for using APRs or PAPRs are met. This level is appropriate when decontaminating patient/victims. A NIOSH-certified CBRN tight-fitting APR with a canister-type gas mask or CBRN PAPR for air levels greater than AEGL-2. A NIOSH-certified CBRN PAPR with a loose-fitting facepiece, hood, or helmet and a filter or a combination organic vapor, acid gas, and particulate cartridge/filter combination or a continuous flow respirator for air levels greater than AEG L-1. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Escape mask, face shield, coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL D: (GREEN ZONE): Select when the contaminant and concentration of the contaminant are known and the concentration is below the appropriate occupational exposure limit or less than AEG L-1 for the stated du ration times. Limited to coveralls or other work clothes, boots, and gloves.

Notes: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. NIOSH recommends: **4 hours** (At least 4 but <8 hours of resistance to breakthrough $>0.1\ \mu g/cm^2/min$): Teflon gloves, suits, boots. Safety equipment suppliers/

manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *When used as a weapon, use SCBA Respirator Certified By NIOSH For CBRN Environments. Where there is a potential for overexposure*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode).

Storage: Poison inhalation chemical (PIH); check oxygen content prior to entering storage area. Poison gas. (1) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. This gas is highly toxic. Even slight exposure to these gasses can cause death. Store outdoors in a secure, restricted area that containing warning signs. This area must be roofed and shaded with the cylinders stored off the ground and separated from all other products assigned to other hazard categories and radiant heat sources on nonwooden floors. If indoors, store in a well-ventilated areas in temperatures not to exceed 50°C. (2) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location; keep acids away from bases and red, yellow, and blue-coded chemicals. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area Provide ventilation along the floor as the vapors are heavier than air. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: UN1589 Cyanogen chloride, stabilized, Hazard Class: 2.3; Labels: 2.3-Poisonous gas, 8-Corrosive material Inhalation Hazard Zone A. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner. Military driver shall be given full and complete information regarding shipment and conditions in case of emergency. AR 50-6 deals specifically with the shipment of chemical agents. Shipments of agent will be escorted in accordance with AR 740-32.

Spill Handling:

UN 2810 Toxic liquids, organic, n.o.s.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 0.7/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 1000/300
Then: Protect persons downwind (mi/km)
Day 1.1/1.8
Night 2.8/4.5

CK, when used as a weapon

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 500/60
Then: Protect persons downwind (mi/km)
Day 0.6/0.9
Night 2.4/3.8

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 2500/800
Then: Protect persons downwind (mi/km)
Day 3.6/5.8
Night 7.0 + /11.0 + *

* + means distance can be larger in certain atmospheric conditions.

cyanogen chloride, stabilized

First: Isolate in all directions (ft/m) 300/100
Then: Protect persons downwind (mi/km)
Day 0.3/0.5
Night 0.9/1.5

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 1250/400
Then: Protect persons downwind (mi/km)
Day 2.0/3.2
Night 4.3/6.8

If in a building, evacuate building and confine vapors by closing doors and shutting down HV AC systems. Restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit and to disperse the gas. Wear chemical protective suit with SCBA to combat spills. Stay upwind and use water spray to "knock down" vapor; contain runoff. Stop the flow of gas, if it can be done safely from a distance. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place; and repair leak or allow cylinder to empty. Keep this chemical out of confined spaces, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include phosgene, hydrogen cyanide, hydrogen chloride, and oxides of nitrogen and carbon. Containers may explode when heated or if they are contaminated with water. Containers may rocket. Firefighting gear (including SCBA) does not provide adequate protection. If exposure occurs, remove and isolate gear immediately and thoroughly decontaminate personnel. Let it burn! Cyanogen chloride will not burn, but getting close to put out a fire surrounding a broken CK container is very dangerous. Use an unattended fire monitor to "knock down" the cyanogen chloride gas, and remain aware that the water that falls to the ground becomes acidic, and may be concentrated and dangerous. Stay away from it! *Containers:* Cyanogen chloride can't burn, but the container can explode if heated by the surrounding fire, so you should evacuate immediately. If a container of cyanogen chloride is near a fire, use water hoses (use an unmanned fire monitor if possible to reduce the danger to you) to cool the container so it won't explode. Since the container can explode even if you are trying to keep it cool, evacuate the area. firefighting risks: The cyanogen chloride gas and the hydrochloric acid (HCl) formed when the gas mixes with firefighting water are both dangerous, so one could easily get injured or killed fighting a fire. That's why, it's best to let the surrounding fire burn out. However, if there is some reason that you have to put out the fire, do it from a secure, explosion-proof location; use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. Use the firefighting method that's best for what's burning. But first think it through—do you really have to fight this fire? Heat causes decomposition, producing toxic and corrosive fumes of hydrogen cyanide, hydrogen chloride, nitrogen oxides. Cyanogen chloride is a gas that moves downwind and downhill; it's diluted by the wind. It is heavier than air which means that it sticks together longer than if it were lighter than air. Stay upwind from a spill. It will dissolve in water, so spraying water into the cloud from an unmanned fire monitor will help react it with water as well as mix it with the air and get rid of it. But remember the water will be full of HCl. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. React with strong calcium hypochlorite solution for 24 hours, then flush to sewer with large volumes of water.

References

(31); (173); (101); (138); (85); (100).

United States Environmental Protection Agency, Cyanogen Chloride, Health and Environmental Effects Profile No. 57, Office of Solid Waste, Washington, DC (April 30, 1980).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 8, 62−63 (1981) and 6, No. 1, 46−49 (1986).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Cyanogen chloride, Trenton, NJ (April 2004).

Cyanogen Iodide C:1630

Formula: CIN; CNI

Synonyms: Cyanogen moniodide; Iodine cyanide; Jodcyan; NCI; Yoduro de cianogeno (Spanish)

CAS Registry Number: 506-78-5

HSDB Number: 6328

RTECS Number: NN1750000

UN/NA & ERG Number: (PIH) UN2928 (Toxic solids, corrosive, organic, n.o.s)/154; UN1588 (cyanides, inorganic, solid, n.o.s.)/157; UN3290 (toxic solid, corrosive, inorganic, n.o.s.),/154

EC Number: 208-053-3

Regulatory Authority and Advisory Information

Hazard Alert: Exposure can be lethal, Corrosive, Polymerization hazard, Environmental hazard.

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 1000/10,000 lb (454/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1000 lb (454 kg)

United States DOT Regulated Marine Pollutant (49CFR172.101, append ix B) as cyanides, inorganic, n.o.s.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%; NPRI; CEPA Priority Substance List, Ocean dumping prohibited.

Very toxic to aquatic organisms, ICSC/0662

Hazard symbols, risk, & safety statements: Hazard symbol: T+, C; risk phrases: R19; R26/27/28; R32; R34; R35, R36; R50/53; safety phrases: S7; S13; S28; S2935; S36; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Cyanogen iodide is a combustible, white crystalline solid. Very pungent odor. Molecular weight = 152.92; specific gravity (H_2O:1) = 1.84; freezing/melting point = 146.5°C; vapor pressure = 1 mmHg @ 25.2°C. Explosive limits: LEL: 6000 ppm; UEL: unknown. Hazard identification (based on NFPA-704 M Rating System): Health 4, flammability 0, reactivity ₩. Soluble in water; slow reaction releasing deadly hydrogen cyanide gas.

Potential Exposure: A psudohalogen compound used as a preservative in taxidermy. Generally used for destroying all lower forms of life.

Incompatibilities: Reacts slowly with water releasing hydrogen cyanide. Incompatible with phosphorus (molten); reacts with incandescence to produce phosphorus iodide[NFPA, cameo]. Contact with alcohols, acids, ammonia, carbon dioxide or alkaline material and bases produces toxic gases including hydrogen cyanide. Incompatible with nitriles.

Permissible Exposure Limits in Air

NIOSH IDLH = 25 mg[CN]/m^3

as iodides

ACGIH TLV[1]: 0.01 ppm/0.1 milligram per cubic meter, inhalable fraction and vapor, TWA

as cyanides

OSHA PEL: 5 mg[CN]/m^3/4.7 ppm TWA

NIOSH REL: 5 mg[CN]/m^3/4.7 ppm/10 minutes, Ceiling Concentration

ACGIH TLV[1]: 5 mg[CN]/m^3 [skin] Ceiling Concentration

PAC Ver. 29[138]

PAC-1: 35 milligram per cubic meter

PAC-2: 180 milligram per cubic meter

PAC-3: 290 milligram per cubic meter

DFG MAK: 2 mg[CN]/m^3, inhalable fraction TWA; Peak Limitation Category II(1) [skin]; Pregnancy Risk Group: C

Skin contact may contribute significantly in overall exposure.

Determination in Air: Use NIOSH Analytical Method #7904; #6010, cyanides.

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 200 μg[CN]/L; State Drinking Water Standards: California 150 μg[CN]/L; State Drinking Water Guidelines: Arizona 220 μg[CN]/L; Maine. 140 μg[CN]/L; Minnesota 100 μg[CN]/L. United States Army field drinking-water standards for cyanide: 2 mg[CN]/L assuming a water consumption of 15 L/day and 6 mg[CN]/L assuming a water consumption of 5 L/day. United States Army field drinking-water standards for cyanide, long-term consumption 0.5 mg[CN]/L; Short-term consumption; Raw water constituents (maximum) 20 mg[CN]/L.

Routes of Entry: Ingestion, absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Highly irritating to eyes and skin; may cause burns. Converted to cyanide in the body. Causes convulsions, paralysis, and death from respiratory failure. Poisonous, may be fatal if swallowed or absorbed through skin. Health effects are similar to cyanides and iodides. Upon ingestion, a bitter, acrid, burning taste is sometimes noted. Other symptoms are anxiety, confusion, dizziness, giddiness, rapid and difficult breathing; palpitations, tightness in chest; unconsciousness; violent convulsions and death.

Long-Term Exposure: Long-term contact with iodides can cause weakness, anemia, loss of appetite; loss of weight; and general depression.

Points of Attack: Blood.

Medical Surveillance: EKG, blood cyanide level.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek Medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek Medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Effects may be delayed; keep victim under observation. Use amyl nitrate capsules if symptoms develop. All area employees should be trained regularly in emergency measures for cyanide poisoning and in CPR. A cyanide antidote kit should be kept in the immediate work area and must be rapidly available. Kit ingredients should be replaced every 1−2 years to ensure freshness. Persons trained in the use of this kit; oxygen use, and CPR must be quickly available.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: W*here there is a potential for overexposure:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with cyanogen iodide all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Refrigerate at (approx.) 4°C. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2928 Toxic solids, corrosive, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, 8-Corrosive material, Technical Name Required. UN3290 Toxic solid, corrosive, inorganic, n.o.s., Hazard class: 6.1; Labels: 6.1-Poisonous materials, 8-Corrosive material. UN1588 Cyanides, inorganic, solid, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: If outside, cover material to protect from wind, rain, or spray. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include hydrogen ioside, hydrogen cyanide, and oxides of nitrogen and carbon. Firefighting gear (including SCBA) does not provide adequate protection. If exposure occurs, remove and isolate gear immediately and thoroughly decontaminate personnel. This chemical is a combustible solid. *Small fires:* dry chemical, carbon dioxide; water spray; or foam. *Large fires:* water spray, fog, or foam. Move container from fire area if you can do so without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Wear positive pressure breathing apparatus and special protective clothing. Remove and isolate contaminated clothing at the site. Thermal decomposition products may include cyanide gas, iodide gas, and nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (2); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Cyanogen Iodine, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Cyanogen Iodide, Trenton, NJ (January 2003).

NFPA 491M (1991).

Cyanophos C:1640

Formula: $C_8H_{16}N_5O_6P_2S_2$

Synonyms: Bay 34727; Bayer 34727; Ciafos; Cianofos (Spanish); *O*-(4-Cyanophenyl) *O*,*O*-dimethyl phosphorothioate; *O*,*p*-Cyanophenyl *O*,*O*-dimethyl phosphorothioate; Cyanophos organophosphate compound; Cyanox; Cyap; *O*, *O*-Dimethyl-*O*-(4-cyano-phenyl)-monothiophosphat (German); *O*,*O*-Dimethyl *O*,*p*-cyanophenyl phosphorothioate; *O*,*O*-Dimethyl *O*-4-cyano phenyl phosphorothioate; ENT 25,675; May & Baker S-4084; Phosphoro thioic acid, *O*-(4-cyanophenyl)-*O*,*O*-dimethyl ester; Phosphoro thioic acid, *O*-(4-cyanophenyl)-9,9-dimethyl ester; Phosphoro thioic acid, *O*,*O*-dimethyl ester, *O*-ester with *p*-hydroxybenzonitrile; S 4084; Sumitomo S 4084; Sunitomo S 4084

CAS Registry Number: 2636-26-2

HSDB Number: 6427

RTECS Number: TF7600000

UN/NA & ERG Number: UN3278 (organophosphorus pesticide, liquid, toxic)/151; UN3018 (organophosphorus pesticide, liquid, toxic)/152

EC Number: 220-130-3 [*Annex I Index No.:* 015-087-00-0]

Regulatory Authority and Advisory Information

Hazard Alert: Poison inhalation hazard, Neurotoxin (cumulative), Environmental hazard, Agricultural chemical.

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg)

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

United States DOT 49CFR172.101, Inhalation Hazardous Chemical, as organic phosphate, Substance ID: EDF-041

NPRI; CEPA Priority Substance List, Ocean dumping prohibited.

Hazard symbols, risk, & safety statements: Hazard symbol: Xn, N; risk phrases: R21/22; R33; R50/53; safety phrases: S2; S36/37; S41; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)]

Description: Cyanophos is a yellow to reddish-yellow or amber liquid. Molecular weight = 243.23; boiling point = 119°C (decomposes); freezing/melting point = 14.8°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 0. Slightly soluble in water.

Potential Exposure: A potential danger to those involved in the manufacture, formulation, and application of this insecticide which is used against rice stem borers and house flies. It is not registered as a pesticide in the United States.

Incompatibilities: Alkaline materials and exposure to light can cause rapid decomposition. Contact with oxidizers may cause the release of phosphorous oxides. Contact with strong reducing agents, such as hydrides, may cause the formation of flammable and toxic phosphine gas.

Permissible Exposure Limits in Air

NIOSH REL: (nitriles) 2 ppm, Ceiling Concentration, not to be exceeded in any 15-minute work period.

PAC Ver. 29[138]

PAC-1: 2.3 milligram per cubic meter

PAC-2: 25 milligram per cubic meter

PAC-3: 130 milligram per cubic meter

Determination in Air: Filter/Bubbler; Potassium hydroxide; Ion-specific electrode; NIOSH Analytical Method (IV) #7904, Cyanides. OSHA versatile sampler-2; Toluene/Acetone; GC/Flame photometric detection for sulfur, nitrogen, or phosphorus; NIOSH Analytical Method (IV) Method #5600, Organophosphorus Pesticides. See also NIOSH Criteria Document 212 *Nitriles*.

Routes of Entry: Inhalation, ingestion, skin contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Cyanophos is an organophosphorus insecticide. It is a cholinesterase inhibitor. Death may occur after a large oral dose; with smaller accidental doses, onset of illness may be delayed. The LD_{50} oral (rat) is 25 mg/kg (highly toxic). Symptoms of organophosphorus pesticide poisoning include: headache, giddiness, nervousness, blurred vision; weakness, nausea, cramps, diarrhea, and discomfort in the chest. Signs include: sweating, pinpoint pupils; tearing; salivation and other excessive respiratory tract secretion; vomiting, cyanosis, papilledema; uncontrollable muscle twitches followed by muscular weakness, convulsions; coma; loss of sphincter control.

Long-Term Exposure: Cholinesterase inhibitor; possible cumulative effect. Cyanophos may damage the nervous system; resulting in convulsions, respiratory failure. May cause liver damage. See NIOSH Criteria Document 212 *Nitriles*.

Points of Attack: Respiratory system; central nervous system; peripheral nervous system; plasma cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When Cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of “normal.” Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider CBC. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Effects may be delayed; keep victim under observation.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See NIOSH also Criteria Document 212 *Nitriles*.

Respirator Selection: W*here there is a potential for overexposure:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Cyanophos is stable to storage for

2 years or more under normal conditions. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: UN3278 Organophosphorus compound, liquid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Hazard Technical Name Required, Potential Inhalation Hazard (Special Provision 5). UN3018 Organophosphorus pesticides, liquid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling:

Organophosphorus spill, liquid

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.3/0.4
Night 0.8/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 600/200
Then: Protect persons downwind (mi/km)
Day 1.4/2.3
Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Do not touch spilled material. Do not breathe vapors. Stay upwind; keep out of low areas. Remove all ignition sources. Ventilate area of spill or leak. This material is a combustible liquid. For a spill or leak of a combustible liquid, shut off ignition sources; no flares, smoking, or flames in hazard area. Stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include hydrogen chloride and oxides of phosphorus, sulfur, nitrogen, and carbon. This material may burn, but does not ignite readily. For small fires, use dry chemical, carbon dioxide; water spray; or foam. For large fires, use water spray, fog, or foam. Stay upwind; keep out of low areas. Move container from fire area if you can do it without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Wear positive pressure breathing apparatus and special protective clothing. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR165 recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Cyanophos, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Cyanophos, #2304, Trenton, NJ (March 2004).

Cyanopyridines C:1650

Formula: $C_6H_4N_2$; $C_5H_4N\text{-}CN$

Synonyms: *2-cyano-isomer:* Picolinic acid nitrile; 2-Pyridinecarbo nitrile

3-cyano-isomer: 3-Azabenzonitrile; 3-Cyanopyridine; Nicotinic acid nitrile; Nicotinonitrile; 3-Pyridinecarbonitrile; 3-Pyridinenitrile; 3-Pyridylcarbonitrile

4-cyano-isomer: 4-Azabenzonitrile; Isonicotino nitrile; 4-Pyridine carbonitrile

CAS Registry Number: 100-70-9 (2-cyano-); 100-54-9 (3-cyano-); 100-48-1 (4-cyano-)

HSDB Number: 5338 (2-cyano-); 5335 (3-cyano-)

RTECS Number: QT3030000 (3-cyano-)

UN/NA & ERG Number: UN3276 (nitriles, toxic, n.o.s.)/151

EC Number: 202-880-3 (2-cyano-); 202-863-0 (3-cyano-); 202-865-2 (4-cyano-)

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Highly flammable, Possible polymerization hazard (nitriles), Environmental hazard.

As cyanide compounds:

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants as cyanide, total

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P030 as cyanides soluble salts and complexes, n.o.s.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents. as cyanides, soluble salts and complexes, n.o.s.

EPCRA (Section 313): X + CN-where X = H + or any other group where a formal dissociation may occur. For example, KCN or Ca(CN)2. Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, append ix B) as cyanide mixtures, cyanide solutions or cyanides, inorganic, n.o.s.

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xn; risk phrases: R11; R19; R20/21/22; R36/37/38; safety phrases: S24/25; S26; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: The cyanopyridines are as follows: *2-cyano-:* A white to tan liquid or solid. Almond odor. Boiling point = −213°C; freezing/melting point = 27°C; flash point = 89°C. *3-cyano-*: a colorless liquid or gray crystalline solid. Molecular weight = 104.12; boiling point = 83 to 84°C; freezing/melting point = 47−49°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 3, reactivity 0. Soluble in water. *4-cyano-*: a beige solid. freezing/melting point = 75.8°C.

Potential Exposure: The cyanopyridines are used in the synthesis of organic compounds and as corrosion inhibitors for aluminum.

Incompatibilities: Oxidizing agents, such as perchlorates, peroxides, and permanganates. Nitriles may polymerize in the presence of metals and some metal compounds. They are incompatible with acids; mixing nitriles with strong oxidizing acids can lead to extremely violent reactions. Nitriles are generally incompatible with other oxidizing agents such as peroxides and epoxides. The combination of bases and nitriles can produce hydrogen cyanide. Nitriles are hydrolyzed in both aqueous acid and base to give carboxylic acids (or salts of carboxylic acids). These reactions generate heat. Peroxides convert nitriles to amides. Nitriles can react vigorously with reducing agents. Acetonitrile and propionitrile are soluble in water, but nitriles higher than propionitrile have low aqueous solubility. They are also insoluble in aqueous acids[101].

Permissible Exposure Limits in Air

NIOSH IDLH = 25 mg[CN]/m^3

NIOSH REL: (nitriles) 2 ppm, Ceiling Concentration, not to be exceeded in any 15-minute work period.

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 200 μg[CN]/L; State Drinking Water Standards: California 150 μg[CN]/L; State Drinking Water Guidelines: Arizona 220 μg[CN]/L; Maine. 140 μg[CN]/L; Minnesota 100 μg[CN]/L. United States Army field drinking-water standards for cyanide: 2 mg[CN]/L assuming a water consumption of 15 L/day and 6 mg[CN]/L assuming a water consumption of 5 L/day. United States Army field drinking-water standards for cyanide, long-term consumption 0.5 mg[CN]/L; Short-term consumption; Raw water constituents (maximum) 20 mg[CN]/L.

Harmful Effects and Symptoms

Short-Term Exposure: *Inhalation:* May cause irritation to the nose and throat. *Skin:* May cause irritation. *Eyes:* May cause irritation. Animal data suggests eye damage can result from contact. *Ingestion:* Possible central nervous system damage due to cyanide content.

Long-Term Exposure: No information found. The LD_{50} oral-rat for 3-cyanopiridines is 1105 mg/kg (slightly toxic).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek Medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. When working with liquids, wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. When working with powders or dusts, wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See NIOSH Criteria Document 212 *Nitriles.*

Respirator Selection: Wear a chemical cartridge respirator with organic vapor or organic vapor/acid gas cartridges, if necessary.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from heat or flame and separate from oxidizing materials.

Shipping: UN3276 Nitriles, liquid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required, Potential Inhalation Hazard (Special Provision 5).

Spill Handling:

Nitriles spill

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.3/0.5
Night 0.5/0.8

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Wash area of spill with soap and water. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New York State Department of Health, *Chemical Fact Sheet* Cyanopyridine(s), Bureau of Toxic Substance Assessment, Albany, NY (June 1986).

Cyclanilide C:1663

Formula: $C_{11}H_9Cl_2NO_3$

Synonyms: Cyclopropanecarboxylic acid, 1-[((2,4-dichlorophenyl)amino)carbonyl]-; Cyclopropanecarboxamide, 1-carboxy-, *N*-(2,4-dichlorophenyl)-; 1-(2,4-Dichlorophenylaminocarbonyl) cyclopropanecarboxylic acid; EXP 31039B; Finish; RPA 90946

CAS Registry Number: 113136-77-9

HSDB Number: 7018

RTECS Number: Not found.

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 419-150-7 [*Annex I Index No.:* 616-110-00-2]

Regulatory Authority and Advisory Information

Carcinogenicity: EPA: Not likely a carcinogen to humans.

Hazard Alert: Poison, Environmental hazard.

Marine pollutant, IMDG

Hazardous to aquatic life or environment, with possible long-lasting effects[293]. Toxic to aquatic life with long-lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xn, N; risk phrases: R22; R51/R53; safety phrases: S2; S29/35; S36/37/39; S41; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: A white or pale yellow, crystalline or powdery solid. No characteristic odor. Molecular weight = 274.10; specific gravity (H_2O:1) = 1.65; boiling point = -510°C; specific gravity (H_2O:1) = 1.47; freezing/melting point = 195.5°C; 190°C; vapor pressure = 84×10^{-2} @25°C; flash point = ~260°C. Low solubility in water; solubility = .0.05 g/L.

Potential Exposure: Cyclanilide, amalonanilate plant growth regulator and fungicide is used as a cotton harvest aid

Incompatibilities: May react violently with strong oxidizers, bromine, 90% hydrogen peroxide, phosphorus trichloride, silver powders, or dust. Incompatible with silver compounds. Mixture with some silver compounds forms explosive salts of silver oxalate. Keep away from reducing agents, oxidizers, sulfuric acid, caustics, ammonia, aliphatic amines, alkanolamines, isocyanates, alkylene oxides, epichlorohydrin. Compounds of the carboxyl group react with all bases, both inorganic and organic (i.e., amines) releasing substantial heat, water, and a salt that may be harmful. Incompatible with arsenic compounds (releases hydrogen cyanide gas), diazo compounds, dithiocarbamates, isocyanates, mercaptans, nitrides, sulfides (releasing heat, toxic, and possibly flammable gases), thiosulfates, and dithionites (releasing hydrogen sulfate and oxides of sulfur).

Permissible Exposure Limits in Air: No standards set.

Permissible Concentration in Water: Hazardous to the aquatic environment. Do not allow release to the environment unless proper permits are obtained from the federal government.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = > 3$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Harmful Effects and Symptoms

Short-Term Exposure: Contact with eyes or skin may cause irritation or injury. Inhalation should be avoided; use NIOSH- or CEN (UK)-approved APRs for pesticides. May be harmful if swallowed. Delayed pulmonary edema may occur after inhalation. LD_{50} (oral, rat) = 315 mg/kg[72].

Medical Surveillance: Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a drug or other inhalation therapy. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure.

First Aid Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Applicators and other handlers must wear: Coveralls worn over long-sleeved shirt and long pants; Chemical-resistant gloves such as DuPont Tychem suit fabrics, barrier laminate, or Viton; Chemical-resistant footwear plus socks; Protective eye wear; Chemical-resistant headgear for overhead exposure; Chemical-resistant apron when cleaning equipment, mixing, or loading[72]. Agricultural Use/Engineering Controls: When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the WPS for agricultural pesticides, 40 CFR 170.240(d)(4-6), the handler PPE requirements may be reduced or modified as specified in the WPS. Firefighters should wear NIOSH-approved SCBA and full protective clothing.

Respirator Selection: Wherever and whenever workplace conditions warrant respirator use, a respiratory protection program must be followed that meets one or more of the following requirements: OSHA's 29 CFR 1910.134, ANSI Z88.2, or European Standard EN149.

Storage: Color code—Blue: Health Hazard/Poison. Store in a secure poison location. Cyanophos is stable to storage for 2 years or more under normal conditions. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft (NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. First, remove all sources of ignition. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use water spray, dry chemical, carbon dioxide; or alcohol-resistant foam extinguishers. Thermal decomposition products may include hydrogen chloride and oxides of nitrogen and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. In accordance with 40CFR165 recommendations for the disposal of pesticides and pesticide containers. noncombustible containers should be crushed and buried under more than 40 cm of soil[30]. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (204); (100).

United States Environmental Protection Agency, Office of Pesticide Programs, Pesticide Residue Limits, "Cyclanilide," 40 CFR 180.506. http://frwebgate.access.gpo.gov/cgi-bin/get-cfr.cgi.

United States Environmental Protection Agency, Office of Pesticide Programs, "Pesticide Fact Sheet: Cyclanilide," Washington, DC (May 19, 1997). http://www.epa.gov/opprd001/factsheets/cyclanilide.pdf.

Cycloate C:1668

Formula: $C_{11}H_{21}NOS$

Synonyms: Cyclo hexylethylcarbamothioic acid-*S*-ethyl ester; Cyclohexylethylthiocarbamic acid-*S*-ethyl ester; *S*-Ethyl cyclohexylethylthiocarbamate; *S*-Ethyl-*N*-ethyl-*N*-cyclohexylthiolcarbamate; Hexylthiocarbam; Etsan; Eurex; R-2063; Ro-Nee t; R o-Neet-6E; Ro-Neet-10G; Ronit; Sabet

CAS Registry Number: 1134-23-2

HSDB Number: 1712

RTECS Number: GU7200000

UN/NA & ERG Number: UN3082 (environmentally hazardous substances, liquid, n.o.s.)/171

EC Number: 214-482-7

Regulatory Authority and Advisory Information

California Proposition 65 Chemical[102]: Developmental/Reproductive toxin, 3/19/1999.

Hazard Alert: Suspected reprotoxic hazard, Agricultural chemical.

Potential Ground water Pollutant [California FAC Section 13145(d)/12811, active]

RCRA Universal Treatment Standards: Wastewater (mg/L), 0.003; Nonwastewater (mg/kg), 1.4

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xn, N; risk phrases: R22; R51/53; R62; R63; safety phrases: S29/35; S41; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Cycolate is an oily, clear, or amber to yellow liquid. Aromatic odor; molecular weight = 215.36; specific gravity (H_2O:1) = 1.0 @ 20°C; boiling point = 145−146°C @ 10 mmHg; freezing/melting point = 12°C; vapor pressure = 1.6×10^{-3} mmHg @ 20°C. Flash point = 100°C; 139 C (oc); moderately soluble in water; solubility = 75−100 mg/L.

Potential Exposure: Cycolate is a thiocarbamate herbicide used to control broad leaf weeds, annual and perennial grasses and nutgrass in spinach, beets, and sugar beets.

Incompatibilities: Cycolate reacts violently with powerful oxidizers such as calcium hypochlorite. Thiocarbamate esters are combustible. Poisonous gases are generated by the thermal decomposition of thiocarbamate compounds, including carbon disulfide, oxides of sulfur, oxides of nitrogen, hydrogen sulfide, ammonia, and methylamine. Thio and dithiocarbamates slowly decompose in aqueous solution to form carbon disulfide and methylamine or other amines. Such decompositions are accelerated by acids. Flammable gases are generated by the combination of thiocarbamates with aldehydes, nitrides, and hydrides. Thiocarbamates are incompatible with acids, peroxides, and acid halides.

Determination in Water: Octanol−water coefficient: Log K_{ow} = > 3.5. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood. Fish toxicity (threshold)[101]: Very low—658.46663 ppb, MATC.

Routes of Entry: Poisoning can occur by inhalation, ingestion, and absorption through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Some thiocarbamates may react with recently ingested alcohol or alcohol-containing products including wine, medications, and cold remedies such as cough syrups. Low toxicity. Concentrated solutions are slightly corrosive to eyes and mucous membranes. Dust inhalation can cause irritation of the respiratory system with sneezing. Eye contact can cause irritation, watering, pain, and inflammation of the eyelids. Dermal contact can cause irritation and minor ulceration. Ingestion can cause nausea, vomiting, fever, muscle twitching, seizure, rapid respiration, slow heartbeat. Severe exposure may result in death. LD_{50} (oral, rat) = 1700 mg/kg; LD_{50} (dermal, rat) ≥ 2500 mg/kg.

Long-Term Exposure: Human toxicity (long term)[101]: Intermediate—35.00 ppb, Health advisory.

Points of Attack: Respiratory system, central nervous system, cardiovascular system, skin, eyes.

Medical Surveillance: Preliminary medical exam to detect chronic diseases of Central nervous system, liver, heart, kidneys, lung, and skin, as well as endocrinological or immunological disturbances, should protect susceptible individuals. Periodical medical exams of internal organs, skin, and eyes are important to avoid chronic occupational intoxications. They should include lab and patch tests when necessary[83]. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a drug or other inhalation therapy. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. Before employment and at regular times after that, the following are recommended: If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider CBC and chest X-ray following acute overexposure. Examination of the nervous system. In addition to comprehensive initial medical and work histories emphasizing reproductive experience and menstrual history, patient should have physical examination and testing of genito-urinary tract, sperm count, motility, and morphology. If required, other tests, such as serum testosterone, serum FSH, and serum LH may be indicated.

First Aid: Eyes: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious and able to swallow, have victim drink 4 to 8 oz of water. Do not induce vomiting. *Note to physician or authorized medical personnel*: Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a drug or other inhalation therapy. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure.

Personal Protective Methods: Reacts with the following absorbent materials: Cellulose-Based; Mineral- and Clay-Based; Dirt/Earth[88]. Applicators and other handlers must wear: Coveralls worn over long-sleeved shirt and long pants; Chemical-resistant gloves such as DuPont Tychem suit fabrics, barrier laminate, or Viton; Chemical-resistant footwear plus socks; Protective eye wear; Chemical-resistant headgear for overhead exposure; Chemical-resistant apron when cleaning equipment, mixing, or loading[83]. Agricultural Use/Engineering Controls: When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the WPS for agricultural pesticides, 40 CFR 170.240 (d)(4-6), the handler PPE requirements may be reduced or modified as specified in the WPS. Firefighters should wear NIOSH-approved SCBA and full protective clothing.

Respirator Selection: *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any MSHA/NIOSH/MSHA or European Standard EN149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full facepiece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, SCBA). All respirators selected must be approved by NIOSH under the provisions of 42 CFR84. The current listing of NIOSH-certified respirators can be found in the NIOSH/NPPTL Certified Equipment List, which is available on the NIOSH website.

Storage: Color code—Blue: Health Hazard/Poison. Store in a secure poison location. Cyanophos is stable to storage for 2 years or more under normal conditions. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: UN3082 Environmentally Hazardous substances, liquid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Soil Adsorption Index (K_{oc}) = 400.

Fire Extinguishing: A combustible liquid. Thermal decomposition products may include oxides of sulfur, nitrogen, and carbon. Use dry chemical, carbon dioxide; water spray; or alcohol-resistant foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA

1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Do not discharge into drains or sewers. Dispose of waste material as hazardous waste using a licensed disposal contractor to an approved landfill. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Incineration with effluent gas scrubbing is recommended. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(102); (31); (173); (101); (138); (100).

United States Environmental. Protection Agency, Office of Pesticide Programs, Pesticide Residue Limits, "Cycloate," 40 CFR 180.212. www.epa.gov/pesticides/food/viewtols.htm.

Cycasin C:1660

Formula: $C_8H_{16}N_2O_8$

Synonyms: β-D-Glucopyranoside (methyl-ONN-azoxy) methyl-; Side methylazoxymethanol β-D-glucoside

CAS Registry Number: 14901-08-7

HSDB Number: 5096

RTECS Number: LZ5982000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Sufficient Evidence; Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B, 1976[9]

California Proposition 65 Chemical[102]: Cancer 1/1/1988.

Hazard Alert: Poison, Combustible, Neurotoxin, Possible risk of forming tumors, Suspected of causing genetic defects Suspected reprotoxic hazard.

Hazardous Waste (EPA-RCRA) Hazardous Constituent Waste (EPA)

Hazard symbols, risk, & safety statements: Hazard symbol: T; risk phrases: R40; R62; R63; safety phrases: S13; S22; S36/37/39; S41; S45; S53 (see Appendix 4)

Description: Cycasin is a crystalline solid with long needles. Molecular weight = 252.08; freezing/melting point = (decomposes) 154°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 2, reactivity 0.

Incompatibilities: Material hydrolyzed under alkaline conditions[IARC, 193].

Potential Exposure: Cycasin occurs naturally, in the seeds, roots, and leaves of cycad plants which are found in the tropical and subtropical regions of the world. Nuts from the cycads are used to make chips, flour, and starch. Cycasin is not produced or used commercially. The major potential Exposure is the ingestion of the foods containing cycasin. It is estimated that about 50−55% of the inhabitants of Guam are potentially exposed (50,000−60,000 persons) to cycasin. Wastewater from the preparation of the cycad nuts contain large amounts of cycasin and represents a potential secondary exposure source.

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

North Dakota[60] has set a guideline for cycasin in ambient air of zero.

Harmful Effects and Symptoms

Cycasin is carcinogenic in five animal species, inducing tumors in various organs. Following oral exposure, it is carcinogenic in the rat, hamster, guinea pig, and fish. By this route, the data in the mouse is of borderline significance and the negative experiment in chickens only lasted 68 weeks. It is active in single-dose experiments and following prenatal exposure. The carcinogenicity of its metabolite, methylazoxymethanol, has been demonstrated in the rat and the hamster, and that of a closely related synthetic substance, methylazoxymethanol acetate. In the rat. LD_{50} (oral-rat) = 270 mg/kg (moderately toxic).

Short-Term Exposure: Poisonous; a neurotoxin. May cause eye damage.

Long-Term Exposure: A possible human carcinogen. Laboratory tests on animals suggest this chemical is a teratogen; mutation data has been reported. May cause liver and brain damage.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, Avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. When working with liquids, wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. When working with powders or dusts, wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full facepiece respirator with an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with cycasin all handlers should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft (NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Disposal of unused product must be undertaken by qualified personnel who are knowledgeable in all applicable regulations and follow all pertinent safety precautions including the use of appropriate protective equipment. For proper handling and disposal, always comply with federal, state, and local regulations. At the time of review, criteria for land treatment or burial (sanitary landfill) disposal practices are subject to significant revision. Prior to implementing land disposal of waste residue (including waste sludge), consult with environmental regulatory agencies for guidance on acceptable disposal practices[72].

References

(102); (31); (173); (101); (138).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 3, 48–49 (1981).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Cycasin, Trenton, NJ (December 2002).

Cycloheptene C:1670

Formula: C_7H_{12}

***Synonyms*:** cis-Cycloheptene; Suberane; Suberylene

CAS Registry Number: 628-92-2

RTECS Number: GU4615000

UN/NA & ERG Number: UN2242/128 (P)

EC Number: 211-060-4

Regulatory Authority and Advisory Information

Hazard Alert: Highly flammable liquid. Polymerization hazard, Inhalation hazard (possible narcotic effect); Electrostatic hazard.

Hazard symbols, risk, & safety statements: Hazard symbol: F; risk phrases: R11; R18; R19; R21; safety phrases: S16; S29; S33; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Cyclo heptene is a flammable, colorless, oily liquid. Molecular weight = 96.2; boiling point = 115°C; flash point = −7°C (also listed @ 23°C). Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 3, reactivity 0. Insoluble in water.

Potential Exposure: Cycloheptene may be used in organic synthesis or for making other chemicals.

Incompatibilities: Vapors may form explosive mixture with air. Cycloheptene may react exothermically with reducing agents to release hydrogen gas. In the presence of various catalysts (such as acids) or initiators, may undergo exothermic addition polymerization reactions[101]. Incompatible with strong oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

No standards or PAC available.

Routes of Entry: Inhalation, passing through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Cycloheptene can affect you when breathed in and by passing through your skin. Exposure can cause you to feel dizzy, lightheaded and to pass out. Inhalation may have a narcotic effect[101]. Contact can irritate the skin.

Long-Term Exposure: May cause drying and cracking of the skin.

Points of Attack: Skin.

Medical Surveillance: Evaluation by a dermatologist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: *Clothing:* Avoid skin contact with cycloheptene. Wear solvent-resistant gloves and clothing. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day and put on before work. *Eye Protection:* Wear splash-proof chemical goggles and face shield when working with liquid, unless full facepiece respiratory protection is worn.

Respirator Selection: Where there is potential exists for exposures to cycloheptene, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Cycloheptene must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine), since violent reactions occur. store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where cycloheptene is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gal or more of cycloheptene should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of cycloheptene. Wherever cycloheptene is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN2242 Cycloheptene, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep cycloheptene out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for

firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Cycloheptene, Trenton, NJ (March 2000).

Cyclohexane C:1680

Formula: C_6H_{12}

Synonyms: Benzene hexahydride; Benzene, hexahydro; Ciclohexano (Spanish); Cyclohexan (German); Hexahydrobenzene; Hexamethylene; Hexanaphthene

CAS Registry Number: 110-82-7

HSDB Number: 60

RTECS Number: GU6300000

UN/NA & ERG Number: UN1145/128

EC Number: 203-806-2 [*Annex I Index No.:* 601-017-00-1]

Regulatory Authority and Advisory Information

Carcinogenicity: EPA: Available data are inadequate for an assessment of human carcinogenic potential.

Hazard Alert: Highly flammable, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U056

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1000 lb (454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%; NPRI.

Hazard symbols, risk, & safety statements: Hazard symbol: F, N, Xn; risk phrases: R11; R36/37/38; R62; R65; R67; R51/53; safety phrases: S2; S9; S16; S21; S25; S33; S60; S61; S62; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Cyclohexane is a colorless liquid with a mild, sweet odor. Molecular weight = 84.16; specific gravity (H_2O:1) = 0.774; boiling point = 81°C; freezing/melting point = 6.6°C; vapor pressure = 75 mmHg @ 19.3°C; flash point = −20°C (cc); autoignition temperature = 260°C. The explosive limits are: LEL: 1.3%; UEL: 8.4%. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 3, reactivity 0. Insoluble in water.

Potential Exposure: Cyclohexane is used as a chemical intermediate; as a solvent for fats, oils, waxes, resins, certain synthetic rubbers; and as an extractant of essential oils in the perfume industry.

Incompatibilities: May form explosive mixture with air. Contact with oxidizers, nitrogen dioxide, and oxygen can cause fire and explosion hazard. Can explode in heat when mixed with dinitrogen tetraoxide liquid.

Permissible Exposure Limits in Air

NIOSH IDLH = 1300 ppm [LEL]

Conversion factor: 1 ppm = 3.44 milligram per cubic meter @ 25°C & 1 atm

Odor threshold = 0.16 ppm.

OSHA PEL: 300 ppm/1050 milligram per cubic meter TWA

NIOSH REL: 300 ppm/1050 milligram per cubic meter TWA

ACGIH TLV[1]: 300 ppm/344 milligram per cubic meter TWA

PAC Ver. 29[138]

PAC-1: 300 ppm

PAC-2: 1700 ppm

PAC-3: 10,000 ppm

DFG MAK: 200 ppm/700 milligram per cubic meter TWA; Peak Limitation Category II(4); Pregnancy Risk Group D

Australia: TWA 300 ppm (1050 milligram per cubic meter), 1993; Austria: MAK 300 ppm (1050 milligram per cubic meter), 1999; Belgium: TWA 300 ppm (1030 milligram per cubic meter), 1993; Denmark: TWA 200 ppm (690 milligram per cubic meter), 1999; Finland: TWA 300 ppm (1050 milligram per cubic meter); STEL 375 ppm (1315 milligram per cubic meter), 1999; France: VME 300 ppm (1050 milligram per cubic meter), VLE 375 ppm (1300 milligram per cubic meter), 1999; Hungary: TWA 500 milligram per cubic meter; STEL 1000 milligram per cubic meter, 1993; the Netherlands: MAC-TGG 875 milligram per cubic meter, 2003; Norway: TWA 150 ppm (525 milligram per cubic meter), 1999; Poland: MAC (TWA) 300 milligram per cubic meter, MAC (STEL) 1000 milligram per cubic meter, 1999; Russia: TWA 150 ppm; STEL 80 milligram per cubic meter, 1993; Sweden: NGV 300 ppm (1000 milligram per cubic meter), KTV 370 ppm (1300 milligram per cubic meter), 1999; Switzerland: MAK-W 300 ppm (1050 milligram per cubic meter), KZG-W 600 ppm (2100 milligram per cubic meter), 1999; Turkey: TWA 300 ppm (1050 milligram per cubic meter), 1993; United Kingdom: TWA 100 ppm (350 milligram per cubic meter); STEL 300 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 100 ppm. Several states have set guidelines or standards for cyclohexane in ambient air[60] ranging from 1.4 milligram per cubic meter (Massachusetts) to 10.5−13.0 milligram per cubic meter (North Dakota) to 17.0 milligram per cubic meter (Virginia) to 21.0 milligram per cubic meter (Connecticut, Florida and New York) to 25.0 milligram per cubic meter (Nevada).

Determination in Air: Use NIOSH Analytical Method #1500 for Hydrocarbons, BP 36-126°C; OSHA Analytical Method 7.

Permissible Concentration in Water: Russia[43] set a MAC of 0.1 mg/L in water bodies used for domestic purposes and 0.01 mg/L in water bodies used for fishery purposes.

Determination in Water: No Method listed. Octanol−water coefficient: Log $K_{\text{ow}} = > 3.4$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: High concentrations (300 ppm): irritates eyes, nose, and respiratory tract. Inhalation of high concentration (300 ppm) may cause irritation of the eyes, nose, and throat. Higher concentrations may act as a narcotic resulting in dizziness, nausea, vomiting, or loss of consciousness. Levels of 1800 ppm can cause death. Vapor or liquid may cause skin irritation. This chemical destroys the skin's natural oils. If allowed to remain in contact with skin, may cause cracking, drying, chapping, smarting, and reddening. Ingestion of the liquid may cause aspiration into the lungs and chemical pneumonia. Animal studies suggest a lethal dose between 1 oz and 1 pt for an adult. Exposure to high levels can cause nausea, dizziness, lightheadedness, and drowsiness. Unconsciousness and death may occur at levels far above the occupational exposure limit. Alcohol synergistically increases the toxic effects of cyclohexane.

Long-Term Exposure: Prolonged or repeated exposure may cause skin drying, rash, and dermatitis. May cause damage to the liver, kidneys, brain, heart, and circulatory system.

Points of Attack: Eyes, respiratory system; central nervous system; skin.

Medical Surveillance: Consider possible irritant effects to the skin and respiratory tract in any preplacement or periodic examination, as well as any renal or liver complications. NIOSH lists the following tests: whole blood (chemical/metabolite); whole blood (chemical/metabolite); during exposure, expired air, expired air: during exposure; urine (chemical/metabolite); urine (chemical/metabolite) End-of-shift; urine (chemical/metabolite) Last 4 Hours of 8-Hour Exposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Do not induce vomiting.

Personal Protective Methods: Wear appropriate clothing to prevent repeated or prolonged skin contact. **8 hours** (more than 8 hours of resistance to breakthrough >0.1 μg/cm^2/min): nitrile rubber gloves, suits, boots; Viton gloves, suits; 4H and Silver Shield gloves; Barricade-coated suits; Responder suits; **4 hours** (At least 4 but <8 hours of resistance to breakthrough >0.1 μg/cm^2/min): polyvinyl alcohol gloves; Teflon gloves, suits, boots. Wear eye protection to prevent any reasonable probability of eye contact. Employees should wash promptly when skin is wet or contaminated. Remove clothing immediately if wet or contaminated to avoid flammability hazard.

Respirator Selection: *1000 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOv (APF = 25) [any powered, APR with organic vapor cartridge(s)]; or CcrFOv (APF = 50) [any chemical cartridge respirator with a full facepiece and organic vapor cartridge (s)]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance causes eye irritation or damage; eye protection needed; shield, hydrocarbon-insoluble rubber, or plastic apron.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with cyclohexane all handlers should be trained on its proper handling and storage. Before entering confine d space where cyclohexane may be present, check to make sure that an explosive concentration does not exist. Cyclohexane must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates), since violent reactions occur. Store in tightly closed containers in a cool well-ventilated area away from heat. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever cyclohexane is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1145 Cyclohexane, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a highly flammable liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (2); (100).

New York State Department of Health, *Chemical* Fact Sheet: Cyclohexane, Bureau of Toxic Substance Assessment, Albany, NY of Toxic Substance Assessment (Mar. 1986 and Version 2).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Cyclohexane, Trenton, NJ (December 1999).

Cyclohexanol C:1690

Formula: $C_6H_{12}O$; $C_6H_{11}OH$

Synonyms: Adronal; Anol; Ciclohexanol (Spanish); 1-Cyclohexanol; Cyclohexyl alcohol; Hexahydrophenol; Hexalin; Hydralin; Hydrophenol; Hydroxycyclohexane; Naxol; Phenol, hexahydro-

CAS Registry Number: 108-93-0

HSDB Number: 61

RTECS Number: GB7875000

UN/NA & ERG Number: UN1986 (Alcohols, flammable, toxic, n.o.s.)/131

EC Number: 203-630-6 [*Annex I Index No.:* 603-009-00-3]

Regulatory Authority and Advisory Information

California Proposition 65 Chemical[102]: developmental, male, *delisted 1/25/2002.*

Hazard Alert: Flammable, Suspected reprotoxic hazard, Suspected of causing genetic defects, Hormone, Primary irritant (w/o allergic reaction).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xn; risk phrases: R10; R20/22-R37/38; R61; safety phrases: S2; S24/25. WGK (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Cyclohexanol is a sticky solid (above 25°C/77°F) or colorless, viscous liquid. Faint camphor odor. Molecular weight = 100.16; specific gravity (H_2O:1) = 0.95 @ 25°C; boiling point = 161°C; freezing/melting point = 24°C; vapor pressure = 1 mmHg @ 21°C; flash point = 68°C; autoignition temperature = 300°C. The explosive limits are: LEL: 2.4%; UEL: 12%. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 2, reactivity 0. Slight solubility in water; solubility = 4% @ 20°C.

Potential Exposure: Cyclohexanol is used in making placticizers, dry cleaning, dyebath; and textile finishing formulations; as a solvent for ethyl cellulose and other resins; it is used in soap manufacture; it is used as a raw material for adipic acid manufacture; as a nylon intermediate.

Incompatibilities: Forms explosive mixture in air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Attacks some plastics.

Permissible Exposure Limits in Air

NIOSH IDLH = 400 ppm

Conversion factor: 1 ppm = 4.10 milligram per cubic meter @ 25°C & 1 atm

Odor threshold = 0.07 ppm

OSHA PEL: 50 ppm/200 milligram per cubic meter TWA

NIOSH REL: 50 ppm/200 milligram per cubic meter TWA [skin]

ACGIH TLV[1]: 50 ppm/206 milligram per cubic meter TWA [skin]
PAC Ver. 29[138]
PAC-1: 150 ppm
PAC-2: 580 ppm
PAC-3: 3500 ppm [≥10% LEL, lower explosive limit but <50% LEL]
DFG MAK: 50 ppm/210 milligram per cubic meter [skin]; Peak Limitation Category I(1) Pregnancy Risk Group: D
Australia: TWA 50 ppm (200 milligram per cubic meter) [skin], 1993; Austria: MAK 50 ppm (200 milligram per cubic meter), 1999; Belgium: TWA 50 ppm (206 milligram per cubic meter) [skin], 1993; Denmark: TWA 50 ppm (200 milligram per cubic meter), 1999; Finland: TWA 50 ppm (200 milligram per cubic meter); STEL 75 ppm (300 milligram per cubic meter), 1999; France: VME 50 ppm (200 milligram per cubic meter), VLE 75 ppm (300 milligram per cubic meter), 1999; Hungary: TWA 20 milligram per cubic meter; STEL 40 milligram per cubic meter [skin], 1993; the Netherlands: MAC-TGG 1 milligram per cubic meter, 2003; Norway: TWA 25 ppm (100 milligram per cubic meter), 1999; the Philippines: TWA 50 ppm (200 milligram per cubic meter), 1993; Poland: MAC (TW A) 20 milligram per cubic meter; STEL 60 milligram per cubic meter, 1999; Russia: TWA 25 ppm, 1993; Sweden: NGV 50 ppm (200 milligram per cubic meter), KTV 75 ppm (300 milligram per cubic meter), 1999; Switzerland: MAK-W 50 ppm (200 milligram per cubic meter), KZG-W 100 ppm (400 milligram per cubic meter), 1999; United Kingdom: TWA 50 ppm (208 milligram per cubic meter), 2000; United Kingdom: LTEL 50 ppm (200 milligram per cubic meter), 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 50 ppm [skin]. Several states have set guidelines or standards for cyclohexanol in ambient air[60] ranging from 0.476 milligram per cubic meter (Kansas) to 2.0 milligram per cubic meter (North Dakota) to 3.3 milligram per cubic meter (Virginia) to 4.0 milligram per cubic meter (Connecticut) to 4.76 milligram per cubic meter (Nevada).

Determination in Air: See NIOSH Analytical Method (IV) #1402, Method #1405, and OSHA Analytical Method 7.

Permissible Concentration in Water: Russia[43] set a MAC in water bodies used for domestic purposes of 0.05 mg/L.

Determination in Water: No method listed. Octanol−water coefficient: Log $K_{ow} = 1.2$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Cyclohexanol irritates the eyes, skin, and respiratory tract. May affect the central nervous system. In high concentrations it can cause headache, nausea, vomiting, dizziness, and unconsciousness.

Long-Term Exposure: Removes the natural oils from the skin causing drying, cracking, and dermatitis. Prolonged or high exposures can cause liver, kidney, and lung damage.

Points of Attack: Eyes, skin respiratory system.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Lung function tests, liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek Medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a Medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. **8 hours** (more than 8 hours of resistance to breakthrough >0.1 μg/cm^2/min): butyl rubber gloves, suits, boots; nitrile rubber gloves, suits, boots; polyvinyl alcohol gloves; Teflon gloves, suits, boots; Viton gloves, suits; **4 hours** (At least 4 but <8 hours of resistance to breakthrough >0.1 μg/cm^2/min): Neoprene rubber gloves, suits, boots; polyvinyl chloride gloves, suits, boots; 4H and Silver Shield gloves Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. When working with liquids, wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. When working with powders or dusts, wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 400 ppm:* CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)];* or PaprOv (APF = 25) [any powered, APR with organic vapor cartridge(s)];* or GmFOv (APF = 50) (any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister); or Sa (APF = 10) (any supplied-air respirator);* or SCBAF (APF = 50) (any SCBA with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, SCBA). *Substance reported to cause eye irritation or damage; eye protection required.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with cyclohexanol all handlers should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Cyclohexanol must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine), since violent reactions occur. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1986 Alcohols, toxic, flammable, n.o.s., Hazard Class: 3; Labels: 3-Flammable liquid, 6.1-Poison Inhalation Hazard, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid or solid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged Exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(102); (31); (173); (101); (138).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Cyclohexanol, Trenton, NJ (January 1997).

Cyclohexanone C:1700

Formula: $C_6H_{10}O$

Synonyms: Anon; Anone; Ciclohexanona (Spanish); Cyclohexyl ketone; Hexalin; Hexanon; Hydralin; Hytrol O; Ketohexamethylene; Nadone; NCI-C55005; Oxocyclohexane; Pimelic ketone; Pimelin ketone; Pomelic acetone; Sextone

CAS Registry Number: 108-94-1

HSDB Number: 186

RTECS Number: GW1050000

UN/NA & ERG Number: UN1915/127

EC Number: 203-631-1 [*Annex I Index No.:* 606-010-00-7]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human Inadequate Evidence; Animal Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1999.

Hazard Alert: Highly flammable, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction).

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U057

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.36; Nonwastewater (mg/L), 0.75 TCLP

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 5000 lb (2270 kg)

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1% (cyclohexanone, cyclohexanone, peroxide, carcinogen)

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xn; risk phrases: R11; R20; R62; R63; safety phrases: S2; S21; S25; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Cyclohexanone is a water-white to slightly yellow liquid with a peppermint-like or acetone-like odor. The Odor Threshold is 0.12−0.24 ppm in air. Molecular weight = 98.14; specific gravity (H_2O:1) = 0.95 @ 20°C; boiling point = 155.43°C; freezing/melting point = −32.1°C; flash point = 44°C; autoignition temperature = 420°C. The explosive limits are: LEL: 1.1% @ 100°C; UEL: 9.4%. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 3, reactivity 0 Soluble in water.

Potential Exposure: It is used in metal degreasing and as a solvent for lacquers, resins; and insecticides. It is an intermediate in adipic acid manufacture. Also used as an emulsifier.

Incompatibilities: May form explosive mixture with air. Contact with oxidizing agents or nitric acid may cause a violent reaction. Do not use brass, copper, bronze, or lead fittings. Attacks many coatings and plastic materials.

Permissible Exposure Limits in Air

NIOSH IDLH = 700 ppm

Conversion factor: 1 ppm = 4.02 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 50 ppm/200 milligram per cubic meter TWA

NIOSH REL: 25 ppm/100 milligram per cubic meter TWA [skin]

ACGIH TLV[1]: 20ppm TWA; 50 ppm STEL [skin]; confirmed animal carcinogen with unknown relevance to humans.

PAC Ver. 29[138]

PAC-1: 60 ppm

PAC-2: 830 ppm

PAC-3: 5000 ppm

DFG MAK: [skin] Carcinogen Category 3B

European OEL: 10 ppm TWA; 20 ppm STEL [skin] (2000)

Australia: TWA 25 ppm (100 milligram per cubic meter), 1993; Austria: MAK 25 ppm (100 milligram per cubic meter), 1999; Belgium: TWA 25 ppm (100 milligram per cubic meter), 1993; Denmark: TWA 25 ppm (100 milligram per cubic meter) [skin] 1999; Finland: TWA 50 ppm (200 milligram per cubic meter); STEL 75 ppm (250 milligram per cubic meter), 1999; France: VME 25 ppm (100 milligram per cubic meter), 1999; Japan: 25 ppm (100 milligram per cubic meter), 1999; Norway: TWA 20 ppm (80 milligram per cubic meter), 1999; the Philippines: TWA 50 ppm (200 milligram per cubic meter), 1993; Poland: MAC (TWA) 20 milligram per cubic meter; STEL 160 milligram per cubic meter, 1999; Russia: TWA 25 ppm; STEL 10 milligram per cubic meter, 1993; Sweden: NGV 25 ppm (100 milligram per cubic meter), KTV 50 ppm (200 milligram per cubic meter) [skin] 1999; Switzerland: MAK-W 25 ppm (100 milligram per cubic meter), KZG-W 50 ppm (200 milligram per cubic meter), 1999; Turkey: TWA 50 ppm (200 milligram per cubic meter), 1993; United Kingdom: TWA 25 ppm (102 milligram per cubic meter); STEL 100 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: ACGIH TLV: [skin]; confirmed animal carcinogen with unknown relevance to humans. Several states have set guidelines or standards for cyclohexanone in ambient air[60] ranging from 1.0−4.0 milligram per cubic meter (North Dakota) to 1.6 milligram per cubic meter (Virginia) to 2.0 milligram per cubic meter (Connecticut) to 2.38 milligram per cubic meter (Nevada).

Determination in Air: Use NIOSH Analytical Method #1300 (Ketones), Method #2555, and OSHA Analytical Method 1. Also, NIOSH Analytical Method #2549, Volatile organic compounds.

Permissible Concentration in Water: Russia[43] set a MAC in water bodies used for domestic purposes of 0.2 mg/L.

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact

Harmful Effects and Symptoms

Short-Term Exposure: Cyclohexanone irritates the eyes, skin, and respiratory tract. Contact can burn the eyes. LD_{50} (oral-rat) = 1535 mg/kg (slightly toxic). Cyclohexanone may affect the central nervous system. Exposure of high concentrations can cause dizziness, lightheadedness, and unconsciousness.

Long-Term Exposure: Repeated or prolonged contact with skin may cause drying, cracking, and dermatitis. The following chronic (long-term) health effects can occur at some time after exposure to cyclohexanone and can last for months or years: cyclohexanone may damage the developing fetus. Long-term exposure may cause liver and kidney damage. Long-term exposure may cause clouding of the eye lenses (cataracts).

Points of Attack: Eyes, skin, respiratory system; central nervous system; liver, kidneys.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater, or significant skin contact) the following are recommended before beginning work and at regular times after that: Liver function tests. If symptoms develop or overexposure is suspected, the following may also be useful: kidney function tests. Exam of the eyes. Interview for brain effects including recent memory, mood, concentration, headaches, malaise, and altered sleep patterns. Consider cerebellar, autonomic, and peripheral nervous system evaluation. Positive and borderline victims should be referred for neuropsychological testing.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek Medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Prevent skin contact. **8 hours** (more than 8 hours of resistance to breakthrough >0.1 μg/cm^2/min): butyl rubber gloves, suits, boots; 4H and Silver Shield gloves; **4 hours** (At least 4 but <8 hours of resistance to breakthrough >0.1 μg/cm^2/min): polyvinyl alcohol gloves. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Remove clothing immediately if set or contaminated to avoid flammability hazard.

Respirator Selection: *625 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOv (APF = 25) [any powered, APR with organic vapor cartridge(s)]. *700 ppm:* CcrFOv (APF = 50) [any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s)]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or PaprTOv (APF = 50) [any powered, APR with a tight-fitting facepiece and organic vapor cartridge(s)]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance causes eye irritation or damage; eye protection needed.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with Cyclohexanone all handlers should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Cyclohexanone must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, chlorates, nitrates, and permangates), since violent reactions occur. Store in tightly closed containers in a cool well-ventilated area away from heat, sparks, and flames. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1915 Cyclohexanone, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged Exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to

fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (2); (100).

National Institute for Occupational Safety and Health (NIOSH), "Criteria for a Recommended Standard: Occupational Exposure to Ketones", NIOSH Document Number 78-173, Cincinnati OH (1978).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Cyclohexanone, Trenton, NJ (February 2001).

Sax, N.I., Ed., "*Dangerous Properties of Industrial Materials Report*," 5, No. 6, 50−52 (1985).

Cyclohexene C:1710

Formula: C_6H_{10}

Synonyms: Benzene tetrahydride; Benzene, tetrahydro-; Cyclohexene; Cyclohex-1-ene; Hexanaphthylene; Tetrahydrobenzene; 1,2,3,4-Tetrahydrobenzene

CAS Registry Number: 110-83-8

HSDB Number: 1624

RTECS Number: GW2500000

UN/NA & ERG Number: UN2256/130 (P)

EC Number: 203-807-8

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Highly flammable, Polymerization hazard, Environmental hazard.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: F+, T, N; risk phrases: R11; R19; R22; safety phrases: S21; S29/35; S61; (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Cyclohexene is a colorless liquid (cyclic alkene) with a sweetish odor. Molecular weight = 82.15; specific gravity (H_2O:1) = 0.81; boiling point = 82.7°C; freezing/melting point = −104°C; vapor pressure = 67 mmHg @ 20°C; flash point = −6°C; autoignition temperature = 310°C. Explosive limits in air: LEL: 1.2%; UEL: −4.8% @ 100°C. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 3, reactivity 0. Insoluble in water.

Potential Exposure: May be used as an intermediate in making other chemicals (e.g., adipic acid, maleic acid, hexahydro benzoic acid), oil extraction and as a catalyst solvent.

Incompatibilities: Vapor may form explosive mixture with air. The substance can form explosive peroxides. The substance may polymerize under certain conditions. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

NIOSH IDLH = 2000 ppm

OSHA PEL: 300 ppm/1015 milligram per cubic meter TWA

NIOSH REL: 300 ppm/1015 milligram per cubic meter TWA

ACGIH TLV[1]: 300 ppm/1010 milligram per cubic meter TWA

PAC Ver. 29[138]

PAC-1: 900 ppm

PAC-2: 1700 ppm

PAC-3: 10.000 ppm

Australia: TWA 300 ppm (1015 milligram per cubic meter), 1993; Austria: MAK 300 ppm (1015 milligram per cubic meter), 1999; Belgium: TWA 300 ppm (1010 milligram per cubic meter), 1993; Denmark: TWA 300 ppm (1015 milligram per cubic meter), 1999; Finland: TWA 300 ppm (1015 milligram per cubic meter) [skin] 375 ppm (1270 milligram per cubic meter), 1999; France: VME 300 ppm (1015 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 1015 milligram per cubic meter, 2003; the Philippines: TWA 300 ppm (1015 milligram per cubic meter), 1993; Poland: MAC (TWA) 300 milligram per cubic meter, MAC [skin] 900 milligram per cubic meter, 1999; Russia [skin] 50 milligram per cubic meter, 1993; Switzerland: MAK-W 300 ppm (1015 milligram per cubic meter), KZG-W 600 ppm (2030 milligram per cubic meter), 1999; Turkey: TWA 300 ppm (1050 milligram per cubic meter), 1993; United Kingdom: TWA 300 ppm (1020 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: 300 ppm TWA. Several states have set guidelines or standards for Cyclohexene in ambient air[60] ranging from 10.15 milligram per cubic meter (North Dakota) to 17.0 milligram per cubic meter (Virginia) to 20.3 milligram per cubic meter (Connecticut) to 24.2 milligram per cubic meter (Nevada).

Determination in Air: Charcoal adsorption followed by workup with CS_2, and analysis by GC. Use NIOSH Analytical Method #1500 for Hydrocarbons, BP 36-126°C; OSHA Analytical Method 7.

Permissible Concentration in Water: Russia[43] set a MAC in water bodies used for domestic purposes of 0.02 mg/L.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact

Harmful Effects and Symptoms

Short-Term Exposure: Cyclohexene irritates the eyes, skin, and respiratory tract. This chemical can be absorbed through the skin, thereby increasing exposure. Swallowing the liquid may cause droplets to enter the lung and cause chemical pneumonia. Overexposure can cause dizziness, lightheadedness, loss of muscle coordination. Higher exposures can cause tremors, collapse, and death. A closely related chemical, cyclopropane, can cause irregular heartbeat, although it is not known if this chemical causes the same effect. High exposure can cause liver and brain damage.

Long-Term Exposure: Repeated or high concentrations can cause dry skin and rash, liver and brain damage.

Points of Attack: Eyes, skin, respiratory system; central nervous system.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Liver function tests. Examination of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Do NOT induce vomiting.

Personal Protective Methods: Wear solvent-resistant gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash. Remove clothing immediately if wet or contaminated to avoid flammability hazard.

Respirator Selection: *Up to 2000 ppm*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOv (APF = 25) [any powered, APR with organic vapor cartridge(s)]; or CcrFOv (APF = 50) [any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s)]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. May form peroxides in storage. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers (such as chlorine, bromine, and fluorine). Sources of ignition, such as smoking and open flames, are prohibited where cyclohexene is handled, used, or stored. Metal containers involving the transfer of 5 gal or more of cyclohexene should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of cyclohexene. Wherever cyclohexene is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN2256 Cyclohexene, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep cyclohexene out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of

carbon. Use dry chemical, carbon dioxide; or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.
Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References
(31); (173); (101); (138); (2); (100).
New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Cyclohexene, Trenton, NJ (February 2001).

Cyclohexenyl Trichlorosilane C:1720

Formula: $C_9H_9Cl_3Si$; $C_6H_9SiCl_3$
Synonyms: Cyclohexene, 4-(trichlorosilyl)-; Trichloro-3-cyclohexenylsilane; 4-(Trichlorosilyl) cyclohexene
CAS Registry Number: 10137-69-6
HSDB Number: 7795
RTECS Number: VV2800000
UN/NA & ERG Number: UN1762/156
EC Number: 233-377-7
Regulatory Authority and Advisory Information
Hazard Alert: Flammable, Corrosive, Violent reaction with water; Air reactive.
Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.
Hazard symbols, risk, & safety statements: Hazard symbol: T+, Xn; risk phrases: R14; R34; R36/37/38; R34; R40; R45; R51; safety phrases: S22; S26; S36/37/39; S45; S53; S41 (see Appendix 4)
Description: Cyclohexenyl trichlorosilane is a colorless fuming liquid. Odor like hydrogen chloride. Molecular weight = 215.59; specific gravity = 1.23 @ 20°C; boiling point = > 150°C @ 750 mmHg; melting point = < 25 C[136]; flash point = > 66°C[136]; 99°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 2, reactivity 0~~W~~. Reacts with water, rapidly releasing corrosive hydrogen chloride gas.
Potential Exposure: This material is used to make silicone polymers.
Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Chlorosilanes react vigorously with bases and both organic and inorganic acids generating toxic and/or flammable gases. Chlorosilanes react with water, moist air, or steam releasing heat and toxic, corrosive fumes of hydrogen chloride. The reaction may also release flammable hydrogen fumes. Attacks metals in the presence of moisture. Some chlorosilanes are pyrophoric; self-ignite in air. Contact with ammonia can cause a self-igniting compound.
Permissible Exposure Limits in Air
PAC Ver. 29[138]
based on 15 other trichlorosilanes with identical PACs (for reference only)
PAC-1: **0.60**$_{\mathbf{A}}$ ppm
PAC-2: **7.3**$_{\mathbf{A}}$ ppm
PAC-3: **33**$_{\mathbf{A}}$ ppm
*AEGLs (Acute Emergency Guideline Levels) are marked with a sub script "A" and correspond to 60-minute values.
Determination in Air: No OEL established.
Permissible Concentration in Water: No criteria set ~~W~~ (water reactive).
Routes of Entry: Inhalation.
Harmful Effects and Symptoms
Short-Term Exposure: Cyclohexenyl Trichlorosilane can affect you when breathed in. Exposure can irritate the lungs, causing coughing and/or shortness of breath. Higher exposures can cause a build-up of fluid (pulmonary edema), a medical emergency. This can cause death. Cyclohexenyl Trichlorosilane is a corrosive chemical and contact can cause severe skin and eye burns. Exposure can irritate the eyes, nose, and throat. LD_{50} (oral-rat) = 2830 mg/kg (slightly toxic).
Long-Term Exposure: Repeated Exposure may cause bronchitis with phlegm and shortness of breath.
Points of Attack: Lungs.
Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. If symptoms

develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek Medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a Medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear plash-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to Cyclohexenyl Trichlorosilane exists, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—White: Corrosive or contact Hazard; Store separately in a corrosion resistant location. Prior to working with Cyclohexenyl Trichlorosilane all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from water, steam and moisture because toxic and corrosive chloride gases, including hydrogen chloride can be produced. Sources of ignition, such as smoking and open flames, are prohibited where cyclohexenyl trichlorosilane is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN1762 Cyclohexenyl trichlorosilane, Hazard class: 8; Labels: 8-Corrosive material.

Spill Handling:

Cyclohexenyl trichlorosilane when spilled in water

Initial isolation and protective action distances as Chlorosilanes, corrosive, n.o.s.

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.3/0.5
Night 0.9/1.5

Stay upwind and uphill. Isolate the area of release or fire and deny entry. Remove all ignition sources. Stop the release if it can be done safely from a distance. All equipment used to handle this material must be grounded. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. *Small spill*: Cover with *dry* earth, *dry* sand, or other noncombustible material followed with plastic sheet to minimize spreading or contact with water or rain. Use clean nonsparking tools to collect material and place material into loosely covered plastic containers for later disposal. Prevent material and runoff from entering sewers and waterways if it can be done safely well ahead of the release. Use vapor suppressing foam to disperse vapors−contain runoff. Water spray may reduce vapor, but may not prevent ignition in enclosed spaces. Ventilate confined area if it can be done without placing personnel at risk. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include phosgene, hydrogen chloride, and oxides of metal and carbon. *FOR CHLOROSILANES DO NOT USE WATER. USE AFFF ALCOHOL-RESISTANT, MEDIUM EXPANSION FOAM. Small fire*: use *dry* chemical, CO_2, *dry* sand, or alcohol-resistant *foam*. May react with foams releasing corrosive/toxic gases. *Large fire*: use water spray or alcohol-resistant foam if it is available in sufficient amounts. Under favorable conditions, experienced crews can use coordinated fog streams to sweep the flames off the surface of the burning liquid. Combustible material: may burn but does not ignite readily. Most vapors are heavier than air. They will spread along ground and collect in low or confined areas (sewers, basements, tanks). Vapors may travel to source of ignition and flashback. Containers may explode when heated or if contaminated with water. Keep exposures cool long after fire is out to protect against reignition. Do not direct straight streams into the liquid. Cool exposed containers with large quantities of water from unattended equipment or remove intact containers if it can be done safely. *Do not get water on spilled substance or inside containers*. If cooling streams are ineffective (*venting sound increases in volume and pitch, tank discolors, or shows signs of deforming*), withdraw immediately to a secure location. Always stay away from ends of tanks, especially when engulfed in flames. If material or contaminated runoff from fire control enters waterways, notify downstream users of potentially contaminated water. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156.

References

(31); (173); (101); (138).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Cyclohexenyl Trichlorosilane, Trenton, NJ (December 1998).

Cyfluthrin C:1806

Formula: $C_{22}H_{18}Cl_2FNO_3$

Synonyms: Aztec; Attatox; Bay FCR 1272; Baythroid; Baythroid H; Baythroid technical; Bug-B-Gon; Contur; Cyano(4-fluoro-3-phenoxyphenyl)methyl 3-(2,2-dichloroethenyl)-2,2-dimethylcyclopropanecarboxylate; Cyclopropanecarboxylic acid, 3-(2,2-dichloroethenyl)-2,2-dimethyl-, cyano(4-fluoro-3-phenoxyphenyl)methyl ester; Cyclopropanecarboxylic acid, 2-(2,2-dichlorovinyl)-3,3-dimethyl-, ester with(4-fluoro-3-phenoxyphenyl)hydroxyacetonitrile; Cyfluthin; Cyfluthrine; Cylathrin; Cyfoxylate; Eulan SP; FCR 1272; Intuder; Intuder HPX; Laser; Renounce; Responsar; Solfac; Tempo; Tempo H; Tempo 20WP

CAS Registry Number: 68359-37-5

HSDB Number: 6599

RTECS Number: GZ1253000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154; UN3349 (pyrethroid pesticide, solid toxic)/151

EC Number: 269-855-7 [*Annex I Index No.:*607-254-00-7]

Regulatory Authority and Advisory Information

Carcinogenicity: EPA, Not likely a human carcinogen

Hazard Alert: Poison, Combustible, Highly toxic, Possible polymerization hazard (nitriles), Possible endocrine disruptor.

Clean water act: Section 311 Hazardous Substances/RQ (same as CERCLA) as pyrethrins

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%

Permissible Exposure Limits for Chemical Contaminants (CAL/OSHA) as pyrethrum

Hazard symbols, risk, & safety statements: Hazard symbol: T+, N; risk phrases: R26/28; R50/53; safety phrases: S1/2; S28; S36/37/39; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: In pure form this chemical may be colorless crystalline solid or powder. Commercial is a yellowish paste or viscous, yellowish-brown oil. Aromatic odor. Molecular weight = 434.29; specific gravity (H_2O:1) = 1.28; boiling point = 210°C (decomposes); freezing/melting point = 59°C; 79°C; vapor pressure = 1.6×10^{-8} mmHg @ 20°C; 3×10^{-4} mmHg @ 25°C. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 1, reactivity 0. Low solubility in water.

Potential Exposure: Cyfluthrin is a synthetic pyrethroid, nonsystemic insecticide used to control a variety of chewing and sucking insects on cotton, hops, cereals, corn, peanuts, fruit, potatoes, and other crops and vegetables. It is also used to control structural pests such as termites. Cyfluthrin can be found in both Restricted Use Pesticides (RUP) and General Use Pesticides (GUP) category. It is also a nitrile.

Incompatibilities: May react violently with strong oxidizers, bromine, 90% hydrogen peroxide, phosphorus trichloride, silver powders, or dust. Incompatible with silver compounds. Mixture with some silver compounds forms explosive salts of silver oxalate. Nitriles may polymerize in the presence of metals and some metal compounds. They are incompatible with acids; mixing nitriles with strong oxidizing acids can lead to extremely violent reactions. Nitriles are generally incompatible with other oxidizing agents such as peroxides and epoxides. The combination of bases and nitriles can produce hydrogen cyanide. Nitriles are hydrolyzed in both aqueous acid and base to give carboxylic acids (or salts of carboxylic acids). These reactions generate heat. Peroxides convert nitriles to amides. Nitriles can react vigorously with reducing agents. Acetonitrile and propionitrile are soluble in water, but nitriles higher than propionitrile have low aqueous solubility. They are also insoluble in aqueous acids[101].

Permissible Exposure Limits in Air:

ACGIH TLV[1]: (all pyrethrins) 5 milligram per cubic meter TWA

NIOSH REL: *Nitriles:* 2 ppm, Ceiling Concentration, not to be exceeded in any 15-minute work period.

Determination in Air: Collection by impinger or fritted bubbler, analysis by gas liquid chromatography/ultraviolet.

See NIOSH IV, Method #5008,[18] pyrethrum. See also NIOSH Criteria Document 212 *Nitriles*.

Determination in Water: Octanol−water coefficient: Log K_{ow} = > 5. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood. Fish toxicity (threshold)[101]: Extra high—0.01330 ppb, MATC.

Harmful Effects and Symptoms

Short-Term Exposure: Contact with eyes or skin may cause irritation or injury. Inhalation should be avoided; use NIOSH- or CEN (UK)-approved APRs for pesticides. May be harmful if swallowed. LD_{50} (oral, rat) = >400 mg/kg; LD_{50} (dermal, rat) = 5 g/kg.

Long-Term Exposure: Fluorides may cause bone disease (pain and tenderness of the bones); mottled teeth in children. May be an endorine disruptor. See NIOSH Criteria Document 212 *Nitriles*. Human toxicity (long term)[101]: Very low—175.00 ppb, Health advisory.

Points of Attack: Endocrine system, bones.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended: Employees should be screened for history of certain Medical conditions which might place the employee at increased risk from pyrethroid exposure. Chronic respiratory disease: In persons with chronic respiratory disease, especially asthma, the inhalation of pyrethroids might cause exacerbation of symptoms due to its sensitizing properties. Lung function tests. These may be normal if the person is not having an attack at the time of the test. Consider chest X-ray if lung symptoms are present. Skin disease: Pyrethroids can cause dermatitis which may be allergic in nature. Persons with preexisting skin disorders may be more susceptible to the effects of this agent. Evaluation by a qualified allergist, including exposure history and testing, may help diagnose allergy. Any employee developing the above-listed conditions should be referred for further medical examination[9].

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Applicators and other handlers must wear: Coveralls worn over long-sleeved shirt and long pants; Chemical-resistant gloves such as DuPont Tychem suit fabrics, barrier laminate, or Viton; Chemical-resistant footwear plus socks; Protective eye wear; Chemical-resistant headgear for overhead exposure; Chemical-resistant apron when cleaning equipment, mixing, or loading[83]. Agricultural Use/Engineering Controls: When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the WPS for agricultural pesticides, 40 CFR 170.240(d)(4-6), the handler PPE requirements may be reduced or modified as specified in the WPS. Firefighters should wear NIOSH-approved SCBA and full protective clothing.

Respirator Selection: NIOSH/OSHA *for pyrethrum*: *50 milligram per cubic meter:* CcrOv95 (APF = 10) [any air-purifying half-mask respirator equipped with an organic vapor cartridge(s) in combination with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *125 milligram per cubic meter:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOvHie (APF = 25) (any air-purifying full facepiece respirator equipped with an organic vapor cartridge in combination with a high-efficiency particulate filter). *250 milligram per cubic meter:* CcrFOv100 (APF = 50) [any air-purifying full facepiece respirator equipped with organic vapor cartridge(s) in combination with an N100, R100, or P100 filter]; or PaprTOvHie (APF = 50) [any powered, APR with a tight-fitting facepiece and organic vapor cartridge(s) in combination with a high-efficiency particulate filter]; or SCBAF (APF = 50) (any SCBA with full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *5000 milligram per cubic meter:* SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—Blue: Health Hazard/Poison. Store in a secure poison location at temperature <35°C and away from alkaline materials. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Always store pesticides in their original containers, complete with labels that list ingredients, directions for use, and first aid steps in case of accidental poisoning. Never store pesticides in cabinets with or near food, animal feed, or medical supplies. Do not store pesticides in places where flooding is possible or in places where they might spill or leak into wells, drains, ground water, or surface water[72].

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN3349 (pyrethroid pesticide, solid, toxic)/151 Pyrethroid pesticide, solid toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous material UN3439 Nitriles, solid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling:

Nitriles spill

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.3/0.5
Night 0.5/0.8

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen and carbon and HF and hydrogen chloride gases. *On a small fire:* use dry chemical, CO_2, or water spray. On a large fire, use water spray, fog, or regular foam. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal; do not scatter the material. Use water spray or fog; do not use straight streams. *Fire involving storage or vehicular tanks:* Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Do not get water inside containers. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. ALWAYS stay away from tanks engulfed in fire. For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies.

Disposal Method Suggested: Incineration would be an effective disposal procedure where permitted. If an efficient incinerator is not available, the product should be mixed with large amounts of combustible material and contact with the smoke should be avoided. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers.

References

(31); (173); (101); (138); (203); (100).

EXTOXNET, Extension Toxicology Network, *Pesticide Information Profile, Cyfluthrin*, Oregon State University, Corvallis, OR (March 2001). http://pmep.cce.cornell.edu/profiles/extoxnet/carbaryl-dicrotophos/cyfluthrin-ext.html.

United States Environmental Protection Agency, Office of Pesticide Programs, *Pesticide Residue Limits, Cyfluthrin*, 40 CFR 180.436. http://www.epa.gov/pesticides/food/viewtols.htm.

Cycloheximide C:1730

Formula: $C_{15}H_{23}NO_4$

Synonyms: Acti-Aid; Actidione; Actidione TGF; Actidone; Actispray; 3[2-(3,5-Dimethyl-2-oxocyclohexyl)-2-hydroxyethyl]glutarimide; Glutarimide,3-[2-(3,5-dimethyl-2-oxocyclohexyl)-2-hydroxyethyl]-; Hizarocin; Kaken; Naramycin; Naramycin A; Neocycloheximide; NSC-185; 2,6-Piperidinedione, 4-(2-3,5-dimethyl-2-oxocyclohexyl)-2-hydroxyethyl-, (IS)-[1a (S*),3a,5b]-

CAS Registry Number: 66-81-9; 21059-09-6

HSDB Number: 1552 (66-81-9)

RTECS Number: MA4375000

EC Number: 200-636-0 [*Annex I Index No.:* 613-140-00-8]

Regulatory Authority and Advisory Information

United States Environmental Protection Agency Gene-Tox Program: Positive: *E. coli polA* with S9; Sperm morphology-mouse; Negative: *N. crassa-aneuploidy*; Inconclusive: Carcinogenicity-mouse/rat; Inconclusive: *D. melanogaster*-whole sex chromosome loss; Inconclusive: Mammalian micronucleus; *E. coli* polA without S9.

California Proposition 65 Chemical[102]: Cancer; Developmental/Reproductive toxin 1/1/1989.

Hazard Alert: Reproductive toxin: possible risk of gene damage/impaired fertility; Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction), Poisonous, fatal if swallowed.

Banned or Severely Restricted (in agriculture) (Malaysia) (UN)[13]

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg)

European/International Regulations *(66-81-9)*: Hazard symbol: T+, N; risk phrases: R61; R28; R50/53; R62; R63; R68; safety phrases: S41; S45; S53; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water. (CAS 66-81-9)

Description: Cycloheximide is a colorless crystalline substance. Molecular weight = 281.39; boiling point = (decomposes) 492°C; freezing/melting point = 115−121°C; vapor pressure = 6×10^{-3} mPa @ 25°C; flash point = 250°C. Highly soluble in water.

Potential Exposure: A potential danger to those involved in the manufacture, formulation, or application of this fungicide and pesticide. Used as an antibiotic, plant growth regulator, and protein synthesis inhibitor. Used on oranges for processing and to inhibit growth of many pathogenic plant fungi. Also used as a repellent for rodents and other animal pests; and in cancer therapy.

Incompatibilities: Incompatible with oxidizers, acid anhydrides; strong bases.

Permissible Exposure Limits in Air

66-81-9

PAC Ver. 29[138]

PAC-1: 0.18 milligram per cubic meter

PAC-2: 2 milligram per cubic meter

PAC-3: 12 milligram per cubic meter

Determination in Water: No method listed. Octanol−water coefficient: Log $K_{ow} = < 0.6$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short-Term Exposure: Contact can cause eye and skin irritation. Exposure can cause excessive salivation; nausea, vomiting, diarrhea, and elevated Blood urea nitrogen (BUN). High exposures can also cause imbalance, tremors, seizures, and coma. Extremely toxic (LD_{50} value for rats is only 3.7 mg/kg). The probable oral lethal dose in humans is 5−50 mg/kg, or 7 drops to 1 teaspoonful for a 150-lb person. Signs of skin irritation may appear as much as 6−24 hours after exposure.

Long-Term Exposure: May cause mutations and damage the developing fetus. May cause liver and kidney damage.

Points of Attack: Reproductive system. Liver and kidneys.

Medical Surveillance: Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a Medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours following skin contact.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Where there is a potential for overexposure:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizing agents; acid hydrides, and strong bases.

Spill Handling: Avoid breathing dusts. Keep upwind. Wear SCBA. Material is rapidly inactivated at room temperature by dilute alkali. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Thermal decomposition products may include oxides of nitrogen and carbon. Wear SCBA and full protective clothing. Use dry chemical, carbon dioxide; water spray; alcohol foam or polymer foam extinguishers. Thermal decomposition products may include oxides of nitrogen and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: High-temperature incinerator with flue gas scrubbing equipment.

References

(102); (31); (173); (101); (138); (80); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 2, No. 5, 41–43 (1982) and 9, No. 1, 55–64 (1989).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Cycloheximide, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Cycloheximide, Trenton NJ (January 1999).

Cyclohexylamine C:1740

Formula: $C_6H_{13}N$; $C_6H_{11}NH_2$

Synonyms: Aminocyclohexane; Aminohexahydrobenzene; Aniline, hexahydro-; CHA; Ciclohexilamina (Spanish); Cyclohexanamine; Cyclohexaneamine; Hexahydroaniline; Hexahydrobenzenamine

CAS Registry Number: 108-91-8

HSDB Number: 918

RTECS Number: GX0700000

UN/NA & ERG Number: UN2357/132

EC Number: 203-629-0 [*Annex I Index No.:* 612-050-00-6]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 15,000 ($1.00% concentration).

Carcinogenicity: IARC: Human Inadequate Evidence 1980; Animal Limited Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1987. United States Environmental Protection Agency Gene-Tox Program, Positive: Cell transformation-SA7/SHE; Cytogenetics-male germ cell; Positive/dose response: In vitro cytogenetics-nonhuman; Negative: In vivo cytogenetics-nonhuman bone marrow; Negative: In vitro cytogenetics-human lymphocyte; Negative: D *melanogaster*-reciprocal translocation; Negative: D *melanogaster* sex-linked lethal; Inconclusive: Carcinogenicity-mouse/rat; Inconclusive: D *melanogaster*-whole sex chrom. loss; Inconclusive: Rodent dominant lethal; Host-mediated assay; Inconclusive: *E coli polA* without S9

Clean Air Act: Accidental Release Prevention/Flammable Substances (Section 112 [r], Table 3), TQ = 15,000 lb (6810 kg).

Hazard Alert: Highly flammable, Corrosive, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Possible sensitization hazard (skin), Primary irritant (w/o allergic reaction).

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 10,000 lb (4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10,000 lb (4540 kg)

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazard symbols, risk, & safety statements: Hazard symbol: C, Xn, Xi; risk phrases: R11; R21/22; R34; R36/37/38; R43; R62; R63; safety phrases: S1/2; S21; S26; S36/37/39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Cyclohexylamine is a colorless to yellow liquid (amines, primary aromatic). It has an unpleasant fishy odor. Molecular weight = 99.17; specific gravity (H_2O:1) = 0.82 @ 20°C; boiling point = 134.4°C; freezing/melting point = −17.8°C; vapor pressure = 11 mmHg @ 20°C; 7.7 mmHg @ 22°C; flash point = 31°C; autoignition temperature = 293°C. Explosive limits: LEL: 1.2%, 12,000 ppm[138]; UEL: 9.4%. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 3, reactivity 0. Soluble in water.

Potential Exposure: CHA is used in making dyes, chemicals, dry cleaning chemicals; insecticides, plasticizers, rubber chemicals; and as a chemical intermediate in the production of cyclamate sweeteners. Used in water treatment and as a boiler feedwater additive. It is also used in rubber production to retard degradation.

Incompatibilities: May form explosive mixture with air. Cyclohexylamine is a strong base: it reacts violently with acid. Contact with strong oxidizers may cause fire and explosion hazard. Incompatible with organic anhydrides; isocyanates, vinyl acetate; acrylates, substituted allyls; alkylene oxides; epichlorohydrin, ketones, aldehydes, alcohols, glycols, phenols, cresols, caprolactum solution; lead. Corrosive to copper alloys, zinc, or galvanized steel.

Permissible Exposure Limits in Air

OSHA PEL: None

NIOSH REL: 10 ppm/40 milligram per cubic meter TWA

ACGIH TLV[1]: 10 ppm/41 milligram per cubic meter TWA; not classifiable as a human carcinogen

PAC* Ver. 29[138]

PAC-1: **1.8**$_{\mathbf{A}}$ ppm

PAC-2: **8.6**$_{\mathbf{A}}$ ppm

PAC-3: **30**$_{\mathbf{A}}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60-minute values.

DFG MAK: 2 ppm/8.2 milligram per cubic meter TWA; Peak Limitation Category I(2); Pregnancy Group C

Australia: TWA 10 ppm (40 milligram per cubic meter), 1993; Austria: MAK 10 ppm (40 milligram per cubic meter), 1999; Belgium: TWA 10 ppm (41 milligram per cubic meter), 1993; Denmark: TWA 10 ppm (40 milligram per cubic meter) [skin], 1999; Finland: STEL 10 ppm (40 milligram per cubic meter) [skin], 1999; France: VME 10 ppm (40 milligram per cubic meter) [skin], 1999; Hungary: TWA 1 milligram per cubic meter; STEL 2 milligram per cubic meter, 1993; the Netherlands: MAC-TGG 5 milligram per cubic meter [skin], 2003; Poland: TWA 40 milligram per cubic meter; STEL 80 milligram per cubic meter, 1999; Russia: STEL 1 milligram per cubic meter, 1993; Sweden: TWA 5 ppm (20 milligram per cubic meter); STEL 10 ppm (40 milligram per cubic meter), 1999; Switzerland: MAK-W 10 ppm (40 milligram per cubic meter), KZG-W 20 ppm (80 milligram per cubic meter) [skin], 1999; United Kingdom: TWA 10 ppm (41 milligram per cubic meter) [skin] 2000; Argentina, Bulgaria, Columbia, Israel; Jordan, South Korea, Mexico; New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Several states have set guidelines or standards for cyclohexylamine in ambient air[60] ranging from 95.238 μ/m^3 (Kansas) to 400 μ/m^3 (North Dakota) to 650 μ/m^3 (Virginia) to 800 μ/m^3 (Connecticut) to 952 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #2010, amines, aliphatic, and OSHA Analytical Method PV-2016.

Permissible Concentration in Water: No criteria set but EPA[32] has suggested a permissible concentration based on health effects of 550 μg/L.

Routes of Entry: Inhalation, ingestion, skin absorption, eye and skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: This chemical can be absorbed through the skin, thereby increasing exposure. Cyclohexylamine is caustic to the skin, eyes, and respiratory tract. Its systemic effects in humans include nausea, vomiting, anxiety, restlessness, drowsiness, lightheadedness, anxiety, apprehension, slurred speech; papillary dilation; severe skin irritation. Cyclohexylamine may also be a skin sensitizer. Inhalation can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

This material is classified as moderately toxic, LD_{50} (oral-rat) = 156 mg/kg-probable oral lethal dose is 50 to 500 mg/kg or between 1 teaspoon and 1 oz for a 70-kg (150 lb) persons. It is considered a nerve poison; and is a weak methemoglobin-forming substance.

Long-Term Exposure: Cyclohexylamine causes mutations (genetic changes). Such chemicals may have a cancer risk. Many scientists believe there is no safe level of exposure to a cancer-causing agent. It may damage the developing fetus. It may also damage the testes (male reproductive gland) and reduce the fertility of females. *Other Long-Term Effects:* Exposure may increase blood pressure. Repeated or severe exposures may damage vision and possible kidneys and liver. Cyclohexylamine may cause a skin allergy. Very low future exposures can cause itching and a skin rash. The FDA banned the use of cyclamates as artificial sweeteners in 1969 because of their metabolic conversion to cyclohexylamine, which was thought to be carcino genic in rats. There is now no evidence that CHA is a carcinogen, however.

Points of Attack: Eyes, skin, respiratory system; central nervous system.

Medical Surveillance: Before beginning employment and at regular times after that, the following is recommended: blood pressure check. If symptoms develop or overexposure is suspected, the following may be useful: eye and vision exam. Kidney and liver function tests. Skin testing with dilute cyclohexylamine may help diagnose allergy, if done by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Note to Physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. **8 hours** (more than 8 hours of resistance to breakthrough >0.1 μg/cm^2/min): Responder suits. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical.

Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures *over 10* ppm; Use a NIOSH/MSHA or European Standard EN149-approved full facepiece respirator with an organic vapor cartridge/canister. Increased protection is obtained from full facepiece PAPRs. *Where there is potential for high exposures exists*, use a NIOSH/MSHA or European Standard EN149-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA or European Standard EN149-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: (1) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. (2) Color code—Red: Flammability Hazard: store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with cyclohexylamine all handlers should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Protect containers from physical damage. Outdoor or detached storage is recommended. Cyclohexylamine must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from sources of heat. Sources of ignition, such as smoking and open flames are prohibited where cyclohexylamine is handled, used, or stored. The vapor can form explosive mixtures in the air. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN2357 Cyclohexylamine, Hazard class: 8; Labels: 8-Corrosive material, 3-Flammable liquid.

Spill Handling: Stay upwind; keep out of low areas. Wear self-contained (positive pressure if available) breathing apparatus and full protective clothing. Establish forced ventilation to keep levels below explosive limit. Shut off ignition sources; no flares, smoking, or flames in hazard area. Do not touch spilled material; stop leak if you can do it without risk. Use water spray to reduce vapors. *Small spills*: take up with vermiculite, dry sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: dike far ahead of spill for later disposal. Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration; incinerator equipped with a scrubber or thermal unit to reduce nitrogen oxides emissions.

References

(31); (173); (101); (138); (2); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Cyclohexylamine, Washington, DC (October 21, 1977).

National Institute for Occupational Safety and Health (NIOSH), Information Profiles on Potential Occupational Hazards-Single Chemicals: Cyclohexylamine, Report TR 79-607, pp 45−55, Rockville, MD (December 1979).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Cyclohexylamine, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Cyclohexylamine, Trenton, NJ (February 2001).

Cyclohexyl Isocyanate C:1750

Formula: $C_7H_{11}NO$; $C_6H_{11}NCO$
Synonyms: CHI; Cyclohexane, isocyanato-; Isocyanatocyclohexane; Isocyanic acid, cyclohexyl ester
CAS Registry Number: 3173-53-3
HSDB Number: 8037
RTECS Number: NQ8650000
UN/NA & ERG Number: (PIH) UN2488/155
EC Number: 221-639-3
Regulatory Authority and Advisory Information
Hazard Alert: Poison inhalation hazard, Flammable liquid, Suspected reprotoxic hazard, Environmental hazard.
United States DOT 49CFR172.101, Inhalation Hazardous Chemical
Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.
Hazardous to aquatic life or environment, with possible long-lasting effects[291]. Do not allow release to the environment unless proper permits are obtained from the federal government.
Hazard symbols, risk, & safety statements: Hazard symbol: T+, F, N, Xi; risk phrases: R10; R21/22/26; R34; R36/37/38; R42; R51; R61; safety phrases: S16; S23; S26; S28; S29/35; S36/37; S39; S41; S45; S57; S61 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.
Description: Cyclohexyl isocyanate is a clear, flammable liquid. It has a sharp, pungent odor. Molecular weight = 125.19; specific gravity (H_2O:1) = 0.98; boiling point = 168°C; flash point = 48°C (cc). Explosive limits: LEL: 20,000 ppm; UEL: unknown. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 2, reactivity 0. Soluble in water (reaction).
Potential Exposure: The material is used in the synthesis of agricultural chemicals.
Incompatibilities: Cyclohexyl isocyanate polymerize due to heating above 93°C/200°F and under the influence of various chemicals including organometallic compounds. Cyclohexyl isocyanate decomposes in fire, forming toxic hydrogen cyanide and nitrogen oxides fumes. May form explosive mixture with air. Isocyanates are highly flammable and reactive with many compounds, even with themselves. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Reaction with moist air, water or alcohols may form amines and insoluble polyureas and react exothermically, releasing toxic, corrosive, or flammable gases, including carbon dioxide; and, at the same time, may generate a violent release of heat increasing the concentration of fumes in the air. Incompatible with amines, aldehydes, alkali metals, ammonia, carboxylic acids, caprolactum, alkaline materials, glycols, ketones, mercaptans, hydrides, organotin catalysts, phenols, strong acids, strong bases, strong reducing agents such as hydrides, urethanes, ureas. Elevated temperatures or contact with acids, bases, tertiary amines, and acylchlorides may cause explosive polymerization. Attacks some plastics, rubber, and coatings. Contact with metals may evolve flammable hydrogen gas.
Permissible Exposure Limits in Air
PAC* Ver. 29[138]
PAC-1: 0.0031 ppm
PAC-2: $\mathbf{0.34_A}$ ppm
PAC-3: $\mathbf{0.10_A}$ ppm
*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60-minute values.
Routes of Entry: Inhalation, ingestion.
Harmful Effects and Symptoms
Short-Term Exposure: A lacrimator (causes tearing). Exposure can severely irritate and may burn the skin, eyes, nose, throat, and lungs. Very high levels may lead to a build-up of fluid in the lungs (pulmonary edema), a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.
Long-Term Exposure: Repeated or prolonged contact may cause skin sensitization. Repeated or prolonged inhalation exposure may cause lung damage and/or asthma. A suspected carcinogen.
Points of Attack: Lungs, skin.
Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. butyl rubber gloves have been recommended by the manufacturer as protection against this substance. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to cyclohexyl isocyanate exists, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Poison inhalation chemical (PIH); check oxygen content prior to entering storage area. (1) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. (2) Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with cyclohexyl isocyanate all handlers should be trained on its proper handling and storage. Cyclohexyl isocyanate must be stored to avoid contact with moisture and temperatures above 93°C, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from water, strong bases; alcohol, metal compounds or surface active materials. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2488 Cyclohexyl isocyanate, Hazard class: 6.1; Labels: 6.1-Poison Inhalation Hazard, 3-Flammable liquid, Inhalation Hazard Zone B.

Spill Handling:

Cyclohexyl isocyanate

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.3/0.5
Night 0.5/0.8

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Cyclohexyl isocyanate may burn, but does not readily ignite. Containers may explode in fire. Thermal decomposition products may include hydrogen cyanide and oxides of nitrogen and carbon. Use dry chemical, CO_2, water spray; or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Cyclohexyl isocyanate, Trenton, NJ (March 2000).

Cyclohexyl Trichlorosilane C:1760

Formula: $C_6H_{11}Cl_3Si$; $C_6H_{11}SiCl_3$
Synonyms: Silane, trichlorohexyl-; Trichlorocyclohexylsilane; 1-(Trichlorosilyl)cyclohexane
CAS Registry Number: 98-12-4
HSDB Number: 7784
RTECS Number: VV2890000
UN/NA & ERG Number: UN1763/156
EC Number: 202-639-2
Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade).

Hazard Alert: Flammable, Corrosive, water and air reactive.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: F, C; risk phrases: R10; R14; R34; safety phrases: S1; S26; S28; S36/37/39; S41; S45; (see Appendix 4). R10

Description: Cyclohexyl trichlorosilane is a colorless to pale yellow liquid. Molecular weight = 217.6; boiling point = 208°C; flash point = 91°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 2, reactivity 1~~W~~. Insoluble in water; reactive, rapidly releasing corrosive hydrogen chloride gas.

Potential Exposure: The material is used to make silicone polymers.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Chlorosilanes react vigorously with bases and both organic and inorganic acids generating toxic and/or flammable gases. Chlorosilanes react with water, moist air, or steam to produce heat and toxic, corrosive fumes of hydrogen chloride. They may also produce flammable gaseous hydrogen. Attacks metals in the presence of moisture.

Permissible Exposure Limits in Air

No standards or PACs available for this specific material. See below:

PAC Ver. 29[138]

based on 15 other trichlorosilanes with identical PACs (for reference only)

PAC-1: $\mathbf{0.6}_{\mathbf{A}}$ ppm
PAC-2: $\mathbf{7.3}_{\mathbf{A}}$ ppm
PAC-3: $\mathbf{33}_{\mathbf{A}}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a sub script "**A**" and correspond to 60-minute values.

Routes of Entry: Inhalation

Harmful Effects and Symptoms

Short-Term Exposure: Cyclohexyl trichlorosilane can affect you when breathed in. Exposure can irritate the eyes, nose, throat, and lungs, causing coughing, wheezing, and/or shortness of breath. Cyclohexyl trichlorosilane is a corrosive chemical and can cause severe skin and eye burns leading to permanent eye damage. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. LD_{50} (oral-rat) = 2830 mg/kg (slightly toxic).

Long-Term Exposure: Repeated exposure may cause bronchitis to develop.

Points of Attack: Lungs.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If Symptoms develop or overexposure is suspected, chest X-ray should be considered. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek Medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to Cyclohexyl trichlorosilane exists, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from water, steam and moisture; and away from combustible materials, such as wood, oil and paper; and incompatible materials listed above. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1763 Cyclohexyltrichlorosilane, Hazard class: 8; Labels: 8-Corrosive material.

Spill Handling:

Cyclohexyltrichlorosilane when spilled in water

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.3/0.5
Night 0.9/1.5

Stay upwind and uphill. Isolate the area of release or fire and deny entry. Remove all ignition sources. Stop the release if it can be done safely from a distance. All equipment used to handle this material must be grounded. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. *Small spill*: Cover with *dry* earth, *dry* sand, or other noncombustible material followed with plastic sheet to minimize spreading or contact with water or rain. Use clean nonsparking tools to collect material and place material into loosely covered plastic containers for later disposal. Prevent material and runoff from entering sewers and waterways if it can be done safely well ahead of the release. Use vapor suppressing foam to disperse vapors−contain runoff. Water spray may reduce vapor, but may not prevent ignition in enclosed spaces. Ventilate confined area if it can be done without placing personnel at risk. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include hydrogen chloride and oxides of carbon. *Do not use water or hydrous agents. FOR CHLOROSILANES DO NOT USE WATER. USE AFFF ALCOHOL-RESISTANT, MEDIUM EXPANSION FOAM. Small fire*: use *dry chemical*, CO_2, *dry* sand, or alcohol-resistant foam. May react with foams releasing corrosive/toxic gases. *Large fire*: use water spray or alcohol-resistant foam if it is available in sufficient amounts. Under favorable conditions, experienced crews can use coordinated fog streams to sweep the flames off the surface of the burning liquid. Combustible material: may burn but does not ignite readily. Most vapors are heavier than air. They will spread along ground and collect in low or confined areas (sewers, basements, tanks). Vapors may travel to source of ignition and flashback. Containers may explode when heated or if contaminated with water. Keep exposures cool long after fire is out to protect against reignition. Do not direct straight streams into the liquid. Cool exposed containers with large quantities of water from unattended equipment or remove intact containers if it can be done safely. *Do not get water on spilled substance or inside containers*. If cooling streams are ineffective (*venting sound increases in volume and pitch, tank discolors, or shows signs of deforming*), withdraw immediately to a secure location. Always stay away from ends of tanks, especially when engulfed in flames. If material or contaminated runoff from fire control enters waterways, notify downstream users of potentially contaminated water. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156.

References

(31); (173); (101); (138).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Cyclohexyl Trichlorosilane, Trenton, NJ (November 1998).

Cyclonite C:1770

Formula: $C_3H_6N_6O_6$

Synonyms: Cyclotrimethylenetrinitramine; Hexahydro-1,3,5-trinitro-*s*-triazine; Hexogen; Hexolite; Hexotol; HMX; RDX; Trimethylenetrinitramine; 1,3,5-Trinitro-1,3,5-triazacyclohexane; Trinitrotrimethylenetriamine

121-82-4: Cyclotrimethylenetrinitramine, [wet with =>10% water]; A 3 (explosive); Composition A 3; CPX 301; CX 84A; *Cyclonite;* Cyclotrimethylenenitramine; Cyclotrimethylenetrinitramine, [desensitized]; Hexahydro-1,3,5-trinitro-1,3,5-s-triazine; Hexahydro-1,3,5-trinitro-1,3,5-triazine; Hexogen (explosive); Hexogen 5W; PBX 9407; PBX (AF) 108; PBX-B 2238; PBX-C 117; PBX-L 3; PBX-L 5; PBX-MC; PBX-MV F; PBX-W 108; PBXN 6; PBXN 107; PBXN 107A; PBXN 108; PBXN (AF) 108; PBXW 108 (E); PBXN 201; PE 4; PE 4 (EXPLOSIVE); PHX 34; RDX; T4; 1,3,5 Triaza-1,3,5-trinitrocyclohexane; S-Triazine, hexahydro-1,3,5-trinitro-; 1,3,5 Trinitro-1,3,5-triazacyclohexane; 1,3,5 Trinitrohexahydro-1,3,5-triazine; 1,3,5 Trinitrohexahydro-*s*-triazine; 1,3,5 Trinitroperhydro-1,3,5-triazine; Trimethylenetrinitramine; TS 1; TS 1 (PROPELLANT); V 29; V 29 (propellant);cyclotrimethylenetrinitramine, [wetted with => 15% water, o]

2691-41-0: Cyclotetramethylene tetranitramine, [wet with => 10% water]; 1,3,5,7-Tetranitro-1,3,5,7-tetraazacyclooctane; 1,3,5,7-Tetranitro-1,3,5,7-tetrazocane; Beta-HMX; Cyclotetramethylenetetranitramine; HMX; HMX 2; Homocyclonite; HW 4; IRX 21; JO 9159; JO-X; LX 14; LX 14-0; Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine; Octahydro-1,3,5,7-tetranitro-*S*-tetrazocine; Octogen; Oktogen; ORA 86B; PBXC 121; PBXC 126; PBXC 129; PBXK-C 1203; PBXN 101; PBXN 110; PBXN 5; PBXN 9; PBXW 11; PBXW 113; PBXW 128; Renowex 1001; Rowanex 2000; Rowanex 3000; SW 21; Tetramethylenetetranitramine

CAS Registry Number: 121-82-4 (RDX); 2691-41-0 (HMX)

HSDB Number: 2079 (RDX); 5893(HMX)

RTECS Number: XY9450000

UN/NA & ERG Number: UN0072/(RDX, wetted with not <15% water by mass)/112; UN0483/(RDX)/112; UN0226/(HMX); UN7272 *Note*: Explosives aren't listed by specific names or UN/NA numbers in the ERG; however, they are assigned to response guides based on their division or class[101].

EC Number: 204-500-1

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 5000 (commercial grade); *Theft hazard* 400 (commercial grade) *(Hexolite, RDX; RDX & HMX mixture, 121-82-4; HMX, 2691-41-0)*.

Carcinogenicity: EPA: Possible Human Carcinogen (based on animal studies). No human data.

Hazard Alert: Suspected of causing genetic defects, Explosive (when dry).

Hazard symbols, risk, & safety statements: Hazard symbol: E, T; risk phrases: R40; R1; R2; R20/22; R62; safety phrases: S1; S39; S41; S45; S47 (see Appendix 4)

Description: Hexahydro-1,3,5-trinitro-*S*-triazine is a white crystalline compound. Molecular weight = 222.15; specific gravity (H_2O:1) = 1.82; boiling point = > 260°C; freezing/melting point = 202−204°C; vapor pressure = 4×10^{-4} mmHg @ 20°C; exothermic decomposition = 100°C; hazard identification (based on NFPA-704 M Rating System): Health 2, flammability* (explosive), reactivity (see incompatibilities)*. Insoluble in water.

Potential Exposure: A potential danger to those involved in the manufacture of this material and its handling in munitions and solid-propellant manufacture. It is also used as a rat poison; a powerful military explosive; a base charge for detonators; and in plastic explosives.

Incompatibilities: Heat, physical damage, shock, and detonators. Detonates on contact with mercury fulminate. Keep away from other explosives, combustibles, oxidizers (such as chlorates, nitrates, perchlorates, permanganates, peroxides; bromine, chlorine, and fluorine); reducing agents; and aqueous alkaline solutions.

Permissible Exposure Limits in Air

OSHA PEL: None

NIOSH REL: 1.5 milligram per cubic meter TWA; 3 milligram per cubic meter STEL [skin]

ACGIH TLV[1]: 0.5 milligram per cubic meter TWA [skin]; not classifiable as a human carcinogen

PAC Ver. 29[138]

121-82-4 (RDX)

PAC-1: 3 milligram per cubic meter

PAC-2: 26 milligram per cubic meter

PAC-3: 160 milligram per cubic meter

2691-41-0 (HMX)

PAC-1: 19 milligram per cubic meter

PAC-2: 210 milligram per cubic meter

PAC-3: 1300 milligram per cubic meter

Australia: TWA 1.5 milligram per cubic meter; STEL 3 milligram per cubic meter [skin], 1993; Belgium: TWA 1.5 milligram per cubic meter; STEL 3 milligram per cubic meter [skin], 1993; Denmark: TWA 1.5 milligram per cubic meter [skin], 1999; Finland: TWA 1.5 milligram per cubic meter; STEL 4.5 milligram per cubic meter [skin], 1999; France: VME 1.5 milligram per cubic meter [skin], 1999; Hungary: TWA 1 milligram per cubic meter; STEL 2 milligram per cubic meter, 1993; Norway: TWA 1.5 milligram per cubic meter, 1999; the Philippines: TWA 0.4 milligram per cubic meter [skin], 1993; Poland: MAC (TWA) 1 milligram per cubic meter, MAC (ST EL) 3 milligram per cubic meter, 1999; Russia: STEL 1 milligram per cubic meter, 1993; Switzerland: MAK-W 1.5 milligram per cubic meter [skin], 1999; United Kingdom: TWA 1.5 milligram per cubic meter; STEL 3 milligram per cubic meter [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Several states have set guidelines or standards for cyclonite in ambient air[60] ranging from 15 μ/m^3 (North Dakota) to 25 μ/m^3 (Virginia) to 30 μ/m^3 (Connecticut) to 36 μ/m^3 (Nevada). This chemical can be absorbed through the skin, thereby increasing exposure.

Determination in Air: Use NIOSH Analytical Method (IV) #0500, Particulates NOR, total dust.

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: This chemical can be absorbed through the skin, thereby increasing exposure. Irritates the eyes, skin, and respiratory tract. Skin contact causes a burning sensation and rash. Other symptoms include headache, nausea, vomiting, loss of appetite; weakness, confusion, dizziness. LD_{50} (oral-rat) = 100 mg/kg (moderately toxic).

Long-Term Exposure: Repeated Exposure can cause irritability, sleeplessness, seizures, anorexia, kidney damage. Exposure to high levels can damage the nervous system.

Points of Attack: Eyes, skin, central nervous system.

Medical Surveillance: Examination of the nervous system. Kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a Medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Neoprene gloves and plastic clothing are recommended. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use chemical cartridge respirator. Where *there is a potential for overexposure:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode).

Storage: Explosive. Color code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Detached storage in a secure area is recommended. Store in tightly closed containers in a cool well-ventilated area away from other explosives, combustibles or strong oxidizers (such as chlorine, bromine, and fluorine). Also keep cyclonite away from shock and heat sources. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN0483 Cyclotrimethylenetrinitramine, desensitized or Cyclonite, desensitized or Hexogen, desensitized or RDX, desensitized, Hazard Class: 1D; Labels: 1D-Explosive (with a mass explosion hazard); D-Substances or articles which may mass detonate (with blast and/or fragment hazard) when exposed to fire. UN0072 Cyclotrimethylenetrinitramine, wetted or Cyclonite, wetted or Hexogen, wetted or RDX, wetted with not <15% water by mass, Hazard Class: 1D; Labels: 1D-Explosive (with a mass explosion hazard); D-Substances or articles which may mass detonate (with blast and/or fragment hazard) when exposed to fire.

Spill Handling:

Explosives: Divisions 1.1; 1.2. 1.3 or 1.5

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small Spill: 0.33 mi/1800 ft/500 m
Large Spill: 0.5 mi/2500 ft/800 m
Fire/Rail car: 1 mi/5200 ft/1600 m

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Cover spill with soda ash, mixed and sprayed with water. Place into bucket of water and allow to stand for 2 hours. Do not operate radio transmitters or electronic detonator in spill area. Ventilate area of spill or leak after clean-up is complete. Keep Cyclonite out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Cyclonite is a highly dangerous explosion hazard, especially at high temperatures. In case of a fire, immediately evacuate area. An evacuation distance of 1 mi is recommended Thermal decomposition products may include oxides of nitrogen and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Pour over soda ash, neutralize and flush to sewer with water. Also HMX may be recovered from solid propellant waste.

References

(31); (173); (101); (138); (2).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Cyclonite, Trenton, NJ (January 1999).

Cyclopentadiene C:1780

Formula: C_5H_6

Synonyms: 1,3-Cyclopentadiene; Pentole; Pyropentylene; R-Pentene

CAS Registry Number: 542-92-7

HSDB Number: 2514

RTECS Number: GY1000000

UN/NA & ERG Number: UN1993 (flammable liquids, n.o.s.)/128

EC Number: 208-835-4

Regulatory Authority and Advisory Information

Hazard Alert: Highly flammable liquid, Explosive (with oxygen or ozone), Possible polymerization hazard.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: F; risk phrases: R11; R19; safety phrases: S (see Appendix 4)

Description: Cyclopentadiene is a flammable, colorless liquid with a sweet odor, like turpentine. Molecular weight = 66.10; specific gravity (H_2O:1) = 0.8; boiling point = 42.0°C; freezing/melting point = −85°C; vapor pressure = 400 mmHg @ 20°C; flash point = 25°C (oc); autoignition temperature = 640°C. Insoluble in water.

Potential Exposure: Cyclopentadiene is used as an intermediate in the manufacture of resins, insecticides, fungicides, and other chemicals.

Incompatibilities: Vapors may form explosive mixture with air. Converted (dimerized) to higher-boiling dicyclopentadiene upon standing in air and @ 32°F/0°C; this conversion may be violent and exothermic; this reaction is accelerated by peroxides or trichloroacetic acid. Reacts violently with potassium hydroxide. Violent reaction with strong oxidizers; strong acids; dinitrogen tetroxide; magnesium. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, alkaline earth metals, nitrogen oxides. May accumulate static electrical charges, and may cause ignition of its vapors.

Permissible Exposure Limits in Air

NIOSH IDLH = 750 ppm

OSHA PEL: 75 ppm/200 milligram per cubic meter TWA

NIOSH REL: 75 ppm/200 milligram per cubic meter TWA

ACGIH TLV[1]: 75 ppm/203 milligram per cubic meter TWA

No standards or PAC available.

DFG MAK: (IIb) substances, for which (still) no MAK-values can be established.

Australia: TWA 75 ppm (200 milligram per cubic meter), 1993; Austria: MAK 75 ppm (200 milligram per cubic meter), 1999; Belgium: TWA 75 ppm (203 milligram per cubic meter), 1993; Denmark: TWA 75 ppm (200 milligram per cubic meter), 1999; Finland: TWA 75 ppm (200 milligram per cubic meter); STEL 115 ppm (310 milligram per cubic meter), 1999; France: VME 75 ppm (200 milligram per cubic meter), 1999; Hungary: TWA 20 milligram per cubic meter; STEL 40 milligram per cubic meter, 1993; the Netherlands: MAC-TGG 200 milligram per cubic meter, 2003; Norway: TWA 40 ppm (110 milligram per cubic meter), 1999; the Philippines: TWA 75 ppm (200 milligram per cubic meter), 1993; Poland: TWA 200 milligram per cubic meter, 1999; Russia: STEL 5 milligram per cubic meter, 1993; Switzerland: MAK-W 75 ppm (200 milligram per cubic meter), 1999; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: 75 ppm TWA. Several states have set guidelines or standards for cyclopentadiene in ambient air[60] ranging from 2.0−4.0 milligram per cubic meter (North Dakota) to 3.3 milligram per cubic meter (Virginia) to 4.0 milligram per cubic meter (Connecticut) to 4.76 milligram per cubic meter (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #2523.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Exposure can irritate the eyes, skin, and respiratory tract. Skin contact causes a burning sensation and rash.

Long-Term Exposure: Exposure may damage the liver and kidneys. Exposure can cause a skin allergy to develop. If allergy develops, even low exposures may cause symptoms.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function tests. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Do NOT induce vomiting.

Personal Protective Methods: Wear appropriate clothing to prevent repeated or prolonged skin contact. Wear eye protection to prevent any reasonable probability of eye contact. Employees should wash promptly when skin is wet or contaminated. Remove clothing immediately if wet or contaminated to avoid flammability hazard.

Respirator Selection: *Up to 750 ppm:* CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or PaprOv (APF = 25) [any powered, APR with organic vapor cartridge(s)]; or Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Should be stored at −20 − 0°C. May form peroxides in storage. Prior to working with cyclopentadiene all handlers should be trained on its proper handling and storage. Cyclopentadiene must be stored to avoid contact with strong oxidizing agents because violent reactions occur. Cyclopentadiene must be stored at temperatures below 0°C or it may undergo an explosive chemical reaction. Sources of ignition, such as smoking and open flames are prohibited where cyclopentadiene is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1993 Flammable liquids, n.o.s., Hazard Class: 3; Labels: 3-Flammable liquid, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (2).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Cyclopentadiene, Trenton, NJ (January 1999).

Cyclopentane C:1790

Formula: C_5H_{10}

Synonyms: Pentamethylene

CAS Registry Number: 287-92-3

HSDB Number: 62

RTECS Number: GY2390000

UN/NA & ERG Number: UN1146/128

EC Number: 206-016-6 [*Annex I Index No.:* 601-030-00-2]

Regulatory Authority and Advisory Information

Hazard Alert: Highly flammable, Electrostatic hazard, Environmental hazard.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects[194]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: F, N; risk phrases: R11; R52/53; safety phrases: S2; S16; S21; S29/35; S33; S41; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Cyclopentane is a colorless liquid. Molecular weight = 70.13; specific gravity (H_2O:1) = 0.75 @ 20°C; boiling point = 49°C; freezing/melting point = −93.6°C; vapor pressure = 400 mmHg @ 31°C; 317.8 mmHg @ 25°C; relative vapor density (air = 1) = 2.42: Flash point = −37.2°C; autoignition temperature = 361°C. Explosive limits in air: LEL: 1.1%, 10,000 ppm[138]; UEL: 8.7%. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 3, reactivity 0. Insoluble in water.

Potential Exposure: Cyclopentane is used as a solvent.

Incompatibilities: May form explosive mixture with air. May accumulate static electrical charges, and may cause ignition of its vapors. Contact with strong oxidizers may cause fire and explosion.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 2.87 milligram per cubic meter @ 25°C & 1 atm

OSH A PEL: None

NIOSH REL: 600 ppm/1720 milligram per cubic meter TWA

ACGIH TLV[1]: 600 ppm/1720 milligram per cubic meter TWA

PAC Ver. 29[138]

PAC-1: 1800 ppm

PAC-2: 3800 ppm [= >10% LEL, lower explosive limit but <50% LEL]

PAC-3: 23,000 ppm [= >10% LEL, lower explosive limit but <50% LEL]

Australia: TWA 600 ppm (1720 milligram per cubic meter), 1993; Belgium: TWA 600 ppm (1720 milligram per cubic meter), 1993; Denmark: TWA 300 ppm (850 milligram per cubic meter), 1999; France: VME 600 ppm (1720 milligram per cubic meter), 1999; Norway: TWA 300 ppm (850 milligram per cubic meter), 1999; Switzerland: MAK-W 600 ppm (1720 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 1720 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 600 ppm. Several states have set guidelines or standards for cyclopentane in ambient air[60] ranging from 17.0 milligram per cubic meter (Connecticut) to 17.2−25.8 milligram per cubic meter (North Dakota) to 29.0 milligram per cubic meter (Virginia) to 41.0 (Nevada).

Determination in Air: No method available.

Permissible Concentration in Water: Vermont[61] has set a guideline for cyclopentane in drinking water of 30.7 mg/L.

Determination in water: No method available. Octanol−water coefficient: Log K_{ow} = >3. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact This chemical can be absorbed through the skin, thereby increasing exposure.

Harmful Effects and Symptoms

Short-Term Exposure: Vapors are irritating to eyes, nose, and throat. If inhaled, will cause dizziness, nausea, vomiting, difficult breathing, or loss of consciousness. Ingestion irritates the stomach. Contact with the liquid is irritating to eyes and skin. This chemical can be absorbed through the skin, thereby increasing exposure. This compound is moderately toxic by ingestion and inhalation. Ingestion causes irritation of the stomach, and aspiration produces severe lung irritation and rapidly developing pulmonary edema. Contact with liquid irritates eyes and skin. Cyclopentane is a nervous system depressant. Alcohol consumption synergistically increases the toxic effects of this compound.

Long-Term Exposure: Cyclopentane can cause drying and cracking of the skin.

Points of Attack: Eyes, nose, throat, respiratory system; stomach and nervous system.

Medical Surveillance: Consider possible irritant effects to the skin and respiratory tract in preplacement and periodic examinations as well as any renal or liver complications.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Do not induce vomiting, guard against aspiration. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear solvent-resistant gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where *there is a potential for overexposure:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode).

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with cyclopentane all handlers should be trained on its proper handling and storage. Before entering confined space where cyclopentane may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool well-ventilated area away from strong oxidizers (such as chlorine, bromine, and fluorine). Use only nonsparking tools and equipment, especially when opening and closing containers of cyclopentane. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1146 Cyclopentane, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or foam extinguishers. Water may be ineffective because of low flash point. Do not extinguish fire unless flow of chemical can be stopped. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to

cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Cyclopentane, Washington, DC, Chemical Emergency Preparedness Program (October 31, 1985).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Cyclopentane, Trenton, NJ (January 2001).

Cyclosarin (Agent GF) C:1795

Formula: $C_7H_{14}FO_2P$; $CH_3PO(F)OC_6H_{11}$

Synonyms: CMPF; Cyclohexyl methylphosphonofluoridate; *O*-Cyclohexyl-methylphosphonofluoridate; Cyclohexyl sarin; Cyclosarin; Cyclosin; GF; Methyl cyclohexylfluorophosphonate; Phosphonofluoridic acid, methyl-, cyclohexyl ester; *Chlorosarin*: *O*-Isopropyl methylphosphonochloridate.

CAS Registry Number: 329-99-7 (agent GF, Methyl cyclohexylfluorophosphonate); 1445-76-7 (Chlorosarin)

HSDB Number: 7597; 7671 (Chlorosarin)

RTECS Number: Not established

UN/NA & ERG Number: UN2810 (toxic liquid, organic, n.o.s.)/153

EC Number: Not found

Regulatory Authority and Advisory Information

Report any release of WMD to National Response Center 1-800-424-8802

Department of Homeland Security Screening Threshold Quantity: *Theft Hazard* CUM 100 g (*1445-76-7)*

Hazard Alert: Poison, Dangerous cumulative neurotoxin, Water reactive.

While not a mandated "Federally listed" waste, GF is more toxic than most RCRA listed chemicals. However, GF is a "listed" hazardous waste in some states where it may have been stockpiled by the military.

Description: Cyclosarin (GF) is a liquid nerve agent/organophosphate containing fluoride. GF is a colorless liquid. The odor is variously described as nondescript, sweet, fruit-like. Odor threshold is about 12 milligram per cubic meter. Molecular weight = 180.2 g/mol; specific gravity (H_2O:1) = 1.133 g/mL @ 20°C; boiling point = 239°C; freezing point = −30°C; liquid density = 1.1327 @20°C; vapor density (air = 1) = 6.2; vapor pressure = 0.44 mmHg @ 25°C; volatility = 581 milligram per cubic meter @ 25°C; flash point = 94°C. ~~W~~ Practically insoluble in water; solubility = 0.37% @ 20°C. Hydrolyzed by water.

1445-76-7 (Chlorosarin): Molecular weight = 156.55 o-Isopropyl methylphosphonochloridate.

History of the agent: Cyclo-sarin (GF) is believed to have been synthesized about the time of World War II by the Germans. Following the war, in the early 1950s, both the United States and Great Britain undertook a systematic study of potential nerve agents including GF. Some sources in the United States suggest that interest in GF was stimulated by work undertaken in an "iron curtain country". However, for various reasons related to its lower toxicity and relatively high cost, it was never manufactured. Iraq is believed to have produced large quantities of cyclosarin for use as a chemical weapon. Iraq fielded artillery projectiles filled with cyclo-sarin (GF) and sarin (GB). Animal tests did not find that GF−GB mixtures to have any special effects as the toxicity range was approximately intermediate between the two agents.

Potential Exposure: A quick-acting and lethal cholinesterase inhibitor and casualty agent. Females appear to be more susceptible to nerve agent effects. Small percentages of general population have genetic traits that may increase susceptibility.

Incompatibilities: Fairly stable. Cyclo-sarin (GF) is hydrolyzed by water; rapidly hydrolyzed in the presence of heat and alkalies; by dilute solution of aqueous sodium hydroxide. Contact with alkaline conditions produce isopropyl alcohol and polymer substances. Contact with acid conditions produce HF; alkaline conditions produce isopropyl alcohol and polymers. Reasonably stable when stored in steel at normal temperatures; slightly corrosive to steel when heated.

Persistence of Chemical Agent: Cyclo-sarin has intermediate persistence [as persistent as Tabun (Agent GA)]. GF evaporates about 20 times more slowly than water. Heavily splashed liquid persists 1 or 2 days under average weather conditions[AFM 3−9]. Approximately 20 times more persistent than sarin (GB)[AFM 3−9]. Following (for reference and calculation) are persistence rates for sarin (GB): Summer: 10 min to 24 hours; Winter: 2 hours to 3 days.

Permissible Exposure Limits in Air:

IDL H: 0.05 milligram per cubic meter[United States Army]

Conversion factor: 1 ppm = 7.4 milligram per cubic meter °C = 0.56 × (°F-32)

STEL: 5.0×10^{-5} milligram per cubic meter

Worker Population Limit (WPL) = 3.0×10^{-5} milligram per cubic meter (8-hour TWA)

General Population Limit (GPL) = 1.0×10^{-6} milligram per cubic meter (24-hour TWA lifetime chronic value)

PAC* Ver. 29[138]

329-99-7, agent (GF)

PAC-1: **0.0002**$_{\mathbf{A}}$ ppm
PAC-2: **0.0024**$_{\mathbf{A}}$ ppm
PAC-3: **0.018**$_{\mathbf{A}}$ ppm
*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60-minute values.
Acute Exposure Guideline Levels (AEGLs)
Level 1: potential discomfort; nondisabling; reversible
10 minutes—0.00049 ppm
30 minutes—0.00028 ppm
1 hour—0.0002 ppm
4 hours—0.0001 ppm
8 hours—0.00050 ppm
Level 2: Irreversible or other serious, long-lasting effects; impaired ability to escape; potential delayed recovery
10 minutes-0.0062 ppm
30 minutes-0.0035 ppm
1 hour-0.0024 ppm
4 hour-0.0013 ppm
8 hour—0.00091 ppm
Level-3: Life threatening; possible death
10 minutes—0.053 ppm
30 minutes—0.027 ppm
1 hour—0.018 ppm
4 hour—0.0098 ppm
8 hour—0.0071 ppm
1445-76-7 (Chlorosarin)
PAC* Ver. 29[138]
PAC-1: 4.80E + 04 ppm
PAC-2: 0.006 ppm
PAC-3: 0.022 ppm

Determination in Air: Air sampling is a good indicator of other pathways (e.g., off-gassing from soil) and is useful in risk analysis since it has health-based exposure limits. Onsite and downwind sampling should be conducted within 6 in. above potentially contaminated surfaces/soil to assess any off-gassing hazard as well as at breathing zone level (e.g., 5 ft) to assess potential public health inhalation exposures. Appropriate solid phase sorbent medium (e.g., tubes, PUF samplers) and SUMMA canisters can be used for sample collection and subsequent laboratory analysis.

Permissible Concentration in Water: unknown.

Determination in Water: G-agents are unlikely to persist in water. If analysis is performed, standard EPA volatile water sampling methods should be used. Contact pollution control authorities and advise shutting water intakes. Although G-agent contamination of large water sources is unlikely, there are military screening levels to determine if smaller, contained water supplies (e.g., tank truck) have been contaminated. Acceptable levels for troops drinking 5−15 L/day of a contaminated supply for 7 days are 4 to12 μg/L. This level is a reasonable value to use for the general population since their consumption rate is considerably less[91].

Determination in Soil: Industrial Exposure Scenario = 5.2 to 8.2 mg/kg; Residential Exposure Scenario = 0.22 to 0.31 mg/kg[91].

Routes of Entry: Enters the body primarily through the respiratory tract, but is highly toxic through the skin and digestive tract. *Inhalation* (a primary exposure route; inhalation of very small concentrations can produce effects.), *skin* [especially toxic from contact with liquid agent; usually mode rate to severe localized effects and systemic effects such as sweating. Effects can also result from absorption of vapors through skin]. *Eyes* [the most sensitive target organs of nerve agent exposure: miosis (reduction in pupil size) will typically be the first sign of exposure]. *Ingestion* (overall systemic effects)[91].

Harmful Effects and Symptoms

Cyclo-sarin (Agent GF) is a quick-acting chemical warfare nerve agent/nerve gas. Both the liquid and the vapor can kill you. Small amounts can injure in seconds, and can quickly lead to death. *Note:* Sarin is 26 times more deadly than cyanide gas and 20 times more deadly than Potassium cyanide. A single drop, if vaporized, can kill every person in an enclosed room![136]

Short-Term Exposure:

A strong cholinesterase inhibitor. Eye/skin toxicity: Very high; Rate of action: Very rapid. Physiological action: Cessation of breath−death may follow. Detoxification rate: Low. LD_{50} (subcutaneous-rat) = 0.225 mg/kg. Median lethal dose (mg-min/m^3): 2500 by skin (vapor) or 350 (liquid); 35 inhaled. Median incapacitating dose: 25 inhaled. LD_{50} (subcutaneous, mice) reported from 16 μg/kg to 400 μg/kg (compared to Sarin: LD_{50} (mice) = 200 μg/kg). (*Note*: Sarin: *A single drop on the skin can cause death. Death may occur within 15 minutes after fatal dose is absorbed*). See also Sarin (Agent GB) at S:0130.

Long-Term Exposure: May cause neuropsychiatric effects (as long as a year or more following acute manifestation) and possible EEG changes. Both are documented as acute manifestations of nerve agent poisoning; mild neuropsychiatric changes occur after even low-dose nerve agent exposure. The duration of the neuropsychiatric effects after nerve agent exposure is less well documented, but available information suggests that these effects persist for several weeks or possibly several months. Studies of EEG changes following organophosphate nerve agent exposure found differences between the exposed and control populations but suggested no relationship between their findings and alterations in brain function[81].

Points of Attack: Skin, eyes, lungs.

Medical Surveillance: Annual physical and respiratory function exams and a baseline cholinesterase[91].

Decontamination: *Important*: The rapid physical removal of a chemical agent is essential. If one does not have the equipment and/or training, don't enter the hot or the warm zone to rescue and/or decontaminate victims. Medical personnel should wear the proper PPE. If the victim can't move, decontaminate without touching and without entering the hot or the warm zone. Nerve gasses stay in clothing; *do not* touch with bare skin—if possible, seal contaminated clothes and personal belongings in a sealed double bag. Use clean water from any source; if possible, use a hose (spray or fog to prevent injury to the victim) or other system to avoid touching the victim. Don't wait for soap or for the victim to remove clothing, begin washing immediately. Do not delay decontamination to obtain warm water; time is of the essence; use cold water instead. Immediately flush the eyes with water for at least 15 minutes. If time is available, decontaminate outer personal protection equipment (PPE) with a dilute household bleach solution**. Use warm soapy water instead of dilute bleach for decon of bare skin. Use caution to avoid hypothermia in children and the elderly. *Patients exposed to liquid:* All visible droplets should be blotted (not wiped) away using an absorbent material (e.g., paper towels, facial tissues, etc.); if available, towelettes moistened with a neutralizing solution should be used. Absorbent powders may also be used for removal of droplets (in the absence of standard absorbents, field expedients such as flour may be useful). GF should be decontaminated by washing in available clean water at least 3 times. Skin decontamination may be unnecessary if the exposure was to GF vapor only. Use liquid soap (dispose of container after use and replace), large amounts of water, and mild to moderate friction with a single-use sponge or washcloth in the first and second washes. Scrubbing of exposed skin with a brush is discouraged; skin damage may occur and may increase absorption. The third wash should be to rinse with large amounts of warm or hot water. Wash off the diluted bleach solution after 15 minutes. Hair should be thoroughly cleaned using soap and water, with care being taken to prevent wash water from getting into the victim's eyes, open wounds, or mouth. Remember that the water used to decontaminate victims is dangerous. Be sure to decontaminated the victims as much as possible before releasing them from the decon area to prevent them from spreading the nerve gas. Rinse the eyes, mucous membranes; or open wounds with sterile saline or water and then move away from the hot zone in an upwind and uphill direction. *Patients exposed to nerve agent by vapor (only)*: should be decontaminated by removing all clothing in a clean-air environment and shampooing or rinsing the hair to prevent vapor-off gassing; take care to prevent wash water from getting into the victim's eyes, open wounds, or mouth.

Surface decontamination (nonporous surfaces, vehicles, etc.): Use hypochlorite bleach slurries, or dilute alkalis. *Confined spaces*: Use steam and ammonia.

**Note*: The following can be used in addition to household bleach: (1) solids, powders, and solutions containing various types of bleach [sodium hypochlorite [NaOCl] or calcium hypochlorite [$Ca(OCl)_2$]]; (2) "DS2 solution" (2% NaOH; 70% diethylene triamine; 28% ethylene glycol monomethyl ether); (3) towelettes moistened with sodium hydroxide (NaOH) dissolved in water, phenol, ethanol, and ammonia.

***Note:* Use 5% solution of common bleach (sodium hypochlorite) or calcium hypochlorite solution (48 oz per 5 gal of water) to decontaminate scissors used in clothing removal, clothes, and other items.

First Aid: The immediate treatment for nerve agent intoxication is intravenous injection of 2 mg atropine sulfate (intramuscular injection should be considered if the patient is hypoxic and ventilation cannot be initiated, as there is a risk of ventricular fibrillation). This should be followed by additional injections of atropine at 10−15 minute intervals, continuing until bradycardia has been reversed (e.g., until the heart rate is at 90 beat/minute or less). If breathing has stopped, a mechanical respirator should be used to ventilate the patient. *Do not attempt mouth-to-mouth resuscitation*. If possible, oxygen or oxygen-enriched air should be used for ventilation. If possible, monitor cardiac activity.

Notes for physician and medical personnel: Oximes (pralidoxime salts, obidoxime) may be of use in restoring acetylcholinesterase activity. Obidoxime may be used to treat GF intoxication; however, it may cause liver damage. Animal studies indicate that the oxime Hi-6 may be significantly superior to other oximes in the treatment of GF intoxication, but it is not widely available. Therefore pralidoxime salts should be used, with a slow intravenous infusion of 500 mg. to 1 g. being given initially. Diazepam may be administered to control convulsions. It also has value in controlling the victim's fear. An initial dose of 5 mg may be followed by additional doses at 15-minute intervals up to a total of 15 mg[92].

Other effective antidote: National Response Team (NRT) lists atropine and (if more severe) 2-PAM Chloride injections; atropine eye drops[91].

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. *Outer suit*: Tychem F, Butylrubber, LV, Responder, TK, Tyvek-F, or Reflector decontamination suits. *Gloves*: Butyl rubber gloves, M-3 and M-4 Norton, or Chemical Protective Set. See: http://www2.dupont.com/Personal_Protection/en_US/assets/downloads/tychem/permguide82004.pdf. Although resistant to liquid chemical agents, impermeable protective clothing may be penetrated after a few hours of exposure to heavy concentration of agent. Consequently, liquid contamination on the clothing must be neutralized or removed as soon as possible. Contact lenses should NOT be worn when working with this chemical. Medical personnel treating casualties should avoid direct (skin-to-skin) contact; protective gear including breathing protection should be worn when treating casualties prior to decontamination. *Latex gloves are not adequate protection*. Casualties should be decontaminated as rapidly as possible (see the section on decontamination). Remove casualties from exposure as rapidly as possible. *Casualties must not be moved into clean treatment areas where unmasked/ungloved personnel are working until decontamination is complete*. During decontamination operations there should also be PPE/respiratory measures to minimize potential exposures to associated chlorine vapors.

Respirator Selection: *When the types of inhalation hazards and their concentrations are unknown or anticipated to be high*, hazard evaluation responders must use NIOSH- or European Standard EN149-approved chemical, biological, radiological, and nuclear (CBRN) SCBA respirators. The CBRN APR full-face respirator provides a lower level of protection than the SCBA and its use is generally allowed once conditions are understood and exposures are determined to be at lower levels. Once the level of danger is established and where there is potential for exposure to the chemical exists, use a NIOSH/MSHA or European Standard EN149-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA or European Standard EN149-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode. The M40 Series (which replaced the M17A1 protective mask) mask provides respiratory protection against all known military toxic chemical agents, but it cannot be used in an oxygen deficient environment and is *not approved for civilian use*. It does not afford protection against industrial toxics, such as ammonia and carbon monoxide.

Storage: Color code—Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. Reasonably stable in steel at normal temperatures. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN2810 Toxic liquids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling:

UN2810 Toxic liquids, organic, n.o.s.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 0.7/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 1000/300
Then: Protect persons downwind (mi/km)
Day 1.1/1.8
Night 2.8/4.5

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

GF, when used as a weapon

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/60
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 0.2/0.3

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 500/300
Then: Protect persons downwind (mi/km)
Day 0.5/0.8
Night 0.6/1.0

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Spills must be contained by covering with vermiculite, diatomaceous earth; clay, fine sand; sponges, and paper or cloth towels. This containment is followed by treatment with copious amounts of aqueous sodium hydroxide solution (a minimum 10% wt.). Scoop up all material and place in a fully removable head drum with a high density polyethylene liner. The decontamination solution must be treated with excess bleach to destroy the CN formed during hydrolysis. Cover the contents with additional bleach before affixing the drum head. After sealing the head, the exterior of the drum shall be decontaminated and then labeled in accordance with IAW, EPA, and DOT regulations. All leaking containers shall be over-packed with vermiculite placed between the interior and exterior containers. Decontaminate and label per IAW, EPA, and DOT regulations. Dispose of the material per IAW waste disposal methods provided below. Conduct general area monitoring with an approved monitor to confirm that the atmospheric concentrations do not exceed the airborne Exposure limit. If 10% wt. sodium hydroxide is not available then the following decontaminants may be used instead and are listed in order of preference: Decontaminating Solution No. 2 [DS2: (2% NaOH, 70% diethylenetriamine, 28% ethylene glycol monomethyl ether)], sodium carbonate and Supertropical Bleach Slurry (STB). Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire: If tank, rail car, or tank truck is involved in fire, isolate for at least 800 m (½ mi) in all directions; also, consider initial evacuation for 800 m (½ mi) in all directions.

Fire Extinguishing: Thermal decomposition products may include fluorides and oxides of phosphorus and carbon. When heated, vapors may form explosive mixture with air, presenting an explosion hazard indoors, outdoors, and in sewers. Containers may explode when heated. Water, fog, foam, CO_2; Avoid using extinguishing methods that will cause splashing or spreading of the GA. Thermal decomposition products may include hydrogen cyanide, oxides of nitrogen, oxides of phosphorus; carbon monoxide; and hydogen cyanide may be produced in fire. Respiratory protection is required. Positive pressure, full facepiece, NIOSH-approved SCBA will be worn where there is danger of oxygen deficiency and when directed by the fire chief or chemical accident/incident (CAI) operations officer. The M9 or M17 series mask may be worn in lieu of SCBA when there is no danger of oxygen deficiency. In cases where firefighters are responding to a chemical accident/incident for rescue/reconnaissance purposes they will wear appropriate levels of protective clothing. Complete protection required; have decontaminants available (bleach, alkali) and atropine. Bleaching powder (chlorinated line) destroys tabun but gives rise to cyanogen chloride. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156.

Disposal Method Suggested: Principles and methods for destruction of chemical weapons: "Destruction of chemical weapons" means a process by which chemicals are converted in an essentially irreversible way to a form unsuitable for production of chemical weapons, and which in an irreversible manner renders munitions and other devices unusable as such. Each nation shall determine how it shall destroy chemical weapons, except that the following processes may not be used: dumping in any body of water, land burial or open-pit burning. It shall destroy chemical weapons only at specifically designated and appropriately designed and equipped facilities. Each nation shall ensure that its chemical weapons destruction facilities are constructed and operated in a manner to ensure the destruction of the chemical weapons; and that the destruction process can be verified under the provisions of this Convention. (Organization for the Prohibition of Chemical Weapons; Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and Their Destruction). Grossly liquid-contaminated materials should be decontaminated and containerized and labeled in accordance with DOT and EPA requirements as a hazwaste. Wastewater solution from decon should be analyzed to ensure no residual agent is present. The National Response Plan, ESF-3 designates United States Army Corps of Engineers (USACE) as the primary agency to manage contaminated debris. USACE and the Department of Defence (DOD) typically use safety procedures prior to transport that include "head space" (off gas) monitoring around containers prior to shipment to ensure no leakage/off-gassing. Typically waste will be transported in accordance with state requirements to a designated disposal facility, such as a RCRA-permitted hazardous waste facility (typically an incinerator). Wastewater solution from the decontamination process will be analyzed to ensure no residual agent is present. It is likely that the solution will not contain residual agents and therefore not need to be classified as a hazardous waste but sampling must be used to verify. Chlorinated wastewater may need to be treated/neutralized prior to disposal[91]. United States munitions stockpiles of G-agent are/have undergone destruction/disposal in the states of Utah, Oregon, Arkansas, Alabama, and Kentucky. State/local plans to address potential releases from United States Army properties are in place at these sites.

References

(31); (101); (138); (85); (86); (87); (169); (92); (93); (94); (103); (105); (163); (175); (176); (186); (187); (190).

National Response Team, *Quick Reference Guides (QRGs) for Chemical Warfare Agents: Cyclosarin*, Various Agencies, Key References Cited/Several sources were used in developing the QRGs. Because most references are considered (31); "secondary" sources, comparisons among multiple sources helped to verify information. When conflicting information was found between listed references, a determination was made as to what was more correct and up-to-date, based on (31); publication date and level of peer-review (2009).

Cyclopropane C:1800

Formula: C_3H_6
Synonyms: Ciclopropano (Spanish); Cyclopropane, liquefied; RC-270; Trimethylene
CAS Registry Number: 75-19-4
HSDB Number: 812
RTECS Number: GZ0690000
UN/NA & ERG Number: UN1027/115
EC Number: 200-847-8 [*Annex I Index No.:* 601-016-00-6]
Regulatory Authority and Advisory Information
Department of Homeland Security Screening Threshold Quantity (pounds): *Release Hazard* 10,000 ($1.00% concentration).
Hazard Alert: Extremely flammable gas, Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated, Possible narcotic hazard.
Clean Air Act: Accidental Release Prevention/Flammable Substances (Section 112 [r], Table 3), TQ = 10,000 lb (4540 kg).
Hazard symbols, risk, & safety statements: Hazard symbol: F+; risk phrases: R5; R12; R21; safety phrases: S2; S9; S16; S33; S38 (see Appendix 4).
Description: Cyclopropane is a gas. Molecular weight = 42.09; specific gravity (H_2O:1) = 1.88; boiling point = −33.5°C; freezing/melting point = −126.6°C; flash point = flammable gas. Flammable limits: LEL: 2.4%; UEL: 10.4%; autoignition temperature = 498°C. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 4, reactivity 0.
Potential Exposure: Cyclopropane is used as an anesthetic and used to make other chemicals.
Incompatibilities: May form explosive mixture with air. Heat, flame, or contact with oxidizers can cause fire and explosion hazard. May accumulate static electrical charges, and may cause ignition of its vapors. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.
Permissible Exposure Limits in Air
PAC Ver. 29[138]
PAC-1: 85 ppm
PAC-2: 930 ppm
PAC-3: 5600 ppm
Determination in Air: Charcoal adsorption followed by workup with CS_2, and analysis by GC. Use NIOSH Analytical Method #1500 for hydrocarbons.
Harmful Effects and Symptoms
Short-Term Exposure: Cyclopropane can affect you when breathed in. Cyclopropane is used as a surgical anesthetic. High levels can cause you to feel dizzy, lightheaded, and to pass out. Very high levels can cause coma and death. Liquid can cause frostbite. May affect the nervous system; and cause heart-rate disorders.
Medical Surveillance: EKG, examination of the nervous system.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek Medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a Medical facility. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.
Personal Protective Methods: *Clothing:* Avoid skin contact with Cyclopropane. Wear protective gloves and clothing. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Where exposure to cold equipment, vapors, or liquid may occur, employees should be provided with special clothing designed to prevent the freezing of body tissue. *Eye Protection:* Wear gas-proof goggles, unless full facepiece respiratory protection is worn. Wear splash-proof chemical goggles when working with liquid, unless full facepiece respiratory protection is worn.
Respirator Selection: Where there is potential exists for exposure to cyclopropane, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.
Storage: Check oxygen content prior to entering storage area. Flammable gas. Color code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with cyclopropane all handlers should be trained on its proper handling and storage. Before entering confined space where this gas may be present, check to make sure that an explosive concentration does not exist. Cyclopropane must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates) and oxygen, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat or

flame. Outside or detached storage is recommended. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: UN1027 Cyclopropane, Hazard Class: 2.1; Labels: 2.1-Flammable gas. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit and to disperse the gas. Stop the flow of gas if it can be done safely. If source of leak is a cylinder and the leak cannot be stopped in place, remove leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. Keep this chemical out of confined space, such as a sewer because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Cyclopropane is a flammable gas. Thermal decomposition products may include oxides of carbon. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier.

References

(31); (173); (101); (138); (2).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet:* Cyclopropane, Trenton, NJ (March 1999).

Cyclosporin A C:1804

Formula: $C_{62}H_{111}N_{11}O_{12}$

Synonyms: Antibiotic S 7481F1; Ciclosporin; Consupren; Cyclosporin; Cyclosporine; Cyclosporine A; Cyclo[l-alanyl-D-alanyl-*N*-methyl-L-leucyl-*N*-methyl-L-leucyl-*N*-methyl-L-valyl-(3R,4R,6E)-6,7-didehydro-3-hydroxy-*N*,4-dimethyl-L-2-aminooctanoyl-L-2-aminobutanoyl-*N*-methyl-glycyl-*N*n-methyl-L-; Leucyl-L-valyl-*N*-methyl-L-leucyl]; Neoplanta; Nneoral; OL 27-400; [R-(R*,R*-(E))]-Cyclic-(l-alanyl-D-alanyl-*N*-methyl-L-leucyl-*N*-methyl-L-leucyl-*N*-methyl-L-valyl-3-hydroxy-*N*, 4-dimethyl-L-2-amino-6-octenoyl-L-alpha-amino-butyryl-*N*-methylglycyl-*N*-methyl-L-leucyl-L-valyl-*N*-methyl-L-leucyl); Ramihyphin A S 7481F1; *S*-Neoral; Sandimmun; Sandimmun neoral; Sandimmune; Sang-35

CAS Registry Number: 59865-13-3;79217-60-0; 104250-72-8

HSDB Number: 6881 (59865-13-3)

RTECS Number: GZ4120000

UN/NA & ERG Number: UN3249 (Medicine, solid, toxic, n.o.s.)/151

Regulatory Authority and Advisory Information

Carcinogenicty: NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen

California Proposition 65 Chemical[102]: Cancer, January 1, 1992

Hazard Alert: Poison, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard.

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xn; risk phrases: R45; R20/21/22; R22; R36; R40; R50; R60; R62; R63; safety phrases: S16; S22; S24/25; S26; S36/37/39; S45; S53; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: White crystalline solid or powder. Molecular weight = 1202.6; specific gravity (H_2O:1) = 1.02 @ 20°C; boiling point = 1294°C; freezing/melting point = ~150°C. Slightly soluble in water.

Potential Exposure: Cyclosporin A is a fungal metabolite; an amide immunosuppressant drug used in various surgeries.

Incompatibilities: Amides/imides react with azo and diazo compounds to generate toxic gases. Flammable gases are formed by the reaction of organic amides/imides with strong reducing agents such as hydrideds and active metals. Amides are very weak bases (weaker than water). Imides are less basic yet and in fact react with strong bases to form salts. That is, they can react as acids. Mixing amides with dehydrating agents such as such as phosphorus pentoxide or thionyl chloride generates the corresponding nitrile. The combustion of these compounds generates mixed oxides of nitrogen (NOx).

Permissible Exposure Limits in Air: No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Routes of Entry:

Harmful Effects and Symptoms

Short-Term Exposure: Symptoms of Exposure to this compound include hepatotoxicity, nephrotoxicity, hyperkalemia, hyperuricemia, convulsions, renal dysfunction, tremor, hirsutism, hypertension, gum hyperplasia, cramps, acne, headache, diarrhea, nausea, vomiting, abdominal discomfort, paresthesia, flushing, leukopenia, lymphoma, sinusitis, and gynecomastia. In 2% or less of persons exposed, it has caused allergic reactions, anemia, anorexia, confusion, conjunctivitis, edema, fever, brittle fingernails, gastritis, hearing loss, hiccups, hyperglycemia, muscle pain, peptic ulcer, thrombocytopenia, and tinnitus. Rare reactions include anxiety, chest pain, constipation, depression, hair breaking hematuria, joint pain, lethargy, mouth sores, myocardial infarction, night sweats, pancreatitis, pruritus, swallowing difficulty, tingling, upper gastrointestinal bleeding, visual disturbance, weakness, and weight loss. It has caused kidney and liver damage. An increased susceptibility to infection may occur. Other symptoms include gastrointestinal disturbance, rashes, and angioedema[101]. LD_{50} (oral-rat) = 1.5 g/kg.

Long-Term Exposure: May cause Cancer, tumors, mutagenic and reproductive effects.

Points of Attack: reproductive system.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure. Pregnant women should avoid contact. Employees should be notified by a physician that this chemical may affect there productive system. In addition to comprehensive initial medical and work histories emphasizing reproductive experience and menstrual history, patient should have physical examination and testing of genitourinary tract, sperm count, motility, and morphology. If required, other tests, such as serum testosterone, serum FSH, and serum LH may be indicated.

First Aid: *Skin Contact*[52]: Flood all areas of body that have contacted the substance with water. Don't wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others. *Eye Contact:* Remove any contact lenses at once. Flush eyes well with copious quantities of water or normal saline for at least 20−30 minutes. Seek medical attention. *Inhalation:* Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing, or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion:* If convulsions are not present, give a glass or two of water or milk to dilute the substance. Assure that the person's airway is unobstructed and contact a hospital or poison center immediately for advice on whether or not to induce vomiting.

Personal Protective Methods: *Skin Contact*[52]: Flood all areas of body that have contacted the substance with water. Don't wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others. *Eye Contact:* Remove any contact lenses at once. Flush eyes well with copious quantities of water or normal saline for at least 20−30 minutes. Seek medical attention. *Inhalation:* Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing, or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion:* If convulsions are not present, give a glass or two of water or milk to dilute the substance. Assure that the person's airway is unobstructed and contact a hospital or poison center immediately for advice on whether or not to induce vomiting.

Respirator Selection: *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA-or European Standard EN149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA)

Storage: Color code—Blue: Health Hazard/Toxics/Poisons: A known carcinogen; refrigerate (∼ −20°C) and store in a secure poison location.
Shipping: UN3249 Medicine, solid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials.
Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Dampen spilled material with alcohol to avoid dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.
Fire Extinguishing: Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include oxides of nitrogen and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.
Disposal Method Suggested: It is inappropriate and possibly dangerous to the environment to dispose of expired or waste drugs and pharmaceuticals by flushing them down the toilet or discarding them to the trash. Household quantities of expired or waste pharmaceuticals may be mixed with wet cat litter or coffee grounds, double-bagged in plastic, discard in trash. Larger quantities shall carefully take into consideration applicable DEA, EPA, and FDA regulations. If possible return the pharmaceutical to the manufacturer for proper disposal being careful to properly label and securely package the material. Alternatively, the waste pharmaceutical shall be labeled, securely packaged, and transported by a state licensed medical waste contractor to dispose by burial in a licensed hazardous or toxic waste landfill or incinerator.

References

(109); (102); (31); (173); (101); (138); (100).

lambda-Cyhalothrin C:1808

Formula: $C_{23}H_{19}ClF_3NO_3$
Synonyms: (*R* + *S*)-α-Cyano-3-phenoxybenzyl(1*S* + 1*R*)-*cis*-3-(*Z*-2-Chloro-3,3,3-trifluoroprop-1-enyl)-2,2-dimethylcyclopropanecarboxylate; (*RS*)-α-Cyano-3-phenoxybenzyl *(Z)*-(1*RS*,3*RS*)-(2-chloro-3,3,3-trifluoropropenyl)-2,2-dimethylcyclopropanecarboxylate; Cyclopropanecarboxylic acid, 3-(2-chloro-3,3,3-trifluoro-1-propenyl)-2,2-dimethyl-, cyano (3-phenoxyphenyl)methyl ester, [1α*(S**)*,3α*(Z)*]-(+)-; λ-Cyhalothrin; Cyhalothrin-K; Charge; Commodore; Demand; Demand cs; Double barrel; Excaliber; Grenade; Hallmark; Icon; Impasse; Karate; Matador; Ninja; Pp-321; Rate; Saber; Samurai; Scimitar; Sentinel; Warrior
CAS Registry Number: 91465-08-6
HSDB Number: 6791 as cyhalothrin
RTE CS Number: GZ1227780
UN/NA & ERG Number: UN3349 (Pyrethroid pesticide, solid toxic)/151; UN3077 (environmentally hazardous substances, solid, n.o.s.)/171; UN3082 (environmentally hazardous substances, liquid, n.o.s.)/171
EC Number: 415-130-7 [*Annex I Index No.:* 607-252-006]
Regulatory Authority and Advisory Information
Hazard Alert: Possible endocrine disruptor.
Clean water act: Section 311 Hazardous Substances/RQ (same as CERCLA) as pyrethrins
Permissible Exposure Limits for Chemical Contaminants (CAL/OSHA) as pyrethrum
Hazard symbols, risk, & safety statements: Hazard symbol: T+, N; risk phrases: R21; R25; R26; R50/53; safety phrases: S1/2; S28; S36/37/39; S38; S41; S45; S60; S61 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.
Description: Colorless to beige powder; or viscous yellowish-brown liquid. Mild odor. Liquid formulations containing organic solvents may be flammable. Molecular weight = 449.85; specific gravity (H_2O:1) = 1.25 @25°C; boiling point = (decomposes); freezing/melting point = 50°C; vapor pressure = (est.) 1.1×10^{-6} mmHg @ 20°C; flash point = 75°C. Slight solubility in water; solubility = <1 ppm. Hydrolyzed by water (slowly @ pH = 7−9, rapidly @ pH = >9). Physical and toxicological properties may be affected by the carrier solvents used in commercial formulations.
Potential Exposure: Pyrethroid insecticide and acaridide used to control a variety of pests in many crops. Also used in structural pest situations. A United States Environmental Protection Agency Restricted Use Pesticide (RUP). Only cyhalothrin is banned for use in EU; *not* the *lamda*-isomer (CAS 68085-85-8).
Incompatibilities: May react violently with strong oxidizers, bromine, 90% hydrogen peroxide, phosphorus trichloride, silver powders, or dust. Incompatible with silver compounds. Mixture with some silver compounds forms explosive salts of silver oxalate. Hydrolyzed by water (slowly @ pH = 7−9, rapidly @ pH = > 9).
Permissible Exposure Limits in Air:
ACGIH TLV[1]: (all pyrethrins) 5 milligram per cubic meter TWA
Determination in Air: Collection by impinger or fritted bubbler, analysis by gas liquid chromatography/ultraviolet. See NIOSH IV, Method #5008,[18] pyrethrum.

Permissible Concentration in Water: *Fluoride ion:* Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guidelines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg[F]/L. Safe Drinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg[F]/L; SMCL = 2 mg/F/L, as Fluoride.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = > 6$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood. Fish toxicity (threshold)[101]: Extra high—0.04384 ppb, MATC.

Routes of Entry: Inhalation, ingestion, dermal or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: High toxicity. Contact with eyes or skin may cause irritation or injury. Ingestion is harmful. Inhalation should be avoided. *Inhalation:* Convulsions, cough, trouble breathing, sore throat. *Skin:* Pain and redness. *Eyes:* Pain and redness. *Ingestion:* Abdominal pain and coughing. LD_{50} (oral, rat) = 50−166 mg/kg; LD_{50} (dermal, rat) = > 500 mg/kg.

Long-Term Exposure: May cause respiratory disease, asthma, skin sensitization, skin allergy, dermatitis.

Points of Attack: Lungs, skin.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended: Employees should be screened for history of certain medical conditions which might place the employee at increased risk from pyrethroid exposure. Chronic respiratory disease: In persons with chronic respiratory disease, especially asthma, the inhalation of pyrethroids might cause exacerbation of symptoms due to its sensitizing properties. Lung function tests. These may be normal if the person is not having an attack at the time of the test. Consider chest X-ray if lung symptoms are present. Skin disease: Pyrethroids can cause dermatitis which may be allergic in nature. Persons with preexisting skin disorders may be more susceptible to the effects of this agent. Evaluation by a qualified allergist, including exposure history and testing, may help diagnose allergy. Any employee developing the above-listed conditions should be referred for further medical examination[9]. Evaluation by aqualified allergist, including Exposure history and testing, may help diagnose allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek Medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Applicators and other handlers must wear: Coveralls worn over long-sleeved shirt and long pants; Chemical-resistant gloves such as DuPont Tychem suit fabrics, barrier laminate, or Viton; Chemical-resistant footwear plus socks; Protective eye wear; Chemical-resistant headgear for overhead exposure; Chemical-resistant apron when cleaning equipment, mixing, or loading[83]. Agricultural Use/Engineering Controls: When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the WPS for agricultural pesticides, 40 CFR 170.240 (d)(4-6), the handler PPE requirements may be reduced or modified as specified in the WPS. Firefighters should wear NIOSH-approved SCBA and full protective clothing.

Respirator Selection: NIOSH/OSHA *for pyrethrum*: *50 milligram per cubic meter:* CcrOv95 (APF = 10) [any air-purifying half-mask respirator equipped with an organic vapor cartridge(s) in combination with an N95, R95, or P95 filter]. The following filters may also be used: N99, R99, P99, N100, R100, P100; or Sa (APF = 10) (any supplied-air respirator). *125 milligram per cubic meter:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOvHie (APF = 25) (any air-purifying full facepiece respirator equipped with an organic vapor cartridge in combination with a high-efficiency particulate filter). *250 milligram per cubic meter:* CcrFOv100 (APF = 50) [any air-purifying full facepiece respirator equipped with organic vapor cartridge(s) in combination with an N100, R100, or P100 filter]; or PaprTOvHie (APF = 50) [any powered, APR with a tight-fitting facepiece and organic vapor cartridge(s) in combination with a high-efficiency particulate filter]; or SCBAF (APF = 50) (any SCBA with full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *5000 milligram per cubic meter:* SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—Blue: Health Hazard/Poison. Store in a secure poison location at temperature <35°C and away from alkaline materials. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: Shipping: UN3349 Pyrethroid pesticide, solid toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous material. UN3082 Environmentally hazardous substances, liquid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: First remove all sources of ignition. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Ventilate area of spill or leak. Use water spray to reduce vapor. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include HF, hydrogen chloride and oxides of carbon. Use dry chemical, carbon dioxide; or alcohol-resistant foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration would be an effective disposal procedure where permitted. If an efficient incinerator is not available, the product should be mixed with large amounts of combustible material and contact with the smoke should be avoided. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers.

References

(31); (173); (101); (138); (122); (100).

National Pesticide Telecommunications Network (Now NPIC), "*lambda*-Cyhalothrin General Fact Sheet:" Corvallis, OR (January 2001). http://www.npic.orst.edu/factsheets/l_cyhalogen.pdf.

EXTOXNET, Extension Toxicology Network, "Pesticide Information Profile, *lambda* Cyhalothrin," Oregon State University, Corvallis, OR. http://extoxnet.orst.edu/pips/lambdacy.htm.

United States Environmental Protection Agency, Office of Pesticide Programs, Pesticide Residue Limits, "*lambda*-Cyhalothrin," 40 CFR 180.438. www.epa.gov/pesticides/food/viewtols.htm.

Cyhexatin C:1810

Formula: $C_{18}H_{34}O_4Sn$; $(C_6H_{11}O)_3SnOH$

Synonyms: Plictran; Tricyclohexylhydroxystannane and ENT 27395-X; Tricyclohexyltin hydroxide

CAS Registry Number: 13121-70-5

HSDB Number: 1782

RTECS Number: WH8750000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154; UN2786/153 (Organotin pesticides, solid, toxic)

EC Number: 236-049-1 [*Annex I Index No.*: 050-002-00-0]

Regulatory Authority and Advisory Information

California Proposition 65 Chemical[102]: Cancer; Developmental/Reproductive toxin 1/1/1989.

Hazard Alert: Poison, Organometallic, Strong reducing agent, Reproductive toxin: possible risk of gene damage/impaired fertility; Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction), Environmental hazard.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), listed as "severe pollutant."

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. as tin compounds; Canada, CEPA Prohibited Export Substance List.

Hazard symbols, risk, & safety statements: Hazard symbol: Xn, N; risk phrases: R20/21/22; R50/53; R62; R63; safety phrases: S2; R13; S41; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Cyhexatin is a colorless to white, nearly odorless, crystalline powder. Molecular weight = 385.16; boiling point = 227°C (decomposes); freezing/melting point = 195−198°C. Practically insoluble in water.

Potential Exposure: Used as an agricultural chemical and pesticide. A potential danger to those involved in the manufacture, formulation, and application of this acaricide (miticide).

Incompatibilities: Incompatible with strong oxidizers. May react exothermically as base in the Incompatible with strong oxidizers. May react exothermically as base in the Incompatible with strong oxidizers. Reacts exothermically as base in the presence of strong acids, forming salts. Keep away from ultraviolet radiation which may cause conversion to dicyclohexyltin oxide and further to cyclohexylstannoic acid[136].

Permissible Exposure Limits in Air

NIOSH IDLH 80 milligram per cubic meter [25 mg[Sn]/m^3] as Sn

OSHA PEL: 0.1 mg[Sn]/m^3/0.32 milligram per cubic meter TWA

NIOSH REL: 5 milligram per cubic meter TWA

ACGIH TLV[1]: 5 milligram per cubic meter TWA; not classifiable as a human carcinogen

PAC not available

DFG MAK: 0.1 milligram per cubic meter (as Sn)[skin] (measured as the, inhalable fraction); Pregnancy Risk Group D

Australia: TWA 0.1 mg[Sn]/m^3 [skin], 1993; Austria: MAK 0.1 mg[Sn]/m^3 [skin], 1999; Australia: TWA 5 milligram per cubic meter, 1993; Belgium: TWA 5 milligram per cubic meter, 1993; Denmark: TWA 0.1 mg[Sn]/m^3 [skin], 1999; Denmark: TWA 5 milligram per cubic meter, 1999; France: VME 5 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 5 milligram per cubic meter, 2003; Hungary: STEL 0.1 mg[Sn]/m^3 [skin], 1993; Norway: TWA 0.1 mg[Sn]/m^3, 1999; the Philippines: TWA 0.1 mg[Sn]/m^3, 1993; Russia: STEL 0.02 milligram per cubic meter [skin], 1993; Switzerland: MAK-W 0.1 mg [Sn]/m^3, KZG-W 0.2 mg[Sn]/m^3 [skin], 1999; Thailand: TWA 0.1 mg[Sn]/m^3, 1993; United Kingdom: TWA 5 milligram per cubic meter; STEL 10 milligram per cubic meter, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Several states have set guidelines or standards for cyhexatin in ambient air[60] ranging from 50 μ/m^3 (North Dakota) to 80 μ/m^3 (Virginia) to 100 μ/m^3 (Connecticut) to 119 μ/m^3 (Nevada).

Determination in Air: Filter/XAD-2 (tube); CH$_3$COOH/CH$_3$CN; High-pressure liquid chromatography/graphite furnace AA spectrometry; NIOSH Analytical Method (IV) #5504, Organotin.

Permissible Concentration in Water: State Drinking Water Guidelines: Minnesota 4000 μg[Sn]/L. Fish Tox (ppb): 0.083480 MATC; EXTRA HIGH; FISH STV (Sediment Toxicity Value): INTERMEDIATE.

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates eyes, skin, and respiratory system. Symptoms of exposure include headache, vertigo (an illusion of movement); sore throat; cough; abdominal pain; vomiting; skin burns; pruritus. Cyhexatin is moderate in acute oral toxicity to animals. This is in contrast to alkyl tin compounds with smaller (methyl and ethyl) radicals which are highly toxic. A diet including 6 mg/kg of body weight of cyhexatin for 2 years showed no effect in rats. LD$_{50}$ (oral-rat) = 180 mg/kg (moderately toxic).

Long-Term Exposure: This chemical has been shown to cause liver and kidney damage in animals. Human Toxicity: 5.250 ppb; HIGH

Points of Attack: Eyes, skin, respiratory system; liver, kidneys.

Medical Surveillance: NIOSH lists the following tests: CBC (RBC Hemolysis), electrocardiogram, especially on workers over 40 years, glaucoma, liver function tests; urine (chemical/metabolite). For organotins, preplacement and periodic examinations should include the skin, eyes, blood, central nervous system; liver and kidney function.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 3.2 milligram per cubic meter:* Any air-purifying half-mask respirator with organic vapor cartridge(s) in combination with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100; or Sa (APF = 10) (any supplied-air respirator). *Up to 8 milligram per cubic meter:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOvHie (APF = 25) (any air-purifying full facepiece respirator equipped with an organic vapor cartridge in combination with a high-efficiency particulate filter). *Up to 16 milligram per cubic meter:*

CcrFOv100 (APF = 50) [any air-purifying full facepiece respirator equipped with organic vapor cartridge(s) in combination with an N100, R100, or P100 filter]; or GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or PaprTOvHie (APF = 50) [any powered, APR with a tight-fitting facepiece and organic vapor cartridge(s) in combination with a high-efficiency particulate filter]; or SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 80 milligram per cubic meter:* SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp:ASCBA (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, dark, well-ventilated area away from oxidizers.

Shipping: UN2786 Organotin pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous material. UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft (NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include oxides of metals and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(102); (31); (173); (101); (138); (80); (100).

National Institute for Occupational Safety and Health (NIOSH), *Criteria for a Recommended Standard: Occupational Exposure to Organotin Compounds*, NOSH Document No. 77-115, Cincinnati OH (1977).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet: Cyhexatin*, Trenton, NJ (December 2002).

Cymoxanil C:1820

Formula: $C_7H_{10}N_4O_3$

Synonyms: Acetamide, 2-cyano-*N*-[(ethylamino)carbonyl]-2-(methoxyimino)-; Curzate; 2-Cyano-*N*-[(ethylamino)carbonyl]-2-(methoxyimino)acetamide; 2-Cyano-*N*-ethylcarbamoyl-2-methoxyiminoacetamide; **Cymoxanil**; DPX 3217; DPX 3217 M; DPX-T3217; Evolve; MZ-Curzate; Tanos cymoxanil

CAS Registry Number: 57966-95-7

HSDB Number: 6914

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

RTE CS Number: AB5957000

EC Number: 261-043-0 [*Annex I Index No.:* 616-035-00-5]

Regulatory Authority and Advisory Information

Carcinogenicity: EPA: Not likely to be carcinogenic to humans.

Hazard Alert: Sensitization hazard, Environmental hazard, Agricultural chemical.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

United States National Primary Drinking Water Regulations: MCLG = 0.2 mg[CN^-]/L; MCL = 0.2 mg [CN^-]/L as Cyanide.

Clean water act: Section 307 Priority Pollutants as cyanide, total; Toxic Pollutant (Section 401.15)

RCRA Universal Treatment Standards: Wastewater (mg/L), 1.2 (total); 0.86 (a menable); Nonwastewater (mg/kg), 590 (total); 30 (amenable)

RCRA Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 9010(40)

EPCRA Section 304 RQ: CERCLA, 10 lb (4.54 kg)
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%
United States DOT Regulated marine pollutant (49 CFR 172.101, Appendix B) as cyanides, mixtures or solutions.
Hazard symbols, risk, & safety statements: Hazard symbol: Xn, N, Xi; risk phrases: R22; R43; R50/R53; safety phrases: S2; S29/35; S36/37; S60; S61 (see Appendix 4)

Description: A white to peach (pale pink) crystalline solid. Molecular weight = 198.20; specific gravity (H_2O:1) = 1.31 @ 25°C; melting point = 159−160°C; vapor pressure = 12×10^{-8} mmHg @ 25°C. Low solubility in water; solubility increases with temperature.

Potential Exposure: Cymoxanil is a cyanoacetamide oxime fungicide applied as a seed treatment to cut potato seed pieces or as a foliar to control late blight.

Incompatibilities: Slowly hydrolyzes in water, releasing ammonia and forming acetate salts. Light sensitive.

Permissible Concentration in Water: Safe Drinking Water Act (47FR 9352): MCL, 0.2 mg/L; MCLG, 0.2 mg/L. Federal Drinking Water Guidelines: EPA 200 μg[CN]/L; State Drinking Water Standards: California 150 μg[CN]/L; State Drinking Water Guidelines: Arizona 220 μg[CN]/L; Maine. 140 μg[CN]/L; Minnesota 100 μg[CN]/L. United States Army field drinking-water standards for cyanide: 2 mg[CN]/L assuming a water consumption of 15 L/day and 6 mg[CN]/L assuming a water consumption of 5 L/day. United States Army field drinking-water standards for cyanide, long-term consumption 0.5 mg[CN]/L; Short-term consumption; Raw water constituents (maximum) 20 mg [CN]/L.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = <1.0$. Unlikely to bioaccumulate in marine organisms. Fish toxicity (threshold)[101]: High—1.53362 ppb, MATC.

Harmful Effects and Symptoms

Short-Term Exposure: Contact with eyes or skin may cause irritation or injury. Inhalation should be avoided; use NIOSH- or CEN (UK)-approved APRs for pesticides. May be harmful if swallowed. LD_{50} (oral, rat) = >1 g/kg; LD_{50} (dermal, rat) = >3 g/kg.

Long-Term Exposure: May cause skin sensitization. Human toxicity (long term)[101]: Low—91.00 ppb, Health advisory

Points of Attack: Skin.

Medical Surveillance: Evaluation by a qualified allergist, including exposure history and testing, may help diagnose allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek Medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Evaluation by a qualified allergist, including exposure history and testing, may help diagnose allergy.

Personal Protective Methods: Applicators and other handlers must wear: Coveralls worn over long-sleeved shirt and long pants; Chemical-resistant gloves such as DuPont Tychem suit fabrics, barrier laminate, or Viton; Chemical-resistant footwear plus socks; Protective eye wear; Chemical-resistant headgear for overhead exposure; Chemical-resistant apron when cleaning equipment, mixing, or loading[83]. Agricultural Use/Engineering Controls: When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the WPS for agricultural pesticides, 40 CFR 170.240(d)(4-6), the handler PPE requirements may be reduced or modified as specified in the WPS. Firefighters should wear NIOSH-approved SCBA and full protective clothing.

Respirator Selection: Wherever and whenever workplace conditions warrant respirator use, a respiratory protection program must be followed that meets one or more of the following requirements: OSHA's 29 CFR 1910.134, ANSI Z88.2, or European Standard EN 149.

Storage: Color code—Blue: Health Hazard/Poison. Store in a secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: First remove all sources of ignition. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Ventilate area of spill or leak. Use water spray to reduce vapor. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a Hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen and carbon. As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 m/150 ft for liquids and at least 25 m/75 ft for solids. *Fire involving storage or vehicular tanks:* Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m (1/2 mi) in all directions. *On a Small fire:* use dry chemical, CO_2, water spray, or regular *foam. On a large fire:* use water spray, fog, or regular foam. Do not scatter spilled material with high pressure streams of water. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal. *Fire involving tanks:* From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. Always stay away from tanks engulfed in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Do not discharge into drains or sewers. Burn in incinerator specifically designed for pesticide disposal or dispose as a Hazardous waste in a landfill approved and licensed for the disposal of pesticides. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Ultimate disposal of the chemical must consider: the material's impact on air quality; potential migration in soil or water; effects on animal, aquatic, and plant life; and conformance with environmental and public health regulations.

References

(31); (173); (101); (138).

United States Environmental Protection Agency, Office of Pesticide Programs, "Pesticide Fact Sheet: Cymoxanil," Washington DC (April 21, 1998). http://www.epa.gov/opprd001/factsheets/cymozanil.pdf.

United States Environmental Protection Agency, Office of Pesticide Programs, Pesticide Residue Limits, "Cymoxanil" 40 CFR 180.503. www.epa.

Cypermethrin C:1830

Formula: $C_{22}H_{19}Cl_2NO_3$

Synonyms: Agrothrin; Ammo; Ardap; Arrivo; Avicade; Barricade; CCN52; CNN 52; (RS)-α-Cyano-3-phenoxybenzyl (1RS)-*cis, trans*-3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropanecarboxylate; Cyano(3-phenoxyphenyl)methyl 3-(2,2-dichloroethenyl)-2, 2-dimethylcyclopropanecarboxylate; Cyano(3-phenoxyphenyl)methyl 3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropanecarboxylate; (±)-α-Cyano-3-phenoxybenzyl 2,2-dimethyl-3-(2,2-dichlorovinyl)cyclopropanecarboxylate; Cyano(3- phenoxyphenyl)methyl 3-(2,2-dichloroethenyl)-2,2-dimethylcyclopropanecarboxylate; Cyclopropanecarboxylic acid, 3-(2,2-dichloroethenyl)-2,2-dimethyl-, cyano(3-phenoxyphenyl) methyl ester; Cymbush 3e; Cymbush 2e; Cymperator; Cynoff; Cypercare; Cyperkill; Cypersect; Cyrux; Demon; Dorsan-c (+cypermethrin); Dysect; Fastac; Flectron; F 56701; FMC 45497; FMC 45806; FMC 30980; Folcord; Imperator; Jf5705f; Kafil super; Kencis; Nagata; NRDC 149; NRDC 160; NRDC 166; Nurelle; Permasect c; Polytrin; PP383; Prevail; Ralo 10; Ripcord; Rocyper; Rycopel; Sherpa; Siperin; Stockade; Supersect; Topclip-parasol; Ustaad; W 1 43467; WRDC 149

CAS Registry Number: 52315-07-8; (former numbers: 69865-47-0; 86752-99-0; 86753-92-6; 88161-75-5; 97955-44-7)

HSDB Number: 6600

UN/NA & ERG Number: UN3352 (liquid)/151; UN3349 (pyrethroid pesticide, solid, toxic)/151

RTECS Number: GZ1250000

EC Number: 257-842-7 [*Annex I Index No.:* 607-422-00-X]

Regulatory Authority and Advisory Information

Carcinogenicity: EPA Group C, possible human carcinogen.

Hazard Alert: Poison, Possible endocrine disruptor, Suspected of causing genetic defects, Suspected reprotoxic hazard

Clean water act: Section 311 Hazardous Substances/RQ (same as CERCLA) as pyrethrins

Permissible Exposure Limits for Chemical Contaminants (CAL/OSHA) as pyrethrum

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R25; R37; R48/22; R50/53; safety phrases: S1/2; S36/37/39; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to waters

Description: Thick, yellow-brown liquid or semisolid mass (technical product). Molecular weight = 416.30; specific gravity (H_2O:1) = 1.25 @ 20°C; freezing/melting point = 41.2°C; 70°C; vapor pressure = 5.1×10^{-8} mmHg @ 70°C; 1.7×10^{-9} mmHg @ 20°C[83]. Very sparingly soluble in water; solubility = 0.041 ppm @ room temp; about 0.01 ppm @ 20°C.

Potential Exposure: Pyrethroid insecticide used to control pests on cotton, fruit, and vegetable crops. Also used in commercial and residential settings, ships, laboratories, and food-processing plants. A United States Environmental Protection Agency Restricted Use Pesticide (RUP).

Incompatibilities: May react violently with strong oxidizers, bromine, 90% hydrogen peroxide, phosphorus trichloride, silver powders, or dust. Incompatible with silver compounds. Mixture with some silver compounds forms explosive salts of silver oxalate.

Permissible Exposure Limits in Air:

ACGIH TLV[1]: (all pyrethrins) 5 milligram per cubic meter TWA

Determination in Air: Collection by impinger or fritted bubbler, analysis by gas liquid chromatography/ultraviolet. See NIOSH IV, Method #5008,[18] pyrethrum.

Determination in Water: Octanol−water coefficient: Log K_{ow} => 5. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood. Collection by impinger or fritted bubbler, analysis by gas liquid chromatography/ultraviolet. See NIOSH IV, Method #5008,[18] pyrethrum. Octanol−water coefficient: Log K_{ow} = >4.5. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood. Fish toxicity (threshold)[101]: Extra high—0.21494 ppb, MATC.

Harmful Effects and Symptoms

Short-Term Exposure: Pyrethrins can affect you when breathed in and by passing through your skin. Irritates the eyes and respiratory tract. High exposure can affect the nervous system causing headache, nausea, vomiting, fatigue, and restlessness, rhinorrhea (discharge of thin nasal mucous). LD_{50} (oral, rat) = 57,500 μg/kg; LD_{50} (dermal, rat) = <2 g/kg.

Long-Term Exposure: High or repeated exposure can cause lung allergy (with cough, wheezing, and/or shortness of breath) or hay fever symptoms (sneezing, runny, or stuffy nose). Allergic "pneumonia" can also occur with cough, chest pain, breathing difficulty, and abnormal chest X-ray. Repeated attacks may lead to permanent scarring. Skin allergy may also develop with rash and itching, even with lower exposures. Dermal contact can cause rash with redness, blisters, and intense itching. A severe generalized allergy can occur with weakness and collapse. Human toxicity (long term)[101]: High—7.00 ppb, Health advisory.

Points of Attack: Respiratory system, skin, central nervous system

Medical Surveillance: This chemical is a suspected or known human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and advice for medical monitoring. Before beginning employment and at regular times after that, the following are recommended: Employees should be screened for history of certain medical conditions which might place the employee at increased risk from pyrethroid exposure. Chronic respiratory disease: In persons with chronic respiratory disease, especially asthma, the inhalation of pyrethroids might cause exacerbation of symptoms due to its sensitizing properties. Lung function tests. These may be normal if the person is not having an attack at the time of the test. Consider chest X-ray if lung symptoms are present. Skin disease: Pyrethroids can cause dermatitis which may be allergic in nature. Persons with preexisting skin disorders may be more susceptible to the effects of this agent. Evaluation by a qualified allergist, including exposure history and testing, may help diagnose allergy. Any employee developing the above-listed conditions should be referred for further medical examination[9]. Examination of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. *Do not induce vomiting when formulations containing petroleum solvents are ingested*. Otherwise, give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Applicators and other handlers must wear: Coveralls worn over long-sleeved shirt and long pants; Chemical-resistant gloves such as DuPont Tychem suit fabrics, barrier laminate, or Viton; Chemical-resistant footwear plus socks; Protective eye wear; Chemical-resistant headgear for overhead exposure; Chemical-resistant apron when cleaning equipment, mixing, or loading[83]. Agricultural Use/Engineering Controls: When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the WPS for agricultural pesticides, 40 CFR 170.240(d)(4-6), the handler PPE requirements may be reduced or modified as specified in the WPS. Firefighters should wear NIOSH-approved SCBA and full protective clothing.

Respirator Selection: NIOSH/OSHA *for pyrethrum*: *50 milligram per cubic meter:* CcrOv95 (APF = 10) [any air-purifying half-mask respirator equipped with an organic vapor cartridge(s) in combination with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *125 milligram per cubic meter:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOvHie (APF = 25) (any air-purifying full facepiece respirator equipped with an organic vapor cartridge in combination with a high-efficiency particulate filter). *250 milligram per cubic meter:* CcrFOv100 (APF = 50) [any air-purifying full facepiece respirator equipped with organic vapor cartridge(s) in combination with an N100, R100, or P100 filter]; or PaprTOvHie (APF = 50) [any powered, APR with a tight-fitting facepiece and organic vapor cartridge(s) in combination with a high-efficiency particulate filter]; or SCBAF (APF = 50) (any SCBA with full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *5000 milligram per cubic meter:* SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—Blue: Health Hazard/Poison. Store in a secure poison location at temperature <35°C and away from alkaline materials. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: UN3349 Pyrethroid pesticide, solid toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous material. UN3352 Pyrethroid pesticide, liquid toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: First remove all sources of ignition. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Ventilate area of spill or leak. Use water spray to reduce vapor. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include hydrogen chloride and oxides of nitrogen and carbon. *On a small fire:* use dry chemical, CO_2, or water spray. On a large fire, use water spray, fog, or regular foam. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal; do not scatter the material. Use water spray or fog; do not use straight streams. *Fire involving storage or vehicular tanks:* Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Do not get water inside containers. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. ALWAYS stay away from tanks engulfed in fire. For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies.

Disposal Method Suggested: Incineration would be an effective disposal procedure where permitted. If an efficient incinerator is not available, the product should be mixed with large amounts of combustible material and contact with the smoke should be avoided. In accordance with 40 CFR 165, follow recommendations for the disposal of pesticides and pesticide containers.

References

(31); (173); (101); (138); (100).

EXTOXNET, Extension Toxicology Network, “Pesticide Information Profile, Cyperme thrin,” Oregon State University, Corvallis, OR (September 1993). http://pmep.cce.cornell.edu/profiles/extoxnet/carbaryl-dicrotophos/cypermet-ext.html.

α-Cypermethrin C:1831

Formula: $C_{22}H_{19}Cl_2NO_3$

Synonyms: Alphacypermethrin; (+)-Alphamethrin; α-Cyano-3-phenoxybenzyl 3-(2,2-dich lorovinyl)-2,2-dimethylcyclopropanecarboxylate, (±)-*cis* isomer; Cyano (3-phenoxyphenyl)methyl 3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropanecarboxylate, (±)-*cis* isomer; Cyclopropanecarboxylicacid, 3-(2,2-dichloroethenyl)-2,2-dimethyl-, cyano(3-phenoxyphenyl)methyl ester, [1α(S*), 3α]-(+)-

Cypermethrin-s: *s*-Cyano(3-phenoxyphenyl)methyl (±)-*cis/trans*-3-(2,2-dichloethenyl)-2,2-dimethylcyclopropane arboxylate; Cyclopropanecarboxylic acid, 3-(2,2-dichloroethenyl)-2,2-dimethyl-, cyano(3-phenoxyphenyl) methyl ester, (*S*)-; Cypermethrin-minus; Fury (*s*-isomer); FMC 56701 (*s*-isomer)

zeta-Cypermethrin; *zeta*-Cypermethrin; Bestox; Concord; Dominex; Fastac; Fendona; FMC 45497; NRDC 160; Renegade; WL-85871

CAS Registry Number: 67375-30-8; 66841-24-5 (*d*-trans-β-Cypermethrin); 97955-44-7 (*zeta-*)

HSDB Number: 6554 (67375-30-8)

UN/NA & ERG Number: UN3352 (liquid)/151; UN3349 (pyrethroid pesticide, solid, toxic)/151

RTECS Number: GZ1250000

EC Number: Not assigned [*Annex I Index No.:* 607-422-00-X]

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Endocring Disruptor, Suspected reprotoxic hazard, Environmental hazard.

United States DOT Regulated United States DOT Regulated marine pollutant (49CFR172.101, Appendix B), severe pollutant

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R25; R37; R48/22; R50/53; safety phrases: S1/2; S36/37/39; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Colorless crystalline solid or viscous yellowish-brown semisolid mass. Mild aromatic odor. Molecular weight = 416.30; specific gravity (H_2O:1) = 1.36

@ 20°C; boiling point = 200°C @ 0.07 mmHg; freezing/melting point = 80.5°C; vapor pressure = 170 mmHg @ 20°C. Very low solubility in water; solubility = 0.2 ppm @ 20°C.

Potential Exposure: Pyrethroid Insecticide used for the control of a wide range of chewing and sucking insects (particularly *lepidotera, coleoptera*, and *hemiptera*) in fruit (including citrus), vegetables, vines, cereals, maize, beet, oilseed rape, potatoes, cotton, rice, soya beans, forestry, and other crops. Control of cockroaches, mosquitoes, flies, and other insect pests in public health; and flies in animal houses. Also used as an animal ectoparasiticide. *zeta*-Cypermethrin only is a United States Environmental Protection Agency Restricted Use Pesticide (RUP).

Incompatibilities: May react violently with strong oxidizers, bromine, 90% hydrogen peroxide, phosphorus trichloride, silver powders, or dust. Incompatible with silver compounds. Mixture with some silver compounds forms explosive salts of silver oxalate.

Determination in Water: Collection by impinger or fritted bubbler, analysis by gas liquid chromatography/ultraviolet. See NIOSH IV, Method #5008,[18] pyrethrum. Octanol−water coefficient: Log $K_{ow} = >6$. Values at or above 3.0 are likely to bioaccumulate in marine organisms.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 7$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Harmful Effects and Symptoms

Short-Term Exposure: Pyrethrins can affect you when breathed in and by passing through your skin. Irritates the eyes and respiratory tract. High exposure can affect the nervous system causing headache, nausea, vomiting, fatigue, and restlessness, rhinorrhea (discharge of thin nasal mucous). LD_{50} (oral, rat) $= < 100$ mg/kg; LD_{50} (dermal, rat) $= < 2$ g/kg.

Long-Term Exposure: High or repeated exposure can cause lung allergy (with cough, wheezing, and/or shortness of breath) or hay fever symptoms (sneezing, runny, or stuffy nose). Allergic "pneumonia" can also occur with cough, chest pain, breathing difficulty, and abnormal chest X-ray. Repeated attacks may lead to permanent scarring. Skin allergy may also develop with rash, redness, blisters, and itching, even with lower exposures. A severe generalized allergy can occur with weakness and collapse. Fluorides may cause bone disease (pain and tenderness of the bones); mottled teeth in children.

Points of Attack: Respiratory system, bones, skin, central nervous system

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended: Lung function tests. These may be normal if the person is not having an attack at the time of the test. Consider chest X-ray if lung symptoms are present. Evaluation by a qualified allergist, including exposure history and testing, may help diagnose allergy. Examination of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. *Do not induce vomiting when formulations containing petroleum solvents are ingested.* Otherwise, give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Applicators and other handlers must wear: Coveralls worn over long-sleeved shirt and long pants; Chemical-resistant gloves such as DuPont Tychem suit fabrics, barrier laminate, or Viton; Chemical-resistant footwear plus socks; Protective eye wear; Chemical-resistant headgear for overhead exposure; Chemical-resistant apron when cleaning equipment, mixing, or loading[83]. Agricultural Use/Engineering Controls: When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the WPS for agricultural pesticides, 40 CFR 170.240 (d)(4-6), the handler PPE requirements may be reduced or modified as specified in the WPS. Firefighters should wear NIOSH-approved SCBA and full protective clothing.

Respirator Selection: Wherever and whenever workplace conditions warrant respirator use, a respiratory protection program must be followed that meets one or more of the following requirements: OSHA's 29 CFR 1910.134, ANSI Z88.2, or European Standard EN 149.

Storage: Color code—Blue: Health Hazard/Poison. Store in a secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: UN3349 Pyrethroid pesticide, solid toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous material. UN3352 Pyrethroid pesticide, liquid toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: First remove all sources of ignition. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Ventilate area of spill or leak. Use water spray to reduce vapor. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include formaldehyde, acrolein, hydrogen cyanide, hydrogen chloride, and HF. *On a small fire:* use dry chemical, CO_2, or water spray. On a large fire: use water spray, fog, or regular foam. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal; do not scatter the material. Use water spray or fog; do not use straight streams. *Fire involving storage or vehicular tanks:* Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Do not get water inside containers. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. ALWAYS stay away from tanks engulfed in fire. For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies.

Disposal Method Suggested: Do not discharge into drains or sewers. Burn in incinerator specifically designed for pesticide disposal or dispose as a Hazardous waste in a landfill approved and licensed for the disposal of pesticides. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Ultimate disposal of the chemical must consider: the material's impact on air quality; potential migration in soil or water; effects on animal, aquatic, and plant life; and conformance with environmental and public health regulations.

References

(31); (173); (101); (138); (100).

International Programme on Chemical Safety (IPCS), "*Environmental Health Criteria, alpha-Cypermethrin,*" Geneva, Switzerland (1992). http://www.inchem.org/documents/ehc/ehc/ehc142.htm.

Cyphenothrin C:1840

Formula: $C_{24}H_{25}NO_3$

Synonyms: S-2703; S-2703 Forte; α-Cyano-3-phenoxybenzyl 2,2-dimethyl-3-(2-methylpropenyl)cyclopropanecarboxylate; Cyclopropanecarboxylic acid, 2,2-dimethyl-3-(2-methyl-1-propenyl)-, cyano(3-phenoxyphenyl)methyl ester; (RS)-α-Cyano-3-phenoxybenzyl (1R)-*cis, trans*-crysanthemate; Cyphenothrin (35% *cis*-; 65% *trans*-); Gokilaht; Multicide

CAS Registry Number: 39515-40-7

RTECS Number: GZ1453500

UN/NA & ERG Number: UN3349 (pyrethroid pesticide, solid, toxic)/151; UN3352/151; UN3082 (environmentally hazardous substances, liquid, n.o.s.)/171

EC Number: 254-484-5

Regulatory Authority and Advisory Information

AB 1803-Well Monitoring Chemical (CAL) as pyrethrins

Permissible Exposure Limits for Chemical Contaminants (CAL/OSHA) as pyrethrum

Clean Water Act: Section 311 Hazardous Substances/RQ (same as CERCLA) as pyrethrins

EPCRA Section 304 RQ: CERCLA, 1 lb (0.454 kg) as pyrethrins

Hazardous to aquatic life or environment, with possible long-lasting effects[192].

Hazard symbols, Risk Do not allow release to the environment unless proper permits are obtained from the federal government & safety statements: Hazard symbol: Xn, N; risk phrases: R22; R50/53; safety phrases: S41; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Thick, yellow liquid. Molecular weight = 375.46; boiling point = 154°C; freezing/melting point = 25°C; vapor pressure = 3.13×10^{-6} mmHg; flash point = 130°C. Low solubility in water.

Potential Exposure: Pyrethroid insecticide. Those involved in the manufacture and application of this agricultural chemical.

Incompatibilities: May react violently with strong oxidizers, bromine, 90% hydrogen peroxide, phosphorus trichloride, silver powders, or dust. Incompatible with silver compounds. Mixture with some silver compounds forms explosive salts of silver oxalate

Permissible Exposure Limits in Air:

ACGIH TLV[1]: (all pyrethrins) 5 milligram per cubic meter TWA

Determination in Air: Collection by impinger or fritted bubbler, analysis by gas liquid chromatography/ultraviolet. See NIOSH IV, Method #5008,[18] pyrethrum.

Permissible Concentration in Water: No criteria set. Runoff from spills or fire control may cause water pollution.

Determination in Water: Collection by impinger or fritted bubbler, analysis by gas liquid chromatography/ultraviolet. See NIOSH IV, Method #5008,[18] pyrethrum. Octanol−water coefficient: Log $K_{ow} = 7$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Harmful Effects and Symptoms

Short-Term Exposure: Pyrethrins can affect you when breathed in and by passing through your skin. Irritates the eyes and respiratory tract. High exposure can affect the nervous system causing headache, nausea, vomiting, fatigue, and restlessness, rhinorrhea (discharge of thin nasal mucous). LD_{50} (oral, at) = 320 mg/kg.

Long-Term Exposure: High or repeated Exposure can cause lung allergy (with cough, wheezing, and/or shortness of breath) or hay fever symptoms (sneezing, runny, or stuffy nose). Allergic "pneumonia" can also occur with cough, chest pain, breathing difficulty, and abnormal chest X-ray. Repeated attacks may lead to permanent scarring. Skin allergy may also develop with rash and itching, even with lower exposures. Dermal contact can cause rash with redness, blisters, and intense itching. A severe generalized allergy can occur with weakness and collapse

Points of Attack: Respiratory system, skin, central nervous system

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended: Employees should be screened for history of certain medical conditions which might place the employee at increased risk from pyrethroid exposure. Chronic respiratory disease: In persons with chronic respiratory disease, especially asthma, the inhalation of pyrethroids might cause exacerbation of symptoms due to its sensitizing properties. Lung function tests. These may be normal if the person is not having an attack at the time of the test. Consider chest X-ray if lung symptoms are present. Skin disease: Pyrethroids can cause dermatitis which may be allergic in nature. Persons with preexisting skin disorders may be more susceptible to the effects of this agent. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Any employee developing the above-listed conditions should be referred for further medical examination[77]. Examination of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get Medical attention. *Do not induce vomiting when formulations containing petroleum solvents are ingested*. Otherwise, give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Applicators and other handlers must wear: Coveralls worn over long-sleeved shirt and long pants; Chemical-resistant gloves such as DuPont Tychem suit fabrics, barrier laminate, or Viton; Chemical-resistant footwear plus socks; Protective eye wear; Chemical-resistant headgear for overhead exposure; Chemical-resistant apron when cleaning equipment, mixing, or loading[72]. Agricultural Use/Engineering Controls: When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the WPS for agricultural pesticides, 40 CFR 170.240(d)(4-6), the handler PPE requirements may be reduced or modified as specified in the WPS. Firefighters should wear NIOSH-approved SCBA and full protective clothing.

Respirator Selection: NIOSH/OSHA *for pyrethrum*: *50 milligram per cubic meter:* CcrOv95 (APF = 10) [any air-purifying half-mask respirator equipped with an organic vapor cartridge(s) in combination with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *125 milligram per cubic meter:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOvHie (APF = 25) (any air-purifying full facepiece respirator equipped with an organic vapor cartridge in combination with a high-efficiency particulate filter). *250 milligram per cubic meter:* CcrFOv100 (APF = 50) [any air-purifying full facepiece respirator equipped with organic vapor cartridge(s) in combination with an N100, R100, or P100 filter]; or PaprTOvH, i.e., (APF = 50) [any powered, APR with a tight-fitting facepiece and organic vapor cartridge(s) in combination with a high-efficiency particulate filter]; or SCBAF (APF = 50) (any SCBA with full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *5000 milligram per cubic meter:* SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—Blue: Health Hazard/Poison. Store in a secure poison location at temperature <35°C and away from alkaline materials. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: UN3349 Pyrethroid pesticide, solid toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous material. UN3352 Pyrethroid pesticide, liquid toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN3082 Environmentally hazardous substances, liquid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required

Spill Handling: First remove all sources of ignition. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Ventilate area of spill or leak. Use water spray to reduce vapor. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; or alcohol-resistant foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration would be an effective disposal procedure where permitted. If an efficient incinerator is not available, the product should be mixed with large amounts of combustible material and contact with the smoke should be avoided. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Noncombustible containers should be crushed and buried under more than 40 cm of soil[30].

References

(31); (204)(100).

Cyproconazole C:1850

Formula: $C_{15}H_{18}ClN_3O$

Synonyms: Alto; Alto Elite; Atemi; Atemi-50-SL;EVIPOL; α-(4-Chlorophenyl)-α-(1-cyclopropylethyl)-1*H*-1,2,4-triazole-1-ethanol; (2*RS*, 3*RS*)-2-(4-Chlorophenyl)-3-cyclopropyl-1-(1*H*-1,2,4-triazol-1-yl)butan-2-ol; Flint; Noah gold; SAN-619 F; Sentinel; SN 108266; 1*H*-1,2,4-Triazole-1-ethanol, α-(4-chlorophenyl)-α-(1-cyclopropylethyl)-

CAS Registry Number: 94361-06-5

HSDB Number: 7706

UN/NA & ERG Number: UN3082 (environmentally hazardous substances, liquid, n.o.s.)/171

EC Number: [*Annex I Index No.:* 650-032-00-X]

Regulatory Authority and Advisory Information

Carcinogenicity: EPA Group 2b, probable carcinogen

Hazard symbols, risk, & safety statements: Hazard symbol: Xn, N; risk phrases: R22; R50/53; R63; safety phrases: S2; S36/37; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Colorless, crystalline solid. Odorless. Molecular weight = 291.78; specific gravity (H_2O:1) = 1.26; boiling point = decomposes @ 295−300°C; freezing/melting point = 104−106.5°C; vapor pressure = 2.5×10^{-7} mmHg @ 20°C. Moderately soluble in water.

Potential Exposure: Triazole fungicide used to control fungus on cereals, coffee beans; anthracnose and other diseases on turfgrass; used against rust and leaf spot disease.

Incompatibilities: The triazoles are sensitive to heat, friction, and impact. Sensitivity varies with the type substitution to the triazole ring. Metal chelated and halogen substitution of the triazol ring make for a particularly heat sensitive material. Azido and nitro derivatives have been employed as high explosives. No matter the derivative these materials should be treated as explosives[88].

Determination in Water: Octanol−water coefficient: Log K_{ow} = 2.9−3.1. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood. Fish toxicity (threshold)[101]: Very low—3210.91612 ppb, MATC.

Routes of Entry: Ingestion, dermal contact

Harmful Effects and Symptoms

Short-Term Exposure: Contact may irritate skin and cause eye irritation and possible severe injury. Inhalation should be avoided; use NIOSH- or CEN (UK)-approved APRs for pesticides. Poisonous if swallowed. LD_{50} (oral, rat) = (male) 1020 mg/kg; (female) 1330 mg/kg[14].

Medical Surveillance: Contact physician if poisoning is suspected or if redness, itching, burning of the skin or eyes develop

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear positive pressure SCBA. Wear chemical protective clothing that is specifically recommended by the manufacturer. DuPont Tychem Suit Fabrics is recommended by one government source[88]. It may provide little or no thermal protection. Structural firefighters' protective clothing provides limited protection in fire situations ONLY; it is not effective in spill situations where direct contact with the substance is possible.

Respirator Selection: Where the neat (undiluted) test chemical is weighed and diluted, wear a NIOSH-approved half face respirator equipped with a combination filter cartridge, i.e., organic vapor/acid gas/H EPA (specific for organic vapors, HCl, acid gas, SO_2, and a high-efficiency particulate filter)[88]. Wherever and whenever workplace conditions warrant respirator use, a respiratory protection program must be followed that meets one or more of the following requirements: OSHA's 29 CFR 1910.134, ANSI Z88.2, or European Standard EN 149.

Storage: Color code—Blue: Health Hazard/Poison. Store in a secure poison location. Refrigerate. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN3082 Environmentally hazardous substances, liquid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required

Spill Handling: For solids, isolate spill or leak area in all directions for at least 25 m/75 ft. Increase, in the downwind direction, as necessary. First remove all sources of ignition. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Stop leak if you can do it without risk. Prevent entry into waterways, sewers, basements, or confined areas. Cover with plastic sheet to prevent spreading. Absorb or cover with dry earth, sand, or other noncombustible material and transfer to containers. If you spill this chemical, you should dampen the solid spill material with water, then transfer the dampened material to a suitable container. Use absorbent paper dampened with water to pick up any remaining material. Seal your contaminated clothing and the absorbent paper in a vapor-tight plastic bag for eventual disposal. Wash all contaminated surfaces with a soap and water solution. Do not reenter the contaminated area until the Safety Officer (or other responsible person) has verified that the area has been properly cleaned. Do not allow water to get inside containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: See the "Incompatibilities" section. Use dry chemical, carbon dioxide; or Halon extinguishers. Thermal decomposition products may include toxic oxides of nitrogen and hydrogen chloride gas. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Contact a licensed disposal facility about surplus and nonrecyclable solutions. Burn in a chemical incinerator equipped with an afterburner and scrubber. Extra care must be exercised as the material in an organic solvent is highly flammable. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office. Incineration or permanganate oxidation.

References

(31); (173); (101); (138); (100).

United States National Library of Medicine, ChemIDplus Advanced, Bethesda MD, http://chem.sis.nlm.nih.gov/chemidplus/rn/94361-06-5.

Cyprodinil C:1860

Formula: $C_{14}H_{15}N_3$

Synonyms: CGA 219417 technical; Chorus; *N*-(4-Cyclopropyl-6-methyl-pyrimidin-2-yl)-; 4-Cyclopropyl-6-methyl-*N*-phenyl-2-pyrimidinamine; 2-Pyrimidinamine, 4-cyclopropyl-6-methyl-*N*-phenyl-; aniline; Switch; UNIX; Vanguard

CAS Registry Number: 121552-61-2

HSDB Number: 7019

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171 or UN3082 (environmentally hazardous substances, liquid, n.o.s.)/171

EC Number: Not assigned [*Annex I Index No.:* 612-242-00-X]

Regulatory Authority and Advisory Information

Carcinogenicity: EPA: Not likely a human carcinogen

Hazard Alert: Poison, Sensitization hazard, Environmental hazard.

Hazard symbols, risk, & safety statements: Hazard symbol: Xi, N; risk phrases: R43; R50/53; safety phrases: S2, S24; S29/35; S37, S46; S60; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: White crystalline solid or beige powder. Molecular weight = 225.30; freezing/melting point = 70−75°C; vapor pressure = 5.0×10^{-4} mmHg. Low solubility in water; solubility = 12 mg/L @20°C.

Potential Exposure: Cyprodinil is an anilino pyrimidine fungicide applied to the foliage of almonds, grapes, stone fruit crops, and pome fruit crops to control plant diseases. Target fungi for cyprodinil include scab and brown rot blossom

Determination in Water: Octanol−water coefficient: Log K_{ow} = ~4.0. Values of more than 3.0 are likely to bioaccumulate in marine organisms. Fish toxicity (threshold)[101]: Low—160.91666 ppb, MATC.

Harmful Effects and Symptoms

Short-Term Exposure: Skin, eye, and respiratory tract irritant. Inhalation should be avoided; use NIOSH- or CEN (UK)-approved APRs for pesticides. May be harmful if swallowed.

Long-Term Exposure: Human toxicity (long term)[101]: High −1.15894 ppb, CHCL (Chronic Human Carcinogen Level)

Points of Attack: Skin.

Medical Surveillance: Evaluation by a qualified allergist, including exposure history and testing, may help diagnose allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Do not induce vomiting when formulations containing petroleum solvents are ingested.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of dermal contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. DuPont Tychem suit fabrics[88]. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Wherever and whenever workplace conditions warrant respirator use, a respiratory protection program must be followed that meets one or more of the following requirements: OSHA's 29 CFR 1910.134, ANSI Z88.2, or European Standard EN 149.

Shipping: UN3082 Environmentally hazardous substances, liquid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required. UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Stop leak if you can do it without risk. Prevent entry into waterways, sewers, basements, or confined areas. Cover with plastic sheet to prevent spreading. Absorb or cover with dry earth, sand, or other noncombustible material and transfer to containers. Do not allow water to get inside containers.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen and carbon. On a small fire: use dry chemical, carbon dioxide, or water spray. On a large fire: use water spray, fog, or regular foam. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal. Use water spray or fog; do not scatter material using straight water jet streams. Do not allow water to get inside containers. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank for massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn.

Disposal Method Suggested: Recycle any unused portion of the material for its approved use or return it to the manufacturer or supplier. Ultimate disposal of the chemical must consider: the material's impact on air quality; potential migration in soil or water; effects on animal, aquatic, and plant life; and conformance with environmental and public health regulations.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Office of Pesticide Programs, "Pesticide Fact Sheet: Cyprodinil," Washington, DC (April 6, 1998). http://www.epa.gov/opprd001/factsheets/cyprodinil.pdf.

D

2,4-D and Esters D:0100

Formula: $C_8H_6Cl_2O_3$; $Cl_2C_6H_3OCH_2COOH$

Synonyms: Acetic acid (2,4-dichlorophenoxy)-; Acide 2,4-dichloro phenoxyacetique (French); Acido 2,4-dicloro-fenoxiacetico (Spanish); Agrotect; Amidox; Amoxone; Aqua-Kleen; Barrage; BH 2,4-D; Brush-Rhap; B-Selektonon; Bush killer; Chipco turf herbicide "D"; Chloroxone; Citrus fix; Crop rider; Crotilin; D 50; Dacamine; 2,4-d Acid; Debroussaillant 600; Decamine; Ded-Weed; Ded-Weed LV-69; Deherban; Desormone; Dichlorophenoxyacetic acid; 2,4-Dichlorophenoxyacetic acid, salts and esters; 2,4-Dichlorphenoxyacetic acid; (2,4-Dichlor-phenoxy)-essigsaeure (German); Dicopur; Dicotox; Dinoxol; DMA-4; Dormone; 2,4-D phenoxy pesticide; 2,4-D, Salts and esters; Emulsamine BK; Emulsamine E-3; ENT 8538; Envert 171; Envert DT; Esteron; Esteron 44 weed killer; Esteron 76 BE; Esteron 99; Esteron 99 concentrate; Esteron brush killer; Esterone four; Estone; Farmco; Fernesta; Fernimine; Fernoxone; Ferxone; Foredex 75; Formula 40; Hedonal; Hedonal (herbicide); Herbidal; Ipaner; Krotiline; Lawn-Keep; Macrondray; Miracle; Monosan; Mota maskros; Moxone; Netagrone; Netagrone 600; NSC 423; 2,4-PA (in Japan); Pennamine; Pennamine D; Phenox; Pielik; Planotox; Plantgard; Rhodia; Salvo; Spritz-Hormin/2,4-D; Spritz-Hormit/2,4-D; Super D weedone; Superormone concentre; Transamine; Tributon; Trinoxol; U 46; U 46DP; U-5043; Vergemaster; Verton; Verton 2D; Verton D; Vertron 2D; Vidon 638; Visko; Visko-Rhap; Visko-Rhap low drift herbicides; Visko-Rhap low volatile 4L; Weed-AG-Bar; Weedar; Weedar-64; Weed-B-Gon; Weedez wonder bar; Weedone; Weedone LV4; Weed-Rhap; Weed tox; Weedtrol

CAS Registry Number: 94-75-7; 1929-73-3 (butoxyethyl ester); 25168-26-7 (isooctyl ester); 94-11-1 (isopropyl ester)

HSDB Number: 202; 6307 (butoxyethyl ester); 4068 (isooctyl ester); 1634 (isopropyl ester)

RTECS Number: AG6825000; AG7700000 (butoxyethyl ester); AG8575000 (isooctyl ester); AG8750000 (isopropyl ester)

UN/NA & ERG Number: UN3345/153

EC Number: 202-361-1 [*Annex I Index No.:* 607-039-00-8]; 217-680-1 (butoxyethyl ester); 246-704-3 (isooctyl ester); 202-305-6 (isopropyl ester)

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human Limited Evidence, animal Inadequate Evidence, possibly carcinogenic to humans, *possibly carcinogenic to humans*, Group 2B, 1987. United States Environmental Protection Agency Gene-Tox Program, Positive: In vivo cytogenetics-nonhuman bone marrow; Positive: In vitro cytogenetics-human lymphocyte; Positive: *B. subtilis* rec assay; *E. coli polA* without S9; Positive: V79 cell culture-gene mutation; Positive: *S. cerevisiae* gene conversion; Negative: *D. melanogaster*-whole sex chromosome loss; Negative: *D. melanogaster*-nondisjunction; Negative: Histidine reversion-Ames test; Negative: *D. melanogaster* sex-linked lethal; Negative: In vitro UDS-human fibroblast; TRP reversion; Negative: *S. cerevisiae-homozygosis*; Inconclusive: Carcinogenicity-mouse/rat; Mammalian micronucleus.

Hazard Alert: Poison, Water reactive, Sensitization hazard, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction), Environmental hazard.

United States Environmental Protection Agency, FIFRA 1998 Status of Pesticides: Supported

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.5 kg)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U240; Tox # D016, Regulated level = 200 mg/L.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA Toxicity Characteristic (Section 261.24), Maximum Concentration of Contaminants, regulatory level, 10.0 mg/L

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.72; Nonwastewater (mg/kg), 10

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8150 (10)

United States National Primary Drinking Water Regulations: MCLG: 0.07 mg/L; MCL = 0.07 mg/L

CERCLA/SARA 313: Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Canada, Drinking Water Quality, 0.1 mg/L IMAC

Mexico, Drinking Water Criteria, 0.1 mg/L.

Hazardous to aquatic life or environment, with possible long lasting effects[194]. Harmful to aquatic life with long lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: Xn, N, Xi; risk phrases: R22; R37; R41; R43; R51; R62; R63; safety phrases: S2; S24; S25; S26; S29/35; S36/37/39; S41; S46; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: 2,4-Dichlorophenoxyacetic acid is a white to yellow crystalline powder with a slight phenolic odor. Molecular weight = 221.04; specific gravity (H_2O:1) = 1.57;

Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens.
DOI: http://dx.doi.org/10.1016/B978-0-323-38968-6.00004-1

boiling point = decomposes below BP @ 158°C; freezing/melting point = 138°C; vapor pressure = 53 Pa @ 160°C; 8×10^{-6} mmHg[72]; 0.4 mmHg @ 160°C[77]. Slightly soluble in water; solubility = 0.05%. Decomposes rapidly in water. The taste and Odor Threshold in water is 3.13 mg/L.

Potential Exposure: 2,4-Dichlorophenoxyacetic acid, was introduced as a plant growth-regulator in 1942. It is registered in the United States as a herbicide for control of broadleaf plants and as a plant growth-regulator. Thus, workers engaged in manufacture, formulation or application are affected, as may be citizens in areas of application. The Vietnam war era defoliant, Agent Orange, was a mixture of 2,4-D and 2,4,5-T.

Incompatibilities: A weak acid, incompatible with bases. Decomposes in sunlight or heat, forming hydrogen chloride and phosgene. Contact with strong oxidizers may cause fire and explosions.

Permissible Exposure Limits in Air

NIOSH IDLH = 100 milligram per cubic meter
OSHA PEL: 10 milligram per cubic meter TWA
NIOSH REL: 10 milligram per cubic meter TWA
ACGIH TLV[1]: 10 milligram per cubic meter TWA; not classifiable as a human carcinogen
Protective Action Criteria (PAC) Ver. 29[138]
PAC-1: 30 milligram per cubic meter
PAC-2: 94 milligram per cubic meter
PAC-3: 500 milligram per cubic meter

2,4-D, including salts and esters

DFG MAK: 1 milligram per cubic meter, inhalable fraction TWA; Peak limitation Category II(8) [skin]; Pregnancy Risk Group C

Australia: TWA 10 milligram per cubic meter, 1993; Austria: MAK 10 milligram per cubic meter, 1999; Belgium: TWA 10 milligram per cubic meter, 1993; Denmark: TWA 5 milligram per cubic meter, 1999; Finland: TWA 10 milligram per cubic meter; STEL 20 milligram per cubic meter, [skin], 1993; France: VME 10 milligram per cubic meter, 1999; Hungary: TWA 1 milligram per cubic meter; STEL 2 milligram per cubic meter, [skin], 1993; the Netherlands: MAC-TGG 10 milligram per cubic meter, 2003; the Philippines: TWA 10 milligram per cubic meter, 1993; Poland: MAC (TWA) 7 milligram per cubic meter, MAC (STEL) 20 milligram per cubic meter, 1999; Switzerland: MAK-W 10 milligram per cubic meter, KZG-W 50 milligram per cubic meter, 1999; Thailand: TWA 10 milligram per cubic meter, 1993; Turkey: TWA 10 milligram per cubic meter, 1993; United Kingdom: TWA 10 milligram per cubic meter; STEL 20 milligram per cubic meter, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Russia[43] set a MAC in ambient air in residential areas of 0.02 milligram per cubic meter on a momentary basis and 0.01 milligram per cubic meter on a daily average basis for the sodium salt of 2,4-D. Several states have set guidelines or standards for 2,4-D in ambient air[60] ranging from 100 μ/m^3 (North Dakota) to 105 μ/m^3 (Pennsylvania) to 160 μ/m^3 (Virginia) to 200 μ/m^3 (Connecticut) to 238 μ/m^3 (Nevada).

Determination in Air: Collection on a glass fiber filter and analysis by HPLC with UV detection. Use NIOSH Analytical Method #5001[18].

Permissible Concentration in Water: Safe Drinking Water Act (47FR 9352): MCL, 0.1 mg/L; MCGL, 0.07 mg/L, as 2,4-D. The U.S.[35] has set a MPC in bottled water intended for human consumption of 0.1 mg/L. Aquatic toxicity: 350 ppm/24 hours/bass, bluegill/50% kill/fresh water; 1.0−5.0 ppm/96 hours/oyster/39% shell growth disease/salt water. Waterfowl toxicity: LD_{50} = 2025.0 mg/kg.

Determination in Water: Fish Tox = 4247.00420 ppb MATC (VERY LOW). Octanol-water coefficient: Log K_{ow} = 2.81. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, skin absorption, ingestion, and skin and eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: *Inhalation:* May cause irritation of the mouth, nose and throat, headache, nausea, vomiting, and diarrhea at levels above 10 milligram per cubic meter. Nerve damage, which may be delayed, may include swelling of legs and feet; muscle twitch and stupor. Severe exposures may result in death. *Skin:* Dust or liquid left in contact with the skin for several hours may be absorbed. This may result in severe delayed symptoms as listed above. These symptoms may last for months or years. *Eyes:* Irritation may occur. *Ingestion:* The oral dose required to produce symptoms is about 1/12 ounce (1/2 teaspoon). Increasing amounts may result in increasingly severe symptoms as listed above. Death has resulted from as little as 1/5 ounce. Survival for more than 48 hours is usually followed by complete recovery, although symptoms may last for several months.

Long-Term Exposure: 2,4-D can cause kidney, liver, and adrenal gland/or problems. Workers exposed to 2,4-D in the manufacturing process over a 5 to 10 year period at levels above 10 milligram per cubic meter complained of weakness, rapid fatigue; headache and vertigo. Liver damage, low blood pressure, and slowed heartbeat were also found. Based on animal tests, 2,4-D may affect human reproduction. Human Tox = 70.00000 ppb MCL (Low).

Points of Attack: Skin, central nervous system (CNS), and liver, kidneys.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function tests. Exam of the nervous system. NIOSH lists the following tests: blood plasma; urine (chemical/metabolite); urine (chemical/metabolite) 24 hour collection.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the

skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. 8 hours (more than 8 hours of resistance to breakthrough $>0.1\ \mu g/cm^2/min$): natural rubber gloves, Neoprene rubber gloves, suits, and boots; nitrile rubber gloves, suits, and boots; polyvinyl alcohol gloves. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: 100 milligram per cubic meter: Any air-purifying half-mask respirator with organic vapor cartridge(s) in combination with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or PaprOvHie (APF = 25) (any air-purifying full facepiece respirator equipped with an organic vapor cartridge in combination with a high-efficiency particulate filter); or Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any self-contained breathing apparatus (SCBA) with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece); or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type SCBA).

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with 2,4-D, all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a dark, cool, well-ventilated area. Keep away from oxidizers, heat, and sunlight. A regulated, marked area should be established where this chemical is stored in compliance with OSHA Standard 1910.1045.

Shipping: UN3345 Phenoxyacetic acid derivative pesticide, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. A DOT regulated marine pollutant.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: 2,4-Dichlorophenoxyacetic acid esters may burn, but do not readily ignite. Thermal decomposition products may include phosgene hydrogen chloride and oxides of carbon. Use dry chemical, CO_2, water spray; or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration of phenoxys is effective in 1 second @ 982°C, using a straight combustion process or @ 482°C using catalytic combustion. Over 99% decomposition was reported when small amounts of 2,4-D were burned in a polyethylene bag. See "References"[22] for additional detail. In accordance with 40CFR165, follow (31); recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following (100) Package (2) label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (173); (101); (138); (80).

United States Environmental Protection Agency, Office of Solid Waste, *2,4-Dichlorophenoxy Acetic Acid, Health and Environmental Effects Profile No. 77*, Washington, DC (April 30, 1980)

New York State Department of Health, *Chemical Fact Sheet: 2,4-D*, Bureau of Toxic Substance Assessment, Albany, NY (March 1986 and Version 2)

Sax N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 6, 49–52 (1981) and 7, No. 6, 11–46 (1987)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: 2,4-D, #0593*, Trenton, NJ, (April 2008 revision)

Dacarbazine D:0110

Formula: $C_6H_{10}N_6O$

Synonyms: Deticene; DIC; (Dimethyltriazeno)imidazolecarboxamide; 4-(3,3-Dimethyl-1-triazeno)imidazole-5-carboxamide; 4-(5)-(3,3-Dimethyl-1-triazeno)imidazole-5(4)-carboxamide; 4-(Dimethyltriazeno)imidazole-5-carboxamide; 5-(3,3-Dimethyl-1-triazeno)imidazole-4-carboxamide; 5-(3,3-Dimethyltriazeno)imidazole-4-carboxamide; 5-(Dimethyltriazeno)imidazole-4-carboxamide; 5-(3,3-Dimethyl-1-triazenyl)-1H-imidazole-4-carboxamide; DTIC; DTIC-Dome; NCI-C04717; NSC-45388

CAS Registry Number: 4342-03-4

HSDB Number: 3219

RTECS Number: NI3950000

UN/NA & ERG Number: UN3249 (Medicines, toxic, solid, n.o.s.)/151

EC Number: 224-396-1

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen;IARC: Human Limited Evidence; animal Sufficient Evidence, *possibly carcinogenic to humans*, Group 2B, 1987; NCI: Carcinogenesis Studies (ipr); clear evidence: mouse, rat

California Proposition 65 Chemical[102]: Cancer 1/1/1988; Developmental/Reproductive toxin 1/29/1999

Hazard Alert: Poison, Possible neurotoxin, Possible sensitization hazard, Reproductive toxin,

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xi, Xn; risk phrases: R20/21/22; R36/37/38; R39; R40; R45; R46; R50; R63; safety phrases: S16; S26; S36/37/39; S41; S45; S53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Dacarbazine is a white to ivory-colored crystalline solid. Molecular weight = 182.22; freezing/melting point = 250°C−255°C. Low solubility in water; solubility = 0.01 mm/mg @25°C.

Potential Exposure: Dacarbazine is used in cancer chemotherapy. Dacarbazine is used as an antineoplastic agent in the treatment of certain skin cancers, and is occasionally used in the therapy of other neoplastic diseases which have become resistant to alternative treatment.

Health professionals who handle this drug (for example, pharmacists, nurses, and physicians) may possibly be exposed during drug preparation, administration, or cleanup; however, the risks can be avoided through use of appropriate containment equipment and work practices[10]. People receiving dacarbazine in treatment are also exposed.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides. Explosive decomposition reported @ 250°C−255°C.

Permissible Exposure Limits in Air

No standards or PAC available.

Harmful Effects and Symptoms

Symptoms of exposure to this compound may include nausea, vomiting, bone marrow suppression, leukopenia, thrombocytopenia, hepatotoxicity, hepatic vein thrombosis and hepatocellular necrosis. Other symptoms may include hemopoietic depression, anemia, anaphylaxis, anorexia, diarrhea, facial paresthesias, death, and rarely, erythematous and urticarial rashes, and photosensitivity reactions. It may cause cardiovascular collapse, burning of the throat, abdominal pain, oliguria, anuria, delirium, fall of blood pressure, convulsions, muscular weakness with respiratory failure and collapse. Large doses may cause gastrointestinal (GI) bleeding. Exposure may also result in alopecia, facial flushing, and a flu-like syndrome of fever, myalgias and malaise. It can cause chills, dermatological reactions and neurotoxicity[101].

Long-Term Exposure: There is sufficient evidence that dacarbazine is carcinogenic in experimental animals. Rats given dacarbazine orally or intraperitoneally developed tumors of the breast, thymus, spleen, and brain in a minimum of 18 weeks after initial exposure. Intraperitoneal administration of dacarbazine to mice produced tumors in the lung, blood-producing tissue; and uterus.

First Aid: *Skin Contact*[52]: Flood all areas of body that have contacted the substance with water. Don't wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others. *Eye Contact:* Remove any contact lenses at once. Flush eyes well with copious quantities of water or normal saline for at least 20−30 minutes. Seek medical attention. *Inhalation:* Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion:* If convulsions are not present, give a glass or two of water or milk to dilute the substance. Assure that the person's airway is unobstructed and contact a hospital or poison center immediately for advice on whether or not to induce vomiting.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100 F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type SCBA).

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with dacarbazine all handlers should be trained on its proper handling and storage. Store in a refrigerator or a cool, dry place and protect from light. A regulated, marked area should be established where this chemical is stored in compliance with OSHA Standard 1910.1045.

Shipping: UN3249 Medicine, solid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Dampen spilled material with alcohol to avoid dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Thermal decomposition products may include oxides of nitrogen and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: It is inappropriate and possibly dangerous to the environment to dispose of expired or waste drugs and pharmaceuticals by flushing them down the toilet or discarding them to the trash. Household quantities of expired or waste pharmaceuticals may be mixed with wet cat litter or coffee grounds, double-bagged in plastic, discard in trash. Larger quantities shall carefully take into consideration applicable DEA, EPA, and FDA regulations. If possible return the pharmaceutical to the manufacturer for proper disposal being careful to properly label and securely package the material. Alternatively, the waste pharmaceutical shall be labeled, securely packaged and transported by a state licensed medical waste contractor to dispose by burial in a licensed hazardous or toxic waste landfill or incinerator.

References

(109); (102); (31); (173); (101); (138); (100).

Daminozide D:0120

Formula: $C_6H_{12}N_2O_3$; $(CH_3)_2NNHCOCH_2CH_2COOH$

Synonyms: Alar; Alar-85; Aminozide; B-9; B995; Bernsteinsaeure-2,2-dimethylhydrazid (German); B-Nine; Butanedioic acid mono(2,2-dimethylhydrazide); Dimas; *N*-Dimethyl amino-β-carbamyl propionic acid; *N*-(Dimethylamino)succinamic acid; *n*-Dimethylaminosuccinamidsaeure (German); DMASA; DMSA; Kylar; NCI-C03827; SADH; Succinic acid 2,2-dimethylhydrazide; Succinic-1,1-dimethyl hydrazide

CAS Registry Number: 1596-84-5

HSDB Number: 1769

RTECS Number: WM9625000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 216-485-9 [*Annex I Index No.:* 607-171-00-6]

Regulatory Authority and Advisory Information

Carcinogenicity: NCI: Carcinogenesis Studies (feed); clear evidence: mouse, rat[9].

California Proposition 65 Chemical[102]: Cancer 1/1/1990; methylhydrazine and its salts 7/1/1992.

Hazard Alert: Poison, Combustible, Agricultural chemical (restricted use pesticide (RUP).

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xn; risk phrases: R45; R40; safety phrases: S2; S36/37; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Daminozide is a colorless crystalline solid. Molecular weight = 160.22; freezing/melting point = 157°C−164°C; vapor pressure = 1×10^{-8} mmHg @ 20°C.

Potential Exposure: Daminozide is a herbicide/plant growth regulator used on certain fruit (especially apples) to improve the balance between growth and fruit production and to improve fruit quality and synchronize maturity. A RUP. United States sales were suspended in 1989 due to health considerations.

Incompatibilities: Daminozide may be heat sensitive. Incompatible with strong oxidizing agents, strong acids, and bases. Also incompatible with wetting agents, alkaline materials, oils and copper-containing compounds. May corrode metals (NTP, 1992). May generate toxic gases with acids, aldehydes, amides, carbamates, cyanides, inorganic fluorides, halogenated organics, isocyanates, ketones, metals, nitrides, peroxides, phenols, epoxides, acyl halides, and reducing agents. May generate flammable gases with alkali metals. Explosive reactions can occur with strong oxidizing agents, metal salts, peroxides, and sulfides[101]. Compounds of the carboxyl group react with all bases, both inorganic and organic (i.e., amines) releasing substantial heat, water and a salt that may be harmful. Incompatible with arsenic compounds (releases hydrogen cyanide gas), diazo compounds, dithiocarbamates, isocyanates, mercaptans, nitrides, and sulfides (releasing heat, toxic and possibly flammable gases), thiosulfates and dithionites (releasing hydrogen sulfate and oxides of sulfur).

Permissible Exposure Limits in Air

No standards or PAC available.

Permissible Concentration in Water: No criteria set.

Determination in Water: Log $K_{\text{ow}} = -1$. Unlikely to bioaccumulate in marine organisms. Fish Tox = 31007.43129000 pbb MATC, Very Low.

Routes of Entry: Inhalation, ingestion, and absorbed through skin

Harmful Effects and Symptoms

Short-Term Exposure: Symptoms of exposure to daminozide may include convulsions, coma, liver and kidney damage and irritation to the GI tract and respiratory tract. Daminozide is harmful if swallowed, inhaled or absorbed through the skin. It may cause irritation to the GI tract and respiratory tract[101].

Long-Term Exposure: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. However, daminozide metabolizes to diamethylhydrazine which is a proven carcinogen in animal tests. It has a low dermal irritation potential and it is neither teratogenic nor mutagenic[35]. The acute oral LD_{50} for rats is 8400 mg/kg (insignificantly toxic). It is not an acute toxicant to fish or wildlife. Human Tox = 40.22989 ppb CHCL (Chronic Human Carcinogen Level) (INTERMEDIATE.)

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100 F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type SCBA).

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with daminozide all handlers should be trained on its proper handling and storage. Store in a cool, dry place or in a refrigerator. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft[70]. Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested:

References

(102); (31); (101); (138). (100).

(173); (101); (138).

Danthron D:0125

Formula: $C_{14}H_8O_4$

Synonyms: Altan; Ailax; Anthraquinone, 1,8-dihydroxy-; Antrapurol; Capsuvac; Chrysazin; Codanthramer; Codanthrusate; Codalax; Conthram; Cotron; Danivac; Danlax; Danthro-lax; Danthrone; Dianthon; Diaquone; 1,8-Dihydroxy-9,10-anthracenedione; 1,8-Dihydroxy-9,10-anthraquinone; Dihydroxyanthraquinone; 1,8-Dihydroxyanthraquinone; Dionone; Dioxyanthrachinonum; 1,8-Dioxyanthraquinone; Dorbane; Dorbanex; Duolax; Fenogar; Istin; istizin; Laxanorm; Laxanthreen; Laxipur; Laxipurin ltan; Normax; Modane; Modaton; Zwitsalax

CAS Registry Number: 117-10-2

HSDB Number: 7764 as 1,8-Dihydroxyanthraquinone

RTECS Number: CB6650000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 204-173-5

Regulatory Authority and Advisory Information

Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen

California Proposition 65 Chemical[102]: Cancer January 1, 1992

Hazard Alert: Poison, combustible, Possible nervous system toxin, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction), Drug.

Restricted for sale in the United States under Section 201 (p),Federal Food, and Cosmetic Act [21 U.S.C. 321(p)]; Sec. 310.545(a)(12)(iv)(B); [64 CFR 4535-40 (½9/99)]

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xn; Xi; risk phrases: R36/37/38; R45; R620; safety phrases: S2; S22; S36/37; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Red-orange to orange crystalline powder or reddish-brown crystalline solid. Molecular weight = 240.22; specific gravity (H_2O:1) = @ 20°C; boiling point = (decomposes); freezing/melting point = 192.8°C; vapor pressure = 8.6×10^{-10} mmHg @ 25°C (est.)[72]; flash point = > 190°C. Henry's Law constant = 5.5×10^{-11} atm-m^3/mol @ 25°C (est)[72]. Practically insoluble in water; solubility = < 1 mg/mL @ 20°C.

Potential Exposure: A potential liver carcinogen and possible narcotic, this compound is no longer sold or marketed in the United States Nervous system toxin-acute effects; Respiratory toxin-acute effects other than severe or moderate irritation; Liver-acute effects; Eye irritant-mild.

Incompatibilities: Keep away from strong reducing agents, such as hydrides, nitrides, alkali metals, and sulfides.

Permissible Exposure Limits in Air:

PAC* Ver. 29[138]

PAC-1: 6.7 milligram per cubic meter

PAC-2: 73 milligram per cubic meter

PAC-3: 440 milligram per cubic meter

Determination in Air:

Permissible Concentration in Water:

Determination in Water: Octanol-water coefficient: Log K_{ow} = 3.9 (est)[72]. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Eyes, skin, ingestion

Harmful Effects and Symptoms

Short-Term Exposure: May cause mild eye irritation and skin rash. This compound may be an acute nervous system toxin; acute respiratory toxin and exhibit acute liver effects. Symptoms of exposure to this compound may include abdominal cramps, prolonged diarrhea. It colors the urine pink or red. It also colors the peri-anal skin pink or red. Other adverse effects, which are uncommon, include excessive bowel activity (griping, nausea, and vomiting), peri-anal irritation, weakness, dizziness, palpitations, and sweating. Superficial sloughing of discolored skin may occur in incontinent persons or children wearing napkins (diapers)[101].

Long-Term Exposure: May cause cancer.; Liver carcinogen; Liver chronic effects; GI tract-chronic effects; Leukopenia and liver damage have also been reported. There has been reported a suspected allergic reaction with facial swelling, redness and discomfort. Prolonged use may cause discoloration (staining) of mucosa of the large intestine. Large doses may produce nephritis. Enteritis may also occur from large doses. Frequent or prolonged use may result in dependence[101].

Points of Attack: Nervous system; Liver, kidneys, and GI tract

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA-or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100 F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type SCBA)

Storage: Color code-Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft[70]. Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products include oxides of carbon. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Thermal decomposition products may include oxides of nitrogen and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full

facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: It is inappropriate and possibly dangerous to the environment to dispose of expired or waste drugs and pharmaceuticals by flushing them down the toilet or discarding them to the trash. Household quantities of expired or waste pharmaceuticals may be mixed with wet cat litter or coffee grounds, double-bagged in plastic, discard in trash. Larger quantities shall carefully take into consideration applicable DEA, EPA, and FDA regulations. If possible return the pharmaceutical to the manufacturer for proper disposal being careful to properly label and securely package the material. Alternatively, the waste pharmaceutical shall be labeled, securely packaged and transported by a state licensed medical waste contractor to dispose by burial in a licensed hazardous or toxic waste landfill or incinerator.

References

(102); (31); (173); (101); (138); (100).

Daunomycin D:0130

Formula: $C_{27}H_{29}NO_{10}$

Synonyms: 13,057 R.P.; Acetyladriamycin; Cerubidin; Daunamycin; Daunomicina (Spanish); Daunorubicin; Daunorubicine; DM; FI6339; Leukaemmycin C; 5,12-Naphthacenedione, 8-Acetyl-10-(3-amino-2,3,6-trideoxy-α-L-lyxohexopyranosyl)oxy-7,8,9,10-tetrahydro-6,8, 11-trihydroxy-1-methoxy-, (8-cis)-; NCI-C04693; NSC-82151; RP 13057; Rubidomycin; Rubidomycine; Rubomycin C; Rubomycin C-1; Streptomyces

CAS Registry Number: 20830-81-3

HSDB Number: 5095

RTECS Number: HB7875000

UN/NA & ERG Number: UN3249 (Medicines, toxic, solid, n.o.s.)/151; UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 244-069-7

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Sufficient Evidence, 1987*, possibly carcinogenic to humans*, Group 2B; NCI: Carcinogenesis Studies (ipr); clear evidence: rat, no evidence, mouse, 1977

California Proposition 65 Chemical[102]: Cancer 1/1/1988.

Hazard Alert: Poison, Suspected of causing genetic defects, Suspected reprotoxic hazard, Drug.

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U059

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA Land Ban Waste Restrictions

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 10 lb (4.54 kg)

Description: Daunomycin is a thin red, needle-shaped material. Molecular weight = 527.6; freezing/melting point = 172°C[Santa Cruz Biotech]; 190°C (decomposes). Soluble in water.

Potential Exposure: An antibiotic. It is used as a medicine for treating cancer.

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Harmful Effects and Symptoms

Short-Term Exposure: Poisonous if swallowed.

Long-Term Exposure: It may cause cancer in humans and may be teratogenic.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with daunomycin all handlers should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Store in tightly closed containers in a cool, well ventilated area.

Shipping: UN3249 Medicine, solid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: *Isolation Distance, Spill*: 25 m/75 ft[70]. Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical may burn but does not easily ignite. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Thermal decomposition products may include oxides of nitrogen and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: It is inappropriate and possibly dangerous to the environment to dispose of expired or waste drugs and pharmaceuticals by flushing them down the toilet or discarding them to the trash. Household quantities of expired or waste pharmaceuticals may be mixed with wet cat litter or coffee grounds, double-bagged in plastic, discard in trash. Larger quantities shall carefully take into consideration applicable DEA, EPA, and FDA regulations. If possible return the pharmaceutical to the manufacturer for proper disposal being careful to properly label and securely package the material. Alternatively, the waste pharmaceutical shall be labeled, securely packaged and transported by a state licensed medical waste contractor to dispose by burial in a licensed hazardous or toxic waste landfill or incinerator. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(102); (31); (173); (101); (138).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Daunomycin*, Trenton, NJ (January 1999)

Dazomet D:0132

Formula: $C_5H_{10}N_2S_2$

Synonyms: AMA-20; Basamid; Basamid g; Basamid-granular; Basamid p; Basamid-puder; Carbothialdin; Carbothialdine; Caswell No. 840; Crag; Crag fungicide 974; Crag nemacide; Dazomet-powder BASF; Dimethyl formocarbothialdine; 3,5-Dimethylperhydro-1,3,5-thiadiazin-2-thion (Czech, German); 3,5-Dimethyl-1,2,3,5-tetrahydro-1, 3,5-thiadiazinethione-2; 3,5-Dimethyltetrahydro-1,3,5-2*H*-thiadiazine-2-thione; 3,5-Dimethyltetrahydro-1,3,5-thiadiazine-2-thione; 3,5-Dimethyl-1,3,5-thiadiazinane-2-thione; 3,5-Dimethyl-2-thionotetrahydro-1,3,5-thiadiazine; DMTT; Fennosan b 100; Mico-fume; Mylon; Mylone; Mylone 85; N 521; Nalcon 243; Prezervit; Stauffer n 521; Tetrahydro-2*H*-3,5-dimethyl-1,3,5-thiadiazine-2-thione;Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione; Tetrahydro-3,5-dimethyl-2*H*-1,3,5-thiadiazine-2-thione; Thiadiazin; 2*H*-1,3,5-Thiadiazine-2-thione, tetrahydro-3, 5-dimethyl-; 2-Thio-3,5-dimethyltetrahydro-1,3,5-thiadiazine; Tiazon; Troysan 142; UCC 974

CAS Registry Number: 533-74-4; 53404-60-7 (sodium salt)

HSDB Number: 1642

RTECS Number: XI2800000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 208-576-7 [*Annex I Index No.*613-008-00-X]

Human toxicity (long term)(101): Intermediate—24.500 ppb, Health advisory

Regulatory Authority and Advisory Information

Carcinogenicity: EPA Group D, Not classifiable as a human carcinogen.

Hazard Alert: Skin irritant/sensitizer

Potential Ground water Pollutant [California FAC Section 13145(d)/12811, active]

EPA Hazardous Waste Number (RCRA No.): U366

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%

Hazard symbols, risk, & safety statements: Hazard symbol: Xi, Xn, N; risk phrases: R22; R36; R50/53; safety phrases: S2, S15; S22, S24; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to waters

Description: White crystalline solid. Nearly odorless. Molecular weight = 162.27; freezing/melting point = 102°C−105°C (decomposes prior to boiling); vapor pressure = 3.2×10^{-6} mm @ 20°C; flash point = 93°C. Combustible in dust form. Highly soluble in water; solubility = 1300 mg/L @ 25°C.

Potential Exposure: Dazomet is a dithiocarbamate insecticide, herbicide, fumigant, fungicide, nematicide. It is used as a soil fumigant used against germinating weed seeds, soil insects, nematodes, and soil-borne diseases in forest nursery seed beds, tobacco crops, greenhouse crops, and substrates for potted plants, turf, and ornamentals. It is also used as an antimicrobial agent for slimicide preparations and for adhesives, paper-mill slimicide, paint, and cooling water slimicides.

Incompatibilities: Sensitive to moisture and heat. Decomposes on heating above 102°C, producing toxic fumes including nitrogen oxides and sulfur oxides. Dithiocarbamate esters are combustible. They react violently with powerful oxidizers such as calcium hypochlorite. Poisonous gases are generated by the thermal decomposition of Dithiocarbamate compounds, including carbon disulfide, oxides of sulfur, oxides of nitrogen, hydrogen sulfide, ammonia, and methylamine. Thio and dithiocarbamates slowly decompose in aqueous solution to form carbon disulfide and methylamine or other amines. Such decompositions are accelerated by acids. Flammable gases are generated by the combination of dithiocarbamate with aldehydes, nitrides, and hydrides. Dithiocarbamate are incompatible with acids, peroxides, and acid halides.

Determination in Water: EPA EMSLC Method 630. The Determination of Dithiocarbamate Pesticides in Municipal and Industrial Wastewater by UV-VIS Spectrophotometry. Octanol-water coefficient: Log $K_{\mathrm{ow}} = 1.4$. Unlikely to bioaccumulate in marine organisms. Fish toxicity (threshold)(101): Intermediate—16.769960 ppb, MATC (Maximum Acceptable Toxicant Concentration).

Routes of Entry: Poisoning can occur by inhalation, ingestion and absorption through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Corrosive. Irritates skin and a severe eye irritant. Poisonous if swallowed. Unlike carbamates the dithiocarbamates are not cholinesterase inhibitors, but some of them may react with recently ingested alcohol or alcohol-containing products including wine, medications, and cold remedies such as cough-syrups. LD_{50} (oral, rat) = 300−350 mg/kg; LD_{50} (dermal, rat) = > 2 g/kg.

Long-Term Exposure: Sensitization hazard, May cause liver damage.

Points of Attack: Skin and liver (possible toxin).

Medical Surveillance: Evaluation by a qualified allergist, including exposure history and testing, may help diagnose allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Do not induce vomiting when formulations containing petroleum solvents are ingested.

Personal Protective Methods: Reacts with the following absorbent materials: Cellulose-Based; Mineral-and Clay-Based; Dirt/Earth[88]. Applicators and other handlers must wear: Coveralls worn over long-sleeved shirt and long pants; Chemical-resistant gloves such as DuPont Tychem suit fabrics, barrier laminate, or Viton; Chemical-resistant footwear plus socks; Protective eye wear; Chemical-resistant headgear for overhead exposure; Chemical-resistant apron when cleaning equipment, mixing, or loading[83]. Agricultural Use/Engineering Controls: When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the Worker Protection Standard (WPS) for agricultural pesticides, 40 CFR 170.240(d)(4-6), the handler PPE requirements may be reduced or modified as specified in the Worker Protection Standard. Firefighters should wear NIOSH approved SCBA and full protective clothing.

Respirator Selection: Where there is potential exists for exposures over 2 milligram per cubic meter, use an NIOSH/MSHA or European Standard EN 149-approved full facepiece respirator with a pesticide cartridge. Increased protection is obtained from full facepiece air purifying respirators (APRs). If while wearing a filter, cartridge or canister respirator, you can smell, taste, or otherwise detect Disulfiram, or in the case of a full facepiece respirator you experience eye irritation, leave the area immediately. Check to make sure the respirator-to-face seal is still good. If it is, replace the filter, cartridge, or canister. If the seal is no longer good, you may need a new respirator. *Where there is potential for high exposures exists*, use an NIOSH/MSHA or European Standard EN 149-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use an NIOSH/MSHA or European Standard EN 149-approved SCBA with a full facepiece operated in the pressure-demand or other positive-pressure mode.

Storage: Color code-White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Color code-Blue: Health Hazard/Poison. Store in a secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: First remove all sources of ignition. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Disulfiram itself does not burn readily. Thermal decomposition products may include oxides of nitrogen, sulfur and carbon If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Do not discharge into drains or sewers. Dispose of waste material as hazardous waste using a licensed disposal contractor to an approved landfill. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. A potential candidate for liquid injection incineration at a temperature range of 650°C to 1600°C and a residence time 0.1 to 2 seconds. Also, a potential candidate for rotary kiln incineration at a temperature range of 820°C to 1600°C and residence times of seconds for liquids and gases, and hours for solids[83].In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (100).

United States National Library of Medicine, *ChemIDplus Advanced*, Bethesda, MD, http://chem.sis.nlm.nih.gov/chemidplus/rn/533-74-4

2,4-DB D:0133

Formula: $C_{10}H_{10}Cl_2O_3$

Synonyms: Acido 2,4-diclorofenoxibutirico (Spanish); Butirex; Butormone; Butoxon; Butoxone; Butoxone ester; Butoxone amine; Butyrac; Butyrac 118; Butyrac 200; Butyrac ester; Campbell's db straight; Campbell's redlegor; Butanoic acid, 4-(2,4-dichlorophenoxy)-; Butyric acid, 4-(2,4-dichlorophenoxy)-; Caswell No. 316; 4-(2,4-DB); 2,4-D butyric; 4-(2,4-Dichlorophenoxy)butyric acid; γ-(2,4-Dichlorophenoxy)butyric acid; 2,4-DM; Desormone 2,4, DB; Embutox klean-up; Embutone; Embutox; Legumex D

CAS Registry Number: 94-82-6

HSDB Number: 6603

RTECS Number: ES9100000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 202-366-9 [Annex I Index No.: 607-083-00-8]

Human toxicity (long term)(101): Low—70.00 ppb, Health advisory

Regulatory Authority and Advisory Information

Carcinogenicity: EPA, Not likely to be carcinogenic to humans; IARC, Group 2b, Possibly carcinogenic to humans.

California Proposition 65 Chemical[102]: Developmental toxin, male, delisted (1/1/2005)

Hazard Alert: Suspected reprotoxic hazard, Developmental/Reproductive toxin: possible endocrine disruptor, Environmental hazard.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%

California EPA AB2588-Air Toxics "Hot Spots" Chemicals (CAL) as chlorophenoxy pesticides.

The "Director's List" (CAL/OSHA) as chlorophenoxy pesticides.

Hazardous to aquatic life or environment, with possible long lasting effects[293]. Toxic to aquatic life with long lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: Xn, N; risk phrases: R22; R51/53; safety phrases: S2; S25; S29; S46; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [2-Hazard to waters (est.)]

Description: White to light-brown crystalline solid. May be shipped as a concentrate to be mixed with water and used as a spray. Slight phenolic odor. Molecular weight = 249.09; boiling point = 324°C; freezing/melting point = 115°C−119°C; vapor pressure = 3.5×10^{-6} mmHg @ 25°C(est); 9.44×10^{-3} mmHg @ 25°C. Highly soluble in water.

Potential Exposure: 2,4-DB is a chlorophenoxy/aryloxyalkanoic acid selective systemic herbicide used to control annual and perennial broadleaf weeds in many field crops such as alfalfa, peanuts, cereals and soybeans; used as a defoliant. In the plant, the compound changes to 2,4-D and inhibits growth at the tips of stems and roots.

Incompatibilities: 2,4-DB is a weak organic acid. Keep away from oxidizers, sulfuric acid, caustics, ammonia, aliphatic amines, alkanolamines, isocyanates, alkylene oxides, and epichlorohydrin. Corrosive to iron, aluminum, zinc, and possibly other metals, especially in the presence of moisture.

Determination in Air: Filter; none; Gravimetric; NIOSH IV [Particulates NOR; #0500 (total), #0600 (respirable)][18].

Determination in Water: Octanol-water coefficient: Log $K_{ow} = > 3.0$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, ingestion, and absorbed through the skin. Fish toxicity (threshold)(101): Low—269.85657 ppb, MATC (Maxmium AcceptableToxicant Concentration).

Harmful Effects and Symptoms

Short-Term Exposure: Poisonous; may be fatal if inhaled, swallowed, or absorbed through skin. Severely irritates eyes, skin, and respiratory tract, with burning sensation, pain, redness, and swelling. Metabolic stimulant. If inhaled, causes coughing, dilated pupils, headache, profuse persperation, intense thirst, extreme fatigue, rapid pulse, high fever, clammy, flushed skin, rapid breathing, nausea, vomiting, cyanosis (bluish tint to skin and lips), anxiety and confusion, convulsions, and risk of lung edema. If swallowed, face and lips turn bluish. Liver injury with associated jaundice, kidney failure, and cardiac arrhythmias are commonly noted. Nerve damage, which may be delayed, may include swelling of legs and feet, muscle twitch and stupor. Severe exposure can cause death from heart failure. Dust or liquid left in contact with the skin for several hours may be absorbed. This may result in severe delayed symptoms as listed above. These symptoms may last for months or years. LD_{50} (oral, rat) = 700−800 mg/kg; LD_{50} (dermal, rat) = > 5 g/kg.

Long-Term Exposure: Workers exposed to chlorophenoxy compounds over a 5 to 10 year period at levels above 10 milligram per cubic meter complained of weakness, rapid fatigue, headache and vertigo. Liver damage, low blood pressure, and slowed heartbeat were also found. Based on animal tests, may affects human reproduction

Points of Attack: Eyes, skin, respiratory system, CNS, cardiovascular system, liver, and kidney

Medical Surveillance: Preliminary medical exam to detect chronic diseases of CNS, liver, heart, kidneys, lung, and skin, as well as endocrinological or immunological disturbances, should protect susceptible individuals. Periodical medical exams of internal organs, skin and eyes are important to avoid chronic occupational intoxications. They should include lab and patch tests when necessary[83]. See a physician if poisoning is suspected for if redness, itching, or burning of the skin or eyes develop

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. *Do not induce vomiting when formulations containing petroleum solvents are ingested*. Otherwise, give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Applicators and other handlers must wear: Coveralls worn over long-sleeved shirt and long pants; Chemical-resistant gloves such as DuPont Tychem suit fabrics, barrier laminate, or Viton; Chemical-resistant footwear plus socks; Protective eye wear; Chemical-resistant headgear for overhead exposure; Chemical-resistant apron when cleaning equipment, mixing, or loading[83]. Agricultural Use/Engineering Controls: When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the Worker Protection Standard (WPS) for agricultural pesticides, 40 CFR 170.240(d)(4-6), the handler PPE requirements may be reduced or modified as specified in the Worker Protection Standard. Firefighters should wear NIOSH approved SCBA and full protective clothing.

Respirator Selection: Wherever and whenever workplace conditions warrant respirator use, a respiratory protection program must be followed that meets one or more of the following requirements: OSHA's 29 CFR 1910.134, ANSI Z88.2, or European Standard EN 149.

Storage: Color code-Blue: Health Hazard/Poison. Store in a secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: For solids, isolate spill or leak area in all directions for at least 50 m/150 ft. Increase, in the downwind direction, as necessary. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Stop leak if you can do it without risk. Prevent entry into waterways, sewers, basements or confined areas. Cover with plastic sheet to prevent spreading. Absorb or cover with dry earth, sand or other noncombustible material and transfer to containers. Do not allow water to get inside containers.

Fire Extinguishing: Thermal decomposition in fire produces toxic hydrogen chloride fumes. On small fire, use dry chemical powder, carbon dioxide, or alcohol-resistant foam. On a large fire: Use water spray, fog or alcohol-resistant foam. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal. Dike fire-control water for later disposal. Use water spray or fog; do not scatter material using straight water jet streams. *Fire involving storage or vehicular tanks:* Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Do not allow water to get inside containers. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. *Always* stay away from tanks engulfed in fire. For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn.

Disposal Method Suggested: Do not discharge into drains or sewers. Dispose of waste material as hazardous waste using a licensed disposal contractor to an approved landfill. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Incineration with effluent gas scrubbing is recommended. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(102); (31); (173); (101); (138); (100).

EXTOXNET, Extension Toxicology Network, "*Pesticide Information Profile, 2,4-DB*," Oregon State University, Corvallis, OR (June 1996). http://extoxnet.orst.edu/pips/24-DB.htm

DCPA D:0136

Formula: $C_{10}H_6Cl_4O_4$ *Note:* "DCPA" is also a synonym for Propanil (CAS 709-98-8)

Synonyms: Acme DCPA; Chlorthal dimethyl; Chlorthal-methyl; DAC 893; Dacthal; Dacthal w-75; Decimate (with Propachlor); Dimethyl tetrachloroterephthalate; Dimethyl 2,3,5,6-tetrachloroterephthalate; Fatal; Green weeder; 2,3, 5,6-Tetrachloro-1,4-benzenedicarboxylic acid, dimethyl ester; Tetrachloroterephthalic acid, dimethyl ester

CAS Registry Number: 1861-32-1

HSDB Number: 358

RTECS Number: WZ1500000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 217-464-7

Regulatory Authority and Advisory Information

Carcinogenicity: EPA Group C, possible human carcinogen.

Hazard Alert: Suspected reprotoxic hazard, Possible endocrine disruptor. (some alkyl phthalates)

Washington state requires supplemental labeling as "DACTHAL W-75"

Hazard symbols, risk, & safety statements: Hazard symbol: N; risk phrases: R51/53; R63; safety phrases: S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [2-Hazard to waters (est.)]

Description: Colorless to gray crystalline solid. Practically odorless. Molecular weight 331.96; specific gravity (H_2O:1) = 1.56; boiling point = 345°C; freezing/melting point = 156°C; vapor pressure <0.4 mmHg @ 30°C. Practically insoluble in water; solubility = 0.5 ppm @ 25°C.

Potential Exposure: DCPA is an alkyl phthalate; benzenedicarboxylic acid herbicide, pesticide pre-emergent herbicide is used on annual broadleaf weeds and grasses in a wide spectrum of vegetable crops.

Incompatibilities: May react violently with strong oxidizers, bromine, 90% hydrogen peroxide, phosphorus trichloride, silver powders or dust. Incompatible with silver compounds. Mixture with some silver compounds forms explosive salts of silver oxalate.

Permissible Concentration in Water: Federal Drinking Water Guidelines: 70 ppb[93].

Determination in Water: EPA Methods 8081, 608.2, 515.2; Octanol-water coefficient: Log $K_{ow} = > 4.0$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood. *State Drinking Water Guidelines*: Arizona 3500 ug/L; California 3500 ug/L; Washington 530 ug/L; Wisconsin 70 ug/L[83].

Routes of Entry: Inhalation and ingestion. Absorbed through the intact skin

Harmful Effects and Symptoms

Short-Term Exposure: Symptoms include apprehension, anxiety, confusion, nervous excitation; dizziness; headache; numbness and weakness in limbs; muscle twitching, tremors; nausea and vomiting; slow, shallow respiration, bluish face; convulsions; loss of consciousness; breathing stops; death. LD_{50} (oral, rat) = > 3 g/kg; LD_{50} (dermal, rabbit) = > 10 g/kg.

Long-Term Exposure: May cause reproductive and fetal effects. May affect lungs, thyroid, liver, and kidneys. May cause skin sensitization.

Points of Attack: Reproductive cells. Lungs, liver, thyroid, and skin.

Medical Surveillance: Preliminary medical exam to detect chronic diseases of CNS, liver, heart, kidneys, lung, and skin, as well as endocrinological or immunological disturbances, should protect susceptible individuals. Periodical medical exams of internal organs, skin and eyes are important to avoid chronic occupational intoxications. They should include lab and patch tests when necessary[83]. This chemical is a suspected or known human carcinogen. Exposed persons should contact a physician for advice regarding the possible long term health effects and advice for medical monitoring. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a drug or other inhalation therapy. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. Evaluation by a qualified allergist, including exposure history and testing, may help diagnose allergy.

First Aid: Eyes: Speed in removing material from skin is of extreme importance. Eye contact can cause dangerous amounts of these chemicals to be quickly absorbed through the mucous membrane into the bloodstream. Directly, irrigate with large amounts of plain, tepid water or saline for 20 minutes, occasionally lifting the lower and upper lids. During this time, remove contact lenses, if easily removable without additional trauma to the eye. Get medical aid immediately. Have physician check for possible delayed damage. *Skin:* Get medical aid. Skin and/or eye contact can cause dangerous amounts of these chemicals to be absorbed into the bloodstream. Wearing the appropriate PPE equipment and respirator for organochlorine pesticides, immediately flush exposed skin, hair, and under nails with plain, running, tepid water for 20 minutes, then wash twice with mild soap. Shampoo hair promptly if contaminated; protect eyes. Do not scrub skin or hair, since this can increase absorption through the skin. Rinse thoroughly with water. Victims who are able and cooperative may assist with their own decontamination. Remove and double-bag contaminated clothing and personal belongings. Leather absorbs many organochlorines; therefore, items such as leather shoes, gloves, and belts should be discarded. If the skin is swollen or inflamed, cool affected areas with cold compresses. *Ingestion:* Call poison control. Loosen all clothing. Never give anything by mouth to an unconscious person. Get medical aid. *Do not induce vomiting*. *In cases of ingestion, the patient is at risk of CNS depression or seizures, which may lead to pulmonary aspiration during vomiting. If the victim is conscious and able to swallow, *administer an aqueous slurry of activated charcoal at 1 gm/kg (usual adult dose 60−90 g, child dose 25−50 g). A soda can and straw may be of assistance when offering charcoal to a child. The efficacy of activated charcoal for some organochlorine poisoning (such as chlordane) is uncertain. If victim is *unconscious or having convulsions,* do nothing except keep victim warm. **In some cases you may be specifically instructed by Poison Control to induce vomiting by way of two tablespoons of syrup of ipecac (adult) washed down with a cup of water. Do not give activated charcoal before or with ipecac syrup. Inhalation:* Get medical aid. Do not contaminate yourself. Wearing the appropriate PPE equipment and respirator for organochlorine pesticides, immediately remove the victim from the contaminated area to fresh air. For inhalation exposures, monitor for respiratory distress. If the victim is not breathing, administer artificial respiration. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. If cough or breathing difficulty develops, evaluate for respiratory tract irritation, bronchitis, or pneumonitis. If breathing is difficult, administer 100% humidified supplemental oxygen through bag/mask apparatus until medical help arrives. Do not leave victim unattended

Personal Protective Methods: Wear acid resistant protective eye protection, gloves, and clothing to prevent any reasonable probability of dermal contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquids or dust-proof goggles and faceshield when working with powders or dusts, unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures *over* 1 ppm, use an NIOSH/MSHA or European Standard EN 149-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use an NIOSH/MSHA or European Standard EN 149-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Blue: Health Hazard/Poison. Store in a secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizing agents; acid hydrides, and strong bases.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: *Liquid or wettable powder:* Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Powder: First remove all sources of ignition. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are

required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include chlorine. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration in a unit with efficient gas scrubbing. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (122); (100).

United States Environmental Protection Agency, Office of Pesticide Programs, "*Pesticide Residue Limits: Chlorthal-dimethly*," 40 CFR 180.185, http://www.epa.gov/pesticides/food/viewtols.htm

United States Environmental Protection Agency, "*Reregistration Eligibility Decision (RED), DCPA*," Office of Prevention, Pesticides and Toxic Substances, Washington, DC (November 1998). http://www.epa.gov/REDs/0270red.pdf

United States Environmental Protection Agency, "*Reregistration Eligibility Decision (RED) Facts, DCPA*," Office of Prevention, Pesticides and Toxic Substances, Washington, DC (November 1998). http://www.epa.gov/REDs/factsheets/0270fact.pdf

EXTOXNET, Extension Toxicology Network, "*Pesticide Information Profile, DCPA, Chlorthal, Clorthal-dimethyl*," Oregon State University, Corvallis, OR (June 1996); (122). http://extoxnet.orst.edu/pips/DCPA.htm

United States Environmental Protection Agency, Office of Water, Washington, DC (November 1993)

DDT D:0140

Formula: $C_{14}H_9Cl_5$

Synonyms: Agritan; Anofex; Arkotine; Azotox; Benzene, 1,1′-(2,2,2-Trichloroethylidene)bis(4-chloro); α,α-Bis(*p*-chlorophenyl)-β,β,β-trichlorethane; 1,1-Bis-(*p*-chlorophenyl)-2,2,2-trichloroethane; 2,2-Bis(*p*-chlorophenyl)-1,1-trichloroethane; Bosan supra; Bovidermol; Chlorophenothan; α-Chlorophenothane; Chlorophenothane; Chlorophenotoxum; Citox; Clofenotane; *p,p*'-DDT; 4,4′ DDT; Dedelo; Deoval; Detox; Detoxan; Dibovan; *p,p*'-Dichlorodiphenyltrichloroethane; 4,4′-Dichlorodiphenyl trichloroethane; Dichlorodiphenyltrichloroethane; Dichlorodiphenyl trichloroethane 2,2-bis(*p*-chlorophenyl)-1,1,1-trichloroethane; Diclorodifeniltricloroetano (Spanish); Dicophane; Didigam; Didimac; Diphenyltrichloroethane; Dodat; Dykol; ENT1506; Estonate; Ethane, 1,1,1-Trichloro-2,2-bis(*p*-chlorophenyl)-; Genitox; Gesafid; Gesapon; Gesarex; Gesarol; Guesarol; Gyron; Havero-Extra; Ivoran; Ixodex; Kopsol; Mutoxin; NCI-C00464; Neocid; OMS 16; Parachlorocidum; PEB1; Pentachlorin; Pentech; Pzeidan; Rukseam; Santobane; 1,1,1-Trichlor-2,2-bis(4-chlor-phenyl)-aethan (German); 1,1,1-Trichloro-2,2-bis(*p*-chlorophenyl) ethane; Trichlorobis(4-chlorophenyl)ethane; 1,1,1-Trichloro-2, 2-di(4-chlorophenyl)-ethane; Zeidane; Zerdane

CAS Registry Number: 50-29-3 (technical and p,p'-)

HSDB Number: 200

RTECS Number: KJ3325000

UN/NA & ERG Number: UN2761 (Organochlorine pesticides, solid toxic)/151

EC Number: 200-024-3 [*Annex I Index No.*: 602-045-00-7]

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen: dichlorodiphenyltrichloroethane; IARC: Animal Sufficient Evidence, Human Inadequate Evidence. Group 2B, 1991; NCI: Carcinogenesis Bioassay (feed); no evidence: mouse, rat. United States Environmental Protection Agency Gene-Tox Program, Positive: Carcinogenicity-mouse/rat; In vitro cytogenetics-nonhuman; Positive: *D. melanogaster*-partial sex chromosome loss; Positive: V79 cell culture-gene mutation; Negative: Host-mediated assay; Sperm morphology-mouse; Negative: *D. melanogaster* sex-linked lethal; *S. cerevisiae-homozygosis*; Inconclusive: *D. melanogaster*-whole sex chromosome loss; Inconclusive: *D. melanogaster*-nondisjunction; Rodent dominant lethal; Inconclusive: Mammalian micronucleus; *E. coli polA* without S9.

California Proposition 65 Chemical[102]: Cancer 10/1/1987 (DDT); Developmental/Reproductive toxin (female) 5/15/98 (*p,p'*-DDT).

Hazard Alert: Poison, Flammable, Endocrine disruptor (high), Possible risk of forming tumors, Reproductive toxin: possible risk of gene damage/impaired fertility; Suspected reprotoxic hazard, Environmental hazard, Agricultural chemical.

Persistent Organic Pollutants (POP) (UN)

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/1992); Toxic Pollutant (Section 401.15)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U061

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.0039; Nonwastewater (mg/kg), 0.087

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8080 (0.1); 8270 (10)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg)

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), severe pollutant

Canada, Drinking Water Quality, 0.03 mg/L MAC

Mexico, Drinking Water Criteria, 0.001 mg/L

Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)]

List of Stockholm Convention POPs: Annex B (Restriction).

Hazard symbols, risk, & safety statements: Hazard symbol: T, F, N; risk phrases: R10; R25; R40; R48/25; R50/53; R62; R63; safety phrases: S1/2; S22; S36/37; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: DDT is a waxy solid or slightly off-white powder of indefinite melting point with a weak, chemical odor. Molecular weight = 354.58; boiling point = 260°C; freezing/melting point = 107°C−109°C; flash point = 72°C−75°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 0. Poor solubility in water.

Potential Exposure: DDT is a low-cost broad-spectrum insecticide. However, following an extensive review of health and environmental hazards of the use of DDT, United States Environmental Protection Agency decided to ban further use of DDT in December 1972. This decision was based on several properties of DDT that had been well evidenced[1]: DDT and its metabolites are toxicants with long-term persistence in soil and water[2]; it is widely dispersed by erosion, runoff, and volatization[3]; and the low-water solubility and high lipophilicity of DDT result in concentrated accumulation of DDT in the fat of wildlife and humans which may be hazardous.

Incompatibilities: Contact with strong oxidizers may cause fire and explosion hazard. Incompatible with salts of iron or aluminum, and bases. Do not store in iron containers.

Permissible Exposure Limits in Air

NIOSH IDLH = 500 milligram per cubic meter

OSHA PEL: 1 milligram per cubic meter TWA [skin]

NIOSH REL: 0.5 milligram per cubic meter TWA; Suspected occupational carcinogen. Reduce exposure to lowest feasible level. See *NIOSH Pocket Guide*, Appendix A

ACGIH TLV[1]: 1 milligram per cubic meter TWA; confirmed animal carcinogen with unknown relevance to humans.

PAC Ver. 29[138]

PAC-1: 3 milligram per cubic meter

PAC-2: 34 milligram per cubic meter

PAC-3: 210 milligram per cubic meter

DFG MAK: 1 milligram per cubic meter TWA measured as the, inhalable fraction [skin]; Peak Limitation Category II (8).

Arab Republic of Egypt: TWA 1 milligram per cubic meter, 1993; Australia: TWA 1 milligram per cubic meter, 1993; Austria: MAK 1 milligram per cubic meter, [skin], 1999; Belgium: TWA 1 milligram per cubic meter, 1993; Denmark: TWA 1 milligram per cubic meter, 1999; Finland: TWA 1 milligram per cubic meter; STEL 3 milligram per cubic meter, [skin], 1999; France: VME 1 milligram per cubic meter, continuous; carcinogen, 1999; the Netherlands: MAC-TGG 1 milligram per cubic meter, 2003; India: TWA 1 milligram per cubic meter, 1993; Norway: TWA 1 milligram per cubic meter, 1999; the Philippines: TWA 1 milligram per cubic meter, [skin], 1993; Poland: MAC (TWA) 0.1 milligram per cubic meter; STEL 0.8 milligram per cubic meter, 1999; Russia: STEL 0.1 milligram per cubic meter, 1993; Switzerland: MAK-W 1 milligram per cubic meter, [skin], 1999; Thailand: TWA 1 milligram per cubic meter, 1993; Turkey: TWA 1 milligram per cubic meter, [skin], 1993; United Kingdom: TWA 1 milligram per cubic meter; STEL 3 milligram per cubic meter, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: confirmed animal carcinogen with unknown relevance to humans. Russia[43] set a MAC for ambient air in residential areas of 0.005 milligram per cubic meter on a momentary basis and 0.001 milligram per cubic meter on a daily average basis. Several states have set guidelines or standards for DDT in ambient air[60] ranging from 1.8 μ/m^3 (Pennsylvania) to 2.38 μ/m^3 (Kansas) to 5.0 μ/m^3 (Connecticut) to 10.0 μ/m^3 (North Dakota) to 16.0 μ/m^3 (Virginia) to 24 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method #S-274.

Permissible Concentration in Water: State Drinking Water Standards: Illinois 50 μg/L; State Drinking Water Guidelines: Arizona 0.10 μg/L; Florida 0.1 μg/L; Maine 1 μg/L; Minnesota 1 μg/L; New Hampshire 0.1 μg/L.

Determination in Water: Gas chromatography (EPA Method 608) or gas chromatography plus mass spectrometry (EPA Method 625). Octanol-water coefficient: Log K_{ow} = >6. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, skin absorption, ingestion, and eye and skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: *Inhalation:* Can cause irritation. 500−4200 milligram per cubic meter has produced dizziness. *Skin:* Can cause irritation in very high concentrations. DDT can be absorbed through the skin if dissolved in vegetable oils or other solvents. *Eyes:* Can cause irritation.

Ingestion: 1/30-1/4 ounce has caused nausea, vomiting, headache and convulsions. Other symptoms include weakness, restlessness, dizziness, a lack of coordination; numbness of face and extremities; abdominal pain; diarrhea, tremors, and death. Symptoms may be delayed from 1/2-3 hours. Estimated lethal dose is between one teaspoon and one ounce. Can cause a prickling or tingling sensation in the mouth, tongue, lower face; nausea, vomiting, confusion, a sense of apprehension, weakness; loss of muscle control; tremors, paresthesia tongue; lips, face, dizziness, confusion, malaise (vague feeling of discomfort), headache, fatigue, convulsions, and paresis hands. High exposures can cause convulsions and death.

Long-Term Exposure: DDT may cause liver and kidney damage. Prolonged or repeated exposure can cause irritation of the eyes, skin, and throat. Occupational exposure to DDT has been associated with changes in genetic material. DDT levels build up and stay in the body for long periods of time. Exposure to DDT and aldrin may increase retention of DDT in the body. DDT causes cancer in laboratory animals. Whether it causes cancer in humans is unknown.

Points of Attack: Eyes, skin, CNS, kidneys, liver, and peripheral nervous system. Cancer site in animals: liver, lung, and lymphatic tumors.

Medical Surveillance: Serum DDT level. Urine *dichlorodiphenyl acetic acid* level. Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: (No longer manufactured). Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Any barrier will prevent contamination from the dry chemical. Also, safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type SCBA).

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with DDT all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers, strong bases, and heat. Should not be stored in iron containers. Always store pesticides in their original containers, complete with labels that list ingredients, directions for use, and first aid steps in case of accidental poisoning. Never store pesticides in cabinets with or near food, animal feed, or medical supplies. Do not store pesticides in places where flooding is possible or in places where they might spill or leak into wells, drains, ground water, or surface water[72]. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2761 Organochlorine pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Do not dry sweep. Use vacuum (use special HEPA vac, NOT a standard shop-vac) or a wet method to reduce dust during clean-up. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Thermal decomposition products may include toxic chlorides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration has been successfully used on a large scale for several years; huge incinerator equipment with scrubbers to catch HCl, a combustion product, are in use at several facilities, such as Hooker Chemical, Dow Chemical and other producers of chlorinated hydrocarbon products. One incinerator operates @ 900°C–1400°C with air and steam added which precludes formation of Cl_2. A few companies also constructed incinerator-scrubber combinations of smaller size, e.g., a system built by Garver-Davis, Inc., of Cleveland, Ohio, for the Canadian government, can handle 200–500 lb DDT/day as a kerosene solution. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(109); (102); (31); (173); (101); (138); (2); (203); (100).

United States Environmental Protection Agency, *DDT: Ambient Water Quality Criteria*, Washington, DC (1980)

United States Environmental Protection Agency, *DDT Health and Environmental Effects Profile No. 60*, Washington, DC, Office of Solid Waste (April 30, 1980)

Sax N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 3, 51–54 (1981) and 5, No. 1, 12–20 (1985)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: DDT*, Trenton, NJ (July 2002)

New York State Department of Health, *Chemical Fact Sheet: DDT*, Bureau of Toxic Substance Assessment, Albany, NY (Mar. 1986 and Version 2)

Decaborane D:0150

Formula: $B_{10}H_{14}$

Synonyms: Boron hydride; Decaborane; Decaborano (Spanish); Decarboron tetradecahydride

CAS Registry Number: 17702-41-9; *(alt.)* 1304-02-5

HSDB Number: 2515

RTECS Number: HD1400000

UN/NA & ERG Number: UN1868/134

EC Number: 241-711-8

Regulatory Authority and Advisory Information

Hazard Alert: Poison: high acute toxicity, Flammable solid, Strong reducing agent, Water reactive.

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 500 lb (227 kg)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T +, F, risk phrases: R10; R5; R11; R24/25; R26; R36/37/38; safety phrases: S16; S27; S36/37/39; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [1-Low hazard to water. (est.)]

Description: Decaborane is a colorless solid with a bitter odor. The Odor Threshold is 0.06 ppm. Molecular weight = 122.24; specific gravity (H_2O:1) = 0.94; boiling point = 212.7°C; freezing/melting point = 99.6°C; flash point = 80°C (cc); vapor pressure = 0.05 mmHg @ 25°C; Autoignition temperature = 149°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 1 ₩. Very slightly soluble in cold water; slowly hydrolyzes. Reacts with hot water.

Potential Exposure: Decaborane is used as a catalyst in olefin polymerization; in rocket propellants; in gasoline additives and as a vulcanizing agent for rubber.

Incompatibilities: May ignite spontaneously on exposure to air. Decomposes slowly in hot water. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, and oxygenated solvents; dimethyl sulfoxide (reaction may be violent), oxygen @ >100°C). Carbon tetrachloride, ethers, halocarbons, halogenated compounds form shock-sensitive mixtures. Attacks some plastics, rubber, and coatings.

Permissible Exposure Limits in Air

NIOSH IDLH = 15 milligram per cubic meter

OSHA PEL: 0.05 ppm/0.3 milligram per cubic meter TWA [skin]

NIOSH REL: 0.05 ppm/0.3 milligram per cubic meter TWA; 0.15 ppm/0.9 milligram per cubic meter STEL [skin]

ACGIH TLV[1]: 0.05 ppm/0.25 milligram per cubic meter TWA; 0.15 ppm/0.75 milligram per cubic meter [skin] STEL

PAC Ver. 29[138]

PAC-1: 0.75 milligram per cubic meter

PAC-2: 10 milligram per cubic meter

PAC-3: 100 milligram per cubic meter

DFG MAK: 0.05 ppm/0.25 milligram per cubic meter, Peal Limitation Category II(2) [skin]

Australia: TWA 005 ppm (0.3 milligram per cubic meter); STEL 0.15 ppm, [skin], 1993; Austria: MAK 0.05 ppm (0.3 milligram per cubic meter), [skin], 1999; Belgium: TWA 0.05 ppm (0.25 milligram per cubic meter); STEL 0.15 ppm, [skin], 1993; Denmark: TWA 0.05 ppm (0.3 milligram per cubic meter), [skin], 1999; Finland: TWA 0.05 ppm (0.25 milligram per cubic meter); STEL 0.15 ppm, [skin], 1999; France: VME 0.05 ppm (0.3 milligram per cubic meter), [skin], 1999; Hungary: TWA 0.3 milligram per cubic meter; STEL 0.6 milligram per cubic meter, [skin], 1993; the Netherlands: MAC-TGG 0.3 milligram per cubic meter, 2003; Norway: TWA 0.05 ppm (0.3 milligram per cubic meter), 1999; the Philippines: TWA 0.05 ppm (0.3 milligram per cubic meter), [skin], 1993; Switzerland: MAK-W 0.05 ppm (0.25 milligram per cubic meter), KZG-W 0.1 ppm, [skin], 1999; Turkey: TWA 0.05 ppm (0.3 milligram per cubic meter), [skin], 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: STEL 0.15 ppm/0.75 milligram per cubic meter [skin]. Several states have set guidelines or standards for decaborane in ambient air[60] ranging from 3−9 μ/m^3 (North Dakota) to 5 μ/m^3 (Virginia) to 6 μ/m^3 (Connecticut) and 7 μ/m^3 (Nevada).

Determination in Air: No method available.

Routes of Entry: Inhalation, skin absorption, ingestion, and eye and skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Vapor exposure may cause clouding of the eyes with loss of vision. Contact can cause severe eye burns and may also irritate the skin. Sign and symptoms of acute exposure to decaborane may include tightness in the chest; dyspnea (shortness of breath), cough, and wheezing. Nausea and pulmonary edema may also occur. Neurological effects of acute exposure include dizziness, headache, weakness, a lack of coordination; muscle spasms; tremor, and seizures. Exposure to decaborane may irritate or burn the skin, eyes, and mucous membranes. Exposure to decaborane may irritate or burn the skin, eyes, and mucous membranes. Exposure can cause restlessness, headaches, dizziness, and nausea. High concentrations can cause muscle twitching; convulsions, unconsciousness, and death. High or repeated exposures may damage the liver and kidneys. Decaborane can be absorbed through the skin, thereby increasing exposure.

Long-Term Exposure: May cause damage to the CNS; liver and kidneys.

Points of Attack: CNS, liver, and kidneys.

Medical Surveillance: Before beginning employment and at regular times after that, the following is recommended: examination of the nervous system. If symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function tests. Exam of the eyes and vision.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Any barrier will prevent contamination from the dry chemical. Also, safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Up to 3 milligram per cubic meter: Sa (APF = 10) (any supplied-air respirator). Up to 7.5 milligram per cubic meter: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). Up to 15 milligram per cubic meter: SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* PD: PP (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister having an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type SCBA).

Storage: (1) Color code-Red Stripe: Flammability Hazard: Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1 hour fire wall from flammable or reactive materials. Store flammable solids up to maximum allowable quantity per control area in an approved flammable storage area. Do not store in a basement.(2) Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with decaborane all handlers should be trained on its proper handling and storage. Decaborane must be stored to avoid contact with oxidizers, such as permanganates, nitrates, peroxides, chlorates, and perchlorates; or halogenated compounds, since violent reactions occur. Store in tightly closed containers in a cool well-ventilated area away from heat and water. Heat can cause an explosion. Contact with water can slowly produce flammable hydrogen gas. Detached storage is preferable. Sources of ignition, such as smoking and open flames are prohibited where decaborane is handled, used or stored.

Shipping: UN1868 Decaborane, Hazard Class: 4.1; Labels: 4.1-Flammable solid, 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. For small quantities, sweep into paper or other suitable material, place in appropriate container and burn in safe place (such as fume hood). Large quantities may be reclaimed. If reclamation is not practical, dissolve in flammable solvent (such as alcohol) and atomize in suitable combustion chamber.

Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: Cover with water, sand or earth; shovel into metal container and keep material under water. *Large spills*: Dike for later disposal and cover with wet sand or water. Clean up only under supervision of an expert. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. The solid can self-ignite in oxygen, and mixtures with oxidizing materials can be explosive. Thermal decomposition products may include flammable hydrogen and boron fumes. Use dry chemical or CO_2 extinguishers. Avoid halogenated extinguishing agents, as they can react violently. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration with aqueous scrubbing of exhaust gases to remove B_2O_3 particulates.

References

(31); (173); (101); (138); (100).

Sax N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 8, 64−65 (1981)

United States Environmental Protection Agency, Chemical Hazard Information Profile: *Decaborane*, [14] Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Decaborane*, Trenton, NJ (February 1999)

Decabromodiphenyl Ether D:0160

Formula: $C_{12}Br_{10}O$

Synonyms: AFR 1021; Benzene, 1,1′-oxybis(2,3,4,5,6-pentabromo-); Berkflam B 10E; Bis(pentabromophenyl) ether; BR 55N; Bromkal 81; Bromkal 82-ODE; Bromkal 83-1ODE; DE83; DE 83R; Decabrom; Decabromobiphenyl ether; Decabromobiphenyl oxide; Decabromodiphenyl oxide (EPA); Decabromophenyl ether; EB 10FP; EBR 700; Ether, bis(pentabromophenyl); FR 300; FR 300BA; FRP 53; FR-PE; 1,1′-Oxybis(2,3,4,5,6-pentabromobenzene); Pentabromophenyl ether; Planelon DB 100; Saytex 102; Saytex 102E; Tardex 100

CAS Registry Number: 1163-19-5

HSDB Number: 2911

RTECS Number: KN3525000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171; UN3152 (Polyhalogenated biphenyls, solid)/171

EC Number: 214-604-9

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Limited Evidence*, not classifiable as carcinogenic to humans*, Group 3, 1990, NTP: Carcinogenesis Studies (feed); some evidence, rat; equivocal evidence, mouse (NTP: TR-309,86); EPA: Suggestive evidence of carcinogenic potential.

California Proposition 65 Chemical[102]: Cancer (1/1/1988); Reproductive toxin (10/1/1994), *as polybrominated Biphenyls (PBB)*

Hazard Alert: Combustible, Environmental hazard

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada National Pollutant Release Inventory (NPRI)

As Polybrominated Biphenyls (PBB)

RCRA Section 261 Hazardous Constituents, waste number not listed. D004

RCRA Ground Water Monitoring List. Suggested test method(s) (PQL ug/L): 8080(50); 8250(100)

EPCRA Section 313 Form R *de minimus* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazardous to aquatic life or environment, with possible long lasting effects.[195]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: F, N, Xi, Xn; risk phrases: R11; R20/21; R38; R51/53; R65; R67; safety phrases: S29/35; S36/37; S45; S60; S61; S62; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: DBDPO is a white to off-white powder. *A polybrominated biphenyl.* Molecular weight = 959.22; specific gravity (H_2O:1) = 3 v@ 20°C; freezing/melting point = 298.4°C−302.5°C; vapor pressure = < 1 mmHg @ 20°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. Slightly soluble in water; solubility = < 1 mgm/mL @ 20°C.

Potential Exposure: It is used as a fire retardant for thermoplastics and man-made fibers.

Incompatibilities: Incompatible with strong oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides. Ethers have a tendency to form unstable and explosive peroxides.

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Routes of Entry: Inhalation and skin absorption.

Harmful Effects and Symptoms

Short-Term Exposure: This chemical can be absorbed through the skin, thereby increasing exposure. DBDPO irritates the eyes, skin, and respiratory tract.

Long-Term Exposure: This chemical can accumulate in the body and may cause liver damage. Thyroid enlargement (goiter) may occur. There is limited evidence that this chemical causes cancer in animals; it may cause liver cancer[193]. Some closely related polybrominated biphenyl compounds have been shown to damage the developing fetus.

Points of Attack: Liver, thyroid, liver, and kidney.

Medical Surveillance: Liver, kidney, and thyroid function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with DPDPO all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area away from strong oxidizers. Where possible, automatically transfer this chemical from drums or other storage containers to process containers. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required. UN3152 Polyhalogenated biphenyls, solid or Polyhalogenated terphenyls, solid, Hazard class: 9; Labels: 9-Miscellaneous hazardous material.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Do not dry sweep. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical may burn but does not easily ignite. Thermal decomposition products may include hydrogen bromide and oxides of carbon. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(102); (31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Decabromodiphenyl Ether*, Trenton, NJ (May 1998)

United States Environmental Protection Agency, *"Reregistration Eligibility Decision (RED), p-Chloro-m-cresol,"* Office of Prevention, Pesticides and Toxic Substances, Washington, DC (January 1997). http://www.epa.gov/oppsrrd1/REDs/3046red.pdf

Decanoic Acid D:0164

Formula: $C_{10}H_{20}O_2$

Synonyms: Acido decanoico (Spanish); Capric acid; *n*-Capric acid; Caprinic acid; Caprynic acid; *n*-Decanoic acid; *n*-Decoic acid; Decylic acid; *n*-Decylic acid; Econosan; Hexacid-1095; Neo-fat 10; 1-Nonanecarboxylic acid

CAS Registry Number: 334-48-5

HSDB Number: 2751

RTECS Number: HD9100000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 206-376-4

Regulatory Authority and Advisory Information

Hazard Alert: Combustible, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction), Environmental hazard.

Hazardous to aquatic life or environment, with possible long lasting effects[194]. Harmful to aquatic life with long lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: Xi, N; risk phrases: R36/37/38, R53; R62; safety phrases: S26; S29/35; S36/37/39 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: White crystalline solid or needles. Unpleasant, rancid odor. Molecular weight = 172.26; specific gravity (H_2O:1) = 0.8858 @ 40°C; boiling point = 268°C–270°C; freezing/melting point = 31.5°C; vapor pressure = 1 mm @ 125°C; flash point = 112.78°C (cc); Autoignition temperature = 375°C; Explosive limits: LEL = 5.5%; UEL = 0.8%. Hazard identification (based on NFPA-704M Rating System): Health Hazards (Blue): 2; Flammability (Red): 1; Reactivity (Yellow): 0. Practically insoluble in water; solubility = < 1 mg/mL @ 18°C; 140 mg/L.

Potential Exposure: Deconoic acid (fatty acids, saturated, linear, number of C-atoms > = 8 and < = 12, with terminating carboxyl group) is a carboxylic acid microbiocide used in cleaning, sanitizing and disinfecting applications for food processors and dairy farmers.

Incompatibilities: An organic carboxylic acid. Keep away from oxidizers, sulfuric acid, caustics, ammonia, aliphatic amines, alkanolamines, isocyanates, alkylene oxides, and epichlorohydrin. Corrosive solution; attacks most common metals. React violently with strong oxidizers, bromine, 90% hydrogen peroxide, phosphorus trichloride, silver powders or dust. Mixture with some silver compounds forms explosive salts of silver oxalate. Incompatible with silver compounds.

Determination in Water: Octanol-water coefficient: Log $K_{ow} = \sim 4.0$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, skin and eye contact, and ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Vapors cannot be tolerated even at low concentrations; can cause severe irritation of eyes and throat; may cause eye and lung injury. If inhaled, causes coughing or difficult breathing. Contact with liquid or solid causes second and third degree burns in a short time; very injurious to the eyes. If swallowed, causes nausea and vomiting. Toxicity by ingestion: Grade 3. LD_{50} (oral, rat) = > 10 g/kg.

Long-Term Exposure: May cause lung damage.

Medical Surveillance: Lung x-ray.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious and able to swallow, have victim drink four to eight ounces of water. Do not induce vomiting. *Note to physician or authorized medical personnel*: Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a drug or other inhalation therapy. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure

Respirator Selection: Wherever and whenever workplace conditions warrant respirator use, a respiratory protection program must be followed that meets one or more of the following requirements: OSHA's 29 CFR 1910.134, ANSI Z88.2, or European Standard EN 149.

Storage: Color code-Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Carboxylic acids are generally weak acids, but can still be corrosive. Store in tightly closed containers in a cool, well-ventilated area. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from heat and incompatible materials. Sources of ignition, such as smoking and open flames are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of five gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Do not dry sweep. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products includes oxides of carbon. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Recycle any unused portion of the material for its approved use or return it to the manufacturer or supplier. Ultimate disposal of the chemical must consider: the material's impact on air quality; potential migration in soil or water; effects on animal, aquatic, and plant life; and conformance with environmental and public health regulations[83].

References

(31); (173); (101); (138); (100).

United States National Library of Medicine, *ChemIDplus Advanced*, Bethesda, MD, http://chem.sis.nlm.nih.gov/chemidplus/rn/334-48-5

Deltamethrin D:0167

Formula: $C_{22}H_{19}Br_2NO_3$

Synonyms: Butoflin; Butoss; Butox; Cislin; Crackdown; (*S*)-α-Cyano-*m*-phenoxybenzyl (1R,3R)-3-(2,2-dibromovinyl)-2,2-dimethylcyclopropanecarboxylate; 1R-[1-α(S*),3-α)]-Cyano(3-phenoxyphenyl)methyl-3-(2,2-dibromovinyl)-2,2-dimethylcyclopropanecarboxylate; Cyclopropanecarboxylic acid, 3-(2,2-dibromoethenyl)-2,2-dimethyl-, cyano(3-phenoxyphenyl)methyl ester, [1R-(1α(*S**,3α)]-; Decamethrin; (1R,3R)-3-(2,2-Dibromovinyl)-2,2-dimethylcyclopropane carboxylic acid, (*S*)-α-cyano-3-phenoxybenzyl ester; Decis; Delta; Deltaguard; Esbecythrin; FMC 45498; JMC 45498; K-othrine dust; NRDC 161; RU 22974; Striker IEC insecticide (mixture of deltamethrin and tralomethrin)

CAS Registry Number: 52918-63-5

HSDB Number: 6604

RTECS Number: GZ1233000

UN/NA & ERG Number: UN2811 (toxic solids, organic, n.o.s.)/154; UN3349 (pyrethroid pesticide, solid, toxic)/151

EC Number: 258-256-6 [*Annex I Index No.:* 607-319-00-X]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC, Animal Inadequate Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3; EPA, Not Likely to be Carcinogenic to Humans

Hazard Alert: Poison, Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Agricultural chemical, Environmental hazard.

Permissible Exposure Limits for Chemical Contaminants (CAL/OSHA) as pyrethrum

Clean water act: Section 311 Hazardous Substances/RQ (same as CERCLA) as pyrethrins

Hazardous to aquatic life or environment, with possible long lasting effects[291,292].

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R23/25; R50/53; R62; R63; safety phrases: S1/2; S24; S28; S29/35; S36/37/39; S38; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to waters

Description: Colorless, white, or off-white crystalline solid or powder. Odorless. Combustible. Molecular weight = 505.21; freezing/melting point = 98°C−100°C; boiling point decomposes on distillation; vapor pressure = 2×10^{-8} mmHg @ 25°C; 0.002 mmHg @ 25°C; specific gravity (H_2O:1) = 1.22 @ 25°C. Practically insoluble in water; solubility = ≤ 0.002 mg/L.

Potential Exposure: Deltamethrin is a synthetic pyrethroid insecticide that kills insects on contact and through digestion. It is used to control a variety of chewing and sucking insects that infest fruit, vegetables and field crops, including apples, pears and plums; peas, glasshouse cucumbers, tomatoes, peppers, potted plants, and ornamentals; hops, oats, cotton and other field crops. Deltamethrin is also used to control residential and commercial insect pests. Some formulations are RUPs)

Incompatibilities: May react violently with strong oxidizers, bromine, 90% hydrogen peroxide, phosphorus trichloride, silver powders or dust. Incompatible with silver compounds. Mixture with some silver compounds forms explosive salts of silver oxalate.

Permissible Exposure Limits in Air:
ACGIH TLV[1]: (all pyrethrins) 5 milligram per cubic meter TWA

Determination in Air: Collection by impinger or fritted bubbler, analysis by gas liquid chromatography/ultraviolet. See NIOSH IV, Method #5008[18], pyrethrum.

Determination in Water: Collection by impinger or fritted bubbler, analysis by gas liquid chromatography/ultraviolet. See NIOSH IV, Method #5008[18], pyrethrum. Octanol-water coefficient: Log $K_{ow} = >5$. Values above 3.0 are likely to bioaccumulate in marine organisms. Fish toxicity (threshold): Extra high—0.02258 ppb, MATC (Maximum Acceptable Toxicant Concentration)

Routes of Entry: Inhalation, ingestion, and absorbed through the skin

Harmful Effects and Symptoms

Short-Term Exposure: Poisonous. May be fatal if inhaled, swallowed, or absorbed through skin. Contact may cause severe irritation and burns to skin and eyes. Pyrethrins can affect you when breathed in and by passing through your skin. Irritates the eyes and respiratory tract. High exposure can affect the nervous system causing headache, nausea, vomiting, fatigue, and restlessness, rhinorrhea (discharge of thin nasal mucous). LD_{50} (oral), depending on carrier solvent = 30−2000 mg/kg; LD_{50} (dermal, rabbit) = > 2 g/kg.

Long-Term Exposure: High or repeated exposure can cause lung allergy (with cough, wheezing and/or shortness of breath) or hay fever symptoms (sneezing, runny, or stuffy nose). Allergic “pneumonia” can also occur with cough, chest pain, breathing difficulty and abnormal chest x-ray. Repeated attacks may lead to permanent scarring. Skin allergy may also develop with rash and itching, even with lower exposures. Dermal contact can cause rash with redness, blisters and intense itching. A severe generalized allergy can occur with weakness and collapse. May cause reproductive and fetal effects. May cause tumors. Human toxicity (long term)(101): Low—70.00 ppb, Health advisory.

Points of Attack: Respiratory system, skin, CNS, and brain. Reproductive cells.

Medical Surveillance: In addition to comprehensive initial medical and work histories emphasizing reproductive experience and menstrual history, patient should have physical examination and testing of genito-urinary tract, sperm count, motility and morphology. If required, other tests, such as serum testosterone, serum follicle stimulating hormone (FSH), and serum lutenizing hormone (LH) may be indicated. Employees should be screened for history of certain medical conditions which might place the employee at increased risk from pyrethroid exposure. Chronic respiratory disease: In persons with chronic respiratory disease, especially asthma, the inhalation of pyrethroids might cause exacerbation of symptoms due to its sensitizing properties. Lung function tests. These may be normal if the person is not having an attack at the time of the test. Consider chest x-ray if lung symptoms are present. Skin disease: Pyrethroids can cause dermatitis which may be allergic in nature. Persons with pre-existing skin disorders may be more susceptible to the effects of this agent. Evaluation by a qualified allergist, including exposure history and testing, may help diagnose allergy. Any employee developing the above-listed conditions should be referred for further medical examination[9].

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. *Do not induce vomiting when formulations containing petroleum solvents are ingested.* Otherwise, give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Applicators and other handlers must wear: Coveralls worn over long-sleeved shirt and long pants; Chemical-resistant gloves such as DuPont Tychem suit fabrics, barrier laminate, or Viton; Chemical-resistant footwear plus socks; Protective eye wear; Chemical-resistant headgear for overhead exposure; Chemical-resistant apron when cleaning equipment, mixing, or loading[83]. Agricultural Use/Engineering Controls: When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the Worker Protection Standard (WPS) for agricultural pesticides, 40 CFR 170.240(d)(4-6), the handler PPE requirements may be reduced or modified as specified in the Worker Protection Standard. Firefighters should wear NIOSH approved SCBA and full protective clothing.

Respirator Selection: NIOSH/OSHA *for pyrethrum*: 50 milligram per cubic meter: CcrOv95 (APF = 10) [any air-purifying half-mask respirator equipped with an organic vapor cartridge(s) in combination with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator).125 milligram per cubic meter: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOvHie (APF = 25) (any air-purifying full facepiece respirator equipped with an organic vapor cartridge in combination with a high-efficiency particulate filter). 250 milligram per cubic meter*:* CcrFOv100 (APF = 50) [any air-purifying full facepiece respirator equipped with organic vapor cartridge(s) in combination with an N100, R100, or P100 filter]; or PaprTOvHie (APF = 50) [any powered, air-purifying respirator with a tight-fitting facepiece and organic vapor cartridge(s) in combination with a high-efficiency particulate filter]; or

SCBAF (APF = 50) (any SCBA with full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). 5000 milligram per cubic meter*:* SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd, Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code-Blue: Health Hazard/Poison. Store in a secure poison location at temperature <35°C and away from alkaline materials. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.UN3349 Pyrethroid pesticide, solid toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: UN2811: *Isolation Distance, Spill*: 25 m/75 ft[70]. Isolation Distance, Fire: 800 m/0.5 mi[70]. First remove all sources of ignition. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Ventilate area of spill or leak. Use water spray to reduce vapor. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include hydrogen bromide and oxides of nitrogen and carbon. *On a small fire:* Use dry chemical, CO_2 or water spray.On a large fire: Use water spray, fog or regular foam. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal; do not scatter the material. Use water spray or fog; do not use straight streams. *Fire involving storage or vehicular tanks:* Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Do not get water inside containers. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. ALWAYS stay away from tanks engulfed in fire. For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies.

Disposal Method Suggested: Incineration would be an effective disposal procedure where permitted. If an efficient incinerator is not available, the product should be mixed with large amounts of combustible material and contact with the smoke should be avoided. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers.

References

(31); (173); (101); (138); (100).

EXTOXNET, Extension Toxicology Network, "*Pesticide Information Profile, Deltamethrin*," Oregon State University, Corvallis, OR (September 1995). http://extoxnet.orst.edu/pips/deltamet.htm

United States Environmental Protection Agency, Office of Pesticide Programs, "*Pesticide Residue Limits: Deltamethrin*," 40 CFR 180.435. www.epa.gov/pesticides/food/viewtols.htm

Johnson, M.; Luukinen, B.; Buhl, K.; Stone, D., *Deltamethrin Technical Fact Sheet*; National Pesticide Information Center, Oregon State University Extension Services, Corvallis, OR (2010)

National Pesticide Information Center, *Deltamethrin Technical Fact Sheet*, Oregon State University Extension Services, Corvallis, OR (2010)

Demeton D:0170

Formula: $C_8H_{19}O_3PS_2$

Synonyms: *demeton:* Bay 10756; Bayer 10756; Bayer 8169; Demetona (Spanish); Demeton-O + Demeton-S; Demox; Denox; Diethoxy thiophosphoric acid ester of 2-ethylmercaptoethanol; *O,O*-Diethyl-2-ethylmercaptoethyl thiophosphate, diethoxythiophosphoric acid; *O,O*-Diethyl *S*-2-(ethylthio)ethyl phosphorothioate mixed with phosphorothioic acid, *O,O*-diethyl *O*-2-(ethylthio)ethyl ester; E-1059; ENT 17295; Mercaptophos (in former USSR); Phosphorothioic acid,*O,O*-diethyl *O*-2-(ethylthio)ethyl ester, mixed with *O,O*-diethyl *S*-2-(ethylthio)ethyl phosphorothioate; Systemox; Systox; UL

demeton-S: Bay 18436; Bayer 18436; Bayer 25/154; *O,O*-Dimethyl-*S*-(2-aethtyl-thio-aethyl)-monothiophosphat

(German); *O,O*-Dimethyl *S*-(2-eththioethyl) phosphorothioate; *O,O*-Dimethyl *S*-[2-(eththio)ethyl] phosphorthioate; Dimethyl *S*-(2-eththioethyl) thiophosphate; *O,O*-Dimethyl *S*-ethylmercaptoethyl thiophosphate; *O,O*-Dimethyl *S*-ethylmercaptoethyl thiophosphate, thiolo-isomer; *O,O*-Dimethyl-*S*-(3-thia-pentyl)-monothiophosphat (German); Duratox; *S*-[2-(Ethylthio)ethyl] *O,O*-dimethyl phosphorothioate; *S*-[2-(Ethylthio)ethyl]dimethyl phosphorothiolate; *S*-[2-(Ethylthio)ethyl] *O,O*-dimethyl thiophosphosphate; Isometasystox; Isomethylsystox; Metaisoseptox; Metaisosystox; Metasystox Forte; Methyl demeton thioester; Methyl isosystox; Methyl-mercaptofos teolovy; Thiophosphate de *O,O*-dimethyle et de *S*-2-ethylthioethyle (French)

CAS Registry Number: 298-03-3 (demeton-O); 126-75-0 (demeton-S); 8065-48-3 (mixture); (*alt.* mixture) 8000-97-3; (*alt.* mixture) 8058-73-9; 919-86-8

HSDB Number: 201 as systox

RTECS Number: TF3150000 (mixture); TF3125000 (demeton-O); FT3130000 (demeton-S)

UN/NA & ERG Number: (PIH) UN3278 (organophosphorus pesticide, liquid, toxic)/151; UN3017 (organophosphorus pesticides, liquid, toxic, flammable)/131; UN2810 (toxic liquid, organic, n.o.s.)/153

EC Number: 204-801-8 [*Annex I Index No.:* 015-029-00-4] (demeton-S); 206-053-8 [*Annex I Index No.:* 015-028-00-9] (demeton-O); [*Annex I Index No.:* 015-118-00-8] (mixture)

Regulatory Authority and Advisory Information

United States Environmental Protection Agency Gene-Tox Program, Positive: *B. subtilis* rec assay; Histidine reversion-Ames test; Positive: *S. cerevisiae-homozygosis*; Positive/dose response: In vitro UDS-human fibroblast; TRP reversion; Negative: *E. coli polA* without S9; *D. melanogaster* sex-linked lethal

Hazard Alert: Poison inhalation hazard, Neurotoxin (cumulative), Flammable liquid, Environmental hazard, Suspected of causing genetic defects, Suspected reprotoxic hazard, Drug, Agricultural chemical.

Banned or Severely Restricted (in agriculture) (Germany and Russia)[13]

United States Environmental Protection Agency, FIFRA 1998 Status of Pesticides: Canceled (mixture)

United States DOT 49CFR172.101, Inhalation Hazardous Chemical, as organic phosphate, Substance ID: EDF-041

Demeton and Demeton-S:

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500 lb (227 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 500 lb (227 kg).

Hazardous to aquatic life or environment, with possible long lasting effects[291]. (*O-*)

European/International Regulations (*O-; 298-03-3* & *mixture 8065-48-3*): Hazard symbol: T+, F, N; risk phrases: R10; R27/28; R29; R33; R50; R60, R61; R62; R63; safety phrases: S1/2; 28; S36/37; S41; S45; S60; S61; (*S-; 126-75-0*): Hazard symbol: T+, N; risk phrases: R27/28; R33; safety phrases: S1/2; S28; S36/37; S41; S45 (see Appendix 4).

Description: Demeton is a light brown liquid with an odor of sulfur compounds; freezing/melting point $\leq -13°C$. Molecular weight = 516.92; boiling point = 134°C @ 2 mmHg @ 20°C; flash point = 45°C; Explosive limits: LEL: 1%; UEL: 5.3%. Hazard identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 0. Insoluble in water.

Potential Exposure: A potential danger to those involved in the manufacture, formulation, and application of this systemic insecticide and acaricide.

Incompatibilities: May form explosive mixture with air. Strong oxidizers, strong bases, soluble mercury, other pesticides, and water.

Permissible Exposure Limits in Air

NIOSH IDLH = 10 milligram per cubic meter

8065-48-3

OSHA PEL: 0.1 milligram per cubic meter TWA[skin]

NIOSH REL: 0.1 milligram per cubic meter TWA [skin]

8065-48-3

ACGIH TLV[1]: 0.01 milligram per cubic meter TWA, inhalable fraction and vapor [skin]; BEIA: Acetylcholinesterase inhibiting pesticides; methemoglobin in blood; 1.5% of hemoglobin, during or end-of-shift as methemoglobin inducers.

919-86-8

ACGIH TLV[1]: 0.01 milligram per cubic meter TWA, inhalable fraction and vapor [skin] sensitizer; BEIA: Acetylcholinesterase inhibiting pesticides; methemoglobin in blood; 1.5% of hemoglobin, during or end-of-shift as methemoglobin inducers.

8065-48-3,demeton

PACVer. 29[138]

PAC-1: 0.18 milligram per cubic meter

PAC-2: 2 milligram per cubic meter

PAC-3: 20 milligram per cubic meter

DFG MAK: [skin]; BAT information, as acetylcholine esterase inhibitors.

Australia: TWA 0.01 ppm (0.1 milligram per cubic meter), [skin], 1993; Austria: MAK 0.01 ppm (0.1 milligram per cubic meter), [skin], 1999; Belgium: TWA 0.01 ppm (0.11 milligram per cubic meter), [skin], 1993; Finland: STEL 0.1 ppm (0.3 milligram per cubic meter), [skin], 1999; France: VME 0.01 ppm (0.1 milligram per cubic meter), [skin], 1999; India: TWA 0.01 ppm (0.1 milligram per cubic meter), [skin], 1993; the Netherlands: MAC-TGG 0.1 milligram per cubic meter, 2003; the Philippines: TWA 0.1 milligram per cubic meter, [skin], 1993; Russia: STEL 0.02 milligram per cubic meter, [skin], 1993; Switzerland: MAK-W 0.01 ppm (0.1 milligram per cubic meter), [skin], 1999; Thailand: TWA 0.1 milligram per cubic meter, 1993; Turkey: TWA 0.1 milligram per cubic meter, [skin], 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: TWA 0.05 milligram per cubic meter [skin]. States which have set guidelines or standards for Demeton in ambient air[60] include North Dakota @ 1.0 μ/m^3 and Connecticut and Nevada @ 2.0 μ/m^3.

Determination in Air: Use NIOSH Analytical Method (IV) #5514.

Permissible Concentration in Water: A MAC of 0.01 mg/L in water bodies used for domestic purposes has been set in Russia[35],[43].

Routes of Entry: Inhalation, skin absorption, ingestion, and eye and skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Demeton can be absorbed through the skin, thereby increasing exposure. Demeton may cause effects on the nervous system by cholinesterase inhibiting effect, causing convulsions, respiratory failure and possible death. High exposure (above OEL) may result in unconsciousness and death. Acute exposure to Demeton may produce the following symptoms of exposure: pinpoint pupils; pain; seizures, blurred vision; headache, dizziness, and muscle spasms; and profound weakness. Vomiting, diarrhea, abdominal pain, seizures, and coma may also occur. The heart rate may decrease following oral exposure or increase following dermal exposure. Chest pain may be noted. Hypotension (low blood pressure) may occur, although hypertension (high blood pressure) is not uncommon. Respiratory symptoms include dyspnea (shortness of breath), respiratory depression, and respiratory paralysis. Psychosis may occur. This material is a cholinesterase inhibitor. It is readily absorbed through the skin and is extremely toxic. Probable human lethal oral dose is 5−50 mg/kg or seven drops to one teaspoonful for 150 lb. person. Acute dose is believed to be 12−20 mg by oral route. The effects may be delayed. Medical observation is indicated.

Long-Term Exposure: May cause mutations. May damage the developing fetus. May damage the nervous system; causing sensation of “pins and needles” in the hands and feet. May cause depression, irritability and personality changes. Cumulative effect is possible. Demeton may affect cholinesterase, causing significant depression of blood cholinesterase.

Points of Attack: Respiratory system, lungs, CNS, cardiovascular system, skin, eyes, plasma, and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When cholinesterase enzyme levels are reduced by 25% or more below pre-employment levels, risk of poisoning is increased, even if results are in lower ranges of “normal.” Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider complete blood count (CBC). Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: 1 milligram per cubic meter: Sa (APF = 10) (any supplied-air respirator). 2.5 milligram per cubic meter: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). 5 milligram per cubic meter: SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). 10 milligram per cubic meter: Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type SCBA).

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with demeton all handlers should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well ventilated area away from oxidizers, strong bases; water, soluble mercury; and other pesticides. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: UN3278 Organophosphorus compound, liquid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Hazard Technical Name Required, Potential Inhalation Hazard (Special Provision 5). UN3017 Organophosphorus pesticides, liquid, toxic, flammable, flash point not $<$ 23°C, Hazard class: 6.1; Labels: 6.1-Poisonous materials, 3-Flammable liquid. UN2810 Toxic liquids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling:

Organophosphorus Spill, Liquid

Initial Isolation and Protective Action Distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24 h response line).

Small Spills (from a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30

Then: Protect persons downwind (mi/km)

Day 0.3/0.4

Night 0.8/1.2

Large Spills (from a large package or from many small packages)

First: Isolate in all directions (ft/m) 600/200

Then: Protect persons downwind (mi/km)

Day 1.4/2.3

Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Do not touch spilled material. Do not breathe vapors. Stay upwind; keep out of low areas. Remove all ignition sources. Ventilate area of spill or leak. This material is a combustible liquid. For a spill or leak of a combustible liquid, shut off ignition sources; no flares, smoking or flames in hazard area. Stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: Absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: Dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include sulfur oxides and carbon monoxide. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: The thiono-and thiolo-isomers of this mixture are 50% hydrolyzed in 75 minutes and 0.85 minute, respectively @ 20°C and pH 13. At pH 9 and 70°C, the half-life of Demeton is 1.25 hour, but an pH 1-5 it is over 11 hours. Sand and rushed limestone may be added together with a flammable solvent; the resultant mixture may be burned in a furnace with afterburner and alkaline scrubber[22]. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (2); (80).

United States Environmental Protection Agency, Chemical Hazard Information Profile: *Demeton*, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Demeton*, Trenton, NJ (April 1999)

New York State Department of Health, *Chemical Fact Sheet: Demeton*, Bureau of Toxic Substance Assessment, Albany, NY (April 1986)

Demeton-methyl D:0180

Formula: $C_6H_{15}O_3PS_2$
Synonyms: Bay 15203; Bayer 21/116; Demethon-methyl; Duratox; ENT18,862; *S* (and *O*)-2-(Ethylthio)ethyl *O,O*-dimethyl phosphorothioate; Metasystox; Methyl demeton; Methyl mercaptophos; Methyl systox; Phosphorothioic acid, *O*-2-(ethylthio)ethyl *O,O*-dimethyl ester mixed with *S*-2-(ethylthio)ethyl *O,O*-dimethyl phosphorothioate
CAS Registry Number: 8022-00-2; 919-86-8 (Demeton-S-methyl)
HSDB Number: 6410
RTECS Number: TG1760000
UN/NA & ERG Number: (PIH) UN3018 (organophosphorus pesticides, liquid, toxic)/152; UN2810 (toxic liquid, organic, n.o.s.)/153
EC Number: 212-758-2 [*Annex I Index No.:* 015-031-00-5] (*S*-methyl); 212-758-1 [*Annex I Index No.:* 015-030-00-X] (*O*-methyl)
Regulatory Authority and Advisory Information
Hazard Alert: Poison inhalation hazard, Neurotoxin (cumulative), Combustible, Suspected of causing genetic defects.
Banned or Severely Restricted (Restricted in many countries) (UN)[35]
United States DOT 49CFR172.101, Inhalation Hazardous Chemical, as organic phosphate, Substance ID: EDF-041.
Hazard symbols, risk, & safety statements: Hazard Symbol (*S*-methyl): T, N; risk phrases: R24/25; R28; R33; R51/53; R62; safety phrases: S1/2; S28; S36/37; S41; S45; S61 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): No value found. [2-Hazard to waters (est.)]
Description: Demeton-methyl is a colorless to pale yellow oily liquid. Unpleasant odor. It is a mixture of Demeton-S and Demeton-O and may be formulated in a flammable organic solvent that may alter the physical properties shown here. Molecular weight = 230.30. Specific gravity (H_2O:1) = 1.2; boiling point = decomposes < 100°C. Hazard identification (based on NFPA-704M Rating System): Health 2, Flammability 2, Reactivity 0. Slightly soluble in water; solubility = 0.03%−0.3% @ 20°C.
Potential Exposure: An organophosphate insecticide. Those engaged in the manufacture, formulation and application of the insecticide and acaricide on agricultural and horticultural crops.
Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides. Strong oxidizers may cause release of toxic phosphorus oxides. Organophosphates, in the presence of strong reducing agents such as hydrides, may form highly toxic and flammable phosphine gas. Keep away from alkaline materials.
Permissible Exposure Limits in Air
OSHA PEL: None
NIOSH REL: 0.5 milligram per cubic meter TWA [skin]
ACGIH TLV[1]: 0.05 milligram per cubic meter TWA [skin] inhalable fraction and vapors (2006); BEI: methemoglobin in blood; 1.5% of hemoglobin, during or end-of-shift as methemoglobin inducers.
919-86-8, Demeton-S-methyl
PAC Ver. 29[138]
PAC-1: 0.45 milligram per cubic meter
PAC-2: 5 milligram per cubic meter
PAC-3: 22 milligram per cubic meter
DFG MAK: 0.5 ppm/4.8 milligram per cubic meter TWA; Peak Limitation Category II(2) [skin]
Australia: TWA 0.5 milligram per cubic meter, [skin], 1993; Austria: MAK 0.05 ppm (0.5 milligram per cubic meter), [skin], 1999; Belgium: TWA 0.5 milligram per cubic meter, [skin], 1993; France: VME 0.5 milligram per cubic meter, [skin], 1999; Russia: STEL 0.1 milligram per cubic meter, [skin], 1993; Switzerland: MAK-W 0.05 ppm (0.5 milligram per cubic meter), [skin], 1999; the Netherlands: MAC-TGG 0.5 milligram per cubic meter, [skin], 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: TWA 0.5 milligram per cubic meter [skin]
Determination in Air: None listed. Use NIOSH Analytical Method (IV) Method #5600, Organophosphorus Pesticides.
Determination in Water: No criteria set. Octanol-water coefficient: Log $K_{ow} = 1.3$. Unlikely to bioaccumulate in marine organisms.
Routes of Entry: Inhalation; skin absorption.
Harmful Effects and Symptoms
Short-Term Exposure: Methyl demeton can be fatal by skin contact even if there is no feeling of irritation. Exposure can cause rapid, fatal organophosphate poisoning. Acute exposure to this chemical may produce the following signs and symptoms: pinpoint pupils; blurred vision; headache, dizziness, and muscle spasms; profound weakness; vomiting, diarrhea, and abdominal pain; loss of coordination; seizures, coma, and death. The heart rate may decrease following oral exposure or increase following dermal exposure. Hypotension (low blood pressure) is not uncommon. Respiratory symptoms include dyspnea (shortness of breath), respiratory depression, and respiratory paralysis. Psychosis may occur. Eye contact may cause irritation.
Long-Term Exposure: May cause mutations. In animal studies this chemical causes a decrease in fertility and is toxic to the animal fetus. See also "Demeton" entry.
Points of Attack: Respiratory system, lungs, CNS, cardiovascular system, skin, eyes, plasma, and red blood cell cholinesterase.
Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below pre-employment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider CBC. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Effects may be delayed; medical observation is recommended.

Note to Physician: 1,1′-trimethylenebis(4-formylpyridinium bromide)dioxime (a.k.a. TMB-4 dibromide and TMV-4) has been used as an antidote for organophosphate poisoning. Contact local poison control center for additional guidance.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: SCBA > 0.45 milligram per cubic meter. None specifically listed by NIOSH for Methyl Demeton. *Herewith, for reference only, is the requirement for (8065-48-3) Demeton*: 1 milligram per cubic meter: Sa (APF = 10) (any supplied-air respirator). 2.5 milligram per cubic meter: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). 5 milligram per cubic meter: SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). 10 milligram per cubic meter: Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type SCBA).

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. See "Demeton" for guidance.

Shipping: UN3018 Organophosphorus pesticides, liquid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN2810 Toxic liquids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling:

Initial Isolation and Protective Action Distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24 h response line).

Small Spills (from a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.3/0.4
Night 0.8/1.2

Large Spills (from a large package or from many small packages)

First: Isolate in all directions (ft/m) 600/200
Then: Protect persons downwind (mi/km)
Day 1.4/2.3
Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Do not touch spilled material. Do not breathe vapors. Stay upwind; keep out of low areas. Remove all ignition sources. Ventilate area of spill or leak. This material is a combustible liquid. For a spill or leak of a combustible liquid, shut off ignition sources; no flares, smoking or flames in hazard area. Stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: Absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: Dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include hydrogen chloride and oxides of phosphorus, sulfur, nitrogen and carbon. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Alkaline hydrolysis or incineration[22]. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (2); (100).

Sax N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 68−69 (1981). (As Meta-Systox)

United States Environmental Protection Agency, Chemical Hazard Information Profile: *Demeton-S-Methyl*, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Methyl Demeton*, Trenton, NJ (April 1999)

Desmedipham D:0185

Formula: $C_{16}H_{16}N_2O_4$

Synonyms: Betanal-475; Betanal AM; Betanex; Betamix 70 WP; Betanex 70 WP; Carbamic acid, *N*-phenyl-, 3-[(ethoxycarbonyl)amino]phenyl ester; *m*-Carbaniloyloxycarbanilic acid ethyl ester; 3-[(Ethoxycarbonyl)amino]phenyl *N*-phenylcarbamate; Ethyl *m*-hydroxycarbanilate carbanilate; Ethyl phenylcarbamoyloxyphenylcarbamate; EP 475; Phenylcarbamoyloxyphenylcarbamate; Progress; Schering 38107; SN-475; SN-38107

CAS Registry Number: 13684-56-5

RTECS Number: FD0425000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171; UN2757 (carbamate pesticides, solid, toxic)/151

EC Number: 237-198-5 [*Annex I Index No.:* 616-113-00-9]

Human toxicity (long term)(101): Very low—280.00 ppb, Health advisory

Regulatory Authority and Advisory Information

Carcinogenicity: EPA Group E, Evidence of noncarcinogenicity for humans.

Hazard Alert: Poison, Agricultural chemical.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%

Hazard symbols, risk, & safety statements: Hazard symbol: N; risk phrases: R33; R50/53; safety phrases: S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Colorless, crystalline solid. Molecular weight = 300.34; boiling point = (decomposes); freezing/melting point = 120°C; vapor pressure = 2.9×10^{-9} mmHg @ 20°C. Low solubility in water.

Potential Exposure: A postemergence bis-carbamate herbicide used on sugarbeets to control annual weeds such as pigweed, wild mustard, lamb's quarters, nightshade, chickweed, buckwheat, goosefoot, ragweed, fiddleneck, and kochia.

Incompatibilities: Esters with acids to liberate heat along with alcohols and acids. Strong oxidizing acids may cause a vigorous reaction that is sufficiently exothermic to ignite the reaction products. Heat is also generated by the interaction of esters with caustic solutions. Flammable hydrogen is generated by mixing esters with alkali metals and hydrides. Carbamates are incompatible with reducing agents, strong acids, oxidizing acids, peroxides, and bases. Contact with active metals or nitrides cause the release of flammable, and potentially explosive, hydrogen gas. Forms Carbon monoxide and toxic nitrogen oxides when heated to decomposition.

Determination in Air: Filter; none; Gravimetric; NIOSH IV [Particulates NOR; #0500 (total), #0600 (respirable)][18].

Determination in Water: Octanol-water coefficient: Log $K_{ow} = 3.4$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood. Fish toxicity (threshold)(101): Low—225.68038 ppb, MATC (Maximum Acceptable Toxicant Concentration)

Routes of Entry: Skin absorption, ingestion, inhalation

Harmful Effects and Symptoms

Short-Term Exposure: Eye pupils are small; blurred vision; eye watering; runny nose; cough; shortness of breath; salivation; nausea, stomach cramps, diarrhea, and vomiting; increased blood pressure; profuse sweating; hypermotility, hallucinations; agitation; tingling of the skin; slow heartbeat; convulsions; fluid in lungs; loss of consciousness; incontinence; breathing stops; death. Carbamate insecticides inhibit the cholinesterase activity of enzymes, causing accumulation of acetylcholine at synapses and altering the way in which nervous impulses are transmitted. However, within several hours carbamates spontaneously detach from the enzymes. LD_{50} (oral, rat) = >4500 mg/kg.

Long-Term Exposure: A potent acetylcholinesterase (AChE) inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause dermatitis; liver damage.

Points of Attack: Respiratory system, lungs, CNS, cardiovascular system, skin, eyes, plasma, and red blood cell cholinesterase

Medical Surveillance: Preliminary medical exam to detect chronic diseases of CNS, liver, heart, kidneys, lung, and skin, as well as endocrinological or immunological disturbances, should protect susceptible individuals. Periodical medical exams of internal organs, skin and eyes are important to avoid chronic occupational intoxications. They should include lab and patch tests when necessary[83]. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a drug or other inhalation therapy. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. Before employment and at regular times after that, the following are recommended: Plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When acetylcholinesterase enzyme levels are reduced by 25% or more below pre-employment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider CBC and chest x-ray following acute overexposure

First Aid: Speed in removing material from eyes and skin is of extreme importance. *Eyes:* Eye contact can cause dangerous amounts of these chemicals to be quickly absorbed through the mucous membrane into the bloodstream. Immediately and gently flush eyes with plenty of warm or cold water (NO hot water) for at least 15 minutes, occasionally lifting the upper and lower eyelids. Get medical aid immediately. *Skin:* Get medical aid. Dermal contact can cause dangerous amounts of these chemicals to be absorbed into the bloodstream. Wearing the appropriate PPE equipment and respirator for carbamate pesticides, immediately flush skin with plenty of soap and water for at least 15 minutes while removing contaminated clothing and shoes. Shampoo hair promptly if contaminated; protect eyes. *Ingestion:* Call poison control. Loosen all clothing. Never give anything by mouth to an unconscious person. Get medical aid. Do NOT induce vomiting. *If conscious, alert, and able to swallow, rinse mouth and have victim drink four to eight ounces of water. Check to see if poison control instructs you to use ipecac syrup, otherwise administer slurry of activated charcoal (2 oz in 8 oz of water). If victim is *UNCONSCIOUS OR HAVING CONVULSIONS*, do nothing except keep victim warm. **In some cases you may be specifically instructed by poison control to induce vomiting by way of two tablespoons of syrup of ipecac (adult) washed down with a cup of water.* Do NOT give activated charcoal before or with ipecac syrup. *Inhalation:* Get medical aid. Do not contaminate yourself. Wearing the appropriate PPE equipment and respirator for carbamate pesticides, immediately remove the victim from the contaminated area to fresh air. If the victim is not breathing, administer artificial respiration. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. If breathing is difficult, administer oxygen through bag/mask apparatus until medical help arrives. Do not leave victim unattended. *Note to physician or authorized medical personnel.* Administer atropine, 2 mg (1/30 gr) intramuscularly or intravenously as soon as any local or systemic signs or symptoms of an intoxication are noted; repeat the administration of atropine every 3 to 8 minutes until signs of atropinization (mydriasis, dry mouth, rapid pulse, hot and dry skin) occur; initiate treatment in children with 0.05 mg mg/kg of atropine; repeat at five to 10 minute intervals. Watch respiration, and remove bronchial secretions if they appear to be obstructing the airway; intubate if necessary. *Medical note:* 2-PAMCI may be contraindicated in the case of some carbamate poisonings.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of dermal contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. DuPont Tychem suit fabrics[88]. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At concentrations above the NIOSH REL, or where there is no REL, at any detectable* *concentration:* SCBAF:Pd,Pp (APF = 10,000): (any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus). *Escape*: GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type SCBA).

Storage: Color code-Blue: Health Hazard/Poison. Store in a secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong alkalis (i.e., Sodium Hydroxide, Sodium Bicarbonate, etc.).

Shipping: UN2757 Carbamate pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: For solids, isolate spill or leak area in all directions for at least 25 m/75 ft. Increase, in the downwind direction, as necessary. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Stop leak if you can do it without risk. Prevent entry into waterways, sewers, basements or confined areas. Cover with plastic sheet to prevent spreading. Absorb or cover with dry earth, sand or other noncombustible material and transfer to containers. Do not allow water to get inside containers.

Fire Extinguishing: Decomposes above 230°C releasing toxic carbons of nitrogen and carbon. *On small fire*, use dry chemical powder, carbon dioxide, water spray, or foam. *On large fire*, use water spray, fog or alcohol-resistant foam. Do not scatter material using straight water jet streams. Dike fire control water for later disposal; do not scatter the material. Move containers from fire area if you can do it without risk. *Fire involving storage or vehicular tanks:* Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Do not allow water to get inside containers. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. *Always* stay away from tanks engulfed in fire. For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn.

Disposal Method Suggested: Do not discharge into drains or sewers. Dispose of waste material as hazardous waste using a licensed disposal contractor to an approved landfill. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Incineration with effluent gas scrubbing is recommended. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (100).

Pesticide Management Education Program, "*Desmedipham (Betanex) Herbicide Profile 3/85*," Cornell University, Ithaca, NY (March 1985). http://pmep.cce.cornell.edu/profiles/herb-growthreg/dalapon-ethephon/desmedipham/herb-prof-desmedipham

United States Environmental Protection Agency, Office of Pesticide Programs, "*Pesticide Residue Limits: Desmedipham,*" 40 CFR 180.353. www.epa.gov/pesticides/food/viewtols.htm

2,4-DES-sodium D:0190

Formula: $C_8H_7Cl_2NaO_5$; $Cl_2C_6H_3O(CH_2)_2OSO_3Na$

Synonyms: Crag herbicide 1; Crag Sesone; 2,4-Des-Na; 2,4-Des-natrium (German); 2-(2,4-Dichlorophenoxy)ethanol hydrogen sulfate sodium salt; 2,4-Dichlorophenoxyethyl sulfate, sodium salt; Disul; Disul-NA; Disul-sodium; Natrium-2,4-dichlorphenoxyathylsulfat (German); SES; Sesone; Sodium-2-(2,4-dichlorophenoxy)ethyl sulfate; Sodium-2,4-dichlorophenoxyethyl sulfate; Sodium-2,4-dichlorophenyl cellosolve sulfate

CAS Registry Number: 136-78-7

HSDB Number: 2522 as sdium-2,4-dichlorophenoxyethyl sulfate

RTECS Number: KK4900000

UN/NA & ERG Number: UN3345/153

EC Number: 205-259-5 [*Annex I Index No.:* 016-025-00-5]

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Primary irritant (w/o allergic reaction). Hazard symbols, risk, & safety statements: Hazard symbol: Xn; risk phrases: R22; R38; R41; safety phrases: S2; S26; S41 (see Appendix 4)

Description: Sesone or Crag pesticide is a colorless, odorless, and crystalline solid. It's a noncombustible solid, but commercial products may be formulated using flammable organic solvents, which can change the physical properties shown here. Molecular weight = 309.13; freezing/melting point = 245°C (decomposes); vapor pressure = 0.1 mmHg. Hazard identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Soluble in water; solubility = 26% @ 25°C.

Potential Exposure: Used as corrosion inhibitor, pharmaceutical intermediate and emulsifier. A potential danger to those involved in manufacture, formulation and application of this herbicide as well as citizens in the area of application.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides.

Permissible Exposure Limits in Air

NIOSH IDLH = 500 milligram per cubic meter as Crag herbicide

OSHA PEL: 15 milligram per cubic meter TWA, total dust; 5 milligram per cubic meter TWA, respirable fraction
NIOSH REL: 10 milligram per cubic meter TWA, total dust; 5 milligram per cubic meter TWA, respirable fraction
ACGIH TLV[1]: 10 milligram per cubic meter TWA; Not Suspected as a Human carcinogen, as Sesone
PAC not available
Russia: STEL 5 milligram per cubic meter [skin] 1993; United Kingdom: TWA 2 ppm (7.4 milligram per cubic meter); STEL 6 ppm (22 milligram per cubic meter), 2000; the Netherlands: MAC-TGG 7.4 milligram per cubic meter, 2003. Several states have set guidelines or standards for sesone in ambient air[60] ranging from 100 μ/m^3 (North Dakota) to 160 μ/m^3 (Virginia) to 200 μ/m^3 (Connecticut) to 238 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method #S-356 (II-5).

Routes of Entry: Inhalation, ingestion skin and eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates eyes, skin, and respiratory tract. High levels of exposure may cause CNS effects, convulsions. May affect the kidneys and liver.

Long-Term Exposure: May cause liver and kidney damage.

Points of Attack: Eyes, skin, CNS, liver, and kidneys.

Medical Surveillance: liver function. Kidney function. Tests of nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: 50 milligram per cubic meter: Qm (APF = 25) (any quarter-mask respirator (N, R, or P filters). 100 milligram per cubic meter: Any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100; or Sa (APF = 10) (any supplied-air respirator). 250 milligram per cubic meter: PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter); or Sa:Cf (APF = 25) (any powered, air-purifying respirator with a dust and mist filter). 500 milligram per cubic meter: 100 F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAF (APF = 50) (any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter*; or SaF (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode*; PaprTHie (APF = 50) (any SCBA with a full facepiece); or SaT: Cf (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode.) *Escape:* 100 F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type SCBA). *Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area away from oxidizers and acids. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: UN3345 Phenoxyacetic acid derivative pesticide, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Thermal decomposition products may include oxides of nitrogen and carbon If material or contaminated runoff enters waterways, notify

downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Sesone is hydrolyzed by alkali to $NaHSO_4$ and apparently dichlorophenoxyethanol. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (2).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Sesone*, Trenton, NJ, (October 2001).

Diacetone Alcohol D:0200

Formula: $C_6H_{12}O_2$: $(CH_3)_2C(OH)CH_2COCH_3$

Synonyms: Acetonyldimethylcarbinol; Diacetonalkohol (German); Diacetone-alcool (French); Diacetone, 4-hydroxy-4-methyl-2-pentatone, 2-methyl-2-pentanol-4-one; Diketone alcohol; Dimethylacetonylcarbinol; 4-Hydroxy-2-keto-4-methylpentane; 4-Hydroxyl-2-keto-4-methylpentane; 4-Hydroxy-4-methyl-pentan-2-on (German); 4-Hydroxy-4-methyl-2-pentanone; 4-Hydroxy-4-methylpentan-2-one; 4-Methyl-4-hydroxy-2-pentanone; 2-Methyl-2-pentanol-4-one; 2-Pentanone, 4-hydroxy-4-methyl-; tyranton

CAS Registry Number: 123-42-2

HSDB Number: 1152 as 4-hdroxy-4-methyl-2-pentanone

RTECS Number: SA9100000

UN/NA & ERG Number: UN1148/129

EC Number: 204-626-7 [*Annex I Index No.:* 603-016-00-1]

Regulatory Authority and Advisory Information

Hazard Alert: Combustible/Flammable (technical), Primary irritant (w/o allergic reaction), Vapor may have a narcotic effect.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xi; risk phrases: R10; R36/37/38; safety phrases: S2; S24/25; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Diacetone alcohol is a colorless liquid. Mild, mint odor. Molecular weight = 116.18; specific gravity (H_2O:1) = 0.93; boiling point = 164°C; freezing/melting point = −46.8°C; vapor pressure = 1.1 mmHg @ 20°C; flash point = 64°C; 58°C (acetone free); 64°C (commercial grade). Explosive limits: LEL: 1.8%; UEL: 6.9%. Hazard identification (based on NFPA-704 M Rating System): Health 1, Flammability 2, Reactivity 0. Soluble in water.

Potential Exposure: It is used as a solvent for pigments, cellulose esters; oils and fats. It is used in hydraulic brake fluids and in antifreeze formulations.

Incompatibilities: Vapor may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides.

Permissible Exposure Limits in Air

NIOSH IDLH = 1800 ppm [LEL]

Conversion factor: 1 ppm = 4.75 milligram per cubic meter @ 25°C & 1 atm

Odor threshold = 0.28 ppm.

OSHA PEL: 50 ppm/240 milligram per cubic meter TWA

NIOSH REL: 50 ppm/240 milligram per cubic meter TWA

ACGIH TLV[1]: 50 ppm/238 milligram per cubic meter TWA

PAC Ver. 29[138]

PAC-1: 150 ppm

PAC-2: 350 ppm

PAC-3: 2100 ppm

DFG MAK: 20 ppm/96 milligram per cubic meter TWA; Peak Limitation Category I(2) [skin] Pregnancy Risk Group D

Australia: TWA 50 ppm (240 milligram per cubic meter), 1993; Austria: MAK 50 ppm (240 milligram per cubic meter), 1999; Belgium: TWA 50 ppm (238 milligram per cubic meter), 1993; Finland: TWA 50 ppm (240 milligram per cubic meter); STEL 75 ppm (360 milligram per cubic meter), 1999; France: VME 50 ppm (240 milligram per cubic meter), 1999; Norway: TWA 25 ppm (120 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 120 milligram per cubic meter, 2003; Russia: STEL 100 milligram per cubic meter, 1993; Sweden: NGV 25 ppm (120 milligram per cubic meter), KTV 20 ppm (240 milligram per cubic meter), 1999; Switzerland: MAK-W 50 ppm (240 milligram per cubic meter), 1999; Turkey: TWA 50 ppm (240 milligram per cubic meter), 1993; United Kingdom: TWA 50 ppm (241 milligram per cubic meter); STEL 75 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: TWA 50 ppm. Several states have set guidelines or standards for diacetone alcohol in ambient air[60] ranging from 0.03 milligram per cubic meter (Nevada) to 2.4−3.6 milligram per cubic meter (North Dakota) to 4.0 milligram per cubic meter (Virginia) to 4.8 milligram per cubic meter (Connecticut).

Determination in Air: Use NIOSH Analytical Method #1402, Method #1405, or OSHA Analytical Method 7.

Routes of Entry: Inhalation, ingestion, and skin and eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin, and respiratory tract. Eye contact can cause corneal tissue damage. Contact can irritate the skin, causing a burning sensation. It can cause you to become dizzy, lightheaded, and to pass out.

Long-Term Exposure: Repeated contact may lead to skin rash. Exposure may damage the liver, kidneys and the blood cells. Although there is no evidence involving this chemical, many similar solvents can cause nerve and brain damage.

Points of Attack: Eyes, skin, and respiratory system.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function tests. CBC. NIOSH lists: Expired Air; pulmonary function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. 8 hours (more than 8 hours of resistance to breakthrough $> 0.1\ \mu g/cm^2/min$): butyl rubber gloves, suits, and boots; 4 hours (At least 4 but < 8 hours of resistance to breakthrough $> 0.1\ \mu g/cm^2/min$): Noeprene rubber gloves, suits, and boots; 4H and Silver Shield gloves. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Neoprene and polyvinyl chloride are among the recommended protective materials. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: 1250 ppm: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]. 1800 ppm: CcrFOv (APF = 50) [any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s)]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted acid gas canister]; or PaprTOv (APF = 50) [any powered, air-purifying respirator with a tight-fitting facepiece and organic vapor cartridge(s)]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-, mounted organic vapor canister]; or SCBAE (any appropriate escape-type SCBA). *Note:* Substance causes eye irritation or damage; eye protection needed.

Storage: Color code-Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Diacetone alcohol must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine) or strong alkalis (such as sodium hydroxide or potassium hydroxide), since violent reactions occur. Store in tightly closed containers in a cool well-ventilated area away from heat. Sources of ignition, such as smoking and open flames are prohibited where diacetone alcohol is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of five gallons or more of diacetone alcohol should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters.

Shipping: UN1148 Diacetone alcohol, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (2); (100).

National institute for Occupational Safety and Health (NIOSH), "*Criteria for a Recommended Standard: Occupational Exposure to Ketones*," NIOSH Document Number 78-173, Cincinnati OH (1978)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Diacetone Alcohol*, Trenton, NJ (May 2003)

Dialifor D:0210

Formula: $C_{14}H_{17}ClNO_4PS_2$

Synonyms: *n*-[2-Chloro-1-(diethoxyphosphinpthioylthio) ethyl]phthalimide; *S*-[2-Chloro-1-(1,3-dihydro-1,3-dioxo-2H-isoindol-2-yl)ethyl] *O,O*-diethyl phosphorodithioate; *S*-(2-Chloro-1-phthalimidoethyl) *O,O*-diethyl phosphorodithioate; Dialifos; *O,O*-Diethyl *S*-(2-chloro-1-phthalimidoethyl) phosphorodithioate; *O,O*-Diethyl phosphorodithioate *S*-ester with *n*-(2-chloro-1-mercaptoethyl) phthalimide; ENT 27,320; Hercules 14503; Phosphorodithioic acid, *S*-[2-chloro-1-(1,3-dihydro-1,3-dioxo-2H-isoindol-2-yl)ethyl] *O,O*-diethyl ester; Phosphorodithioic acid, 5-[2-chloro-1-(1,3-dihydro-1,3-dioxo-2H-isoindol-2-yl)ethyl] *O,O*-diethyl ester; Phosphorodithioic acid, *S*-(2-chloro-1-phthalimidoethyl) *O,O*-diethyl ester; Torak

CAS Registry Number: 10311-84-9

HSDB Number: 1559

RTECS Number: TD5165000

UN/NA & ERG Number: (PIH) UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 233-689-3 [*Annex I Index No.:* 015-088-00-6]

Regulatory Authority and Advisory Information

Hazard Alert: Poison inhalation hazard, Possibly fatal if swallowed, Suspected reprotoxic hazard, Environmental hazard, Agricultural chemical.

Banned or Severely Restricted (Malaysia, Germany)[13]

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), severe pollutant, as Dialifos

United States DOT 49CFR172.101, Inhalation Hazardous Chemical, as organic phosphate, Substance ID: EDF-041.

Hazardous to aquatic life or environment, with possible long lasting effects[291,292].

Hazard symbols, risk, & safety statements: Hazard symbol: T+, N; risk phrases R24; R28; R33; R50/53; R63; safety phrases: S1/2; S28; S29/35; S36/37; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Dialifor is a crystalline solid. The commercial product may also be available as a colorless oil. Molecular weight = 393.86; freezing/melting point (solid) = 68°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Insoluble in water.

Potential Exposure: A potential danger to those involved in the manufacture, formulation and application of this insecticide.

Incompatibilities: Strong bases. Contact with oxidizers may cause the release of phosphorous oxides. Contact with strong reducing agents, such as hydrides, may cause the formation of flammable and toxic phosphine gas.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 0.45 milligram per cubic meter

PAC-2: 5 milligram per cubic meter

PAC-3: 39 milligram per cubic meter

Determination in Air: No method available.

Determination in Water: Octanol-water coefficient: Log $K_{ow} = > 4.5$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, skin absorption, and ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: This material is highly toxic (the LD_{50} for rats is 5 mg/kg). Ingestion can be fatal. This material can cause serious symptoms, and in extreme cases, death by respiratory arrest. Organic phosphorus insecticides are absorbed by the skin, as well as by the respiratory and GI tracts. They are cholinesterase inhibitors. Symptoms of exposure include headache, giddiness; blurred vision; nervousness, weakness, nausea, cramps, diarrhea, and discomfort in the chest. Signs include sweating, tearing, salivation, vomiting, cyanosis, convulsions, coma, loss of reflexes and loss of sphincter control.

Long-Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, CNS, cardiovascular system, skin, eyes, plasma, and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When cholinesterase enzyme levels are reduced by 25% or more below pre-employment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider CBC. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/ manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type SCBA).

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with dialifor all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area away from strong bases.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft[70]. Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Thermal decomposition products may include phosphorus, sulfur, and nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Alkaline hydrolysis or incineration. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (80); (100).

Sax N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 2, No. 5, 43–45 (1982)

United States Environmental Protection Agency, Chemical Hazard Information Profile: *Dialifor*, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

Diallate D:0220

Formula: $C_{10}H_{17}Cl_2NOS$; $[(CH_3)_2CH]_2NCOSCH_2CCl = CHCl$

Synonyms: Avadex; Bis(1-methylethyl)carbamothioic acid, *S*-(2,3-dichloro-2-propenyl) ester; Carbamothioic acid, bis(1-methylethyl) *S*-(2,3-dichloro-2-propenyl) ester; CP 15,336; DATC; 2,3-DCDT; Diallat (German); Di-allate; Diallate carbamate herbicide; *S*-(2,3-Dichloroallyl) diisopropylthiocarbamate; *S*-2,3-Dichloroallyl di-isopropyl (thiocarbamate); *S*-2,3-Dichloroallyl diisopropylthiocarbamate; *S*-2,3-Dichloroallyldiisopropyl thiocarbamate; Dichloroallyldiisopropyl thiocarbamate; 2,3-Dichloroallyl *N*,*N*-Diisopropylthiolcarbamate; 2,3-Dichloro-2-propene-1-thiol, isopropylcarbamate; *S*-(2,3-Dichloro-2-propenyl)bis (1-methylethyl) carbamothioate; Diisopropylthiocarbamic acid,-(2,3-dichloroallyl) ester; Di-isopropylthiolocarbamate des-(2,3-dichloro allyle) (French); 2-Propene-1-thiol, 2,3-dichloro-, diisopropylcarbamate

CAS Registry Number: 2303-16-4

HSDB Number: 1566

RTECS Number: EX8225000

UN/NA & ERG Number: UN2902 (Pesticides, liquid, toxic, n.o.s)/151

EC Number: 218-961-1 [*Annex I Index No.:* 006-019-00-0]

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Agricultural chemical, Environmental hazard.

Carcinogenicity: IARC: Animals Sufficient Evidence; Human No Adequate Data, Group 3, 1998

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U062

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

Hazardous to aquatic life or environment, with possible long lasting effects[291,292].

Hazard symbols, risk, & safety statements: Hazard symbol: N, Xn; risk phrases: R20; R36/37/38; R51/53; safety phrases: S16; S26; S29/35; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)]

Description: Diallate is a brown liquid. Molecular weight = 270.21; boiling point = 150°C @ 9 mmHg; freezing/melting point = 25°C–30°C. Decomposes >200°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. Slightly soluble in water; solubility = 14 mg/L @ 25°C.

Potential Exposure: A thiocarbamate herbicide. The slow release of poisonous gases from hydrolysis of many thio and dithiocarbamates requires the use of respirators during handling. Poisoning can also occur by ingestion and absorption through the skin. Diallate is potential danger to those involved in the manufacture, formulation and application of this re-emergence herbicide.

Incompatibilities: Thiocarbamate esters are combustible. They react violently with powerful oxidizers such as calcium hypochlorite. Poisonous gases are generated by the thermal decomposition of thiocarbamate compounds, including carbon disulfide, oxides of sulfur, oxides of nitrogen, hydrogen sulfide, ammonia, and methylamine. Many materials in this group slowly decompose in aqueous solution to form carbon disulfide and methylamine or other amines. Such decompositions are accelerated by acids. Flammable gases are generated by the combination of thiocarbamates with aldehydes, nitrides, and hydrides. Thiocarbamates are incompatible with acids, peroxides, and acid halides.

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Permissible Concentration in Water: Russia[43] set a MAC of 0.03 mg/L in water used for domestic purposes[35],[43].

Routes of Entry: Ingestion, inhalation, absorption through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Eye contact can irritate and possibly cause burns. Inhalation caused irritation of the respiratory tract with chest tightness and/or difficulty breathing. Higher levels can affect the nervous system. With nausea, vomiting, diarrhea, abdominal pain; reduced muscle coordination; blurred vision; muscle twitching; convulsions, coma and possible death.

Long-Term Exposure: High or repeated exposures can cause liver and kidney damage. There is limited evidence that diallate causes liver cancer in animals.

Points of Attack: Skin, eyes, and nervous system.

Medical Surveillance. Lung function tests. Kidney and liver function tests. Examination of the nervous system. Interview exposed person for brain effects, including memory, mood, concentration, headaches, malaise, and altered sleep patterns.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least

15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type SCBA).

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with diallate all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area away from alkalies. Where possible, automatically pump liquid from drums or other storage containers to process containers. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2992 Carbamate pesticides, liquid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include sulfur oxides, nitrogen oxides, and chlorides. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Land burial is acceptable for small quantities. Larger quantities can be incinerated[22]. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (173); (101); (138); (100).

Sax N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 3, No. 1, 50−53 (1983)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Diallate*, Trenton, NJ (April 2004)

2,4-Diaminoanisole D:0230

Formula: $C_7H_{10}N_2O$; $H_3COC_6H_3(NH_2)_2$

Synonyms: 3-Amino-4-methoxyaniline; 1,3-Benzenediamine, 4-methoxy-; C.I. 76050; C.I. Oxidation base 12; 2,4-DAA;

2,4-Diamineanisole; *m*-Diaminoanisole; 2,4-Diaminoanisole; 1,3-Diamino-4-methoxybenzene; 2,4-Diamino-1-methoxybenzene; 2,4-Diaminophenyl methyl ether; Furro L; 4-Methoxy-1,3-benzenediamine; *p*-Methoxy-*m*-phenylenediamine; 4-Methoxy-*m*-phenylenediamine; 4-Methoxy-1,3-phenylenediamine; 4-MMPD; Pelagol DA; Pelagol grey L; Pelagol L; *m*-Phenylenediamine, 4-methoxy-*sulfate:* Anisole, 2,4-diamino-, hydrogen sulfate; Anisole, 2,4-diamino-, sulfate; 1,3-Benzenediamine, 4-methoxy, sulfate (1:1); C.I. 76051; C.I. Oxidation base 12A; 2,4-DAA Sulfate; 2,4-Diaminoanisole sulfate; 2,4-Diaminoanisole sulfate; 2,4-Diamino-anisol sulfate; 2,4-Diamino-1-methoxybenzene; 1,3-Diamino-4-methoxybenzene sulfate; 2,4-Diamino-1-methoxybenzene sulfate; 2,4-Diaminosole sulfate; Durafur brown MN; Fouramine BA; Fourrine 76; Fourrine SLA; Furro SLA; 4-Methoxy-1,3-benzenediamine sulfate; 4-Methoxy-1,3-benzenediamine sulfate (1:1); 4-Methoxy-1,3-benzenediamine sulfate; 4-Methoxy-*m*-phenylenediamine sulfate; *p*-Methoxy-*m*-phenylenediamine sulfate; 4-Methoxy-*m*-phenylenediamine sulfate; 4-MMPD sulfate; NAKO TSA; NCI-C01989; Oxidation base 12A; Pelagol BA; Pelagol grey; Pelagol grey SLA; Pelagol SLA; Renal SLA; Ursol SLA; Zoba SLE

CAS Registry Number: 615-05-4; 39156-41-7 (sulfate)

HSDB Number: 4130

RTECS Number: ST2690000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154; UN3143 (Dyes, solid, toxic, n.o.s./151[or] Dye intermediates, solid, toxic, n.o.s.)/151;

EC Number: 210-406-1 [*Annex I Index No.:* 612-200-00-0]; 54-323-9 [*Annex I Index No.:* 612-200-00-0] (sulfate)

Regulatory Authority and Advisory Information

615-05-4

Carcinogenicity: IARC: Human No Evidence, animal Sufficient Evidence*, possibly carcinogenic to humans*, Group 2B, 1998.

California Proposition 65 Chemical[102]: Cancer 10/1/1990

Hazard Alert: Poison, Suspected of causing genetic defects, Environmental hazard

39156-41-7 (sulfate); NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen

Banned or Severely Restricted (Sweden)[35]

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1% (sulfate, carcinogen)

Hazardous to aquatic life or environment, with possible long lasting effects[293]. Toxic to aquatic life with long lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard Symbol (*includes sulfate*): T, N; risk phrases: R45; R22; R68; R50/53; R62; safety phrases: S29/35; S41; S45; S53; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class) (*615-05-4*): 3-Severe hazard to water.

Description: 2,4-Diaminoanisole is a needle-like solid. Molecular weight = 138.19; freezing/melting point 67°C−68°C. The sulfate is an off-white to violet powder. Molecular weight = 236; boiling point = 150°C @ 5 mmHg; freezing/melting point 66°C−67°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. (includes sulfate). Soluble in water; solubility >1000 g/L @ 25°C.

Potential Exposure: The principal use of 2,4-diamino-anisole (and its salts such as the sulfate) as a component of oxidation (permanent) hair and fur dye formulations. Human exposure to 2,4-diaminoanisole sulfate may possibly occur through skin absorption at chemical and dye production facilities, as well as through dermal contact in persons using hair dyes containing the chemical.

Incompatibilities: Incompatible with strong oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides. The sulfate may react violently with aluminum and magnesium.

Permissible Exposure Limits in Air

NIOSH (*2,4-Diaminoanisole and its salts*): Potential human carcinogen; Reduce exposure to lowest feasible level; See *NIOSH Pocket Guide*, Appendix A

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

DFG MAK: [skin] Carcinogen Category 2

This chemical can be absorbed through the skin, thereby increasing exposure.

Determination in Air: NIOSH Analytical Method #5013, Dyes.

Determination in Water: Octanol-water coefficient: Log K_{ow} = >4. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, passing through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: This chemical can be absorbed through the skin, thereby increasing exposure. Contact may cause irritation and possible eye damage. High exposures to the sulfate can cause poisoning with trembling, diarrhea, trouble breathing and even death.

Long-Term Exposure: The sulfate can cause both skin and lung allergies to develop. There is sufficient evidence for the carcinogenicity of 2,4-diaminoanisole sulfate in experimental animals. In rats, dietary administration of the technical grade 2,4-diaminoanisole sulfate increased the incidence of cancers of the skin and the associated glands; and of thyroid cancers in each sex. In mice, dietary administration of 2,4-diaminoanisole sulfate induced thyroid tumors in each sex. Female rats exposed to technical-grade 2,4-diamonoanisole sulfate in the feed developed tumors of the thyroid, mammary, clitoral, and pituitary glands.

Points of Attack: Skin, eyes, and lungs.

Medical Surveillance: Evaluation by a qualified allergist. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Lung function tests.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Gloves are usually worn by hairdressers when applying hair dyes. Beyond that, NIOSH recommends minimization of exposure. Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type SCBA).

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with 2,4-DAA sulfate all handlers should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used or stored in compliance with OSHA Standard 1910.1045. Store in tightly closed containers in a cool, well ventilated area away from aluminum and magnesium.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN3143 Dyes, solid, toxic, n.o.s. or Dye intermediates, solid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft[70]. Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Thermal decomposition products may include oxides of nitrogen and carbon. The sulfite decomposition products may include oxides of nitrogen, sulfur and carbon. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed[22].

References

(109); (102); (31); (173); (101); (138); (100).

National Institute for Occupational Safety and Health, *2,4-Diaminoanisole in Hair and Fur Dyes*, Current Intelligence Bulletin No. 19, Washington, DC (January 13, 1978)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: 2,4-Diaminoanisole Sulfate*, Trenton, NJ (January 2001).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: 2,4-Diaminoanisole*, Trenton, NJ (July 2001).

4,4-Diamino-diphenyl-methane D:0250

Formula: $C_{13}H_{14}N_2$; $H_2NC_6H_4CH_2C_6H_4NH_2$

Synonyms: 4-(4-Aminobenzyl)aniline; Ancamine TL; Aniline, 4,4′-methylenedi-; Araldite hardener 972; Benzenamine, 4,4′-methylenebis-; Benzenamine, 4,4′-methylenebis-(aniline); Bis-*p*-aminofenylmethan; Bis(*p*-aminophenyl)methane; Bis(4-aminophenyl)methane; Bis (aminophenyl)methane; Curithane; DADPM; DAPM; DDM; DDV; *p,p*'-Diaminodifenylmethan; *p,p*'-Diaminodiphenylmethane; 4,4′-Diaminodiphenylmethane; Diaminodiphenylmethane; Di-(4-aminophenyl)methane; Dianilinemethane; 4,4′-Diphenylmethanediamine; Epicure DDM; Epikure DDM; HT 972; Jeffamine AP-20; MDA; 4,4′-Methylenebis(aniline); Methylenebis(aniline); 4,4′-Methylenebis(Benzeneamine); *p,p*′-Methylenedianiline; Methylenedianiline; 4,4′-Methylenedibenzenamine; 4,4′-Metilendianilina (Spanish); Sumicure M; Tonox

CAS Registry Number: 101-77-9; 13552-44-8 (dihydrochloride salt)

HSDB Number: 2541

RTECS Number: BY5425000

UN/NA & ERG Number: UN2651/153

EC Number: 202-974-4 [*Annex I Index No.:* 612-051-00-1]

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen [4,4′-Methylenedianiline (101-77-9) and its Dihydrochloride (13552-44-8)]; IARC: Human No Adequate Data, animal Sufficient Evidence, *possibly carcinogenic to humans*, Group 2B, 1998; OSHA/NIOSH: Potential human carcinogen.

California Proposition 65 Chemical[102]: Cancer 1/1/1988.

Hazard Alert: Poison, Polymerization hazard, Possible risk of forming tumors, Suspected of causing genetic defects, Sensitization hazard, Primary irritant (w/o allergic reaction), Environmental hazard; *dihydrochloride salt*: Reproductive hazard. Listed for Tier 1 screening as an endocrine disruptor[88].

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR 1910.1050)

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazardous to aquatic life or environment, with possible long lasting effects[293]. Toxic to aquatic life with long lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

European/International Regulations (*101-77-9*): Hazard symbol: T, N, Xi; risk phrases: R45; R19; R36/37/38; R39/23/24/25; R43; R48/20/21/22; R68; R50/53; R62; safety phrases: S53; S29/35; S45; S61; S41 (see Appendix 4)

Hazard symbols, risk, & safety statements: not listed in Annex I (*dichloride salt*).

WGK[100] (German Aquatic Hazard Class) (*101-77-9*): 3-Severe hazard to water.

Description: 4,4'-Diaminodiphenylmethane is a pale yellow crystalline solid (turns light brown on contact with air) with a faint amine-like odor. Molecular weight = 198.26; specific gravity (H_2O:1) = 1.07 @ 103°C; boiling point = 398°C; freezing/melting point = 92.5°C; vapor pressure = 2×10^{-7} mmHg @ 25°C; flash point = 221°C (cc). Hazard identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Slightly soluble in water.

Potential Exposure: Used as an intermediate and as a curing agent. Approximately 99% of the DDM produced is consumed in its crude form (occasionally containing not more than 50% DDM and ply-DDM) at its production site by reaction with phosgene in the preparation of isocyanates and polyisocyanates. These isocyanates and polyisocyanates are employed in the manufacture of rigid polyurethane foams which find application as thermal insulation. Polyisocyanates are also used in the preparation of the semiflexible polyurethane foams used for automotive safety cushioning. DDM is also used as: an epoxy hardening agent; a raw material in the production of polyurethane elastomers; in the rubber industry as a curative for Neoprene and as an antifrosting agent (antioxidant) in footwear; a raw material in the production of Quana nylon; and a raw material in the preparation of poly (amide-imide) resins (used in magnet wire enamels).

Incompatibilities: Dust forms and explosive mixture with air. May polymerize in temperatures >125°C. A weak base. Incompatible with strong oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong acids. Flammable gaseous hydrogen may be generated in combination with strong reducing agents, such as hydrides[101].

Permissible Exposure Limits in Air

OSHA PEL: 0.010 ppm TWA; 0.100 ppm STEL. Potential human carcinogen. See 29CFR1910.1050.

NIOSH REL: Limit exposure to lowest feasible concentration. NIOSH considers this chemical to be a potential occupational carcinogen as defined by the OSHA carcinogen policy [29 CFR 1990]. See *NIOSH Pocket Guide*, Appendix A

ACGIH TLV[1]: 0.1 ppm/0.81 milligram per cubic meter TWA [skin]; confirmed animal carcinogen with unknown relevance to humans.

101-77-9

PAC Ver. 29[138]

PAC-1: 0.1 ppm

PAC-2: 3.4 ppm

PAC-3: 20 ppm

DFG MAK: [skin]; danger of skin sensitization; Carcinogen Category 2; BLW information available.

Australia: TWA 0.1 ppm (0.8 milligram per cubic meter), [skin], 1993; Austria: carcinogen, 1999; Belgium: TWA 0.1 ppm (0.81 milligram per cubic meter), [skin], carcinogen, 1993; Denmark: TWA 0.1 ppm (0.8 milligram per cubic meter), 1999; Japan: 0.4 milligram per cubic meter, [skin], 2B carcinogen, 1999; Norway: TWA 0.1 ppm (0.8 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 0.2 milligram per cubic meter, [skin], 2003; United Kingdom: LTEL 0.1 ppm (0.8 milligram per cubic meter); STEL 0.5 ppm, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: confirmed animal carcinogen with unknown relevance to humans. Several states have set guidelines or standards for MDA in ambient air[60] ranging from zero (North Dakota) to 0.4 μ/m^3 (Kansas) to 0.8 μ/m^3 (Virginia) to 2.67 μ/m^3 (New York) to 4.0 μ/m^3 (South Carolina) to 8.0 μ/m^3 (Connecticut) to 19.0 μ/m^3 (Nevada).

Determination in Air: Use OSHA Analytical Method #ID-57; or, special filter; potassium hydroxide/methanol; high-pressure liquid chromatography/ultraviolet/electrochemical detection; NIOSH Analytical Method (IV) #5029.

Determination in Water: No criteria set. Octanol-water coefficient: Octanol-water coefficient: Log $K_{ow} = 1.6$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, passing through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes. A single large exposure or repeated smaller exposures can cause serious liver disease (toxic hepatitis) with symptoms of fever, upper abdominal pain; jaundice, dark urine; fatigue, and loss of appetite.

Long-Term Exposure: 4,4'-Methylene dianiline can cause liver damage and may damage the kidneys. Repeated or prolonged contact with skin may cause skin sensitization and dermatitis. Causes thyroid and bladder cancer in animals; a possible carcinogen in humans.

Points of Attack: Liver, kidneys, and skin. In animals: bladder cancer.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended: liver function tests. If symptoms develop or overexposure is suspected, the following may be useful: kidney function tests. Evaluation by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: 4,4′-Methylenedianiline (1910.1050 & 1926.60) < or = 10 × PEL: Half-mask respirator with high-efficiency* cartridge**. < or = 50 × PEL: Full-facepiece respirator with high-efficiency* cartridge or canister**. < or = 1000 × PEL: Full-facepiece powered air-purifying respirator with high-efficiency* cartridge**. >1000 × PEL or unknown concentration: (1) SCBA with full facepiece in positive-pressure mode; or (2) Full-facepiece positive-pressure demand supplied-air respirator with auxiliary self-contained air supply. *Escape*: (1) Any full-facepiece air-purifying respirator with high-efficiency* cartridges**; or (2) Any positive-pressure or continuous-flow-SCBA with full facepiece or hood. Firefighting full-facepiece SCBA in positive-pressure demand mode.

* A high-efficiency filter means a filter that is at least 99.97% efficient against mono-dispersed particles of 0.3 μm (micrometers) in diameter or higher.

** Combination High-Efficiency/Organic Vapor Cartridges shall be used whenever Methylenedianiline is in liquid form or a process requiring heat is used.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers (such as chlorine, bromine, and fluorine). A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2651 4,4′-Diaminodiphenyl methane, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Controlled incineration (oxides of nitrogen are removed from the effluent gas by scrubbers and/or thermal devices).

References

(109); (102); (31); (173); (101); (138); (100).

National institute for Occupational Safety and Health (NIOSH), *Current Intelligence Bulletin 47, 4,4'-Methylenedianiline (MDA)*, Cincinnati, Ohio (July 25, 1986)

Occupational Health and Safety Administration (OSHA), "*Occupational Exposure to 4,4'-Methylenedianiline (MDA)*," Federal Register 54, No. 91, 20672−20741 (May 12, 1989)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: 4,4'-Methylene Dianiline*, Trenton, NJ (June 2001).

Diatomaceous Earth D:0260

Formula: O_2Si; SiO_2

Synonyms: Amorphous silica; Diatomaceous silica; Diatomite, uncalcined; Precipitated amorphous silica; Silica, amorphous diatomaceous earth; Silicon dioxide (amorphous)

CAS Registry Number: 61790-53-2; 7631-86-9 (silica, amorphous, hydrated); *(alt.)* 12750-99-1; *(alt.)* 29847-98-1; *(alt.)* 37337-67-0; *(alt.)* 54511-18-1; *(alt.)* 56748-40-4;*(alt.)* 67016-73-3

HSDB Number: 682 as amorphous silica

RTECS Number: HL8600000; VV7311000 (natural)

UN/NA & ERG Number: No citation.

EC Number: 231-545-4 (silicon dioxide)

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Inadequate Evidence; Human Inadequate Evidence*, not classifiable as carcinogenic to humans*, Group 3, 1997; NIOSH (*Silica, amorphous silica, fused*): Potential occupational carcinogen.

Hazard Alert: Possible risk of forming tumors,.

WGK[100] (German Aquatic Hazard Class): Nonhazard to water.

Description: Diatomaceous earth is a transparent to gray, odorless amorphous powder. Molecular weight = 60.78; specific gravity (H_2O:1) = 2.20; boiling point = 2230°C; freezing/melting point = 1710°C. Hazard identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 0. Insoluble in water.

Potential Exposure: Diatomaceous earth is used as a filtering agent and as a filler in construction materials, pesticides, paints, and varnishes. The calcined version (which has been heat treated) is the most dangerous and contains crystallized silica, and should be handled as silica. See also other entries on silica.

Incompatibilities: High temperatures causes the formation of crystalline silica. Incompatible with fluorine, oxygen difluoride, chlorine difluoride.

Permissible Exposure Limits in Air

diatomaceous earth, uncalcined & Silica, amorphous precipitated and gel

OSHA PEL: ***either one of the methods:*** 20 mppcf [millions of particles per cubic foot of air, based on impinger samples counted by light-field techniques] **or** 80 milligram per cubic meter divided by the value "%SiO2," TWA

NIOSH REL: 6 milligram per cubic meter TWA

ACGIH TLV[1]: withdrawn for the following: *silica amorphous, precipitated and gel; silica fume; silica fused; diatomaceous earth, calcined.*

NIOSH IDLH = 3000 milligram per cubic meter

PAC Ver. 27; No values found in Ver. 29[138]

Diatomaceous earth (flux calcinated)

PAC-1: 0.9 milligram per cubic meter

PAC-2: 9.9 milligram per cubic meter

PAC-3: 59 milligram per cubic meter

Diatomaceous earth (uncalcined)

PAC-1: 18 milligram per cubic meter

PAC-2: 200 milligram per cubic meter

PAC-3: 1200 milligram per cubic meter

DFG MAK (*diatomaceous earth, uncalcined)*: 4 milligram per cubic meter, inhalable fraction; Pregnancy Risk Group C. Austria: MAK 4 milligram per cubic meter, 1999; Norway: TWA 1.5 milligram per cubic meter (respirable dust), 1999; Switzerland: MAK-W 4 milligram per cubic meter, 1999; Thailand: TWA 80 milligram per cubic meter, 1993;

United Kingdom: TWA 6 milligram per cubic meter, total dust, 2000; United Kingdom: TWA 1.2 milligram per cubic meter, (respirable dust), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: TWA 3 milligram per cubic meter (respirable fraction, for particulate matter containing no asbestos and < 1% crystalline silica). Russia[43] set a MAC of 2 milligram per cubic meter in work-place air.

Determination in Air: Filter; Low-temperature ashing; X-ray diffraction spectrometry; NIOSH Analytical Method (IV) #7501[58]

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short-Term Exposure: Unknown at this time.

Long-Term Exposure: Exposure can cause permanent scarring of the lungs, especially if diatomaceous earth has been calcined (heat treated). Symptoms include shortness of breath and cough. This can begin anywhere from months to years after exposure. The name of this disease is silicosis. With heavy exposure, individuals may become respiratory cripples. This can be fatal.

Points of Attack: Lungs.

Medical Surveillance: Before first exposure to calcined diatomaceous earth and at regular times after, the following are recommended: Medical exam of the lungs. Lung function tests. Chest X-ray (every 2−5 years).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility.

Personal Protective Methods: Wear protective gloves and clothing. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: 30 milligram per cubic meter: Qm (APF = 25) (any quarter-mask respirator). 60 milligram per cubic meter: Any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100; or Sa (APF = 10) (any supplied-air respirator). 150 milligram per cubic meter: Sa: Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). 300 milligram per cubic meter*:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). 3000 milligram per cubic meter: SaF: Pd, Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type SCBA).

Storage: Color code-Green: General storage may be used. Store in tightly closed containers in a cool well-ventilated area.

Shipping: This material is not singled out by DOT[19] in its Performance-Oriented Packaging Standards.

Spill Handling: Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use any extinguishing agent suitable for surrounding fire. Thermal decomposition products may include oxides of silicon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Diatomaceous Earth*, Trenton, NJ (August 1985)

Diazepam D:0270

Formula: $C_{16}H_{13}ClN_2O$
Synonyms: Alboral; Aliseum; Amiprol; Ansiolin; Ansiolisina; Apaurin; Apozepam; Assival; Atensine; Atilen; 2H-1,4-Benzodiazepin-2-one,7-chloro-1,3-dihydro-1-methyl-5-phenyl-bialzepam; Calmocitene; Calmpose; Cercine; Ceregulart; 7-Chloro-1,3-dihydro-1-methyl-5-phenyl-2H-1,4-benzodiazepin-2-one; 7-Chloro-1-methyl-5-3H-1,4-benzodiazepin-2(1H)-one; 7-Chloro-1-methyl-2-*oxo*-5-phenyl-3H-1,4-benzodiazepine; 7-Chloro-1-methyl-5-phenyl-2H-1,4-benzodiazepin-2-one; 7-Chloro-1-methyl-5-phenyl-3H-1,4-benzodiazepin-2(1H)-one; 7-Chloro-1-methyl-5-phenyl-1,3-dihydro-2H-1,4-benzodiazepin-2-one; Condition; DAP; Diacepan; Diapam; Diazemuls; Diazepam; Diazetard; Dienpax; Dipam; Dipezona; Domalium; Duksen; Duxen; E-Pam; Eridan; Faustan; Freudal; Frustan; Gihitan; Horizon; Kabivitrum; Kiatrium; LA-III; Lembrol; Levium; Liberetas; Methyl diazepinone; 1-Methyl-5-phenyl-7-chloro-1,3-dihydro-2H-1,4-benzodiazepin-2-one; Morosan; Noan; NSC-77518; Pacitran; Paranten; Paxate; Paxel; Plidan; Quetinil; Quiatril; Quievita; Relaminal; Relanium; Relax; Renborin; RO 5-2807; S.A.R.L.; Saromet; Sedipam; Seduksen; Seduxen; Serenack; Serenamin; Serenzin; Setonil; Sibazon; Sonacon; Stesolid; Stesolin; Tensopam; Tranimul; Tranqdyn; Tranquirit; Umbrium; Unisedil; USEMPAX AP; Valeo; Valitran; Valium; Valium R; Vatran; Velium; Vival; Vivol; WY-3467; Zipan
CAS Registry Number: 439-14-5
HSDB Number: 3057
RTECS Number: DF1575000
UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154; UN3249 (Medicine, solid, toxic, n.o.s.)/151
EC Number: 207-122-5

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Inadequate Evidence; Human Inadequate Evidence*, not classifiable as carcinogenic to humans*, Group 3, 1987.

California Proposition 65 Developmental/Reproductive toxin 1/1/1992.

Hazard Alert: Poison, May be combustible, Reproductive toxin: possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Drug.

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xi, Xn; risk phrases: R21/22; R23/24/25; R36/37/38; R39; R51; R62; R63; safety phrases: S7; S16; S26; S36/37; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Diazepam is a yellow crystalline powder. Molecular weight = 284.75; freezing/melting point = 125°C−126°C. Insoluble in water.

Potential Exposure: A potential danger to those involved in the manufacture, packaging or consumption of this widely used tranquilizing drug.

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Symptoms of exposure to this compound may include drowsiness, ataxia, skin rash, dysarthria, nausea, diplopia, anxiety, depression, constipation, changes in salivation, blurred vision, urinary retention, incontinence, tremor, headache, confusion, slurred speech, vertigo, changes in libido, and jaundice. Other symptoms of exposure include fatigue, dizziness, respiratory depression, nystagmus, incoordination of the upper extremities, cardiac arrest, hyporeflexia, muscular weakness, agitation, insomnia, grand mal seizures, organic brain syndrome, paradoxical excitement, delirium, coma, hallucinations, vomiting, lethargy, and respiratory failure or arrest. It can cause tinnitus, excitability, rage reaction, phlebitis, and lactic acidosis. It can also cause central nervous depression, brown discoloration of the lenses, lightheadedness, amnesia, mental depression, blood disorders, dysphoria, slight wheezing, cyanosis, increased respiratory rate, abnormal blood gases, convulsions, increase in chromosomal aberrations, aplastic anemia, leukopenia, leukocytosis, encephalopathy, bilateral gynecomastia, allergic conjunctivitis, angle closure glaucoma, reduction of cardiac output and stroke volume, increase in heart rate and peripheral resistance, cholestasis, disorganization of thought, depressed pupillary response, inhibited performance recall, improved recall of information, reduced reaction time, apprehension, vascular disease, bronchopneumonia, bullous and vesicular skin eruptions, eccrine sweat gland and sweat duct necrosis, skin pallor and death. Exposure can cause decreased blood pressure, increase in hostility and irritability, and vivid or disturbing dreams. Exposure can also lead to hypotension, increased muscle spasticity, sleep disturbances, stimulation, neutropenia, hypoactivity, syncope, bradycardia, urticaria, cardiovascular collapse and hiccups. Damage to the eyes, CNS, and pulmonary tract may occur. It may also cause dryness of the mouth, aggressive behavior, blood dyscrasias and hepatic dysfunction. If exposure occurs during pregnancy, it may cause lethargy and hypotonia in the offspring. The neonate may also experience apneic attacks. Symptoms may include hypertonia, hyperreflexis, difficulty in sucking, hypothermia and midline cleft deformities of the lip and palate. Depressed CNS function may also occur in the neonate[101].

Short-Term Exposure: When used as a medical drug, diazepam can cause drowsiness and difficulty with coordination, concentration, and balance. It may also cause irritability, anxiety, weakness, headaches, upset stomach, and joint pains. Less common side effects include jaundice, skin rashes; or a drop in the white blood cell count. These effects might also occur from work-place exposure due to breathing in dust during packaging or manufacture. LD_{50} = (oral-rat) 352 mg/kg (moderately toxic).

Long-Term Exposure: Diazepam is a probable teratogen and may be a mutagen. Handle with extreme caution. Sudden discontinuing the exposure following high exposure for at least 3 months may cause shakiness, irritability, and possible convulsions.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: blood test for diazepam level.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposure to diazepam, use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece respirator with a high efficiency particulate filter. Greater protection is provided by a powered-air purifying respirator (PAPR). *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in the pressure-demand or other positive-pressure mode.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with diazepam all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. If you are required to work in a sterile environment, you require specific training.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN3249 Medicine, solid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft[70]. Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use extinguishing agents suitable for surrounding fire. Thermal decomposition products may include hydrogen chloride, chlorine and oxides of nitrogen and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Diazepam*, Trenton, NJ (December 1995)

Diazinon D:0280

Formula: $C_{12}H_{21}O_3N_2SP$

Synonyms: AG-500; AI3-19507; Alfa-Tox; Antigal; Antlak; Basudin; Basudin 10G; Basudin E; Bazuden; Caswell No. 342; Dazzel; *O,O*-Diaethyl-*O*-(2-isopropyl-4-methyl-pyrimidin-6-yl)-monothiophosphat (German); *O,O*-Diaethyl-*O*-(2-isopropyl-4-methyl-6-pyrimidyl)-thionophosphat (German); Dianon; Diaterr-Fos; Diazajet; Diazatol; Diazide; Diazinon AG 500; Diazinone; Diazitol; Diazol; Dicid; Diethyl 2-isopropyl-4-methyl-6-pyrimidinl phosphorothionate; Diethyl 4-(2-isopropyl-6-methylpyrimidinl)phosphorothionate; *O,O*-Diethyl *O*-2-isopropyl-6-methylpyrimidin-4-yl phosphorothionate; *O,O*-Diethyl *O*-(2-isopropyl-4-methyl-6-pyrimidyl) phosphorothionate; *O,O*-Diethyl *O*-(2-isopropyl-4-methyl-6-pyrimidyl) thionophosphate; Diethyl 2-isopropyl-4-methyl-6-pyrimidylthionophosphate; *O,O*-Diethyl 2-isopropyl-4-methylpyrimidyl-6-thiophosphate; *O,O*-Diethyl *O*-6-methyl-2-isopropyl-4-pyrimidinyl phosphorthioate; *O,O*-Diethyl *O*-[6-methyl-2-(1-methylethyl)-4-pyrimidinyl] phosphorthioate; Dimpylate; Dipofene; Diziktol; Dizinon; Dyzol; ENT 19,507; EPA pesticide chemical code 057801; Exodin; G-24480; G 301; Gardentox; Geigy 24480; Isopropylmethylpyrimidyl diethyl thiophosphate; *O*-2-Isopropyl-4-methylpyrimyl *O,O*-diethyl phosphorothioate; Kayazinon; Kayazol; NA 2783 (DOT); NCI-C08673; Neocidol; Neocidol (oil); Nipsan; Nucidol; Oleodiazinon; Phosphoric acid, *O,O*-diethyl *O*-6-methyl-2-(1-methylethyl)-4-pyrimidinyl ester; Phosphorothioate, *O,O*-diethyl *O*-6-(2-isopropyl-4-methylpyrimidyl); Phosphorothioic acid, *O,O*-diethyl *O*-(2-isopropyl-6-methyl-4-pyrimidinyl) ester; Phosphorothioic acid, *O,O*-diethyl *O*-(isopropylmethylpyrimidyl) ester; Phosphorothioic acid, *O,O*-diethyl *O*-[6-methyl-2-(1-methylethyl)-4-pyrimidinyl] ester; 4-Pyrimidinol, 2-isopropyl-6-methyl-, *O*-ester with *O,O*-diethyl phosphorothioate; Root Guard; Sarolex; Spectracide; Spectracide 25EC; Srolex; Thiophosphate de *O,O*-diethyle et de *O*-2-isopropyl-4-methyl 6-pyrimidyle (French); Thiophosphoric acid 2-isopropyl-4-methyl-6-pyrimidyl diethyl ester

CAS Registry Number: 333-41-5

HSDB Number: 303

RTECS Number: TF3325000

UN/NA & ERG Number: (PIH) UN2783 (organophosphorus pesticides, solid, toxic)/152

EC Number: 206-373-8 [*Annex I Index No.:* 015-040-00-4]

Regulatory Authority and Advisory Information

Hazard Alert: Poison inhalation hazard, Neurotoxin (cumulative), Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction), Environmental hazard.

United States DOT 49CFR172.101, Inhalation Hazardous Chemical, as organic phosphate, Substance ID: EDF-041

United States Environmental Protection Agency, FIFRA 1998 Status of Pesticides: Supported

United States Environmental Protection Agency Gene-Tox Program, Negative: Carcinogenicity-mouse/rat; Histidine reversion-Ames test; Negative: In vitro UDS-human fibroblast; TRP reversion; Negative: *S. cerevisiae-homozygosis*; Inconclusive: *B. subtilis* rec assay; *E. coli polA* without S9

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), severe pollutant

Canada, Drinking Water Quality, 0.02 mg/L MAC.

Hazardous to aquatic life or environment, with possible long lasting effects[291,292].

Hazard Symb Do not allow release to the environment unless proper permits are obtained from the federal government. ols, Risk & Safety statements: Hazard symbol: Xn, N; risk phrases: R22; R50/53; R62; R63; safety phrases: S2; S24/25; S29; S41; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Diazinon is a combustible, colorless, oily liquid. Faint amine odor. Technical grade is pale to dark brown. Commercial formulations may use carrier solvents which can change the physical properties listed here. Molecular weight = 304.38; boiling point = decomposes below BP @ 120°C; 83°C−84°C @ 0.002 mm; flash point = 82°C; ∼100°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Practically insoluble in water; solubility = 0.004%.

Potential Exposure: Producers, formulators and applicators of this nonsystemic pesticide and acaricide. Diazinon is used in the United States on a wide variety of agricultural crops, ornamentals, domestic animals; lawns and gardens; and household pests.

Incompatibilities: Reaction with nitrosating agents (e.g., nitrites, nitrous gases, nitrous acid) capable of releasing carcinogenic nitrosamines. Hydrolyzes slowly in water and dilute acid. Reacts with strong acids and alkalis with possible formation of highly toxic tetraethyl thiopyrophosphates. Incompatible with copper-containing compounds. Contact with oxidizers may cause the release of phosphorous oxides. Contact with strong reducing agents, such as hydrides; may cause the formation of flammable and toxic phosphine gas.

Permissible Exposure Limits in Air

OSHA PEL: None

NIOSH REL: 0.1 milligram per cubic meter TWA [skin]

ACGIH TLV[1]: 0.01 milligram per cubic meter TWA, inhalable fraction and vapor [skin]; not classifiable as a human carcinogen; TLV-BEIA issued (2000), Acetylcholinesterase inhibiting pesticides.

No PAC available

DFG MAK: 0.1 milligram per cubic meter (measured as the, inhalable fraction); Peak Limitation Category II(2) [skin]; Pregnancy Risk Group C

Australia: TWA 0.1 milligram per cubic meter, [skin], 1993; Austria: MAK 0.1 milligram per cubic meter, [skin], 1999; Belgium: TWA 0.1 milligram per cubic meter, [skin], 1993; Finland: TWA 0.1 milligram per cubic meter; STEL 0.3 milligram per cubic meter, [skin], 1999; France: VME 0.1 milligram per cubic meter, [skin], 1999; Hungary: STEL 0.1 milligram per cubic meter, [skin], 1993; India: TWA 0.1 milligram per cubic meter, [skin], 1993; the Netherlands: MAC-TGG 0.1 milligram per cubic meter, 2003; Norway: TWA 0.1 milligram per cubic meter, 1999; Russia: STEL 0.2 milligram per cubic meter, [skin], 1993; Switzerland: MAK-W 0.1 milligram per cubic meter, [skin], 1999; United Kingdom: TWA 0.1 milligram per cubic meter, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Several states have set guidelines or standards for diazinon in ambient air[60] ranging from 1.0 μ/m^3 (North Dakota) to 1.6 μ/m^3 (Virginia) to 2.0 μ/m^3 (Connecticut and Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #5600, Organophosphorus Pesticides. See also OSHA Analytical Method 62[58].

Permissible Concentration in Water: Canada set a MAC of 0.02 mg/L. Russia set a MAC in water bodies for domestic purposes of 0.3 mg/L. The United States Environmental Protection Agency has determined a NOAEL of 0.05 mg/kg/day which gives a long-term Health advisory: of 0.0175 mg/L and a lifetime Health advisory: of 0.00063 mg/L. Several states have set guidelines for Diazinon in drinking water[61] ranging from 4 μg/L (Maine) to 14 μg/L (California and Kansas).

Determination in Water: By Methylene Chloride extraction followed by gas chromatography. Octanol-water coefficient: Octanol-water coefficient: Log $K_{ow} = >3$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, skin absorption, ingestion, and skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Diazinon can affect you when breathed in and quickly enters the body by passing through the skin. May cause skin and eye irritation. Exposure can cause organophosphate poisoning with headache, sweating, nausea, and vomiting, diarrhea, muscle twitching and possible death. It is a moderately toxic organophosphate chemical. LD_{50} = (oral-rat) 66 mg/kg (moderately toxic).

Long-Term Exposure: Diazinon may damage the developing fetus. Exposure can cause severe organophosphate poisoning with headache, sweating, nausea and vomiting; diarrhea, loss of coordination; and death. Diazinon may affect the liver.

Points of Attack: Eyes, respiratory system; CNS, cardiovascular system, and blood cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below pre-employment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider CBC. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates. Liver function tests. Exam of the nervous system. CBC.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Effects may be delayed; medical observation is recommended.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for Exposures over 0.1 milligram per cubic meter use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator with a pesticide cartridge. The prefilter should be a high efficiency particulate filter. More protection is provided by a full facepiece respirator than by a half-mask respirator, and even greater protection is provided by a PAPR.

Where there is potential for high exposures exists, use an NIOSH/MSHA or European Standard EN 149-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use an NIOSH/MSHA or European Standard EN 149-approved SCBA with a full facepiece operated in the pressure-demand or other positive-pressure mode.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Store in tightly closed containers in a cool well-ventilated area away from water, and oxidizers, such as (peroxides, nitrates, permanganates, chlorates, and perchlorates).

Shipping: UN2783 Organophosphorus pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling:

Initial Isolation and Protective Action Distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24 h response line).

Small Spills (from a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.3/0.4
Night 0.8/1.2

Large Spills (from a large package or from many small packages)
First: Isolate in all directions (ft/m) 600/200
Then: Protect persons downwind (mi/km)
Day 1.4/2.3
Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Do not touch spilled material. Do not breathe vapors. Stay upwind; keep out of low areas. Remove all ignition sources. Ventilate area of spill or leak. This material is a combustible liquid. For a spill or leak of a combustible liquid, shut off ignition sources; no flares, smoking or flames in hazard area. Stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: Absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: Dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Diazinon decomposes on heating above 120°C; decomposition products may include oxides of phosphorus, sulfur, nitrogen and carbon. products include oxides of phosphorus, nitrogen and carbon. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Diazinon is hydrolyzed in acid media about 12 times as rapidly as parathion, and at about the same rate as parathion in alkaline media. In excess water this compound yields diethylthiophosphoric acid and 2-isopropyl-4-methyl-6-hydroxypyrimidine. With insufficient water, highly toxic tetraethyl monothiopyrophosphate is formed. Therefore, incineration would be a preferable ultimate disposal method with caustic scrubbing of the incinerator effluent[22]. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (2); (80); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Diazinon,* Trenton, NJ (March 1998)

United States Environmental Protection Agency, *Health advisory: Diazinon,* Washington, DC, Office of Drinking Water (August 1987)

Sax N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 7, No. 5, 36−43 (1987)

Diazomethane D:0290

Formula: CH_2N_2

Synonyms: Azimethylene; Azomethylene; Diazirine; Diazometano (Spanish); Diazonium methylide; Methane, diazo-

CAS Registry Number: 334-88-3

HSDB Number: 1628

RTECS Number: PA7000000

UN/NA & ERG Number: UN1953/119

EC Number: 206-382-7 [*Annex I Index No.*: 006-068-00-8]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human No Adequate Data; Animal Limited Evidence*, not classifiable as carcinogenic to humans*, Group 3, 1987[9]; ACGIH:A2; Suspected human carcinogen. DFG MAK: Carcinogen Category 2. United States Environmental Protection Agency Gene-Tox Program, Positive: *N crassa*-reversion; *S. cerevisiae*-reversion; Positive/limited: Carcinogenicity-mouse/rat.

Hazard Alert: Exposure can be lethal, Flammable gas, Possible risk of forming tumors, Suspected reprotoxic hazard.

Banned or Severely Restricted (Belgium, Sweden) (UN)[13]

OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 500 lb (227 kg)

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, F; risk phrases: R 45; R50/53; safety phrases: S21; S41; S45; S53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Diazomethane is a flammable, yellow gas or a liquid under pressure. Musty odor. Molecular weight = 42.04; specific gravity (H_2O:1) = 1.45; boiling point = −22.7°C; freezing/melting point = −145°C; Autoignition temperature = 100°C (explodes). Hazard identification (based on NFPA-704 M Rating System): Health 4, Flammability 3, Reactivity 3 ₩. Decomposes in water; reaction.

Potential Exposure: Diazomethane is a powerful methylating agent for acidic compounds, such as carboxylic acids, phenols and enols. It is used in pesticide manufacture and pharmaceutical manufacture.

Incompatibilities: Heat (at about or above 100°C), shock, friction, concussion, sunlight, or other intense illuminations may cause explosions. Contact with alkali metals; drying agents such as calcium sulfate, or rough edges (such as ground glass) may cause explosions. Diazo compounds can detonate. This applies in particular to organic azides that have been sensitized by the addition of metal salts or strong acids. Toxic gases are formed by mixing materials of this class with acids, aldehydes, amides, carbamates, cyanides, inorganic fluorides, halogenated organics, isocyanates, ketones, metals, nitrides, peroxides, phenols, epoxides, acyl halides, and strong oxidizing or reducing agents. Flammable gases are formed by mixing materials in this group with alkali metals. Explosive combination can occur with strong oxidizing agents, metal salts, peroxides, and sulfides. This chemical is sensitive to prolonged exposure to heat. This chemical is incompatible with strong oxidizing agents[101].

Permissible Exposure Limits in Air

NIOSH IDLH = 2 ppm

Conversion factor: 1 ppm = 1.72 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 0.2 ppm/0.4 milligram per cubic meter TWA

NIOSH REL: 0.2 ppm/0.4 milligram per cubic meter TWA

ACGIH TLV[1]: 0.2 ppm/0.34 milligram per cubic meter TWA; Suspected Human Carcinogen

PAC Ver. 29[138]

PAC-1: 0.6 ppm

PAC-2: 6.6 ppm

PAC-3: 40 ppm

DFG MAK: Carcinogen Category 2

Australia: TWA 0.2 ppm (0.4 milligram per cubic meter), carcinogen, 1993; Austria: carcinogen, 1999; Finland: TWA 0.2 ppm (0.4 milligram per cubic meter), 1999; France: VME 0.2 ppm (0.4 milligram per cubic meter), 1993; Hungary carcinogen, 1993; India: STEL 0.4 milligram per cubic meter [skin] 1993; Norway: TWA 0.2 ppm (0.4 milligram per cubic meter), 1999; Russia: TWA 0.2 ppm (0.4 milligram per cubic meter), 1993; Switzerland: MAK-W 0.2 ppm (0.35 milligram per cubic meter), carcinogen, 1999; United Kingdom: carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: Suspected Human Carcinogen. Several states have set guidelines or standards for diazomethane in ambient air[60] ranging from 1.3 μ/m^3 (New York) to 2.0 μ/m^3 (South Carolina) to 4.0 μ/m^3 (Florida and North Dakota) to 7.0 μ/m^3 (Virginia) to 8.0 μ/m^3 (Connecticut) to 10.0 μ/m^3 (Nevada).

Determination in Air: See NIOSH Analytical Method (IV) #2515[18].

Permissible Concentration in Water: No criteria set, but EPA[32] has suggested a permissible ambient goal of 5.5 μg/L, based on health effects.

Routes of Entry: Inhalation, ingestion, and skin and eye contact (liquid).

Harmful Effects and Symptoms

Short-Term Exposure: Cough and shortness of breath; headaches; flushed skin; fever, chest pain; pulmonary edema; pneumonitis, asthma, and eye irritation. It is extremely toxic. Inhalation can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Exposure can cause severe lung damage with symptoms of coughing, chest pain; shortness of breath; fever and fatigue. Exposure to the gas or liquid can cause severe skin burns and eye damage. Contact with the liquid can cause frostbite.

Long-Term Exposure: Repeated exposures, even at low levels, may cause an asthma-like lung allergy. This chemical is a possible human carcinogen.

Points of Attack: Respiratory system, lungs, eyes, and skin.

Medical Surveillance: This chemical is a suspected human carcinogen[1]. Exposed persons should contact a physician for advice regarding the possible long term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. These may be normal at first if the person is not having an attack at the time. If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose allergy.

Consider chest X-ray after acute overexposure. NIOSH lists the following tests: blood gas analysis; chest X-ray, electrocardiogram, pulmonary function tests: forced vital capacity (FVC), forced expiratory volume (1 s); white blood cell count/differential.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Frostbite: Wear appropriate safety gloves (for cold) and personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear eye protection to prevent any possibility of contact. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Up to 2 ppm: Sa (APF = 10) (any supplied-air respirator); *or SCBA (any SCBA with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type SCBA).

*Substance causes eye irritation or damage; eye protection needed

Storage: Poison inhalation chemical (PIH); check oxygen content prior to entering storage area. Should not be stored but prepared as needed. Color code-Blue: Health Hazard/Poison: This gas is highly toxic. Even slight exposure to this gas can cause death. Store outdoors in a secure, restricted area that containing warning signs. This area must be roofed and shaded with the cylinders stored off the ground and separated from all other products assigned to other hazard categories and radiant heat sources on non-wooden floors. If indoors, store in a well-ventilated areas in temperatures not to exceed 50°C. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Diazomethane must be stored to avoid contact with alkali metals such as lithium, sodium, or potassium; or drying agents such as calcium sulfate, since violent reactions occur. Safety barriers or shields should be used to protect workers from accidental explosions. Sources of ignition, such as smoking and open flames are prohibited where diazomethane is handled, used, or stored. Metal containers used in the transfer of five gallons or more diazomethane should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of diazomethane. Wherever diazomethane is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN1953 Compressed gas, toxic, flammable, n.o.s. ***Inhalation Hazard Zone A, B, C, or D***, Hazard Class: 2.3; Labels: 2.3-Poison Gas, 2.1-Flammable gas, Technical Name Required.

Spill Handling:

Inhalation Hazard **Zone A: Zone B; Zone C: Zone D**

Initial Isolation and Protective Action Distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24 h response line).

Small Spills (from a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) Zone **A** 300/90: Zone **B**, C or D:100/30

Then: Protect persons downwind (mi/km)

Day Zone **A**: 0.3/0.5; Zone **B**, C & D: 0.1/0.2

Night Zone **A**: 1.4/2.3; Zone **B**, C & D: 0.2/0.3

Large Spills (from a large package or from many small packages)

First: Isolate in all directions (ft/m) Zone A: 2000/600; Zone B: 1000/300; Zones C or D: 600/180
Then: Protect persons downwind (mi/km)
Day Zone **A**: 1.7/2.8; Zone **B**: 0.8/1.2; Zone C: 0.7/1.1; Zone D: 0.5/0.8
Night Zone **A**: 5.4/8.7 Zone **B**: 2.2/3.5; Zone C: 2.0/3.2; Zone D: 1.3/2.0
If in a building, evacuate building and confine vapors by closing doors and shutting down HVAC systems. Restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak to disperse the gas. Wear chemical protective suit with SCBA to combat spills. Stay upwind and use water spray to "knock down" vapor; contain runoff. Stop the flow of gas, if it can be done safely from a distance. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place; and repair leak or allow cylinder to empty. If in liquid form, allow to vaporize or absorb the spilled chemical by using a sponge and water. Decompose chemically with a 10% ceric ammonium nitrate solution. Keep this chemical out of confined spaces, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable and explosive gas. Thermal decomposition products may include oxides of nitrogen and carbon. This gas is under pressure; containers may rupture and explode when heated. Use dry chemical or sand to extinguish fire. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Decompose chemically with ceric ammonium nitrate under constant agitation and cooling[24].

References

(31); (173); (101); (138); (100).

Sax N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 3, 55 (1981)
New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Diazomethane*, Trenton, NJ (October 1998)

Dibenz(a,h)anthracene D:0300

Formula: $C_{22}H_{14}$
Synonyms: AI3-18996; 1,2: 5,6-Benzanthracene; 1,2,5,6-DBA; DBA; 1,2,5,6-Dibenzanthracene; 1,2: 5,6-Dibenz(a) anthracene; 1,2: 5,6-Dibenzanthracene; Dibenzanthracene; Dibenz(a,h)antraceno (Spanish); 1,2: 5,6-Dibenzoanthracene
CAS Registry Number: 53-70-3
HSDB Number: 5097
RTECS Number: HN2625000
UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154; UN3077 (environmentally hazardous substances, solid, n.o.s.)/171[101]
EC Number: 200-181-8 [*Annex I Index No.*: 601-041-00-2]
Regulatory Authority and Advisory Information
Carcinogenicty: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen. NIOSH has recommended that coal tar pitch volatiles, including polycyclic aromatic hydrocarbons (PAHs) be treated as potential human carcinogen. ACGIH: Confirmed Human Carcinogen *Polycyclic Aromatic Compounds.* United States Environmental Protection Agency Gene-Tox Program, Positive: Cell transformation-RLV F344 rat embryo; Positive: Cell transformation-SA7/SHE; N crassa-forward mutation; Positive: Histidine reversion-Ames test; Positive: *D. melanogaster* sex-linked lethal; Positive: V79 cell culture-gene mutation; Positive/dose response: SHE-clonal assay; Inconclusive: Cell transformation-mouse prostate; In vivo SCE-nonhuman; Inconclusive: In vitro UDS-human fibroblast.
California Proposition 65 Chemical[102]: Cancer 1/1/1988.
Hazard Alert: Poison, Combustible, Possible risk of forming tumors, Suspected reprotoxic hazard, Environmental hazard.
OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR 1910.1002) as coal tar pitch volatiles.
Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; Section 307(a)(1) Toxic pollutant designated, pursuant to of the and is subject to effluent limitations as PAHs
United States National Primary Drinking Water Regulations: MCLG = zero mg/L; MCL = 0.0002 mg/L as PAHs.
United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U063
RCRA, 40CFR261, Appendix 8 Hazardous Constituents
RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.055; Nonwastewater (mg/kg), 8.2
RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8100 (200); 8270 (10)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

List of Stockholm Convention POPs: Annex C (Unintentional production and release) *as polychlorinated dibenzofurans (PCDFs).*

Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R45; R50/53; R63; safety phrases: S29; S53; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to waters.

Description: Dibenz(a,h)anthracene is a colorless, crystalline solid. PAHs are compounds containing multiple benzene rings and are also called polynuclear aromatic hydrocarbons. Molecular weight = 278.35; specific gravity (H_2O:1) = 1.38; boiling point = 524°C; freezing/melting point = 267°C−270°C. Hazard identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 0. Insoluble in water.

Potential Exposure: Dibenz(a,h)anthracene is a chemical substance formed during the incomplete burning of fossil fuel, garbage, or any organic matter and is found in smoke in general; it condenses on dust particles and is distributed into water and soil and on crops. DB(a,h)A is a PAH and is also a component of coal tar pitch, which is used in industry as a binder for electrodes, and creosote is used to preserve wood. PAHs are also found in limited amounts in bituminous materials and asphalt used in industry and for paving.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides.

Permissible Exposure Limits in Air

NIOSH IDLH = 80 milligram per cubic meter as coal tar pitch volatiles

Dibenz(a,h)anthracene falls in the category of coal tar pitch volatiles

OSHA PEL: 0.2 milligram per cubic meter TWA [1910.1002] (benzene-soluble fraction). OSHA defines "coal tar pitch volatiles" in 29 CFR 1910.1002 as the fused polycyclic hydrocarbons that volatilize from the distillation residues of coal, petroleum (excluding asphalt), wood, and other organic matter.

NIOSH REL: 0.1 milligram per cubic meter (cyclohexane-extractable fraction). NIOSH considers coal tar products (i.e., coal tar, coal tar pitch, or creosote) to be potential occupational carcinogens

ACGIH TLV[1]: 0.2 milligram per cubic meter TWA (as benzene soluble aerosol); Confirmed Human Carcinogen

PAC Ver. 29[138]

PAC-1: 0.093 milligram per cubic meter

PAC-2: 1 milligram per cubic meter

PAC-3: 2.9 milligram per cubic meter

DFG MAK: [skin] Carcinogenic Category 2; Germ Cell Mutation Category 3A

France: carcinogen, 1993; Norway: TWA 0.04 milligram per cubic meter, 1999; Poland: TWA 0.004 milligram per cubic meter, 1999

Determination in Air: Use NIOSH Analytical Method #5506 PAHs by HPLC; NIOSH Analytical Method #5515, PAHs by GC; OSHA Analytical Method ID-58.

Permissible Concentration in Water: For the maximum protection of human health from the potential carcinogenic effects due to exposure of polynuclear aromatic hydrocarbons through ingestion of contaminated water and contaminated aquatic organisms, therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 1×10^{-5}, 1×10^{-6}, and 1×10^{-7}. The corresponding criteria are 28.0 *n*g/l, 2.8 *n*g/l, and 0.28 *n*g/l, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 311.0 *n*g/l, 31.1 *n*g/l, and 3.11 *n*g/l, respectively.

Determination in Water: Extraction with methylene chloride may be followed by measurement by gas chromatography coupled with mass spectrometry.

Routes of Entry: Inhalation, skin and/or eye contact.

Harmful Effects and Symptoms

Long-Term Exposure: DB(a,h)A is a toxic chemical and is a probable carcinogen in humans. It has caused cancer in laboratory animals when it is ingested or applied to their skin. Because DB(a,h)A causes cancer in animals, it is likely that humans exposed in the same manner would develop cancer as well. DB(a,h)A may affect the skin, resulting in photosensitization.

Points of Attack: Respiratory system, skin, bladder, and kidneys.

Medical Surveillance: NIOSH lists: CBC; chest X-ray; pulmonary function tests: FVC; Forced Expiratory Volume (1 s); photopatch testing; sputum cytology; urinalysis (routine); cytology, hematuria.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type SCBA).

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. See the entry on "Coal Tar Pitch Volatiles." A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft[70]. Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol extinguishers. Thermal decomposition products may include oxides of carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: See the entry on Coal Tar Pitch Volatiles. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(109); (102); (31); (173); (101); (138); (2); (18); (100).

United States Public Health Service, "*Toxicological Profile for Dibenz(a,h)Anthracene*, Atlanta, Georgia, Agency for Toxic Substances & Disease Registry (October 1987)

Sax N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 4, No. 6, 94−104 (1984)

Dibenzofuran D:0310

Formula: $C_{12}H_8O$

Synonyms: (1,1′-Biphenyl)-2,2′-diyl oxide; 2,2′-Biphenylene oxide; 2,2′-Biphenylyleme oxide; Dibenzo(b,d)furan; Dibenzofurano (Spanish); Diphenylene oxide

CAS Registry Number: 132-64-9

HSDB Number: 2163

RTECS Number: HP4450000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 205-071-3

Regulatory Authority and Advisory Information

Carcinogenicity: EPA Classification D, not classifiable as to human carcinogenicity

Hazard Alert: Environmental hazard.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) *As Dibenzofurans*

Persistent Organic Pollutants (UN) as dibenzofurans (chlorinated)

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, CEPA Toxic Substances.

Hazardous to aquatic life or environment, with possible long lasting effects[293]. Toxic to aquatic life with long lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, F, N, Xn, Xi; risk phrases: R11; R20/21/22; R36/37/38; R43; R40; R48/20; R50/53; R59; safety phrases: S1; S7/9; S16; S20/21/22; S23/S24/25; S29/35; S36/37/38; S39; S40; S43; S45; S53; S61; S63; S67; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Dibenzofuran is a white crystalline powder. Molecular weight = 168.20; boiling point = 285°C288°C; freezing/melting point = 85°C−87°C; vapor pressure = 4.4×10^{-3} mmHg @ 25°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Very slightly soluble in water.

Potential Exposure: This material is used as an insecticide and in organic synthesis to make other chemicals. It is derived from coal tar creosote.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 30 milligram per cubic meter

PAC-2: 330 milligram per cubic meter

PAC-3: 2000 milligram per cubic meter

Routes of Entry: Inhalation, passing through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Dibenzofuran can be absorbed through the skin, thereby increasing exposure. Exposure irritates the eyes, skin, and respiratory tract. Poisonous if ingested. See also entry for "Coal Tar."

Long-Term Exposure: Repeated contact may cause skin growths, rashes, and changes in skin color. Exposure to sunlight may make rash worse.

Points of Attack: Skin.

Medical Surveillance: Evaluation by a qualified allergist.

First Aid: *Skin Contact:* [52] Flood all areas of body that have contacted the substance with water. Don't wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others. *Eye Contact:* Remove any contact lenses at once. Flush eyes well with copious quantities of water or normal saline for at least 20−30 minutes. Seek medical attention. *Inhalation:* Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion:* If convulsions are not present, give a glass or two of water or milk to dilute the substance. Assure that the person's airway is unobstructed and contact a hospital or poison center immediately for advice on whether or not to induce vomiting.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type SCBA).

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Thermal decomposition products may include oxides of carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Dibenzofuran*, Trenton, NJ (December 2005)

Dibenzyldichlorosilane D:0320

Formula: $C_{14}H_{14}Cl_2Si$; $(C_6H_5CH_2)_2SiCl_2$

Synonyms: Dichlorobis(phenylmethyl)silane

CAS Registry Number: 18414-36-3

HSDB Number: 7802

RTECS Number: VV2977000

UN/NA & ERG Number: UN2434/156

Regulatory Authority and Advisory Information

Hazard Alert: Combustible, Corrosive, Water reactive.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%., *based on other chlorosilanes listed.*

Description: A colorless, corrosive liquid. Hazard Vapor pressure = < 1. identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 2₩. Reacts with water, rapidly releasing corrosive hydrogen chloride gas.

Potential Exposure: This material is used as an intermediate in the production of silicone polymers.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides. Chlorosilanes react vigorously with bases and both organic and inorganic acids generating toxic and/or flammable gases. Chlorosilanes react with water, moist air, or steam to produce heat and toxic, corrosive fumes of hydrogen chloride. They may also produce flammable gaseous hydrogen.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

based on other dichlorosilanes with identical PACs (for reference only)

PAC-1: $\mathbf{0.9}_{\mathbf{A}}$ ppm

PAC-2: $\mathbf{11}_{\mathbf{A}}$ ppm

PAC-3: $\mathbf{50}_{\mathbf{A}}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: The health effects are not well known at this time. However, closely related chemicals cause irritation of the eyes, nose, throat and lungs. Dibenzyl dichlorosilane is a corrosive chemical and can cause severe eye and skin burns. This substance can give of corrosive hydrogen chloride gas on contact with water, steam, or moisture. It is possible that higher exposures may cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: Although it is not known if this chemical causes lung problems, similar corrosive or highly irritating substances may affect the lungs.

Points of Attack: Skin and lungs.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following is recommended. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable

probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposure to Dibenzyl dichlorosilane, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area away from combustible materials and any form of moisture. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: UN2434 Dibenzyldichlorosilane, Hazard class: 8; Labels: 8-Corrosive material.

Spill Handling:

Dibenzyldichlorosilane, When Spilled in Water

Initial Isolation and Protective Action Distances as Chlorosilanes, corrosive, n.o.s.

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24 h response line).

Small Spills (from a small package or a small leak from a large package)

When Spilled in Water

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.1/0.2

Large Spills (from a large package or from many small packages)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.4/0.6

Stay upwind and uphill. Isolate the area of release or fire and deny entry. Remove all ignition sources. Stop the release if it can be done safely from a distance. All equipment used to handle this material must be grounded. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. *Small spill*: Cover with *dry* earth, *dry* sand, or other noncombustible material followed with plastic sheet to minimize spreading or contact with water or rain. Use clean nonsparking tools to collect material and place material into loosely covered plastic containers for later disposal. Prevent material and runoff from entering sewers and waterways if it can be done safely well ahead of the release. Use vapor suppressing foam to disperse vapors—contain runoff. Water spray may reduce vapor, but may not prevent ignition in enclosed spaces. Ventilate confined area if it can be done without placing personnel at risk. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Dibenzyl dichlorosilane may burn, but does not readily ignite. Thermal decomposition products may include hydrogen chloride and oxides of metal and carbon. *Do not use wate or hydrous agents. FOR CHLOROSILANES, DO NOT USE WATER. USE AFFF ALCOHOL-RESISTANT, MEDIUM EXPANSION FOAM.* *Small fire*: Use *dry* chemical, CO_2, *dry* sand, or alcohol-resistant foam. May react with foams releasing corrosive/toxic gases. *Large fire*: Use water spray or alcohol-resistant foam if it is available in sufficient amounts. Under favorable conditions, experienced crews can use coordinated fog streams to sweep the flames off the surface of the burning liquid. Combustible material: may burn but does not ignite readily. Most vapors are heavier than air. They will spread along ground and collect in low or confined areas (sewers, basements, tanks). Vapors may travel to source of ignition and flash back. Containers may explode when heated or if contaminated with water. Keep exposures cool long after fire is out to protect against reignition. Do not direct straight streams into the liquid. Cool exposed containers with large quantities of water from unattended equipment or remove intact containers if it can be done safely. *Do not get water on spilled substance or inside containers*. If cooling streams are ineffective (*venting sound increases in volume and pitch, tank discolors or shows signs of deforming*), withdraw immediately to a secure location. Always stay away from ends of tanks, especially when engulfed in flames. If material or contaminated runoff from fire control enters waterways, notify downstream users of potentially contaminated water. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156.

References

(31); (173); (101); (138).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Dibenzyl dichlorosilane*, Trenton, NJ (May 2001).

Diborane D:0330

Formula: B_2H_6

Synonyms: Boroethane; Boron hydride; Diborane (6); Diborane hexanhydride; Diborano (Spanish); Diboron hexahydride

CAS Registry Number: 19287-45-7

HSDB Number: 520

RTECS Number: HQ9275000

UN/NA & ERG Number: UN1911/119

EC Number: 242-940-6

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 2500 (≥1.00% concentration).; *Theft hazard* 15 (≥2.67% concentration).

Hazard Alert: Poison inhalation hazard (extremely toxic gas with inadequate warning properties; may be fatal) Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated, Extremely flammable, Suspected reprotoxic hazard.

OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 100 lb (45 kg).

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 2500 lb (1135 kg)

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, F+, Xn; risk phrases: R5; R12; R21; R23/24/25; R26; R36/37/38; R39; R61; safety phrases: S1; S1; S9; S16; S28; S33; S36/37/39; S38; S41; S45 (see Appendix 4)

Description: Diborane is a compressed, colorless, and flammable gas. It has a nauseating, sickly sweet odor. Molecular weight = 27.67; specific gravity (air = 1) = 0.96; boiling point = −92.5°C; freezing/melting point = −165.5°C; vapor pressure = 39.5 atm @ 17°C; Relative vapor density (air = 1) = 0.97; flash point = −90°C (flammable gas); Autoignition temperature = 40°C−50°C. Explosive limits: LEL: 0.8%; UEL: 88%. Hazard identification (based on NFPA-704 M Rating System): Health 4, Flammability 4, Reactivity 3. Reacts with water, forming hydrogen gas and boric acid.

Potential Exposure: Diborane is used as the source of boron in the semiconductor industry; as a catalyst for olefin polymerization; a rubber vulcanizer; a reducing agent; a flame-speed accelerator; a chemical intermediate for other boron hydrides; as a doping agent; in rocket propellants, and in the conversion of olefins to trialkyl boranes and primary alcohols.

Incompatibilities: A strong reducing agent. Unstable above 8°C. The presence of contaminants may lower the autoignition temperature; ignition may take place at, or below, room temperature. Diborane can polymerize, forming liquid pentaborane (See P:0190). It ignites spontaneously in moist air; and on contact with water, hydrolyzes exothermically forming hydrogen and boric acid. Contact with halogenated compounds (including fire extinguishers) may cause fire and explosion. Contact with aluminum, lithium and other active metals form hydrides which may ignite spontaneously. Incompatible with aluminum, carbon tetrachloride; nitric acid; nitrogen trifluoride and many other chemicals. Reacts with oxidized surfaces. Attacks some plastics, rubber or coatings.

Permissible Exposure Limits in Air

NIOSH IDLH = 15 ppm

Conversion factor: 1 ppm = 1.13 milligram per cubic meter @ 25°C & 1 atm

Odor Threshold = 2.5 ppm.

OSHA PEL: 0.1 ppm/0.1 milligram per cubic meter TWA

NIOSH REL: 0.1 ppm/0.1 milligram per cubic meter TWA

ACGIH TLV[1]: 0.1 ppm/0.11 milligram per cubic meter TWA

PAC* Ver. 29[138]

PAC-1: 0.3 ppm

PAC-2: $\mathbf{1.0_A}$ ppm

PAC-3: $\mathbf{3.7_A}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

DFG MAK: No numerical value established. Data may be available.

Australia: TWA 0.1 ppm (0.1 milligram per cubic meter), 1993; Austria: MAK 0.1 ppm (0.1 milligram per cubic meter), 1999; Belgium: TWA 0.1 ppm (0.11 milligram per cubic meter), 1993; Finland: TWA 0.1 ppm (0.1 milligram per cubic meter); STEL 0.3 ppm (0.3 milligram per cubic meter), 1999; France: VME 0.1 ppm (0.1 milligram per cubic meter), 1999; Japan: 0.01 ppm (0.012 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 0.1 milligram per cubic meter, 2003; the Philippines: TWA 0.1 ppm (0.1 milligram per cubic meter), 1993; Russia: STEL 0.1 milligram per cubic meter, 1993; Switzerland: MAK-W 0.1 ppm (0.1 milligram per cubic meter), KZG-W 0.2 ppm, 1999; Turkey: TWA 0.1 ppm (0.1 milligram per cubic meter), 1993; United Kingdom: TWA 0.1 ppm (0.12 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: TWA 0.1 ppm. Several states have set guidelines or standards for diborane in ambient air[60] ranging from 30 μ/m^3 (North Dakota) to 50 μ/m^3 (Virginia) to 60 μ/m^3 (Connecticut) to 71 μ/m^3 (Nevada).

Determination in Air: NIOSH Analytical Method (IV) #6006.

Permissible Concentration in Water: No criteria set. (Diborane reacts on contact with water as noted above.)

Routes of Entry: Inhalation, skin and eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Diborane is the least toxic of the boron hydrides. Can be fatal if inhaled. In acute poisoning, the symptoms are similar to "metal fume fever": tightness, heaviness, and burning in chest; coughing, shortness of breath; chills, fever, and pericardial pain; nausea, shivering, and drowsiness. Signs appear soon after exposure or after a latent period of up to 24 hours and persist for 1−3 days or more. Pneumonia may develop later. Reversible liver and kidney changes were seen in rats exposed to very high gas levels. This has not been noted in humans. Subacute poisoning is characterized by pulmonary irritation symptoms, and if this is prolonged, CNS symptoms, such as headaches, dizziness, vertigo, chills, fatigue, muscular weakness; and only infrequent transient tremors, appear. Convulsions do not occur. NIOSH lists symptoms as; chest tightness, precordial pain, shortness of breath; nonproductive cough; nausea, headache, lightheadedness, vertigo (an illusion of movement), chills, fever, fatigue, weakness, tremor, muscle fasiculation. In animals: liver, kidney damage; pulmonary edema; hemorrhage. LD_{50} (rat, inhalation) = 80 ppm.

Long-Term Exposure: Prolonged exposure may cause lung damage. Chronic exposure leads to wheezing, dyspnea, tightness, dry cough; rales; and hyperventilation which persist for several years.

Points of Attack: Respiratory system, CNS, liver, and kidneys.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. If symptoms develop or overexposure has occurred, the following may be useful: liver and kidney function tests. Examination of the nervous system. NIOSH lists the following tests: chest X-ray; pulmonary function tests: FVC, forced expiratory volume (1 s).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. For emergency situations, wear a positive pressure, pressure-demand, full facepiece SCBA or pressure-demand supplied air respirator with escape SCBA and a fully encapsulating, chemical resistant suit. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Up to 1 ppm: Sa (APF = 10) (any supplied-air respirator). Up to 2.5 ppm: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). Up to 5 ppm: SCBAF (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or SaF (APF = 50) (any SCBA with a full facepiece); or SaT: Cf (APF = 50) (any supplied-air respirator with a full facepiece). Up to 15 ppm: SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted canister providing protection against the compound of concern]; or SCBAE (any appropriate escape-type SCBA).

Storage: PIH; check oxygen content prior to entering storage area. Poison gas. (1) Color code-Blue: Health Hazard/ Poison: Store in a secure poison location. This gas is highly toxic. Even slight exposure to these gasses can cause death. Store outdoors in a secure, restricted area that containing warning signs. This area must be roofed and shaded with the cylinders stored off the ground and away from radiant heat sources on nonwooden floors. If indoors, store in a well-ventilated areas in temperatures not to exceed 50°C. (2) Color code-Red Stripe: Flammability Hazard: Store separately from all other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1 hour fire wall from flammable or reactive materials. (3) Color code-Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Diborane must be stored to avoid contact with: air, active metals, such as aluminum and lithium; halogenated compounds, such as chlorine; and oxidizing agents such as permanganates, nitrates, peroxides, chlorates, and perchlorates, since violent reactions occur. Containers should be dry, clean, and free of oxygen. Store in tightly closed containers in a cool well-ventilated area away from heat and moisture. Containers are usually stored in "dry ice" or are refrigerated in some other way. Diborane can ignite spontaneously in moist air at room temperature. Use dry nitrogen purge in any transfer. Sources of ignition, such as smoking and open flames are prohibited where diborane is handled, used, or stored. Use only nonsparking tools and equipment, especially when opening and closing containers of diborane. Wherever diborane is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: UN1911 Diborane, Hazard Class: 2.3; Labels: 2.3-Poisonous gas, 2.1-Flammable gas Inhalation Hazard Zone A. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling:

Diborane and diborane, compressed

Initial Isolation and Protective Action Distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24 h response line).

Small Spills (from a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 0.7/1.2

Large Spills (from a large package or from many small packages)

First: Isolate in all directions (ft/m) 600/180
Then: Protect persons downwind (mi/km)
Day 0.8/1.2
Night 2.5/4.1

If in a building, evacuate building and confine vapors by closing doors and shutting down HVAC systems. Restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Wear chemical protective suit with SCBA to combat spills. Stay upwind and use water spray to "knock down" vapor; contain runoff. Stop the flow of gas, if it can be done safely from a distance. If possible, dilute the leak with an inert gas and exhaust through a fume hood. If source is a cylinder and the leak cannot be stopped in place, specially trained personnel may be able to remove the leaking cylinder to a safe place in the open air; repair leak or allow cylinder to empty. Keep this chemical out of confined spaces, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Firefighting gear (including SCBA) does not provide adequate protection. If exposure occurs, remove and isolate gear immediately and thoroughly decontaminate personnel. This chemical is a highly flammable and reactive gas; it will ignite without warning in moist air at room temperature. Thermal decomposition products may include boron and hydrogen at high heat; and hydrogen and boron hydrides at lower temperatures. This gas is under pressure; containers may rupture and explode when heated. Approach fire with extreme caution; consider letting it burn. Do not extinguish fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Stop the flow of gas and use water spray to protect personnel during the shut-off. Use water from an unmanned source to keep fire-exposed containers cool. Diborane may react violently with halogenated extinguishing agents. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify

downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Incineration with aqueous scrubbing of exhaust gases to remove B_2O_3 particulates.

References

(31); (173); (101); (138).

Sax N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 2, No. 1, 105−107 (1982) United States Environmental Protection Agency, Chemical Hazard Information Profile: *Diborane*, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Diborane*, Trenton, NJ (December 1999)

Dibromobenzene D:0340

Formula: $C_6H_4Br_2$

Synonyms: Benzene dibromide; Benzene, dibromo-; Bromobenzene; *o*-Dibromobenzene

CAS Registry Number: 106-37-6 (1,4-isomer); 26249-12-7

HSDB Number: 2734

RTECS Number: CZ1780000

UN/NA & ERG Number: UN2514/130; UN1993 (flammable liquids, n.o.s.)/128

EC Number: 204-390-2 (1,4-); 247-544-7

Regulatory Authority and Advisory Information

Hazard Alert: Flammable liquid, Environmental hazard.

Hazardous to aquatic life or environment, with possible long lasting effects[293]. Toxic to aquatic life with long lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: Xn, N: risk phrases: R10; R36/37/38; R50/53; safety phrases: S29/35; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Dibromobenzene is a heavy colorless liquid. Pleasant aromatic odor. Molecular weight = 235.91; specific gravity = 1.84; boiling point = 219−225.5°C; freezing/melting point = 86°C−89°C; flash point = 47°C−49°C. Insoluble in water.

Potential Exposure: Dibromobenzene is used as a solvent for oils and in organic synthesis.

Incompatibilities: Extremely flammable. May form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides.

Permissible Exposure Limits in Air: No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices. Russia[43] set a MAC value for ambient air in residential areas of 0.2 milligram per cubic meter on a momentary basis.

Determination in Water: Log $K_{ow} = \sim 4$. Values above 3.0 are likely to bioaccumulate in aquatic organisms.

Routes of Entry: Inhalation, passing through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Exposure can irritate the eyes, nose and throat. High levels can cause you to feel dizzy, lightheaded and to pass out. Contact can irritate the eyes and skin.

Long-Term Exposure: Similar chemicals can cause liver damage.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures to dibromobenzene, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149

(Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with dibromobenzene all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers. Sources of ignition, such as smoking and open flames, are prohibited where dibromobenzene is used, handled, or stored, in a manner that could create a potential fire or explosion hazard.

Shipping: UN1993 Flammable liquids, n.o.s., Hazard Class: 3; Labels: 3-Flammable liquid, Technical Name Required. UN2514 Bromobenzene, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include hydrogen bromide and oxides of carbon. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Use a licensed professional waste disposal service to dispose of this material. All federal, state, and local environmental regulations must be observed. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Incineration with flue gas scrubbing.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Dibromobenzene*, Trenton, NJ (April 2006)

Dibromochloromethane D:0350

Formula: $CHBr_2Cl$

Synonyms: CDBM; Chlorodibromomethane; Clorodibromometano (Spanish); NCI-C55254

CAS Registry Number: 124-48-1

HSDB Number: 2763

RTECS Number: PA6360000

UN/NA & ERG Number: UN2810 (toxic liquid, organic, n.o.s.)/153

EC Number: 204-704-0

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human No Adequate Data; Animal Limited Evidence*, not classifiable as carcinogenic to humans*, Group 3; EPA: Classification C, Possible Human Carcinogen.

California Proposition 65 Chemical[102]: Cancer delisted 10/29/1999.

Hazard Alert: Poison, Possible risk of forming tumors, Suspected of causing genetic defects,

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants

Safe Drinking Water Act (47FR 9352): Priority List (55 FR 1470)

United States National Primary Drinking Water Regulations: n/a mg/L; MCL = 0.080 mg/L, as total trihalomethanes (TTHMs)

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.057; Nonwastewater (mg/kg), 15

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8010 (1); 8240 (5)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)

Description: Dibromochloromethane is a clear colorless liquid. Molecular weight = 208.28; specific gravity (H_2O:1) = 2.45 @ 20°C; boiling point = 119°C−120°C; freezing/melting point = −20°C; vapor pressure = 5.54 mmHg @ 25°C. Also reported as ≤20°C.

Potential Exposure: Dibromochloromethane is used as a chemical intermediate in the manufacture of fire extinguishing agents; aerosol propellants; refrigerants, and pesticides. Dibromochloromethane has been detected in drinking water in the United States. It is believed to be formed by the haloform reaction that may occur during water chlorination. Dibromochloromethane can be removed from drinking water via treatment with activated carbon. There is a potential for dibromochloromethane to accumulate in the aquatic environment because of its resistance to degradation. Volatilization is likely to be an important means of environmental transport.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, and magnesium.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 1.1 milligram per cubic meter

PAC-2: 12 milligram per cubic meter

PAC-3: 73 milligram per cubic meter

Permissible Concentration in Water: The Maximum Contaminant Level (MCL) for total trihalomethanes (including dibromochloromethane) in drinking water has been set by the United States Environmental Protection Agency at 0.10 mg/L (44 RF 68624). Illinois has set a guideline for CDBN in drinking water[61] of 1.0 μg/L.

Routes of Entry: Ingestion, inhalation, passing through the unbroken skin

Harmful Effects and Symptoms

Symptoms of exposure to dibromochloromethane may include irritation of the skin, eyes, mucous membranes and upper respiratory tract. It may also cause fatigue and may be imitating to the lung and cornea. Other symptoms may include CNS effects, lung and cornea irritation and liver and kidney damage. Prolonged exposure can cause nausea, dizziness, headache, and narcosis.

Short-Term Exposure: Very little toxicity information is available. It is, however, an irritant and narcotic. Symptoms include dizziness, headache, liver and kidney damage.

Long-Term Exposure: May cause liver and kidney damage. Dibromochloromethane gave positive results in mutagenicity tests with salmonella typhimurium TA 100. LD_{50} = (oral-rat) 848 mg/kg (slightly toxic).

Points of Attack: Liver, kidneys, and skin.

Medical Surveillance: Liver and kidney function tests.

First Aid: *Skin Contact:* [52] Flood all areas of body that have contacted the substance with water. Don't wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others. *Eye Contact:* Remove any contact lenses at once. Flush eyes well with copious quantities of water or normal saline for at least 20−30 minutes. Seek medical attention. *Inhalation:* Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion:* If convulsions are not present, give a glass or two of water or milk to dilute the substance. Assure that the person's airway is unobstructed and contact a hospital or poison center immediately for advice on whether or not to induce vomiting.

Personal Protective Methods: Wear protective gloves (nitrile gloves may provide protection[52]) and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type SCBA).

Storage: Color code-Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers under an inert atmosphere, away from light, in a refrigerator. Where possible, automatically pump liquid from drums or other storage containers to process containers. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2810 Toxic liquids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling:

UN2810, Toxic liquids, organic, n.o.s.

Initial Isolation and Protective Action Distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency

Environmental Response Team at (908) 548-8730 (24 h response line).

Small Spills (from a small package or a small leak from a large package)
First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 0.7/1.2

Large Spills (from a large package or from many small packages)
First: Isolate in all directions (ft/m) 1000/300
Then: Protect persons downwind (mi/km)
Day 1.1/1.8
Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include hydrogen bromide, hydrogen chloride and oxides of carbon. It may also emit toxic fumes of chloride ion and bromide ion. It also decomposes to phosgene analogs. It may cause narcosis[101]. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: May be destroyed by high-temperature incinerator equipped with an HCl scrubber.

References

(102); (31); (173); (101); (138).

United States Environmental Protection Agency, *Dibromochloromethane*, *Health and Environmental Effects Profile No. 61*, Washington, DC, Office of Solid Waste (April 30, 1980)

Sax N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 5, No. 2, 61–63 (1985)

1,2-Dibromo-2,4-dicyanobutane D:0363

Formula: $C_6H_6Br_2N_2$

Synonyms: Biochek; Bioclear; 2-Bromo-2-(bromomethyl) glutaronitrile; 1-Bromo-1-(bromomethyl)-1,3-propanedicarbonitrile; Dibromodicyanobutane; Glutaronitrile, 2-bromo-2-(bromomethyl)-; Merck 48051; Metacide 38; Metasol; Pentanedinitrile, 2-bromo-2-(bromomethyl)-; Tektamer

CAS Registry Number: 35691-65-7

HSDB Number: 7313

RTECS Number: MA5599000

UN/NA & ERG Number: UN3261/154; UN3439 (Nitrile, solid)/151

EC Number: 262-281-0

Regulatory Authority and Advisory Information

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

WGK[100] (German Aquatic Hazard Class):No value assigned.

Description: Light yellow crystalline solid or powder. Commercial products may be soluble concentrate (liquid or solid); pellets/tablets. Mild, acrid, sweet odor. Molecular weight = 265.93; specific gravity (H_2O:1) = 0.970 @ 20°C; freezing/melting point = 52°C; vapor pressure = 5.03×10^{-5} @25°C. Henry's Law constant = 3.9×10^{-10} atm-m^3/mol @ 25°C (est)[83]. Slightly soluble in water; solubility 0.212 g/100 mL.

Potential Exposure: Nitrile microbiocide used as a preservative in food grade adhesives and as a slimicide in the manufacture of food grade paper and paperboard; used to control slime-forming bacteria and fungi in recirculating water cooling system; oil recovery drilling mud systems; paper mill and pulp mill water systems and similar industrial processing and chemical systems.

Incompatibilities: Corrosive. Strong oxidizers and reducing agents, strong acids and bases. Reacts with acids, steam, warm water producing toxic and flammable hydrogen cyanide fumes. Hydrogen cyanide is produced when propionitrile is heated to decomposition. Nitriles may polymerize in the presence of metals and some metal compounds. They are incompatible with acids; mixing nitriles with strong oxidizing acids can lead to extremely violent reactions. Nitriles are generally incompatible with other oxidizing agents such as peroxides and epoxides. The combination of bases and nitriles can produce hydrogen cyanide. Nitriles are hydrolyzed in both aqueous acid and base to give carboxylic acids (or salts of carboxylic acids). These reactions generate heat. Peroxides convert nitriles to amides. Nitriles can react vigorously with reducing agents. Acetonitrile and propionitrile are soluble in water, but nitriles higher than propionitrile have low aqueous solubility. They are also insoluble in aqueous acids[101].

Determination in Water: Octanol-water coefficient: Log $K_{ow} = < 2.0$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, skin absorption, ingestion, and skin and/or eye contact

Harmful Effects and Symptoms

Short-Term Exposure: Contact may cause burns to skin and eyes. May affect the iron metabolism, causing asphyxia. It is highly toxic. Forms cyanide in the body. Exposure results in headache, dizziness, rapid pulse, deep-rapid breathing, nausea, vomiting, unconsciousness, convulsions, and sometimes death. May cause cyanosis (blue coloration of skin and lips caused by lack of oxygen). LD_{50} (oral, rat) = 0.77 g/kg[83].

Long-Term Exposure: Chronic exposure over long periods may cause fatigue and weakness. Can cause same general symptoms as hydrogen cyanide but onset of symptoms is likely to be slower. May cause liver and kidney damage. See NIOSH Criteria Document 212 *Nitriles*.

Points of Attack: In animals: liver, and kidney damage.

Medical Surveillance: Liver and kidney function tests

First Aid Move victim to fresh air. Call 911 or emergency medical service. Administer oxygen if breathing is difficult. If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Use amyl nitrate capsules if symptoms develop. All area employees should be trained regularly in emergency measures for cyanide poisoning and in CPR. A cyanide antidote kit should be kept in the immediate work area and must be rapidly available. Kit ingredients should be replaced every 1−2 years to ensure freshness. Persons trained in the use of this kit, oxygen use, and CPR must be quickly available. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear positive pressure SCBA. Wear chemical protective clothing that is specifically recommended by the manufacturer. DuPont Tychem Suit Fabrics is recommended by one government source[88]. It may provide little or no thermal protection. Structural firefighters' protective clothing provides limited protection in fire situations ONLY; it is not effective in spill situations where direct contact with the substance is possible.

Respirator Selection: Wherever and whenever workplace conditions warrant respirator use, a respiratory protection program must be followed that meets one or more of the following requirements: OSHA's 29 CFR 1910.134, ANSI Z88.2, or European Standard EN 149.

Spill Handling: For *liquids*, isolate spill or leak area in all directions for at least 50 m/150 ft. Increase, in the downwind direction, as necessary. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Stop leak if you can do it without risk. Prevent entry into waterways, sewers, basements or confined areas. Cover with plastic sheet to prevent spreading. Absorb or cover with dry earth, sand or other noncombustible material and transfer to containers. Do not allow water to get inside containers. For *solids*, isolate spill or leak area in all directions for at least 25 m/75 ft. Increase, in the downwind direction, as necessary. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Stop leak if you can do it without risk. Prevent entry into waterways, sewers, basements or confined areas. Cover with plastic sheet to prevent spreading. Absorb or cover with dry earth, sand or other noncombustible material and transfer to containers. Do not allow water to get inside containers.

Shipping: UN3261 Corrosive solid, acidic, organic, n.o.s., Hazard class: 8; Labels: 8-Corrosive material, Technical Name Required. UN3439 Nitriles, solid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Nitriles spill

Initial Isolation and Protective Action Distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information

from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24 h response line).
First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.1/0.2
Large Spills (from a large package or from many small packages)
First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.3/0.5
Night 0.5/0.8
Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include Thermal decomposition products may include oxides of nitrogen and carbon and hydrogen bromide gas. *Fire involving storage or vehicular tanks: Isolate* for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. *Small fire:* Dry chemical, carbon dioxide or water spray. *Large fire:* Dry chemical, carbon dioxide, alcohol-resistant foam, or water spray. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal; do not scatter the material. *Fire involving tanks or car/trailer loads:* Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Do not get water inside containers. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. Always stay away from tanks engulfed in fire. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Recycle any unused portion of the material for its approved use or return it to the manufacturer or supplier. Ultimate disposal of the chemical must consider: the material's impact on air quality; potential migration in soil or water; effects on animal, aquatic, and plant life; and conformance with environmental and public health regulations[83].

References

(31); (173); (101); (138); (100).
United States Environmental Protection Agency, "*Reregistration Eligibility Decision (RED), Dibromodicyanobutane*," Office of Prevention, Pesticides and Toxic Substances, Washington, DC (June 1996). http://www.epa.gov/REDs/factsheets/2780fact.pdf

2,3-Dibromo-1-propanol D:0366

Formula: $C_3H_6Br_2O$
Synonyms: Allyl alcohol dibromide; β-Dibromohydrin; Brominex-257; DBP; DBP (Flame retardant); 1,2-Dibromopropan-3-ol; Dibromopropanol; 2,3-Dibromopropanol; 2,3-Dibromopropyl alcohol glycerol; 1,2-Dibromohydrin; NCI-C55436; 1-Propanol, 2,3-dibromo-
CAS Registry Number: 96-13-9
HSDB Number: 2879
RTECS Number: UB0175000
UN/NA & ERG Number: UN2810 (toxic liquid, organic, n.o.s.)/153
EC Number: 202-480-9 [*Annex I Index No.:* 602-088-00-1]
Regulatory Authority and Advisory Information
Carcinogenicty: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen
California Proposition 65 Chemical[102]: Cancer, October 1, 1994
Hazard Alert: Poison, Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction), Environmental hazard.
Hazardous to aquatic life or environment, with possible long lasting effects[194]. Harmful to aquatic life with long lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.
Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R45; R20/22; R24; R36/37/38; R50/53; R62; R63; safety phrases: S29/35; S41; S45; S53; S61 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: 2,3-Dibromo-1-propanol is a clear, colorless to slightly yellow thick liquid. Molecular weight = 217.9; specific gravity (H_2O:1) = 2.12 @ 20°C; boiling Point = 219°C @ 760.0 mmHg; freezing/melting point = °C; vapor Pressure = 1 mm Hg @ 57°C; 5 mm Hg @ 84.5°C; 10 mm Hg @ 98°C; flash point = > 113°C; Slightly soluble in water; solubility = < 100 mg/mL @ 20°C.

Potential Exposure: Chemical intermediate used to produce insecticides, pharmaceuticals, and flame retardants.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides.

Permissible Exposure Limits in Air: No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices

Routes of Entry: Inhalation, ingestion, or skin absorption

Harmful Effects and Symptoms

Short-Term Exposure: 2,3-Dibromo-1-propanol is an irritant of the skin, eyes, mucous membranes and upper respiratory tract. LD_{50} = (oral-rat) ~650 mg/kg.

Long-Term Exposure: May produce tumors. A suspected human carcinogen.

Points of Attack: Skin, digestive tract, intestines, nasal mucosa, liver, and clitoral gland (in animal studies of rats and mice).

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure.

First Aid: *Skin Contact:* Flood all areas of body that have contacted the substance with water. Don't wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others. *Eye Contact:* Remove any contact lenses at once. Flush eyes well with copious quantities of water or normal saline for at least 20−30 minutes. Seek medical attention. *Inhalation:* Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion:* If convulsions are not present, give a glass or two of water or milk to dilute the substance. Assure that the person's airway is unobstructed and contact a hospital or poison center immediately for advice on whether or not to induce vomiting.

Personal Protective Methods: Wear protective gloves (nitrile gloves may provide protection[52]) and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: This chemical react s with cellulose-based absorbents. *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA-or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type SCBA).

Storage: Color code-Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. Color code-Red: Flammability Hazard: Store in a flammable (liquid or solid materials) storage area or approved cabinet away from sources if ignition.

Shipping: UN2810 Toxic liquids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling:

UN2810 Toxic liquids, organic, n.o.s.

Initial Isolation and Protective Action Distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24 h response line).

Small Spills (from a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 0.7/1.2

Large Spills (from a large package or from many small packages)

First: Isolate in all directions (ft/m) 1000/300
Then: Protect persons downwind (mi/km)
Day 1.1/1.8
Night 2.8/4.5

Fire: If tank, rail car, or tank truck is involved in fire, isolate for at least 800 m (½ mi) in all directions; also, consider initial evacuation for 800 m (½ mi) in all directions.

Initial Isolation and Protective Action Distances:

Fire Extinguishing: This chemical has a flash point and is combustible. Thermal decomposition products may include hydrogen bromide and oxides of carbon. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Use a licensed professional waste disposal service to dispose of this material. Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(109); (102); (31); (173); (101); (138); (100).

Dibutylamine D:0370

Formula: $C_8H_{19}N$

Synonyms: 1-Butanamine, *n*-butyl; *n*-butyl-1-butanamine; DBA; *n*-Dibutylamine; Di(*n*-butyl)amine; Di-*n*-butylamine (DOT); DNBA

CAS Registry Number: 111-92-2

HSDB Number: 310

RTECS Number: HR7780000

UN/NA & ERG Number: UN2248/132

EC Number: 203-921-8 [*Annex I Index No.:* 612-049-00-0]

Regulatory Authority and Advisory Information

United States Environmental Protection Agency Gene-Tox Program, Positive: In vitro SCE-nonhuman; Positive/dose response: In vitro cytogenetics-nonhuman.

Hazard Alert: Flammable liquid, Corrosive, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction).

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: F, T, Xn; risk phrases: R10; R20/21/22; R23; R34; R35; R36/37/38; R62; safety phrases: S23; S26; S28; S36/37/39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Dibutylamine is a colorless liquid with an odor of ammonia. Molecular weight = 129.28; specific gravity (H_2O:1) = 0.76; boiling point = 159°C−161°C; freezing/melting point = −61.9 to −59°C; flash point = 42°C−47°C; Autoignition temperature = 260°C. Explosive Limits: LEL: 1.1%; UEL-unknown. Hazard identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 0. Slightly soluble in water.

Potential Exposure: Used as a corrosion inhibitor; and intermediate for emulsifiers, rubber products, dyes; and insecticides.

Incompatibilities: May form explosive mixture with air. Aqueous solution is a strong base. Incompatible with acids, acid chlorides; acid anhydrides; halogens, isocyanates, vinyl acetate; acrylates, substituted allyls; alkylene oxides, epichlorohydrin, ketones, aldehydes, alcohols, glycols, phenols, cresols, caprolactum solution; strong oxidizers; reactive organic compounds. Attacks copper alloys, zinc, tin, tin alloys; galvanized steel. Also, carbon dioxide is listed as incompatible by the state of New Jersey.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 0.45 ppm

PAC-2: 5 ppm

PAC-3: 21 ppm

Routes of Entry: Inhalation, through the skin; ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: This chemical is corrosive. This chemical can be absorbed through the skin, thereby increasing exposure. Skin or eye contact can cause severe irritation and burns. Inhalation can cause irritation of the respiratory tract and/or shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: May cause lung irritation; bronchitis may develop with coughing, phlegm and/or shortness of breath.

Points of Attack: Lungs.

Medical Surveillance. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Consider chest X-ray following acute over exposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Viton and polyvinyl alcohol are among the recommended protective materials. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: (1) Color code-White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. (2) Color code-Red: Flammability Hazard: Store in a flammable (liquid or solid materials) storage area or approved cabinet away from sources if ignition. Prior to working with dibutylamine all handlers should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well ventilated area away from incompatible materials listed above. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN2248 Di-*n*-butylamine, Hazard class: 8; Labels: 8-Corrosive material, 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include nitrogen oxides, hydrocarbons, amines, and carbon monoxide. Use dry chemical, water spray; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Dibutylamine*, Trenton, NJ (October 1998)

Dibutylaminoethanol D:0380

Formula: $C_{10}H_{23}NO$; $(C_4H_9)_2NCH_2CH_2OH$

Synonyms: DBAE; β-Di-*N*-butylaminoethanol; 2-Di-*N*-butylaminoethanol; 2-Dibutylaminoethanol; Dibutylamino ethanol; 2-Di-*N*-butylaminoethyl alcohol; *N*,*N*-Dibutyl ethanolamine; *N*,*N*-Dibutyl-*N*-(2-hydroxyethyl)amine

CAS Registry Number: 102-81-8

RTECS Number: KK3850000

UN/NA & ERG Number: UN2735 (amines, liquid, corrosive, n.o.s.)/153

EC Number: 203-057-1

Regulatory Authority and Advisory Information

Hazard Alert: Flammable, Corrosive

Hazard symbols, risk, & safety statements: Hazard symbol: C, F; risk phrases: R10; R21/22; R34; safety phrases: S26; S36/37/39; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: 2-Di-*n*-butylaminoethanol is a colorless to yellowish liquid. Faint amine-like odor. Molecular weight = 173.33; boiling point = 224°C−232°C; freezing/melting point = < -69°C; flash point = 96°C; Autoignition temperature = 240°C. Explosive Limits: LEL: 0.9%; UEL = 5.5%. Hazard identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 0. Solubility in water = 11.6 g/L @ 25°C.

Potential Exposure: This material is used in organic synthesis.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides.

Permissible Exposure Limits in Air

OSHA PEL: None

NIOSH REL: 2 ppm/14 milligram per cubic meter TWA [skin]

ACGIH: 0.5 ppm/3.5 milligram per cubic meter TWA [skin]; TLV-BEIA issued; Acetylcholinesterase inhibiting pesticides.

PAC not available

Australia: STEL of 4 ppm (28 milligram per cubic meter). Several states have set guidelines or standards for dibutylaminoethanol in ambient air[60] ranging from 0.14 milligram per cubic meter (North Dakota) to 0.23 milligram per cubic meter (Virginia) to 0.28 milligram per cubic meter (Connecticut) to 0.333 milligram per cubic meter (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #2007, aminoethanol Compounds.

Routes of Entry: Inhalation, skin absorption, ingestion, and skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Corrosive, Contact may burn the eyes and irritate the skin. The vapor can irritate the nose, throat and bronchial tubes. LD_{50} = (oral-rat) 1070 mg/kg (slightly toxic).

Long-Term Exposure: High or repeated exposure may damage the liver and kidneys. Related chemicals can cause lung allergy (asthma) or skin allergy, with rash. They can also cause a fluid build-up in the lungs with high exposures, a medical emergency. Its not known whether 2-n-dibutylaminoethanol has these effects.

Points of Attack: Eyes, skin, and respiratory system.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function tests. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. These may be normal if the person is not having an attack at the time of the test. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures *over* 2 ppm; Use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in the pressure-demand or other positive-pressure mode.

Storage: Color code-White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with DBAE all handlers should be trained on its proper handling and storage. 2-*N*-Dibutylamineothanol must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates), since violent reactions may occur. Sources of ignition, such as smoking and open flames are prohibited where 2-n-dibutylaminoethanol is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: UN2735 Amines, liquid, corrosive, n.o.s, or Polyamines, liquid, corrosive, n.o.s., Hazard class: 8; Labels: 8-Corrosive material, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: 2-N-Dibutyl aminoethanol*, Trenton, NJ (October 2006)

Di-*tert*-butyl-*p*-cresol D:0390

Formula: $C_{15}H_{24}O$; $[(CH_3)_3C]_2C_6H_2(CH_3)OH$

Synonyms: BHT; Butylated hydroxytoluene; DBPC; Dibutylated hydroxytoluene; 3,5-Di-*tert*-butyl-4-hydroxytoluol; FEMA 2184; 4-Methyl-2,6-di-*tert*-butylphenol

CAS Registry Number: 128-37-0; 58500-82-6

HSDB Number: 1147

RTECS Number: GO7875000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 204-881-4

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Limited Evidence; Human No Adequate Data, *not classifiable as carcinogenic to humans*, Group 3, 1987; NCI: Carcinogenesis Bioassay (feed); no evidence: mouse, rat. United States Environmental Protection Agency Gene-Tox Program, Positive: *D. melanogaster*-whole sex chromosome loss; Negative: Histidine reversion-Ames test; Mouse specific locus; Negative: *D. melanogaster* sex-linked lethal; Inconclusive: *D. melanogaster*-reciprocal translocation; Inconclusive: Mammalian micronucleus; Sperm morphology-mouse

Hazard Alert: Poison, Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction).

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. (D2B, D2A); listed on Canada's DSL List.

Hazard symbols, risk, & safety statements: Hazard symbol: Xn; risk phrases: R22 Harmful if swallowed; R22; R 36; R37; R38; R62; R63; safety phrases: S24; S25; S26; S36; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: BHT is a white to pale yellow crystalline solid or powder. Molecular weight = 220.39; boiling point = 265°C; specific gravity (H_2O:1) = 1.05 @ 20°C; freezing/melting point = 68°C; vapor pressure = .01 mmHg @ 20°C; flash point = 127°C (cc). Hazard identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Insoluble in water; solubility = 0.00004%.

Potential Exposure: DBPC is used as a food and feed additive, flavor, and packaging material; as an antioxidant in human foods and animal feeds. It is also used as an antioxidant to stabilize petroleum fuels, rubber and vinyl plastics.

Incompatibilities: Contact with oxidizers may cause fire and explosion hazard.

Permissible Exposure Limits in Air

OSHA PEL: None

NIOSH REL: 10 milligram per cubic meter TWA

ACGIH TLV[1]: 2 milligram per cubic meter TWA (intermittent, vapor and aerosol); Not Classifiable as a Human carcinogen, as butylated hydroxytoluene (BHT) (2001).

128-37-0

PAC Ver. 28, no values found in Ver. 29[138]

PAC-1: 6 milligram per cubic meter

PAC-2: 29 milligram per cubic meter

PAC-3: 180 milligram per cubic meter
DFG MAK: 20 milligram per cubic meter, inhalable fraction TWA; Peak Limitation Category II(2); Carcinogen Category 4; Pregnancy Risk Group C
Australia: TWA 10 milligram per cubic meter, 1993; Austria: MAK 10 milligram per cubic meter, 1999; Belgium: TWA 10 milligram per cubic meter, 1993; Finland: TWA 10 milligram per cubic meter; STEL 20 milligram per cubic meter, [skin], 1999; France: VME 10 milligram per cubic meter, 1999; Switzerland: MAK-W 10 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 10 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: not classifiable as a human carcinogen

Determination in Air: Use NIOSH II-1,[1] P&CAM Method #226 and OSHA Analytical Method PV-2108

Determination in Water: No tests listed. Octanol-water coefficient: Log $K_{ow} = 5.1$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes and skin. This compound has an acute oral LD_{50} for rats of 890 mg/kg which is classified as slightly toxic.

Long-Term Exposure: Repeated or prolonged contact with skin may cause dermatitis. BHT may cause liver damage. BHT may damage the developing fetus. Repeated exposure to high levels may affect the liver. BHT may cause changes in behavior and learning ability; and reduce the blood's ability to clot, but this is not known for sure at this time. In animals: decreased growth rate, increased liver weight.

Points of Attack: Eyes, skin, and liver.

Medical Surveillance: Liver function tests.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type SCBA).

Storage: Color code-Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. Prior to working with DBPC all handlers should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Store in tightly closed containers in a cool well-ventilated area away from oxidizing agents (such as peroxides, permanganates, chlorates, perchlorates, and nitrates).

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft[70]. Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: DBPC is a combustible solid, but does not readily ignite. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Water or foam may cause frothing. Thermal decomposition products may include oxides of carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: 2,6-Di-tert-Butyl-p-Cresol*, Trenton, NJ (April 2004)

Dibutyl Phosphate D:0400

Formula: $C_8H_{18}NO_4P$; $(n\text{-}C_4H_9O)_2PO(ON)$

Synonyms: Dibutyl acid *o*-phosphate; Dibutyl acid phosphate; Di-*N*-butyl hydrogen phosphate; Di-*N*-butyl phosphate; Dibutyl phosphoric acid; Phosphoric acid, dibutyl ester

CAS Registry Number: 107-66-4

HSDB Number: 2513

RTECS Number: TB9605000

UN/NA & ERG Number: UN1760 (corrosive liquids, n.o.s.)/154; UN3261/154

EC Number: 203-509-8

Regulatory Authority and Advisory Information

Hazard Alert: Combustible, Corrosive, Irritant.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: C, Xi; risk phrases: R34; R37/38; R40; R41; safety phrases: S25; S26; S36/37/39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Dibutyl phosphate is a pale amber to brown, odorless liquid. Molecular weight = 210.24; specific gravity (H_2O:1) = 1.06; boiling point = (decomposes) 135°C−138°C; freezing/melting point = −13°C; vapor pressure ≈1 mmHg @ 20°C; flash point = 188°C (oc); Autoignition temperature = 420°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 0. Practically insoluble in water.

Potential Exposure: This material is used as a catalyst in organic synthesis.

Incompatibilities: Dibutyl phosphate is a medium strong acid. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides. Attacks many metals forming flammable and explosive hydrogen gas. Attacks some plastics, rubber, and coatings.

Permissible Exposure Limits in Air

NIOSH IDLH = 30 ppm

OSHA PEL: 1 ppm/5 milligram per cubic meter TWA

NIOSH REL: 1 ppm/5 milligram per cubic meter TWA; 2 ppm/10 milligram per cubic meter STEL

ACGIH TLV[1]: 1 ppm TWA inhalable fraction and vapor; 2 ppm STEL inhalable fraction and vapor. [skin]

PAC Ver. 29[138]

PAC-1: 2 ppm

PAC-2: 21 ppm

PAC-3: 125 ppm

DFG MAK: Germ Cell Mutation Category 3A

Australia: TWA 1 ppm (5 milligram per cubic meter); STEL 2 ppm, 1993; Belgium: TWA 1 ppm (8.8 milligram per cubic meter); STEL 2 ppm (17 milligram per cubic meter), 1993; Finland: TWA 1 ppm (8 milligram per cubic meter); STEL 3 ppm (24 milligram per cubic meter), [skin], 1999; France: VME 1 ppm (5 milligram per cubic meter), 1999; Norway: TWA 1 ppm (5 milligram per cubic meter), 1999; the Philippines: TWA 1 ppm (5 milligram per cubic meter), 1993; Switzerland: MAK-W 1 ppm (8.5 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 5 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: STEL 2 ppm. Some states have set guidelines or standards for dibutyl phosphate in ambient air[60] ranging from 50−100 μ/m^3 (North Dakota) to 80 μ/m^3 (Virginia) to 100 μ/m^3 (Connecticut) to 119 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #5017.

Determination in Water: Octanol-water coefficient: Log $K_{ow} = < 1.5$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion, and eye and/or skin contact. Passes through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Exposure can irritate and burn the eyes. Inhalation can irritate the respiratory tract causing coughing, wheezing, and shortness of breath. Skin contact irritates the skin causing rash or burning sensation.

Long-Term Exposure: Can cause drying and cracking of skin. Can cause lung irritation.

Points of Attack: Respiratory system, skin, and eyes.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater) the following are recommended before beginning work and at regular times after that. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. NIOSH lists the following tests: whole blood (chemical/metabolite); breath; urine (chemical/metabolite); urine (chemical/metabolite), end-of-shift

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Prevent skin contact. 8 hours (more than 8 hours of resistance to breakthrough $>0.1\ \mu g/cm^2/min$): butyl rubber gloves, suits, and boots; nitrile rubber gloves, suits, and boots; polyvinyl alcohol gloves; Viton gloves, suits. 4 hours (At least 4 but <8 hours of resistance to breakthrough $>0.1\ \mu g/cm^2/min$): 4H and Silver Shield gloves. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Up to 10 ppm: Sa (APF = 10) (any supplied-air respirator). Up to 25 ppm: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode. Up to 30 ppm: SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type SCBA).

Storage: Color code-White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Dibutyl phosphate must be stored to avoid contact with strong oxidizers, such as chlorine, chlorine dioxide, and bromine, since violent reactions occur.

Shipping: UN1760 Corrosive liquids, n.o.s., Hazard class: 8; Labels: 8-Corrosive material, Technical Name Required. UN3261 Corrosive solid, acidic, organic, n.o.s., Hazard class: 8; Labels: 8-Corrosive material, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Dibutyl phosphate is a combustible liquid. Thermal decomposition products may include oxides of phosphorus, carbon monoxide; phosphine, and phosphoric acid. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Dibutyl Phosphate*, Trenton, NJ (February 1998)

Dibutyl Phthalate D:0410

Formula: $C_{16}H_{22}O_4$; $C_6H_4(COOC_4H_9)2$

Synonyms: *o*-Benzenedicarboxylic acid, dibutyl ester; 1,2-Benzenedicarboxylic acid, dibutyl ester; Benzene-*o*-dicarboxylic acid di-*n*-butyl ester; Bis-*n*-butyl phthalate; BUFA; Butyl phthalate; *n*-Butyl phthalate (DOT); Celluflex DPB; DBP; DBP (ester); Di(*n*-butyl) 1,2-benzenedicarboxylate; Dibutyl 1,2-benzene dicarboxylate; Dibutyl 1,2-benzenedicarboxylate; Di-*n*-butyl phthalate; Dibutyl *o*-phthalate; Elaol; Ergoplast FDB; Ftalato de *n*-butilo (Spanish); Genoplast B; Hexaplas M/B; Kodaflex dibutyl phthalate (DBP); Morflex-240; NLA-10; Palatinol C; Palatinol DBP; Phthalic acid, dibutyl ester; Polycizer DBP; PX 104; RC Plasticizer DBP Staflex DBP; Uniplex 150; Witcizer 300

CAS Registry Number: 84-74-2

HSDB Number: 922

RTECS Number: TI0875000

UN/NA & ERG Number: UN3082 (environmentally hazardous substances, liquid, n.o.s.)/171

EC Number: 201-557-4 [*Annex I Index No.:* 607-318-00-4]

Regulatory Authority and Advisory Information

Carcinogenicity: EPA: Not Classifiable as to human carcinogenicity. United States Environmental Protection Agency Gene-Tox Program, Negative: *S. cerevisiae*-reversion; Inconclusive: In vitro SCE-nonhuman.

California Proposition 65 Chemical[102]: Developmental/ Reproductive toxin (female) 12/2/2005.

Hazard Alert: Combustible, Endocrine disruptor (high), Possible risk of forming tumors, Reproductive toxin: possible risk of gene damage/impaired fertility; Suspected reprotoxic hazard, Electrostatic hazard, Environmental hazard.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U069

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.057; Nonwastewater (mg/kg), 28

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8060 (5); 8270 (10)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb(4.55 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Canada, WHMIS, Ingredients Disclosure List, CEPA Priority Substance List, National Priority Release Inventory.

Hazardous to aquatic life or environment, with possible long lasting effects.[291] Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R101; R23/24/25; R39; R51; R61; R62; R63; safety phrases: S16; S29/35; S36/37; S41; S45; S53; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Dibutyl phthalate is a colorless oily liquid with a very weak aromatic odor. Molecular weight = 278.34; specific gravity (H_2O:1) = 1.05 @ 20°C; boiling point = 340°C; freezing/melting point = −35°C; vapor pressure = 0.00007 mmHg @ 20°C; flash point = 157°C; Autoignition temperature = 402°C; Explosive limits: LEL: 0.5% @ 235°C; UEL: ≈ 2.5%. Hazard identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Corrosive. Practically insoluble in water; solubility = 0.001% @ 25°C.

Potential Exposure: Use in making vinyl compounds; in plasticizing vinyl acetate emulsion systems and in plasticizing cellulose esters. Also used as a lacquer solvent (nail polish remover) and insect repellent.

Incompatibilities: DBP is a medium strong acid. Reacts with strong oxidizers, strong alkalis; strong acids; nitrates. Attacks many metals forming flammable and explosive hydrogen gas.

Permissible Exposure Limits in Air

NIOSH IDLH = 4000 milligram per cubic meter

OSHA PEL: 5 milligram per cubic meter TWA

NIOSH REL: 5 milligram per cubic meter TWA

ACGIH TLV[1]: 5 milligram per cubic meter TWA

PAC Ver. 29[138]

PAC-1: 15 milligram per cubic meter

PAC-2: 1600 milligram per cubic meter

PAC-3: 9300 milligram per cubic meter

DFG MAK: 0.05 ppm/0.58 milligram per cubic meter; Peak Limitation Category I(1) Pregnancy Risk Group: C

Australia: TWA 5 milligram per cubic meter, 1993; Austria: MAK 5 milligram per cubic meter, 1999; Belgium: TWA 5 milligram per cubic meter, 1993; France: VME 5 milligram per cubic meter, 1999; Hungary: TWA 2 milligram per cubic meter; STEL 4 milligram per cubic meter [skin] 1993; India: TWA 5 milligram per cubic meter, 1993; Japan: 5 milligram per cubic meter, 1999; Norway: TWA 3 milligram per cubic meter, 1999; the Philippines: TWA 5 milligram per cubic meter, 1993; Poland: MAC (TWA) 5 milligram per cubic meter, MAC (STEL) 10 milligram per cubic meter, 1999; Russia: STEL 0.5 milligram per cubic meter, 1993; Sweden: NGV 3 milligram per cubic meter, KTV 5 milligram per cubic meter, 1999; Switzerland: MAK-W 5 milligram per cubic meter, 1999; United Kingdom: TWA 5 milligram per cubic meter; STEL 10 milligram per cubic meter, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: TWA 5 milligram per cubic meter. Russia has set a limit for ambient air of 0.1 milligram per cubic meter on a once daily basis; the Czech Republic[35] has set ambient air limits at 0.8 milligram per cubic meter on a daily average basis and 2.4 milligram per cubic meter on a half-hour exposure basis.

Determination in Air: Use NIOSH Analytical Method (IV) #5020.

Permissible Concentration in Water: State Drinking Water Guidelines: Florida 700 μg/L; Maine 700 μg/L; Minnesota 700 μg/L; New Hampshire 800 μg/L; Wisconsin 100 μg/L.

Determination in Water: Gas chromatography (EPA Method 606) or gas chromatography plus mass spectrometry (EPA Method 625). Octanol-water coefficient: Log $K_{ow} = > 4.5$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, ingestion; eye and skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Highly corrosive. The substance irritates the eyes, skin, nasal passages, and upper respiratory system. May cause skin allergy; stomach irritation; light sensitivity.

Long-Term Exposure: Unknown at this time. However this chemical may cause lung problems. Di-*n*-butyl phthalate may also damage the developing fetus and may also damage the testes (male reproductive glands).

Points of Attack: Eyes, respiratory system, and GI system.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. ACGIH recommends butyl rubber; Neoprene, nitrile rubber, and viton as good to excellent protective materials. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: 50 milligram per cubic meter: Any air-purifying full facepiece respirator equipped with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100. 125 milligram per cubic meter: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). 250 milligram per cubic meter: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). 4000 milligram per cubic meter: SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). Emergency or planned entry into unknown concentrations or IDLH conditions: SCBAF: Pd, Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type SCBA). *Note:* Substance causes eye irritation or damage; eye protection needed.

Storage: Color code-Blue: Health Hazard/Toxics/Poisons. Store in tightly closed containers in a cool well-ventilated area away from heat. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Di-*n*-butyl phthalate must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, or chlorine dioxide); strong alkalis (such as sodium hydroxide, potassium hydroxide and lithium hydroxide); and strong acids (such as sulfuric acid, hydrochloric acid, and nitric acid), since violent reactions occur. Sources of ignition, such as smoking and open flames are prohibited where di-*n*-butyl phthalate is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN3082 Environmentally hazardous substances, liquid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include phthalic anhydride and oxides of carbon. Use dry chemicals or carbon dioxide. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: May be absorbed on vermiculite, sand or earth and disposed of in a sanitary landfill. Alternatively, it may be incinerated[22]. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(102); (31); (173); (101); (138); (2); (80); (100).

United States Environmental Protection Agency, *Phthalate Esters: Ambient Water Quality Criteria*, Washington, DC (1980)

National institute for Occupational Safety and Health (NIOSH), *Profiles on Occupational Hazards for Criteria Document Priorities: Phthalates, 97-103, Report PB-274-273*, Cincinnati, OH (1977)

United States Environmental Protection Agency, *Di-n-butyl Phthalate, Health and Environmental Effects Profile No. 62*, Washington, DC, Office of Solid Waste (April 30, 1980)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Di-n-butyl Phthalate*, Trenton, NJ (February 1989)

Sax N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 5, No. 4, 40−44 (1985)

Dicamba D:0420

Formula: $C_8H_6Cl_2O_3$; $Cl_2C_6H_2(OCH_3)COOH$

Synonyms: AI3-27556; *o*-Anisic acid, 3,6-dichloro-; Banex; Banlen; Banvel; Banvel 4S; Banvel 4WS; Banvel CST; Banvel herbicide; Banvel II herbicide; Benzoic acid, 3,6-dichloro-2-methoxy-; Brush Buster; Caswell No. 295; Compound B dicamba; Dianate; Dicamba benzoic acid herbicide; Dicambra; 3,6-Dichlor-3-methoxy-benzoesaeure (German); 3,6-Dichloro-*o*-anisic acid; 2,5-Dichloro-6-methoxybenzoic acid; 3,6-Dichloro-2-methoxybenzoic acid; EPA pesticide chemical code 029801; MDBA; Mediben; 2-Methoxy-3,6-dichlorobenzoic acid; Velsicol 58-CS-11; Velsicol compound R

CAS Registry Number: 1918-00-9

HSDB Number: 311

RTECS Number: DG7525000

UN/NA & ERG Number: UN3082 (environmentally hazardous substances, liquid, n.o.s.)/171; UN2770 (Benzoic derivative pesticides, liquid, flammable, toxic)/151

EC Number: 217-635-6 [*Annex I Index No.*: 607-043-00-X]

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Suspected reprotoxic hazard.

United States Environmental Protection Agency, FIFRA 1998 Status of Pesticides: Supported

United States Environmental Protection Agency Gene-Tox Program, Positive: *B. subtilis* rec assay; *E. coli polA* without S9; Negative: Histidine reversion-Ames test; Negative: In vitro UDS-human fibroblast; TRP reversion; Negative: *S. cerevisiae-homozygosis*; Inconclusive: *D. melanogaster* sex-linked lethal

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)

Safe Drinking Water Act (47FR 9352): Priority List (55 FR 1470)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1000 lb (454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, Drinking Water Quality, 0.12 mg/L MAC.

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xn, N; risk phrases: R11; R20/21/22; R36; R41; R51/53; safety phrases: S16; S26; S36/37/39; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [2-Hazard to water. (est.)]

Description: Dicamba is a white or brown nonflammable, colorless, odorless solid. May be dissolved in a flammable liquid carrier. Molecular weight = 221.04; specific gravity (H_2O:1) = 1.57; boiling point = 195°C (decomposes below B.P.); freezing/melting point = 114°C−116°C. Hazard identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 0. Highly soluble in water.

Potential Exposure: A potential danger to those involved in manufacture, formulation and application of this post-emergence herbicide. Used to control allual and perennial broad leaf weeds in corn, sorghum, small grain pastures; and noncroplands.

Incompatibilities: Incompatible with sulfuric acid, bases, ammonia, aliphatic amines; alkanolamines, isocyanates, alkylene oxides; epichlorohydrin. Dicamba decomposes in heat, producing toxic and corrosive fumes including hydrogen chloride.

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices. Although no United States exposure limits have been established, this chemical can be absorbed through the skin, thereby increasing exposure

Russia: STEL 1 milligram per cubic meter, [skin], 1993.

Permissible Concentration in Water: A no-adverse-effect-level in drinking water has been calculated by NSA/NRC[46] at 0.009 mg/L. States which have set guidelines for dicamba in drinking water[61] include Maine @ 9.0 μg/L and Wisconsin @ 12.5 μg/L. Canada's MAC in drinking water is 0.12 mg/L.

Determination in Water: A detection limit of 1 ppb for dicamba by electron-capture gas chromatography has been reported by NAS/NRC[46]. Octanol-water coefficient: Log K_{ow} = 2.2.Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Ingestion, inhalation, and skin absorption.

Harmful Effects and Symptoms

Short-Term Exposure: Dicamba irritates the eyes, skin, and respiratory tract. Exposure can cause nausea, vomiting, loss of appetite and weight; muscle weakness; and exhaustion. The acute toxicity of dicamba is relatively low. Dicamba produced no adverse effect when fed to rats at up to 19.3 mg/kg/day and 25 mg/kg/day in subchronic and chronic studies. The no-adverse-effect dose in dogs was 1.25 mg/kg/day in a 2-year feeding study. Based on these data, an ADI was calculated at 0.0012 mg/kg/day. LD_{50} = (oral-rat) 1037 mg/kg (slightly toxic).

Long-Term Exposure: May affect the liver.

Points of Attack: Liver.

Medical Surveillance: Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type SCBA).

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with dicamba all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area away from incompatible materials listed above, heat and water.

Shipping: UN3082 Environmentally hazardous substances, liquid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.; UN2770 Benzoic derivative pesticides, liquid, flammable, toxic, Labels: 3-Flammable liquid, 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Use extinguishers suitable for surrounding fire. Thermal decomposition products may include chlorine and hydrogen chloride. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Land disposal or incineration are disposal options[22]. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (80); (100).

United States Environmental Protection Agency, *Health advisory: Dicamba, Washington, DC, Office of Drinking Water* (August 1987)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Dicamba*, Trenton, NJ (January 1999)

United States Department of Agriculture (USDA), Soil Conservation Service, *SCS/ARS/CES Pesticide Properties Database: Version 2.0*, Syracuse, NY,(1990).

Dichlobenil D:0423

Formula: $C_7H_3Cl_2N$

Synonyms: Barrier; Benzonitrile, 2,6-dichloro-; Bh prefix d; Carsoron; Carsoron G4; Carsoron G 20-SR; Casoron 133; Code H133; DBN; 2,6-DBN; DCB; DCBN; Decabane; 2,6-Dichlorobenzonitrile; 2,6-Dichlorocyanobenzene; Du-sprex; Dyclomec; Fydulan; Fydumas; Fydusit; H 133; H 1313; NIA 5996; Niagara 5996; Niagara 5006; Prefix d

CAS Registry Number: 1194-65-6

HSDB Number: 312

RTECS Number: DI3500000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171; UN3082 (environmentally hazardous substances, liquid, n.o.s.)/171; UN3439 (nitrile, solid)/151

EC Number: 214-787-5 [*Annex I Index No.:* 608-015-00-X]

Regulatory Authority and Advisory Information

Carcinogenicity: EPA Group C, possible human carcinogen

Potential Ground water Pollutant [California FAC Section 13145(d)/12811, active]

Clean Water Act: Section 311 Hazardous Substances/RQ (same as CERCLA)

EPCRA Section 304 RQ: CERCLA, 100 lb (45.4 kg)

Hazard symbols, risk, & safety statements: Hazard symbol: Xn, N; risk phrases: R21; R50/R53; safety phrases: S2; S36/37; S61; S41 (see Appendix 4)

Description: White solid. Molecular weight = 172.01; boiling point = 269°C; boiling point = decomposes @ 120°C before boiling; freezing/melting point = 143°C−146°C; vapor pressure = 1×10^{-3} mmHg @ 25. Practically insoluble in water; solubility = 18 ppm @ 20°C.

Potential Exposure: Dichlobenil is a substituted benzene/benzonitrile herbicide used on cranberry bogs, dichondra, ornamentals, blackberry, raspberry, and blueberry fields, apple, pear, filbert and cherry orchards, vineyards, hybrid poplar-cottonwood plantations, and rights-of-way to control weeds; and sewers to remove roots. It acts on dandelion, prickly oxtongue (pre-emergence), and tree roots.

Incompatibilities: Nitriles may polymerize in the presence of metals and some metal compounds. They are incompatible with acids; mixing nitriles with strong oxidizing acids can lead to extremely violent reactions. Nitriles are generally incompatible with other oxidizing agents such as peroxides and epoxides. The combination of bases and nitriles can produce hydrogen cyanide. Nitriles are hydrolyzed in both aqueous acid and base to give carboxylic acids (or salts of carboxylic acids). These reactions generate heat. Peroxides convert nitriles to amides. Nitriles can react vigorously with reducing agents. Acetonitrile and propionitrile are soluble in water, but nitriles higher than propionitrile have low aqueous solubility. They are also insoluble in aqueous acids[101].

Permissible Exposure Limits in Air:

NIOSH REL: *Nitriles:* 2 ppm, Ceiling Concentration, not to be exceeded in any 15-minute work period. See NIOSH Criteria Document 212 *Nitriles*.

Determination in Air: Filter; none; Gravimetric; NIOSH IV [Particulates NOR; #0500 (total), #0600 (respirable)]. Determination in Air[18].

Permissible Concentration in Water: Federal Drinking Water Guidelines: 9 ppb[14].

Determination in Water: Octanol-water coefficient: Log K_{ow} = 2.6−2.7. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood. Fish toxicity (threshold)(101): Very low—973.64357 ppb, MATC (Maximum Acceptable Toxicant Concentration)

Routes of Entry: Inhalation, absorbed through the unbroken skin.

Harmful Effects and Symptoms

Short-Term Exposure: Contact can irritate the skin and eyes. Inhalation may irritate the nose and throat. High exposure can cause headache, dizziness, a drop in blood pressure, rapid pulse, loss of appetite, seizures, coma and death. Repeated high exposure may result in a loss of smell, acne-like rash. LD_{50} (oral, rat) = > 2500 mg/kg. Moderately toxic.

Long-Term Exposure: May cause cancer. Human toxicity (long term)(101): High—9.10 ppb, Health advisory

Points of Attack: Eyes, skin, liver, and kidneys

Medical Surveillance: This chemical is a suspected or known human carcinogen. Exposed persons should contact a physician for advice regarding the possible long term health effects and advice for medical monitoring. Preliminary medical exam to detect chronic diseases of CNS, liver, heart, kidneys, lung, and skin, as well as endocrinological or immunological disturbances, should protect susceptible individuals. Periodical medical exams of internal organs, skin and eyes are important to avoid chronic occupational intoxications. They should include lab and patch tests when necessary[83].

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Do not induce vomiting when formulations containing petroleum solvents are ingested

Respirator Selection: Wherever and whenever workplace conditions warrant respirator use, a respiratory protection program must be followed that meets one or more of the following requirements: OSHA's 29 CFR 1910.134, ANSI Z88.2, or European Standard EN 149.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of dermal contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type SCBA).

Storage: Color code-Blue: Health Hazard/Poison. Store in a secure poison location. Prior to working with dichlobenil, all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area away from incompatible materials listed above, heat and water.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required. UN3082 Environmentally hazardous substances, liquid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required. UN3439 Nitriles, solid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling:

Nitriles spill

Initial Isolation and Protective Action Distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24 h response line).

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.1/0.2

Large Spills (from a large package or from many small packages)

First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.3/0.5
Night 0.5/0.8

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Use extinguishers suitable for surrounding fire. Thermal decomposition products may include oxides of nitrogen, hydrogen cyanide, hydrogen. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Land disposal or incineration are disposal options. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138).

New Jersey Department of Health and Senior Services, *Hazardous Substance Fact Sheet: Dichlobenil*, Trenton, NJ (October 2000). http://www.state.nj.us/health/eoh/rtkweb/0636.pdf

United States Environmental Protection Agency, "*Reregistration Eligibility Decision (RED), Dichlobenil*," Office of Prevention, Pesticides and Toxic Substances, Washington, DC (October 1998). http://www.epa.gov/REDs/0263red.pdf

United States Environmental Protection Agency, Office of Pesticide Programs, "*Pesticide Residue Limits: Dichlobenil,*" 40 CFR 180.231. www.epa.gov/pesticides/food/viewtols.htm

Dichloran D:0427

Formula: $C_6H_4Cl_2N_2O_2$; $Cl_2C_6H_2(NO_2)NH_2$

Synonyms: AI-50; AI3-08870; AL-50; Allisan; Aniline, 2,6-dichloro-4-nitro-; Benzenamine, 2,6-dichloro-4-nitro-; Bortran; Botran; Caswell No. 311; CDNA; CNA; DCNA; Dicloran; 2,6-Dichloro-4-nitrobenzenamine; 2,6-Dichloro-4-nitroaniline; Ditranil; Fumite dicloran smoke acaricide; 4-Nitro-2,6-dichloroaniline; 4-Nitroaniline, 2,6-dichloro-; RD-6584; Resisan; U-2069

CAS Registry Number: 99-30-9

HSDB Number: 1570

RTECS Number: BX2975000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154; UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 202-746-4

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Suspected reprotoxic hazard, Developmental toxin (TRI)

Potential Ground water Pollutant [California FAC Section 13145(d)/12811, active]

EPCRA Section 313 Form R *de minimus* concentration reporting level: 1.0%

Hazard symbols, risk, & safety statements: Hazard symbol: Xi; risk phrases: R36/R37/38; safety phrases: S26; S27/39 (see Appendix 4)

Description: Dicloran is a yellow crystalline solid or power. Odorless. Molecular weight = 207.01; boiling point = (decomposes); freezing/melting point = 193°C−195°C. Hazard identification (based on NFPA-704M Rating System): Health 2, Flammability 0, Reactivity 0. Low solubility in water; solubility = 1 g/L @ 60°C.

Potential Exposure: Dichloran is a substituted benzene/chlorophenyl fungicide Used to control fungi on a variety of crops. The top crop usages in California are on celery, head lettuce, and grapes (table, wine and raisin).

Incompatibilities: Keep away from strong oxidizing agents, strong acids; acid anhydrides; acid chlorides; acetic anhydride; and carbon dioxide.

Determination in Water: Octanol-water coefficient: Log $K_{ow} = 2.8$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Harmful Effects and Symptoms

Short-Term Exposure: Contact with eyes or skin: may be fatal if absorbed through skin; may cause skin irritation. Inhalation should be avoided; may cause respiratory tract irritation. May be harmful and possibly fatal, if swallowed. LD_{50} (oral, rat) = > 2000 mg/kg.

Routes of Entry: Inhalation, ingestion, and skin absorption.

Long-Term Exposure: May cause tumors, reproductive and fetal effects.

Points of Attack: Eyes, liver, blood, CNS, spleen, and liver. Reproductive cells.

Medical Surveillance: In addition to comprehensive initial medical and work histories emphasizing reproductive experience and menstrual history, patient should have physical examination and testing of genito-urinary tract, sperm count, motility and morphology. If required, other tests, such as serum testosterone, serum FSH, and LH may be indicated.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.*

Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Storage: Color code-Blue: Health Hazard/Poison. Store in a secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft[70]. Isolation Distance, Fire: 800 m/0.5 mi[70]. First remove all sources of ignition. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 m/150 ft for liquids and at least 25 m/75 ft for solids. Increase, in the downwind direction, as necessary, the isolation distance shown above. Eliminate all ignition sources (no smoking, flares, sparks or flames in immediate area). Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Stop leak if you can do it without risk. Prevent entry into waterways, sewers, basements or confined areas. Absorb or cover with dry earth, sand or other noncombustible material and transfer to containers. Do not get water inside containers. Soil Adsorption Index (K_{oc}) = 5000 (estimate).

Fire Extinguishing: Decomposes above 350°C emitting oxides of nitrogen and carbon and hydrogen chloride gas. *Fire involving storage or vehicular tanks:* Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. *Small fire:* Dry chemical, carbon dioxide or water spray. *Large fire:* Dry chemical, carbon dioxide, alcohol-resistant foam or water spray. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal; do not scatter the material. *Fire involving tanks or car/trailer loads:* Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Do not get water inside containers. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. Always stay away from tanks engulfed in fire. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with a licensed waste disposal service or environmental regulatory agencies for guidance on acceptable disposal practices. Dissolve or mix material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber.

References

(31); (173); (101); (138).

United States Environmental Protection Agency, Office of Pesticide Programs, "*Pesticide Residue Limits: Dicloran,*" 40 CFR 180.200. www.epa.gov/pesticides/food/viewtols.htm

Dichloroacetic Acid D:0430

Formula: $C_2H_2Cl_2O_2$

Synonyms: Acetic acid, bichloro-; Acetic acid, dichloro-; Bichloroacetic acid; DCA; Dichlorethanoic acid

CAS Registry Number: 79-43-6

HSDB Number: 6894

RTECS Number: AG6125000

UN/NA & ERG Number: UN1764/153

EC Number: 201-207-0 [*Annex I Index No.:* 607-066-00-5]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Limited Evidence; Human Inadequate Data, *not classifiable as carcinogenic to humans*, Group 2B, 1995; EPA: Likely to produce cancer in humans.

California Proposition 65 Chemical[102]: Cancer 5/1/1996; male 8/7/2009.

Hazard Alert: Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction).

United States National Primary Drinking Water Regulations: zero mg/L; MCL = 0.060 mg/L, dichloroacetic acid, as a haloacetic acid.

Hazard symbols, risk, & safety statements: Hazard symbol: T, C, N, Xi, Xn; risk phrases: R20; R23/24/25; R35; R36/37/38; R39; R40; R51; R62; R63; safety phrases: S16; S26; S36/37; S39; S41; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: DCA is a corrosive, combustible, colorless liquid with a pungent odor. Molecular weight = 128.94; specific gravity (H_2O:1) = 1.56; boiling point = 193.8°C; freezing/melting point = 9.7−13.5°C; vapor pressure = 1 mmHg @ 44°C; flash point = 110°C. Autoignition temperature = 190°C; Hazard identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 1. Highly corrosive. Soluble in water.

Potential Exposure: This haloacetic acid can be a byproduct of drinking water disinfection and may increase the risk of cancer. This chemical is used as starting material for the production of glyoxylic; dialkyloxy acids; and sulfonamides. It is also used as a fungicide, a medication; and a chemical intermediate in pharmaceuticals.

Incompatibilities: DCA is a medium strong acid; incompatible with nonoxidizing mineral acids; organic acids; bases, acrylates, aldehydes, alcohols, alkylene oxides; ammonia, aliphatic amines; alkanolamines, aromatic amines; amides, furfuryl alcohol (explosion hazard), glycols, isocyanates, ketones. Attacks metals generating flammable hydrogen gas. Attacks some plastics, rubber, and coatings.

Permissible Exposure Limits in Air

ACGIH TLV[1]: 0.5 ppm/2.64 milligram per cubic meter [skin]; confirmed animal carcinogen with unknown relevance to humans

PAC Ver. 29[138]

PAC-1: 1.5 ppm

PAC-2: 8.9 ppm

PAC-3: 140 ppm

DFG MAK: Germ Cell Mutation Category 3A

Russia: STEL 4 milligram per cubic meter, 1993

Permissible Exposure Limits in Water: Safe Drinking Water Act (47FR 9352): zero mg/L; MCL = 0.060 mg/L, dichloroacetic acid, as a haloacetic acid.

Determination in Water: Octanol-water coefficient: Log $K_{ow} = < 1.0$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Corrosive. Destructive to the eyes, skin, and tissues of the respiratory tract; causes severe irritation and burns. Eye contact may cause permanent damage. Higher exposures can cause chemical pneumonitis and pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Symptoms can include burning sensation, coughing, wheezing, laryngitis, shortness of breath, headache, nausea, and vomiting.

Long-Term Exposure: Increased risk of cancer. May cause damage to the developing fetus. May affect the liver and kidneys. May damage the nervous system causing numbness, "pins and needles," and/or weakness in the hands and feet. Repeated exposure may cause lung irritation, bronchitis. There is limited evidence that DCA causes liver cancer in animals.

Points of Attack: Lungs, liver, kidneys, and nervous system.

Medical Surveillance: This chemical may increase the risk of cancer. Exposed persons should contact a physician for advice regarding the possible long term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Lung function tests, kidney function tests. Examination of the nervous system. Liver and kidney function tests. Lung function tests. Examination of the nervous system. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: SCBA > 1.5 ppm. *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA-or European Standard EN 149-approved SCBA that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-face-piece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type SCBA).

Storage: Color code-White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with DCA all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area away from incompatible materials listed above. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1764 Dichloricacetic acid, Hazard class: 8; Labels: 8-Corrosive material.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid, but does not readily ignite. Thermal decomposition products may include phosgene, hydrogen chloride, carbon monoxide. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(102); (31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Dichloroacetic Acid*, Trenton, NJ (February 1999)

Dichloroacetylene D:0440

Formula: C_2Cl_2; ClC≡CCl

Synonyms: DCA; Dichlorlethyne; Ethyne, dichloro-

CAS Registry Number: 7572-29-4

HSDB Number: 7200

RTECS Number: AP1080000

UN/NA & ERG Number: FORBIDDEN, Not produced commercially.

EC Number: [*Annex I Index No.:* 602-069-00-8]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Limited Evidence; Human Inadequate Data*, not classifiable as carcinogenic to humans*, Group 3, 1999.

Hazard Alert: Unstable explosive, Highly toxic gas, Possible risk of forming tumors, Suspected reprotoxic hazard.

OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 250 lb (114 kg)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: A, E, Xn; risk phrases: R20; R40; R45; R48/20; safety phrases: S2; S36/37.

WGK[100] (German Aquatic Hazard Class): No value found. [1-Low hazard to water. (est.)]

Description: DCA is a volatile, pyrophoric oil. It has an unpleasant, sweetish odor. A gas above 32°C/90°F. Molecular weight = 94.92; specific gravity (H_2O:1) = 1.26 @ 20; boiling point = (explodes) 33°C; freezing/melting point = −50 to −66°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Insoluble in water.

Potential Exposure: DCA, dichloroacetylene, is not produced commercially and is a possible decomposition product of trichloroethylene or trichloroethane. Reported to be a by-product of vinylidene chloride (see V:0220). Also, a closed circuit anesthesia with trichloroethylene, heat and moisture produced by soda-lime absorption of CO_2 may produce dichloroacetylene (DCA) along with phosgene and carbon monoxide (CO).

Incompatibilities: An unstable explosive; heat or shock may cause explosion. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong acids (forms poisonous gases of phosgene and hydrogen chloride), strong bases.

Permissible Exposure Limits in Air
OSHA PEL: None
NIOSH REL: 0.1 ppm/0.4 milligram per cubic meter Ceiling Concentration; Potential occupational carcinogen; limit exposure to lowest feasible level. See *NIOSH Pocket Guide*, Appendix A.
ACGIH TLV[1]: 0.1 ppm/0.39 milligram per cubic meter Ceiling Concentration; confirmed animal carcinogen with unknown relevance to humans.
PAC Ver. 29[138]
PAC-1: 0.0091 ppm
PAC-2: 0.1 ppm
PAC-3: 3.4 ppm
DFG MAK: Carcinogen Category 2
Australia: TWA 0.1 ppm (0.4 milligram per cubic meter), carcinogen, 1993; Austria: carcinogen, 1999; Belgium: STEL 0.1 ppm (0.39 milligram per cubic meter), 1993; Finland: TWA 0.1 ppm (0.4 milligram per cubic meter); STEL 0.3 ppm (1.2 milligram per cubic meter), 1993; Norway: TWA 0.1 ppm (0.4 milligram per cubic meter), 1999; the Netherlands: MAC-continuous 0.4 milligram per cubic meter, 2003; United Kingdom: STEL 0.1 ppm (0.39 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea: New Zealand, Singapore, and Vietnam: ACGIH TLV: Ceiling Concentration 0.1 ppm. Several states have set guidelines or standards for dichloroacetylene in ambient air[60] ranging from 3.2 μ/m^3 (Virginia) to 4.0 μ/m^3 (North Dakota) to 8.0 μ/m^3 (Connecticut) to 10.0 μ/m^3 (Nevada).

Determination in Air: The NIOSH pocket guide lists no methods. However, see NIOSH Analytical Method 1003, hydrocarbons, halogenated

Routes of Entry: Inhalation, skin absorption, ingestion, and skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Eye contact can cause irritation. Inhalation can irritate the respiratory tract with coughing, wheezing, and/or shortness of breath. Exposure can cause headache, loss of appetite; extreme nausea; vomiting; involvement of the trigeminal nerve and facial muscles causing paralysis of the face; and the development of facial herpes. Higher exposure may cause a build-up of fluid in the lungs (pulmonary edema). This can cause death. LD_{50} (mouse, inhalation) = $<$ 20 ppm.

Long-Term Exposure: There is limited evidence that DCA causes kidney cancer in animals. Dichloroacetylene can cause nervous system damage leading to weakness and behavioral changes; and may affect the kidneys. May cause lung irritation and the development of bronchitis with coughing, phlegm, and/or shortness of breath.

Points of Attack: CNS, lungs, and kidneys.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. If symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function tests. Exam of the nervous system. Consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Avoid skin contact. Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash or dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Wear protective gloves and clothing. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work.

Eye Protection: Wear splash-proof chemical goggles when working with liquid, unless full facepiece respiratory protection is worn. Wear gas-proof goggles, unless full facepiece respiratory protection is worn.

Respirator Selection: NIOSH: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type SCBA).

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with DCA all handlers should be trained on its proper handling and storage. Dichloroacetylene must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates), since violent reactions occur. Keep dichloroacetylene away from strong acids (such as hydrochloric, sulfuric, and nitric); because poisonous gases may be given off, including phosgene and hydrogen chloride. Store in tightly closed containers in a cool, well-ventilated area away from heat, potassium, sodium and aluminum powders. Sources of ignition, such as smoking and open flames are prohibited where dichloroacetylene is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Use only nonsparking tools and equipment, especially when opening and closing containers of dichloroacetylene. Wherever dichloroacetylene is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Explosive! Dichloroacetylene is cited by DOT[19] as "FORBIDDEN."

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Dichloroacetylene is a combustible liquid; becomes a gas above 32°C/90°F. It will explode before it reaches a temperature that is hot enough to burn. Poisonous gas is produced in fire including phosgene, hydrogen chloride, chloroform, chlorine, dioxin. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Dichloroacetylene*, Trenton, NJ (March 2004)

Dichlorobenzalkoniumb Chloride D:0450

Formula: C_8H_{17} to $C_{18}H_{37}$; $C_9H_{11}Cl_2N \cdot Cl$

Synonyms: Alkyl(C_6H_{18})dimethyl-3,4-dichlorobenzylammonium chloride; Alkyl(C_8H_{17} to $C_{18}H_{37}$) dimethyl-3,4-dichlorobenzyl ammonium chloride; Dichlorobenzalkonium chloride; Tetrosan

CAS Registry Number: 8023-53-8

HSDB Number: 6440

RTECS Number: BO3200000

Regulatory Authority and Advisory Information

Hazard Alert: Deadly poison[193], Combustible, Primary irritant (w/o allergic reaction).

Superfund/EPCRA 302, Extremely Hazardous Substances: *Dropped from listing in 1988.*

Hazard symbols, risk, & safety statements: Hazard symbol: Xn; risk phrases: R22; R36/37/38; safety phrases: S16; S26; S36/37; S45 (see Appendix 4)

Description: Dichlorobenzalkonium chloride is a colorless, crystalline solid. Specific gravity (H_2O:1) = 0.89; freezing/melting point = 33°C−34°C. Hazard identification (based on NFPA-704 M Rating System): Health 0, Flammability 1, Reactivity 0. Soluble in water.

Potential Exposure: This material is used as an antiseptic, germicide, algicide, sterilizer, and deodorant.

Incompatibilities: Chlorides may be incompatible with acids, acid fumes. Esters may be incompatible with moisture and nitrates. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions.

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Harmful Effects and Symptoms

Short-Term Exposure: Eye contact can cause vomiting, diarrhea, and abdominal pain. Ingestion causes burning pain in the mouth, throat and abdomen with spitting of blood; drooling, vomiting; burns and ulcers in the mouth, throat, pharynx, and esophagus; shock, restlessness, confusion, weakness, apprehension; muscle weakness; difficulty in breathing; depression; bluing of the skin; and death from shock or asphyxiation. Ten percent (10%) concentrated aqueous solutions are irritating to the skin and concentrations as low as 0.1–0.5% are irritating to the eyes and mucous membranes. Concentrations ranging from 2% to 17.5% have caused dermal necrosis. Ingestion can cause corrosion of upper intestinal tract. Swelling of throat and lungs with fluid (edema) also can occur. Death can occur due to paralysis of respiratory muscles or circulatory collapse. The oral LD_{50} (oral-rat) = 730 mg/kg (slightly toxic).

Long-Term Exposure: May cause liver and kidney damage. Prolonged or repeated contact may cause allergic contact dermatitis to skin and allergic reaction in the lungs.

Points of Attack: Liver, kidneys, lungs, and skin.

Medical Surveillance: Liver and kidney function tests. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If concentrated (10% or greater) solution is ingested, patient should swallow a large quantity of milk, egg whites or gelatin solution. If breathing is difficult, give oxygen.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type SCBA).

Storage: Color code-Green: General storage may be used. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area away from acids, acid fumes; moisture and nitrates.

Shipping:

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, or foam extinguishers. Thermal decomposition products may include nitrogen oxides, ammonia, and hydrogen chloride. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Use a licensed professional waste disposal service to dispose of this material. Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138).

United States Environmental Protection Agency, Chemical Hazard Information Profile: *Dichlorobenzalkonium Chloride*, Washington, DC, Chemical Emergency Preparedness Program (October 31, 1985)

Dichlorobenzenes D:0460

Formula: $C_6H_4Cl_2$

Synonyms: *1,2-DCB:* Benzene, 1,2-dichloro-; Chloroben; Chloroden; Cloroben; DCB; *o*-Dichlorbenzol; Dichloricide; *o*-Dichlorobenzene; 1,2-Dichlorobenzene; Dichlorobenzene, *o*-; *o*-Dichlorobenzol; *o*-Diclorobenceno (Spanish); 1,2-Diclorobenceno (Spanish); Dilantin DB; Dilatin DB; Dizene; Dowtherm E; J100; NCI-C54944; ODB; ODCB; Orthodichlorobenzene; Orthodichlorobenzol; Special termite fluid; Termitkil; Ultramac S40

1,3-DCB: Benzene, *m*-dichloro-; Benzene, 1,3-dichloro-; *m*-Dichlorobenzene; *m*-Dichlorobenzol; *m*-Diclorobenceno (Spanish); 1,3-Diclorobenceno (Spanish); Metadichlorobenzene; *m*-Phenylene dichloro

1,4-DCB: Benzene, *p*-dichloro-; Benzene, 1,4-dichloro-; 1,4-Dichlorobenzol; *p*-Chlorophenyl chloride; Di-chloricide; *p*-Dichlorobenzene; *p*-Diclorobenceno (Spanish); 1,4-Diclorobenceno (Spanish); Evola; Paracide; Para Crystals; Paradi; Paradichlorobenzene; Paradow; Paramoth; Paranuggets; Parazene; PDB; Persia-Perazol; Santochlor; Santoclor

mixed isomers: Amisia-Mottenschutz; Benzene, dichloro-; DCB; Dichlorobenzene (mixed isomers); Diclorobenceno (Spanish); Dilatin DBI; Mottenschutzmittel evau P; Mott-EX; Totamott

CAS Registry Number: 95-50-1 (*o*-DCB); 541-73-1 (*m*-DCB); 106-46-7 (*p*-DCB); 25321-22-6 (mixed isomers)

HSDB Number: 521(*o*-DCB); 522 (*m*-DCB); 523 (*p*-DCB)

RECS Number: CZ4500000 (*o*-DCB); CZ4499000 (*m*-DCB); CZ4550000 (*p*-DCB); CZ4430000 (mixed isomers)

UN/NA & ERG Number: (*o*-DCB) UN1591/152; (*p*-DCB) UN1592/152; (*m*-DCB) UN2810 (toxic liquid, organic, n.o.s.)/153; UN3077 (environmentally hazardous substances, solid, n.o.s.)/171; UN3082 (environmentally hazardous substances, liquid, n.o.s.)/171

EC Number: 202-425-9 [*Annex I Index No.:* 602-034-00-7] (*o*-DCB); 208-792-1 [*Annex I Index No.:* 602-067-00-7]; 203-400-5 [*Annex I Index No.:* 602-035-00-2] (*p*-DCB); 246-837-7 (mixed isomers)

Regulatory Authority and Advisory Information

1,4-Dichlorobenzene NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen

***m*-DCB, CAS 541-73-1**

Carcinogenicity: IARC: Animal Inadequate Evidence; Human Inadequate Data*, not classifiable as carcinogenic to humans*, Group 3, 1999; EPA: Not Classifiable as to human carcinogenicity.

Hazard Alert: Poison, Flammable, Possible risk of forming tumors, Suspected of causing genetic defects, Environmental hazard.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/1992); Toxic Pollutant (Section 401.15)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U071

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.036; Nonwastewater (mg/kg), 6.0

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8010 (5); 8020 (5); 8120 (10); 8270 (10)

Safe Drinking Water Act (47FR 9352): Regulated chemical (47FR9352) as dichlorobenzene; Priority List (55FR1470)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.; classification of B3, D1B on Canada's DSL List.

Hazard symbols, risk, & safety statements: Hazard symbol: T, F, Xn, N; risk phrases: R22; R51/53; R62; safety phrases: S61; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to waters (*all isomers*)

o-DCB, 95-50-1

Carcinogenicity: IARC: Animal, No Cancer Evidence; Human, Inadequate Data*, not classifiable as carcinogenic to humans*, Group 3, 1999; EPA: Not Classifiable as to human carcinogenicity.

Hazard Alert: Agricultural chemical, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction). Listed for Tier 1 screening as an endocrine disruptor[88].

United States National Primary Drinking Water Regulations: MCLG = 0.6 mg/L; MCL = 0.6 mg/L as *o-DCB*.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/1992); Toxic Pollutant (Section 401.15)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U070

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.088; Nonwastewater (mg/kg), 6.0

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8010 (2); 8020 (5); 8120 (10); 8270 (10)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%., CEPA Priority Substance List, National Pollutant Release Inventory (NPRI); Drinking Water Quality 0.2 mg/L MAC and ≤0.003 mg/L AO

Hazard symbols, risk, & safety statements: Hazard symbol: T, F, Xn, N; risk phrases: R22; R36/37/38; R51/53; R62; R63; safety phrases: S23; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to waters (*all isomers*)

p-DCB, CAS 106-46-7

Carcinogenicty: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; Carcinogenicity: IARC: Animal Limited Evidence; Human Inadequate Data, *not classifiable as carcinogenic to humans*, Group 2B; NCI: Carcinogenesis Studies (gavage); clear evidence: mouse, rat.

Hazard Alert: Agricultural chemical, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction). Listed for Tier 1 screening as an endocrine disruptor[88].

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

United States National Primary Drinking Water Regulations: MCLG = 0.075 mg/L; MCL = 0.075 mg/L, as *p-DCB*.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/1992); Toxic Pollutant (Section 401.15)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U072; D027

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA Toxicity Characteristic (Section 261.24), Maximum Concentration of Contaminants, regulatory level, 7.5 mg/L

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.090; Nonwastewater (mg/kg), 6.0

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8010 (2); 8020 (5); 8120 (15); 8270 (10)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%., CEPA Priority Substance List, NPRI; Drinking Water Quality 0.005 mg/L MAC and ≤0.001 mg/L AO

Hazard symbols, risk, & safety statements: Hazard symbol: T, F, Xn, N; risk phrases: R22; R36/37/38; R51/53; R62; R63; safety phrases: S22; S23; S24/25; S41; S45; S46; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to waters (*all isomers*)

Description: There are three isomeric forms of dichlorobenzene (DCB):

m-DCB is a flammable liquid and vapor. Molecular weight = 147.00; specific gravity (H_2O:1) = 1.29 @ 20°C; boiling point = 173°C; freezing/melting point = −24.8°C; vapor pressure = 0.75 mmHg @ 8°C; flash point = 63°C. Explosive limits: LEL: 119,000 ppm; UEL: unknown. Hazard identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0.

o-DCB is a colorless to pale yellow liquid with a pleasant, aromatic odor. Molecular weight = 147.00; specific gravity (H_2O:1) = 1.31 @ 20°C; boiling point = 180°; freezing/melting point = −17°C; vapor pressure = 0.75 mmHg @ 16.3°C; flash point = 60°C; 66°C (cc); Autoignition temperature: 648°C. Explosive limits: LEL: 2.2%; UEL: 9.2%. Hazard identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 0. Insoluble in water.

p-DCB is a colorless or white solid with a mothball-like odor. Molecular weight = 147.00; specific gravity (H_2O:1) = 1.25 @ 55°C; boiling point = 174°C; freezing/melting point = 53.1°C; vapor pressure = 0.75 mmHg @ 8°C; 13 mmHg @ 20°C; flash point = 66°C. Insoluble in water. Explosive limits: LEL: 2.5%; UEL: unknown. Hazard identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 0. Insoluble in water.

Potential Exposure: The major uses of *o*-DCB are as a process solvent in the manufacturing of toluene diisocyanate and as an intermediate in the synthesis of dyestuffs, herbicides, and degreasers. *p*-Dichlorbenzene is used primarily as a moth repellant, a mildew control agent; space deodorant; and in insecticides, which accounts for 90% of the total production of this isomer. Information is not available concerning the production and use of *m*-DCB. However, it may occur as a contaminant of *o*-or *p*-DCB formulations. Both *o*-and *p*-isomers are produced almost entirely as by-products during the production of monochlorobenzene.

Incompatibilities: For *o*-DCB and *m*-DCB: acid fumes, chlorides, strong oxidizers; hot aluminum, or aluminum alloys. For *p*-DCB: Strong oxidizers; although, incompatibilities for this chemical may also include other materials listed for *o*-DCB.

Permissible Exposure Limits in Air

NIOSH IDLH = 200 ppm ***(m-isomer); 150 ppm (p-isomer)***

OSHA PEL: 50 ppm/300 milligram per cubic meter Ceiling Concentration

NIOSH REL: 50 ppm/300 milligram per cubic meter Ceiling Concentration

ACGIH TLV[1]: 25 ppm TWA; 50 ppm STEL, not classifiable as a human carcinogen

541-73-1, m-DCB

NIOSH IDLH = 200 ppm

PAC Ver. 29[138]

PAC-1: 6 ppm

PAC-2: 66 ppm

PAC-3: 400 ppm

DFG MAK: 2 ppm/12 milligram per cubic meter TWA; Peak Limitation Category II(2); Pregnancy Risk Group C

95-50-1, o-DCB

Odor threshold = 0.30 ppm.

OSHA PEL: 50 ppm/300 milligram per cubic meter Ceiling Concentration

NIOSH REL: 50 ppm/300 milligram per cubic meter Ceiling Concentration

ACGIH TLV[1]: 25 ppm/150 milligram per cubic meter TWA; 50 ppm/301 milligram per cubic meter Ceiling Concentration

DFG MAK: [skin]; Pregnancy Risk Group C

PAC Ver. 29[138]

PAC-1: 50 ppm

PAC-2: 170 ppm

PAC-3: 1000 ppm

DFG MAK: 10 ppm/61 milligram per cubic meter TWA; Peak Limitation Category II(2) [skin]; Pregnancy Risk Group C; BAT information available

Australia: TWA 50 ppm (300 milligram per cubic meter), 1993; Austria: MAK 50 ppm (300 milligram per cubic meter), [skin], 1999; Belgium: STEL 50 ppm (301 milligram per cubic meter), [skin], 1993; Finland: TWA 50 ppm (300 milligram per cubic meter); STEL 75 ppm (450 milligram per cubic meter), [skin], 1999; France: VLE 50 ppm (300 milligram per cubic meter), 1999; Hungary: TWA 50 milligram per cubic meter; STEL 100 milligram per cubic meter, [skin], 1993; Japan: STEL 25 ppm (150 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 122 milligram per cubic meter, 2003; Norway: TWA 25 ppm (150 milligram per cubic meter), 1999; the Philippines: TWA 50 ppm (300 milligram per cubic meter), 1993; Poland: MAC (TWA) 20 milligram per cubic meter, MAC (ceiling) 300 milligram per cubic meter, 1999; Russia: STEL 50 milligram per cubic meter, 1993; Sweden: ceiling 50 ppm (300 milligram per cubic meter), 1999; Switzerland: MAK-W 50 ppm (300 milligram per cubic meter), KZG-W 100 ppm (600 milligram per cubic meter), 1999; Thailand: TWA 50 ppm (300 milligram per cubic meter), 1993; Turkey: TWA 50 ppm (300 milligram per cubic meter), 1993; United Kingdom: STEL 50 ppm (306 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: STEL 50 ppm

106-46-7, p-DCB

NIOSH IDLH = 150 ppm, potential human carcinogen

Odor threshold = 0.18 ppm.

OSHA PEL: 75 ppm/450 milligram per cubic meter TWA

NIOSH REL: Potential carcinogen. Limit exposure to lowest feasible level; See *NIOSH Pocket Guide*, Appendix A

ACGIH TLV[1]: 10 ppm/60 milligram per cubic meter TWA; confirmed animal carcinogen with unknown relevance to humans.

PAC Ver. 29[138]

PAC-1: 30 ppm

PAC-2: 170 ppm

PAC-3: 1000 ppm

DFG MAK: [skin] Carcinogen Category 2; Pregnancy Risk Group 3B; BAT suspended 2003

Australia: TWA 75 ppm (450 milligram per cubic meter); STEL 110 ppm, 1993; Austria: carcinogen, 1999; Belgium: TWA 75 ppm (451 milligram per cubic meter); STEL 110 ppm (661 milligram per cubic meter), 1993; Finland: TWA 75 ppm (450 milligram per cubic meter); STEL 115 ppm (690 milligram per cubic meter), [skin], 1999; France: VME 75 ppm (450 milligram per cubic meter), VLE 110 ppm (675 milligram per cubic meter), 1999; Japan: 50 ppm (300 milligram per cubic meter), 2B carcinogen, 1999; the Netherlands: MAC-TGG 150 milligram per cubic meter, 2003; the Philippines: TWA 75 ppm (450 milligram per cubic meter), 1993; Poland: MAC (TWA) 20 milligram per cubic meter, 1999; Russia: TWA 50 ppm, 1993; Sweden: NGV 75 ppm (450 milligram per cubic meter), KTV 110 ppm (700 milligram per cubic meter), 1999; Switzerland: MAK-W 50 ppm (300 milligram per cubic meter), KZG-W 100 ppm (600 milligram per cubic meter), 1999; Turkey: TWA 75 ppm (450 milligram per cubic meter), 1993; United Kingdom: TWA 25 ppm (153 milligram per cubic meter); STEL 50 ppm (306 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: confirmed animal carcinogen with unknown relevance to humans. Russia[43 gives a MAC for ambient air in residential areas of 0.035 milligram per cubic meter on a once daily basis for *p*-DCB[35].

Determination in Air: Use NIOSH Analytical Method 1003 or OSHA Analytical Method 7.

Permissible Concentration in Water: Safe Drinking Water Act (47FR 9352): MCL, 0.6 mg/L; MCLG, 0.6 mg/L. ***(m-DCB)*** Federal Drinking Water Standards: EPA 600 μg/L; Federal Drinking Water Guidelines: EPA 600 μg/L; State Drinking Water Standards: New Jersey 600 μg/L; State Drinking Water Guidelines: Arizona 620 μg/L; Connecticut 210 μg/L; Maine 60 μg/L; Wisconsin 1250 μg/L. (***o-DCB***) Federal Drinking Water Guidelines: EPA 600 μg/L; State Drinking Water Standards: New Jersey 600 μg/L; State Drinking Water Guidelines: Arizona 620 μg/L; Maine 63 μg/L; Minnesota 600 μg/L. (***p-DCB***) Federal Drinking Water Standards: EPA 75 μg/L; Federal Drinking Water Guidelines: EPA 75 μg/L; State Drinking Water Standards: California 5 μg/L; Massachusetts 5 μg/L; State Drinking Water Guidelines: Arizona 75 μg/L; Maine 21 μg/L; Minnesota 10 μg/L.

Determination in Water: Gas chromatography (EPA Methods 601, 602, 612) or gas chromatography plus mass spectrometry (EPA Method 625). Gas-chromatographic methods have been developed for *p*-PDB with a sensitivity of 380 pg/cm peak high, and *p*-PDB concentrations as low as 1.0 ppb in water have been analyzed according to NAS/NRC. Octanol-water coefficient: Log K_{ow} (*p*-) = 3.37. Values above 3.0 are likely to bioaccumulate in aquatic organisms.

Routes of Entry: *o*-DCB: inhalation, skin absorption, ingestion, and skin and/or eye contact. *p*-DCB: Inhalation, ingestion, and eye and skin contact.

Harmful Effects and Symptoms

Human exposure to dichlorobenzene is reported to cause hemolytic anemia and liver necrosis, and 1,4-dichlorobenzene has been found in human adipose tissue. In addition, the dichlorobenzenes are toxic to nonhuman mammals, birds, and aquatic organisms and impart an offensive taste and odor to water. The dichlorobenzenes are metabolized by mammals, including humans, to various dichlorophenols; some are as toxic as the dichlorobenzenes.

Exposure can damage blood cells. Contact can cause irritation of the skin and eyes. Prolonged contact can cause severe burns. It may damage the liver, kidneys and lungs. Exposure can cause headache, dizziness; swelling of the eyes, hands and feet; and nausea. Higher levels can cause severe liver damage and death. Persons with preexisting pathology (hepatic, renal, CNS; blood) or metabolic disorders; who are taking certain drugs (hormones or otherwise metabolically active), or who are otherwise exposed to DCBs or related (chemically or biologically) chemicals by such means as occupation, or domestic use or abuse, e.g., pica or "sniffing") of DCB products, might well be considered at increased risk from exposure to DCBs.

Short-Term Exposure: *o-DCB:* Can be absorbed through the skin, thereby increasing exposure. Irritates the eyes, skin, and respiratory tract. Prolonged skin contact may cause blisters. May affect the CNS. Exposure can cause headache and nausea. Higher exposure can cause dizziness, lightheadedness, and unconsciousness.

m-DCB: Can be absorbed through the skin, thereby increasing exposure. Symptoms are similar to *o*-DCB and *m*-DCB may damage the red blood cells leading to low blood count.

p-DCB: Can be absorbed through the skin, thereby increasing exposure. Exposure can cause headache, dizziness, nausea, swelling of the hands and feet. Contact with the dust can irritate and burn the eyes and skin. Skin allergy may develop.

Long-Term Exposure: *o-DCB:* Liver, kidney, or circulatory system problems. Repeated or prolonged contact may cause skin sensitization and allergy. Long term exposure may cause damage to the blood cells, liver, kidneys, and lungs.

m-DCB: Repeated or prolonged contact may cause skin sensitization and allergy. May affect the liver and kidneys.

p-DCB: Anemia; liver, kidney, or spleen damage; changes in blood. May be carcinogenic to humans; it causes kidney and liver cancer in animals. There is a suggested association between this chemical and leukemia. There is evidence that *p*-DCB can damage the developing animal fetus. Repeated exposure can damage the nervous system; skin allergy and damage the lungs, liver, and kidneys. *p*-DCG may affect the blood and cause hemolytic anemia.

Points of Attack: *o*-DCB and *m*-DCB: liver, kidneys, skin, and eyes. *p*-DCB: liver, respiratory system, eyes, kidneys, and skin.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater, or significant skin contact) the following are recommended before beginning work and at regular times after that: Liver and kidney function tests. Lung function tests. CBC. If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. NIOSH lists the following tests: (*o*-isomer) urine (chemical/metabolite); (*p*-isomer) Expired Air, liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. 4 hours (At least 4 but $<$8 hours of resistance to breakthrough $>$ 0.1 μg/cm^2/min): Viton gloves, suits; 4H and Silver Shield gloves. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof (*o*-DCB or *m*-DCB) or dust-proof (*p*-DCB) chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: For o-DCB: 2000 ppm: CcrFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted acid gas canister]; or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). Emergency or planned entry into unknown concentrations or IDLH conditions: SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-, mounted organic vapor canister]; or SCBAE (any appropriate escape-type SCBA). *Note:* Substance causes eye irritation or damage; eye protection needed.

p-DCB: NIOSH: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full face-piece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type SCBA).

Storage: Color code-Red (*o*-DCB): Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Color code-Blue (*m*-DCB): Health Hazard/Poison: Store in a secure poison location. Prior to working with any DCB all handlers should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Dichlorobenzene must be stored to avoid contact with strong oxidizers, such as permanganates, nitrates, peroxides, chlorates, and perchlorates, hot aluminum or aluminum alloys, since violent reactions occur. Store in tightly closed containers in a cool well-ventilated area away from heat and direct light. Sources of ignition, such as smoking and open flames are prohibited where dichlorobenzene is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Always store pesticides in their original containers, complete with labels that list ingredients, directions for use, and first aid steps in case of accidental poisoning. Never store pesticides in cabinets with or near food, animal feed, or medical supplies. Do not store pesticides in places where flooding is possible or in places where they might spill or leak into wells, drains, ground water, or surface water[72]. A regulated, marked area should be established where *p*-DCB is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: *m*-DCB: UN2810 Toxic liquids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. United States DOT Regulated Marine Pollutant. UN3077 Environmentally hazardous substances, solis, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required. UN3082 Environmentally hazardous substances, liquid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

UN2810 Toxic liquids, organic, n.o.s.

Initial Isolation and Protective Action Distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24 h response line).

Small Spills (from a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 0.7/1.2

Large Spills (from a large package or from many small packages)

First: Isolate in all directions (ft/m) 1000/300
Then: Protect persons downwind (mi/km)
Day 1.1/1.8
Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: *p-DCB:* This chemical is a combustible solid. Use dry chemical, carbon dioxide, or foam extinguishers. Thermal decomposition products may include hydrogen chloride. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode. *o-DCB and m-DCB:* These chemicals are combustible liquids. Thermal decomposition products may include hydrogen chloride and chlorine. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced[22]. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(109); (31); (173); (101); (138); (2); (203); (80); (100).

United States Environmental Protection Agency, *Dichlorobenzene: Ambient Water Quality Criteria*, Washington, DC (1980)

United States Environmental Protection Agency, *1,2-Dichlorobenzene, Health and Environmental Effects Profile No. 64*, Washington, DC, Office of Solid Waste (April 30, 1980)

United States Environmental Protection Agency, *1,3-Dichlorobenzene*, *Health and Environmental Effects Profile No. 65*, Washington, DC, Office of Solid Waste (April 30, 1980)

United States Environmental Protection Agency, *1,4-Dichlorobenzene*, *Health and Environmental Effects Profile No. 66*, Washington, DC, Office of Solid Waste (April 30, 1980)

United States Environmental Protection Agency, Dichlorobenzenes, *Health and Environmental Effects Profile No. 67*, Washington, DC, Office of Solid Waste (April 30, 1980)

Sax N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 4, No. 2, 45−48 (1984) (1,3-Dichlorobenzene); 4, No. 2, 49−52, and 6, No. 2, 50−57 (1986) (Mixed isomers)

United States Public Health Service, *Toxicological Profile for 1,4-Dichlorobenzene*, Atlanta, Georgia, agency for Toxic Substances & Disease Registry (December 1987)

New York State Department of Health, *Chemical Fact Sheet: ortho-Dichlorobenzene*, Bureau of Toxic Substance Assessment, Albany, NY (March 1986)

New York State Department of Health, *Chemical Fact Sheet: para-Dichlorobenzene*, Bureau of Toxic Substance Assessment, Albany, NY (April 1986)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: 1,3-Dichlorobenzene*, Trenton, NJ (February 1999)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: 1,4-Dichlorobenzene*, Trenton, NJ (December 2005)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: 1,2-Dichlorobenzene*, Trenton, NJ (December 2005)

3,3-Dichlorobenzidine (Its Dihydrochloride and Other Salts)

D:0470

Formula: $C_{12}H_{10}Cl_2N_2$; $C_6H_3ClNH_2C_6H_3ClNH_2$

Synonyms: Benzidine, 3,3′-dichloro-; (1,1′-biphenyl)-4,4′-diamine, 3,3′-dichloro-; C.I. 23060; Curithane C 126; DCB; 4,4′-Diamino-3,3′-dichlorobiphenyl; 4,4′-Diamino-3,3′-dichlorodiphenyl; *o,o*’-Dichlorobenzidine; Dichlorobenzidine; 3,3′-Dichloro-4,4′-biphenyldiamine; 3,3′-Dichlorobiphenyl-4,4′-diamine; 3,3′-Dichloro-4,4′-diamino(1,1-biphenyl); 3,3′-Dichloro-4,4′-diaminobiphenyl; 3,3-Diclorobencidina (Spanish)

dihydrochloride: A13-22046; Benzidine, 3,3′-dichloro-, dihydrochloride; (1,1′-Biphenyl)-4,4′-diamine, 3,3′-dichloro-, dihydrochloride; 3,3′-Dichlorobenzidine hydrochloride; 3,3′-Dichloro-(1,1′-biphenyl)-4,4′-diamine dihydrochloride

sulfate: (1,1′-Biphenyl)-4,4′-diamine, 3,3′-dichloro-, sulfate (1:2); 3,3′-Dichlorobenzidine dihydrogen bis(sulfate); 3,3′-

Dichlorobenzidine sulfate; Sulfato de 3,3-diclorobenzidina (Spanish)

CAS Registry Number: 91-94-1; 612-83-9 (dihydrochloride); 64969-34-2 (sulfate)

HSDB Number: 1632 (91-94-1)

RTECS Number: DD0525000; DD0550000 (dihydrochloride)

UN/NA & ERG Number: UN1885/153; UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 202-109-0 [*Annex I Index No.:* 612-068-00-4]; 210-323-0 [*Annex I Index No.:* 612-069-00-X] (dihydrochloride); 265-293-1 [*Annex I Index No.:* 612-069-00-X] (sulfate)

Regulatory Authority and Advisory Information

91-94-1

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC:[9] Human Inadequate Evidence, animal Sufficient Evidence, 1982*, possibly carcinogenic to humans*, Group B2, 1987; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies.

California Proposition 65 Chemical[102]: Cancer 10/1/1987.

Hazard Alert: Poison, Combustible, Sensitization hazard (skin), Environmental hazard

Hazardous to aquatic life or environment, with possible long lasting effects[293]. Toxic to aquatic life with long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

European/Int Do not allow release to the environment unless proper permits are obtained from the federal government. ernational Regulations (91-94-1): Hazard symbol: T, N, Xi; risk phrases: R45; R21; R23/24/25; R39; R43; R50/53; R62; R63; safety phrases: S7; S16; S29/35; S45; S53; S36/37; S41; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class) (91-94-1): 3-Severe hazard to water.

612-83-9, dihydrochloride

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen;. United States Environmental Protection Agency Gene-Tox Program, Positive: Carcinogenicity-mouse/rat; Positive: Cell transformation-RLV F344 rat embryo; Positive: Cell transformation-SA7/SHE; Histidine reversion-Ames test; Inconclusive: In vitro UDS-human fibroblast.

California Proposition 65 Chemical[102]: Cancer 5/15/1998.

Hazard Alert: Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard.

Banned or Severely Restricted (several countries) (UN)[13],[35]

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR 1910.1007)

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/1992); Toxic Pollutant (Section 401.15)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U073

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (20)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

European/International Regulations (91-94-1): Hazard symbol: T, N, Xi; risk phrases: R45; R21; R43; R50/53; R62; R63; safety phrases: S53; S45; S60; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class) (91-94-1): 3-Severe hazard to water.

Dyhydrochloride and Sulfate:

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR 1910.1007)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

European/International Regulations (*3,3′-dichlorobenzidine salts*): Hazard symbol: T, N, Xi; risk phrases: R45; R21; R43; R50/53; R62; R63; safety phrases: S53; S45; S60; S61.

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: 3,3’-Dichlorobenzidine is a gray or purple crystalline solid. Molecular weight = 253.13; boiling point = 368°C; 402°C[138]; freezing/melting point = 132.5°C; Autoignition temperature = ~350°C. Hazard identification (based on NFPA-704 M Rating System): Health 0, Flammability 1, Reactivity 0. Practically insoluble in water; solubility = 0.07% @ 15°C.

Potential Exposure: A halide-and amine-substituted aromatic compound used in the dye industry, curing agent for isocyanate terminated resins. The major uses of dichlorobenzidine are in the manufacture of pigments for printing ink, textiles, plastics, and crayons and as a curing agent for solid urethane plastics. There are no substitutes for many of its uses. Additional groups that may be at risk include workers in the printing or graphic arts professions handling the 3,3’-DCB-based azo pigments. 3,3’-DCB may be present as an impurity in the pigments, and there is some evidence that 3,3’-DCB may be metabolically liberated from the azo pigment.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides. Achemical base: neutralize acids to form salts plus water with an exothermic reaction. May be incompatible with isocyanates, halogenated organics, peroxides, phenols (acidic), epoxides, anhydrides, and acid halides. Flammable gaseous hydrogen is generated by amines in combination with strong reducing agents such as hydrides, nitrides, alkali metals, and sulfides.

Permissible Exposure Limits in Air

OSHA PEL: Cancer suspect agent. Exposures of workers to this chemical is to be controlled through the required use of engineering controls, work practices; and personal protective equipment (PPE), including respirators. See 29 CFR 1910.1003-1910.1016 for specific details of these requirements. See Appendix B of the *NIOSH Pocket Guide*.

NIOSH REL (*3,3'-Dichlorobenzidine and its salts*): A potential occupational carcinogen. Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A *Note:* OSHA and NIOSH concluded that benzidine and benzidine-based dyes were potential occupational carcinogens and recommended that worker exposure be reduced to the lowest feasible level. OSHA and NIOSH further concluded that *o*-tolidine and *o*-dianisidine (and dyes based on them) may present a cancer risk to workers and should be handled with caution and exposure minimized.

ACGIH TLV[1]: [skin] confirmed animal carcinogen with unknown relevance to humans; exposure to carcinogens must be kept to a minimum.

PAC Ver. 29[138]

91-94-1

PAC-1: 2.1 ppm

PAC-2: 23 ppm

PAC-3: 140 ppm

DFG MAK: [skin] Carcinogen Category 2

Australia [skin], carcinogen, 1993; Austria: [skin], carcinogen, 1999; France: carcinogen, 1993; Sweden: carcinogen, 1999; Switzerland: TWA 0.1 milligram per cubic meter, [skin], Carcinogen 1993; Switzerland 0.1 milligram per cubic meter, carcinogen, 1999; United Kingdom: carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: confirmed animal carcinogen with unknown relevance to humans. Several states have set guidelines or standards for dichlorobenzidine in ambient air[60] ranging from zero (North Dakota, Pennsylvania, Virginia) to 0.002 μ/m^3 (Rhode Island) to 0.10 μ/m^3 (New York) to 0.15 μ/m^3 (South Carolina).

Determination in Air: Use NIOSH Analytical Method #5509,[18] OSHA Analytical Method ID-65.

Permissible Concentration in Water: To protect freshwater and saltwater aquatic life: no criteria developed due to insufficient data. *To protect human health:* preferably zero. An additional life-time cancer risk of 1 in 100,000 results at a level of 0.103 μg/L[6]. States which have set guidelines for dichlorobenzidine in drinking water[61] include Kansas and Minnesota: both at 0.21 μg/L.

Determination in Water: Chloroform extraction followed by concentration and high performance liquid chromatography (EPA Method 605) or gas chromatography plus mass spectrometry (EPA Method 625).

Routes of Entry: Inhalation, skin absorption, ingestion, and skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Skin allergic sensitization, dermatitis, headache, dizziness, caustic burns; frequent urination; dysuria, hematuria (blood in the urine); GI upset; upper respiratory infection.

Long-Term Exposure: 3,3'-Dichlorobenzidine was shown to be a potent carcinogen in rats and mice in feeding and injection experiments, but no bladder tumors were produced. LD_{50} = (oral-rat) 5250 mg/kg (insignificantly toxic).

Points of Attack: Bladder, liver, lung, skin, and GI tract.

Medical Surveillance: Preplacement and periodic examinations should include history of exposure to other carcinogens, smoking, alcohol, medication, and family history. The skin, lung, kidney, bladder, and liver should be evaluated; sputum or urinary cytology may be helpful. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Full body protective clothing and gloves should be used by those employed in handling operations. Full-face supplied air respirators of continuous flow or pressure demand type should also be used. On exit from a regulated area, employees should shower and change into street clothes, leaving their protective clothing and equipment at the point of exit to be placed in impervious containers at the end of the work shift for decontamination or disposal. Effective methods should be used to clean and decontaminate gloves and clothing. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type SCBA).

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft[70]. Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Thermal decomposition products may include hydrogen chloride and oxides of nitrogen and carbon. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration (816°C, 0.5 second for primary combustion; 1204°C, 1.0 second for secondary combustion). The formation of elemental chlorine can be prevented through injection of steam or methane into the combustion process. nitrogen oxides may be abated through the use of thermal or catalytic devices[22]. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(109); (102); (31); (173); (101); (138); (2); (100).

United States Environmental Protection Agency, *3,3'-Dichlorobenzidine: Ambient Water Quality Criteria*, Washington, DC (1980)

United States Environmental Protection Agency, *3,3'-Dichlorobenzidine, Health and Environmental Effects Profile No. 68*, Washington, DC, Office of Solid Waste (April 30, 1980)

Sax N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 2, No. 5, 45−49 (1982) and 3, No. 2, 79−82 (1983)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: 3,3'-Dichlorobenzidine*, Trenton, NJ (May 2001).

1,4-Dichloro-2-butene D:0480

Formula: $C_4H_6Cl_2$

Synonyms: *cis-isomer:* 2-Butene, 1,4-dichloro-; 1,4-DCB; DCB; 1,4-Dichloro-2-butene; 1,4-Dichlorobutene-2; 1,4-Dicloro-2-butano (Spanish)

trans-isomer: AI3-52332; 2-Butene, 1,4-dichloro-, (*E*)-; 2-Butene, 1,4-dichloro-, *trans*-; 2-Butylene dichloride; (*E*)-1,4-Dichloro-2-butene; (*E*)-1,4-Dichlorobutene; *trans*-1,4-Dichloro-2-butene; *trans*-1,4-Dichlorobutene; *trans*-2,3-Dichlorobut-2-ene; 1,4-Dichloro-*trans*-2-butene; 1,4-Dichloro butene-2, (*E*)-; 1,4-Dichlorobutene-2, *trans*-

CAS Registry Number: 764-41-0 (*cis*-); 110-57-6 (*trans*-); 11069-19-5 (mixed isomers)

HSDB Number: 6008

RTECS Number: EM4900000 (*cis*-)/132; EM4903000 (*trans*-); EM4730000 (mixed isomers)

UN/NA & ERG Number: UN3384/131; UN2920 (corrosive liquid, flammable, n.o.s.)/132

EC Number: 212-121-8 [*Annex I Index No.:* 602-073-00-X]; 203-779-7(*trans*-)

Regulatory Authority and Advisory Information

Carcinogenicity: ACGIH (*cis-& trans-*): A2; Suspected human carcinogen. IARC (*1,4-isomer*): Animal Inadequate Evidence; Human No Data*, not classifiable as carcinogenic to humans*, Group 3.

California Proposition 65 Chemical[102]: Cancer 1/1/1990

Hazard Alert: Poison, Flammable liquid, Toxic, Corrosive.

Air Pollutant Standard Set. See below, "Permissible Exposure Limits in Air" section.

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U074

RCRA, 40CFR261, Appendix 8 Hazardous Constituents
RCRA Land Ban Waste Restrictions
Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg)
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. (1,4-Dichloro-2-butene and Dichlorobutene)
trans-isomer:
RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8240 (5)
Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500 lb (227 kg)
Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ:
EHS, 500 lb (227 kg)
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.
European/International Regulations (*cis-*): Hazard symbol: T+, N; risk phrases: R45; R10; R24/25; R26; R34; R50/53; safety phrases: S41; S45; S53; S60; S61. European/International Regulations (*trans-*): not listed in Annex 1.
WGK[100] (German Aquatic Hazard Class) (*cis-*): 3-Severe hazard to water.

Description: The 1,4-dichloro-2-butenes are colorless liquids. Some have a distinct odor. (*cis*-isomer): Molecular weight = 125; specific gravity (H_2O:1) = 1.18 @ 25°C; boiling point = 158°C; freezing/melting point = 3.5°C; vapor pressure = 3 mmHg @ 25°C. Explosive limits: LEL: 1.5%; UEL: 4.0%. Reacts slowly with water. (*trans*-isomer): This material has a sweet, pungent odor. Molecular weight = 125; specific gravity (H_2O:1) = 1.18 @ 25°C; boiling point = 155.5°C; freezing/melting point = 1°C–3°C; vapor pressure = 6 mmHg @ 25°C; flash point = 53°C. The explosive limits for the *trans*-isomer are LEL: 1.5%; UEL: 4%. Hazard identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 0. Insoluble in water. The *trans-isomer*, only, appears on the EHS list.

Potential Exposure: DC occurs as a by-product in chloroprene manufacture and may be used as a chemical intermediate.

Incompatibilities: Vapors may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides. (*cis*-isomer): Reacts slowly with water forming hydrogen chloride. Attacks metals and may form other, more dangerous materials; attacks some plastics.

Permissible Exposure Limits in Air
764-41-0, cis-isomer
ACGIH TLV[1]: 0.005 ppm/0.025 milligram per cubic meter TWA [skin] Suspected Human Carcinogen
PAC Ver. 29[138]
PAC-1: 0.015 ppm
PAC-2: 1.9 ppm
PAC-3: 12 ppm
DFG MAK: [skin] Carcinogen Category 2; Germ Cell Mutagen Category 3A
Russia[43] set a MAC in work-place air of 1.0 milligram per cubic meter for 1,3-dichloro-2-butene but set no value for 1,4-dichloro-2-butene.
110-57-6, trans-isomer
PAC-1: 0.078 ppm
PAC-2: 0.86 ppm
PAC-3: 3.8 ppm

Permissible Concentration in Water: Russia[43] set a MAC in water bodies used for domestic purposes of 0.05 mg/L for 1,3-dichloro-2-butene but has no value for 1,4-dichloro-2-butene.

Routes of Entry: Inhalation, dermal-absorbed through the skin, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Symptoms of exposure include respiratory distress and burns to skin and eyes. Inhalation of vapor irritates nose and throat. Contact with eyes causes intense irritation and tears. Contact of liquid with skin causes severe blistering. Ingestion causes severe irritation of mouth and stomach and may be fatal. Liquid and vapors from the material are highly corrosive and may damage skin, eyes, lungs, and internal organs.

Long-Term Exposure: The material is a carcinogen according to DFG[3] and ACGIH. Corrosive substances may affect the lungs.

Points of Attack: Lungs and skin.

Medical Surveillance. This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Lung function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable

probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Viton and Saranex are among the recommended protective materials. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type SCBA).

Storage: PIH; check oxygen content prior to entering storage area. (1) Color code-White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. (2) Color code-Red (*cis*-isomer): Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well ventilated area away from oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN3384 Toxic by inhalation liquid, flammable, n.o.s. with an $LC_{50} \leq 1000\ \text{ml/m}^3$ and saturated vapor concentration $\geq$ to 10 LC_{50}, Hazard class: 6.1; Labels: 6.1-Poisonous materials, 3-Flammable liquid, Technical Name Required, Inhalation Hazard Zone B. UN2920 Corrosive liquids, flammable, n.o.s., Hazard class: 8; Labels: 8-Corrosive material, 3-Flammable liquid. The code "D" identifies proper shipping names [Dichlorobutene] which are appropriate for describing materials for domestic transportation but may be inappropriate for international transportation under the provisions of international regulations, e.g., IMO, ICAO). An alternate proper shipping name may be selected when either domestic or international transportation is involved.

Spill Handling:

Poisonous by inhalation liquid, flammable, n.o.s. (Inhalation Hazard Zone B)

Initial Isolation and Protective Action Distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24 h response line).

Small Spills (from a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.1/0.2

Large Spills (from a large package or from many small packages)

First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.3/0.5
Night 0.5/0.8

Wear fully encapsulating, vapor protective clothing. Stop the release if it can be done safely from a distance. Prevent material and runoff from entering sewers and waterways if it can be done safely well ahead of the release. *Small spill*: Absorb with earth, sand, or other noncombustible material and transfer to containers with clean, nonsparking tools for later disposal. *Large spill*: Dike far ahead of liquid spill for later disposal. Water spray may reduce vapor; but may not prevent ignition in closed spaces. Ventilate confined area if it can be done without placing personnel at risk Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources and dampen spilled material with toluene to avoid airborne dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: The material will burn, though it may require some effort to ignite. Thermal decomposition products may include toxic fumes of chlorine-containing compounds. For small fires, use dry chemical, carbon dioxide, spray or foam. For large fires, use water spray, fog, or foam. Wear positive pressure breathing apparatus and full protective clothing. Move containers from fire area if you can do so without risk. Spray containers with cooling water until well after fire is out. Isolate for one-half mile in all directions if tank car or truck is involved in a fire.

Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: High-temperature incineration with hydrochloric acid scrubbing. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(102); (31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: *1,4-Dichlorobutene, trans-*), Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

Sax N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 4, No. 3, 41−44 (1984)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: trans*-1,4-Dichlorobutene, Trenton, NJ (December 2006)

Dichlorodifluoroethylene D:0490

Formula: $C_2Cl_2F_2$; CFCl = CFCl

Synonyms: Dichlorodifluoroethene; Ethene, dichlorofluoro-; Diclorodifluoroetileno (Spanish) to index

CAS Registry Number: 27156-03-2

RTECS Number: KV9460000

UN/NA & ERG Number: UN2810 (toxic liquid, organic, n.o.s.)/153

Regulatory Authority and Advisory Information

Description: Dichlorodifluoro-ethylene is a colorless gas or liquid. Molecular weight = 132.93; boiling point = 21.1°C. ₩ Reacts with water.

Potential Exposure: A potential danger to those involved in the manufacture of this compound or its use in the synthesis of fluorochemicals. Used for chemical research and development purposes.

Incompatibilities: Reacts with moisture, water, steam, forming corrosive and toxic fumes. Incompatible strong reducing agents, active metals; with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides.

Permissible Exposure Limits in Air

No standards or PAC available.

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guidelines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg[F]/L. Safe Drinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg[F]/L; SMCL = 2 mg/F/L, as Fluoride.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short-Term Exposure: Dichlorodifluoro-ethylene can affect you when breathed in. Exposure can irritate the eyes, nose and throat. High levels can cause you to become dizzy, light-headed and pass out. Similar compounds can cause the heart to beat irregularly, or stop, which can cause death.

Long-Term Exposure: May cause liver and kidney damage.

Points of Attack: Liver and kidneys.

Medical Surveillance: If symptoms develop or overexposure has occurred, the following tests may be useful: liver function tests. Kidney function tests. Holter monitor (a special 24 hour EKG to look for irregular heart beat).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash

immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to Dichlorodifluoro-ethylene exists, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. On contact with water or steam, dichlorodifluoro-ethylene produces highly toxic and corrosive fumes. Store in tightly closed containers in a cool, dry area.

Shipping: UN2810 Toxic, liquids, organic, n.o.s., Hazard class 6.1; Labels: 6.1-Poisonous materials Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. If dichlorodifluoro-ethylene gas is leaked, take the following steps: Restrict persons not wearing protective equipment from area of leak until cleanup is complete. Ventilate area of leak to disperse the gas. Stop flow of gas. If source of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air; repair leak or allow cylinder to empty. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Dichlorodifluoroethylene may burn, but does not readily ignite. Thermal decomposition products may include highly toxic fumes of fluorides and chlorides. Containers may explode in fire. Use dry chemical or CO_2 extinguishers. Use water spray to keep fire-exposed containers cool. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (122).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Dichlorodifluoro-Ethylene*, Trenton, NJ (July 2002)

Dichlorodifluoromethane D:0500

Formula: CCl_2F_2

Synonyms: Algofrene type 2; Arcton 6; Arcton 12; CFC-12; Diclorodifluometano (Spanish); Difluorodichloromethane; Electro-CF 12; Eskimon 12; F 12; FC 12; Fluorocarbon 12; Freon 12; Freon F-12; Frigen 12; Genetron 12; Halocarbon 12/Ucon 12; Halon; Halon 122; Isceon 122; Isotron 2; Isotron 12; Ledon 12; Methane, Dichlorodifluoro-; Propellant 12; R 12; Refrigerant 12; Ucon 12; Ucon 12/Halocarbon 12

CAS Registry Number: 75-71-8

HSDB Number: 139

RTECS Number: PA8200000

UN/NA & ERG Number: (PIH) UN1028/126

EC Number: 200-893-9

Regulatory Authority and Advisory Information

Hazard Alert: Poison inhalation hazard, Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated, Environmental hazard (atmospheric).

Clean Air Act: Stratospheric ozone protection (Title VI, Subpart A, Appendix A), Class I, Ozone Depletion Potential (ODP) = 1.0

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U075

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.23; Nonwastewater (mg/kg), 7.2

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8010 (10); 8240 (5)

Safe Drinking Water Act (47FR 9352): Priority List (55 FR 1470) (Removed January 1981)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 5000 lb (2270 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Harms public health and the environment by destroying ozone in the upper atmosphere.

Hazard symbols, risk, & safety statements: Hazard symbol: T, F, N, Xi, Xn; risk phrases: R5; R11; R12; R20; R21; R22; R23/24/25; R39; R58/59; safety phrases: S7; S9; S16; S23; S24/25; S26; S33; S36/37; S38; S41; S45; S57; S59; S61; S41 (see Appendix 4)

Description: Dichlorodifluoromethane is a colorless, nonflammable gas. Ethereal odor at >20% by volume. Shipped as a compressed gas. Molecular weight = 120.91; specific gravity (H_2O:1) = 1.49 @ −29.8°C; boiling point = −30°C; freezing/melting point = −157°C; vapor pressure = 750 mmHg @ −30°C. Hazard identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 0. Soluble in water; solubility = 0.03% @ 25°C.

Potential Exposure: Dichlorodifluoromethane is used as an aerosol propellant, refrigerant and foaming agent.

Incompatibilities: Chemically active metals: sodium, potassium, calcium; powdered aluminum; zinc, magnesium. Attacks magnesium and its alloys.

Permissible Exposure Limits in Air

NIOSH IDLH = 15,000 ppm

OSHA PEL: 1000 ppm/4950 milligram per cubic meter TWA

NIOSH REL: 1000 ppm/4950 milligram per cubic meter TWA

ACGIH TLV[1]: 1000 ppm/4950 milligram per cubic meter TWA; not classifiable as a human carcinogen

PAC Ver. 29[138]

PAC-1: 3000 ppm

PAC-2: 10,000 ppm [> = 10% LEL, lower explosive limit but < 50% LEL]

PAC-3: 50,000 ppm (> LEL, lower explosive limit)

DFG MAK: 1000 ppm/5000 milligram per cubic meter TWA; Peak Limitation Category II(2); Pregnancy Risk Group C.

Australia: TWA 1000 ppm (4950 milligram per cubic meter), 1993; Austria: MAK 1000 ppm (5000 milligram per cubic meter), 1999; Belgium: TWA 1000 ppm (4950 milligram per cubic meter), 1993; Finland: TWA 1000 ppm (4950 milligram per cubic meter); STEL 1250 ppm (6200 milligram per cubic meter), 1999; France: VME 1000 ppm (4950 milligram per cubic meter), 1999; Hungary: TWA 100 milligram per cubic meter; STEL 200 milligram per cubic meter, 1993; Japan: 500 ppm (2500 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 5040 milligram per cubic meter, 2003; Norway: TWA 500 ppm (2475 milligram per cubic meter), 1999; the Philippines: TWA 1000 ppm (4950 milligram per cubic meter), 1993; Poland: MAC (TWA) 4000 milligram per cubic meter, MAC (STEL) 6200 milligram per cubic meter, 1999; Russia: TWA 500 ppm; STEL 3000 milligram per cubic meter, 1993; Switzerland: MAK-W 1000 ppm (5000 milligram per cubic meter), 1999; Turkey: TWA 1000 ppm (4950 milligram per cubic meter), 1993; United Kingdom: TWA 1000 ppm (5030 milligram per cubic meter); STEL 1250 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Several states have set guidelines or standards for R-12 in ambient air[60] ranging from 49.5 milligram per cubic meter (North Dakota) to 82.5 milligram per cubic meter (Virginia) to 99.0 milligram per cubic meter (Connecticut) to 118.0 milligram per cubic meter (Nevada) to 247.0 milligram per cubic meter (North Carolina). Those values may well be modified in the future because of concern over the effect of chlorofluorocarbons on the depletion of the ozone layer in the atmosphere.

Determination in Air: Use NIOSH Analytical Method (IV) #1018.

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guidelines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg[F]/L. Safe Drinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg[F]/L; SMCL = 2 mg[F]/L.

Determination in Water: Use EPA Method 601.

Routes of Entry: Inhalation, eye and/or skin contact (liquid).

Harmful Effects and Symptoms

Short-Term Exposure: Exposure can cause you to become dizzy and lightheaded, and to have trouble concentrating. Exposure can cause the heart to beat irregularly (cardiac arrythmia) or cause heart arrest. This can cause death. Contact with the liquid can cause severe eye and skin burns from frostbite. Breathing the gas can irritate the mouth, nose and throat. High levels can cause asphyxiation.

Points of Attack: Cardiovascular system and peripheral nervous system.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: Special 24 h EKG (Holter monitor) to look for irregular heartbeat.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility.

Personal Protective Methods: Where cold equipment, vapors, or liquid may occur, employees should be provided with special clothing designed to prevent the freezing of body tissues. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. ACGIH recommends Neoprene rubber as a good to excellent protective material. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: 10,000 ppm: Sa (APF = 10) (any supplied-air respirator). 15,000 ppm: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-, mounted organic vapor canister]; or SCBAE (any appropriate escape-type SCBA).

Storage: Check oxygen content prior to entering storage area. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool well-ventilated area away from heat. Dichlorodifluoromethane must be stored to avoid contact with chemically active metals (such as sodium, potassium, calcium, powdered aluminum; zinc, and magnesium), since violent reactions occur. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: UN1028 Dichlorodifluoromethane or Refrigerant gas R-12, Hazard class: 2.2; Labels: 2.2-Nonflammable compressed gas. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak to disperse the gas. Stop flow of gas. If source of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. It may be necessary to contain and dispose of this chemical as a hazardous waste. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. The material itself does not burn. Thermal decomposition products may include hydrogen chloride. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced. Because of potential ozone decomposition in the stratosphere, R-12 should be released to the atmosphere only as a last resort[22]. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (173); (101); (138); (2); (122).

United States Environmental Protection Agency, *Halomethanes: Ambient Water Quality Criteri*a, Washington, DC (1980)

United States Environmental Protection Agency, *Trichlorofluoromethane and Dichlorodifluoromethane, Health and Environmental Effects Profile No. 167*, Washington, DC, Office of Solid Waste (April 30, 1980)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Dichlorodifluoromethane*, Trenton, NJ (May 1998)

New York State Department of Health, *Chemical Fact Sheet: Dichlorodifluoromethane*, Bureau of Toxic Substance Assessment, Albany, NY (January 1999)

1,3-Dichloro-5,5-dimethylhydantoin D:0510

Formula: $C_5H_6Cl_2N_2O_2$
Synonyms: Dactin; Dantion; DCDMH; DDH; 1,3-Dicloro-5,5-dimehyl-2,4-imidazolinedione; Halane; 2,4-Imidazolidinedione, 1,3-dichloro-5,5-dimethyl
CAS Registry Number: 118-52-5
HSDB Number: 4373
RTECS Number: MU0700000
UN/NA & ERG Number: UN1479/140; UN3085 (oxidizing solid, corrosive, n.o.s.)/140
EC Number: 204-258-7
Regulatory Authority and Advisory Information
Hazard Alert: Combustible, Strong oxidizer, Dangerously water reactive, Corrosive, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction).
Hazard symbols, risk, & safety statements: Hazard symbol: C, O, N, Xn; risk phrases: R8; R20/21/R22; R23/24/25; R31; R34; R36/37/38; R51; R62; safety phrases: S17; S26; S36/37/39; S41; S45; S61 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.
Description: DCDMH is a combustible, white powder. Chlorine-like odor. Molecular weight = 197.03; freezing/melting point = 130°C; flash point = 175°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0 Oxidizer, ₩. Slightly soluble in water; solubility = 0.2%. Reacts with water releasing hydrogen chloride gas.
Potential Exposure: It is used as a chlorinating agent, disinfectant, biocide, and laundry bleach. It is also used as a polymerization catalyst in making vinyl chloride; and in drug and pesticide synthesis.
Incompatibilities: A strong oxidizer. Contact with water forms poisonous and corrosive gases. Mixtures with xylene may explode. Not compatible with moisture (especially hot water, steam), strong acids; easily oxidized materials (such as ammonia salts; sulfides, etc.); reducing agents; strong bases; ammonium salts; sulfides. Compounds of the carboxyl group react with all bases, both inorganic and organic (i.e., amines) releasing substantial heat, water and a salt that may be harmful. Incompatible with arsenic compounds (releases hydrogen cyanide gas), diazo compounds, dithiocarbamates, isocyanates, mercaptans, nitrides, and sulfides (releasing heat, toxic and possibly flammable gases), thiosulfates and dithionites (releasing hydrogen sulfate and oxides of sulfur).
Permissible Exposure Limits in Air
NIOSH IDLH = 5 milligram per cubic meter
OSHA PEL: 0.2 milligram per cubic meter TWA
NIOSH REL: 0.2 milligram per cubic meter TWA; 0.4 milligram per cubic meter STEL
ACGIH TLV[1]: 0.2 milligram per cubic meter TWA; 0.4 milligram per cubic meter STEL
PAC not available
Australia: TWA 0.2 milligram per cubic meter; STEL 0.4 milligram per cubic meter, 1993; Belgium: TWA 0.2 milligram per cubic meter; STEL 0.4 milligram per cubic meter, 1993; Finland: TWA 0.2 milligram per cubic meter; STEL 0.6 milligram per cubic meter, 1999; France: VME 0.2 milligram per cubic meter, 1999; the Philippines: TWA 0.2 milligram per cubic meter, 1993; Switzerland: MAK-W 0.2 milligram per cubic meter, 1999; United Kingdom: TWA 0.2 milligram per cubic meter; STEL 0.4 milligram per cubic meter, 2000; the Netherlands: MAC-TGG 0.2 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: STEL 0.4 milligram per cubic meter. Several states have set guidelines or standards for this material in ambient air[60] ranging from 2.0−4.0 μ/m^3 (North Dakota) to 3.2 μ/m^3 (Virginia) to 4.0 μ/m^3 (Connecticut) to 5.0 μ/m^3 (Nevada).
Determination in Air: No method established.
Routes of Entry: Inhalation, ingestion, and eye and/or skin contact.
Harmful Effects and Symptoms
Short-Term Exposure: Irritation of skin, eyes, mucous membrane and respiratory system. LD_{50} = (oral-rat) 542 mg/kg (slightly toxic). Higher levels can irritate the lungs, causing a build-up of fluid (pulmonary edema). This can cause death.
Long-Term Exposure: Can irritate the lungs, causing bronchitis with coughing, phlegm, and/or shortness of breath.
Points of Attack: Eyes and respiratory system.
Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce

vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Up to 2 milligram per cubic meter: Sa (APF = 10) (any supplied-air respirator). Up to 5 milligram per cubic meter: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* Any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted canister providing protection against the compound of concern and having an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type SCBA).

Storage: Check oxygen content prior to entering storage area. Color code-Yellow: Reactive Hazard; Store in a location separate from other materials, especially organic materials, flammables and combustibles, and other incompatible materials. Oxidizers, including oxidizing gases, should have a boundary separation of 8−10 m or a 1 h hour fire wall from flammable or reactive materials. *Note:* Store corrosives in this group in chemical resistant secondary containers and/or in corrosion proof cabinets. Prior to working with this chemical, personnel should be trained on its proper handling and storage. 1,3-Dichloro-5,5-dimethyl hydantoin must be stored to avoid contact with strong acids (such as sulfuric acid, nitric acid, or hydrochloric acid) and easily oxidized materials (such as ammonium salts and sulfides), since violent reactions occur and poisonous gases can be produced. Store in tightly closed containers in a cool well-ventilated area away from water or steam. 1,3-Dichloro-5,5-dimethylhydantoin decomposes with formation of poisonous gases @ 201°C−210°C. If 1,3-dichloro-5,5-dimethylhydantoin contacts water or steam, it decomposes at lower temperatures and produces Thermal decomposition products may include chlorine. Sources of ignition, such as smoking and open flames are prohibited where 1,3-dichloro-5,5-dimethylhydantoin is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Store in a cool, well ventilated area away from incompatible materials listed above. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage.

Shipping: UN1479 Oxidizing solid, n.o.s., Hazard Class: 5.1; Labels: 5.1-Oxidizer, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Conflagrates at 212°C (turns brown). Thermal decomposition products may include hydrogen chloride, phosgene, and oxides of nitrogen and carbon. Chlorine gas evolves at temperatures >210°C[101]. Use dry chemical or carbon dioxide. *Do not use water.* If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration (815.5°C/816°C, 0.5 second for primary combustion; 104.4°C/220°F, 1.0 second for secondary combustion). The formation of elemental chlorine can be prevented by injection of steam or methane into the combustion process. Any nitrogen oxides may be abated by the use of thermal or catalytic devices.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: 1,3-Dichloro-5,5-Dimethyl Hydantoin*, Trenton, NJ (October 1998)

1,1-Dichloroethane D:0520

Formula: $C_2H_4Cl_2$; CH_3CHCl_2
Synonyms: Aethylidenchlorid (German); *asym*-Dichloroethane; Chlorinated hydrochloric ether; Chlorure d'ethylidene (French); 1,1-Dichloraethan (German); Dichloromethylethane; 1,1-Dicloroetano (Spanish); Ethane, 1,1-dichloro-; 1,1-Ethylidene chloride; Ethylidene chloride; Ethylidene dichloride; NCI-C04535
CAS Registry Number: 75-34-3
HSDB Number: 64
RTECS Number: KI0175000
UN/NA & ERG Number: UN2362/130
EC Number: 200-863-5 [*Annex I Index No.:* 602-011-00-1]
Regulatory Authority and Advisory Information
Carcinogenicity: NCI: Carcinogenesis Bioassay (gavage); equivocal evidence: mouse, rat; EPA: Possible Human Carcinogen; NIOSH recommends this material be treated in the work-place with caution because of its structural similarity to other chloroethanes shown to be carcinogenic in animals. (See Chloroethanes*, NIOSH Pocket Guide, Appendix C*)
California Proposition 65 Chemical[102]: Cancer 1/1/1990
Hazard Alert: Highly flammable liquid, Environmental hazard. Listed for Tier 1 screening as an endocrine disruptor[88].
Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)
Clean Water Act: 40CFR423, Appendix A, Priority Pollutants
United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U076
RCRA, 40CFR261, Appendix 8 Hazardous Constituents
RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.059; Nonwastewater (mg/kg), 6.0
RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8010 (1); 8240 (5)
Safe Drinking Water Act (47FR 9352): Priority List (55 FR 1470)
Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1000 lb (454 kg)
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)
Hazardous to aquatic life or environment, with possible long lasting effects[194]. Harmful to aquatic life with long lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.
Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.; B2 Flammable liquid.
Hazard symbols, risk, & safety statements: Hazard symbol: F, Xn, N; risk phrases: R11; R22; R36/37; R52/53; safety phrases: S2; S16; S21; S23; S29; S41; S61.; S41 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.
Description: 1,1-Didichloroethane is a colorless, oily liquid with a chloroform-like odor. Molecular weight = 98.96; specific gravity (H_2O:1) = 1.76 @ 20°C; boiling point = 57.3°C; freezing/melting point = −96.9°C; vapor pressure = 75 mmHg @ 1°C; flash point = −16.6°C (cc); Autoignition temperature = 458°C. Explosive limits: LEL: 8000 ppm; UEL: unknown. Hazard identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 0. Explosive limits: LEL: 5.4%; UEL: 11.4%. Slightly soluble in water; solubility = 0.6%.
Potential Exposure: It is used as a solvent; cleaning and degreasing agent; as well as in organic synthesis as an intermediate.
Incompatibilities: Vapor may form explosive mixture with air. Reacts violently with strong oxidizers, alkali metals; earth-alkali metals; powdered metals; causing fire and explosion hazard. Contact with strong caustic will produce flammable and toxic acetaldehyde gas. Attacks aluminum, iron. Attacks some plastics (including polyethylene) and coatings.
Permissible Exposure Limits in Air
NIOSH IDLH = 3000 ppm
Conversion factor: 1 ppm = 4.05 milligram per cubic meter @ 25°C & 1 atm
Odor threshold = 50−1350 ppm.
OSHA PEL: 100 ppm/400 milligram per cubic meter TWA
NIOSH REL: 100 ppm/400 milligram per cubic meter TWA, potential animal carcinogen, as chloroethanes; See *NIOSH Pocket Guide*, Appendix C
ACGIH TLV[1]: 100 ppm/405 milligram per cubic meter TWA, not classifiable as a human carcinogen
PAC Ver. 29[138]
PAC-1: 300 ppm
PAC-2: 670 ppm
PAC-3: 4000 ppm [> 50% LEL but < 100% LEL = 8000]
DFG MAK: 100 ppm/410 milligram per cubic meter TWA; Peak Limitation Category II(2); Pregnancy Risk Group C
Australia: TWA 200 ppm (810 milligram per cubic meter); STEL 250 ppm, 1993; Austria: MAK 100 ppm (400 milligram per cubic meter), 1999; Belgium: TWA 200 ppm (810 milligram per cubic meter); STEL 250 ppm (1010 milligram per cubic meter), 1993; Finland: TWA 100 ppm (400 milligram per cubic meter); STEL 250 ppm (1000 milligram per cubic meter), 1999; France: VME 200 ppm (810 milligram per cubic meter), 1999; Japan: 100 ppm (400 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 400 milligram per cubic meter, 2003; the Philippines: TWA 100 ppm (400 milligram per cubic meter), 1993; Poland: TWA 50 milligram per cubic meter,

1999; Russia: TWA 100 ppm, 1993; Switzerland: MAK-W 100 ppm (400 milligram per cubic meter), KZG-W 200 ppm (800 milligram per cubic meter), 1999; Thailand: TWA 50 ppm; STEL 100 ppm, 1993; Turkey: TWA 100 ppm (400 milligram per cubic meter), 1993; United Kingdom: TWA 200 ppm (823 milligram per cubic meter); STEL 400 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Several states have set guidelines or standards for ethylidene chloride in ambient air[60] ranging from 8.0 milligram per cubic meter (Connecticut) to 8.1−10.1 milligram per cubic meter (North Dakota) to 13.5 milligram per cubic meter (Virginia) to 19.3 milligram per cubic meter (Nevada).

Determination in Air: Charcoal tube; CS 2; Gas chromatography/Flame ionization detection; NIOSH Analytical Method (IV)#1003, Halogenated hydrocarbons or OSHA Analytical Method 7.

Permissible Concentration in Water: No criteria set for aquatic life or human health due to insufficient data[6]. Several states have set guidelines or standards for ethylidene chloride in drinking water[61] ranging from 1.0 μg/L (Illinois) to 20.0 μg/L (California) to 25 μg/L (New Mexico) to 70.0 μg/L (Vermont) to 850 μg/L (Wisconsin).

Determination in Water: Inert gas purge followed by gas chromatography with halide specific detection (EPA Method 601) or gas chromatography plus mass spectrometry (EPA Method 624). Octanol-water coefficient: Log $K_{ow} = 1.8$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion, and eye and skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: This chemical may affect the CNS. Exposure can cause drowsiness, unconsciousness, and death. High exposures may damage the liver or kidneys. Contact can cause eye and skin irritation with eye burns. Long-term exposure can cause thickening and cracking of skin. 1,1-Dichloroethane is a highly flammable liquid and a dangerous fire hazard. Never use near combustion sources. Do not use 1,1-dichlorethane where welding is being done because deadly phosgene gas can be formed.

Long-Term Exposure: It may damage the developing fetus. The liquid destroys the skin's natural oils. May affect the kidneys and liver. A chloroethane, this chemical may be a potential occupational carcinogen. Prolonged skin contact can cause thickening and cracking of the skin and mild burns. Although not adequately evaluated, similar petroleum-based chemicals can cause brain or other nerve damage.

Points of Attack: Skin, liver, kidneys, lungs, and CNS.

Medical Surveillance: If overexposure or illness is suspected, consider: liver and kidney function tests. Interview for brain effects, including recent memory, mood, concentration, headaches, malaise, and altered sleep patterns. Consider autonomic and peripheral nervous system evaluation. Positive and borderline cases should be referred for neuropsychological testing.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting.

Personal Protective Methods: Wear solvent-resistant protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. NIOSH recommends: 8 hours (more than 8 hours of resistance to breakthrough >0.1 μg/cm^2/min): Tychem 10000 suits. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Teflon is among the recommended protective materials. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: 1000 ppm: Sa (APF = 10) (any supplied-air respirator). 2500 ppm: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). 3000 ppm: SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). Emergency or planned entry into unknown concentrations or IDLH conditions: SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type SCBA).

Storage: Color code-Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. 1,1-Dichloroethane must be stored to avoid contact with strong oxidizers, such as chlorine, bromine and fluorine, since violent reactions occur. Store in tightly closed containers in a cool well-ventilated area away from heat. Sources of ignition, such as smoking and open flames are prohibited where 1,1-dichlorethane is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers used in the transfer of five gallons or more of 1,1-dichloroethane should be grounded and bonded. Drums must be quipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of 1,1-dichloroethane. Always store pesticides in their original containers, complete with labels that list ingredients, directions for use, and first aid steps in case of accidental poisoning. Never store pesticides in cabinets with or near food, animal feed, or medical supplies. Do not store pesticides in places where flooding is possible or in places where they might spill or leak into wells, drains, ground water, or surface water[72].

Shipping: UN2362 1,1-Dichloroethane, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include hydrogen chloride and oxides of carbon. Harmful to aquatic life with long lasting effects. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration; preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(102); (31); (173); (173); (101); (138); (203); (100).

United States Environmental Protection Agency, *Chloroethanes: Ambient Water Quality Criteria*, Washington, DC (1980)

United States Environmental Protection Agency, *1,1-Dichloroethane*, *Health and Environmental Effects Profile No. 69*, Washington, DC, Office of Solid Waste (April 30, 1980)

Sax N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 4, No. 3, 44−47 (1984)

New York State Department of Health, *Chemical Fact Sheet: 1,1-Dichloroethane*, Bureau of Toxic Substance Assessment, Albany, NY (May 1986)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: 1,1-Dichloroethane*, Trenton, NJ (February 2001).

Dichloroethyl Acetate D:0530

Formula: $C_4H_6Cl_2O_2$: $CH_3COOCHClC\ H_2Cl$

Synonyms: Aceto de 1,2-dicloroetilo (Spanish); 1,2-Dichloroethanol acetate; 1,2-Dichloroethyl acetate; Ethanol, 1,2-dichloro-, acetate

CAS Registry Number: 10140-87-1

HSDB Number: 6442

RTECS Number: KK4200000

UN/NA & ERG Number: UN1993 (flammable liquids, n.o.s.)/128

EC Number: 233-398-1

Regulatory Authority and Advisory Information

Hazard Alert: Combustible.

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1000 lb (454 kg).

Description: Dichloroethyl acetate is a water-white liquid. Molecular weight = 155.32; specific gravity (H_2O:1) = 1.3 @ 20°C; boiling point = 58°C−65°C @ 13 mmHg; flash point = 157°C. Hazard identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 0. Insoluble in water.

Potential Exposure: This material is used in organic synthesis.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides. Contact with strong oxidizing acids may cause an exothermic reaction strong enough to ignite reaction products. May explode on contact with nitrates and heat. Reacts with caustic solutions.

Permissible Exposure Limits in Air

PAC Ver. 29[138]
PAC-1: 0.15 ppm
PAC-2: 1.7 ppm
PAC-3: 10 ppm

Routes of Entry: Inhalation and ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: EPA states that the material is toxic by inhalation.

Long-Term Exposure: Prolonged or repeated contact may cause organ damage.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type SCBA).

Storage: Color code-Red: Flammability Hazard: Store in a flammable (liquid or solid materials) storage area or approved cabinet away from sources if ignition. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area away from oxidizers and nitrates. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: UN1993 Flammable liquids, n.o.s., Hazard Class: 3; Labels: 3-Flammable liquid, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Stay upwind; keep out of low areas. Shut off ignition sources; no flares, smoking or flames in hazard area. Stop leak if you can do it without risk. Use water spray to reduce vapors. *Small spills*: Take up with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: Dike far ahead of spill for later disposal. Ventilate area of spill or leak. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include phosgene and chlorine. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138).

United States Environmental Protection Agency, Chemical Hazard Information Profile: *Ethanol*, 1,2-Dichloro, acetate, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Ethanol, 1,2-dichloro, acetate*, Trenton, NJ, (October 2010)

1,2-Dichloroethylene D:0540

Formula: $C_2H_2Cl_2$; ClCH = CHCl

Synonyms: *sym-*: Acetylene dichloride; 1,2-Dichloraethen (German); 1,2-Dichloroethene; *sym*-Dichloroethylene; Dichloroethylene, *sym*; Dichloro-1,2-ethylene; 1,2-Dicloroeteno (Spanish); Dioform; Ethene, 1,2-dichloro-; Ethylene, 1,2-dichloro-; NCI-C56031

cis-isomer: Acetyalyne-dichloride; *cis*-1,2-Dichlorethylene; *cis*-1,2-Dichloroethene; (Z)-1,2-Dichloroethylene; *cis*-Dichloroethylene; 1,2-*cis*-Dichloroethylene; Ethene, 1,2-dichloro-, (Z)-ethene; Ethylene, 1,2-dichloro-, (Z)

trans-isomer: trans-Acetylene dichloride; *trans*-1,2-Dichloroethylene; *trans*-Dichloroethylene; *trans*-1,2-Dicloroeteno (Spanish); Dioform; Ethene, *trans*-1,2-dichloro-; Ethene, 1,2-dichloro-, (*E*)-

CAS Registry Number: 540-59-0 (1,2-); 156-59-2 (*cis*-); 156-60-5 (*trans*-)

HSDB Number: 149 (540-59-0); 5656 (*cis*-); 6361 (*trans*-)

RTECS Number: KV9360000; KV9420000 (*cis*-); RV9400000 (*trans*-)

UN/NA & ERG Number: UN1150/130

EC Number: 208-750-2 [*Annex I Index No.:* 602-026-00-3] (1,2-); 205-859-7 [*Annex I Index No.:* 602-026-00-3] (*cis*-); 205-860-2 [*Annex I Index No.:* 602-026-00-3] (*trans*-)

Regulatory Authority and Advisory Information

Carcinogenicity: EPA (*CAS: 156-59-2*): Not Classifiable as to human carcinogenicity.

Hazard Alert: Highly flammable, Suspected reprotoxic hazard. (*cis*-) Listed for Tier 1 screening as an endocrine disruptor[88].

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/1992); Toxic Pollutant (Section 401.15)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. (*sym*-Dichloroethylene)

European/International Regulations *(1,2-, cis-& trans-isomers*): Hazard symbol: F, Xn, N; risk phrases: R11; R20; R52/53; safety phrases: S2; S7; S16; S29; S41; S61 (see Appendix 4)

cis-isomer:

United States National Primary Drinking Water Regulations (cis-isomer): 0.07 mg/L; MCL = 0.07 mg/L

Hazardous to aquatic life or environment, with possible long lasting effects[194]. Harmful to aquatic life with long lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xn, N; risk phrases: R11; R20; R52/53; safety phrases: S2; S7; S16; S21; S29; S41; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to waters (*all isomers*)

trans-isomer:

United States National Primary Drinking Water Regulations (trans-isomer): 0.1 mg/L; MCL = 0.1 mg/L

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U079

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.054; Nonwastewater (mg/kg), 30

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8010 (1); 8240 (5)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1000 lb (454 kg)

Description: 1,2-Dichloroethylene exists in three isomers, *sym-*, *cis*-60% and *trans*-40%. There are variations in toxicity between these two forms. At room temperature, these chemicals are colorless liquids with a slightly acrid, ethereal odor. The Odor Threshold in air is 17 ppm.

sym-isomer: Molecular weight = 96.95; specific gravity (H_2O:1) = 1.27 @ 25°C; boiling point = 48°C55°C; freezing/melting point = −50°C; flash point = 2°C (cc). Autoignition temperature = 460°C. Explosive Limits: LEL: 9.7%; UEL: 12.8%. Poor solubility in water; solubility = 0.4%.

cis-isomer*:* Molecular weight = 96.94; specific gravity (H_2O:1) = 1.28 @ 20°C; boiling point = 60.3°C; freezing/melting point = −82°C; flash point = 6°C. Explosive limits: LEL: 27,000 ppm; UEL: unknown. Hazard identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 2.

trans-isomer*:* Molecular weight = 96.94; specific gravity (H_2O:1) = 1.26 @ 20°C; boiling point = 47.5°C; freezing/melting point = −49.8°C; vapor pressure = 750 mmHg @ 47.3°C; flash point = 2-4°C. The explosive limits are: LEL: 5.6% or 9.7%;[52] UEL: 12.8%. Slightly soluble in water. Hazard identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 2.

Potential Exposure: Primary irritant (w/o allergic reaction). 1,2-Dichloroethylene is used as a solvent for waxes, resins, and acetylcellulose. It is also used in the extraction of rubber, as a refrigerant; in the manufacture of pharmaceuticals and artificial pearls; and in the extraction of oils and fats from fish and meat.

Incompatibilities: May form explosive mixture with air. Attacks some plastics, rubber, and coatings. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides. Gradual decomposition results in hydrochloric acid formation in the presence of ultraviolet light or upon contact with hot metal or other hot surfaces. Reacts with strong bases; potassium hydroxide; difluoromethylene, dihypofluoride, nitrogen tetroxide (explosive); or copper (and its alloys) producing toxic chloroacetylene which is spontaneously flammable on contact with air. Attacks some plastics and coatings.

Permissible Exposure Limits in Air

NIOSH IDLH = 1000 ppm (1,2-dichloroethylene)

Conversion factor: 1 ppm = 3.97 milligram per cubic meter (*sym*-dichloroethylene)@ 25°C & 1 atm

OSHA PEL: 200 ppm/790 milligram per cubic meter TWA

NIOSH REL: 200 ppm/790 milligram per cubic meter TWA

ACGIH TLV[1]: 200 ppm/793 milligram per cubic meter TWA, all isomers

PAC* Ver. 29[138]

540-59-0 (mixed isomers)

PAC-1: 140 ppm

PAC-2: 500 ppm

PAC-3: 850 ppm

156-59-2, cis-isomer

PAC-1: **140**$_{\mathrm{A}}$ ppm

PAC-2: **500**$_{\mathrm{A}}$ ppm

PAC-3: **850**$_{\mathrm{A}}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

156-60-5, trans-isomer

PAC-1: **280**$_{\mathrm{A}}$ ppm

PAC-2: **1000**$_{\mathrm{A}}$ ppm

PAC-3: **1700**$_{\mathrm{A}}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

DFG MAK: 200 ppm/800 milligram per cubic meter; Peal Limitation Category II(2) (*sym*-)

Australia: TWA 200 ppm (790 milligram per cubic meter), 1993; Austria: MAK 200 ppm (790 milligram per cubic meter), 1999; Belgium: TWA 200 ppm (793 milligram per cubic meter), 1993; Denmark: TWA 200 ppm (790 milligram per cubic meter), 1999; Finland: TWA 200 ppm (790 milligram per cubic meter); STEL 250 ppm (990 milligram per cubic meter), 1999; Hungary: TWA 80 milligram per cubic meter; STEL 160 milligram per cubic meter, 1993; Japan: 150 ppm (590 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 790 milligram per cubic meter, 2003; Norway: TWA 100 ppm (395 milligram per cubic meter), 1999; the Philippines: TWA 200 ppm (790 milligram per cubic meter), 1993; Poland: MAC (TWA) 50 milligram per cubic meter, 1999; Russia: TWA 150 ppm, 1993; Switzerland: MAK-W 200 ppm (790 milligram per cubic meter), KZG-W 400 ppm (1580 milligram per cubic meter), 1999; Turkey: TWA 200 ppm (790 milligram per cubic meter), 1993; United Kingdom: TWA 200 ppm (806 milligram per cubic meter); STEL 250 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: TWA 200 ppm. Several States have set guidelines or standards for *sym*-dichloroethylene in ambient air[60] ranging from 0.110 milligram per cubic meter (Massachusetts) to 13.0 milligram per cubic meter (Virginia) to 15.8 milligram per cubic meter (Connecticut) to 18.8 milligram per cubic meter (Nevada).

Determination in Air: Charcoal absorption workup with CS2, analysis by gas chromatography. Use NIOSH Analytical Method #1003 for hydrocarbons, halogenated or OSHA Analytical Method 7.

Permissible Concentration in Water: Safe Drinking Water Act (47FR 9352): (***trans-1,2-dichloroethylene***) MCL, 0.1 mg/L; MCLG, 0.1 mg/L: (***cis-1,2-dichloroethylene***)): MCL, 0.07 mg/L; MCLG, 0.07 mg/L. (***1,2-dichloroethylene***) State Drinking Water Standards: Florida 70 μg/L; State Drinking Water Guidelines: Arizona 70 μg/L. (***cis-1,2-dichloroethylene***) State Drinking Water Standards: California 6 μg/L; State Drinking Water Guidelines: Maine 70 μg/L; Minnesota 50 μg/L. (***trans-1,2-dichloroethylene***) State Drinking Water Standards: California 10 μg/L; State Drinking Water Guidelines: Arizona 70 μg/L; Maine 140 μg/L; Minnesota 100 μg/L.

Determination in Water: *trans*-1,2-dichloroethylene may be determined by inert gas purge followed by gas chromatography with halide specific detection (EPA Method 601) or gas chromatography plus mass spectrometry (EPA Method 624). Octanol-water coefficient: Log $K_{\mathrm{ow}} = 2$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation of the vapor, ingestion, and skin and eye contact.

Short-Term Exposure: This liquid can act as a Primary irritant (w/o allergic reaction) producing dermatitis and irritation of mucous membranes. 1,2-DCE irritates the eyes, skin, and respiratory tract. Skin contact can cause a burning sensation and rash. 1,2-Dichloroethylene acts principally as a narcotic, causing CNS depression. Symptoms of acute exposure include dizziness, nausea, frequent vomiting; and CNS intoxication, similar to that caused by alcohol. High levels can cause unconsciousness. LD_{50} = (oral-rat) 770 mg/kg (slightly toxic).

Long-Term Exposure: Destroys skin's natural oils. Repeated exposure to the *cis*-or *trans*-isomers may damage the liver and kidneys. Renal effects, when they do occur, are transient.

Points of Attack: Respiratory system, eyes, and CNS.

Medical Surveillance: Consider possible irritant effects on skin or respiratory tract as well as liver and renal function is preplacement or periodic examinations. Expired air analysis may be useful in detecting exposure. For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. If symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function tests. CBC.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. NIOSH recommends: 8 hours (more than 8 hours of resistance to breakthrough $> 0.1\ \mu g/cm^2/min$): Teflon gloves, suits, and boots; Viton gloves, suits; 4H and Silver Shield gloves; Barricade coated suits; CPF3 suits; Responder suits; Trychem 10000 suits. 4 hours (At least 4 but <8 hours of resistance to breakthrough $>0.1\ \mu g/cm^2/min$): polyvinyl alcohol gloves. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Viton is among the recommended protective materials for the *cis*-and *trans*-isomers. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: 1000 ppm: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]; or CcrFOv (APF = 50) [any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s)]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted acid gas canister]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd, Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-, mounted organic vapor canister]; or SCBAE (any appropriate escape-type SCBA). *Note:* Substance causes eye irritation or damage; eye protection needed.

Storage: Color code-Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with 1,2-DCE all handlers should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. 1,2-Dichloroethylene must be stored to avoid contact with strong oxidizers (such as chlorine, bromine and fluorine), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where 1,2-dichloroethylene is used, handled, or stored. Metal containers involving the transfer of five gallons or more of 1,2-dichloroethylene should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of 1,2-dichloroethylene. Wherever 1,2-dichloroethylene is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1150 Dichloroethylene, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: 1,2-DCE is a flammable liquid. Thermal decomposition products may include phosgene and hydrogen chloride. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced[22]. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (173); (101); (138); (2); (100).

United States Environmental Protection Agency, *Dichloroethylenes: Ambient Water Quality Criteria*, Washington, DC (1980)

United States Environmental Protection Agency, *Trans-1,2-Dichloroethylenes, Health and Environmental Effects Profile No. 72*, Washington, DC, Office of Solid Waste (April 30, 1980)

United States Environmental Protection Agency, *Dichloroethylenes, Health and Environmental Effects Profile No. 73*, Washington, DC, Office of Solid Waste (April 30, 1980)

Sax N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 4, No. 3, 48−53 (1984)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: 1,2-Dichloroethylene*, Trenton, NJ (July 2002)

Dichloroethyl Ether D:0550

Formula: $C_4H_8Cl_2O$; $ClCH_2CH_2OCH_2CH_2Cl$

Synonyms: BCEE; Bis(β-chloroethyl) ether; Bis(2-chloroethyl) ether; Bis(2-cloroetil)eter (Spanish); Chlorex; 1-Chloro-2-(β-chloroethoxy)ethane; Chloroethyl ether (DOT); Clorex; DCEE; 2,2′-Dichlor-diaethylaether (German); 2,2′-Dichlorethyl ether; β,β'-Dichlorodiethyl ether; 2,2′-Dichlorodiethyl ether; Dichloroether; β,β'-Dichloroethyl ether; *sym*-Dichloroethyl ether; 2,2′-Dichloroethyl ether; Di(β-chloroethyl) ether; Di(2-chloroethyl) ether; Dichloroethyl ether; Dichloroethyl oxide; ENT 4504; Ethane, 1,1′-oxybis 2-chloro-; Ether dichlore (French); 1,1′-Oxybis(2-chloro)ethane; Oxyde de chlorethyle (French)

CAS Registry Number: 111-44-4

HSDB Number: 502

RTECS Number: KN0875000

UN/NA & ERG Number: UN1916/152 (P)

EC Number: 203-870-1 [*Annex I Index No.:* 603-029-00-2]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal, Limited Evidence; Human, Inadequate Data, *not classifiable as carcinogenic to humans*, Group 3, 1999; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies; NIOSH treats this chemical as a suspected human carcinogen, See *NIOSH Pocket Guide*, Appendix A.

California Proposition 65 Chemical[102]: Cancer 4/1/1988

Hazard Alert: Poison, Highly flammable liquid, Peroxidizable hazard.

Banned or Severely Restricted (Finland, Sweden) (UN)[13]

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U025

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.033; Nonwastewater (mg/kg), 6.0

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg)

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 10,000 lb (4550 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Mexico, drinking water criteria = 0.0003 mg/L.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T +, F; risk phrases: R45; R10; R26/27/28; R51; safety phrases: S1/2; S7/9; S27; S36/37; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Dichloroethyl ether is a clear, colorless liquid. Pungent, fruity odor. It is also described as having a chlorinated solvent-like odor. Molecular weight = 143.02;

boiling point = 176°C−178°C; flash point = 55°C; [17]; Autoignition temperature = 369°C; Explosive limits: LEL: 2.7%; UEL: unknown. Hazard identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 1. Insoluble in water.

Potential Exposure: Dichloroethyl ether is used as a soil fumigant, an insecticide, and an acaricide; in the manufacture of paint, varnish, lacquer, soap, and finish removers. It is also used as a solvent for cellulose esters, naphthalenes, oils, fats, waxes, greases, pectin, tar, and gum; in dry cleaning and in textile scouring.

Incompatibilities: Contact with moisture caused decomposition producing hydrochloric acid. Can form peroxides. May form explosive mixture with air. Contact with strong oxidizers may cause fire and explosion hazard. Attacks some plastics, rubber, and coatings. Attacks metals in the presence of moisture.

Permissible Exposure Limits in Air

NIOSH IDLH = 100 ppm

Conversion factor: 1 ppm = 5.85 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 15 ppm/90 milligram per cubic meter Ceiling Concentration [skin]

NIOSH REL: 5 ppm/30 milligram per cubic meter TWA; 10 ppm/60 milligram per cubic meter STEL [skin]; See *NIOSH Pocket Guide*, Appendix A

ACGIH TLV[1]: 5 ppm/29 milligram per cubic meter TWA; 10 ppm/58 milligram per cubic meter STEL [skin], not classifiable as a human carcinogen

PAC Ver. 29[138]

PAC-1: 10 ppm

PAC-2: 25 ppm

PAC-3: 250 ppm

DFG MAK: 10 ppm/59 milligram per cubic meter TWA; Peak Limitation Category I(1) [skin]

Australia: TWA 5 ppm (30 milligram per cubic meter); STEL 10 ppm, [skin], 1993; Austria: MAK 5 ppm (30 milligram per cubic meter), [skin], 1999; Belgium: TWA 5 ppm (29 milligram per cubic meter); STEL 10 ppm (58 milligram per cubic meter), [skin], 1993; Finland: TWA 5 ppm (30 milligram per cubic meter); STEL 10 ppm (60 milligram per cubic meter), [skin], 1999; France: VME 5 ppm (30 milligram per cubic meter), [skin], 1999; Japan: 15 ppm (88 milligram per cubic meter), [skin], 1999; the Netherlands: MAC-TGG 30 milligram per cubic meter, 2003; the Philippines: TWA 15 ppm (90 milligram per cubic meter), [skin], 1993; Poland: MAC (TWA) 10 milligram per cubic meter, MAC (STEL) 60 milligram per cubic meter, 1999; Russia: STEL 0.6 milligram per cubic meter, [skin]; TWA 15 ppm; STEL 2 milligram per cubic meter, [skin], 1993; Sweden: carcinogen, 1999; Switzerland: MAK-W 5 ppm (30 milligram per cubic meter), KZG-W 25 ppm (50 milligram per cubic meter), [skin], 1999; Thailand: TWA 15 ppm (90 milligram per cubic meter), 1993; Turkey: TWA 15 ppm (90 milligram per cubic meter), [skin], 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: STEL 10 ppm [skin]. Several states have set guidelines have set guidelines or standards for BCEE in ambient air[60] ranging from 0.0714 milligram per cubic meter (Kansas) to 0.3−0.6 milligram per cubic meter (North Dakota) to 0.5 milligram per cubic meter (Virginia) to 0.6 milligram per cubic meter (Connecticut) to 0.714 milligram per cubic meter (Nevada) to 0.72 milligram per cubic meter (Pennsylvania).

Determination in Air: Charcoal tube; CS2; Gas chromatography/Flame ionization detection; NIOSH Analytical Method (IV) #1004 or OSHA Analytical Method 7.

Permissible Concentration in Water: State Drinking Water Guidelines: Arizona 0.030 μg/L; Florida 1.5 μg/L; Maine 0.3 μg/L; Minnesota 0.3 μg/L; New Hampshire 0.03 μg/L.

Determination in Water: CH_2Cl_2 extraction followed by gas chromatography with halogen; specific detector (EPA Method 611) or gas chromatography plus mass spectrometry (EPA Method 625). Octanol-water coefficient: Log K_{ow} = 1.3. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, skin absorption, ingestion, and skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: BCEE can be absorbed through the skin, thereby increasing exposure. Exposure irritates the eyes, skin, and respiratory tract. Skin and eye contact may cause burns. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. At concentrations above 500 ppm, coughing, retching, and vomiting may occur; as well as profuse tearing. There can be irritation at lower concentrations. This material is very toxic; the probable oral lethal dose is 50−500 mg/kg, or between one teaspoon and one ounce for a 150 pound person. It can be a CNS depressant in high concentrations. It is extremely irritating to the eyes, nose, and respiratory passages. It can penetrate the skin to cause serious and even fatal poisoning. Poisonous; may be fatal if inhaled, swallowed or absorbed through skin.

Long-Term Exposure: BCEE may damage the liver and kidneys. Can irritate the lungs; repeated exposures may cause bronchitis.

Points of Attack: Respiratory system, skin, eyes, liver, and kidneys. This chemical causes liver cancer in animals and may be a potential human carcinogen.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. If symptoms develop or overexposure is suspected, the following may also be useful: Liver and kidney function tests. Lung function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. NIOSH recommends: 8 hours (more than 8 hours of resistance to breakthrough > 0.1 $\mu g/cm^2/min$): Tychem 10000 suits; 4 hours (At least 4 but < 8 hours of resistance to breakthrough > 0.1 $\mu g/cm^2/min$): Teflon gloves, suits, and boots. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Teflon and chlorinated polyethylene are among the recommended protective materials. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type SCBA).

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with BCEE all handlers should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Bis (2-chloroethyl) ether must be stored to avoid contact with strong oxidizers, such as chlorine, bromine, and chlorine dioxide, since violent reactions occur, and moisture. Store in tightly closed containers in a cool, dry, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames are prohibited where bis (2-chloroethyl) ether is used, handled, or stored in a manner that could create a potential fire or explosion hazard. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN1916 2,2′-Dichlorodiethyl ether, Hazard class: 6.1; Labels: 6.1-Poisonous materials, 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb spills in vermiculite, dry sand, earth, or similar material. Keep material out of water sources and sewers. Build dikes to contain flow as necessary. Use water spray to knock down vapors. *Spill or leak:* Shut off ignition sources; no flares, smoking or flames in hazard area. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: Absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: Dike far ahead of spill for later disposal. Keep unnecessary people away; isolate hazard area and deny entry. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include phosgene, hydrogen chloride, chlorine fumes and explosive hydrogen gas. Use dry chemical, carbon dioxide, or foam extinguishers. Dike fire control water for later disposal; do not scatter the material. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to

cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: A potential candidate for liquid injection incineration at a temperature range of 650 to 1600°C and a residence time 0.1 to 2 seconds. Also, a potential candidate for rotary kiln incineration at a temperature range of 820 to 1600°C and residence times of seconds for liquids and gases, and hours for solids. Also, a potential candidate for fluidized bed incineration at a temperature range of 450 to 980°C and residence times of seconds for liquids and gases, and longer for solids[72]. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(102); (31); (173); (101); (138); (100).

United States Environmental Protection Agency, *Chloroalkyl Ethers: Ambient Water Quality Criteria*, Washington, DC (1980)

United States Environmental Protection Agency, *Bis (2-Chloroethyl) Ether, Health and Environmental Effects Profile No. 24*, Washington, DC, Office of Solid Waste (April 30, 1980)

International Agency for Research on Cancer, *IARC: Monographs on the Carcinogenic Risks of Chemicals to Humans*, Lyon, France 9, 117 (1975)

United States Environmental Protection Agency, *Chemical Hazard Information Profile: Dichloroethyl Ether*, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

Sax N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 4, 62–76 (1987)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Bis(2-Chloroethyl) Ether*, Trenton, NJ (June 2003)

Dichloroisocyanuric Acid D:0555

Formula: $C_3H_2Cl_2N_3O_3$

Synonyms: ACL 70; CDB 60; Dichloroisocyanurate; Dichloroisocyanuric acid, dry or dichloroisocyanuric acid salts; Dichloro-*s*-triazinetrione; 1,3-Dichloro-*s*-triazine-2,4,6-(1H,3H,5H)-trione; Fi clor 71; Hilite 60; Isocyanuric acid, dichloro-; Isocyanuric dichloride; Orced; Troclosene; *S*-Triazine-2,4,6(1H,3H,5H)-trione, 1,3-dichloro-; 1,3,5-Triazine-2,4,6(1H,3H,5H)-trione, 1,3-dichloro-

CAS Registry Number: 2782-57-2

HSDB Number: 5897

RTECS Number: XZ1845000

UN/NA & ERG Number: UN2465/140 (Dichloroisocyanuric acid, dry, or its salts)

EC Number: 220-487-5 [*Annex I Index No.:* 613-029-00-4

Regulatory Authority and Advisory Information

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Clean Water Act: Section 307 Priority Pollutants as cyanide, total; Toxic Pollutant (Section 401.15)

RCRA Universal Treatment Standards: Wastewater (mg/L), 1.2 (total); 0.86 (amenable); Nonwastewater (mg/kg), 590 (total); 30 (amenable)

RCRA Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 9010(40)

Safe Drinking Water Act (47FR 9352): MCL, 0.2 mg/L; MCLG, 0.2 mg/L.

EPA Hazardous Waste Number (RCRA No.): D001 (40CFG261)

EPCRA Section 304 RQ: CERCLA, 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%

Hazard symbols, risk, & safety statements: Hazard symbol: O, Xn, N; risk phrases: R8; R22; R31; R36/37; R50/53; safety phrases: S2; S8; S26; S41; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: White, crystalline solid, powder, or granules. Chlorine odor. Molecular weight = 197.97; freezing/melting point = 227°C (decomposes); vapor pressure = 2.0×10^{-9} mmHg @25°C. Moderately soluble in water; reaction may be violent, forming hypochlorous acid and releasing chlorine gas. ₩

Potential Exposure: This triazinetrione biocide, and water treatment chemical used in disinfectants and cleaning solution in domestic products and in food processing plants.

Incompatibilities: A strong oxidizer and chlorinating compound. Violent reaction with organic and flammable materials. Contact with materials containing nitrogen, such as ammonia, ammonium salts, or urea, may be violent and form highly explosive nitrogen trichloride. Contact with water forms hypochlorous acid and evolves extremely dense and noxious fumes of chlorides; chlorine gas. Triazine compounds are incompatible with oxidizers, acids, acid chlorides, acid halides, isocyanates, halogenated organics, peroxides, phenols (acidic), epoxides, and anhydrides. Contact with strong reducing agents such as hydrides may generate explosive a flammable gas.

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 200 μg[CN]/L; State Drinking Water Standards: California 150 μg[CN]/L; State Drinking Water Guidelines: Arizona 220 μg[CN]/L; Maine. 140 μg[CN]/L; Minnesota 100 μg[CN]/L. United States Army field drinking-water standards for cyanide: 2 mg[CN]/L assuming a water consumption of 15 L/day and 6 mg[CN]/L assuming a water consumption of 5 L/day. United States Army field drinking-water standards for cyanide, long term consumption 0.5 mg[CN]/L; Short-term consumption; Raw water constituents (maximum) 20 mg[CN]/L.

Determination in Water: Distillation followed by silver nitrate titration or colorimetric analysis using pyridine pyrazolone (or barbituric acid). Octanol-water coefficient: Log $K_{ow} = 1.3$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, passing through the skin, ingestion

Harmful Effects and Symptoms

Short-Term Exposure: May cause skin and severe eye irritation. Moderately poisonous if ingested or inhaled. LD_{50} (oral, rat) = 150 mg/kg *as chlorinated isocyanurates*[83].; 1170 mg/kg[lit]

Long-Term Exposure: May cause lung irritation and damage. May cause skin allergy. Contact with some triazine compounds may increase risks for tumors known to be associated with hormonal factors. These have been observed in both animals and human beings, and are consistent with the known effects on the hypothalamic pituitary gonadal axis. Repeated exposure may cause weight loss and reduced red blood cell count. A mutagen

Points of Attack: Liver, lungs, and skin. May cause reproductive and fetal effects.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following is recommended: Lung function tests. Consider chest x-ray following acute overexposure. Evaluation by a qualified allergist. Examination of the nervous system

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water or milk and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Applicators and other handlers must wear: Coveralls worn over long-sleeved shirt and long pants; Chemical-resistant gloves such as DuPont Tychem suit fabrics, barrier laminate, or Viton; Chemical-resistant footwear plus socks; Protective eye wear; Chemical-resistant headgear for overhead exposure; Chemical-resistant apron when cleaning equipment, mixing, or loading[83]. Agricultural Use/Engineering Controls: When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the Worker Protection Standard (WPS) for agricultural pesticides, 40 CFR 170.240(d)(4-6), the handler PPE requirements may be reduced or modified as specified in the Worker Protection Standard. Firefighters should wear NIOSH approved SCBA and full protective clothing.

Respirator Selection: NIOSH (*as cyanides*): 25 milligram per cubic meter: Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted canister providing protection against the compound of concern and having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type SCBA).

Storage: Check oxygen content prior to entering storage area. Color code-Yellow: Reactive Hazard; Store in a location separate from other materials, especially organic materials, flammables and combustibles, and other incompatible materials. Oxidizers, including oxidizing gases, should have a boundary separation of 8–10 m or a 1 hour fire wall from flammable or reactive materials. Store in a cool, well ventilated area away from incompatible materials listed above. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage.

Shipping: UN2465 Dichloroisocyanuric acid, dry, or Dichloroisocyanuric acid salts., Hazard Class: 5.1; Labels: 5.1-Oxidizer. It is a marine pollutant and environmentally hazardous substance.

Spill Handling: For solids, *small spill*, isolate spill or leak area in all directions for at least 25 m/75 ft. Increase, in the downwind direction, as necessary. For a *large spill*, evacuate downwind at least 100 m/330 ft. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Stop leak if you can do it without risk. Keep combustibles (wood, paper, oil, etc.) away from spilled material. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Stop leak if you can do it without risk. Do not allow water to get inside containers. *Small dry spill*: With clean shovel place material into clean, dry container and cover loosely; move containers from spill area. *Large spill*: Dike far ahead of liquid spill for later disposal. Following product recovery, flush area with water. Prevent entry into waterways, sewers, basements or confined areas. Cover with plastic sheet to prevent spreading. Absorb or cover with dry earth, sand or other noncombustible material and transfer to containers. Do not allow water to get inside containers. Prevent entry into waterways, sewers, basements or confined areas. Cover with plastic sheet to prevent spreading. Absorb or cover with dry earth, sand or other noncombustible material and transfer to containers.

Fire Extinguishing: Thermal decomposition products may include extremely dense and noxious fumes of chlorides, carbon monoxide, and other toxic gases. Move containers from fire area if you can do it without risk. *Fire involving storage or vehicular tanks:* Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. *On a small fire*: Use water. Do not use dry chemicals or foams. carbon dioxide or Halon may provide limited control. *On a large fire,* Flood fire area with water from a distance. Do not move cargo or vehicle if cargo has been exposed to heat. *Fire involving tanks or car/trailer loads*: Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Do not allow water to get inside containers. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank.

Disposal Method Suggested: Recycle any unused portion of the material for its approved use or return it to the manufacturer or supplier. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration with effluent gas scrubbing is recommended. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office. Ultimate disposal of the chemical must consider: the material's impact on air quality; potential migration in soil or water; effects on animal, aquatic, and plant life; and conformance with environmental and public health regulations.

References

(31); (173); (101); (138); (100).

United States National Library of Medicine, *ChemIDplus Advanced*, Bethesda, MD, http://chem.sis.nlm.nih.gov/chemidplus/rn/2782-57-2

Dichloromethylphenylsilane D:0560

Formula: $C_7H_8Cl_2Si$; $C_6H_5SiCl_2CH_3$

Synonyms: Dichloromethylphenylsilane; Methylphenyldichlorosilane; Phenylmethyldichlorosilane; Silane, dichloromethylphenyl-

CAS Registry Number: 149-74-6

HSDB Number: 5650

RTECS Number: VV3530000

UN/NA & ERG Number: UN2437/156

EC Number: 205-746-2

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade).

Hazard Alert: Poison, Highly flammable liquid, Corrosive, Violently water reactive

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1000 lb (454 kg)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, F, C, Xn; risk phrases: R11; R14; R34; R36/37/38; R34; R40; R45; R51; safety phrases: S1; S21; S22; S26; S36/37/39; S45; S53; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Dichloromethylphenylsilane is a flammable, colorless liquid. Molecular weight = 191.14; specific gravity (H_2O:1) = 1.18 @ 20°C; boiling point = 205°C; freezing/melting point: −52.7°C; flash point = 82°C. Explosive limits: LEL: 14,190 ppm; UEL: unknown. Hazard identification (based on NFPA-704 M Rating System): Health 3, Flammability 3, Reactivity 2₩. Reacts violently with water, rapidly releasing corrosive hydrogen chloride fumes.

Potential Exposure: Used in the manufacture of silicones; and as a chemical intermediate for silicone fluids, resins, and elastomers.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides. Chlorosilanes react vigorously with bases and both organic and inorganic acids generating toxic and/or flammable gases. Chlorosilanes react with water, moist air, or steam to produce heat and toxic, corrosive fumes of hydrogen chloride. They may also produce flammable gaseous hydrogen. Contact with ammonia may form a self-igniting material. Attacks some metals in the presence of moisture.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 0.9 milligram per cubic meter

PAC-2: 11 milligram per cubic meter

PAC-3: 50 milligram per cubic meter

Routes of Entry: Inhalation, ingestion, and skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: The chemical is toxic and a corrosive irritant. Contact with the skin or eyes causes burns and permanent damage. Inhalation may cause irritation. Higher exposures may cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: Repeated exposure may cause lung irritation and bronchitis.

Points of Attack: Lungs.

Medical Surveillance. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type SCBA).

Storage: Color code-White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with methylphenyldichlorosilane all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area away from moisture, oxidizers, and ammonia. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: UN2437 Methylphenyldichlorosilane, Hazard class: 8; Labels: 8-Corrosive material.

Spill Handling:

Initial Isolation and Protective Action Distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24 h response line).

Small Spills (from a small package or a small leak from a large package)

When Spilled in Water

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.1/0.2

Large Spills (from a large package or from many small packages)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.4/0.6

Stay upwind and uphill. Isolate the area of release or fire and deny entry. Remove all ignition sources. Stop the release if it can be done safely from a distance. All equipment used to handle this material must be grounded. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. *Small spill*: Cover with *dry* earth, *dry* sand, or other noncombustible material followed with plastic sheet to minimize spreading or contact with water or rain. Use clean nonsparking tools to collect material and place material into loosely covered plastic containers for later disposal. Prevent material and runoff from entering sewers and waterways if it can be done safely well ahead of the release. Use vapor suppressing foam to disperse vapors—contain runoff. Water spray may reduce vapor, but may not prevent ignition in enclosed spaces. Ventilate confined area if it can be done without placing personnel at risk. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Dichloromethylphenylsilane is a combustible liquid. Thermal decomposition products may include silicon oxides, hydrogen chloride and oxides of carbon. *Do not use water. FOR CHLOROSILANES, DO NOT USE WATER. USE AFFF ALCOHOL-RESISTANT, MEDIUM EXPANSION FOAM. Small fire*: Use *dry* chemical, CO_2, *dry* sand, or alcohol-resistant foam. May react with foams releasing corrosive/toxic gases. *Large fire*: Use water spray or alcohol-resistant foam if it is available in sufficient amounts. Under favorable conditions, experienced crews can use coordinated fog streams to sweep the flames off the surface of the burning liquid. Combustible material: may burn but does not ignite readily. Most vapors are heavier than air. They will spread along ground and collect in low or confined areas (sewers, basements, tanks). Vapors may travel to source of ignition and flash back. Containers may explode when heated or if contaminated with water. Keep exposures cool long after fire is out to protect against reignition. Do not direct straight streams into the liquid. Cool exposed containers with large quantities of water from unattended equipment or remove intact containers if it can be done safely. *Do not get water on spilled substance or inside containers*. If cooling streams are ineffective (*venting sound increases in volume and pitch, tank discolors or shows signs of deforming*), withdraw immediately to a secure location. Always stay away from ends of tanks, especially when engulfed in flames. If material or contaminated runoff from fire control enters waterways, notify downstream users of potentially contaminated water. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156.

References

(31); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: *Dichloromethylphenylsilane*, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Methylphenyldichlorosilane*, Trenton, NJ (November 1999)

Dichloromonofluoromethane D:0570

Formula: $CHCl_2F$

Synonyms: Algofrene type 5; Dichloromonofluorometha NE; F 21; FC 21; Fluorodichloromethane; Freon F 21; Genetron 21; Halon 112; HCFC-21; Methane, dichlorofluoro-; Monofluorodichlorometha NE; R 21 (refrigerant); Refrigerant 21

CAS Registry Number: 75-43-4

HSDB Number: 142

RTECS Number: PA8400000

UN/NA & ERG Number: UN1029/126

EC Number: 200-869-8

Regulatory Authority and Advisory Information

Hazard Alert: Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated, Suspected of causing genetic defects, Environmental hazard (atmospheric).

Clean Air Act: Stratospheric ozone protection (Title VI, Subpart A, Appendix A), Class I, Ozone Depletion Potential (ODP) =

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Harms public health and the environment by destroying ozone in the upper atmosphere.

Hazard symbols, risk, & safety statements: Hazard symbol: N; risk phrases: R5; R21; R58/59; R62; safety phrases: S9; S33; S38; S57; S59; S61 (see Appendix 4)

Description: Dichlorofluoromethane is a heavy, colorless gas or liquid (below 9°C) with a slight ethereal odor. Molecular weight = 102.92; specific gravity (H_2O:1) = 1.4 1 @ 9°C; boiling point = 8.9°C; freezing/melting point = −130.4°C; Relative vapor density (air = 1) = 3.57; vapor pressure = 750 mmHg @ 8.6°C; Autoignition temperature = 522°C. Hazard identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 0. Poor solubility in water; solubility = 0.7% @ 30°C.

Potential Exposure: This material is used as a refrigerant and a propellant gas.

Incompatibilities: Reacts violently with chemically active metals: sodium, potassium, calcium, powdered aluminum; zinc, magnesium, alkali, alkaline earth. Reacts with acids or acid fumes producing highly toxic chlorine and fluorine fumes. Attacks some forms of plastics, rubber, and coatings.

Permissible Exposure Limits in Air

NIOSH IDLH = 5000 ppm

OSHA PEL: 1000 ppm/4200 milligram per cubic meter TWA

NIOSH REL: 10 ppm/40 milligram per cubic meter TWA

ACGIH TLV[1]: 10 ppm/42 milligram per cubic meter TWA

PAC Ver. 29[138]

PAC-1: 30 ppm

PAC-2: 8300 ppm

PAC-3: 50,000 ppm

DFG MAK: 10 ppm/43 milligram per cubic meter TWA; Peak Limitation Category II(2)

Australia: TWA 10 ppm (40 milligram per cubic meter), 1993; Austria: MAK 10 ppm (45 milligram per cubic meter), 1999; Belgium: TWA 10 ppm (42 milligram per cubic meter), 1993; Denmark: TWA 10 ppm (40 milligram per cubic meter), 1999; Finland: TWA 10 ppm (40 milligram per cubic meter); STEL 20 ppm (80 milligram per cubic meter), 1999; France: VME 10 ppm (40 milligram per cubic meter), 1999; Hungary: STEL 40 milligram per cubic meter, 1993; the Netherlands: MAC-TGG 43 milligram per cubic meter, 2003; Norway: TWA 10 ppm (42 milligram per cubic meter), 1999; the Philippines:

TWA 1000 ppm (4200 milligram per cubic meter), 1993; Poland: MAC (TWA) 40 milligram per cubic meter, MAC (STEL) 200 milligram per cubic meter, 1999; Switzerland: MAK-W 10 ppm (40 milligram per cubic meter), KZG-W 20 ppm (80 milligram per cubic meter), 1999; Turkey: TWA 1000 ppm (4200 milligram per cubic meter), 1993; United Kingdom: TWA 10 ppm (43 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: TWA 10 ppm. Several states have set guidelines or standards for R-21 in ambient air[60] ranging from 0.4 milligram per cubic meter (North Dakota) to 0.5 milligram per cubic meter (North Carolina) to 0.65 milligram per cubic meter (Virginia) to 0.8 milligram per cubic meter (Connecticut) to 0.952 milligram per cubic meter (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #2516.

Determination in Water: No tests listed. Octanol-water coefficient: Log $K_{ow} = 1.55$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion, and eye and skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Contact with the liquid may cause frostbite. This chemical affects the CNS at high concentrations. High exposure could cause asphyxia and/or cardiac arrhythmia (irregular heartbeat). This might lead to cardiac arrest.

Long-Term Exposure: May damage the developing fetus. May damage the liver. May cause irregular heartbeat.

Points of Attack: Respiratory system, lungs, and cardiovascular system.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. EKG, liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If frostbite has occurred, seek medical attention immediately; do NOT rub the affected areas or flush them with water. In order to prevent further tissue damage, do NOT attempt to remove frozen clothing from frostbitten areas. If frostbite has NOT occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: 100 ppm: Sa (APF = 10) (any supplied-air respirator). 250 ppm: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). 500 ppm: SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). 5000 ppm: Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-, mounted organic vapor canister]; or SCBAE (any appropriate escape-type SCBA).

Storage: Check oxygen content prior to entering storage area. Prior to working with dichlorofluoromethane all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area away from chemically active metals; acids, acid fumes; alkali, alkaline earth; since violent reaction occur. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: UN1029 Dichlorofluoromethane or Refrigerant gas R-21 Hazard Class: 2.2; Labels: 2.2-Nonflammable compressed gas. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include chlorine, fluorine. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced. Because of recent discovery of potential ozone decomposition in the stratosphere, this material should be released to the atmosphere only as a last resort.

References

(31); (173); (101); (138); (2).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Dichlorofluoromethane*, Trenton, NJ (January 1999)

1,1-Dichloro-1-nitroethane D:0580

Formula: $C_2H_3Cl_2NO_2$: $CH_3CCl_2NO_2$
Synonyms: Dichloronitroethane; Ethide
CAS Registry Number: 594-72-9
HSDB Number: 1571
RTECS Number: KI1050000
UN/NA & ERG Number: UN2650/153
EC Number: 209-854-0 [*Annex I Index No.:* 610-002-00-9]

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Flammable, Suspected reprotoxic hazard, Agricultural chemical.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, F; risk phrases: R10; R23/24/25; safety phrases: S1/2; S26; S41; S45 (see Appendix 4).

Description: 1,1-Dichloro-1-nitroethane is a colorless liquid with an unpleasant odor; causes tears. Molecular weight = 143.96; boiling point = 124°C; vapor pressure = 15 mmHg @ 20°C; flash point = 58°C; 76°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 3. Poor solubility in water; solubility = 0.3%.

Potential Exposure: This material is used as a fumigant insecticide. Therefore, those engaged in the manufacture, formulation and application of this material may be exposed.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides. Corrosive to iron in the presence of moisture.

Permissible Exposure Limits in Air

NIOSH IDLH = 25 ppm

Conversion factor: 1 ppm = 5.89 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 10 ppm/60 milligram per cubic meter Ceiling Concentration

NIOSH REL: 2 ppm/10 milligram per cubic meter TWA

ACGIH TLV[1]: 2 ppm/12 milligram per cubic meter TWA

PAC not available

DFG MAK: No numerical value established. Data may be available.

Australia: TWA 2 ppm (10 milligram per cubic meter), 1993; Austria: MAK 2 ppm (12 milligram per cubic meter), 1999; Belgium: TWA 2 ppm (12 milligram per cubic meter), 1993; Finland: TWA 10 ppm (60 milligram per cubic meter), STEL 20 ppm (120 milligram per cubic meter), 1999; France: VME 2 ppm (10 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 10 milligram per cubic meter, 2003; the Philippines: TWA 10 ppm (60 milligram per cubic meter), 1993; Poland: MAC (TWA) 30 milligram per cubic meter, MAC (STEL) 60 milligram per cubic meter, 1999; Switzerland: MAK-W 2 ppm (12 milligram per cubic meter), 1999; Thailand: TWA 10 ppm (60 milligram per cubic meter), 1993; Turkey: TWA 10 ppm (60 milligram per cubic meter), 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: TWA 2 ppm. Several states have set guidelines or standards for dichloronitroehtane in ambient air[60] ranging from 100 μ/m^3

(North Dakota) to 160 μ/m^3 (Virginia) to 200 μ/m^3 (Connecticut) to 238 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #1601 or OSHA Analytical Method 7.

Routes of Entry: Inhalation, ingestion, and eye and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: In animals: lung, skin, eye irritation. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. LD_{50} = (oral-rat) 410 mg/kg (moderately toxic).

Long-Term Exposure: This chemical causes liver, heart, kidney, and blood vessel damage in animals.

Points of Attack: Lungs.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: Up to 20 ppm: Sa (APF = 10) (any supplied-air respirator). Up to 25 ppm: Sa: Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or SCBAF (APF = 50) (any SCBA with a full facepiece). SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type SCBA).

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a refrigerator away from oxidizers and sources of ignition. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: UN2650 1,1-Dichloro-1-nitroethane, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include hydrogen chloride and oxides of carbon. Water may be used to blanket fire since liquid is heavier than water (sp gr = 1.4). Apply water gently to the surface of the liquid[17]. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration (816°C, 0.5 second for primary combustion; 1204°C, 1.0 second for secondary combustion). The formation of elemental chlorine can be prevented through injection of steam or methane into the combustion process. nitrogen oxides may be abated through the use of thermal or catalytic devices.

References

(31); (173); (101); (138); (2).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Dichlorofluoromethane #0655*, Trenton, NJ, (April 2004)

2,4-Dichlorophenol D:0590

Formula: $C_6H_4Cl_2O$; $Cl_2C_6H_3OH$

Synonyms: 2,4-DCP; 1,3-Dichloro-4-hydroxybenzene; 4,6-Dichlorophenol; 2,4-Diclorofenol (Spanish); Phenol, 2,4-dichloro-

CAS Registry Number: 120-83-2

HSDB Number: 1139

RTECS Number: SK8575000

UN/NA & ERG Number: UN2020/153

EC Number: 204-429-6 [*Annex I Index No.:* 604-011-00-7]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human Inadequate Evidence, animal Sufficient Evidence, *possibly carcinogenic to humans*, Group 2B, 1999; NCI: Carcinogenesis Studies (feed); no evidence: mouse, rat. United States Environmental Protection Agency Gene-Tox Program, Inconclusive: Histidine reversion-Ames test.

Hazard Alert: Poison, Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction), Environmental hazard.

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U081

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.044; Nonwastewater (mg/kg), 14

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8040 (5); 8270 (10)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Canada, Drinking Water, ≤ 0.0003 mg/L MAC, NPRI

Hazardous to aquatic life or environment, with possible long lasting effects[194]. Harmful to aquatic life with long lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R22; R24; R34; R50/53; R62; R63; safety phrases: S1/2; S26; S36/37/39; S41; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: 2,4-DCP is a colorless crystalline solid with a characteristic odor. Molecular weight = 163.00; boiling point = 210°C; freezing/melting point = 45.0°C; vapor pressure = 0.09 mmHg @ 25°C; flash point = 113°C. Hazard identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 0. Slightly soluble in water.

Potential Exposure: 2,4-Dichlorophenol is a commercially produced substituted phenol used in the manufacture of industrial and agricultural products; in synthesis of pharmaceuticals. As an intermediate in the chemical industry, 2,4-DCP is utilized as the feedstock for the manufacture of 2,4-dichlorophenoxyacetic acid (2,4-D), and 2,4-D derivatives (germicides, soil sterilants, etc.); certain methyl compounds used in mothproofing, antiseptics and seed disinfectants. 2,4-DCP is also reacted with benzene sulfonyl chloride to produce miticides or further chlorinated to pentachlorophenol, a wood preservative. It is thus a widely used pesticide intermediate. The only group expected to be at risk for high exposure to 2,4-DCP is industrial workers involved in the manufacturing or handling of 2,4-DCP and 2,4-D.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides. Contact with acids or acid fumes causes decomposition releasing poisonous chlorine gas. Incompatible with caustics, acid anhydrides; acid chlorides. Quickly corrodes aluminum; slowly corrodes zinc, tin, brass, bronze, copper and its alloys. May accumulate static electrical charges, and may cause ignition of its vapors.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: $\mathbf{0.2}_{\mathbf{E}}$ ppm

PAC-2: $\mathbf{2}_{\mathbf{E}}$ ppm

PAC-3: $\mathbf{20}_{\mathbf{E}}$ ppm

*ERPG [Emergency Response Planning Guidelines] are marked with a subscript "**E**."

Michigan[60] has set a guideline for 2,4-dichlorophenol in ambient air of 77.0 μ/m^3.

Permissible Concentration in Water: Federal Drinking Water Guidelines: 20 μg/L; State Drinking Water Guidelines:

Arizona 21 μg/L; Florida 4 μg/L; Maine 21 μg/L; Minnesota 20 μg/L.

Determination in Water: Methylene chloride extraction followed by gas chromatography with flame ionization or electron capture detection (EPA Method 604) or gas chromatography plus mass spectrometry (EPA Method 625).

Routes of Entry: Inhalation, ingestion, and through the skin.

Harmful Effects and Symptoms

Although a paucity of aquatic toxicity data exists, 2,4-DCP appears to be less toxic than the higher chlorinated phenols. 2,4-DCP's toxicity to certain microorganisms and plant life has been demonstrated and its tumor promoting potential in mice has been reported. In addition, it has been demonstrated that 2,4-DCP can produce objectionable odors when present in water at extremely low levels. These findings, in conjunction with potential 2,4-DCP pollution by waste sources from commercial processes or the inadvertent production of 2,4-DCP due to chlorination of waters containing phenol, lead to the conclusion that 2,4-DCP represents a potential threat to aquatic and terrestrial life, including humans. 2,4-DCP can irritate tissue and mucous membranes. LD_{50} = (oral-rat) 580 mg/kg (slightly toxic).

Short-Term Exposure: 2,4-DCP can be absorbed through the skin, thereby increasing exposure. Skin or eye contact can cause irritation and burns. Inhalation can cause respiratory irritation, coughing and wheezing. A suspected carcinogen.

Long-Term Exposure: May cause liver and kidney damage. May affect the nervous system causing headache, dizziness, nausea, vomiting, weakness, and possible coma. Several other chlorophenols are carcinogenic, although 2,4-DCP has not been identified specifically as a carcinogen.

Points of Attack: Nervous system, liver, and kidneys.

Medical Surveillance: Examination of the nervous system. Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type SCBA).

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with 2,4-DCP all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a refrigerator away from oxidizers, acid, acid fumes; acid chlorides; acid anhydrides; caustics. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2020 Chlorophenols, solid, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Dry chemical or CO_2 are preferred extinguishers. Water or foam may cause frothing. Thermal decomposition products may include corrosive hydrogen chloride. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve in a combustible solvent and incinerate in a furnace equipped with afterburner and scrubber[22]. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, *2,4-Dichlorophenol: Ambient Water Quality Criteria*, Washington, DC (1980)

United States Environmental Protection Agency, Chemical Hazard Information Profile: *Mono/Dichlorophenols*, Washington, DC (1979)

United States Environmental Protection Agency, *2,4-Dichlorophenol, Health and Environmental Effects Profile No. 75*, Washington, DC, Office of Solid Waste (April 30, 1980)

Sax N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 1, No. 7, 50−52 (1981), & 7, No. 3, 70−86 (1987)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: 2,4-Dichlorophenol*. Trenton, NJ (June 1998)

2,6-Dichlorophenol D:0600

Formula: $C_6H_4Cl_2O$; $Cl_2C_6H_3OH$
Synonyms: 2,6-DCP; 2,6-Diclorofenol (Spanish)
CAS Registry Number: 87-65-0
HSDB Number: 4240
RTECS Number: SK8750000
UN/NA & ERG Number: UN2020/153
EC Number: 201-761-3

Regulatory Authority and Advisory Information

Hazard Alert: Environmental hazard.

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U082

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.044; Nonwastewater (mg/kg), 14

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long lasting effects[194]. Harmful to aquatic life with long lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, F, C, Xi; risk phrases: R11; R23/24/25; R34; R36/37/38; R39/23/25; R50; safety phrases: S16; S26; S27; S36/37/S39; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: 2,6-Dichlorophenol is a white crystalline solid having a strong odor similar to *o*-chlorophenol. Molecular weight = 163.00; specific gravity (H_2O:1) = 1.65 @ 20°C; boiling point = 219.5°C; freezing/melting point = 68.5°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0.

Potential Exposure: 2,6-Dichlorophenol is produced as a by-product from the direct chlorination of phenol. It is used primarily as a starting material for the manufacture of trichlorophenols, tetrachlorophenols, and pentachlorophenols. It also acts as a sex pheromone for the Lone Star tick.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, acid fumes, acid anhyrides and acid chlorides.

Permissible Exposure Limits in Air

PAC Ver. 29[138]
PAC-1: 8.8 milligram per cubic meter
PAC-2: 97 milligram per cubic meter
PAC-3: 580 milligram per cubic meter

Permissible Concentration in Water: State Drinking Water Guidelines: Florida 0.4 μg/L.

Routes of Entry: Inhalation, and through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: 2,6 DCP can be absorbed through the skin, thereby increasing exposure. Severe local irritation of eyes, skin, and mucous membranes; causes burns. Other symptoms are tremors, convulsions and respiratory inhibition. LD_{50} = (oral-rat) 2940 mg/kg (slightly toxic).

Long-Term Exposure: May cause liver and kidney damage. May affect the nervous system causing headache, dizziness, nausea, vomiting, weakness, and possible coma. Several other chlorophenols are carcinogenic, although 2,6-DCP has not been identified specifically as a carcinogen.
Points of Attack: Nervous system, liver, and kidneys.
Medical Surveillance: Examination of the nervous system. Liver and kidney function tests.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.
Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type SCBA).
Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with 2,6-DCP all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a refrigerator away from oxidizers and other incompatible materials listed above.
Shipping: UN2020 Chlorophenols, solid, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.
Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.
Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Thermal decomposition products may include hydrogen chloride and oxides of carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.
Disposal Method Suggested: Dissolve in a combustible solvent and incinerate in a furnace equipped with afterburner and scrubber[22]. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (101); (138); (100).

United States Environmental Protection Agency, *2,6-Dichlorophenol, Health and Environmental Effects Profile No. 76*, Washington, DC, Office of Solid Waste (April 30, 1980)

Sax N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 4, No. 5, 35−38 (1984)

Dichlorophenyl Isocyanates D:0620

Formula: $C_7H_3C_{12}NO$ (CAS 102-36-3)

Synonyms: *102-36-3:* Benzene, 1,2-dichloro-4-isocyanato-; 3,4-Dichlorfenylisokyanat; 1,2-Dichloro-4-phenyl isocyanate; 3,4-Dichlorophenyl isocyanate; Dichlorophenyl isocyanate

other dichlorophenyl isocyanates: Benzene, 2,4-dichloro-1-isocyanato-; 1,2-Dichloro-3-phenyl isocyanate; 1,3-Dichloro-2-phenyl isocyanate; 1,4-Dichloro-2-phenyl isocyanate; 2,4-Dichloro-1-phenyl isocyanate; Dichlorophenyl isocyanate

CAS Registry Number: *General group:* 102-36-3; 41195-90-8; 39920-37-1; 5392-82-5; 2612-57-9; 34893-92-0

HSDB Number: 5348 (102-36-3)

RTECS Number: NQ8755000 (General group); NQ8760000 (102-36-3)

UN/NA & ERG Number: UN2250/156

EC Number: 203-026-2 (CAS: 102-36-3); 255-253-1 (CAS: 41195-90-8); 254-699-4 (CAS: 39920-37-1); 226-396-7 (CAS: 5392-82-5); 220-040-4 (CAS: 2612-57-9); 252-276-9 (CAS: 34893-92-0)

Regulatory Authority and Advisory Information

Isocyanic Acid, 3,4-Dichlorophenyl Ester (102-36-3)

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 500 lb (227 kg)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%. (carcinogens), all isomers.

Hazard symbols, risk, & safety statements: Hazard symbol: T; risk phrases: R23/24/25; R36/37/38; R42; R51; safety phrases: S22; S26; S36/37/39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to waters (CAS: 102-36-3)

Description: The dichlorophenyl isocyanates are combustible, crystalline (sugar or sand-like) solids. In general, they are white to yellow in color, but the 1,4-dichloro-2-phenyl isomer is white to light green. Their flash points are generally >113°C but that of the 1,3-dichloro-2-phenyl isomer is reported as 77°C. These chemicals are insoluble in water, and some may be reactive. *1,2-dichloro-4-isomer* (CAS 102-36-3) is the isomer of regulatory focus: Molecular weight = 188.01; boiling point = 240°C; freezing/melting point = 42°C; vapor pressure = 0.02 mmHg @ 25°C. Explosive limits: LEL: 20,000 ppm; UEL: unknown. Reacts with water; decomposition.

Potential Exposure: Those materials used as chemical intermediates.

Incompatibilities: May form explosive mixture with air. Isocyanates are highly flammable and reactive with many compounds, even with themselves. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Reaction with moist air, water or alcohols may form amines and insoluble polyureas and react exothermically, releasing toxic, corrosive or flammable gases, including carbon dioxide; and, at the same time, may generate a violent release of heat increasing the concentration of fumes in the air. Incompatible with amines, aldehydes, alkali metals, ammonia, carboxylic acids, caprolactum, alkaline materials, glycols, ketones, mercaptans, hydrides, organotin catalysts, phenols, strong acids, strong bases, strong reducing agents such as hydrides, urethanes, and ureas. Elevated temperatures or contact with acids, bases, tertiary amines, and acylchlorides may cause explosive polymerization. Contact with metals may evolve flammable hydrogen gas. Attacks some plastics, rubber, and coatings.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

102-36-3

PAC-1: 1.3 milligram per cubic meter

PAC-2: 14 milligram per cubic meter

PAC-3: 120 milligram per cubic meter

Determination in Air: Impinger; Reagent; High-pressure liquid chromatography/Fluorescence/Electrochemical detection; NIOSH Analytical Method (IV) #5522, Isocyanates. See also Method #5521.

Permissible Concentration in Water: Hazardous to the aquatic environment. Reacts with water, forming carbon dioxide.

Harmful Effects and Symptoms

Short-Term Exposure: Exposure can irritate the eyes, nose, throat, air passages and lungs, causing coughing, shortness of breath and tightness in the chest. LD_{50} = (oral-rat) 91 mg/kg[NTIS]

Long-Term Exposure: Dichlorophenyl isocyanates may cause an asthma-like allergy. Future exposures can cause asthma attacks with shortness of breath; wheezing, cough, and/or chest tightness.

Points of Attack: Lungs.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended. Lung function tests. These may be normal if the person is not having an attack at the time of the test. If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose allergy. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure,

begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to dichlorophenyl isocyanates exists, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with these chemicals all handlers should be trained on its proper handling and storage. Store to avoid contact with alcohols, strong bases (such as potassium hydroxide and sodium hydroxide), carboxylic acids; amines, and metals, since violent reactions occur. Store in tightly closed containers in a dry, cool, well-ventilated area away from moisture and temperatures above 40°C.

Shipping: UN2250 Dichlorophenyl isocyanates, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Stay upwind and uphill. Isolate the area of release or fire and deny entry. Remove all ignition sources. Stop the release if it can be done safely from a distance. All equipment used to handle this material must be grounded. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. *Small spill*: Cover with *dry* earth, *dry* sand, or other noncombustible material followed with plastic sheet to minimize spreading or contact with water or rain. Use clean nonsparking tools to collect material and place material into loosely covered plastic containers for later disposal. Prevent material and runoff from entering sewers and waterways if it can be done safely well ahead of the release. Use vapor suppressing foam to disperse vapors—contain runoff. Water spray may reduce vapor, but may not prevent ignition in enclosed spaces. Ventilate confined area if it can be done without placing personnel at risk. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: These chemicals are combustible. Thermal decomposition products may include hydrogen cyanide, oxides of nitrogen and hydrogen chloride gas. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Combustion in an incinerator equipped with afterburner and fume scrubber.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, "*Hazardous Substance Fact Sheets: 1,2-Dichloro-4-Phenyl Isocyanate*, Trenton, NJ (April 1986)

New Jersey Department of Health and Senior Services, "*Hazardous Substance Fact Sheets: 1,3-Dichloro-2-Phenyl Isocyanate*, Trenton, NJ (August 2001).

New Jersey Department of Health and Senior Services, "*Hazardous Substance Fact Sheets: 1,4-Dichloro-2-Phenyl Isocyanate*, Trenton, NJ (October 2001).

New Jersey Department of Health and Senior Services, "*Hazardous Substance Fact Sheets: 2,4-Dichloro-1-Phenyl Isocyanate*, Trenton, NJ (October 2001).

New Jersey Department of Health and Senior Services, "*Hazardous Substance Fact Sheets: 1,2-Dichloro-3-Phenyl Isocyanate*, Trenton, NJ (October 2001).

Dichlorophenyl Trichlorosilane D:0630

Formula: $C_6H_3Cl_5Si$; $Cl_2C_6H_3SiCl_3$

Synonyms: Silane, trichloro(dichlorophenyl)-; Trichloro (dichlorophenyl)silane

CAS Registry Number: 27137-85-5

HSDB Number: 6348

RTECS Number: VV3540000

UN/NA & ERG Number: UN2987/156

EC Number: 248-254-3

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Combustible, Corrosive, Violently water reactive

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: C, T; risk phrases: R34; safety phrases: S26; S36/37/38/39; S41; S45 (see Appendix 4).

Description: Dichlorophenyl trichlorosilane is a straw-colored liquid. Molecular weight = 280.43; boiling point = 258.6°C; vapor pressure = < 1 mmHg @ 18°C; flash point = 141°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 2. Decomposes in water; rapidly releasing corrosive hydrogen chloride gas.

Potential Exposure: This material is used in silicone polymer manufacture.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides. Chlorosilanes react vigorously with bases and both organic and inorganic acids generating toxic and/or flammable gases. Chlorosilanes react with water, moist air, or steam to produce heat and toxic, corrosive fumes of hydrogen chloride. They may also produce flammable gaseous hydrogen.

Permissible Exposure Limits in Air

PAC* Ver. 29[138]

PAC-1: $\mathbf{0.60}_{\mathbf{A}}$ ppm

PAC-2: $\mathbf{7.3}_{\mathbf{A}}$ ppm

PAC-3: $\mathbf{33}_{\mathbf{A}}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values. Russia[43] set a MAC in work-place air of 1.0 milligram per cubic meter.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short-Term Exposure: Exposure can irritate the lungs, causing coughing and/or shortness of breath. Higher exposures can cause a build-up of fluid in the lungs (pulmonary edema). This can cause death. This substance is a corrosive chemical and contact can cause severe skin and eye burns. Exposure can irritate the eyes, nose and throat.

Long-Term Exposure: Repeated exposure may affect the lungs.

Points of Attack: Lungs.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures to dichlorophenyl Trichlorosilane exists, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure demand or other positive-pressure mode.

Storage: (1) Color code-White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. (2) Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Dichlorophenyl trichlorosilane should be stored to avoid contact with moisture or with combustible materials, such as wood, paper and oil.

Shipping: UN2987 Chlorosilanes, corrosive, n.o.s, Hazard class: 8; Labels: 8-Corrosive material.

Spill Handling:

Initial Isolation and Protective Action Distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase

with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24 h response line).

Small Spills (from a small package or a small leak from a large package)

When Spilled in Water

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.2/0.3

Large Spills (from a large package or from many small packages)

First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.3/0.5
Night 1.0/1.5

Stay upwind and uphill. Isolate the area of release or fire and deny entry. Remove all ignition sources. Stop the release if it can be done safely from a distance. All equipment used to handle this material must be grounded. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. *Small spill*: Cover with *dry* earth, *dry* sand, or other noncombustible material followed with plastic sheet to minimize spreading or contact with water or rain. Use clean nonsparking tools to collect material and place material into loosely covered plastic containers for later disposal. Prevent material and runoff from entering sewers and waterways if it can be done safely well ahead of the release. Use vapor suppressing foam to disperse vapors—contain runoff. Water spray may reduce vapor, but may not prevent ignition in enclosed spaces. Ventilate confined area if it can be done without placing personnel at risk. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Dichlorophenyl trichlorosilane may burn, but does not readily ignite. Poisonous gas is produced in fire. *FOR CHLOROSILANES, DO NOT USE WATER. USE AFFF ALCOHOL-RESISTANT, MEDIUM EXPANSION FOAM. Small fire*: Use *dry* chemical, CO_2, *dry* sand, or alcohol-resistant foam. May react with foams releasing corrosive/toxic gases. *Large fire*: Use water spray or alcohol-resistant foam if it is available in sufficient amounts. Under favorable conditions, experienced crews can use coordinated fog streams to sweep the flames off the surface of the burning liquid. Combustible material: may burn but does not ignite readily. Most vapors are heavier than air. They will spread along ground and collect in low or confined areas (sewers, basements, tanks). Vapors may travel to source of ignition and flash back. Containers may explode when heated or if contaminated with water. Keep exposures cool long after fire is out to protect against reignition. Do not direct straight streams into the liquid. Cool exposed containers with large quantities of water from unattended equipment or remove intact containers if it can be done safely. *Do not get water on spilled substance or inside containers*. If cooling streams are ineffective (*venting sound increases in volume and pitch, tank discolors or shows signs of deforming*), withdraw immediately to a secure location. Always stay away from ends of tanks, especially when engulfed in flames. If material or contaminated runoff from fire control enters waterways, notify downstream users of potentially contaminated water. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156.

References

(31); (173); (101); (138).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Dichloro Phenyl Trichlorosilane*, Trenton, NJ (October 2000)

Dichloroprop D:0635

Formula: $C_9H_8Cl_2O_3$

Synonyms: Acide-2-(2,4-dichloro-phenoxy)propionique (French); Acido 2-(2,4-diclorofenoxi)propionico (Spanish); BH 2,4-DP; Celatox-DP; Cornox RD; Cornox RK; Desormone; α-(2,4-Dichlorophenoxy)propionic acid; (+-)-2-(2,4-Dichlorophenoxy)propionic acid; 2-(2,4-Dichlorophenoxy)propionic acid; 2,4-Dichlorophenoxy-α-propionic acid; 2,4-Dichlorophenoxypropionic acid; Dichloroprop; 2-(2,4-Dichlor-phenoxy)-propionsaeure (German); Dichlorprop; 2-(2,4-DP); 2,4-DP (EPA); Embutox; Graminon-plus; Hedonal; Hedonal DP; Herbizid DP; Hormatox; Kildip; NSC 39624; Polyclene; Polymone; Polytox; Propanoic acid, 2-(2,4-dichlorophenoxy)-; Propionic acid, 2-(2,4-dichlorophenoxy)-; RD 406; Seritox 50; U 46; U46 DP-Fluid; Visko-Rhap; Weedone 170; Weedone DP

CAS Registry Number: 120-36-5

HSDB Number: 1575

RTECS Number: UF1050000

UN/NA & ERG Number: UN3345/153; UN2588 (Pesticide, solid, toxic, n.o.s.)/151

EC Number: 204-390-5 [*Annex I Index No.:* 607-045-00-0]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human Limited Evidence, animal Inadequate Evidence, possibly carcinogenic to humans, *possibly carcinogenic to humans*, Group 2B, 1987.

California Proposition 65 Developmental/Reproductive toxin delisted 1/25/2002

Hazard Alert: Poison, Environmental hazard, Agricultural chemical.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Hazardous to aquatic life or environment, with possible long lasting effects[194]. Harmful to aquatic life with long lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: Xi, Xn; risk phrases: R40; R21/22; R38; R41; R51/53; safety phrases: S2; S26; 36/37; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: 2,4-DP is a combustible, colorless to yellowish to tan crystalline solid with a faint phenolic odor; Molecular weight = 235.07; freezing/melting point = 117°C−118°C. Soluble in water; solubility = 350 mg/L @ 20°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. May be applied as a liquid formulated with a flammable carrier, which can alter the physical properties listed here.

Potential Exposure: A phenoxy herbicide.

Incompatibilities: Dust may form explosive mixture with air. Contact with oxidizers may cause a fire and explosion hazard. The aqueous solution is a weak acid. Attacks many metals in presence of moisture. Compounds of the carboxyl group react with all bases, both inorganic and organic (i.e., amines) releasing substantial heat, water and a salt that may be harmful. Incompatible with arsenic compounds (releases hydrogen cyanide gas), diazo compounds, dithiocarbamates, isocyanates, mercaptans, nitrides, and sulfides (releasing heat, toxic and possibly flammable gases), thiosulfates and dithionites (releasing hydrogen sulfate and oxides of sulfur).

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Determination in Water: No method listed. Octanol-water coefficient: Log $K_{ow} = > 3.5$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation and passing through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin, and respiratory tract. Exposure can cause headache, fatigue, muscle twitching, fever, nausea, vomiting, diarrhea, stomach pain, poor appetite, and convulsions.

Long-Term Exposure: There is limited evidence that related phenoxy herbicide compounds cause cancer. May cause liver damage.

Points of Attack: Liver.

Medical Surveillance: Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with 2,4-DP all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area away from strong oxidizers and bases. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically transfer material from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN3345 Phenoxyacetic acid derivative pesticide, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: *Solid material:* Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Liquid formulations containing organic solvents: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include phosgene, hydrogen chloride and oxides of carbon. *Solid material:* This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Thermal decomposition products may include phosgene, hydrogen chloride and carbon monoxide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode. *Liquid formulations containing organic solvents:* This chemical is a combustible liquid. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: 2-(2,4-Dichlorophenoxy) Propionic Acid*, Trenton, NJ (October 2006).

1,2-Dichloropropane D:0640

Formula: $C_3H_6Cl_2$; $ClCH_2CHClCH_3$

Synonyms: Bichlorure de propylene (French); α,β-Dichloropropane; 1,2-Dicloropropano (Spanish); ENT 15,406; NCI-C55141; Propane, 1,2-dichloro-; Propylene chloride; α,β-Propylene dichloride; Propylene dichloride

CAS Registry Number: 78-87-5; 26638-19-7 (dichloropropane)

HSDB Number: 1102

RTECS Number: TX9625000

UN/NA & ERG Number: UN1279/130

EC Number: 201-152-2

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human No Adequate Data; Animal Limited Evidence*, not classifiable as carcinogenic to humans*, Group 3, 1999; NIOSH: Potential occupational carcinogen. United States Environmental Protection Agency Gene-Tox Program, Positive: Histidine reversion-Ames test.

California Proposition 65 Chemical[102]: Cancer 1/1/1990.

Hazard Alert: Highly flammable, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction), Environmental hazard. Listed for Tier 1 screening as an endocrine disruptor[88].

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U083

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.85; Nonwastewater (mg/kg), 18

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8010 (0.5); 8240 (5)

United States National Primary Drinking Water Regulations: MCL = zero mg/L; MCL = 0.005 mg/L

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1000 lb (454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%., National Pollution Release Inventory (NPRI).

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xn; risk phrases: R11, R20/22; R50/53; R62; R63; safety phrases: S2; S16; S21; S24; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Dichloropropane is a colorless stable liquid. Sweet, chloroform-like odor. The odor threshold in air is 0.25 ppm. Molecular weight = 112.99; specific gravity (H_2O:1) = 1.16; boiling point = 96°C; freezing/melting point = −100°C; vapor pressure = 40 mmHg @ 20°C; flash point = 16°C (cc); Autoignition temperature = 557°C. Explosive limits: LEL: 3.4%; UEL: 14.5%. Hazard identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 0. Very slightly soluble in water; solubility = 0.3% @ 20°C.

Potential Exposure: Dichloropropane is used as a chemical intermediate in perchloroethylene and carbon tetrachloride synthesis, and as a lead scavenger for antiknock fluids. It is also used as a solvent for fats, oils, waxes, gums and resins; and in solvent mixtures for cellulose esters and ethers. Other applications include the use of dichloropropane; as a fumigant, alone and in combination with dichloropropane, as a scouring compound; and a metal degreasing agent. It is also used as an insecticidal fumigant.

Incompatibilities: May form explosive mixture with air. May accumulate static electrical charges, and may cause ignition of its vapors. Contact with strong oxidizers, powdered aluminum may cause fire and explosion hazard. Strong acids can cause decomposition and the formation of hydrogen chloride vapors. Reacts with strong bases; *o*-dichlorobenzene, 1,2-dichloroethane. Corrosive to aluminum and its alloys. Attacks some plastics, rubber, and coatings.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 4.62 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 75 ppm/350 milligram per cubic meter TWA

NIOSH REL: Potential occupational carcinogen; limit exposure to lowest feasible level. See *NIOSH Pocket Guide*, Appendix A

ACGIH TLV[1]: 10 ppm/46 milligram per cubic meter TWA, sensitizer, not classifiable as a human carcinogen

78-87-5

NIOSH IDLH = 400 ppm, potential human carcinogen

PAC Ver. 29[138]

78-87-5

PAC-1: 30 ppm

PAC-2: 220 ppm

PAC-3: 2000 ppm

DFG MAK: Carcinogen Category 3B

Australia: TWA 75 ppm (350 milligram per cubic meter); STEL 110 ppm, 1993; Austria: MAK 75 ppm (350 milligram per cubic meter), 1999; Belgium: TWA 75 ppm (347 milligram per cubic meter); STEL 110 ppm (509 milligram per cubic meter), 1993; Denmark: TWA 75 ppm (350 milligram per cubic meter), 1999; Finland: TWA 75 ppm (350 milligram per cubic meter); STEL 115 ppm (530 milligram per cubic meter), 1999; France: VME 75 ppm (350 milligram per cubic meter), 1999; Hungary: TWA 50 milligram per cubic meter; STEL 100 milligram per cubic meter [skin] 1993; the Netherlands: MAC-TGG 350 milligram per cubic meter, 2003; Norway: TWA 40 ppm (185 milligram per cubic meter), 1999; the Philippines: TWA 75 ppm (350 milligram per cubic meter), 1993; Poland: MAC (TWA) 50 milligram per cubic meter, MAC (STEL) 400 milligram per cubic meter, 1999; Russia: STEL 10 milligram per cubic meter, 1993; Switzerland: MAK-W 75 ppm (350 milligram per cubic meter), KZG-W 375 ppm (1750 milligram per cubic meter), 1999; Turkey: TWA 74 ppm (350 milligram per cubic meter), 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: STEL 110 ppm. Russia[35],[43] set a MAC in ambient air in residential areas of 0.18 milligram per cubic meter on a daily average basis. Sever1 from 5.1 μ/m^3 (Massachusetts) to 13.89 μ/m^3 (Kansas) to 3500−5100 μ/m^3 (North Dakota) to 5800 μ/m^3 (Virginia) to 7000 μ/m^3 (Connecticut) to 8330 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #1013 or OSHA Analytical Method 7.

Permissible Concentration in Water: Safe Drinking Water Act (47FR 9352): MCL, 0.005 mg/L; MCLG, zero; Priority List (55 FR 1470). Federal Drinking Water Standards: EPA 5 μg/L; State Drinking Water Standards: California 5 μg/L; State Drinking Water Guidelines: Arizona 0.56 μg/L; Connecticut 5 μg/L; Minnesota 5 μg/L.

Determination in Water: Inert gas purge followed by gas chromatography with halide specific detection (EPA Method 601) or gas chromatography plus mass spectrometry (EPA Method 624). Octanol-water coefficient: Log K_{ow} = about 2.

Routes of Entry: Inhalation of vapor, ingestion, and eye and skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: 1,2-Dichloropropane irritates the eyes, skin, and respiratory tract. It may affect the nervous system. High concentration exposure can result in lightheadedness, dizziness, and unconsciousness. Propylene dichloride may cause dermatitis and defatting of the skin. More severe irritation may occur if it is confined against the skin by clothing. Undiluted, it is moderately irritating to the eyes, but does not cause permanent injury. The vapor can irritate the nose, throat, eyes and air passages. Repeated or prolonged skin contact can cause rash.

Long-Term Exposure: Repeated exposure can cause skin drying and dermatitis. There is limited evidence that this chemical causes cancer in animals. It may cause liver cancer. In animal experiments, acute exposure to propylene dichloride produced CNS narcosis, fatty degeneration of the liver and kidneys. High or repeated exposure can damage the liver, kidneys and brain, Early symptoms include headaches, nausea, personality changes. Based on animal tests this chemical may affect reproduction and may cause malformations in the human fetus.

Points of Attack: Eyes, skin, respiratory system, liver, kidneys, and CNS. *Cancer site:* (in animals) liver and mammary gland tumors.

Medical Surveillance: Liver and kidney function tests. Examination of the nervous system. Evaluate the skin condition.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Teflon is among the recommended protective materials for all dichloropropane isomers. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: At *any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-, mounted organic vapor canister]; or SCBAE (any appropriate escape-type SCBA).

Storage: Color code-Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with 1,2-dichlropropane all handlers should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. 1,2-dichlropropane must be stored to avoid contact with aluminum, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers (such as chlorine, bromine and fluorine); strong acids (such as hydrochloric, sulfuric and nitric); *o*-dichlorobenzene and 1,2-dichlroethane. Sources of ignition, such as smoking and open flames, are prohibited where 1,2-dichlropropane, is handled, used, or stored. Metal containers involving the transfer of five gallons or more of 1,2-dichlropropane should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of 1,2-dichloropropane. Wherever 1,2-dichloropropane is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN1279 1,2-Dichloropropane, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Stay upwind; keep out of low areas. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include chlorine. Use dry chemical, CO_2, or foam extinguishers. Water may be ineffective, except to blanket fire. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced[22]. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(102); (31); (101); (138); (2); (100).

United States Environmental Protection Agency, *Dichloropropanes/Dichloropopenes: Ambient Water Quality Criteria*, Washington, DC (1980)

National institute for Occupational Safety and Health (NIOSH), *Profiles on Occupational Hazards for Criteria Document Priorities: Dichloropropane, pp 292−294, Report PB-274-73*, Cincinnati, OH (1977)

United States Environmental Protection Agency, *1,2-Dichloropopane, Health and Environmental Effects Profile No. 78*, Washington, DC, Office of Solid Waste (April 30, 1980)

United States Environmental Protection Agency, *Dichloropropanes/Dichloropropenes, Health and Environmental Effects Profile No. 79*, Washington, DC, Office of Solid Waste (April, 30, 1980)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: 1,2-Dichloropropane*, Trenton, NJ (July 2002)

Dichloropropanols D:0650

Formula: $C_3H_6Cl_2O$; $C_3H_6OCl_2$

Synonyms: *26545-73-3:* Dichloropropanol; 1,3-Dichloropropanol-2; Glycerin dichlorohydrin; *96-23-1:* α-Dichlorohydrin; Dichlorohydrin; *sym*-Dichloroisopropyl alcohol; 1,3-Dichloropropanol-2; Dichloro-2-propanol, 1,3-; *sym*-Glycerol dichlorohydrin; Glycerol α,β-dichlorohydrin; U 25,354; *616-23-9:* 1,2-Dichloro-3-propanol; 1,2-Dichloropropanol-3; 1,3-Dichloro-2-propanol; 2,3-Dichloro-1-propanol; 2,3-Dichloropropanol; Glycerol-α,β-dichlorohydrin

CAS Registry Number: 96-23-1 (Dichloro-2-propanol, 1,3-); 26545-73-3 (Dichloropropanol); 616-23-9 (2,3-Dichloropropanol)

HSDB Number: 5302

RTECS Number: UB1400000 (96-23-1); UB1225000 (616-23-9) (2,3-dichloropropan-1-ol)

UN/NA & ERG Number: UN2750 (1,3-Dichloropropanol-2)/153

EC Number: 247-787-9 (dichloropropanol); 202-491-9 [*Annex I Index No.:* 602-064-00-0] (dichloro-2-propanol, 1,3-); 210-470-0 (2,3-dichloropropan-1-ol)

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: (chlorophenols) Human Limited Evidence, animal Inadequate Evidence, possibly carcinogenic to humans, *possibly carcinogenic to humans*, Group 2B, 1973; DFG: (96-23-1) Category 2

California Proposition 65 Chemical (*96-23-1*): Cancer: 10/8/2010

Hazard Alert: Poison, Combustible.

Hazardous Constituent Waste (EPA-RCRA), as dichloropropanols

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%., 1,3-Dichloro-2-propanol.

Hazard symbols, risk, & safety statements: Hazard symbol: T; risk phrases: R45; R10; R21; R23/24/25; R39; R50/53; safety phrases: S16; S26; S36/37; S45; S53; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: There are 4 isomers of dichloropropanols 1,3-dichloro-2-propanol (96-23-1) and "dichloropropanols" (26545-73-3) are citations in environmental regulations: $C_3H_6OCl_2$ is a colorless viscous liquid with a chloroform-like odor. Slightly soluble in water. *1,3-Dichloro-2-propanol*: Molecular weight = 128.99; specific gravity (H_2O:1) = 1.37 @ 20°C; boiling point = 174°C; vapor pressure = 1 mmHg @ 28°C; flash point = 74°C; freezing/melting point = −4°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 0. Soluble in water. *2,3-Dichloro-1-propanol*: Boiling point = 182°C. *3,3-Dichloro-1-propanol*: Boiling point = 82-83°C. *1,1-Dichloro-2-propanol*: Boiling point = 146-148°C.

Potential Exposure: It is used as a solvent for hard resins and nitrocellulose; in the manufacture of photographic chemicals and lacquer; as a cement for celluloid; and as a binder of water colors. It occurs in effluents from glycerol and halohydrin production plants.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong acids, acid anhydrides, strong bases.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

96-23-1, *dichloro-2-propanol, 1,3-*

PAC-1: 0.33 ppm

PAC-2: 3.6 ppm

PAC-3: 5.4 ppm

DFG MAK: [skin] Carcinogen Category 2

Harmful Effects and Symptoms

Short-Term Exposure: *2,3-dichloro-1-propanol:*[52] Irritation of the eyes, skin, and mucous membranes; dyspnea, coughing, nausea, vomiting, diarrhea, abdominal pain; GI hemorrhage; toxic hepatitis; jaundice, hemolytic anemia; decreased urinary output from nephritis and renal failure; somnolence, cerebral hemorrhage; CNS depression and coma. High exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. *1,3-dichloro-2-propanol:*[52] Irritation of skin, eyes, and respiratory system; inhalation may cause headache, vertigo, nausea, vomiting; may also cause coma and liver damage.

Long-Term Exposure: Causes cancer in animals; may be a potential human carcinogen. May cause liver, kidney, and/or lung damage.

Points of Attack: CNS, liver, kidneys, and lungs.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Kidney function tests. Liver function tests. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type SCBA).

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with 1,3-dichloro-2-propanol all handlers should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a refrigerator under inert atmosphere away from oxidizers. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2750 1,3-Dichloropropanol-2, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak

until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include hydrogen chloride, phosgene, and oxides of carbon. Use alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, *Dichloropropanol, Health and Environmental Effects Profile No. 80*, Washington, DC, Office of Solid Waste (April 30, 1980)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: 1,3-Dichloropropanol*, Trenton, NJ (January 2001).

Dichloropropenes D:0660

Formula: $C_3H_4Cl_2$; $CHCl = CHCH_2Cl$

Synonyms: β-Chloroallyl chloride; 3-Chloroallyl chloride; 3-Chloropropenyl chloride; 1,3-D; 1,3-Dichloro-1-propene; 1,3-Dichloro-2-propene; α,β-Dichloropropylene; 1,3-Dichloropropylene; 1,3-Dicloropropeno (Spanish); 1-Propene, 1,3-dichloro-; Propene, 1,3-dichloro-; Telone; Telone II

CAS Registry Number: 542-75-6 (1,3-mixture of isomers); (*alt*) 8022-76-2 (1,3-mixture of isomers); 563-58-6 (1,1-); 78-88-6 (2,3-); 26952-23-8 (dichloropropenes); 10061-01-5 (*cis-; Z*); 10061-02-6 (*trans-*)

HSDB Number: 1109 (542-75-6); 5222 (78-88-6)

RTECS Number: UC8310000

UN/NA & ERG Number: UN2047/129

EC Number: 248-134-0 (dichloropropene) 208-826-5 [*Annex I Index No.:* 602-030-00-5]; (*1,3-; 8022-76-2*) 201-153-8 [*Annex I Index No.:* 602-079-00-2]; (*2,3-; 78-88-6*); 233-195-8 [*Annex I Index No.:* 602-030-00-5]; (*cis-; Z; 10061-01-5*)

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen: 1,3-dichloropropene (technical grade) (542-75-6): IARC (*technical grade*): Animal Sufficient Evidence; Human No Adequate Data, *possibly carcinogenic to humans*, Group 2B, 1999; NTP (*technical grade*):NCI: Carcinogenesis Studies (gavage); clear evidence: mouse, rat; NIOSH: Potential occupational carcinogen, See *NIOSH Pocket Guide*, Appendix A. United States Environmental Protection Agency Gene-Tox Program, Positive: Histidine reversion-Ames test

California Proposition 65 Chemical[102]: Cancer 1/1/1989.

Hazard Alert: Highly flammable, Polymerization hazard (nonstabilized); 542-75-6: Possible risk of forming tumors, Suspected of causing genetic defects, Environmental hazard; Sensitization hazard.

United States Environmental Protection Agency, FIFRA 1998 Status of Pesticides: Supported

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U084

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%. (CAS: 542-75-6)

Mexico, drinking water, 0.09 mg/L

Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: *1,3-Dichloropropene mixture of isomers; (542-75-6)*: Hazard symbol: T, N, Xi; risk phrases: R10; R20; R24/25; R29/35;

R36/37/38; R43; R65; R50/53; R62; safety phrases: S1/2; S36/37; S45; S60; S61.

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to waters

2,3-isomer, 78-88-6

Hazard symbol: F, Xn; risk phrases: R11; R20/21/22; R37/38; R41; R50/53; R62; safety phrases: S2; S9; S16; S23; 226; S36/37/39; S41; S61 (see Appendix 4).

cis-isomer; 10061-01-5

Hazard symbols, risk, & safety statements: Hazard symbol: T, N, Xi; risk phrases: R10; R20; R24/25; R36/37/38; R43; R65; R50/53; safety phrases: S1/2; S36/37; S45; S60; S61.

WGK[100] (German Aquatic Hazard Class) (*1,3-; 78-88-6*): 3-Severe hazard to water.

trans-isomer; 10061-02-6

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.036; Nonwastewater (mg/kg), 18

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8010 (5); 8240 (5)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

European/International Regulations (*Z; 10061-01-5*): Hazard symbol: T, N, Xi; risk phrases: R11; R20; R24/25; R36/37/38; R43; R65; R50/53; safety phrases: S1/2; S21; S36/37; S41; S45; S60; S61.

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)]

Description: 1,3-Dichloropropene is a colorless to straw-colored liquid. Sharp, sweet, irritating, chloroform-like odor. Molecular weight = 110.97; specific gravity (H_2O:1) = 1.21; boiling point = 107.7°C; 103°C−110°C (mixed *cis*-and *trans*-isomers); freezing/melting point = −83.8°C; vapor pressure = 29 mmHg @ 20°C; flash point = 35°C. The explosive limits are: LEL: 5.3%; UEL: 14.5%. Hazard identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 0. Practically insoluble in water; solubility = 0.2%.

Potential Exposure: Used as a soil fumigant prior to planting crops, such as cotton, sugar beet, potatoes; used in combinations with dichloropropanes as a soil fumigant. Workers engaged in manufacture, formulation and application of this soil fumigant and nematocide.

Incompatibilities: Vapor may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides. May accumulate static electrical charges, and may cause ignition of its vapors. Incompatible with strong acids; oxidizers, aluminum or magnesium compounds; aliphatic amines; alkanolamines, alkaline materials; halogens, or corrosives. *Note:* Epichlorohydrin may be added as a stabilizer.

Permissible Exposure Limits in Air

OSHA PEL: None

NIOSH REL: 1 ppm/5 milligram per cubic meter TWA [skin]; Potential occupational carcinogen; limit exposure to lowest feasible level. See *NIOSH Pocket Guide*, Appendix A

ACGIH TLV[1]: 1 ppm/4.5 milligram per cubic meter TWA [skin]; confirmed animal carcinogen with unknown relevance to humans (2003)

PAC Ver. 29[138]

542-75-6

PAC-1: 3 ppm

PAC-2: 19 ppm

PAC-3: 120 ppm

78-88-6

PAC-1: 0.33 ppm

PAC-2: 3.6 ppm

PAC-3: 21 ppm

DFG MAK (*cis-and trans-isomers*): [skin] danger of skin sensitization; Carcinogen Carcinogen Category 2

Australia: TWA 1 ppm (5 milligram per cubic meter), [skin], carcinogen, 1993; Austria: carcinogen, 1999; Belgium: TWA 1 ppm (4.5 milligram per cubic meter), [skin], 1993; Denmark: TWA 1 ppm (5 milligram per cubic meter), [skin], 1999; Norway: TWA 1 ppm (5 milligram per cubic meter), 1999; Russia: STEL 5 milligram per cubic meter, 1993; Switzerland: 1 ppm (5 milligram per cubic meter), [skin], carcinogen, 1999; the Netherlands: MAC-TGG 5 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: confirmed animal carcinogen with unknown relevance to humans. Several states have set guidelines or standards for 1,3-dichloropropene in ambient air[60] ranging from 50 μ/m^3 (North Dakota) to 80 μ/m^3 (Virginia) to 100 μ/m^3 (Connecticut) to 119 μ/m^3 (Nevada).

Determination in Air: No method listed.

Permissible Concentration in Water: (*CAS: 26952-23-8*) State Drinking Water Guidelines: Arizona 87 μg/L. (***542-75-6, 1,3-isomer***) State Drinking Water Standards: California 0.5 μg/L; State Drinking Water Guidelines: Florida 0.4 μg/L; Massachusetts 0.4 μg/L; Maine 4 μg/L; Minnesota 2 μg/L; New Hampshire 0.4 μg/L; Wisconsin 0.2 μg/L.

Determination in Water: Inert gas purge followed by gas chromatography with halide specific detection (EPA Method 601) or gas chromatography plus mass spectrometry (EPA Method 624). Fish Tox = 137.01437000 ppb MATC (LOW)

Routes of Entry: Inhalation, skin absorption, ingestion, and skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: This chemical can be absorbed through the skin, thereby increasing exposure. Exposure can cause headaches, chest pain; and dizziness. High levels can cause you to pass out. Contact can severely burn the eyes and skin, with permanent damage. High exposures can damage the kidneys, liver, and lungs.

Long-Term Exposure: There is evidence that 1,3-dichloropropene causes cancer in animals and humans. May damage the kidneys, liver and lungs. May cause chronic headache, and personality changes. Human Tox = 2.86885 ppb CHCL (Chronic Human Carcinogen Level) (HIGH).

Points of Attack: Eyes, skin, respiratory system, CNS, liver, and kidneys. *Cancer site:* (in animals) cancer of the bladder, liver, lung, and stomach.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended: liver function tests; lung function tests, and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. NIOSH recommends: 8 hours (more than 8 hours of resistance to breakthrough $> 0.1\ \mu g/cm^2/min$): polyvinyl alcohol gloves; Viton gloves, suits; Responder suits; 4 hours (At least 4 but $<$ 8 hours of resistance to breakthrough $> 0.1\ \mu g/cm^2/min$): Teflon gloves, suits, and boots. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type SCBA).

Storage: Color code-Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with 1,3-dichloropropene all handlers should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. 1,3-dichloropropene must be stored to avoid contact with aluminum or magnesium compounds; substances containing fluorine, chlorine, bromine, or iodine; and alkaline or corrosive materials, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Separate outside storage is preferred. Sources of ignition, such as smoking and open flames are prohibited where 1,3-dichloropropene is handled, used, or stored. Metal containers involving the transfer of five gallons or more of 1,3-dichloropropene should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers or 1,3-dichloropropene. Always store pesticides in their original containers, complete with labels that list ingredients, directions for use, and first aid steps in case of accidental poisoning. Never store pesticides in cabinets with or near food, animal feed, or medical supplies. Do not store pesticides in places where flooding is possible or in places where they might spill or leak into wells, drains, ground water, or surface water[72]. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2047 Dichloropropene, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Stay upwind; keep out of low areas. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include hydrogen chloride and oxides of carbon. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced[22]. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(109); (102); (31); (80); (173); (101); (138); (203); (100).

United States Environmental Protection Agency, *Dichloropropanes/Dichloropropenes: Ambient Water Quality Criteria*, Washington, DC (1980)

United States Environmental Protection Agency, *1,3-Dichloropropene, Health and Environmental Effects Profile No. 81*, Washington, DC, Office of Solid Waste (April 30, 1980)

United States Environmental Protection Agency, *Dichloropropanes/Dichloropropenes*: *Health and Environmental Effects Profile No. 79*, Washington, DC, Office of Solid Waste (April 30, 1980)

United States Environmental Protection Agency, *Health advisory: 1,3-Dichloropropene*, Washington, DC, Office of Drinking Water (August 1987)

Sax N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 6, No. 5, 88−93 (1986)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: 1,3-Dichloropropene*, Trenton, NJ (December 1999)

Diclofop-methyl D:0695

Formula: $C_{16}H_{14}Cl_2O_4$

Synonyms: Caswell No. 319A; Diclofop methyl ester; Dichlordiphenprop; Dichlorfop-methyl; 2-[4-(2,4-Dichlorophenoxy)phenoxy]-methyl-propionate; 2-[4-(2,4-Dichlorophenoxy)phenoxy]propanoic acid methyl ester; Hoelon; Hoelon 3EC; Hoe-grass; Hoegrass; HOE 23408; Iloxan; Illoxan; One shot; Methyl 2-[2-(2,4-dichlorophenoxy)phenoxy]propanoate; Methyl ester of 2-[4-(2,4-dichlorophenoxy)phenoxy] propanoic acid; Propanoic acid, 2-[4-(2,4-dichlorophenoxy) phenoxy]-, methyl ester

CAS Registry Number: 51338-27-3

HSDB Number: 6607

RTECS Number: UF1180000

UN/NA & ERG Number: UN3345 (solid)/153; UN3348 (liquid)/153; UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 257-141-8 [*Annex I Index No.*: 607-165-00-3]

Regulatory Authority and Advisory Information

Carcinogenicity[83]: EPA Cancer Classification: likely to be carcinogenic to humans; IARC. Group 2b, possibly carcinogenic to humans.

California Proposition 65 Chemical, Cancer 4/6/2010

Hazard Alert: Poison, Combustible solid, Environmental hazard, Sensitization hazard (skin).

EPA Acceptable Daily Intake (ADI): 0.002 mg/kg.

Hazard Alert: Combustible, Suspected reprotoxic hazard (TRI), Possible endocrine disruptor.

California EPA AB2588-Air Toxics "Hot Spots" Chemicals (CAL) as chlorophenoxy pesticides

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%

Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: Xn, N, Xi; risk phrases: R22; R43; R50/53; safety phrases: S2; S24; S29/35; S37; S60; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: A white crystalline solid. Odorless. Can also be commercially available as a clear to dark brown liquid with a typical solvent odor. Molecular weight = 341.19; specific gravity (H_2O:1) = 1.4; boiling point = 173−175; freezing/melting point = 39−43.8°C; vapor pressure = 2.5×10^{-2} mmHg @ 25°C; flash point = ~150°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 0. Slightly soluble in water (forms an emulsion); solubility = 3 mg/L. Physical and toxicological properties may be affected by carrier solvents in commercial formulations.

Potential Exposure: Diclofop-methyl is a chlorophenoxy; aryloxyphenoxypropionate acid selective postemergence herbicide used to control wild oats and annual grassy weeds in grain and vegetable crops: alfalfa, carrots, celery, box, field and French beans, barley, wheat, brassicas, parsnips, peas, potatoes, rapeseed (canola), soy beans, oilseed rape, onions, sugar beets and lettuce. Some uses are classified RUP.

Incompatibilities: Incompatible with oxidizers, chlorates nitrates, peroxides, sulfuric acid, caustics, ammonia, aliphatic amines, alkanolamines, isocyanates, alkylene oxides, and epichlorohydrin.

Permissible Concentration in Water: EU Drinking Water MAC: 0.006 μg/L. Runoff from spills or fire control may cause water pollution.

Determination in Water: Octanol-water coefficient: Log $K_{ow} = >4$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood. Fish toxicity (threshold)(101): Intermedia—10.60669 ppb, MATC (Maximum Acceptable Toxicant Concentration).

Routes of Entry: Inhalation, ingestion, and absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Poisonous; may be fatal if inhaled, swallowed, or absorbed through skin. Severely irritates eyes, skin, and respiratory tract, with burning sensation, pain, redness, and swelling. Metabolic stimulant. If inhaled, causes coughing, dilated pupils, headache, profuse persperation, intense thirst, extreme fatigue, rapid pulse, high fever, clammy, flushed skin, rapid breathing, nausea, vomiting, cyanosis (bluish tint to skin and lips), anxiety and confusion, convulsions, and risk of lung edema. If swallowed, face and lips turn bluish. Liver injury with associated jaundice, kidney failure, and cardiac arrhythmias are commonly noted. Nerve damage, which may be delayed, may include swelling of legs and feet, muscle twitch and stupor. Severe exposure can cause death from heart failure. Dust or liquid left in contact with the skin for several hours may be absorbed. This may result in severe delayed symptoms as listed above. These symptoms may last for months or years. May cause pulmonary edema or bronchopneumonia; symptoms may be delayed. LD_{50} (oral, rat) = >500 mg/kg.

Long-Term Exposure: Workers exposed to chlorophenoxy compounds over a 5 to 10 year period at levels above 10 milligram per cubic meter complained of weakness, rapid fatigue, headache and vertigo. Liver damage, low blood pressure, and slowed heartbeat were also found. Based on animal tests, may affects human reproduction. Human toxicity (long-term)(101): High—1.40 ppb, Health advisory

Points of Attack: Eyes, skin, lungs and respiratory system, CNS, cardiovascular system, liver, and kidney. Liver and kidney toxin; skin sensitizer.

Medical Surveillance: Preliminary medical exam to detect chronic diseases of CNS, liver, heart, kidneys, lung, and skin, as well as endocrinological or immunological disturbances, should protect susceptible individuals. Periodical medical exams of internal organs, skin and eyes are important to avoid chronic occupational intoxications. They should include lab and patch tests when necessary[83]. Medical observation is recommended for 24 to 48 hours following breathing overexposure, as pulmonary edema may be delayed. If symptoms develop or overexposure is suspected, the following may be useful: Liver and kidney function tests. Exam of the nervous system. Evaluation by a qualified allergist, including exposure history and testing, may help diagnose allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. *Do not induce vomiting when formulations containing petroleum solvents are ingested.* Otherwise, give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of dermal and/or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Blue: Health Hazard/Poison. Store in a secure poison location. Prior to working with 2,4-DP all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area away from strong oxidizers and bases. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically transfer material from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. If this material contains a flammable carrier, sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN3345 Phenoxyacetic acid derivative pesticide, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN3348 Phenoxyacetic acid derivative pesticide, liquid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous material. UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required. *Note*: Commercial product may also be a liquid in a flammable carrier.

Spill Handling: As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 m/150 ft for liquids and at least 25 m/75 ft for solids. *Solid material:* First remove all sources of ignition. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Liquid formulations containing organic solvents: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers.

Fire Extinguishing: *Solid material: A* combustible solid. Thermal decomposition products may include hydrogen chloride and oxides of carbon. *Fire involving storage or vehicular tanks:* Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. *On a small fire:* Use dry chemical, CO_2, water spray or regular *foam. On a large fire:* Use water spray, fog or regular foam. Do not scatter spilled material with high pressure streams of water. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal. *Fire involving tanks:* From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. Always stay away from tanks engulfed in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (100).

EXTOXNET, Extension Toxicology Network, "*Pesticide Information Profile, Diclofop-methyl*," Oregon State University, Corvallis, OR (September 1995). http://extoxnet.orst.edu/pips/diclofop.htm

United States Environmental Protection Agency, Office of Pesticide Programs, "*Pesticide Residue Limits: Diclifop-methyl*," 40 CFR 180.385. www.epa.gov/pesticides/food/viewtols.htm

Dichlorotetrafluoroethane D:0680

Formula: $C_2Cl_2F_4$; $F_2ClCCClF_2$

Synonyms: Arcton 114; Arcton 33; CFC-114; Cryofluoran; Cryofluorane; *sym*-Dichlorotetrafluoroethane; 1,2-Dichloro-1,1,2,2-tetrafluoroethane; *sim*-Diclorotetrafluoetano (Spanish); Ethane, 1,2-dichloro-1,1,2,2-tetrafluoro-; Ethane, 1,2-dichloro-tetrafluoro-; F 114; FC 114; Fluorane 114; Fluorocarbon 114; Freon 114; Frigen 114; Frigiderm; Genetron 114; Genetron 316; Halocarbon 114; Halon 242; Ledon 114; Propellant 114; R 114; 1,1,2,2-Tetrafluoro-1,2-dichloroethane; Ucon 114

CAS Registry Number: 76-14-2; 1320-37-2 (1,2-dichlorotetrafluoroethane)

HSDB Number: 146

RTECS Number: KI1101000

UN/NA & ERG Number: UN1958/126

EC Number: 200-937-7 (CAS: 76-14-2); 215-300-9 (CAS: 1320-37-2)

Regulatory Authority and Advisory Information

Hazard Alert: Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated, Environmental hazard (ozone depletion),

Clean Air Act: Stratospheric ozone protection (Title VI, Subpart A, Appendix A), Class I, Ozone Depletion Potential (ODP) = 1.0

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Harms public health and the environment by destroying ozone in the upper atmosphere.

Hazard symbols, risk, & safety statements: Hazard symbol: N; risk phrases: R5; R21; R58/59; safety phrases: S9; S33; S38; S41; S57; S59; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water. (CAS: 76-14-2)

Description: CFC 114 is a colorless gas with a faint, ethereal odor at high concentrations. A liquid below 3.3°C/38°F. Shipped as a liquefied compressed gas. Molecular weight = 170.92; specific gravity (H_2O:1) = 1.46 @ 20°C; boiling point = 3.8°C; freezing/melting point = −93.9°C; vapor pressure = 2014 mmHg @ 25°C; 1.9 atm. @ 70°F[77]. Explosive limits: LEL: 26,000 ppm; UEL: unknown. Hazard identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 0. Slightly soluble in water; solubility = 0.1%.

Potential Exposure: This material is used as a refrigerant and also as a propellant gas.

Incompatibilities: Keep away from welding and hot metals; decomposes, forming hydrogen chloride and hydrogen fluoride. Reacts with acids and acid fumes forming highly toxic chloride gases. Keep away from chemically active metals: sodium, potassium, calcium, powdered aluminum; zinc, and magnesium. Attacks some plastics and coatings.

Permissible Exposure Limits in Air

76-14-2

NIOSH IDLH = 15,000 ppm

Conversion factor: 1 ppm = 6.99 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL 1000 ppm/7000 milligram per cubic meter TWA

NIOSH REL: 1000 ppm/7000 milligram per cubic meter TWA

ACGIH TLV[1]: 1000 ppm/6990 milligram per cubic meter TWA, not classifiable as a human carcinogen

PAC Ver. 29[138]

PAC-1: 3000 ppm

PAC-2: 10,000 ppm [> = 10% LEL, lower explosive limit but < 50% LEL]

PAC-3: 50,000 ppm (> LEL, lower explosive limit)

DFG MAK: 1000 ppm/7100 milligram per cubic meter TWA; Peak Limitation Category II(8); Pregnancy Risk Group D

Australia: TWA 1000 ppm (7000 milligram per cubic meter), 1993; Austria: MAK 1000 ppm (7000 milligram per cubic meter), 1999; Belgium: TWA 1000 ppm (6990 milligram per cubic meter), 1993; Denmark: TWA 500 ppm (3500 milligram per cubic meter), 1999; Finland: TWA 1000 ppm (7000 milligram per cubic meter); STEL 1250 ppm (8750 milligram per cubic meter), 1999; France: VME 1000 ppm (7000 milligram per cubic meter), 1999; Hungary: TWA 100 milligram per cubic meter; STEL 200 milligram per cubic meter, 1993; the Netherlands: MAC-TGG 7130 milligram per cubic meter, 2003; Norway: TWA 500 ppm (3500 milligram per cubic meter), 1999; the Philippines: TWA 1000 ppm (7000 milligram per cubic meter), 1993; Poland: MAC (TWA) 5000 milligram per cubic meter, MAC (STEL) 8750 milligram per cubic meter, 1999; Russia: STEL 3000 milligram per cubic meter, 1993; Switzerland: MAK-W 1000 ppm (7000 milligram per cubic meter), 1999; Turkey: TWA 1000 ppm (7000 milligram per cubic meter), 1993; United Kingdom: TWA 1000 ppm (7110 milligram per cubic meter); STEL 1250 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Several states have set guidelines or standards for R-114 in ambient air[60] ranging from 70 milligram per cubic meter (North Dakota) to 115 milligram per cubic meter (Virginia) to 140 milligram per cubic meter (Connecticut) to 167 milligram per cubic meter (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #1018.

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guidelines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg[F]/L. Safe Drinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg[F]/L; SMCL = 2 mg/F/L, as Fluoride.

Determination in Water: No method cited. Octanol-water coefficient: Log K_{ow} = 2.8. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, skin, and/or eye contact (liquid).

Harmful Effects and Symptoms

Short-Term Exposure: Dichlorotetrafluoroethane can affect you when breathed in. Irritates the eyes and upper respiratory tract. Inhalation of vapors can cause you to become dizzy and lightheaded, drowsy, and pass out. It can cause the heart to beat irregularly or stop, which can cause death. Contact with the liquid can cause frostbite, burning the eyes and skin.

Long-Term Exposure: Can irritate the lungs and cause bronchitis with coughing, phlegm, and/or shortness of breath.

Points of Attack: Respiratory system and cardiovascular system.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. If symptoms develop or overexposure is suspected, the following may be useful: Holter monitor (a special 24 hour EKG to look for irregular heart rhythms).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with the liquid, wear gas-proof goggles and face shield when working with the gas unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: 10,000 ppm: Sa (APF = 10) (any supplied-air respirator). 15,000 ppm: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). Emergency or planned entry into unknown concentrations or IDLH conditions: SCBAF: Pd, Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-, mounted organic vapor canister]; or SCBAE (any appropriate escape-type SCBA).

Storage: Check oxygen content prior to entering storage area. Prior to working with CFC 114 all handlers should be trained on its proper handling and storage. Dichlorotetrafluoroethane must be stored to avoid contact with acids, acid fumes; chemically active metals, such as sodium, potassium, calcium, powdered aluminum; zinc and magnesium, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: UN1958. 1,2-Dichloro-1,1,2,2-tetrafluoroethane or Refrigerant gas R-114, Hazard Class: 2.2; Labels: 2.2-Nonflammable compressed gas. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Dichlorotetrafluoroethane is a nonflammable liquid or gas. Thermal decomposition products may include hydrogen chloride, phosgene and hydrogen fluoride. Extinguish fire using an agent suitable for type of surrounding fire. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any

signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Incineration after mixing with combustible fuel. Use flue gas scrubber[22].

References

(31); (173); (101); (138); (2); (122); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Dichlorotetrafluoroethane*, Trenton, NJ (March 2006)

Dichlorvos D:0690

Formula: $C_4H_7Cl_2O_4P$

Synonyms: Apavap; Astrobot; Atgard; Atgard V; Bay 19149; Bayer 19149; Benfos; Bibesol; Brevinyl; Brevinyl E 50; Canogard; Cekusan; Chlorvinphos; Cyanophos; Cypona; DDVF; DDVP (Insecticide); Dedevap; Deriban; Derribante; DES; Devikol; Dichlofos; Dichlorman; 2,2-Dichloroethenol dimethyl phosphate; 2,2-Dichloroethenyl dimethyl phosphate; 2,2-Dichlorovinyl dimethyl phosphate; Dichlorovos; (2,2-Dichlorvinyl)-dimethyl-phosphat (German); *O*-(2,2-Dichlorvinyl)*O,O*-dimethylphosphat (German); Dimethyl 2,2-dichloroethenyl phosphate; *O,O*-Dimethyl 2,2-dichlorovinyl phosphate; Dimethyl 2,2-dichlorovinyl phosphate; Dimethyl dichlorovinyl phosphate; Divipan; Dquigard; Duo-Kill; Duravos; ENT 20,738; Equigard; Equigel; Estrosel; Estrosol; Ethenol, 2,2-dichloro-, dimethyl phosphate; Fecama; Fekama; Fly-Die; Fly fighter; Herkal; Insectigas D; Krecalvin; Lindan; Mafu; Marvex; Mopari; NCI-C00113; Nefrafos; Nerkol; Nogos; Nogos 50; Nogos G; No-Pest; No-Pest Strip; Novotox; NSC-6738; Nuva; Nuvan; Nuvan 100EC; Nuvan 7; OKO; OMS 14; Panaplate; Phosphate de dimethyle et de 2,2-dichlorovinyle (French); Phosphoric acid, 2,2-dichloroethenyl dimethyl ester; Phosphoric acid, 2-dichloroethenyl dimethyl ester; Phosphoric acid, 2,2-dichlorovinyl dimethyl ester; Phosvit; SD 1750; Szklarniak; Tap 9VP; Task; Task Tabs; Tenac; Tetravos; Unifos (Pesticide); Unitox; Vapona; Vapona insecticide; Vaponite; Verdican; Verdipor; Vinylofos; Vinylophos; Winylophos

CAS Registry Number: 62-73-7; *(alt.)* 8023-22-1; *(alt.)* 8072-21-7; *(alt.)* 8072-39-7; *(alt.)* 11095-17-3; *(alt.)* 11096-21-2; *(alt.)* 12772-40-6; *(alt.)* 55819-32-4; *(alt.)* 62139-95-1; *(alt.)* 95828-55-0; *(alt.)* 116788-91-1

HSDB Number: 319

RTECS Number: TC0350000

UN/NA & ERG Number: (PIH) UN3018 (organophosphorus pesticide, liquid, toxic)/152

EC Number: 200-547-7 [*Annex I Index No.:* 015-019-00-X]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Sufficient Evidence; Human Inadequate Data, *possibly carcinogenic to humans*, Group 2B, 1991 NTP: Carcinogenesis Studies (gavage); some evidence: rat; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies; NCI: Carcinogenesis Studies (gavage); clear evidence: mouse; equivocal evidence: rat. United States Environmental Protection Agency Gene-Tox Program, Positive: *B. subtilis* rec assay; *E. coli polA* without S9; Positive: Histidine reversion-Ames test; TRP reversion; Positive: *S. cerevisiae* gene conversion; Negative: In vivo cytogenetics-nonhuman bone marrow; Negative: Cytogenetics-male germ cell; Host-mediated assay; Negative: Mammalian micronucleus; In vitro SCE-human lymphocytes; Negative: In vitro SCE-human; *D. melanogaster* sex-linked lethal; Inconclusive: Carcinogenicity-mouse/rat; Rodent dominant lethal; Inconclusive: Sperm morphology-mouse.

California Proposition 65 Chemical[102]: Cancer 1/1/1989.

Hazard Alert: Poison inhalation hazard, Neurotoxin (cumulative), Combustible, sensitization hazard, Possible risk of forming tumors, Organometallic, Strong reducing agent, Suspected of causing genetic defects, Suspected reprotoxic hazard, Environmental hazard.

United States Environmental Protection Agency, FIFRA 1998 Status of Pesticides: Supported

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

United States DOT 49CFR172.101, Inhalation Hazardous Chemical, as organic phosphate, Substance ID: EDF-041

Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, N, Xi; risk phrases: R 24/25; R26; R33; R43; R50; R62; R63; safety phrases: S1/2; S28; S29/35; S36/37; S41; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Dichlorvos is a colorless to amber liquid with a mild aromatic odor. Molecular weight = 220.98; boiling point = 140°C under 20 mmHg @ 20°C; flash point ≥ 79°C. Hazard identification (based on NFPA-704 M

Rating System): Health 3, Flammability 1, Reactivity 0. Slightly soluble in water; solubility = 0.5%.

Potential Exposure: A potential danger to those involved in manufacture, formulation and application of this fumigant insecticide in household, public health and agricultural uses. Used as an insecticide and as an anthelminthic for swine and dogs.

Incompatibilities: Contact with oxidizers may cause the release of phosphorous oxides. Organophosphates are susceptible to formation of highly toxic and flammable phosphine gas in the presence of strong reducing agents such as hydrideds and active metals. Partial oxidation by oxidizing agents may result in the release of toxic phosphorus oxides[101] Corrosive to iron, mild steel, some forms of plastics, rubber, and coatings.

Permissible Exposure Limits in Air

NIOSH IDLH = 100 milligram per cubic meter

Conversion factor: 1 ppm = 9.04 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 1 milligram per cubic meter TWA [skin]

NIOSH REL: 1 milligram per cubic meter TWA [skin]

ACGIH TLV[1]: 0.9 milligram per cubic meter TWA measured as inhalable fraction and vapor; [skin, sensitization]; not classifiable as a human carcinogen; BEIA issued; Acetylcholinesterase inhibiting pesticides.

PAC Ver. 29[138]

62-73-7

PAC-1: 1.8 milligram per cubic meter

PAC-2: 20 milligram per cubic meter

PAC-3: 200 milligram per cubic meter

DFG MAK: 0.11 ppm/1 milligram per cubic meter TWA; Peak Limitation Category II(2) [skin], Pregnancy Risk Group C.

Arab Republic of Egypt: TWA 0.1 ppm (1 milligram per cubic meter), 1993; Australia: TWA 0.1 ppm (1 milligram per cubic meter), [skin], 1993; Austria: MAK 0.1 ppm (1 milligram per cubic meter), [skin], 1999; Belgium: TWA 01 ppm (0.9 milligram per cubic meter), [skin], 1993; Denmark: TWA 0.1 ppm (1 milligram per cubic meter), [skin], 1999; Finland: TWA 1 milligram per cubic meter; STEL 3 milligram per cubic meter, [skin], 1999; France: VME 0.1 ppm (1 milligram per cubic meter), [skin], 1999; the Netherlands: MAC-TGG 1 milligram per cubic meter, [skin], 2003; India: TWA 0.1 ppm (1 milligram per cubic meter), [skin], 1993; Norway: TWA 0.1 ppm (1 milligram per cubic meter), 1999; the Philippines: TWA 1 milligram per cubic meter, [skin], 1993; Poland: MAC (TWA) 1 milligram per cubic meter; STEL 3 milligram per cubic meter, 1999; Russia: STEL 0.2 milligram per cubic meter, [skin], 1993; Switzerland: MAK-W 0.1 ppm (1 milligram per cubic meter), [skin], 1999; United Kingdom: TWA 0.1 ppm (0.92 milligram per cubic meter); STEL 0.3 ppm, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: not classifiable as a human carcinogen. milligram per cubic meter.

Determination in Air: Use NIOSH P&CAM Method #295 (II-5) or OSHA Analytical Method 62.

Permissible Concentration in Water: Russia set a MAC in water bodies used for domestic purposes of 1.0 mg/L and in water for fishing of zero.

Determination in Water: No tests listed. Octanol-water coefficient: Log $K_{ow} = 1.47$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, skin absorption, ingestion, and eye and/or skin contact.

Harmful Effects and Symptoms

Symptoms of exposure include sweating, twitching, contracted pupils; respiratory distress (tightness in the chest and wheezing); salivation (drooling); lacrimation (tearing); nausea, vomiting, abdominal cramps; diarrhea, involuntary defecation and urination; slurred speech; coma, apnea (cessation of breathing); and death. Dichlorvos is a very toxic compound with a probable lethal oral dose in humans between 50 and 500 mg/kg, or between one teaspoon and 1 oz. for a 70 kg (150 lb.) person. However, brief exposure (30−60 minutes) to vapor concentrations as high as 6.9 mg/Liter did not result in clinical signs or depressed serum cholinesterase levels. Toxic changes are typical of organophosphate insecticide poisoning with progression to respiratory distress, respiratory paralysis; and death if there is no clinical intervention[72].

Short-Term Exposure: Dichlorvos irritates the eyes and skin. Symptoms include miosis, aching eyes; rhinorrhea (discharge of thin nasal mucous); headache, chest tightness; wheezing, laryngeal spasm; salivation, cyanosis, anorexia, nausea, vomiting, diarrhea, sweating, muscle fasiculation; paralysis, giddiness, ataxia, convulsions; low blood pressure; cardiac irregular/irregularities. The substance may cause effects on the CNS. Cholinesterase inhibitor. High levels of exposure may result in death.

Long-Term Exposure: Repeated or prolonged contact with skin may cause skin sensitization and dermatitis. Cholinesterase inhibitor; cumulative effect is possible: see "Short-Term Exposure." This substance may be carcinogenic to humans; it has been shown to cause cancer of the pancreas in animals. There is limited evidence that Dichlorvos is a teratogen in animals, and may cause birth defects or damage the fetus in humans.

Points of Attack: Eyes, skin, respiratory system, cardiovascular system, CNS, and blood cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When cholinesterase enzyme levels are reduced by 25% or more below pre-employment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider CBC. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates. NIOSH lists the following tests: blood serum; cholinesterase: whole blood (chemical/metabolite); cholinesterase: blood plasma, red blood cells/count; cholinesterase: blood serum, red blood cells/count; urine (chemical/metabolite)

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours following overexposure.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: 10 milligram per cubic meter: Sa (APF = 10) (any supplied-air respirator). 25 milligram per cubic meter: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). 50 milligram per cubic meter: SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). 100 milligram per cubic meter: Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type SCBA).

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with dichlorvos all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong acids; strong alkalis. Dichlorvos will attack some forms of mild iron, plastics, rubber, and coatings.

Shipping: UN3018 Organophosphorus pesticides, liquid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Organophosphorus compounds

Initial Isolation and Protective Action Distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24 h response line).

Small Spills (from a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.3/0.4
Night 0.8/1.2

Large Spills (from a large package or from many small packages)

First: Isolate in all directions (ft/m) 600/200
Then: Protect persons downwind (mi/km)
Day 1.4/2.3
Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Do not touch spilled material. Do not breathe vapors. Stay upwind; keep out of low areas. Remove all ignition sources. Ventilate area of spill or leak. This material is a combustible liquid. For a spill or leak of a combustible liquid, shut off ignition sources; no flares, smoking or flames in hazard area. Stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: Absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: Dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be

necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.
Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include chloride and phosgene fumes and oxides of phosphorus, nitrogen and carbon. Use dry chemical, carbon dioxide, or foam extinguishers. Use SCBA with a full facepiece operated on pressure-demand or other positive-pressure mode. Prevent skin contact with protective clothing. Isolate area and deny entry. Fight fire from maximum distance. Dike fire control water for future disposal. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.
Disposal Method Suggested: 50% hydrolysis is obtained in pure water in 25 minutes @ 70°C and in 61.5 days @ 20°C. A buffered solution yields 50% hydrolysis (37.5°C) in 301 minutes at pH 8, 462 minutes at pH 7, 620 minutes at pH 5.4. Hydrolysis yields no toxic residues. Incineration in a furnace equipped with an afterburner and alkaline scrubber is recommended as is alkaline hydrolysis followed by soil burial[22]. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(102); (31); (173); (80); (173); (101); (138); (203); (100).

United States Environmental Protection Agency, *Investigation of Selected Potential Environmental Contaminants: Haloalkyl Phosphates, Report EPA-560/2076-007*, Washington, DC (August 1976)

Sax N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 3, 57–59 (1981)

United States Environmental Protection Agency, Chemical Hazard Information Profile: *Dichlorvos*, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Dichlorvos*, Trenton, NJ (April 2003)

Dicofol D:0700

Formula: $C_{14}H_9Cl_5$
Synonyms: Acarin; Benzenemethanol, 4-chloro-a(-4-chlorophenyl)-α-(trichloromethyl)-; Benzhydrol, 4,4′-dichloro-α-(trichloromethyl)-; 1,1-Bis(*p*-chlorophenyl)-2,2,2-trichloroethanol; 1,1-Bis(4-chlorophenyl)-2,2,2-trichloroethanol; 4-Chloro-α-(4-chlorophenyl)-α-(trichloromethyl) benzene methanol; CPCA; Decofol; Dichlorokelthane; Di(*p*-chlorophenyl) trichloromethyl carbinol; 4,4′-Dichloro-α-(trichloromethyl)benzhydrol; DTMC; ENT 23,648; Ethanol, 2,2,2-trichloro-1,1-bis(4-chlorophenyl)-; Fumite dicofol; FW 293; Keltane; *p,p*'-Kelthane; Kelthane; Kelthane A; Kelthanethanol; Milbol; Mitigan; NCI-C00486; 2,2,2-Trichloro-1,1-bis(*p*-chlorophenyl)ethanol; 2,2,2-Trichloro-1,1-bis(4-chlorophenyl)ethanol; 2,2,2-Trichloro-1,1-di(4-chlorophenyl)ethanol
CAS Registry Number: 115-32-2
HSDB Number: 631
RTECS Number: DC8400000
UN/NA & ERG Number: UN3082 (environmentally hazardous substances, liquid, n.o.s.)/171
EC Number: 204-082-0 [*Annex I Index No.:* 603-044-00-4]
Regulatory Authority and Advisory Information
Carcinogenicity: NCI: Carcinogenesis Bioassay (feed); clear evidence: mouse; no evidence: rat; IARC: Human, No Adequate Data, 1983; Animal, Limited Evidence, 1983*, not classifiable as carcinogenic to humans*, Group 3, 1987.
Hazard Alert: Poison, Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Sensitization hazard, Environmental hazard.
United States Environmental Protection Agency, FIFRA 1998 Status of Pesticides: Supported
Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)
Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg)
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.
Hazard symbols, risk, & safety statements: Hazard symbol: Xn, N, Xi; risk phrases: R21/22; R38; R43; R50/53; R62; R63; safety phrases: S2; S29/35; S36/37; 60; S41; S61 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)]

Description: Dicofol is a white or brown waxy solid. Molecular weight = 370.48; flash point = 120°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Slightly soluble in water.

Potential Exposure: A potential danger to those involved in manufacture, formulation and application of this organochlorine pesticide. Used as acaricide (miticide) in agricultural and nonagricultural applications. Similar in structure to DDT.

Incompatibilities: Incompatible with alkaline pesticides, strong acids; acid fumes; aliphatic amines; isocyanates. Halogenated aliphatic compounds are moderately or very reactive. Halogenated organics generally become less reactive as more of their hydrogen atoms are replaced with halogen atoms. Halogenated aliphatics are incompatible with strong oxidizing and reducing agents. Also, they are incompatible with many amines, nitrides, azo/diazo compounds, alkali metals, and epoxides. Dicofol hydrolyzes in alkali. It is slightly corrosive to metals. Contact with steel at elevated temperatures causes formation of toxic gases[101].

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Routes of Entry: Inhalation, skin absorption, and ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Dicofol can be absorbed through the skin, thereby increasing exposure. It irritates the skin and the respiratory tract. Exposure can cause headache, nausea, vomiting and poor appetite. Dicofol may affect the CNS causing numbness and weakness in the hands and feet; muscle twitching; seizures, unconsciousness and death. LD_{50} = (oral-rat) ~600 mg/kg.

Long-Term Exposure: May affect the liver and kidneys. May cause personality changes with depression, anxiety, and irritability. May decrease fertility in females. Prolonged or repeated skin contact may cause dermatitis. There is limited evidence that Dicofol causes liver cancer in animals.

Points of Attack: Skin, nervous system, liver, and kidneys.

Medical Surveillance: Liver and kidney function tests. Examination of the nervous system. Dermatological examination.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. For liquid solutions containing Dicofol wear indirect-vent, impact and splash-resistant goggles. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with dicofol all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area away from alkaline pesticides, strong acids; acid fumes, and steel. Where possible, automatically transfer material from drums or other storage containers to process containers. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2996 Organochlorine pesticides, liquid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN3082 Environmentally hazardous substances, liquid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Thermal decomposition products may include hydrogen chloride and oxides of carbon. If dicofol is dissolved in xylene the fumes may cause flashback. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (80); (203); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Dicofol*, Trenton, NJ (October 1998).

Dicrotophos D:0710

Formula: $C_8H_{16}NO_5P$

Synonyms: Bidirl; Bidrin; Bidrin (Shell); Bidrin-R; C-709; C-709 (Ciba-Geigy); Carbicrin; Carbicron; Carbomicron; Ciba 709; Crotonamide, 3-hydroxy-*N*,*N*-dimethyl-, *cis*-, dimethyl phosphate; Crotonamide, 3-hydroxy-*N*,*N*-dimethyl-, dimethylphosphate, (*E*)-; Crotonamide, 3-hydroxy-*N*, *N*-dimethyl-, dimethylphosphate, *cis*-; Diapadrin; Dicroptophos; Didrin; 3-(Dimethoxyphosphinyloxy)-*N*,*N*-dimethyl[e]crotonamide; 3-(Dimethoxyphosphinyloxy)-*N*, *N*-dimethyl-*cis*-crotonamide; 3-(Dimethoxyphosphinyloxy)-*N*,*N*-dimethylisocrotonamide; 3-(Dimethylamino)-1-methyl-3-*oxo*-1-propenyl dimethyl phosphate; (*E*)-2-Dimethyl carbamoyl-1-methylvinyl dimethylphosphate; *cis*-2-Dimethylcarbamoyl-1-methylvinyl dimethylphosphate; *O*, *O*-Dimethyl-*O*-(2-dimethyl-carbamoyl-1-methyl-vinyl)phosphat (German); *O,O*-Dimethyl *O*-(1,4-dimethyl-3-*oxo*-4-azapent-1-enyl) phosphate; *O,O*-Dimethyl *O*-(*N*,*N*-dimethylcarbamoyl-1-methylvinyl) phosphate; Dimethyl phosphate ester with 3-hydroxy-*N*,*N*-dimethyl-*cis*-crotonamide; Dimethyl phosphate of 3-hydroxy-*N*,*N*-dimethyl-*cis*-crotonamide; Ektafos; Ektofos; ENT 24,482; 3-Hydroxy-*N*, *N*-dimethyl-(*E*)-crotonamide dimethyl phosphate; 3-Hydroxy-*N*,*N*-dimethyl-*cis*-crotonamide dimethyl phosphate; 3-Hydroxydimethyl crotonamide dimethyl phosphate; Karbicron; Phosphatede dimethyle et de 2-dimethyl carbamoyl 1-methyl vinyle (French); Phosphoric acid, 3-(dimethylamino)-1-methyl-3-*oxo*-1-propenyl dimethyl ester, (*E*)-; Phosphoric acid, dimethyl ester, ester with (*E*)-3-hydroxy-*N*,*N*-dimethylcrotonamide; Phosphoric acid, dimethyl ester, ester with *cis*-3-hydroxy-*N*,*N*-dimethylcrotonamide; SD 3562; Shell SD-3562

CAS Registry Number: 141-66-2

HSDB Number: 1637

RTECS Number: TC3850000

UN/NA & ERG Number: (PIH) UN3018 (organophosphorus pesticides, liquid, toxic)/152

EC Number: 205-494-3 [*Annex I Index No.:* 015-073-00-4]

Regulatory Authority and Advisory Information

Hazard Alert: Poison inhalation hazard, Neurotoxin (cumulative), Combustible, Suspected of causing genetic defects, Suspected reprotoxic hazard, Environmental hazard. Listed for Tier 1 screening as an endocrine disruptor[88].

United States Environmental Protection Agency, FIFRA 1998 Status of Pesticides: Supported

Banned or Severely Restricted (Germany and Malaysia) (UN)[13]

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)

United States DOT 49CFR172.101, Inhalation Hazardous Chemical, as organic phosphate, Substance ID: EDF

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Hazard symbols, risk, & safety statements: Hazard symbol: T+, N; risk phrases: R24; R28; R33; R50/53; R62; R63; safety phrases: S1/2; S28; S36/37; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)]

Description: Dicrotophos is an amber liquid with a mild ester odor. Molecular weight = 237.22; boiling point = 400°C (Decomposes below boiling point @ 75°C after storage for 31 days); flash point ≥ 94°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Soluble in water.

Potential Exposure: A potential danger to those involved in the manufacture, formulation and application of this organophosphate. Used to control the coffee borer and certain economically important pests of cotton.

Incompatibilities: Attacks some metals: Corrosive to cast iron, mild steel; brass, and stainless steel l304. Decomposes after prolonged storage, but is stable when stored in glass or polyethylene containers with temperatures to 40°C. Contact with oxidizers may cause the release of phosphorous oxides. Contact with strong reducing agents, such as hydrides, may cause the formation of flammable and toxic phosphine gas.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 9.70 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: None

NIOSH REL: 0.25 milligram per cubic meter TWA [skin]

ACGIH TLV[1]: 0.05 milligram per cubic meter TWA measured as inhalable fraction and vapor [skin]; not classifiable as a human carcinogen; BEI: methemoglobin in blood; 1.5% of hemoglobin, during or end-of-shift as methemoglobin inducers.

PAC Ver. 29[138]

141-66-2

PAC-1: 0.15 milligram per cubic meter
PAC-2: 0.9 milligram per cubic meter
PAC-3: 17 milligram per cubic meter

Australia: TWA 0.25 milligram per cubic meter, [skin], 1993; Belgium: TWA 0.25 milligram per cubic meter, [skin], 1993; Denmark: TWA 0.25 milligram per cubic meter, [skin], 1999; Finland: TWA 0.25 milligram per cubic meter, 1999; France: VME 0.25 milligram per cubic meter, [skin], 1999; Switzerland: MAK-W 0.25 milligram per cubic meter, [skin], 1999; the Netherlands: MAC-TGG 0.25 milligram per cubic meter, [skin], 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Several states have set guidelines or standards for dicrotophos in ambient air[60] ranging from 2.5 μ/m^3 (North Dakota) to 4.0 μ/m^3 (Virginia) to 5.0 μ/m^3 (Connecticut) to 6.0 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #5600, Organophosphorus Pesticides.

Routes of Entry: Inhalation, skin absorption, ingestion, and skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Dicrotophos may affect the nervous system; causing convulsions, respiratory failure. Dicrotophos is a cholinesterase inhibitor which can penetrate the skin. Effects may be cumulative. It is extremely toxic. Probable human oral lethal dose is 5−50 mg/kg, seven drops to one teaspoonful for a 70 kg (150 lb.) person. Closely related in toxicity to azodrin. Acute exposure to dicrotophos may produce the following signs and symptoms: pinpoint pupils; blurred vision; headache, dizziness, and muscle spasms; and profound weakness. Vomiting, diarrhea, abdominal pain, seizures, and coma may also occur. The heart rate may decrease following oral exposure or increase following dermal exposure. Hypotension (low blood pressure) is not uncommon. Respiratory symptoms include dyspnea (shortness of breath); respiratory depression; and respiratory paralysis. Psychosis may occur. The effects may be delayed.

Long-Term Exposure: Dicrotophos is a cholinesterase inhibitor; cumulative effect is possible. May damage the nervous system causing numbness, “pins and needles,” sensation and/or weakness of the hands and feet. Repeated exposure may cause personality changes of depression, anxiety or irritability.

Points of Attack: Respiratory system, lungs, CNS, cardiovascular system, skin, eyes, plasma, and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When cholinesterase enzyme levels are reduced by 25% or more below pre-employment levels, risk of poisoning is increased, even if results are in lower ranges of “normal.” Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider CBC. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. Medical observation is recommended; effect may be delayed.

Note to Physician: 1,1′-Trimethylenebis(4-formylpyridinium bromide) dioxime (a.k.a. TMB-4 dibromide and TMV-4) has been used as an antidote for organophosphate poisoning.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode).

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area away from strong oxidizers, metals, strong bases and heat. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: UN3018 Organophosphorus pesticides, liquid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling:

Initial Isolation and Protective Action Distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24 h response line).

Small Spills (from a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30

Then: Protect persons downwind (mi/km)

Day 0.3/0.4

Night 0.8/1.2

Large Spills (from a large package or from many small packages)

First: Isolate in all directions (ft/m) 600/200

Then: Protect persons downwind (mi/km)

Day 1.4/2.3

Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Do not touch spilled material. Do not breathe vapors. Stay upwind; keep out of low areas. Remove all ignition sources. Ventilate area of spill or leak. This material is a combustible liquid. For a spill or leak of a combustible liquid, shut off ignition sources; no flares, smoking or flames in hazard area. Stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: Absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: Dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material may burn but does not ignite readily. Thermal decomposition products may include oxides of phosphorus, nitrogen and carbon. Fire and runoff from fire control water may produce irritating or poisonous gases. Extinguish with dry chemical, carbon dioxide, water spray, fog, or foam. Move container from fire area if you can do so without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Wear positive pressure breathing apparatus and special protective clothing. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dicrotophos decomposes after 7 days @ 90°C and 31 days @ 75°C. Hydrolysis is 50% complete in aqueous solutions @ 38°C after 50 days at pH 9.1 (100 days are required at pH 1.1). Alkaline hydrolysis (NaOH) yields (CH3)2NH. Incineration is also recommended as a disposal method[22]. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (80); (100).

Sax N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 2, No. 5, 49−54 (1982)(2).

United States Environmental Protection Agency, Chemical Hazard Information Profile: *Dicrotophos*, Washington, DC, Chemical Emergency Preparedness Program (October 1998)

Dicyclohexylamine D:0720

Formula: $C_{12}H_{23}N$; C_6H_{11}-NH-C_6H_{11}

Synonyms: *n*-Cyclohexylcyclohexanamine; DCHA; Dicha; Di-Cha; Dodecahydrodiphenylamine

CAS Registry Number: 101-83-7

HSDB Number: 4018

RTECS Number: HY4025000

UN/NA & ERG Number: UN2565/153

EC Number: 202-980-7 [*Annex I Index No.:* 612-066-00-3]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human, No Adequate Data, 1980; Animal, Limited Evidence, 1980, *not classifiable as carcinogenic to humans*, Group 3, 1987.

Hazard Alert: Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction).

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazard symbols, risk, & safety statements: Hazard symbol: C, N; risk phrases: R22; R34; R50/53; R62; safety phrases: S1/2; S26; S36/37/39; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Dicyclohexylamine is a combustible, colorless liquid with a faint amine odor. Molecular weight = 181.36; boiling point = 256°C; flash point ≥ 99°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Slightly soluble in water.

Potential Exposure: Dicyclohexylamine salts of fatty acids and sulfuric acid have soap and detergent properties useful to the printing and textile industries. Metal complexes of DI-CHA are used as catalysts in the paint, varnish, the ink industries. Several vapor-phase corrosion inhibitors are solid DI-CHA derivatives. These compounds are slightly volatile at normal temperatures and are used to protect packaged or stored ferrous metals from atmospheric corrosion. Dicyclohexylamine is also used for a number of other purposes: plasticizers, insecticidal formulations; antioxidant in lubricating oils, fuels, and rubber; and as an extractant.

Incompatibilities: Contact with strong oxidizers can cause fire and explosion hazard.

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

DFG MAK: [skin] No numerical value established.

Russia: STEL1 milligram per cubic meter, [skin], 1993. Russia[43] set a MAC for ambient air in residential areas of 0.008 milligram per cubic meter on a momentary basis.

Permissible Concentration in Water: Russia[43] set a MAC of 0.01 mg/L in water bodies used for domestic purposes.

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Corrosive to the skin and eyes; may cause burns and permanent damage. Dicyclohexylamine is somewhat more toxic that cyclohexylamine. Poisoning symptoms and death appear earlier in rabbits injected with 0.5 g/kg DI-CHA (as opposed to CHA). Doses of 0.25 g/kg are just sublethal, causing convulsions and reversible paralysis. Dicyclohexylamine is a skin irritant. LD_{50} = (oral-rat) 373 mg/kg (moderately toxic). Symptoms of exposure include severe irritation of the eyes, skin and mucous membranes. Also nausea, vomiting, weakness and irritation of the GI tract.

First Aid: *Skin Contact:*[52] Flood all areas of body that have contacted the substance with water. Don't wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others.

Eye Contact: Remove any contact lenses at once. Flush eyes well with copious quantities of water or normal saline for at lest 20−30 minutes. Seek medical attention.

Inhalation: Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure.

Ingestion: If convulsions are not present, give a glass or two of water or milk to dilute the substance. Assure that the person's airway is unobstructed and contact a hospital or poison center immediately for advice on whether or not to induce vomiting.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode).

Storage: (1) Color code-White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. (2) Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with DI-CHA all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a refrigerator away from oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers. Protection from air is recommended for long term storage.

Shipping: UN2565 Dicyclohexylamine, Hazard class: 8; Labels: 8-Corrosive material.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are

required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of nitrogen and carbon Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration; incinerator equipped with a scrubber or thermal unit to reduce nitrogen oxides emissions.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: *Cyclohexylamine*, Washington, DC (October 21, 1977)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Dicyclohexylamine*, Trenton, NJ (August 2000)

Dicyclohexylamine Nitrite D:0730

Formula: $C_{12}H_{24}N_2O_2$: C_6H_{11}-NH-$C_6H_{11}HNO_2$

Synonyms: Dechan; Diana; Dichan; Di-Chan; Dicynit; Dicyclohexylaminonitrite; Dicyclohexylammonium nitrite; Dodecahydrophenylamine nitrite; Leukorrosin C

CAS Registry Number: 3129-91-7

HSDB Number: 4018

RTECS Number: HY4200000

UN/NA & ERG Number: UN2687/133

EC Number: 221-515-9 [*Annex I Index No.:* 007-009-00-9]

Regulatory Authority and Advisory Information

Hazard symbols, risk, & safety statements: Hazard symbol: Xn; risk phrases R20/22; safety phrases: S2; S15; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [1-Low hazard to water. (est.)]

Description: Dicyclohexylamine nitrite is a flammable white powder which has some volatility at room temperature and higher. Molecular weight = 228.38; freezing/melting point = 181°C; flash point = 185°C. Partly soluble in water.

Potential Exposure: It is used as a vapor-phase corrosion inhibitor whereby it vaporizes either from the solid state or from solution, and offers protection against atmospheric rusting. Wrapping paper, plastic wraps; and other materials may be impregnated with dichan to protect metal parts during packaging and storage.

Incompatibilities: Highly flammable and a strong oxidizer. Contact with reducing materials (nitrides, hydrides, sulfides, etc.) or easily oxidized materials may cause fire and explosion hazard.

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

DFG MAK: No numerical value established. Data may be available.

Russia[43] set a MAC of 0.5 milligram per cubic meter in work-place air and a MAC in ambient air in residential areas of 0.02 milligram per cubic meter.

Permissible Concentration in Water: Russia[43] set a MAC in water bodies used for domestic purposes of 0.01 mg/L.

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: LD_{50} = (oral-rat) 284 mg/kg (moderately toxic). It decreases blood pressure.

Long-Term Exposure: Prolonged exposure to dicyclohexylamine nitrite vapor is reported to lead to changes in the CNS, erythrocytes, and methemoglobinemia; and to disturb the functional state of the liver and kidneys of human workers.

Points of Attack: Blood, liver, and kidneys.

Medical Surveillance: Blood pressure. CBC. Liver and kidney function tests.

First Aid: *Skin Contact:*[52] Flood all areas of body that have contacted the substance with water. Don't wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others.

Eye Contact: Remove any contact lenses at once. Immediately flush eyes well with copious quantities of water or normal saline for at least 20−30 minutes. Seek medical attention.

Inhalation: Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure.

Ingestion: Contact a physician, hospital or poison center at once. If the victim is unconscious or convulsing, do not induce vomiting or give anything by mouth. Assure that the patient's airway is open and lay him on his side with his head lower than his body and transport immediately to a medical facility. If conscious and not convulsing, give a glass of water to dilute the substance. Vomiting should not be induced without a physician's advice.

Note to Physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/ manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode.

Storage: Color code-Red Stripe: Flammability Hazard: Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1 hour fire wall from flammable or reactive materials. Store flammable solids up to maximum allowable quantity per control area in an approved flammable storage area. Do not store in a basement. Prior to working with this chemical, personnel should be trained on its proper handling and storage Store in a refrigerator under an inert atmosphere for long-term storage.

Shipping: UN2687 Dicyclohexylammonium nitrite, Hazard Class: 4.1; Labels: 4.1-Flammable solid.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Dampen spilled material with water to avoid airborne dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable solid. Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Thermal decomposition products may include nitrogen oxides and nitrous acid. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration; incinerator equipped with a scrubber or thermal unit to reduce nitrogen oxides emissions.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: *Cyclohexylamine*, Washington, DC (October 21, 1977)

N,N-Dicyclohexylcarbodiimide D:0735

Formula: $C_{13}H_{22}N_2$

Synonyms: Bis(cyclohexyl)carbodiimide; Carbodicyclohexylimide; Carbodiimide, 1,3-dicyclohexylcarbodiimide; Cyclohexanamine, *N,N′*-methanetetrayl-bis-; DCC; DCCD; DCCI; Dicyclocarbodiimide; Dicyclohexylcarbodiimide; *N,N′*-Methanetetraylbiscyclo hexanamine

CAS Registry Number: 538-75-0

HSDB Number: 8049

RTECS Number: FF2160000

UN/NA & ERG Number: UN2928 (toxic solid, corrosive, organic, n.o.s)/154; UN2811 (toxic solids, organic, n.o.s.)/154

EC Number: 208-704-1 ([*Annex I Index No:* 615-019-00-5]

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Combustible, Poison, Sensitization hazard, Corrosive (tissue), Water reactive.

Canada: WHMIS Classification D1A; D2B; on DSL list.

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xn, Xi; risk phrases: R22; R24; R34; R41; R43; safety phrases: S1/2; S24; S26; S37/39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: *N,N′*-Dicyclohexylcarbodiimide (DCC) is a white crystalline solid. Odor is sweet and heavy. Molecular Weight = 206.37; boiling Point = 122°C−124°C@ 6.0 mmHg; freezing/melting Point = 34°C−35°C; flash Point = 112.8°C; Hazard identification (based on NFPA-704 M Rating System): Health 3; Flammability 1; Reactivity 1₩. Insoluble in water; water reactive.

Potential Exposure: Laboratory reagent.

Incompatibilities: Dust may for explosive mixture with air. Reacts with steam and water. *N,N′*-Dicyclohexylcarbodiimide is an amine/imide: contact with strong oxidizers may cause fire and explosions. Incompatible with acids, strong bases, strong reducing agents (may form flammable gasses); azo and diazo compounds (may form toxic gases); chlorinated hydrocarbons; nitro compounds. Contact with mixture of acetic acid + dinitrogen trioxide may cause explosion. The combustion of amide compounds generate nitrogen oxides (NOx). In the presence of moisture, may attack metals and plastics.

Permissible Exposure Limits in Air:

PAC Ver. 29[138]

PAC-1: 0.12 milligram per cubic meter

PAC-2: 1.3 milligram per cubic meter

PAC-3: 8 milligram per cubic meter

Determination in Air: No NIOSH or OSHA method available.

Permissible Concentration in Water: No data available.

Determination in Water: Data not available.

Routes of Entry: Ingestion, inhalation, or absorbed through the skin. Causes burns by all exposure routes.

Harmful Effects and Symptoms

Short-Term Exposure: Corrosive. Highly toxic by inhalation. Severe overexposure can result in death. Harmful if inhaled, swallowed, or absorbed through skin. May cause allergic skin reaction and allergic reaction to the respiratory tract. Depending on the intensity and duration of exposure, this chemical can cause severe destruction of tissues of the mucous membranes and upper respiratory tract. Causes burns to any internal or external area of contact. Symptoms of exposure to this compound may include severe skin and eye irritation, irritation of the mucous membranes and upper respiratory tract; burning feeling, laryngitis; coughing and wheezing, shortness of breath, headache, nausea, and vomiting. Inhalation of this chemical can be fatal, resulting from inflammation, bronchial pneumonia, edema of the larynx, bronchi, and pulmonary tract. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. LD_{50} = (oral-rat) 400 mg/kg.

Long-Term Exposure: The chronic properties of this material have not been fully investigated. May cause skin and respiratory allergies. Repeated exposure to a highly toxic material may result in general deterioration of health and possible organ damage.

Points of Attack: Skin and respiratory tract.

Medical Surveillance: Consideration should be given to the skin, eyes, and respiratory tract (lung function tests) in any placement or periodic examinations. Evaluation by a qualified allergist, including careful exposure history and special testing may help diagnose skin or respiratory tract allergy.

First Aid Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Maintain eye wash fountain and quick-drench facilities in work area. Unless full facepiece respiratory protection is worn, wear splash-proof protective eyeglasses or chemical safety goggles as described in OSHA regulations 29CFR1910.133 or European Standard EN166. Wear Tyvek-type disposable protective clothing or other impervious protective clothing, gloves, lab coat, apron or coveralls, as appropriate, to prevent skin contact. Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Follow the regulations in OSHA 29CFR1910.134 or European Standard EN 149. Use a NIOSH/MSHA or European Standard EN 149-approved respirator; or an approved half face respirrator equipped with an organic vapor/acid gas cartridge (specific for organic vapors, HCl, acid gas and SO2) with a dust/mist filter. Splash proof safety goggles should be worn while handling this chemical. Alternatively, a full face respirator, equipped as above, may be used to provide simultaneous eye and respiratory protection. For emergencies or instances where the exposure levels are not known, use a full-face positive-pressure, air-supplied respirator. WARNING: Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.

Storage: (1) Color code-Blue: Health Hazard/Toxics/ Poisons: Store in a secure poison location. (2) Color code-White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Keep DCC in a tightly closed container in a cool, dry, ventilated area away from sources of incompatible materials, heat, direct sunlight, moisture, or ignition; best stored under an inert atmosphere at refrigerated temperatures. Containers of DCC may be hazardous when empty since they retain product residues (dust, solids); observe all warnings and precautions listed for the product. Shelf life when stored under ideal conditions: >4 years.

Shipping: UN2928 Toxic solids, corrosive, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, 8-Corrosive material, Technical Name Required. UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/ 75 ft[70]. Isolation Distance, Fire: 800 m/0.5 mi[70]. Wear appropriate PPE. Remove all sources of ignition. Ventilate area of leak or spill. *Small spills and leakage*: Should a spill occur while you are handling this chemical*, remove all sources of ignition*. Clean up spills in a manner that does not disperse dust into the air. Reduce airborne dust and prevent scattering by moisteningthe solid spill material with 60%−70% ethanol and using nonsparking tools and equipment, transfer the dampened material to a suitable container. Use absorbent paper dampened with 60%−70% ethanol to pick up any remaining material. Seal the absorbent paper, and any of your clothes, which may be contaminated, in a vapor-tight plastic bag for eventual disposal. Solvent wash all contaminated surfaces with 60%−70% ethanol followed by washing with a soap and water solution. Do not reenter the contaminated area until the Safety Officer (or other responsible person) has verified that the area has been properly cleaned.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen and carbon. In the event of a fire, wear full protective clothing and use a NIOSH/MSHA or European Standard EN 149-approved SCBA with full facepiece operated in the pressure demand or other positive-pressure mode. Burning may produce carbon monoxide, carbon dioxide, nitrogen oxides. Fires involving this material can be controlled with a dry chemical, carbon dioxide or Halon extinguisher.

Disposal Method Suggested: Whatever cannot be saved for recovery or recycling should be managed in an appropriate and approved waste facility. Although not a listed RCRA hazardous waste, this material may exhibit one or more characteristics of a hazardous waste and require appropriate analysis to determine specific disposal requirements. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

References

(31); (173); (101); (138); (100).

Dicyclopentadiene D:0740

Formula: $C_{10}H_{12}$

Synonyms: Bicyclopentadiene; Biscyclopentadiene; 1,3-Cyclopentadiene, dimer; DCPD; Diciclopentadieno (Spanish); 4,7-Methano-1H-indene; 4,7-Methano-1H-indene, 3a,4,7,7a-tetrahydro-; 3a,4,7,7a-Tetrahydro-4,7-methanoindene

CAS Registry Number: 77-73-6

HSDB Number: 321

RTECS Number: PC1050000

UN/NA & ERG Number: UN2048/130

EC Number: 201-052-9 [*Annex I Index No.:* 601-044-00-9]

Regulatory Authority and Advisory Information

United States Environmental Protection Agency Gene-Tox Program, Negative: Histidine reversion-Ames test; *S. cerevisiae-homozygosis*.

Hazard Alert: Suspected reprotoxic hazard, Suspected of causing genetic defects, Hormone, Primary irritant (w/o allergic reaction).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xn, N; R11; R20/22; R36/37/38; R51/53; safety phrases: S2; S21; S36/37; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Cyclopentadiene is a crystalline solid or a liquid (above 32°C) with a disagreeable, camphor-like odor. The Odor Threshold is 0.011 (detectable); 0.020 ppm (recognizable). Molecular weight = 132.22; boiling point = (decomposes) 167−172.2°C; freezing/melting point = 33°C; vapor pressure = 1.4 mmHg @ 20°C; 10 mmHg @ 48°C; flash point = 32°C; Autoignition temperature = 503°C. Hazard identification (based on NFPA-704 M Rating System): Health 1, Flammability 3, Reactivity 1. Explosive limits: LEL: 0.8%; UEL: 6.3%. Practically insoluble in water; solubility = 0.02%.

Potential Exposure: This compound is used in the manufacture of cyclopentadiene as a pesticide intermediate; in the production of ferrocene compounds; in paints, varnishes, and resin manufacture; in production of elastomers, resin systems, and polymers.

Incompatibilities: Forms explosive mixture with air above flash point. Depolymerizes at boiling point and forms two molecules of cyclopentadiene; unless inhibited and maintained under inert atmosphere to prevent polymerization. Violent reaction with strong oxidizers; strong acids; strong bases. Can accumulate static electrical charges, and may cause ignition of its vapors.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 5.41 milligram per cubic meter @ 25°C & 1 atm

The Odor Threshold is 0.011 (detectable); 0.020 ppm (recognizable).

OSHA PEL: None

NIOSH REL: 5 ppm/30 milligram per cubic meter TWA

ACGIH TLV[1]: 5 ppm/27 milligram per cubic meter TWA

PAC* Ver. 29[138]

PAC-1: $\mathbf{0.01}_{\mathbf{A}}$ ppm

PAC-2: **5_A** ppm
PAC-3: **75_A** ppm
*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.
DFG MAK: 0.5 ppm/2.7 milligram per cubic meter TWA; Peak Limitation Category II(1); Pregnancy Risk Group D
Australia: TWA 5 ppm (30 milligram per cubic meter), 1993; Austria: MAK 0.5 ppm (3 milligram per cubic meter), 1999; Belgium: TWA 5 ppm (27 milligram per cubic meter), 1993; Denmark: TWA 5 ppm (30 milligram per cubic meter), 1999; Finland: TWA 5 ppm (30 milligram per cubic meter); STEL 10 ppm (54 milligram per cubic meter) [skin] 1999; France: VME 5 ppm (30 milligram per cubic meter), 1999; Norway: TWA 5 ppm (30 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 3 milligram per cubic meter, 2003; Switzerland: MAK-W 0.5 ppm (3 milligram per cubic meter), KZG-W 1 ppm (6 milligram per cubic meter), 1999; United Kingdom: TWA 5 ppm (27 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: TWA 5 ppm. Several states have set guidelines or standards for dicyclopentadiene in ambient air[60] ranging from 0.3 milligram per cubic meter (North Dakota) to 0.5 milligram per cubic meter (Virginia) to 0.6 milligram per cubic meter (Connecticut) to 0.714 milligram per cubic meter (Nevada).

Determination in Air: See OSHA Analytical Method PV-2098.

Routes of Entry: Inhalation, ingestion, and skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Dicyclopentadiene irritates the skin and eyes. Human subjects reported an Odor Threshold at 0.003 ppm, slight eye or throat irritation @ 1−5 ppm. May cause headache; loss of balance and coordination; and even convulsions. Increased urinary frequency have been reported in exposed workers.

Long-Term Exposure: May affect the liver, kidneys, nervous system; and gastro-intestinal tract. May cause lung irritation with possible cough and shortness of breath. Animal experiments produced leukocytosis and kidney lesions.

Points of Attack: Eyes, skin, respiratory system, CNS, and kidneys.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following is recommended: Lung and kidney function tests. If symptoms develop or overexposure is suspected, the following may be useful: examination of the nervous system and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles when working with powders or dusts and splash-proof goggles when working with liquids unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures *over* 5 ppm; Use an NIOSH/MSHA or European Standard EN 149-approved respirator with a combination cartridge offering protection against organic vapors as well as against dust, fume, and mist. More protection is provided by a full facepiece respirator than by a half mask respirator, and even greater protection is provided by a PAPR. If while wearing a filter, cartridge or canister respirator, you can smell, taste, or otherwise detect dicyclopentadiene, or in the case of a full facepiece respirator you experience eye irritation, leave the area immediately. Check to make sure the respirator-to-face seal is still good. If it is, replace the filter, cartridge, or canister. If the seal is no longer good, you may need a new respirator. *Where there is potential for high exposures exists*, use an NIOSH/MSHA or European Standard EN 149-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use an NIOSH/MSHA or European Standard EN 149-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. May form peroxides in storage. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from oxidizing materials, strong acids; and strong bases. Sources of ignition, such as smoking and open flames are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of five gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical.

Shipping: UN2048 Dicyclopentadiene must carry a "FLAMMABLE LIQUID" label. It falls in Hazard Class 3.

Spill Handling: *Powders and dusts:* Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. *Liquid:* Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (122); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Dicyclopentadiene*, Trenton, NJ (March 2001)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Dicyclopentadiene*, Trenton, NJ, (June 2002 revised)

Dieldrin D:0750

Formula: $C_{12}H_8Cl_6O$

Synonyms: Alvit; Compound 497; Dieldrex; Dieldrina (Spanish); Dieldrine (French); Dieldrite; 2,7: 3,6-Dimethanonaphtha(2,3b)oxirene,3,4,5,6,9,9-hexachloro-1a,2,2a,3,6,6a, 7,7a-octahydro-(1a a,2.b,2a.a,3b,6.b,6aa,7b,7aa); ENT 16,225; HEOD; 1,2,3,4,10,10-Hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4-endo,exo-5,8-di-methanonaphthalene; Hexachloroepoxyoctahydro-endoexo-dimethanonaphthalene; 3,4,5,6,9,9-Hexachloro-1a,2,2a,3,6,6a,7, 7a-octahydro-2,7: 3,6-dimethano; 3,4,5,6,9,9-Hexachloro-1a, 2, 2a, 3, 6, 6a, 7, 7a-octahydro-2,7:3,6-dimethanonaphth (2,3-b)oxirene; (1r,4s,4as, 5r,6r,7s,8s,8ar)1,2,3,4,10,10-Hexachloro-1,4,4a,5,6,7,8,8a-octahydro-6,7-epoxy-1,4:5,8-dimethanonaphthalene; Illoxol; Killgerm dethlac insecticidal laquer; NCI-C00124; Octalox; Oxralox; Panoram; Panoram D-31; Quintox

CAS Registry Number: 60-57-1

HSDB Number: 322

RTECS Number: IO1750000

UN/NA & ERG Number: UN2761 (Organochlorine pesticides, solid toxic)/151

EC Number: 200-484-5 [*Annex I Index No.:* 602-049-00-9]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human, Inadequate Data, 1974; Animal, Limited Evidence, 1974, *not classifiable as carcinogenic to humans*, Group 3, 1987; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies; NCI: Carcinogenesis Bioassay (feed); equivocal evidence: mouse, no evidence: rat, 1978; NIOSH: Potential occupational carcinogen, See *NIOSH Pocket Guide*, Appendix A. United States Environmental Protection Agency Gene-Tox Program, Positive: V79 cell culture-gene mutation; Negative: Rodent dominant lethal; Host-mediated assay; Negative: Histidine reversion-Ames test; *S. cerevisiae-homozygosis*; Inconclusive: *D. melanogaster* sex-linked lethal.

California Proposition 65 Chemical[102]: Cancer 7/1/1988.

Hazard Alert: Poison, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard.

Persistent Organic Pollutants (UN), Environmental hazard.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/1992); Toxic Pollutant (Section 401.15)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P037

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.017; Nonwastewater (mg/kg), 0.13

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8080 (0.05); 8270 (10)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg)

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Mexico, Drinking Water Criteria, 0.0000007 mg/L

Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)]

List of Stockholm Convention POPs: Annex A (Elimination).

Regulations: Hazard symbol: T+, N; risk phrases: R25; R27; R40; R48/25; R50/53; R62; R63; safety phrases: S1/2; S21; S36/37; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Dieldrin is a colorless to light tan solid with a mild chemical odor. The Odor Threshold in water is 0.04 mg/L. Molecular weight = 380.90; boiling point = (decomposes); freezing/melting point = 176.1°C; vapor pressure = 8×10^{-7} mmHg @ 25°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Practically insoluble in water; solubility = 0.02%.

Potential Exposure: Aldrin belongs to the group of cyclodiene insecticides. They are a subgroup of the chlorinated cyclic hydrocarbon insecticides which include DDT, BHC, etc. They were manufactured in the United States by Shell Chemical Co. until the United States Environmental Protection Agency prohibited their manufacture in 1974 under the Federal Insecticide, Fungicide, and Rodenticide Act. The primary use of the chemicals in the past was for control of corn pests, although they were also used by the citrus industry.

Dieldrin's persistence in the environment is due to its extremely low volatility (i.e., a vapor pressure of 1.78×10^{-7} mmHg @ 20°C), and low solubility in water (186 μg/L @ 25°C−29°C). In addition, dieldrin is extremely apolar, resulting in a high affinity for fat which accounts for its retention in animal fats, plant waxes; and other such organic matter in the environment. The fat solubility of dieldrin results in the progressive accumulation in the food chain which may result in a concentration in an organism which would exceed the lethal limit for a consumer.

Incompatibilities: Incompatible with strong acids: concentrated mineral acids; acid catalysts; phenols, strong oxidizers, active metals; like sodium, potassium, magnesium, and zinc. Keep away from copper, iron, and their salts.

Permissible Exposure Limits in Air

NIOSH IDLH = 50 milligram per cubic meter

OSHA PEL: 0.25 milligram per cubic meter TWA[skin]

NIOSH REL: 0.25 milligram per cubic meter TWA[skin]; Potential occupational carcinogen; limit exposure to lowest feasible level. See *NIOSH Pocket Guide*, Appendix A

ACGIH TLV[1]: 0.25 milligram per cubic meter TWA measured as inhalable fraction and vapor [skin]; confirmed animal carcinogen with unknown relevance to humans

PAC Ver. 29[138]

PAC-1: 0.3 milligram per cubic meter

PAC-2: 6.8 milligram per cubic meter

PAC-3: 450 milligram per cubic meter

DFG MAK: 0.25 milligram per cubic meter, measured as the, inhalable fraction; [skin] Peak Limitation Category II (8)

Australia: TWA 0.25 milligram per cubic meter, [skin], 1993; Austria: MAK 0.25 milligram per cubic meter, [skin], 1999; Belgium: TWA 0.25 milligram per cubic meter, [skin], 1993; Denmark 0.25 milligram per cubic meter, [skin], 1999; Finland: TWA 0.25 milligram per cubic meter; STEL 0.75 milligram per cubic meter, [skin], carcinogen, 1999; France: VME 0.25 milligram per cubic meter, [skin], continuous carcinogen, 1999; India: TWA 0.25 milligram per cubic meter, [skin], 1993; the Netherlands: MAC-TGG 0.25 milligram per cubic meter, [skin], 2003; Norway: TWA 0.25 milligram per cubic meter, 1999; the Philippines: TWA 0.25 milligram per cubic meter, [skin], 1993; Poland: MAC (TWA) 0.5 milligram per cubic meter; STEL 1.5 milligram per cubic meter, 1999; Russia: STEL 0.01 milligram per cubic meter, 1993; Switzerland: MAK-W 0.25 milligram per cubic meter, [skin], 1999; Thailand: TWA 0.25 milligram per cubic meter, 1993; Turkey: TWA 0.25 milligram per cubic meter, [skin], 1993; United Kingdom: TWA 0.25 milligram per cubic meter; STEL 0.75 milligram per cubic meter, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Several states have set guidelines or standards for dieldrin in ambient air[60] ranging from 0.035 μ/m^3 (Pennsylvania) to 0.595 μ/m^3 (Kansas) to 2.5 μ/m^3 (North Dakota) to 4.0 μ/m^3 (Virginia) to 5.0 μ/m^3 (Connecticut) to 6.0 μ/m^3 (Nevada).

Determination in Air: Filter; Isooctane; Gas chromatography/Electrochemical detection; NIOSH II(3), Method #S283.

Permissible Concentration in Water: Federal Drinking Water Guidelines: 0.02 ppb[93]. State Drinking Water

Standards: Illinois 1 μg/L; State Drinking Water Guidelines: Arizona 0.001 μg/L State Drinking Water Guidelines: Arizona 0.63 μg/L; Florida 0.002 μg/L; California 0.002 μg/L; Connecticut 0.03 μg/L; Maine 0.02 μg/L; Minnesota 0.2 μg/L; New Hampshire 0.002 μg/L.

Determination in Water: Methylene chloride extraction followed by gas chromatography with electron capture or halogen specific detection (EPA Method 608) or gas chromatography plus mass spectrometry (EPA Method 625).

Permissible Concentration in Water: Octanol-water coefficient: Log $K_{ow} = > 6$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood. Naphthalenes and naphthenic acids are listed as United States DOT marine pollutants and may persist in the environment.

Routes of Entry: Inhalation, skin absorption, ingestion, and eye and/or skin contact.

Harmful Effects and Symptoms

During the past decade, considerable information has been generated concerning the toxicity and potential carcinogenicity of the two organochlorine pesticides, aldrin and dieldrin. These two pesticides are usually considered together since Aldrin is readily epoxidized to dieldrin in the environment. Both are acutely toxic to most forms of life including arthropods, mollusks, invertebrates, amphibians, reptiles, fish, birds and mammals. Dieldrin is extremely persistent in the environment. By means of bioaccumulation it is concentrated many times as it moves up the food chain.

Short-Term Exposure: *Inhalation:* May cause nausea, drowsiness, loss of appetite; visual disturbances and insomnia. Sprays of 1%−2½% have caused giddiness, headache, muscle twitching; convulsions and loss of consciousness. *Skin:* Can be absorbed to cause or increase the severity of symptoms as listed under ingestion. Contact may cause skin rash. *Eyes:* May cause irritation, redness, and affect vision. *Ingestion:* Can cause headache, nausea, irritability, insomnia, high blood pressure; vision problems; loss of coordination; profuse sweating, dizziness, frothing at the mouth; convulsions and loss of consciousness. Death may occur from as little as 1/20 ounce (1.4 gram). Some symptoms may be delayed up to 12 hours. Exposure to dieldrin may affect the CNS; resulting in convulsions.

Long-Term Exposure: May cause liver damage. Dieldrin accumulates in the human body. Dieldrin has caused cancer in laboratory animals. It is considered a suspect occupational carcinogen. May damage the developing fetus. May reduce fertility in males and females. Dieldrin concentrates in breast milk, and therefore, may be transferred to breast feeding infants. Repeated higher exposure can cause tremors, muscle twitching and seizures (convulsions), and may lead to coma and death. Convulsions are somewhat delayed and may occur weeks or months following exposure. Repeated exposure may cause personality changes of depression, anxiety or irritability.

Points of Attack: CNS, liver, kidneys, and skin. *Cancer site* (in animals): lung, liver, thyroid, and adrenal gland tumors.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below pre-employment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider CBC. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates. Blood dieldrin level. Examination of the nervous system. If symptoms develop or overexposure is suspected, the following may be useful: liver function tests. EEG. Blood dieldrin levels (Normal = less than 1 mg/100 ml; level should not exceed 15 mg/100 ml). Examination of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 12 hours after overexposure.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: At *any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:

Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type SCBA).

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with dieldrin all handlers should be trained on its proper handling and storage. Dieldrin must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates and nitrates); strong acids (such as hydrochloric, sulfuric and nitric); chemically active metals (such as potassium, sodium, magnesium, and zinc), since violent reactions occur. Always store pesticides in their original containers, complete with labels that list ingredients, directions for use, and first aid steps in case of accidental poisoning. Never store pesticides in cabinets with or near food, animal feed, or medical supplies. Do not store pesticides in places where flooding is possible or in places where they might spill or leak into wells, drains, ground water, or surface water[72]. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2761 Organochlorine pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Dieldrin is a noncombustible solid. Commercial solutions may contain flammable or combustible liquids. Use dry chemical, carbon dioxide, water spray, alcohol, or polymer foam extinguishers. Thermal decomposition products may include hydrogen chloride and carbon monoxide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration (816°C, 0.5 second minimum for primary combustion; 1760°C, 1.0 second for secondary combustion) with adequate scrubbing and ash disposal facilities[22]. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(102); (31); (173); (101); (138); (203); (100).

United States Environmental Protection Agency, *Aldrin/Dieldrin: Ambient Water Quality Criteria*, Washington, DC (1980)

United States Environmental Protection Agency, *Dieldrin, Health and Environmental Effects Profile No. 82*, Washington, DC, Office of Solid Waste (April 30, 1980)

Sax N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 4, 52−55 (1981) an 6, No. 1, 9−16 (1986)

United States Environmental Protection Agency, *Health Advisory: Dieldrin*, Washington, DC, Office of Drinking Water (August 1987)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Dieldrin*, Trenton, NJ (November 1998)

New York State Department of Health, *Chemical Fact Sheet: Dieldrin*, Bureau of Toxic Substance Assessment, Albany, NY (January 1986 & Version 2)

United States Public Health Service, *Toxicological Profile for Aldrin/Dieldrin*, Atlanta, Georgia, agency for Toxic Substances & Disease Registry (November 1987)

Diepoxybutane D:0760

Formula: $C_4H_6O_2$

Synonyms: 1,1′-Bi(ethylene oxide); Bioxirane; 2,2′-Bioxirane; Butadiendioxyd (German); Butadiene diepoxide; 1,3-Butadiene diepoxide; Butadiene dioxide; Butane diepoxide; Butane, 1,2: 3,4-diepoxy-; DEB; Dioxybutadiene; ENT 26,592; Erythritol anhydride

CAS Registry Number: 1464-53-5; 298-18-0 (DL-1,3-)

HSDB Number: 4046 (1464-53-5)

RTECS Number: EJ8225000

UN/NA & ERG Number: UN3489/131; UN2929/131

EC Number: 215-979-1 [*Annex I Index No.:* 603-060-00-1]

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen.

California Proposition 65 Chemical[102]: Cancer 1/1/1988

Hazard Alert: Poison inhalation hazard, Highly flammable[101], Corrosive, Polymerization hazard, Possible risk of forming tumors, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction).

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U085

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500 lb (227 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg)

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

CHEMISTRY/TOXICOLOGY

Sittig's Handbook of
Toxic and Hazardous Chemicals and Carcinogens
Volume 1: A – D
SEVENTH EDITION

The definitive reference on hazardous chemical substances.
Comprehensive and convenient, *Sittig's Handbook* focuses on the most important hazardous chemicals in commercial use.

- The chemicals are presented alphabetically and classified as a carcinogen, hazardous substance, hazardous waste, or toxic pollutant.
- Find the chemical you are looking for quickly and reliably: entries have a full range of synonyms for each chemical, including trade names and CAS index.
- Relevant data for the United States and EU included throughout, along with the essential chemical hazard information applicable worldwide.
- The seventh edition includes more than 100 new chemical records.
- The trusted source of reliable information depended on by first-line responders (emergency services), industry, logistics companies, scientists, and environmental protection organizations.

For over 30 years, *Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens* has proven to be a reliable, accessible must-have reference work on hazardous materials. This updated and revised 7th edition is the most quickly accessible and comprehensive listing of the hazardous chemicals that are commonly used, transported, and regulated for use in the environment and the workplace. Information is the most vital resource anyone can have when dealing with potential hazardous substance accidents, spillages, fires, or acts of terror. It is also essential for the safe day-to-day operation of chemical processes and environmental protection. Sittig's handbook provides extensive data for over 2200 chemicals in a uniform format, enabling fast and accurate decisions in almost any situation. This new edition contains expanded and reviewed information for each chemical listed (including chemicals classified as WMDs) and has been updated to keep pace with world events, standards, and regulations.

Richard P. Pohanish is the author or co-author of 25 books and database product in the fields of hazardous material, environmental health, chemical safety, and engineering. Active in the publishing and information business for more than half a century, Mr. Pohanish, now retired, formerly held various executive positions with Van Nostrand Reinhold, including President, Information Division. His numerous published works include *Sittig's Handbook of Pesticides and Agricultural Chemicals*, 2nd Edition.

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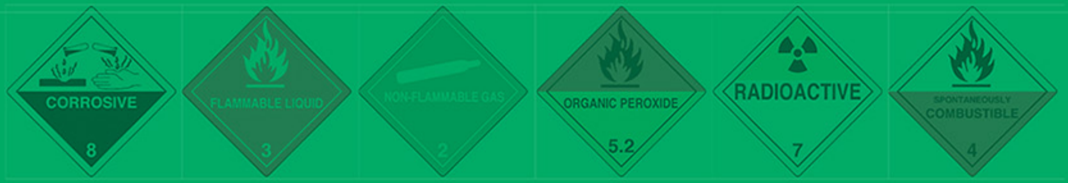
SEVENTH EDITION

Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens

Richard P. Pohanish



Volume 2: E – O

SITTIG'S HANDBOOK OF TOXIC AND HAZARDOUS CHEMICALS AND CARCINOGENS

Seventh Edition

Volume 2: E−O

SITTIG'S HANDBOOK OF TOXIC AND HAZARDOUS CHEMICALS AND CARCINOGENS

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Volume 2: E–O

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As information may not be available for some chemicals, an absence of data does not necessarily mean that a substance is not hazardous. For major incidents, it will be necessary to obtain additional detailed information from other resources as well as more expertise from those with extensive training. Neither the Publisher nor the Editors assume any liability or responsibility for completeness or accuracy of the information presented or any damages of any kind alleged to result in connection with, or arising from, the use of this work.

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Contents

Preface

For more than 35 years *Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens* has continued to serve an ever-widening audience of users. It has been proven to be among the most easy-to-use and essential reference works on hazardous materials. The 7th edition has been updated and expanded, once again, to keep pace with world events and to respond to the ever-expanding need for reliable information on chemicals used in the workplace and the tool shed.

Most users of this work understand the potential dangers of chemicals. Hazardous and toxic substances pose a wide range of health hazards, including irritation, sensitization, and carcinogenicity. Chemicals can possess physical properties of flammability, explosion and corrosion. Many chemicals can harm the environment by poisoning aquatic and plant life.

The chemical industry and its many component businesses are forced to strike a delicate balance because the same properties that make a chemical substance highly useful can also make it extremely harmful. We are told by some industrialists that toxic chemicals are present in nature and that industrial contributions are just the price we have to pay for progress. There is little argument about the chemical industry's critical place in the nation's economy. The United States is the number one chemical producer in the world, generating more than $550 billion a year and employing more than 5 million people. So, somewhere in between lies the truth—or at least an area in which we can function. Information is vital in a world where virtually every aspect of our lives is touched by chemical hazards.

Each year, in the United States, over 2 billion tons of hazardous and toxic chemicals are manufactured. Including imports, more than 3 billion tons are transported employing 800,000 shipments each day. It is estimated that 1.3 billion tons are moved by truck and hundreds of billions of pounds of these hazardous materials are transported through populated areas. The average American household generates approximately 15 pounds of hazardous waste per year. Nearly five million poisonings occur in the United States annually, resulting in thousands of deaths. Based on 2004 TRI data (publically released April 2006), over 4 billion pounds of toxic chemicals are released into the nation's environment each year, including 72 million pounds of recognized carcinogens from nearly 24,000 industrial facilities.

Chemical accidents and spills can range from small to large and can occur anywhere chemicals are manufactured, transported, stored or used. Today's media headlines constantly point out both the information gaps and the need for constantly updated information. On January 9, 2014, for example, an estimated 10,000 gallons[CDC,NTP] of chemicals used to process coal spilled from a damaged 45,000 gallon storage tank into the Elk River in the US state of West Virginia. As the news of the spill developed, it became clear to the public (and many experts) that federal and state officials had sparse data about the health risks of the two potentially toxic organic solvents involved in the spill: primarily crude 4-methylcyclohexanemethanol and a minor component of mixed glycol ethers consisting of glycol phenyl ether and dipropylene glycol phenyl ether. The latter mixture of chemicals was not reported by the manufacturer to the public until 12 days after the initial spill. The unfortunate truth is that the Elk River is a municipal water source that serves approximately 300,000 people in and around Charleston, the state capitol. For weeks following the spill, residents were instructed not to drink or bathe with local tap water.

The problem of toxic chemicals in the United States; and, indeed, in all the world frightens many people. Over the years, these fears are heightened by news stories such as the huge accidental plant fire in Saudi Arabia that killed at least 12 people and injured another dozen (April 2016); the huge explosion at a vinyl chloride plant in Coatzacoalcos, Mexico—A few days later (also April 2016) that killed 24 workers and injured 136; the worst environmental disaster in Vietnam history caused by a chemical spill of cyanide, phenols and iron hydroxide which poisoned tons of marine life and killed people along 120 miles of coastline and stretching some 20 nautical miles out to sea (June 2016); the chemical plant explosion and subsequent spill of highly flammable liquids in Guizhou Province, China (February 2012) that killed more than 20 people and forced the evacuation of almost 30,000. Whether the chemical involves an aluminum dust explosion (Huntington, IN, 2003), a fertilizer explosion in West Texas (April 2013) leads in the water supply (Flint, MI, 2016), the massive Deepwater Horizon oil spill (Gulf of Mexico, 2010), or older problems—Bhopal, India, Love Canal, New York, the disastrous Valley of the (100,000) Drums (Kentucky), the Valley of Death in Brazil, and the like−these incidents generate emotional responses, often from people uninformed about science or technology and confirm the charge of critics that chemicals are "accidents waiting to happen."

In 2001, the 4th Edition of *Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens* was published shortly before the tragic events of the morning of September 11. The decade that followed brought many changes to life in the civilized world. The United States government, for example, established the Department of Homeland Security and enacted laws such as the *Chemical Facilities Security Act of 2003.* These actions were prompted by concerns involving infrastructure protection and the anticipation of another attack, possibly on the nation's chemical and energy facilities or by using trucks

or tank cars that transport highly dangerous and possibly lethal chemicals. "These facilities are found around the country in industrial parks, in seaports, and near the major population centers. Dangerous chemicals routinely travel along our highways, inland waterways, and on railcars that pass through the heart of major cities including Washington, D.C., just a short distance from Capitol Hill. Terrorist attacks on the US chemical industry have the potential to kill tens of thousands of Americans and seriously injure many more. In many instances, these attacks hold the potential for having a cascading effect across other infrastructures, particularly in the energy and transportation sectors. This is both because of the damage that can be caused by the attack, and the enormous expense and effort associated with the clean-up to an affected area in its aftermath."[83] To put it more simply, using the same low tech/high concept approach that turned passenger planes into missiles, terrorists do not need to produce or amass chemical weapons or smuggle them into the United States in order to produce great damage.

"Commercial chemical incidents occur tens of thousands of times each year, often with devastating and exorbitantly expensive consequences. They are indiscriminate in their effects. Workers, companies, the public, emergency response organizations, and all levels of government pay the figurative and literal price. Yet, until now and with few exceptions, chemical incidents have been invisible. Perhaps it is due to their pervasiveness, or to the common tendency to overlook what is taken for granted."[84] This quote is from the highly publicized *600K Report* prepared by the Chemical Safety and Hazard Investigation Board (CSB), an independent, nonpartisan, quasi-legislative US government agency. The CSB described our nation's lack of definitive knowledge of the "big picture" surrounding chemical incidents as "... the industrial equivalent of two 737 airplanes "crashing" year after year, killing all passengers (256 people) without anyone seeming to notice."[84]

Almost 40 years ago, the United States Government Accounting Office (GAO) estimated that 62,000 chemicals were in commercial use. Today, that number has grown to beyond 82,000.

Given the reality of problems inherent to chemical hazards, including accidents and spills, the advent of new threats to our way of life, and the challenges of communicating complex data, it is the goal of this work to provide data so that responsible decisions can be made by all who may have contact with chemicals covered in this reference work. With this in mind the work can be used by those in the following chemical fields and related professions:

Applied research and product development
Attorneys
Campus safety and health
Certified chemical hygiene officer (CCHO)
Chemical engineering
Chemical health and safety
Chemical informatics and information management
Chemicals manufacturers and distributors
Chemical technology
Certified hazardous materials manager (CHMM)
Certified health physicist (CHP)
Certified industrial hygienist (CIH)
Certified safety professional (CSP)
Dyes, pigments and inks
Emergency response personnel
Environmental protection and management
Forensic chemistry
Formulation chemistry
Hazardous waste management
Industrial management
Laboratory management
Loss control management
Pesticide distributors
Process chemistry
Process safety
Project management
Public information and outreach
Public health
Quality control and assurance
Regulatory affairs
Researchers
Science policy
Technical communications
Technical support
Toxicology
Water chemistry

The chemicals chosen for inclusion are officially recognized substances, many identified as carcinogens, as belonging to some designated category of hazardous or toxic materials; with numerically defined safe limits in air in the workplace, ambient air, water; in waste effluents. For the most part these are materials of commerce that can be heavily used and may be transported in bulk.

The 7th edition contains more chemicals and data for each material. In keeping with the broad changes initiated with the fourth edition, contents of the 7th edition are focused on the concept of "regulated chemicals." The carcinogen potential of each chemical was compared to listings and reports from eminent authorities as the International Agency for Research on Cancer (IARC), the US National Toxicology Program (NTP) and the US Environmental Protection Agency.

The "Regulatory Authority and Advisory Bodies" section contains new items including, where available, EPA Gene-Tox Program findings, and many of the individual listings now contain useful advice sought after by the regulated community. As a result, the new volume should be even

more practical for those users of specific chemicals, and to those concerned with both adherence to, and enforcement of, regulations.

Data is furnished, to the extent currently available, in a uniform multisection uniform format to make it easy for users who must find information quickly and/or compare the data contained within records, in any or all of these important categories:

Chemical Name and Record Number
Chemical Formula
Synonyms (including trade names)
Code Numbers (including CAS Registry, HSDB, RTECS, UN/NA & ERG, EC)
Regulatory Authority and Advisory Information (summary)
Description (including physical properties, explosion and fire data and water reaction and solubility)
Potential Exposure
Incompatibilities
Permissible Exposure Limits in Air
Determination in Air
Permissible Concentration in Water
Determination in Water
Routes of Entry
Short-Term Exposure
Long-Term Exposure
Points of Attack
Medical Surveillance
First Aid
Decontamination (selected records)
Personal Protective Methods
Respirator Selection
Storage
Shipping
Spill Handling
Fire Extinguishing
Disposal Method Suggested
References

A Brief history of this work

Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens was first published more than 35 years ago. This work continues to provide first responders and occupational and environmental health and safety professionals with an accessible and portable reference source. Based on a count of CAS numbers, the seventh edition of this handbook contains data on almost 2600 toxic and hazardous chemicals (up from nearly 600 in the first edition, nearly 800 in the second edition, nearly 1300 in the third edition, and nearly 1500 in the fourth edition, and 2200 in the sixth edition).

According to the United State Library of Congress, the history of the project is as follows: 1st edition published in 1981; 2nd edition published in 1985; 3rd edition published in 1991; 4th edition published in 2001; 5th edition November 2007; 6th edition 2012, 7th edition: 2017.

Acknowledgments

The compilation of this 7th edition could not have been realized without the contributions of many of the researchers, scientists, contract employees and institutions that developed the excellent documents and databases that provided so much of the essential data that appear in this work. A full list of these contributors is impossible to compile. Nevertheless, In no particular order, I wish to acknowledge the those associated with US Environmental Protection Agency (EPA); United States Department of Labor; Occupational Safety and Health Administration (OSHA); Department of Health and Human Services; National Institute for Occupational Safety and Health (NIOSH); US Department of Energy (DOE); Agency for Toxic Substances and Disease Registry (ATSDR); American Conference of Governmental Industrial Hygienists (ACGIH); Deutsche Forschungsgemeinschaft (DFG); Centers for Disease Control and Prevention (CDC); NOAA; United States National Library of Medicine (NLM) National Institutes of Health (NIH); Hazardous Substance Data Bank (HSDB) and (TOXNET); US Department of Health and Human Services, Public Health Service, National Toxicology Program (NTP); Federal Emergency Management Agency (FEMA); US Department of Transportation (DOT); US Coast Guard (USCG); National Fire Protection Association (NFPA); International Agency for Research on Cancer; (IARC); New Jersey Department of Health and Senior Services; Chemical Safety and Hazard Investigation Board (CSB); United Nations Environment Programme; the states of New York and New Jersey, and many other government organizations, organizations and companies. It is nearly impossible to express the extent of my gratitude to all of them for their contributions to my research.

Although every effort has been made to produce an accurate and highly useful handbook, the editors and Publisher appreciates the need-for constant improvement. Any comments, corrections, or advice from users of this book are welcomed by the author who asks that all correspondence be submitted in writing and mailed directly to the publisher who will maintain a file for reprints and future editions.

How to Use This Book

Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens focuses on critical data for more than 2600 commercially important, regulated and hazardous, to one degree or another, substances. A large number of these chemicals are known or suspected potentially dangerous carcinogens. Many are found in the workplace and fewer are found in the medical and research fields. Some are found in home basements and worksheds. For the most part, importance is defined by inclusion in official, regulatory, and advisory listings. Much of this information, found in US government sources, has been supplemented by a careful search of many publications and databases.

This handbook is becoming more encyclopedic in nature. When one looks at many, if not most published works in this field, the user simply expects to find numerical data. Here, we have tried, wherever possible, to provide useful descriptive material and references which hopefully opens the door to additional of published materials.

Nevertheless, this is not a seminal research work and it is recommended that this book be used as a guide. This work is not meant to be a substitute for workplace hazard communication programs required by regulatory bodies such as OSHA, and/or any other United States or international government agencies. If data are required for legal purposes, the original source documents [such as Code of Federal Regulations (CFR)], appropriate Federal and State agencies, which are often referenced, should be consulted.

In the pages which follow, the following categories of information will be presented, for each chemical record, discussed with reference to scope, sources, nomenclature employed, and the like. Omission of a category generally indicates a lack of available information.

Chemical name: Each record is arranged alphabetically by a chemical name. These are names used by regulatory and advisory bodies. In very few cases the name may be a popularly-used product name or trade name. The chemical name section of each chemical record is backed-up with the "Synonyms" section and Appendix 5, "Synonym and Trade Name-Cross Index."

Formula: Generally, this has been limited to a commonly used one-line empirical or atomic formula. In the *Molecular Formula* field, the Hill system has been used showing number of carbons (if present), number of hydrogens (if present), followed by alphabetically listed element (s). Multiple carbon−carbon (double and triple) bonds have been displayed where appropriate.

Synonyms: This section contains scientific, product, trade, and other synonym names that are commonly used for each hazardous substance. Some of these names are registered trade names. Some are provided in other major languages other than English, including Spanish, French, and German. In some cases, "trivial" and nicknames (such as MEK for methyl ethyl ketone) have been included because they are commonly used in general communications, especially in the workplace. This section is important because the various "regulatory" lists published by federal, state, international agencies and advisory bodies do not always use the same name for a given hazardous substance. Every attempt has been made to ensure the accuracy of the synonyms and trade names found in this work, but errors of highly complex names are inevitable in compilations of this magnitude. Please note that this work may not include the names of all products currently found in commerce, particularly mixtures that may contain ingredients that are regulated chemicals.

The synonym index contains all synonym names listed in alphabetical order. It should be noted that organic chemical prefixes and interpolations such as (α-) alpha-, (β-) beta-, (γ-) gamma-, (δ-) delta-, (o-) ortho-, (m-) meta-; (p-) para-; sec- (secondary-), trans-, cis-, (n-) normal-, and numbers (1-; 1,2-), etc. are not used when searching for a chemical name. In other words, these prefixes are not treated as part of the chemical name for the purposes of alphabetization. Users should use the substance name without the prefix. For example, to locate *n*-butane, search for butane; to locate 3,3′-dichlorobenzidine; search for dichlorobenzidine; and to locate *α*-cyanotoluene or *alpha*-cyanotoluene, search for cyanotoluene. *Note*: All product names, company names, trademarks, and brands are the registered property of their respective owners. All company, product and service names used in this work are for identification purposes only. Use of these names, logos, and brands does not imply endorsement by the Author, Editors or the Publisher.

CAS Registry Number: The Chemical Abstracts Service (CAS) number is a unique identifier assigned to each chemical registered with the CAS of the American Chemical Society. This number is used to identify chemicals on the basis of their molecular structure. CAS numbers, in the format "nnn-nn-n" [two or more numeric characters (dash) two numeric characters (dash) followed by a single numeric check digit]. CAS numbers should always be used in conjunction with substance names to insure positive identification and to avoid confusion with like-sounding names, i.e., benzene (71-43-2) and benzine (8032-32-4). This 7th edition contains some alternate CAS numbers that may now be considered related, retired, obsolete and/or widely and incorrectly used in the literature. In this section, the first CAS number(s), before the abbreviation "alt." for the word "alternate," is considered (based on several sources) to be the correct CAS number(s). Ultimately, it is the responsibility of the user to find and use the correct number. *Note*: CAS Registry Number is a Registered Trademark of the American Chemical Society.

HSDB Number: HSDB is a toxicology data file on the National Library of Medicine's (NLM's) Toxicology Data Network (TOXNET). HSDB is organized into individual chemical records, and contains over 5000 such records. HSDB is a database focused primarily on the toxicology of potentially hazardous chemicals. The information in HSDB has been assessed by a Scientific Review Panel. Using your computer browser and entering a search such as "HSDB (followed by the Number)" should take you to the exact record you are seeking.

RTECS Number: RTECS (Registry of Toxic Effects of Chemical Substances) is a compendium of data extracted from the open scientific literature. The data are recorded in the format developed by the RTECS staff at NIOSH and arranged in alphabetical order by prime chemical name.[NIOSH] The RTECS numbers are unique identifiers assigned NIOSH. The RTECS number in the format "AAnnnnnnn" (two alphabetic characters followed by seven numeric characters) may be useful for online searching for additional toxicologic information on specific substances. It can, for example, be used to provide access to the MEDLARS computerized literature retrieval services of the NLM in Washington, DC. The RTECS number and the CAS number can serve to narrow down online searches. The RTECS Database is currently available from a growing list of "value-added" vendors that are listed on the Internet from NIOSH or CDC. In the US 1-800-232-4636; Outside the US 1-513-533-8328 or by Email: cdcinfo@cdc.gov.

UN/NA & ERG Number: United Nations-North America numbers are four-digit numbers that identify an individual chemical or group of hazardous substances, chemicals or articles (such as explosives, corrosive substances, pesticides, grenades, etc.) with similar characteristics. These four-digit numbers are normally preceded by UN or NA (e.g., UN1759-NA1759). UN/NA numbers are required to appear on shipping documents, and are often displayed on warning labels, the exterior of packages, and on specified containers such as truck or railway placards. These ID (identification) numbers may also be called NA (North American) numbers or DOT (Department of Transportation) numbers.[cameo] UN numbers are assigned by the United Nations Committee of Experts on the Transport of Dangerous Goods. Identification numbers containing a UN prefix (United Nations numbers) are authorized for use with all international shipments of hazardous materials. NA numbers are assigned by the United States DOT and usually correspond closely, but not always precisely, to the UN listing. The "NA" prefix is used for shipments between Canada and the United States *only*, and may *not* be used for other international shipments. Some chemicals without an assigned UN number may have an NA number. These latter NA numbers are usually in the format and range of NA8000−NA9999. Use of these ID numbers for hazardous materials will (1) serve to verify descriptions of chemicals; (2) provide for rapid identification of materials when it might be inappropriate or confusing to require the display of lengthy chemical names on vehicles; (3) aid in speeding communication of information on materials from accident scenes and in the receipt of more accurate emergency response information; and (4) provide a means for quick access to immediate emergency response information in the *North American Emergency Response Guidebook* (ERG) and also in the international publication, *Recommendations on the Transport of Dangerous Goods*, also known as the *Orange Book*.

EC Number: The European Commission number is a seven digit identification code used in countries of the European Union (EU) for commercially available chemical substances within the EU. This number is an identification number (ID) from *European Inventory of Existing Commercial Chemical Substances*, published by the European Environment Agency, Copenhagen, Denmark. The EC number supercedes the outmoded EINECS, ELINCS and NLP numbers. This section also includes "Annex I, Index Number" for the Export and Import of Dangerous Chemicals found in Annex I of Regulation (EC) No. 689/2008.

Regulatory Authority and Advisory Bodies:
This section contains a listing of major regulatory and advisories for the chemical of concern, including, but not limited to, Homeland Security, OSHA, US EPA, DFG (Germany), US DOT, ACGIH, IARC, NTP, WHMIS (Canada) and the EC, etc. Many law or regulatory references in this work have been abbreviated. For example, Title 40 of the CFR, Part 261, subpart 32 has been abbreviated as 40CFR261.32. The symbol "§" may be used as well to designate a "section" or "part."

- United States Department of Homeland Security. Includes "chemicals of interest" from The Chemical Facility Anti-Terrorism Standards (CFATS Act of 2014) program and the *Federal Register*, Appendix A, including all provisions of 6 CFR Part 27, including § 27.210(a)(1)(i). In developing the list, the DHS looked to existing expert sources of information including other federal regulations related to chemicals, including the following: chemicals covered under the United States Environmental Protection Agency's Risk Management Program. Chemicals included in the Chemical Weapons Convention. Hazardous materials, such as gases that are poisonous by inhalation. Explosives regulated by the DOT. The Department of Homeland Security has identified three security issues related to chemicals: *Release*—Toxic, flammable, or explosive chemicals or materials that, if released from a facility, have the potential for significant adverse consequences for human life or health. *Theft or Diversion*—Chemicals or materials that, if stolen or diverted, have the potential to be misused as weapons or easily converted into weapons using chemical

manipulation and techniques and related equipment with the intent of creating significant adverse consequences for human life or health. *Sabotage or Contamination*—Chemicals or materials that, if mixed with other and possibly readily available materials, have the potential to create significant adverse consequences for human life or health. Also considered were these security issues as well as to determine their potential future inclusion in the final version of Appendix A, and/or coverage under *Chemical Facility Anti-Terrorism Standards: Critical to Government Mission*—Chemicals or facilities the loss of which could create significant adverse consequences for national security or the ability of the government to deliver essential services, and *Critical to National Economy*—Chemicals or facilities the loss of which could create significant adverse consequences for the national or regional economy.

- Carcinogenicity: lists known and suspected human carcinogens, the agency making such a determination, the nature of the carcinogenicity. The following lists and agencies were consulted: *US Department of Health and Human Services 13th Report on Carcinogens (10/2/2014)*. United States Environmental Protection Agency: US EPA's general categories recognized by the 2005 guidelines are as follows: *Group A*: Carcinogenic to Humans: Agents with adequate human data to demonstrate the causal association of the agent with human cancer (typically epidemiologic data). *Group B*: Probably Carcinogenic to Humans: Agents with sufficient evidence (i.e., indicative of a causal relationship) from animal bioassay data, but either limited human evidence (i.e., indicative of a possible causal relationship, but not exclusive of alternative explanations; Group B1), or with little or no human data (Group B2). *Group C*: Possibly Carcinogenic to Humans: Agents with limited animal evidence and little or no human data. *Group D*: Not Classifiable as to Human Carcinogenicity: Agents without adequate data either to support or refute human carcinogenicity. *Group E*: Evidence of Noncarcinogenicity for Humans: Agents that show no evidence for carcinogenicity in at least two adequate animal tests in different species or in both adequate epidemiologic and animal studies.[USEPA] US Department of Health and Human Services *13th Report on Carcinogens (RoC)*, (2014), a science-based document prepared by the National Toxicology Program (NTP) that identifies chemical, biological, and physical agents that are considered cancer hazards for people living in the United States. IARC (International Agency for Research on Cancer),[12] are classified as to their carcinogenic risk to humans by IARC as follows: Group 1: Human Carcinogen; Group 2A: Probable Human Carcinogen; Group 2B: Possible Human Carcinogen.
- Chemicals on California's Proposition 65 List, revised as of September 30, 2016. Officially known as the Safe Drinking Water and Toxic Enforcement Act of 1986. The proposition requires that the Governor protect the state's drinking water sources from being contaminated with chemicals known to cause cancer, birth defects or other reproductive harm, and to revise and republish at least once per year a list of such chemicals. It also requires businesses to inform Californians about exposures to chemicals on the revised list[OEHHA].
- This 7th edition contains a brief summary labeled "Hazard Alert". The purpose of this section is to quickly notify users of specific dangers related to each chemicals of interest. Following is a *sample* of warnings appearing in this section: Asphyxiation hazard • Combustible liquid • Contains gas under pressure • may explode if heated • Endocrine disruptors (high/medium/low, where available) • Dangerous nerve agent • Extremely flammable gas • Flammable liquid • Frostbite/Cryogenic burn hazard • Poison inhalation hazard: exposure can be lethal • Polymerization hazard (high) • Polymerization hazard $>$ 30°C • Possible risk of forming tumors • Primary irritant (w/o allergic reaction) • Sensitization hazard (skin, respiratory) • Suspected of causing genetic defects • Suspected reprotoxic hazard • Environmental hazard, etc. *Warning*: This section is merely a guide and does not purport to be complete for every chemical covered in this work.
- A banned or severely restricted product as designated by the United Nations[13] or by the US EPA Office of Pesticide Programs under FIFRA (Federal Insecticide, Fungicide and Rodenticide Act).[14]
- A substance with an air pollutant standard set or recommended by OSHA and/or NIOSH,[58] ACGIH,[1] DFG.[3] The OSHA limits are the enforceable pre-1989 PELs. The transitional limits that were vacated by court order have not been included. However, the vacated limits are used and enforced by some states. Some airborne limits, for example, such as those from NIOSH and ACGIH are recommendations that do not carry the force of law.
- A substance whose allowable concentrations in workplace air are adopted or proposed by the American Conference of Government Industrial Hygienists

(ACGIH),[1] DFG [Deutsche Forschungsgemeinschaft (German Research Society)].[3] Substances whose allowable concentrations in air and other safety considerations have been considered by OSHA and NIOSH.[2] Substances which have limits set in workplace air, in residential air, in water for domestic purposes or in water for fishery purposes as set forth by the former USSRUNEP/IRPTC Project.[43]

- Substances that are specifically regulated by OSHA under 29CFR1910.1001 to 29CFR1910.1050
- Highly hazardous chemicals, toxics, and reactives regulated by OSHA's "*Process Safety Management of Highly Hazardous Chemicals*" under 29CFR1910.119, Appendix A. Substances that are Hazardous Air Pollutants (Title I, Part A, § 112) as amended under 42USC7412. This list provided for regulating at least 189 specific substances using technology-based standards that employ Maximum Achievable Control Technology (MACT) standards; and, possibly health-based standards if required at a later time. § 112 of the Clean Air Act (CAA) requires emission control by the EPA on a source-by-source basis. Therefore, the emission of substances on this list does not necessarily mean that a firm is subject to regulation.
- Regulated Toxic Substances and Threshold Quantities for Accidental Release Prevention. These appear as Accidental Release Prevention/Flammable Substances, Clean Air Act (CAA) §112(r), Table 3, TQ (threshold quantity) in pounds and kilograms under 40 CFR68.130. The accidental release prevention regulations applies to stationary sources that have present more than a threshold quantity of a CAA § 112(r) regulated substance.
- Clean Air Act (CAA) Public Law 101−549, Title VI, *Protection of Stratospheric Ozone*, Subpart A, Appendix A, class I and Appendix B, Class II, Controlled Substances, (CFCs) Ozone depleting substances under 40CFR82.
- Clean Water Act (CWA) Priority toxic water pollutants defined by the US Environmental Protection Agency for 65 pollutants and classes of pollutants which yielded 129 specific substances.[6]
- Chemicals designated by EPA as "Hazardous Substances"[4] under the Clean Water Act (CWA) 40CFR116.4, Table 116.4A.
- Clean Water Act (CWA) § 311 Hazardous Materials Discharge Reportable Quantities (RQs). This regulation establishes reportable quantities for substances designated as hazardous (see §116.4, above) and sets forth requirements for notification in the event of discharges into navigable waters. Source: 40 CFR117.3, amended at 60FR30937.
- Clean Water Act (CWA) § 307 List of Toxic Pollutants. Source: 40CFR401.15.
- Clean Water Act (CWA) § 307 Priority Pollutant List. This list was developed from the List of Toxic Pollutants classes discussed above and includes substances with known toxic effects on human and aquatic life, and those known to be, or suspected of being, carcinogens, mutagens, or teratogens. Source: 40CFR423, Appendix A.
- Clean Water Act, § 313 Water Priority Chemicals. Source: 57FR41331.
- RCRA Maximum Concentration of Contaminants for the Toxicity Characteristic with Regulatory levels in mg/L. Source: 40CFR261.24.
- RCRA Hazardous Constituents. Source: 40CFR261, Appendix VIII. Substances listed have been shown, in scientific studies, to have carcinogenic, mutagenic, teratogenic or toxic effects on humans and other life forms. This list also contains RCRA waste codes. The words, "waste number not listed" appears when a RCRA number is NOT provided in Appendix VIII.

Characteristic Hazardous Wastes

Ignitability	A nonaqueous solution containing less than 24% alcohol by volume and having a closed cup flash point below 60°C/140°F using Pensky−Martens tester or equivalent An ignitable compressed gas A nonliquid capable of burning vigorously when ignited or causes fire by friction, moisture absorption, spontaneous chemical changes at standard pressure and temperature An oxidizer. See §261.21
Corrosivity	Liquids with a pH equal to or less than 2 or equal to or more than 12.5 or which corrode steel at a rate greater than 6.35 mm (0.25 in.) per year @ 55°C/130°F. See §261.22
Reactivity	Unstable substances that undergo violent changes without detonating Reacts violently with water or other substances to create toxic gases Forms potentially explosive mixtures with air. See §261.23
Toxicity	A waste that leaches specified amounts of metals, pesticides, or organic chemicals using Toxicity Characteristic Leaching Procedure (TCLP). See §261, Appendix II, and §268, Appendix I. **Listed Hazardous Wastes**

"F" wastes	Hazardous wastes from nonspecific sources §261.31
"K" Wastes	Hazardous wastes from specific sources §261.32
"U" Wastes	Hazardous wastes from discarded commercial products, off-specification species, container residues §261.34. Covers some 455 compounds and their salts and some isomers of these compounds
"P" Wastes	Acutely hazardous wastes from discarded commercial products, off-specification species, container residues §261.33. Covers some 203 compounds and their salts plus soluble cyanide salts

Note: If a waste is not found on any of these lists, it may be found on state hazardous waste lists.

RCRA Maximum Concentration of Contaminants for the Toxicity Characteristic. Source: 40CFR261.24, Table I. These are listed with regulatory level in mg/L and "D" waste numbers representing the broad waste classes of ignitability, corrosivity, and reactivity.

EPA Hazardous Waste code(s), or RCRA number, appears in its own field. Acute hazardous wastes from commercial chemical products are identified with the prefix "P." Nonacutely hazardous wastes from commercial chemical products are identified with the prefix "U."

RCRA Universal Treatment Standards. Lists hazardous wastes that are banned from land disposal unless treated to meet standards established by the regulations. Treatment standard levels for wastewater (reported in mg/L) and nonwastewater [reported in mg/kg or mg/L TCLP (Toxicity Characteristic Leachability Procedure)] have been provided. Source: 40CFR268.48 and revision, 61FR15654.

RCRA Ground Water Monitoring List. Sets standards for owners and operators of hazardous waste treatment, storage, and disposal facilities, and contains test methods suggested by the EPA (see Report SW-846) followed by the Practical Quantitation Limit (PQL) shown in parentheses. The regulation applies only to the listed chemical; and, although both the test methods and PQL are provided, they are *advisory only*. Source: 40CFR264, Appendix IX.

Safe Drinking Water Act (SDWA) Maximum Contaminant Level Goals (MCLG) for Organic Contaminants. Source: 40CFR141 and 40CFR141.50, amended 57FR31776.

- Maximum Contaminant Levels (MCL) for Organic Contaminants. Source: 40CFR141.61.
- Maximum Contaminant Level Goals (MCLG) for Inorganic Contaminants. Source: 40CFR141.51.
- MCL for Inorganic Contaminants. Source: 40CFR141.62.
- MCL for Inorganic Chemicals. The MCL for arsenic applies only to community water systems. Compliance with the MCL for arsenic is calculated pursuant to §141.23. Source: 40CFR141.11.
- Secondary Maximum Contaminant Levels (SMCL). Federal advisory standards for the states concerning substances that effect physical characteristics (i.e., smell, taste, color, etc.) of public drinking water systems. Source: 40CFR143.3.
- CERCLA Hazardous Substances ("RQ" Chemicals). From Consolidated List of Chemicals Subject to the Emergency Planning and Community Right-to-Know Act (EPCRA) and § 112(r) of the Clean Air Act, as Amended. Source: EPA 550-B-98-017 *Title III List of Lists*.
- Releases of CERCLA hazardous substances in quantities equal to or greater than their reportable quantity (RQ), are subject to reporting to the National response Center under CERCLA. Such releases are also subject to state and local reporting under §304 of SARA Title III (EPCRA). CERCLA hazardous substances, and their reportable quantities, are listed in 40CFR302, Table 302.4. RQs are shown in pounds and kilograms for chemicals that are CERCLA hazardous substances. For metals listed under CERCLA (antimony, arsenic, beryllium, cadmium, chromium, copper, lead, nickel, selenium, silver, thallium, and zinc), no reporting of releases of the solid is required if the diameter of the pieces of solid metal released is 100 μm (0.004 in.) or greater. The RQs shown apply to smaller particles.
- EPCRA §302 Extremely Hazardous Substances (EHS). From Consolidated List of Chemicals Subject to the Emergency Planning and Community Right-to-Know Act (EPCRA) and § 112(r) of the Clean Air Act, as Amended. Source: EPA 550-B-98-017 *Title III List of Lists*. The presence of Extremely Hazardous Substances in quantities in excess of the Threshold Planning Quantity (TPQ), requires certain emergency planning activities to be conducted. The Extremely Hazardous Substances and their TPQs are listed in 40CFR355, Appendices A and B. For chemicals that are solids, there may be two TPQs given (e.g., 500/10,000). In these cases, the lower quantity applies for solids in powder form with particle size less than 100 μm; or, if the substance is in solution or in molten form. Otherwise, the higher quantity (10,000 pounds in the example) TPQ applies.
- EPCRA §304 Reportable Quantities (RQ). In the event of a release or spill exceeding the reportable quantity, facilities are required to notify State Emergency Response Commissions (SERCs) and Local Emergency Planning Committees (LEPCs). From Consolidated List of Chemicals Subject to the

Emergency Planning and Community Right-to-Know Act (EPCRA) and § 112(r) of the Clean Air Act, as Amended. Source: EPA 550-B-98-017 *Title III List of Lists*.

- EPCRA § 313 Toxic Chemicals. From Consolidated List of Chemicals Subject to the Emergency Planning and Community Right-to-Know Act (EPCRA) and § 112(r) of the Clean Air Act, as Amended. Source: EPA 550-B-98-017 *Title III List of Lists*. Chemicals on this list are reportable under §313 and §6607 of the Pollution Prevention Act. Some chemicals are reportable by category under §313. Category codes needed for reporting are provided for the EPCRA§313 categories. Information and Federal Register references have been provided where a chemical is subject to an administrative stay, and not reportable until further notice.
- From "*Toxic Chemical Release Inventory Reporting Form R and Instructions, Revised 2005 Version*," EPA document 260-B-06-001 was used for *de minimis* concentrations, toxic chemical categories.
- Chemicals which EPA has made the subject of Chemical Hazard Information Profiles or "CHIPS" review documents.
- Chemicals which NIOSH has made the subject of "Information Profile" review documents on "Current Intelligence Bulletins."
- Carcinogens identified by the National Toxicology Program of the US Department of Health and Human Services at Research Triangle Park, NC.[10]
- Substances regulated by EPA[7] under the major environmental laws: Clean Air Act, Clean Water Act, Safe Drinking Water Act, RCRA, CERCLA, EPCRA, etc. A more detailed list appears above. Substances with environmental standards set by some international bodies including those in Europe and Canada.[43]
- Hazard Symbols, Risk Phrases, and Safety Phrases. Explanation of these symbols and phrases can be found in Appendix 4. In the year 2018 it is expected that the Globally Harmonized System of Classification and Labeling of Chemicals (GHS) will be phased in by many countries. Hazard statements are an essential element under the GHS, and will eventually replace the risk phrases (R-phrases) described earlier in the paragraph. In addition to hazard statements, containers and Material Safety Data Sheets (MSDS) will often contain, where necessary, one or multiple pictograms, a signal word such as "Warning" or "Danger," and precautionary statements. The precautionary statements will indicate proper handling procedures aimed at protecting the user and other people who might come in contact with the substance during an accident or in the environment. The container and MSDS will also contain the name of the supplier, manufacturer, or importer. Each hazard statement contains a four-digit code, starting with the letter H (in the format Hxxx). Statements appear under various headings grouped together by code number. The purpose of the four-digit code is for reference only; however, following the code is exact *phrase* as it should appear on labels and MSDS. The collection of Risk and Safety phrases in this work my go beyond those found in some, more generalized Material Safety Data Sheets. It is also possible that some of the warnings are based on animal rather than human studies. These statements are usually preceded by the word "suspected" or "potential".
- Water hazard classifications from the German Federal Water Management Act on Water Hazard Classification, *Verwaltungsvorschrift Wassergefährdende Stoffe* (VwVwS). This law requires all chemical substances be evaluated for their detrimental impact on the physical, chemical, or biological characteristics of water. Substances can be classified as nonhazardous to water (*nwg, nicht wassergefährdende*) or assigned to one of three numeric water hazard classes, WGK-1: low hazard to waters (low polluting to water), WGK-2: hazard to waters (water pollutant), or WGK: 3 severe hazard to waters (severe pollutant). The English acronym for WGK is WHC (water hazard class). This work uses the German initial-acronym "WGK" so there is no confusion as to its source. Material Safety Data Sheets (MSDS) that use these water hazards also use the German acronym. If a value was not assigned or not found in the German database, an estimated has been provided using the format, "*WGK (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]*." These estimates are based on other sources, for example, the US DOT *List of Marine Pollutants (§172.101—Appendix B). Warning*: These estimates are to be used only as a guide. In the case of limited information, it is the responsibility of the users of this work to recognize and address those limitations and to engage in additional research, including direct contact with chemical suppliers and all forms of supplier communications such as the legally required Material Safety Data Sheets (MSDSs), Technical Bulletins, etc.

Description: This section contains a quick summary of properties of the substance including physical state (solid, liquid or gas), color, odor description, molecular weight, density, boiling point, freezing/melting point, vapor

pressure, flash point, autoignition temperature, explosion limits in air, Hazard Identification (based on NFPA-704 M Rating System) in the format: Health (ranked 1 to 4), Flammability (ranked 1 to 4), Reactivity (ranked 1 to 4) (see also below for a detailed explanation of the System and Fire Diamond), and solubility or miscibility in water. This section may also contain special and relevant comments about the substance. Terms in this section are also defined in the glossary.

Odor threshold: This is the lowest concentration in air that most humans can detect by smell. Some value ranges are reported. The value cannot be relied on to prevent overexposure, because human sensitivity to odors varies over wide limits, some chemicals cannot be smelled at toxic concentrations, odors can be masked by other odors, and some compounds rapidly deaden the sense of smell.

Molecular weight: The MW as calculated from the molecular formula using standard elemental molecular weights (e.g. carbon = 12.1).

Boiling point at 1 atm: The value is the temperature of a liquid when its vapor pressure is 1 atm. For example, when water is heated to 100°C/212°F its vapor pressure rises to 1 atm and the liquid boils. The boiling point at 1 atm indicates whether a liquid will boil and become a gas at any particular temperature and sea-level atmospheric pressure.

Melting/Freezing point: The melting/freezing point is the temperature at which a solid changes to liquid or a liquid changes to a solid. For example, liquid water changes to solid ice at 0°C/32°F. Some liquids solidify very slowly even when cooled below their melting/freezing point. When liquids are not pure (e.g., salt water) their melting/freezing points are lowered slightly.

Flash point: This is defined as the lowest temperature at which vapors above a volatile combustible substance will ignite in air when exposed to a flame. Depending on the test method used, the values given may be either Tag Closed Cup (cc) (ASTM D56) or Cleveland Open Cup (oc) (ASTM D93). The values, along with those in *Flammable Limits in Air* and *Autoignition temperature* below, give an indication of the relative flammability of the chemical. In general, the open cup value is slightly higher (perhaps 10 to 15°F higher) than the closed cup value. The flash points of flammable gases are often far below 0° (F or C) and these values are of little practical value, so the term "flammable gas" is often used instead of the flash point value.

Autoignition Temperature: This is the minimum temperature at which the material will ignite without a spark or flame being present. Values given are only approximate and may change substantially with changes in geometry, gas, or vapor concentrations, presence of catalysts, or other factors.

Flammable Limits in Air: The percent concentration in air (by volume) is given for the LEL (lower explosive-flammable limit in air, % by volume) and UEL (upper explosive flammable limit in air, % by volume), at room temperature, unless other specified. The values, along with those in "Flash point" and "Autoignition temperature" give an indication of the relative flammability of the chemical.

NFPA Hazard Classifications: The NFPA 704 Hazard Ratings (Classifications) are based on those found in "*Fire Protection Guide to Hazardous Materials*," 2001 edition, National Fire Protection Association, Quincy, MA, ©1994. The classifications are defined in Table 1.

Table 1. *Explanation of NFPA Hazard Classifications*

Classification	*Definition*
HEALTH HAZARD (blue)	
4	Materials which on very short exposure could cause death or major residual injury (even though prompt medical treatment was given), including those that are too dangerous to be approached without specialized protective equipment
3	Materials which on short exposure could cause serious temporary or residual injury (even though prompt medical treatment was given), including those requiring protection from all bodily contact
2	Materials that, on intense or continued (but not chronic) exposure, could cause temporary incapacitation or possible residual injury, including those requiring the use of protective clothing that has an independent air supply
1	Materials which on exposure would cause irritation but only minor residual injury, including those requiring the use of an approved air-purifying respirator
0	Materials that, on exposure under fire conditions offer no hazard beyond that of ordinary combustible material
FLAMMABILITY (red)	
Classification number and Definition	
4	This degree includes flammable gases, pyrophoric liquids, and Class IA flammable liquids. Materials which will rapidly or completely vaporize at atmospheric pressure and normal ambient temperature, or which are readily dispersed in air and which will burn readily
3	Includes Class IB and IC flammable liquids and materials that can be easily ignited under almost all normal temperature conditions
2	Materials that must be moderately heated before ignition will occur and includes Class II and Class IIIA combustible liquids and solids and semisolids that readily give off ignitable vapors
1	Materials that must be preheated before ignition will occur, such as Class IIIB combustible liquids, and solids and semisolids whose flash point exceeds 200°F/93.4°C, as well as most ordinary combustible materials
0	Materials that will not burn

REACTIVITY (yellow)

4 Materials that, in themselves, are readily capable of detonation, explosive decomposition or explosive reaction at normal temperatures and pressures

3 Materials that, in themselves, are capable of detonation, or explosive reaction, but require a strong initiating source or heating under confinement. This includes materials that are sensitive to thermal and mechanical shock at elevated temperatures and pressures and materials that react explosively with water

2 Materials that are normally unstable and readily undergo violent chemical change, but are not capable of detonation. This includes materials that can undergo chemical change with rapid release of energy at normal temperatures and pressures. This also includes materials that may react violently with water or that may form potentially explosive mixtures in water

1 Materials that are normally stable, but that may become unstable at elevated temperatures and pressures and materials that will react with water with some release of energy, but not violently

0 Materials that are normally stable, even under fire exposure conditions, and that do not react with water

OTHER (white)

₩ Materials which react so violently with water that a possible hazard results when they come in contact with water, as in a fire situation. Similar to Reactivity Classification 2. Oxy—Oxidizing material; any solid or liquid that readily yields oxygen or other oxidizing gas, or that readily reacts to oxidize combustible materials

It should be noted that OSHA and DOT have differing definitions for the term "flammable liquid" and "combustible liquid." DOT defines a flammable liquid as one which, under specified procedures, has a flash point of 140°F/60°C or less. A combustible liquid is defined as "having a flash point above 140°F/60°C and below 200°F/93°C." OSHA defines a combustible liquid as having a flash point above 100°F/37.7°C.

Detection: Only those materials having specific or specialized testing materials have this section. For example, the chemical Abrin or Ricin can be detected using BTA (BioThreat Alert) test strips.

History of the material: This section is reserved for those materials having a useful and interesting background. Some of these materials may be, for example, invasive botanicals that may be found in populated areas Dangerous to both people and pets, these invasive plants may have to be professionally removed to prevent both spreading and accidental poisonings.

Potential Exposure: A brief indication is given of the nature of exposure to each compound in the industrial environment. Where pertinent, some indications are given of background concentration and occurrence from other than industrial discharges such as water purification plants. Obviously in a work of this magnitude, this coverage must be very brief. It is of course recognized that nonoccupational exposures may be important as well.

Incompatibilities: Important, potentially hazardous incompatibilities of each substance are listed where available. Where a hazard with water exists, it is described. Reactivity with other materials are described including structural materials such as metal, wood, plastics, cement, and glass. The nature of the hazard, such as severe corrosion formation of a flammable gas, is described. This list is by no means complete or all inclusive. In some cases a very small quantity of material can act as a catalyst and produce violent reactions such as polymerization, disassociation and condensation. Some chemicals can undergo rapid polymerization to form sticky, resinous materials, with the liberation of much heat. The containers may explode. For these chemicals the conditions under which the reaction can occur are given.

Permissible Exposure Limits in Air: The permissible exposure limit (PEL), has been cited as the federal standard where one exists. Inasmuch as OSHA has made the decision to enforce only pre-1989 PELs, we decided to use these values rather than the transitional limits that were vacated by court order. Except where otherwise noted, the PELs are 8-hour work-shift time-weighted average (TWA) levels. Ceiling limits, Short-Term Exposure Limits (STEL), and TWAs that are averaged over other than full workshifts are noted.

The Short-Term Exposure Limit (STEL) values are derived from NIOSH,[58] ACGIH,[1] and HSE[33] publications. This value is the maximal concentration to which workers can be exposed for a period up to 15 minutes continuously without suffering from: irritation; chronic or irreversible tissue change; or narcosis of sufficient degree to increase accident proneness, impair self-rescue, or materially reduce work efficiency, provided that no more than four excursions per day are permitted, with at least 60 minutes between exposure periods, and provided that the daily TWA also is not exceeded. The "Immediately Dangerous to Life or Health" (IDLH) concentration represents a maximum level from which one could escape within 30 minutes without any impairing symptoms or any irreversible health effects. However, the 30-minute period is meant to represent a MARGIN OF SAFETY and is NOT meant to imply that any person should stay in the work environments any longer than necessary. In fact, every effort should be made to exit immediately. The concentrations are reported in either parts per million (ppm) or milligrams per cubic meter (mg/m^3).

Most US specifications on permissible exposure limits in air have come from ACGIH[1] or NIOSH.[2] In the In

Germany the DFG has established Maximum Concentrations in the workplace.[3] This section also contains numerical values for allowable limits of various materials in ambient air[60] as assembled by the US EPA. Where available, this field contains legally enforceable airborne Permissible Exposure Limits (PELs) from OSHA. It also contains recommended airborne exposure limits from NIOSH, ACGIH, and international sources and special warnings when a chemical substance is a Special Health Hazard Substance. Each are described below. TLVs have not been developed as legal standards and the ACGIH does not advocate their use as such. The TLV is defined as the time-weighted average (TWA) concentration for a normal 8-hour work-day and a 40-hour work-week, to which nearly all workers may be repeatedly exposed, day after day, without adverse effects. A ceiling value (TLV-C) is the concentration that should not be exceeded during any part of the working exposure. If instantaneous monitoring is not feasible, then the TLV-C can be assessed by sampling over a 15-minute period except for those substances that may cause immediate irritation when exposures are short. As some people become ill after exposure to concentrations lower than the exposure limits, this value cannot be used to define exactly what is a "safe" or "dangerous" concentration. ACGIH threshold limit values (TLVs) are reprinted with permission of the American Conference of Governmental Industrial Hygienists, Inc., from the booklet entitled, *Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices*. This booklet is revised on an annual basis. No entry appears when the chemical is a mixture; it is possible to calculate the TLV for a mixture only when the TLV for each component of the mixture is known and the composition of the mixture by weight is also known. According to ACGIH, "Documentation of the Threshold Limit Values and Biological Exposure Indices, 7th Edition" is necessary to fully interpret and implement the TLVs.

OSHA Permissible Exposure Limits (PELs), are found in Tables Z-1, Z-2, and Z-3 of OSHA, "General Industry Air Contaminants Standard (29CFR1910.1000)" that were effective on July 1, 2001 and which are currently enforced by OSHA.

Unless otherwise noted, PELs are the Time-Weighted Average (TWA) concentrations that must not be exceeded during any 8-hour shift of a 40-hour work-week. An OSHA ceiling concentration must not be exceeded during any part of the work-day; if instantaneous monitoring is not feasible, the ceiling must be assessed as a 15-minute TWA exposure. In addition there are a number of substances from Table Z-2 that have PEL ceiling values that must not be exceeded except for a maximum peak over a specified period (e.g., a 5- minute maximum peak in any 2 hours).

NIOSH Recommended Exposure Limits (RELs) are Time-Weighted Average (TWA) concentrations for up to a 10-hour work day during a 40-hour work week. A ceiling REL should not be exceeded at any time. Exposure limits are usually expressed in units of parts per million (ppm), i.e., the parts of vapor (gas) per million parts of contaminated air by volume at 25°C/77°F and one atmosphere pressure. For a chemical that forms a fine mist or dust, the concentration is given in milligrams per cubic meter (mg/m^3).

Protective Action Criteria (PAC) is emergency exposure limits developed by the US Department of Energy (DOE) for more than 3400 chemicals in revision 29, published May 2016. These exposure limits can be used to estimate the consequences of the uncontrolled release of hazardous materials and to plan for emergency response. These PACs have been added to the 7th edition of Sittig because other well established exposure limits in air are available for an only a limited number of chemicals from other governmental and advisory sources. PAC values are given in parts per million (ppm) for volatile liquids and gases; in milligrams per cubic meter (mg/m^3) for solids, particulates, solids, and nonvolatile liquids. Chemicals for which Acute Emergency Guideline Levels (AEGLs) and Emergency Response Planning Guidelines (ERPGs) have their values displayed in *bolded* font.

PAC Definitions[SCAPA]:

There are subtle difference in the definitions of AEGLs, ERPGs, and TEELs and major differences in how they are developed and issued. Differences in their definitions include:

AEGLs pertain to the "general population, including susceptible individuals," but ERPGs and TEELs pertain to "nearly all individuals."

AEGLs are defined as the level "above which" certain health effects are expected, while ERPGs and TEELs are defined as the level "below which" certain health effects are *not* expected.

Acute Emergency Guideline Levels (AEGLs) are defined as follows:

- *AEGL-1*: the airborne concentration (expressed as ppm or mg/m^3) of a substance above which it is predicted that the general population, including susceptible individuals, could experience notable discomfort, irritation, or certain asymptomatic, nonsensory effects. However, these effects are not disabling and are transient and reversible upon cessation of exposure.
- *AEGL-2*: the airborne concentration (expressed as ppm or mg/m^3) of a substance above which it is predicted that the general population, including susceptible individuals, could experience irreversible or other serious, long-lasting, adverse health effects or an impaired ability to escape.
- *AEGL-3*: the airborne concentration (expressed as ppm or mg/m^3) of a substance above which it is predicted that the general population, including susceptible individuals, could experience life-threatening adverse health effects or death.

Emergency Response Planning Guidelines (ERPGs) are defined as follows:

- *ERPG-1*: the maximum concentration in air below which it is believed nearly all individuals could be exposed for up to one hour without experiencing other than mild transient adverse health effects or perceiving a clearly defined objectionable odor.
- *ERPG-2*: the maximum concentration in air below which it is believed nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action.
- *ERPG-3*: the maximum concentration in air below which it is believed nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects.

Additional information on PAC values and links to other sources of information can be found on the webpage for the *Subcommittee for Consequence Assessment and Protective Action (SCAPA)*: http://orise.orau.gov/emi/scapa/teels.htm

The German MAK (DFG MAK) values are conceived and applied as 8-hour time-weighted average (TWA) values.[3]

Short-Term Exposure Limits (15-minute TWA): This field contains Short-Term Exposure Limits (STELs) from ACGIH, NIOSH and OSHA. The parts of vapor (gas per million parts of contaminated air) by volume at 25°C/77°F and one atmosphere pressure is given. The limits are given in milligrams per cubic meter (mg/m^3) for chemicals that can form a fine mist or dust. Unless otherwise specified, the STEL is a 15-minute TWA exposure that should not be exceeded at any time during the work-day.

Determination in Air: The citations to analytical methods are drawn from various sources, such as the *NIOSH Manual of Analytical Methods*.[18] In addition, methods have been cited in the latest US Department of Health and Human Services publications including the *"NIOSH Pocket Guide to Chemical Hazards"* August, 2006.

Permissible Concentrations in Water: The permissible concentrations in water are drawn from various sources also, including: The National Academy of Sciences/ National Research Council, Safe Drinking Water Committee Board on Toxicology and Environmental Health Hazards, *Drinking Water and Health*, 1980.[16]

The priority toxic pollutant criteria published by US EPA 1980.[6]

The multimedia environmental goals for environmental assessment study conducted by EPA.[32] Values are cited from this source when not available from other sources.

The US EPA has come forth with a variety of allowable concentration levels:

For allowable concentrations in "California List" wastes.[38] The California List consists of liquid hazardous wastes containing certain metals, free cyanides, polychlorinated biphenyls (PCBs), corrosives with a pH of less than or equal to 2.0, and liquid and nonliquid hazardous wastes containing halogenated organic compounds (HOCs).

For regulatory levels in leachates from landfills.[37]

For concentrations of various materials in effluents from the organic chemicals and plastics and synthetic fiber industries.[51]

For contaminants in drinking water.[36]

For National Primary and Secondary Drinking Water Regulations.[62]

In the form of health advisories for 16 pesticides,[47] 25 organics,[48] and 7 inorganics.[49]

For primary drinking water standards starting with a priority list of 8 Volatile Organic Chemicals.[40]

State drinking water standards and guidelines [61] as assembled by the US EPA.

Determination in Water: The sources of information in this field have been primarily US EPA publications including the test procedures for priority pollutant analysis[25] and later modifications.[42]

Routes of Entry: The toxicologically important routes of entry of each substance are listed. In other words, the way in which the people or experimental animals were exposed to the chemical is listed, e.g. eye contact, skin contact, inhalation, intraperitoneal, intravenous. Many of these are taken from the *NIOSH Pocket Guide*,[2] but are drawn from other sources as well.

Harmful Effects and Symptoms: These are primarily drawn from NIOSH, EPA publications, and New Jersey and New York State fact sheets on individual chemicals, and are supplemented from information from the draft criteria documents for priority toxic pollutants[26] and from other sources. The other sources include the following:

EPA Chemical Hazard Information Profiles (CHIPS) cited under individual entries.

NIOSH Information Profiles cited under individual entries.

EPA Health and Environmental Effect Profiles cited under individual entries.

Particular attention has been paid to cancer as a "harmful effect" and special effort has been expended to include the latest data on carcinogenicity. See also "Regulatory Authority and Advisory Bodies" section.

Short-Term Exposure: These are brief descriptions of the effects observed in humans when the vapor (gas) is inhaled, when the liquid or solid is ingested (swallowed), and when the liquid or solid comes in contact with the eyes or skin. The term LD50 signifies that about 50% of the animals given the specified dose by mouth will die. Thus, for a Grade 4 chemical (below 50 mg/kg) the toxic dose for 50% of animals weighing 70 kg (150 lb) is $70 \times 50 = 3500$ mg = 3.5 g, or less than 1 teaspoonful; it might be as little as a few drops. For a Grade 1 chemical (5−15 g/kg), the LD50 would be between a pint and a quart for a 150-lb man. All LD50 values have been obtained using small laboratory animals such as rodents,

cats, and dogs. The substantial risks taken in using these values for estimating human toxicity are the same as those taken when new drugs are administered to humans for the first time.

Long-Term Exposure: Where there is evidence that the chemical can cause cancer, mutagenic effects, teratogenic effects, or a delayed injury to vital organs such as the liver or kidney, a description of the effect is given.

Points of Attack: This category is based, in part, on the "Target Organs" in the *NIOSH Pocket Guide*[2] but the title has been changed as many of the points of attack are not organs (blood, for example). This is human data unless otherwise noted.

Medical Surveillance: For each chemical, this information is drawn from many and various government publications and sources including, for example, CDC, NIOSH publications,[27] *New Jersey* or *New york State Fact Sheets*,[70] HSDB/Toxnet, etc. In many cases, statements may refer to known and suspected carcinogen, known or suspected mutagens, reproductive affecters, skin and/or respiratory sensitizers, etc.

First Aid: Guides and guidance to first aid found in this work should not be construed as authorization to emergency personnel to perform the procedures or activities indicated or implied. Care of persons exposed to toxic chemicals must be directed by a physician or other recognized professional or authority. Simple first aid procedures are listed for response to eye contact, skin contact, inhalation, and ingestion of the toxic substance as drawn to a large extent from the *NIOSH Pocket Guide*[2] but supplemented by information from recent commercially available volumes in the United States,[29] in the United Kingdom, and in Japan[24] as well as from state fact sheets. They deal with exposure to the vapor (gas), liquid, or solid and include inhalation, ingestion (swallowing) and contact with eyes or skin. The instruction "Do NOT induce vomiting" is given if an unusual hazard is associated with the chemical being sucked into the lungs (aspiration) while the patient is vomiting. "*Seek medical attention*" or "*Call a doctor*" is recommended in those cases where only competent medical personnel can treat the injury properly. In all cases of human exposure, seek medical assistance as soon as possible. In many cases, medical advice has been included for guidance only. Dosage information has been avoided because dosage recommendations constantly change. Emergency personnel are urged to check all manufacturers' information particularly before administering any drug with which they are not familiar or have not used for some period of time. Also, medications suggested to be administered by qualified medical personnel presume no immediate prior administration of the same, similar or complicating medications.

Personal Protective Methods: This information is drawn heavily from NIOSH publications[2][77] and supplemented by information from the United States,[29] the United Kingdom, and Japan.[24] There are indeed other "personal protective methods" which space limitations prohibit describing here in full. One of these involves limiting the quantities of carcinogens to which a worker is exposed in the laboratory. The items listed are those recommended by (1) NIOSH and/or OSHA, (2) manufacturers, either in technical bulletins or in material safety data sheets (MSDS), (3) the Chemical Manufacturers Association (CMA), or (4) the National Safety Council (NSC), for use by personnel while responding to fire or accidental discharge of the chemical. They are intended to protect the lungs, eyes, and skin.

Respirator Selection: The 7th edition, like its predecessors, presents respirator selection with a full text description. For each line a maximum use concentration (in ppm, mg/m^3, μg/m^3, fibers/m^3, or mppcf) condition (e.g., escape) followed by the NIOSH code and full text related to respirator recommendations. All recommended respirators of a given class, can be utilized at any concentration equal to or less than the class's listed maximum use concentration. Respirator selection should follow recommendations that provide the greatest degree of protection. Respirator codes found in the *NIOSH Pocket Guide* have been included to ease updating.

All respirators selected must be approved by NIOSH under the provisions of 42CFR84. The current listing of NIOSH/MSHA certified respirators can be found in the *NIOSH Certified Equipment List*, which is available on www.cdc.gov/niosh/npptl/topics/respirators/cel. This is the NIOSH Web site.

For firefighting, only self-contained breathing apparatuses with full facepieces operated in pressure-demand or other positive pressure modes are recommended for all chemicals in the *NIOSH Pocket Guide*. In the case of chemical warfare agents, use only SCBA Respirator certified by NIOSH For CBRN environments. CBRN stands for "Chemical, Biological, Radiological, and Nuclear."

Pesticides are not identified as such in the respirator selection tables. For those substances that are pesticides, the recommended air-purifying respirator must be specifically approved by NIOSH/MSHA. Specific information on choosing the appropriate respirator will be provided on pesticide labels. Approved respirators will carry a "TC" number prefix, which signifies they have been tested and certified for a specific level of protection. New respirators may carry a "TC-84A" prefix in compliance with 42 CFR 84 for testing and certifying nonpowered, air-purifying, particulate-filter respirators. The new Part 84 respirators have passed a more demanding certification test than the old respirators (e.g., dust and mist [DM], dust, fume and mist [DFM], spray paint, pesticide, etc.) certified under 30 CFR 11.

Additionally, a complete respirator protection program should be implemented including all requirements in 29CFR1910.134 and 42CFR84. At a minimum, a respirator protection program should include regular training, fit-testing, periodic environmental monitoring, maintenance inspection, and cleaning. The selection of the actual respirator to be used within the classes

of recommended respirators depends on the particular use situation, and should only be made by a knowledgeable person. Remember, air-purifying respirators will not protect from oxygen-deficient atmospheres. For firefighting, only self-contained breathing apparatuses with full facepieces operated in pressure-demand or other positive pressure modes are recommended for all chemicals in the *NIOSH Pocket Guide*.

Storage: The 7th edition now provides, as general guidance, a color-coded classification system similar to those often found in commerce and laboratories. It is the objective of any chemical storage classification system to prevent accidental combination of two or more incompatible materials that might be stored in the same space. To prevent an unwanted and possibly dangerous reaction, chemicals must be separated by space and/or physical barriers. Chemical storage areas should be appropriately labeled. Users must be careful to check the MSDS for both additional and specific information. Some chemical entries contain multiple storage codes because the chemical profile fits more than a single category.

Code	***Hazard***
Red	Flammables (Flash point $<100°F$)
Blue	Health hazards/toxics/poisons
Yellow	Reactives/oxidizers
White	Contact hazards
Green[a]	General storage

[a] *For general storage, the colors gray and orange may also be used by some companies.*

- Chemical containers that are not color coded should contain hazard information on the label.
- Check the MSDS to learn what personal protective equipment is required when using the substance
- *Red*: Flammability hazard: Store in a flammable (liquid or materials) storage area or approved cabinet away from ignition sources and corrosive and reactive materials.
- *Blue*: Health hazard/toxics/poisons: Store in a secure poison location.
- *Yellow*: Reactive hazard; store in a location separate from other materials, especially flammables and combustibles.
- *White*: Corrosive or contact hazard; store separately in a corrosion-resistant location.
- *Green (or gray or orange)*: General storage may be used. Generally, for flammability, health, and corrosivity with an NFPA rating of no higher than "2."
- Chemicals with labels that are colored and diagonally striped may react with other chemicals in the same hazard class. See MSDS for more information.
- *Red Stripe*: Flammability hazard: store separately from all other flammable materials. Example: sodium metal.
- *Yellow Stripe*: Reactivity hazard; store separately in an area isolated from flammables, combustibles, or other yellow coded materials. *Example*: reducing agents.
- *White stripe*: Contact hazard; not compatible with materials in solid white category. Store separately. *Example*: Bases.

Other data in this field is drawn from, or based on, various resources, including the NFPA,[17] from Japanese sources[24] and from publications such as the *Hazardous Substance Fact Sheets* published by the New Jersey Department of Health and Senior Services.[70]

Shipping: The shipping guidance offered herein does not replace the training requirements of the DOT and in no way guarantees that you will be in full compliance with the DOT Regulations. *Labeling*: This section refers to the type label or placard required by regulation on any container or packaging of the subject compound being shipped. In some cases a material may require more than one hazardous materials label. *Quantity limitation*: This section lists quantities of material that may be shipped on passenger aircraft, rail, and cargo aircraft. Materials in certain hazard classes may be shipped under the small quantities exception (see 49 CFR 173.4) with specific approval from the Associate Administrator for Hazardous Materials Safety, DOT. *Hazard class or division*: This number refers to the division number or hazard class that must appear on shipping papers. This information is drawn from DOT publications[19] as well as UN publications[20] and also NFPA publications.[17] The US DOT[19] has published listings of chemical substances which give a hazard classification and required labels. The US DOT listing now corresponds with the UN listing[20] and specifies first a hazard class of chemicals as defined in the following table, and then a packing group (I, II, or III) within each of the classes. These groups are variously defined depending on the hazard class but in general define materials presenting: I—a very severe risk (great danger); II—a serious risk (medium danger); and III—a relatively low risk (minor danger).

Hazard Classification System

The hazard class of dangerous goods is indicated either by its class (or division) number or name. For a placard corresponding to the primary hazard class of a material, the hazard class or division number must be displayed in the lower corner of the placard. However, no hazard class or division number may be displayed on a placard representing the subsidiary hazard of a material. For other than Class 7 or the OXYGEN placard, text indicating a hazard (for example, "CORROSIVE") is not required. Text is shown only in the United States. The hazard class or division number must appear on the shipping document after each shipping name.

Class 1—Explosives
Division 1.1: Explosives with a mass explosion hazard
Division 1.2: Explosives with a projection hazard
Division 1.3: Explosives with predominantly a fire hazard
Division 1.4: Explosives with no significant blast hazard
Division 1.5: Very insensitive explosives with a mass explosion hazard
Division 1.6: Extremely insensitive articles
Class 2—Gases
Division 2.1: Flammable gases
Division 2.2: Nonflammable, nontoxic* gases
Division 2.3: Toxic* gases
Class 3—Flammable liquids [and combustible liquids (United States)]
Class 4—Flammable solids; spontaneously combustible materials; and dangerous when wet materials/Water-reactive substances
Division 4.1: Flammable solids
Division 4.2: Spontaneously combustible materials
Division 4.3: Water-reactive substances/dangerous when wet materials
Class 5—Oxidizing substances and organic peroxides
Division 5.1: Oxidizing substances
Division 5.2: Organic peroxides
Class 6—Toxic* substances and infectious substances
Division 6.1: Toxic* substances
Division 6.2: Infectious substances
Class 7—Radioactive materials
Class 8—Corrosive substances
Class 9—Miscellaneous hazardous materials/Products, Substances or Organisms

**Note*: The words "poison" or "poisonous" are synonymous with the word "toxic."

Spill Handling: Spill or leak information provided is intended to be used only as a guide. The term *Issue warning* is used when the chemical is a poison, has a high flammability, is a water contaminant, is an air contaminant (so as to be hazardous to life), is an oxidizing material, or is corrosive. *Restrict access* is used for those chemicals that are unusually and immediately hazardous to personnel unless they are protected properly by appropriate protective clothing, eye protection, and respiratory protection equipment, etc. *Evacuate area* is used primarily for unusually poisonous chemicals or these that ignite easily. *Mechanical containment* is used for water-insoluble chemicals that float and do not evaporate readily. *Should be removed* is used for chemicals that cannot be allowed to disperse because of potentially harmful effects on humans or on the ecological system in general. The term is not used unless there is a reasonable chance of preventing dispersal, after a discharge or leak, by chemical and physical treatment. *Chemical and physical treatment* is recommended for chemicals that can be removed by skimming, pumping, dredging, burning, neutralization, absorption, coagulation, or precipitation. The corrective response may also include the use of dispersing agents, sinking agents, and biological treatment. *Disperse and flush* is used for chemicals that can be made nonhazardous to humans by simple dilution with water. In a few cases the response is indicated even when the compound reacts with water because, when proper care is taken, dilution is still the most effective way of removing the primary hazard. This material safety data sheet information is drawn from a variety of sources including New Jersey Department of Health and Senior Services *Hazardous Substance Fact Sheets*[70] and EPA *Profiles on Extremely Hazardous Substances.*[82]

Fire Extinguishing: Fire information provided is intended to be used only as a guide. Certain extinguishing agents should not to be used because the listed agents react with the chemical and have the potential to create an additional hazard. In some cases they are listed because they are ineffective in putting out the fire. Many chemicals decompose or burn to give off toxic and irritating gases. Such gases may also be given off by chemicals that vaporize in the heat of a fire without either decomposing or burning. If no entry appears, the combustion products are thought to be similar to those formed by the burning of oil, gasoline, or alcohol; they include carbon monoxide (poisonous), carbon dioxide, and water vapor. The specific combustion products are usually not well known over the wide variety of conditions existing in fires; some may be hazardous. This information is drawn from NFPA publications,[17] FEMA,[78] and other sources. Any characteristic behavior that might increase significantly the hazard involved in a fire is described. The formation of flammable vapor clouds or dense smoke, the possibility of polymerization, and explosions is stated in this section and/or the incompatibility section. Unusual difficulty in extinguishing the fire is noted.

Disposal Method Suggested: The disposal methods for various chemical substances have been drawn from various sources, including government documents and a UN publication.[22,79]

References: The general bibliography for this volume follows immediately. It includes both general reference sources and references dealing with analytical methods. The references at the end of individual chemical records are generally restricted to: references dealing only with that particular compound; and references which, in turn, contain bibliographies giving references to the original literature on toxicological and other behavior of the substance in question.

Key to Abbreviations and Acronyms

α	the Greek letter *alpha*; used as a prefix to denote the carbon atom in a straight chain compound to which the principal group is attached.
as-	prefix for asymmetric
ACGIH	American Conference of Governmental Industrial Hygienists
AEGL	Acute Emergency Guideline Level, developed by the EPA
AIHA	American Industrial Hygeine Association
approx	approximately
asym-	prefix for asymmetric
@	at
atm.	atmosphere
ATSDR	Agency for Toxic Substances and Disease Registry
β	the Greek letter *beta*
BEI	Biological Exposure Indices (ACGIH in the USA; South Africa; New Zealand)
BLV	Biological Limit Values
BP	boiling point.
°C	degrees Centigrade
CAA	Clean Air Act
CAAA	Clean Air Act Amendments of 1990
CAMEO	Computer-Aided Management of Emergency Operations (NOAA)
carc.	carcinogen
CAS	Chemical Abstract Service
cc	cubic centimeter
cc	closed cup (Flash point)
CDC	U.S. Center for Disease Control
CEPA	Canadian Environmental Protection Act
CERCLA	Comprehensive Environmental Response, Compensation, And Liability Act
CFCs	chlorofluorocarbons
CFR	*Code of Federal Regulations*
cis-	(Latin: on this side). Indicating one of two geometrical isomers in which certain atoms or groups are on the same side of a plane
CMA	Chemical Manufacturers Association
CPR	Cardiopulmonary Resuscitation
CWA	Clean Water Act
cyclo-	(Greek, circle). Cyclic, ring structure; as cyclohexane
Δ or δ	Greek letter *delta*
DFG	Deutsche Forschungs-gemeinschaft
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
DOT ID	Department of Transportation Identification Numbers
EEC or EC	European Economic Community
EEGL	Emergency Exposure Guidance Level
EHS	Extremely Hazardous Substances
EINECS	European Inventory of Existing Commercial Chemical Substances
ε	Greek letter epsilon
EPA (US)	Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
ESLI	End of Service Life Indicator
est.	estimate
EU	European Union
°F	degrees Fahrenheit
FDA	Food and Drug Administration
FEMA	Federal Emergency Management Agency
FR	*Federal Register* (United States)
γ	Greek letter *gamma*
GHS	Globally Harmonized System of Classification and Labeling of Chemicals
h	hour(s)
HCFC	hydrochlorofluorocarbons
HCS	Hazard Communication Standard
HSDB	Hazardous Substances Data Bank
IARC	International Agency for Research on Cancer
IATA	International Air Transport Association
IDLH	Immediately Dangerous to Life or Health
ILO	International Labor Office
IRIS	Integrated Risk Information System (EPA)
iso-	(Greek, equal, alike). Usually denoting an isomer of a compound.
kg	kilogram(s)
l	liter(s)
lb	pound(s)
$\mathbf{LC_{50}}$	The concentration of a substance in air that kills 50% of the test population.
$\mathbf{LC_{Lo}}$	The lowest concentration of a substance in air that has been shown to cause death in a test population.
$\mathbf{LD_{50}}$	The dose of a substance administered by any route (other than inhalation) that causes death to 50% of the test population.
$\mathbf{LD_{LO}}$	The lowest dose of a substance administered by any route (other than inhalation)that has been shown to cause death in a test population.

LEL	Lower explosive (flammable) limit in air, % by volume at room temperature or other temperature as noted
LEPC	Local Emergency Planning Committees
LTEL	Long Term Exposure Limit (UK)
m-	an abbreviation for "*meta-*," a prefix used to distinguish between isomers or nearly related compounds
m^3	cubic meter
MACT	Maximum Achievable Control Technology (CAA)
MAK	airborne exposure limit "Maximale Arbeitsplatz-Konzentration" (maximum workplace concentration) from the Deutsche Forschungsgemeinschaft (DFG), German Research Foundation.
MCL	Maximum Contaminant Level (SDWA)
MCLG	Maximum Contaminant Level Goal (SDWA)
mg	milligram(s)
μ	micro
μg	microgram(s)
min	minute(s)
mmHg	millimeters of mercury (non-SI symbol for pressure) Also known as "torr."
mppcf	million particles per cubic foot
MSDS	Material Safety Data Sheets
n-	abbreviation for "normal," referring to the arrangement of carbon atoms in a chemical molecule prefix for normal
N-	Symbol used in some chemical names, indicating that the next section of the name refers to a chemical group attached to a nitrogen atom. The bond to the nitrogen atom
NCI	National Cancer Institute (USA)
NFPA	National Fire Protection Association (USA)
NIOSH	National Institute for Occupational Safety and Health (USA)
NLM	National Library of Medicine (USA)
NOAA	National Oceanic and Atmospheric Administration (USA)
NOAEL	No Observed Adverse Effect Level
NOS	not otherwise specified
NPRI	National Pollutant Release Inventory (Canada)
NTIS	National Technical Information Service (USA)
NTP	National Toxicology Program (USA)
o-	*ortho-*, a prefix used to distinguish between isomers or nearly related compounds.
OEL	Occupational Exposure Limit

ω	Greek letter *omega*
oc	open cup
OSHA	Occupational Safety and Health Administration (USA)
Oxy	Oxidizer or oxidizing agent
p-	an abbreviation for "*para-*," a prefix used to distinguish between isomers or nearly related compounds
PAC	Protective Action Criterion (U.S. DOE)
PBB	polybrominated biphenyl
PCB	polychlorinated biphenyl
PE	polyethylene
PEL	Permissible Exposure Limit (USA, Japan, Mexico)
PNOS	Particulates Not Otherwise Specified
POTW	Publicly Owned Treatments Works
PP	polypropylene
ppb	parts per billion
PPE	Personal Protective Equipment
ppm	parts per million
PQL	Practical Quantitation Limit (RCRA)
prim-	prefix for primary
REL	Recommended Exposure Limits (NIOSH)
RQ	Reportable Quantity
RTECS	Registry of Toxic Effects of Chemical Substances
RTK	Right-to-Know
SARA	Superfund Amendments and Reauthorization Act
s. carc	Suspected Carcinogen
SCAPA	Subcommittee on Consequence Assessment and Protective Actions (DOE)
SCBA	Self-Contained Breathing Apparatus
SDWA	Safe Drinking Water Act
sec-	prefix for secondary
SERC	State emergency response commissions
SMCL	Secondary Maximum Contaminant Levels (SDWA)
STEL	Short-Term Exposure Limit
sym-	abbreviation for "symmetrical," referring to a particular arrangement of elements within a chemical molecule
t-	prefix for tertiary
TC_{Lo}	The lowest concentration of a substance in air that has been shown to produce toxic effects in a test population.
TD_{Lo}	The lowest dose of a substance that has been shown to produce toxic effects in a test population
TEEL	Temporary Emergency Exposure Limit
TRK	Technical Guiding Concentrations (DFG) for workplace control of carcinogens

tert-	abbreviation for "tertiary," referring to a particular arrangement of elements within a chemical molecule
TLV	Threshold Limit Value (ACGIH)
TQ	Threshold Quantity
trans-	(Latin: across). Indicating that one of two geometrical isomers in which certain atoms or groups are on opposite sides of a plane
TRI	Toxic Release Inventory
TSCA	Toxic Substances Control Act
TWA	Time-Weighted Average. Often shown as TWA - 8h (8 hours)
UEL	Upper Explosive (flammable) Limit in air, % by volume at room temperature or other temperature as noted
UN	United Nations
unsym-	prefix for asymmetric
USDA	United States Department of Agriculture
USCG	United States Coast Guard
VOCs	Volatile Organic Compounds
WEEL	Workplace Environmental Exposure Level (AIHA)
WHMIS	Workplace Hazardous Materials Information System (Canada)
>	symbol for "greater than"
<	symbol for "less than"
≤	symbol for "less than or equal to"
≥	symbol for "greater than or equal to"
°	degrees of temperature
%	percent

E

Emetine dihydrochloride E:0050

Formula: $C_{29}H_{42}Cl_2N_2O_4$; $C_{29}H_{40}N_2O_4 \cdot 2HCl$
Synonyms: Amebicide; (-)Emetine, dihydrochloride; 1-Emetine, dihydrochloride; Emetine, hydrochloride; NSC-33669
CAS Registry Number: 316-42-7
RTECS Number: JY5250000
UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154: UN1544 (alkaloid, solid, n.o.s.)/151
EC Number: 206-259-8

Regulatory Authority and Advisory Information

Hazard Alert: Poison (highly toxic), Primary irritant (w/o allergic reaction).

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 1/10,000 lb (0.454/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 1 lb (0.454 kg).

Hazard symbols, risk, & safety statements: Hazard symbol: T+; Xi; risk phrases: R28; R36/37/38; R41; safety phrases: S25; S26; S28; S29; S36/37; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Emetine dihydrochloride is a colorless, combustible powder which turns yellow on exposure to heat or light. Molecular weight = 553.63; boiling point = 600°C; freezing/melting point = 235°C−250°C (decomposes); flash point = >310°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Soluble in water.

Potential Exposure: Emetine dihydrochloride is an injectable form of emetine; an alkaloid and antiamebic; the active ingredient of Ipecac. Emetine dihydrochloride is used as chemical reagent, organic intermediate; in pharmaceutical R&D.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides. Turns yellow on contact with light or heat.

Permissible Exposure Limits in Air

PAC Ver. 28, no values found in Ver. 29[138]
PAC-1: 9.10E-04 milligram per cubic meter
PAC-2: 0.01 milligram per cubic meter
PAC-3: 0.06 milligram per cubic meter

Routes of Entry: Inhalation, ingestion, and eye and/or skin contact.

Harmful Effects and Symptoms

Symptoms include nausea, vomiting, diarrhea, muscle weakness, pain, tenderness, hypotension, precordial pain, and rapid heartbeat. This material is highly toxic orally. It is an eye irritant. Probable oral lethal dose for humans if 5−50 mg/kg, or between seven drops and one teaspoon for a 150-lb person. LD_{50} = (oral-rat) 0.012 mg/kg (12 μg/kg) (extremely toxic).

Short-Term Exposure: Irritates the eyes. Symptoms include nausea, vomiting, diarrhea, muscle weakness, pain, tenderness, hypotension, precordial pain, rapid heartbeat, diarrhea, dyspnea, hallucinations, nausea, or vomiting. This material is highly toxic orally. Probable oral lethal dose for humans if 5−50 mg/kg, or between seven drops and one teaspoon for a 150-lb person. LD_{50} = (oral-rat) 0.012 mg/kg (12 μg/kg) (extremely toxic). Eye irritant, moderate; Heart, cardiovascular system, acute effects; CNS, acute effects; Nervous system toxin, acute effects; Respiratory toxin, acute effects other than severe or moderate irritation; gastrointestinal (GI) tract, acute effects[138].

Points of Attack: Respiratory toxin-chronic; cardiovascular system, chronic effects[138].

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Emetine is an alkaloid. Procedures for alkaloid salts are as follows. Move victim to fresh air; call emergency medical care. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. In case of contact with material, immediately flush skin or eyes with running water for at least 15 minutes. Speed in removing material from skin is of extreme importance. Remove and isolate contaminated clothing and shoes at the site. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should

Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens.
DOI: http://dx.doi.org/10.1016/B978-0-323-38968-6.00005-3

be clean, available each day and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. For emergency situations, wear a positive pressure, pressure-demand, full facepiece self-contained breathing apparatus (SCBA) or pressure-demand supplied air respirator with escape SCBA and a fully encapsulating, chemical resistant suit.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in a refrigerator or a cool, dry place and protect from light.

Shipping: UN1544 Alkaloids, solid, n.o.s. or Alkaloid salts, solid, n.o.s. poisonous, Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft[70]. Isolation Distance, Fire: 800 m/0.5 mi[70]. The following procedures should be used for alkaloid salts. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Remove and isolate contaminated clothing at the site. Do not touch spilled material; stop leak if you can do it without risk. Use water spray to reduce vapors. *Small spills*: Take up with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills*: With clean shovel place material into clean, dry container and cover; move containers from spill area. *Large spills*: Dike far ahead of spill for later disposal. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal and nitrogen oxides decomposition products may include hydrogen chloride and oxides of nitrogen and carbon. Extinguishing methods for alkaloid salts are as follows. *Small fires*: Dry chemical, carbon dioxide; water spray; or foam. *Large fires*: Water spray, fog, or foam. Procedures for alkaloid salts include the following. Move container from fire area if you can do so without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Wear positive pressure breathing apparatus and special protective clothing. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: *Emetine Dihydrochloride*, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

Endosulfan E:0100

Formula: $C_9H_6Cl_6O_3S$

Synonyms: Benzoepin (in Japan); Beosit; Bio 5462; Chlorthiepin; Crisufan; Cyclodan; Devisulphan; Endocel; Endosol; Endosulfan chlorinated hydrocarbon insecticide; Endosulphan; Endox; Ensodulfan (Spanish); Ensure; ENT 23,979; FMC5462; α,β-1,2,3,4,7,7-Hexachlorobiclo(2,2,1)hepten-5,6-bioxymethylenesulfite; 1,2,3,4,7,7-Hexachlorobiclo (2,2,1)hepten-5,6-bioxymethylenesulfite; Hexachlorohexahydromethano 2,4,3-benzodioxathiepin-3-oxide; C, C′-(1,4,5,6,7,7-Hexachloro-8,9,10-trinorborn-5-en-2,3-ylene) (dimethylsulphite)6,7,8,9,10,10-hexachloro-1,5,5a,6,9,9a-hexahydro-6,9-methano-2,4,3-benzodioxathiepin 3-oxide; 6,7,8,9,10,10-Hezachloro-1,5,5a,6,9,9a-hexahydro-6,9-methano-2,4,3-benzodioxathiepin-3-oxide; 1,4,5,6,7,7-Hezachloro-5-norborene-2,3-dimethanol cyclic sulfite; Hildan, HOE 2671; Insecto; Insectophene; Kop-Thiodan; Malix; Maux; 6,9-Methano-2,4,3-benzodioxathiepin, 6,7,8,9,10,10-hexachloro-1,5,5a,6,9,9a-hexahydro-, 3-oxide, NCI-C00566; MOS-570; NIA 5462; Niagra 5462; OMS570; Rasayansulfan; Sulfurous acid cyclic ester with 1,4,5,6,7,7-hexachloro-5-norborene- 2,3-dimethanol; Thidan; Thifor; Thimul; Thiodan (in Russia); Thiodan; Thiodan 35; Thiofor; Thiomul; Thionex; Thiosulfan; Thiosulfan thionel; Tiovel

CAS Registry Number: 115-29-7; 959-98-8 (*alpha-*); 33213-65-9 (*beta-*); *(alt.)* 6994-04-3; *(alt.)* 8003-45-0

HSDB Number: 390

RTECS Number: RB9275000; RB9875200 (beta)

UN/NA & ERG Number: UN2761 (Organochlorine pesticides, solid toxic)/151; UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 204-079-4 [*Annex I Index No.*: 602-052-00-5]

Regulatory Authority and Advisory Information

Carcinogenicity: NCI: Carcinogenesis Bioassay (feed); no evidence: Mouse, rat.

Health Advisory: Poison, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Environmental hazard, Agricultural chemical.

United States Environmental Protection Agency, FIFRA 1998 Status of Pesticides: Supported, 1998

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Toxic Pollutant (Section 401.15)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P050

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 10/10,000 lb (4.54/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg)

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) Severe pollutant

List of Stockholm Convention POPs

Hazardous to aquatic life or environment, with possible long lasting effects[291,292].

Hazard symbols, risk, & safety statements: (CAS: 115-29-7). Hazard symbol: T+, Xn, N; risk phrases: R21; R24/25; R36/37/38; S41; R48/20; R50/53; R65; R67; R62; R63; safety phrases: S1/2; S28; S29/35; S36/37; S45; S60; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Alpha-:

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; Toxic Pollutant (Section 401.15)

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.023; Nonwastewater (mg/kg), 0.066

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8080 (0.1); 8250 (10)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg)

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) Severe pollutant; as endosulfan

Beta-:

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; Toxic Pollutant (Section 401.15)

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.029; Nonwastewater (mg/kg), 0.13

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8080 (0.05)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg)

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) Severe pollutant.

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water. (CAS: 115-29-7)

Description: Endosulfan is a chlorinated cyclodiene insecticide. The pure product is a colorless crystalline solid. The technical product is a light to dark brown waxy solid. It has a rotten egg or sulfur odor. Molecular weight = 406.90; freezing/melting point = 406.91; boiling point = decomposes; freezing/melting point = 70−100°C (technical); 106.1°C (pure); 106°C (a); 212°C (b); vapor pressure = 1.7×10^{-7} mmHg @ 20°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Insoluble in water; solubility = 0.00001%.

Potential Exposure: Those engaged in the manufacture, formulation, and application of this material.

Incompatibilities: Strong acids, strong bases. Hydrolyzed by acids. Contact with alkalis forms toxic sulfur dioxide fumes. Corrosive to iron in the presence of moisture.

Permissible Exposure Limits in Air

OSHA PEL: None

NIOSH REL: 0.1 milligram per cubic meter TWA [skin]

ACGIH TLV[1]: 0.006 ppm/0.1 milligram per cubic meter TWA measured as inhalable fraction and vapor [skin]; not classifiable as a human carcinogen

115-29-7

PAC Ver. 29[138]

PAC-1: 0.3 milligram per cubic meter

PAC-2: 0.8 milligram per cubic meter

PAC-3: 180 milligram per cubic meter

Australia: TWA 0.1 milligram per cubic meter, [skin], 1993; Belgium: TWA 0.1 milligram per cubic meter, [skin], 1993; Denmark: TWA 0.1 milligram per cubic meter, [skin], 1999; Finland: TWA 0.1 milligram per cubic meter; STEL 0.3 milligram per cubic meter, [skin], 1999; France: VME 0.1 milligram per cubic meter, [skin], 1999; India: TWA 0.1 milligram per cubic meter, [skin], 1993; Norway: TWA 0.1 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 0.1 milligram per cubic meter, [skin], 2003; Switzerland: MAK-W 0.1 milligram per cubic meter, [skin], 1999; United Kingdom: TWA 0.1 mg'm^3; STEL 0.3 milligram per cubic meter, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Russia[35,43] set a MAC of 0.1 milligram per cubic meter in work-place air as well as a MAC in ambient air of residential areas of 0.005 milligram per cubic meter on a momentary basis and 0.001 milligram per cubic meter on a daily average basis. Several states have set guidelines or standards for endosulfan in ambient air[60] ranging from 0.238 μ/m^3 (Kansas) to 1.0 μ/m^3 (North Dakota) to 1.6 μ/m^3 (Virginia) to 2.0 μ/m^3 (Connecticut and Nevada) to 2.4 μ/m^3 (Pennsylvania).

Determination in Air: Use OSHA Analytical Method PV-2023.

Permissible Concentration in Water: State Drinking Water Guidelines: Arizona 74 μg/L; Florida 42 μg/L; Maine 42 μg/L.

Determination in Water: Methylene chloride extraction followed by gas chromatography with electron capture or halogen specific detection (EPA Method 608) or gas chromatography plus mass spectrometry (EPA Method 625). Octanol-water coefficient: Log $K_{ow} = > 3.5$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood. Fish Tox = 0.00446000 ppb (EXTRA HIGH).

Routes of Entry: Inhalation, ingestion, and eye and/or skin contact. Can be absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Endosulfan may affect the central nervous system (CNS); blood, resulting in irritability, convulsions, and renal failure. High level exposure at may result in death. The effects may be delayed. Ingestion of endosulfan may result in nausea, vomiting, and diarrhea. Dizziness, agitation, nervousness, tremor, a lack of coordination, and convulsions may also occur. CNS depression may terminate in respiratory failure. Contact with endosulfan may irritate or burn the skin, eyes, and mucous membranes. Human Tox = 42.00000 ppb (INTERMEDIATE). The probable oral lethal dose is 50−500 mg/kg, or one teaspoonful and one ounce for a 150 lb person. LD_{50} = (oral-rat) 18 mg/kg (highly toxic). Death has occurred within 2 hours of heavy dust exposure during bagging operations.

Long-Term Exposure: Repeated exposure may cause brain damage, causing convulsions, loss of coordination, and memory loss. May cause liver and kidney damage. May damage the testes.

Points of Attack: Respiratory system, lungs, CNS, cardiovascular system, skin, eyes, plasma, and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below pre-employment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates. Liver and kidney function tests. Examination of the nervous system. EEG.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Consult hospital or poison control center on use of antidotes. Transport to healthcare facility.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Viton or Neoprene materials are recommended. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. If used out of doors adequate emergency water should be available.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode. A dust respirator approved for pesticide use may be worn. An organic vapor respirator may be necessary if exposure to the solvent is significant.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in a cool, dry, well-ventilated area; free of alkalis, acids, and acid fumes. Where possible, automatically pump liquid from drums or other storage containers to process containers. Always store pesticides in their original containers, complete with labels that list ingredients, directions for use, and first aid steps in case of accidental poisoning. Never store pesticides in cabinets with or near food, animal feed, or medical supplies. Do not store pesticides in places where flooding is possible or in places where they might spill or leak into wells, drains, ground water, or surface water[72].

Shipping: UN2761 Organochlorine pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: *Isolation Distance, Spill*: 25 m/75 ft[70]. Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. In case of spills, stay upwind;

stay out of low areas. Use water spray to reduce vapors. Do not dry sweep. Do not touch spilled material; stop leak if you can do it without risk. Small wet spills: Take up with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills*: With clean shovel place material into clean, dry container and cover; move containers from spill area. *Large spills*: Dike far ahead of spill for later disposal. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Thermal decomposition products may include hydrogen chloride and oxides of sulfur and carbon. Use any extinguishing agent suitable for surrounding fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: A recommended method for disposal is burial 18 in deep in noncropland, away from water supplies, but bags can be burned[22]. Large quantities should be incinerated at high temperature in a unit with effluent gas scrubbing. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (80); (203); (100).

United States Environmental Protection Agency, *Endosulfan: Ambient Water Quality Criteria*, Washington, DC (1980)

United States Environmental Protection Agency, *Endosulfan, Health and Environmental Effects Profile No. 98*, Washington, DC, Office of Solid Waste (April 30, 1980)

United States Environmental Protection Agency, Chemical Hazard Information Profile: *Endosulfan*, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

New York State Department of Health, *Chemical Fact Sheet: Endosulfan*, Bureau of Toxic Substance Assessment, Albany, NY (April 1986)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Endosulfan*, Trenton NJ (May 1999)

Endothall E:0110

Formula: $C_8H_{10}NO_5PS$

Synonyms: Accelerate; Aquathol; Des-I-Cate; 1,2-Dicarboxy 3,6-endoxocyclohexane; 3,6-Endo-epoxy-1,2-cyclohexanedicarboxylic acid; 3,6-Endooxohexahydrophthalic acid; Endothal chlorophenoxy herbicide; Endothall technical; 3,6-Endoxohexahydrophthalic acid; 3,6-Epoxycyclohexane-1,2-dicarboxylic acid; Hexahydro-3,6-endooxyphthalic acid; Hydout; Hydrothal-47; Hydrothol; 7-Oxabicyclo(2.2.1)heptane-2,3-dicarboxylic acid; Tri-endothal

CAS Registry Number: 145-73-3 (monoamine salt); 129-67-9 (disodium salt)

HSDB Number: 391

RTECS Number: RN7875000; RN8225000 (disodium salt)

UN/NA & ERG Number: UN2588 (Pesticides, solid, toxic, n.o.s.)/151; UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 205-660-5 [*Annex I Index No.:* 607-150-00-1] (*145-73-3*); 204-959-8 [*Annex I Index No.*: 607-055--00-5] *129-67-9, disodium salt*

Regulatory Authority and Advisory Information

Hazard Alert: Suspected reprotoxic hazard, Agricultural chemical. Listed for Tier 1 screening as an endocrine disruptor[88].

Banned or Severely Restricted (several countries) (UN)[13]

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P088

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

United States National Primary Drinking Water Regulations: MCLG = 0.1 mg/L; MCL = 0.1 mg/L

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1000 lb (454 kg).

European/International Regulations (*145-73-3; 129-67-9*): Hazard Symbol: T; Risk phrases: R21; R25; R36/37/38; R51; R63; Safety phrases: S1/2; S36/37/39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [2-Hazard to water. (est.)]

Description: Endothall, when pure, is a white crystalline solid. The technical grade is a light brown liquid. Molecular weight = 186.18; boiling point = (decomposes); freezing/melting point = 144°C with conversion to the anhydride. Hazard identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 1. Soluble in water; solubility = 100% @ 20°C.

Incompatibilities: Compounds of the carboxyl group react with all bases, both inorganic and organic (i.e., amines) releasing substantial heat, water and a salt that may be harmful. Incompatible with arsenic compounds (releases hydrogen cyanide gas), diazo compounds, dithiocarbamates, isocyanates, mercaptans, nitrides, and sulfides (releasing heat, toxic, and possibly flammable gases), thiosulfates and dithionites (releasing hydrogen sulfate and oxides of sulfur).
Potential Exposure: Endothall is dicarboxylic acid defoliant and herbicide used on both terrestrial and aquatic weeds.
Permissible Exposure Limits in Air
PAC Ver. 29[138]
129-67-9, disodium salt
PAC-1: 0.15 milligram per cubic meter
PAC-2: 1.7 milligram per cubic meter
PAC-3: 10 milligram per cubic meter
Permissible Concentration in Water: Safe Drinking Water Act (47FR 9352): MCL, 0.1 mg/L; MCLG, 0.1 mg/L.
Determination in Water: Fish Tox = 240.32545000 ppb. Low).
Routes of Entry: Inhalation, ingestion (possibly fatal), and eye and/or skin contact.
Harmful Effects and Symptoms
Short-Term Exposure: Endothall can be fatal if swallowed. May cause serious eye, skin and respiratory irritation. Poisonous: approximate lethal dose (human) is about 2.5 teaspoonful. Little information was found in the available literature on the health effects of endothall in humans except for one case history of a young male suicide victim who ingested an estimated 7−8 g of disodium endothall in solution (approximately 100 mg endothall ion/kg) Repeated vomiting was evident. Autopsy revealed focal hemorrhages and edema in the lungs and gross hemorrhage of the GI tract. LD_{50} = (oral-rat) 18 mg/kg.
Long-Term Exposure: Endothall can cause stomach and intestinal problems. May be mutagenic.
First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.
Personal Protective Methods: Wear rubber gloves for all handling. Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Wear hats, protective suits, and boots for all handling.
Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.
Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with endothall all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area.
Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN2588 Pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.
Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft[70]. Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Do not dry sweep. Use industrial vacuum. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.
Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Thermal decomposition products may include oxides of nitrogen, sulfur, phosphorus, carbon and other corrosive and/or toxic gases. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any

signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Small quantities may be disposed of by burial in soil which is rich in organic matter. Large quantities are best disposed of by incineration[22]. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (= 100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 8, No. 6, 51–56 (1988)

United States Environmental Protection Agency, "Health advisory: Endothall, Washington, DC, Office of Drinking Water (August 1987)

Endothion E:0120

Formula: $C_9H_{13}O_6PS$

Synonyms: AC-18,737; *O*,*O*-Dimethyl *S*-(5-methoxy-4-*oxo*-4H-pyran-2-yl) phosphorothioate; *O*,*O*-Dimethyl-S-[(5-methoxy-pyron-2-yl)-methyl]-thiolphosphat (German); *O*,*O*-Dimethyl *S*-(5-methoxypyronyl-2-methyl) thiolphosphate; DSA (USCG); Endocid; Endocide; Endotiona (Spanish); ENT 24,653; Exothion; 5-Methoxy-2-(dimethoxyphosphinylthiomethyl)pyrone-4; *S*-5-Methoxy-4-oxopyran-2-ylmethyl dimethyl phosphorothioate; *S*-[(5-Methoxy-4H-pyron-2-yl)-methyl]-*O*,*O*-dimethyl-monothiophosphat (German); *S*-(5-Methoxy-4-pyron-2-ylmethyl) dimethyl phosphorothiolate; NIA-5767; Niagra 5767; Phosphate 100; Phosphopyron; Phosphopyrone; Phosphorothioate; Thiophosphate de *O*,*O*-dimethyle et de *S*-[(5-methoxy-4-pyronyl)-methyle] (French)

CAS Registry Number: 2778-04-3

HSDB Number: 1706

RTECS Number: IF8225000

UN/NA & ERG Number: (PIH) UN2783 (organophosphorus pesticides, solid, toxic)/152; UN3018 (organophosphorus pesticide, liquid, n.o.s.)/152

EC Number: 220-472-3 [*Annex I Index No.:* 015-049-00-3]

Regulatory Authority and Advisory Information

Hazard Alert: Poison inhalation hazard: exposure can be lethal, Neurotoxin (cumulative), Combustible, Possible Neurotoxin (cumulative), Environmental hazard.

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 500 lb (227 kg)

United States DOT 49CFR172.101, Inhalation Hazardous Chemical, as organic phosphate, Substance ID: EDF-041.

Harmful to aquatic life in very low concentrations[136] as DSA

Hazardous to aquatic life or environment, with possible long lasting effects[291]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T+; risk phrases: R24/25; R26/27/28; R33; safety phrases: S1/2; S29/35; S36/37; S41; S45; S61 (see Appendix 4).

Description: Endothion is a white crystalline solid with a slight odor. Molecular weight = 280.25; freezing/melting point = 96°C. Hazard identification (based on NFPA-704 M Rating System): Health 4, Flammability 1, Reactivity 0. Soluble in water.

Potential Exposure: This material is a systemic insecticide. It is not sold in the United States or Canada.

Incompatibilities: Contact with oxidizers may cause the release of phosphorous oxides. Contact with strong reducing agents, such as hydrides; may cause the formation of flammable and toxic phosphine gas.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 1.5 milligram per cubic meter

PAC-2: 17 milligram per cubic meter

PAC-3: 100 milligram per cubic meter

Routes of Entry: Inhalation, ingestion, and skin contact.

Short-Term Exposure: Organic phosphorus insecticides are absorbed by the skin, as well as by the respiratory and GI tracts. They are cholinesterase inhibitors. Symptoms of exposure include headache, giddiness; blurred vision; nervousness, weakness, nausea, cramps, diarrhea, and discomfort in the chest. Signs include sweating, tearing, salivation, vomiting, cyanosis, convulsions, coma; loss of reflexes and loss of sphincter control. Exposure may cause psychotic behavior, loss of coordination; unconsciousness, and rarely, convulsions. This material is poisonous to humans. Its toxic effects are most likely related to action on the nervous system; LD_{50} = (oral-rat) 23 mg/kg (highly toxic).

Long-Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. Endothion may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, CNS, cardiovascular system, skin, eyes, plasma, and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below pre-employment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Speed in removing material from skin is of extreme importance. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area away from strong oxidizers.

Shipping: UN2783 Organophosphorus pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN3018 Organophosphorus pesticides, liquid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling:

Initial Isolation and Protective Action Distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24 h response line).

Small Spills (from a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.3/0.4
Night 0.8/1.2

Large Spills (from a large package or from many small packages)

First: Isolate in all directions (ft/m) 600/200
Then: Protect persons downwind (mi/km)
Day 1.4/2.3
Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Do not touch spilled material. Do not breathe vapors. Stay upwind; keep out of low areas. Remove all ignition sources. Ventilate area of spill or leak. This material is a combustible liquid. For a spill or leak of a combustible liquid, shut off ignition sources; no flares, smoking or flames in hazard area. Stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: Absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: Dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material may burn, but does not ignite readily. Thermal decomposition products may include oxides of phosphorus, sulfur, nitrogen and carbon. *For small fires*, use dry chemical, carbon dioxide; water spray; or foam. *For large fires*, use water spray, fog, or foam. Stay upwind; keep out of low areas. Move containers from fire area if you can do it without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Wear positive pressure breathing apparatus and special protective clothing. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR 165 recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138).

United States Environmental Protection Agency, Chemical Hazard Information Profile: *Endothion*, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

Endoxan E:0130

Formula: $C_7H_{15}C_{12}N_2O_2P$

Synonyms: *N*,*N*-Bis-(β-chloraethyl)-*N*′,*O*-propylen-phosphorsaeure-ester-diamid (German); 2-[Bis(2-chloroethyl)amino]-1-*oxo*-3-aza-2-phosphocyclohexane 2-oxide monohydrate; 2-[Bis(2-chloroethyl)amino)-2H-1,3, 2-oxazaphosphorine 2-oxide; 1-Bis(2-chloroethyl)amino-1-*oxo*-2-aza-5-oxaphosphoridine monohydrate; [Bis(chloro-2-ethyl)amino]-2-tetrahydro-3,4,5,6-oxazaphosphorine-1,3, 2-oxide-2 hydrate; 2-[Bis(2-chloroethyl)amino]tetrahydro(2 H)- 1,3,2-oxazaphosphorine 2-oxide monohydrate; *N*,*N*-Bis(2-chloroethyl)-*N*′-(3-hydroxypropyl)phosphorodiamidic acid intramol ester hydrate; Bis(2-chloroethyl)phosphoramide-cyclic propanolamide ester; Bis(2-chloroethyl) phosphoramide cyclic propanolamide ester monohydrate; *N*,*N*-Bis(β-chloroethyl) -*N*′, *O*-propylenephosphoric acid ester; *N*,*N*-Bis(2-chloroethyl)-*N*′, *O*-propylenephosphoric acid ester diamide; CTX; Cyclophosphamide; Cyclophosphamidum; Cyclophosphan; Cyclostin; Cytophosphan; Cytoxan; *N*,*N*-Di(2-chloroethyl)-*N*, *O*-propylenephosphoric acid ester diamide; Endoxanal; Genoxal; Hexadrin; Mitoxan; NCI-C04900; Neosar; NSC-26271; 2-H-1,3,2-Oxazaphosphorinane; Procytox; Semdoxan; Senduxan; SK 20501; Zyklophosphamid (German)

CAS Registry Number: 50-18-0

HSDB Number: 3047

RTECS Number: RP5950000

UN/NA & ERG Number: UN3464 (organophosphorus compound, solid, toxic, n.o.s)/151; UN2811 (toxic solid, organic, n.o.s.)/154; UN1851 (Medicine, liquid, toxic, n.o.s.)/151; UN3249 (Medicines, toxic, solid, n.o.s.)/151

EC Number: 200-015-4

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen: cyclophosphamide; NCI: Carcinogenesis Studies (ipr); clear evidence: mouse, rat; IARC: Human Sufficient Evidence, animal Sufficient Evidence, *carcinogenic to humans*, Group 1, 1987. United States Environmental Protection Agency Gene-Tox Program, Positive: Body fluid assay; Carcinogenicity-mouse/rat; Positive: Cell transformation-RLV F344 rat embryo; Positive: In vitro cytogenetics-human; Positive: In vivo cytogenetics-human bone marrow; Positive: In vivo cytogenetics-human lymphocyte; Positive: Cytogenetics-male germ cell; Host-mediated assay; Positive: Rodent heritable translocation; Positive: L5178Y cells In vitro-TK test; Mammalian micronucleus; Positive: Mouse spot test; *E. coli polA* with S9; Positive: Histidine reversion-Ames test; Mouse specific locus; Positive: Sperm morphology-rat; Sperm morphology-mouse F1; Positive: Sperm morphology-human; Sperm morphology-mouse; Positive: *D. melanogaster* sex-linked lethal; UDS in mouse germ cells; Positive: TRP reversion; *S. cerevisiae* gene conversion; Positive: *S. cerevisiae*-forward mutation; *S. cerevisiae-homozygosis*; Positive: *S. cerevisiae*-reversion; Positive/dose response: Cell transformation-C3H/10T1/2; Positive/dose response: In vivo cytogenetics-nonhuman bone marrow; Positive/dose response: In vivo cytogenetics-mammalian oocyte; Positive/dose response: In vitro cytogenetics-human lymphocyte; Positive/dose response: Rodent dominant lethal; Positive/dose response: In vitro SCE-nonhuman; In vivo SCE-nonhuman; Negative: Cell transformation-BALB/c-3T3; Inconclusive: In vitro SCE-human lymphocytes; Inconclusive: Sperm morphology-rabbit; In vitro UDS-human fibroblast; Positive: CHO gene mutation.

California Proposition 65 Chemical[102]: Cancer 2/27/1987; Developmental/Reproductive toxin (male, female) 1/1/1989.

Hazard Alert: Poison, Neurotoxin (cumulative), Possible risk of forming tumors, Reproductive toxin: possible risk of gene damage/impaired fertility; Suspected reprotoxic hazard.

United States DOT 49CFR172.101, Inhalation Hazard Chemical as organophosphates

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U058

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg)

Hazard symbols, risk, & safety statements: Hazard symbol: T; risk phrases: R62; R63;?; safety phrases: (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Endoxan is a white crystalline powder (monohydrate). It may be used or shipped in solution. Darkens on exposure to light. Odorless. Molecular weight = 261.11; freezing/melting point = 41°C−45°C; flash point = 112°C. Soluble in water; solubility = 4%.

Potential Exposure: Exodan is used as an immunosuppressive agent in nonmalignant diseases; treatment of malignant lymphoma, multiple meyloma; leukemias, and other malignant diseases. Exodan has been tested as an insect chemosterilant and for use in the chemical shearing of sheep. Exodan is not produced in the United States.; manufactured in Germany and imported into the United States since1959. The FDA estimates that 200,000−300,000 patients per year are treated with exodan. It is administered orally and through injection. The adult dosage is usually 1−5 mg/kg of body weight daily or 10−15 mg/kg administered intravenous every 7−10 days[193].

Incompatibilities: Should be protected from exposure to temperatures above 30°C/86°F.

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Routes of Entry: Inhalation and passing through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Exodan irritates the eyes, skin, and respiratory tract. Eye contact can cause severe damage with possible loss of vision. This chemical can be absorbed through the skin, thereby increasing exposure. Exodan may affect the blood, bladder, CNS, and heart. Symptoms of exodan exposure include GI disturbance, leukopenia, nausea, dizziness, liver dysfunction, and hair loss. When used as a medical drug it can cause nausea, vomiting, and may interfere with the body's manufacture of blood cells (anemia). It is not known if this also occurs in work-place exposures. Contact may cause eye damage.

Long-Term Exposure: Exodan is a carcinogen and probable teratogen in humans. It causes bladder and skin cancer. There is limited evidence that this chemical causes sterility in males and females. Repeated exposure may interfere with the body's ability to produce blood cells (anemia). May cause liver damage. The substance may have effects on the blood, bladder, lungs, and bone marrow resulting in leucopenia, cystitis, and pulmonary fibrosis. There is sufficient evidence for the carcinogenicity of exodan both in humans and in experimental animals. Exodan was carcinogenic in rats following administration in drinking water and intravenous injection; and in mice following subcutaneous injection. Dosages were comparable to those used in clinical practice. The chemical produced benign and malignant tumors at various sites including bladder tumors in the rats. Epidemiological studies are available in which persons treated with Exodan for a variety of medical conditions were compared with similarly affected controls. These studies consistently demonstrate an excess of various neoplasms and leukemias in the treated groups; although the number in all five studies was small. LD_{50} = (oral-mouse) 137 mg/kg (Moderately Toxic).

Points of Attack: Blood, lungs, bladder, skin, and liver.

Medical Surveillance: Complete blood count. Lung function tests. Kidney function tests. GI tests. Tests for blood in urine.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. If you are required to work in a "sterile" environment you require special training.

Respirator Selection: Specific respirator(s) have not been recommended by NIOSH. However, based on potential carcinogenicity the following might be considered: *At any detectable concentration*: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100 F (APF = 50) (any air-purifying, full facepiece respirator with an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and

storage. Store in tightly closed containers in a cool, well ventilated area. Store at below 25°C. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN3464 Organophosphorus compound, solid, toxic, n.o.s, Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN3249 Medicine, solid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN1851 Medicine, liquid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling:

Initial Isolation and Protective Action Distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24 h response line).

Small Spills (from a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.3/0.4
Night 0.8/1.2

Large Spills (from a large package or from many small packages)

First: Isolate in all directions (ft/m) 600/200
Then: Protect persons downwind (mi/km)
Day 1.4/2.3
Night 2.8/4.5

Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or foam extinguishers. Thermal decomposition products may include hydrogen chloride and oxides of nitrogen, phosphorus and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(109); (102); (31); (173); (101); (138); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 3, 62–64 (1981) (As Endoxan)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Cyclophosphamide*, Trenton NJ (1998)

Endrin E:0140

Formula: $C_{12}H_8Cl_6O$

Synonyms: Compound 269; 2,7: 3,5-Dimethanonaphth(2,3-b)oxirene, 3,4,5,6,9,9-hexachloro-1a,2,2a,3,6,6a,7,7a-octahydro-, (aa,2.b,2ab,2ab,3a,6a,6ab,7b,7aa)-; Endrex; Endrina (Spanish); Endrin chlorinated hydrocarbon insecticide; Endrine (French); ENT 17,251; Hexachloroepoxyoctahydro-endo, endo-dimethanonapthalene; (1r, 4s, 4as, ss, 7r, 8r, 8ar)-1,2,3,4,10-Hexachloro-1,4,4a,5,6,7,8,8a-octahydro-6,7-epoxy-1,4: 5,8-dimethano naphthalene; Hexadrin; 1,2,3,4,10,10-Hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4-endo-endo-1,4,5,8-dimethanonaphthalene; Mendrin; NCI-C00157; Nendrin

CAS Registry Number: 72-20-8

HSDB Number: 198

RTECS Number: IO1575000

UN/NA & ERG Number: UN2761 (Organochlorine pesticides, solid toxic)/151

EC Number: 200-775-7 [*Annex I Index No.*: 602-051-00-X]

Regulatory Authority and Advisory Information

Carcinogenicity: NCI: Carcinogenesis Bioassay (feed); no evidence: mouse, rat; IARC: Human No Adequate Evidence; Animal Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1987; EPA: Not Classifiable as to human carcinogenicity. United States Environmental Protection Agency Gene-Tox Program, Negative: Histidine reversion-Ames test; Negative: In vitro UDS-human fibroblast; TRP reversion; Negative: *S. cerevisiae-homozygosis*; Negative/limited: Carcinogenicity-mouse/rat; Inconclusive: *D. melanogaster* sex-linked lethal.

California Proposition 65 Chemical[102]: Developmental/Reproductive toxin 5/15/1998.

Hazard Alert: Exposure can be lethal, Combustible; *Note:* Mixture in xylene is Highly flammable; Agricultural chemical, Possible risk of forming tumors, Reproductive toxin: possible risk of gene damage/impaired fertility; Suspected reprotoxic hazard, Environmental hazard [Persistent Organic Pollutants (POP)]

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR423, Appendix A, Priority Pollutants.

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P051; Tox # D012, Regulated level = 0.02 mg/L.

RCRA Toxicity Characteristic (Section 261.24), Maximum Concentration of Contaminants, regulatory level, 0.02 mg/L

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.0028; Nonwastewater (mg/kg), 0.13

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8080 (0.1); 8250 (10)

United States National Primary Drinking Water Regulations: MCLG = 0.002 mg/L; MCL = 0.002 mg/L.

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg)

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), severe pollutant

Mexico, Drinking Water Criteria, 0.07 mg/L

List of Stockholm Convention POPs: Annex A (Elimination)

Hazardous to aquatic life or environment, with possible long lasting effects[291,292].

Hazard symbols, risk, & safety statements: Hazard symbol: T+, N; risk phrases R24; R28; R50/53; R62; R63; safety phrases: S1/2; S21; S22; S29/35; S36/37; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Endrin is the common name of one member of the cyclodiene group of pesticides. It is a cyclic hydrocarbon having a chlorine-substituted, methano-bridge structure. Endrin is a white, crystalline solid. Molecular weight = 380.90; boiling point = (decomposes) below 245°C; freezing/melting point = (decomposes) 200°C/392°F; vapor pressure = 2×10^{-7} mmHg @ 20°C. *Mixture in xylene:* Flash point = 27°C. Explosive limits: LEL: 1.1%; UEL: 7.0%. Hazard identification (based on NFPA-704 M Rating System): Health 4, Flammability 1, Reactivity 0. Insoluble in water.

Potential Exposure: A potential danger to those involved in manufacture, formulation and field application of this insecticide, avicide, and rodenticide. Pesticide not in use; TRI and/or IUR indicates importers or manufacturers are unlikely[88].

Incompatibilities: Incompatible with strong oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids (forms explosive vapors), oxoacids, epoxides, and parathion. Slightly corrosive to metal.

Permissible Exposure Limits in Air

NIOSH IDLH = 2 milligram per cubic meter

OSHA PEL: 0.1 milligram per cubic meter TWA[skin]

NIOSH REL: 0.1 milligram per cubic meter TWA[skin]

ACGIH TLV [1]: 0.1 milligram per cubic meter TWA [skin]; not classifiable as a human carcinogen

PAC Ver. 29[138]

PAC-1: 1.8 milligram per cubic meter

PAC-2: 20 milligram per cubic meter

PAC-3: 2000 milligram per cubic meter

DFG MAK: 0.1 milligram per cubic meter, measured as the, inhalable fraction TWA; Peak Limitation Category II (8); [skin]; Pregnancy Risk Group C

Arab Republic of Egypt: TWA 0.1 milligram per cubic meter, [skin], 1993; Australia: TWA 0.1 milligram per cubic meter, [skin], 1993; Austria: MAK 0.1 milligram per cubic meter, [skin], 1999; Belgium: TWA 0.1 milligram per cubic meter, [skin], 1993; Denmark: TWA 0.1 milligram per cubic meter, [skin], 1999; Finland: TWA 0.1 milligram per cubic meter; STEL 0.3 milligram per cubic meter, [skin], 1999; France: VME 0.1 milligram per cubic meter, [skin], 1999; the Netherlands: MAC-TGG 0.1 milligram per cubic meter, [skin], 2003; Norway: TWA 0.1 milligram per cubic meter, 1999; Poland: MAC (TWA) 0.5 milligram per cubic meter, MAC (STEL) 1.5 milligram per cubic meter, 1999; Switzerland: MAK-W 0.1 milligram per cubic meter, [skin], 1999; Thailand: TWA 0.1 milligram per cubic meter, 1993; Turkey: TWA 0.1 milligram per cubic meter, [skin], 1993; United Kingdom: TWA 0.1 milligram per cubic meter; STEL 0.3 milligram per cubic meter, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Several states have set guidelines or standards for Endrin in ambient air[60] ranging from 0.07 μ/m^3 (Pennsylvania) to 0.238 μ/m^3 (Kansas) to 1.0 μg/L (North Dakota) to 1.6 μg/L (Virginia) to 2.0 μg/L (Connecticut and Nevada).

Determination in Air: Use NIOSH (IV), Method #5519.

Permissible Concentration in Water: Safe Drinking Water Act (47FR 9352): MCL, 0.002 mg/L; MCLG, 0.002 mg/L. Federal Drinking Water Standards: EPA 2 μg/L; Federal Drinking Water Guidelines: EPA 2 μg/L; State Drinking Water Guidelines: Arizona 0.32 μg/L.

Determination in Water: Methylene chloride extraction followed by gas chromatography with electron capture or halogen specific detection (EPA Method 608) or gas chromatography plus mass spectrometry (EPA Method 625). Octanol-water coefficient: Log K_{ow} = 5.3. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood. Fish Tox = 0.00440000 pbb (EXTRA HIGH).

Routes of Entry: Inhalation, skin absorption, ingestion, and skin and/or eye contact. Quickly passes through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Contact can irritate the skin and eyes and may affect vision. Inhalation can cause irritation of the respiratory tract. Exposure can cause headache, nausea, vomiting, diarrhea, loss of appetite; sweating and weakness; lightheadedness, dizziness, convulsions, and unconciousness. Lower exposure can affect concentration, memory and muscle coordination. Endrin can cause death by respiratory arrest. Symptoms include headache, nausea, vomiting, dizziness, tremors, convulsions, loss of consciousness; rise in blood pressure; fever, frothing of the mouth, deafness, coma, and death. This material is extremely toxic. It is rapidly absorbed through the skin. Symptoms appear between 20 minutes and 12 hours after exposure. Doses of 1 mg/kg can cause symptoms. Also, it is a CNS depressant and hepatotoxin. Inhalation may cause irritation to nose and throat; and sudden convulsions, which may occur from 30 minutes to 10 hours after exposure. Recovery is usually rapid, but headache, dizziness, lethargy, weakness, and weight loss may persist to 2–4 weeks. Prolonged breathing or ingestion can result in an onset of symptoms in 3 hours at a dose of 1 mg per kg of body weight. Ingestion of 12 grams has caused death. Pregnant women are considered to be at special risk. A rebuttable presumption notice against pesticide registration was issued on July 27, 1976 by EPA on the basis of oncogenicity, teratogenicity, and reductions in endangered species and nontarget species. Human Tox = 2.00000 ppb MCL (High).

Long-Term Exposure: High or repeated exposure may cause liver damage. May damage the developing fetus. May damage the nervous system causing numbness and weakness in the extremities. Repeated exposure may cause personality changes of depression, anxiety and/or irritability. May cause anorexia.

Points of Attack: Liver, respiratory system, lungs, CNS, cardiovascular system, skin, eyes, plasma, and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1–2 weeks while red blood cell levels may be reduced for 1–3 months. When cholinesterase enzyme levels are reduced by 25% or more below pre-employment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates. Examination of the nervous system. Electroencephalogram (a test for abnormal seizure activity). Blood endrin level. Liver and kidney function tests. NIOSH lists the following tests: whole blood (chemical/metabolite), end-of-shift; blood plasma, blood serum; urine (chemical/metabolite); urine (chemical/metabolite), end-of-shift.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: 1 milligram per cubic meter: Any air-purifying half-mask respirator with organic vapor cartridge(s) in combination with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100; or Sa (APF = 10) (any supplied-air respirator); 2 milligram per cubic meter: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); PaprOvHie (APF = 25) (any air-purifying full facepiece respirator equipped with an organic vapor cartridge in combination with a high-efficiency particulate filter); or CcrFOv100 (APF = 50) [any air-purifying full facepiece respirator equipped with organic vapor cartridge(s) in combination with an N100, R100, or P100 filter]; or GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAF (APF = 50) (any SCBA with full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into* *unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with endrin all handlers should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Always store pesticides in their original containers, complete with labels that list ingredients, directions for use, and first aid steps in case of accidental poisoning. Never store pesticides in cabinets with or near food, animal feed, or medical supplies. Do not store pesticides in places where flooding is possible or in places where they might spill or leak into wells, drains, ground water, or surface water[72]. Store in tightly closed containers in a cool, well ventilated area away from oxidizers and heat. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: UN2761 Organochlorine pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: For leaks or spills, use water spray to disperse vapor and to flush spills. Liquid containing this material should be absorbed in vermiculite, dry sand, and earth. Do not touch spilled material; stop leak if you can do it without risk. Establish forced ventilation to keep levels below explosive limit. *Small dry spills*: Collect powdered material in the most convenient and safe manner and deposit in sealed containers; move containers from spill area. *Large spills*: Dike far ahead of spill for later disposal. Keep unnecessary people away; isolate hazard area and deny entry. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Endrin itself does not burn but it may be dissolved in a flammable liquid. Thermal decomposition products may include phosgene and hydrogen chloride. Use dry chemical, foam, carbon dioxide; water spray for solution. *Small fires:* dry chemical, carbon dioxide; water spray; or foam. *Large fires:* water spray, fog, or foam. Use water to keep fire-exposed containers cool. Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind: keep out of low areas. Establish forced ventilation to keep levels below explosive limit. Wear positive pressure breathing apparatus and special protective clothing. Remove and isolate contaminated clothing at the site. Move container from fire area if you can do it without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: A disposal procedure recommended by the manufacturer consists of absorption, if necessary, and burial at least 18 in deep; preferably in sandy soil in a flat or depressed location away from wells, livestock, children, wildlife, etc. Incineration is the recommended method[22]. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(102); (31); (100); (173); (101); (138); (80); (203).

United States Environmental Protection Agency, *Endrin: Ambient Water Quality Criteria*, Washington, DC (1980)

United States Environmental Protection Agency, *Reviews of the Environmental Effects of Pollutants: XIII, Endrin*, Report EPA-600/1-79-005, Cincinnati, OH (1979)

United States Environmental Protection Agency, *Endrin, Health and Environmental Effects Profile No. 99*, Washington, DC, Office of Solid Waste (April 30, 1980)

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 5, 55−57 (1981)

United States Environmental Protection Agency, Chemical Hazard Information Profile: *Endrin*, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Endrin*, Trenton, NJ (December 1998)

New York State Department of Health, *Chemical Fact Sheet: Endrin*, Bureau of Toxic Substance Assessment, Albany, NY (May 1986)

Enflurane E:0150

Formula: $C_3H_2ClF_5O$; CHF_2OCF_2CHFCl
Synonyms: 2-Chloro-1-(difluoromethoxy)-1,1,2-trifluoroethane; 2-Chloro-1,1,2-trifluoroethyl difluoromethyl ether; Ethrane; Ethrane methylflurether
CAS Registry Number: 13838-16-9; *(alt.)* 22194-21-4; *(alt.)* 22194-22-5
HSDB Number: 7909
RTECS Number: KN6800000
UN/NA & ERG Number: UN1851 (Medicine, liquid, toxic, n.o.s.)/151
EC Number: 237-553-4
Regulatory Authority and Advisory Information
Carcinogenicity: IARC: Animal Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1987. United States Environmental Protection Agency Gene-Tox Program, Negative: V79 cell culture-gene mutation; Inconclusive: Histidine reversion-Ames test; Sperm morphology-mouse.
Hazard Alert: Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction), Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated.
Hazard symbols, risk, & safety statements: Hazard symbol: T, F: risk phrases: R5; R11, R21; R23; R26; R36; R62; R63; safety phrases: S9; S23; S26; S33; S36/37/39; S38; S45(see Appendix 4)
Description: Enflurane is a clear, colorless liquid that easily turns into a nonflammable gas. Mild, sweet odor. Molecular weight = 184.50; specific gravity (H_2O:1) = 1.52; boiling point = 56.7°C; vapor pressure = 175 mmHg; relative vapor density (air = 1) = 1.92. Hazard identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. Very slightly soluble in water.
Potential Exposure: FDA-proprietary drug, used as an anesthetic (gas). Axphyxiant.
Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides. Decomposes on heating, forming toxic and corrosive fumes of hydrogen chloride, hydrogen fluoride, and phosgene. Decomposes in strong sunlight.
Permissible Exposure Limits in Air
OSHA PEL: None
NIOSH REL*: 2 ppm/15.1 milligram per cubic meter [60 minute] Ceiling Concentration [**Note*: REL for exposure to waste anesthetic gas.]
ACGIH TLV [1]: 75 ppm; not classifiable as a human carcinogen
PAC not available
DFG MAK: 20 ppm/150 milligram per cubic meter TWA; Peak Limitation Category II(8); Pregnancy Risk Group C
Australia: TWA 0.5 ppm (3.8 milligram per cubic meter), 1993; Belgium: TWA 75 ppm (566 milligram per cubic meter), 1993; Denmark: TWA 2 ppm (15 milligram per cubic meter), 1999; Norway: TWA 2 ppm (15 milligram per cubic meter), 1999; Sweden: NGV 10 ppm (80 milligram per cubic meter), KTV 20 ppm (150 milligram per cubic meter), 1999; Switzerland: MAK-W 10 ppm (80 milligram per cubic meter, KZG-W 20 ppm (160 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 153 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: not classifiable as a human carcinogen
Determination in Air: Use OSHA Analytical Methods 29 and 103.
Permissible Concentration in Water: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guidelines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg [Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg[F]/L. Safe Drinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg[F]/L; SMCL = 2 mg/F/L, as Fluoride.
Determination in Water: Octanol-water coefficient: Log K_{ow} = Unlikely to bioaccumulate in marine organisms.
Routes of Entry: Inhalation of vapors.
Harmful Effects and Symptoms
Short-Term Exposure: Enflurane can cause skin, eye and respiratory irritation. There is an association between exposure to anesthetic vapors and increased cancers, miscarriages, and birth defects. Enflurane's role in these increased risks in unclear. Medical patients receiving enflurane as surgical anesthesia have had rare cases of seizures (fits) and liver damage. It is not known whether this happens with work-place exposures. Exposure can cause you to become dizzy, lightheaded and to pass out. LD_{50} = (oral-rat) 5450 mg/kg (insignificantly toxic).
Long-Term Exposure: There is limited evidence that enflurane causes lung and liver cancer in animals. It may damage the developing fetus. Exposure to high levels may cause seizures and affect the liver.
Points of Attack: Eyes, CNS, and liver.
Medical Surveillance: Liver function tests.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions,

including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures *over* 2 ppm; Use an NIOSH/MSHA or European Standard EN 149-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use an NIOSH/MSHA or European Standard EN 149-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Check oxygen content prior to entering storage area. Non-combustible gas in cylinders under compressed pressure. Prior to working with enflurane all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area. Check oxygen content before entering confined spaces. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: UN1851 Medicine, liquid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. If the gas is leaking from a vaporizer or other equipment Stop the flow of gas if it can be done safely. Ventilate area of spill or leak to disperse gas. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible liquid or gas. Thermal decomposition products may include hydrogen chloride, hydrogen fluoride, and phosgene. Use any extinguisher suitable for surrounding fires. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier.

References

(31); (173); (101); (138); (122).

National institute for Occupational Safety and Health (NIOSH), "*Criteria for a Recommended Standard: Occupational Exposure to Waste Anesthetic Gases and Vapors*," NIOSH Document Number 77−140, Cincinnati OH (1977)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Enflurane*, Trenton, NJ (April, 1997)

Epichlorohydrin E:0160

Formula: C_3H_5ClO

Synonyms: 1-Chlor-2,3-epoxy-propan (German); 1-Chloro-2,3-epoxypropane; 3-Chloro-1,2-epoxypropane; (Chloromethyl) ethylene oxide; (Chloromethyl)oxirane; 2-(Chloromethyl) oxirane; Chloromethyloxirane; 3-Chloropropene-1,2-oxide; γ-Chloropropylene oxide; 3-Chloropropylene oxide; 3-Chloro-1,2-propylene oxide; Chloropropylene oxide; Epichlorhydrin (German); Epichlorhydrine (French); α-Epichlorohydrin; (dl)-α-Epichlorohydrin; EPI-chlorohydrin; Epiclorhidrina (Spanish); 1,2-Epoxy-3-chloropropane; 2,3-Epoxypropyl chloride; Epoxy resin component; Glycerol epichlorohydrin; Glycidyl chloride;

Oxirane, (chloromethyl)-; Phenoxy resin component; Propane, 1-chloro-2,3-epoxy-; Skekhg

CAS Registry Number: 106-89-8

HSDB Number: 39

RTECS Number: TX4900000

UN/NA & ERG Number: UN2023/131 (P)

EC Number: 203-439-8 [*Annex I Index No.:* 603-026-00-6]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Minimum concentration 1.00%; Release hazard* 20,000

Carcinogenicity: IARC: Human Inadequate Evidence, animal Sufficient Evidence, *probably carcinogenic to humans*, Group 2A, 1999; NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies; NIOSH: Potential occupational carcinogen. United States Environmental Protection Agency Gene-Tox Program, Positive: Carcinogenicity-mouse/rat; Positive: In vitro cytogenetics-human lymphocyte; Positive: In vivo cytogenetics-human lymphocyte; Positive: *N. crassa*-forward mutation; *N. crassa*-reversion; Positive: *E. coli polA* without S9; Histidine reversion-Ames test; Positive: *D. melanogaster* sex-linked lethal; *S. pombe*-forward mutation; Positive: *S. pombe*-reversion; Negative: Sperm morphology-human; Sperm morphology-mouse; Inconclusive: Mammalian micronucleus

California Proposition 65 Chemical[102]: Cancer 10/1/1987; male 10/1/1987.

Hazard Alert: Exposure can be lethal, Highly flammable liquid, Polymerization hazard, Possible risk of forming tumors, Reproductive toxin: possible risk of gene damage/impaired fertility; Suspected reprotoxic hazard, Sensitization hazard, Primary irritant (w/o allergic reaction). Listed for Tier 1 screening as an endocrine disruptor[88].

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 20,000 lb (9080 kg)

United States National Primary Drinking Water Regulations: MCLG = zero mg/L; MCL = TT: Each water system must certify annually, in writing, to the state (using third-party or manufacturers certification) that when it uses epichlorohydrin to treat water, the combination of dose and monomer level does not exceed the levels specified, as follows: 0.01 percent dosed at 20 mg/L (or equivalent).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992).

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U041

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, F, Xi; risk phrases: R45; R11; R19; R23/24/25; R34; R43; R62; R63; safety phrases: S1; S21; S41; S45; S53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Epichlorohydrin is a colorless liquid with a slightly irritating, chloroform-like odor. Molecular weight = 92.53; specific gravity (H_2O:1) = 1.18 @ 25°C; boiling point = 117.9°C; freezing/melting point = −25.6°C; vapor pressure = 13 mmHg @ 20°C; 16.4 mmHg @ 25°C; flash point = 31°C; autoignition temperature = 411°C. Explosive limits: LEL: 3.8%; UEL: 21.0%. Hazard identification (based on NFPA-704 M Rating System): Health 4, Flammability 3, Reactivity 2. Soluble in water; solubility = 7%.

Potential Exposure: Epichlorohydrin, an organochlorine, is used in the manufacture of many glycerol and glycidol derivatives and epoxy resins; as a stabilizer in chlorine-containing materials; as an intermediate in the preparation of cellulose esters and ethers, paints, varnishes, nail enamels, and lacquers; as a cement for celluloid. It is used as an intermediate in the manufacture of various drugs. Increased cancer risk.

Incompatibilities: May form explosive mixture with air. Slowly decomposes on contact with water. Heat or strong acids; alkalies, metallic halides, or contaminants can cause explosive polymerization. Violent reaction with strong oxidizers, aliphatic amines; alkanolamines, amines (especially aniline), alkaline earths; chemically active metals (chlorides of aluminum, iron zinc); powdered metals (aluminum, zinc); alcohols, phenols, organic acids; causing fire and explosion hazard. Will pit steel in the presence of water. Thermal decomposition forms highly toxic phosgene gas. May accumulate static electrical charges, and may cause ignition of its vapors.

Permissible Exposure Limits in Air

NIOSH IDLH = 75 ppm

OSHA PEL: 5 ppm/19 milligram per cubic meter TWA [skin]

NIOSH REL: Potential carcinogen. Limit exposure to lowest feasible concentration; See *NIOSH Pocket Guide*, Appendix A

ACGIH TLV [1]: 0.5 ppm TWA [skin]; confirmed animal carcinogen with unknown relevance to humans.

PAC* Ver. 29[138]

PAC-1: $\mathbf{1.7_A}$ ppm

PAC-2: $\mathbf{24_A}$ ppm

PAC-3: $\mathbf{72_A}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

DFG MAK: [skin] danger of skin sensitization; Carcinogen Category 2; Germ Cell Mutagen Group: 3B

Arab Republic of Egypt: TWA 2 ppm (10 milligram per cubic meter), [skin], 1993; Australia: TWA 2 ppm (10 milligram per cubic meter), [skin], 1993; Austria: [skin], carcinogen, 1999; Belgium: TWA 2 ppm (7.6 milligram per cubic meter), [skin], 1993; Finland: TWA 0.5 ppm (1.9 milligram per cubic meter), [skin], carcinogen, 1999; France: VLE 2 ppm (10 milligram per cubic meter), carcinogen, 1999; Hungary: STEL 1 milligram per cubic meter, [skin], carcinogen, 1999; the Netherlands: MAC-TGG 1.9 milligram per cubic meter, 2003; Norway: TWA 0.5 ppm (1.9 milligram per cubic meter), 1999; the Philippines: TWA 5 ppm (19 milligram per cubic meter), [skin], 1993; Poland: MAC (TWA) 1 milligram per cubic meter; STEL 8 milligram per cubic meter, 1999; Sweden: NGV 0.5 ppm (1.9 milligram per cubic meter), KTV 1 ppm (4 milligram per cubic meter), [skin], 1999; Switzerland: MAK-W 2 ppm (8 milligram per cubic meter), [skin], carcinogen, 1999; Turkey: TWA 5 ppm (19 milligram per cubic meter), [skin], 1993; United Kingdom: TWA 0.5 ppm (1.9 milligram per cubic meter); STEL 1.5 ppm, carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: confirmed animal carcinogen with unknown relevance to humans.

Russia set a MAC values in the ambient air in residential areas [35,43] of 0.2 milligram per cubic meter (200 μ/m^3) on either a momentary or a daily average basis. Several states have set guidelines or standards for epichlorohydrin in ambient air[60] ranging from 2.7 μ/m^3 (Massachusetts) to 8.3 μ/m^3 (North Carolina) to 12.0 μ/m^3 (Pennsylvania) to 20.0 μ/m^3 (Connecticut) to 33.3 μ/m^3 (New York) to 50.0 μ/m^3 (Indiana, South Carolina) to 0–100.0 μ/m^3 (North Dakota) to 0.8–200.0 μ/m^3 (Rhode Island) to 160.0 μ/m^3 (Virginia) to 238.0 μ/m^3 (Nevada).

Determination in Air: Use NIOSH (IV), Method #1010 or OSHA Analytical Method 7.

Permissible Concentration in Water: EPA has suggested a permissible ambient goal of 276 μg/L based on health effects. The EPA more recently calculated[48] a no-observed-adverse-effects-level (NOAEL) of 2 mg/kg/day on the basis of which they have calculated a lifetime Health advisory: of 70 μg/L. United States National Primary Drinking Water Regulations: MCLG = zero mg/L; MCL = TT: Each water system must certify annually, in writing, to the state (using third-party or manufacturers certification) that when it uses epichlorohydrin to treat water, the combination of dose and monomer level does not exceed the levels specified, as follows: 0.01 percent dosed at 20 mg/L (or equivalent). State Drinking Water Guidelines: Arizona 3.5 μg/L; Maine 35 μg/L; Florida 3.0 μg/L.

Determination in Water: A purge-and-trap gas chromatographic (GC)/mass spectrometric procedure for the determination of volatile organic compounds may be used for epichlorohydrin according to EPA[48].

Routes of Entry: Inhalation, skin absorption, ingestion, and skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Epichlorohydrin is corrosive to the eyes, skin, and respiratory tract. Inhalation can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. May affect the nervous system. Exposure may result in unconsciousness. Acute exposure to epichlorohydrin may result in nausea, vomiting, and abdominal pain. Liver and kidney effects may be observed. The respiratory tract may become irritated; dyspnea (shortness of breath) may occur; and in acute cases, respiratory paralysis has been observed. CNS and respiratory depression have been noted. *Inhalation:* Levels below 0.05 ppm have not caused adverse effects. Levels above 20 ppm may cause fatigue, stomach pains, nausea, vomiting, slowed breathing; loss of muscle strength and Blue coloration of the skin. *Skin:* May cause severe blistering, burns, and severe pain which may be delayed. Skin absorption may cause or increase the severity of symptoms listed above. *Eyes:* Levels above 5 ppm may cause severe irritation or burns. Direct contact of the liquid may cause clouding of the cornea and tissue death. *Ingestion:* May cause nausea and stomach pain. Animal studies indicate that the probable lethal dose for an adult is 14 grams (1/2 ounce).

Long-Term Exposure: Increased cancer risk. Stomach problems. Repeated or prolonged contact to epichlorohydrin may cause skin allergy to develop. Repeated or prolonged inhalation exposure may cause asthma. May decrease fertility in males. Repeated overexposure may cause changes in the eyes and lungs; kidney and liver damage and chronic asthmatic bronchitis. Epichlorohydrin causes cancer and changes in the genetic material of laboratory animals; and has been linked to cancers and change in the genetic material of occupationally exposed humans. There is some evidence of lung cancer in humans.

Points of Attack: Eyes, skin, respiratory system, stomach, kidneys, liver, and reproductive system. *Cancer site* (in animals): nasal cancer.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function tests. Consider chest X-ray after acute overexposure. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical

facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Epichlorohydrin slowly penetrates rubber, so all contaminated clothing should be thoroughly washed. 8 hours: Barricade coated suits, Trellchem HPS suits; Trychem 1000 suits; 4 hours: 4 H and Silver Shield gloves, Responder suits. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOvAg (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor and acid gas canister]; or SCBAE (any appropriate escape-type, SCBA).

Storage: (1) Color code-Blue: Health Hazard/Poison: Store in a secure poison location. (2) Color code-Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Epichlorohydrin must be stored to avoid contact with strong oxidizers (such as chlorine, bromine and fluorine), strong acids (such as hydrochloric, sulfuric, and nitric), and chemically active metals (such as aluminum, caustics, chlorides of iron and aluminum and zinc), since violent reactions occur. Sources of ignition, such as smoking and open flames, are prohibited where epichlorohydrin is handled, used, or stored. Metal containers involving the transfer of five gallons or more of epichlorohydrin should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Where possible, automatically pump liquid from drums or other storage containers to process containers. Use only nonsparking tools and equipment, especially when opening and closing containers of epichlorohydrin. Wherever epichlorohydrin is used, handled, manufactured, or stored, use explosion proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2023 Epichlorhydrin, Hazard class: 6.1; Labels: 6.1-Poisonous materials, 3-Flammable liquid.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Establish forced ventilation to keep levels below explosive limit. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include hydrogen chloride and oxides of carbon. Use water spray, dry chemical, foam or carbon dioxide. Water spray may be used to dilute spills to nonflammable mixtures. If leak or spill has not ignited, use water spray to disperse the vapors. Evacuate for a radius of 1500 ft. Isolate for one-half mile in all directions if tank car or truck is involved in fire. Epichlorohydrin may react violently with water. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced[22]. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(109); (102); (31); (173); (101); (138); (100).

National institute for Occupational Safety and Health (NIOSH), "*Criteria for a Recommended Standards: Occupational Exposure to Epichlorohydrin,*" NIOSH Document Number 76-206, Cincinnati OH (1976)

United States Environmental Protection Agency, *Epichlorohydrin, Health and Environmental Effects Profile No. 100*, Washington, DC, Office of Solid Waste (April 30, 1980)

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 4, 57−59 (1981) and 3, 68−71 (1983) and 6, No. 5, 50−51 (1986)

United States Environmental Protection Agency, Chemical Hazard Information Profile: *Epichlorohydrin*, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

New York State Department of Health, *Chemical Fact Sheet: Epichlorohydrin*, Bureau of Toxic Substance Assessment, Albany, NY (March 1986 and Version 2)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Epichlorohydrin*, Trenton, NJ (August 2001).

EPN E:0170

Formula: $C_{14}H_{14}NO_4PS$

Synonyms: *O*-Aethyl-*O*-*N*(4-nitrophenyl)-phenylmonothiophosphonat (German); ENT 17,798; *O*-Ester of *p*-nitrophenol with *O*-ethylphenyl phosphonothioate; Ethoxy-4-nitrophenoxyphenylphosphine sulfide; Ethyl *p*-nitrophenyl benzenethionophosphate; *O*-Ethyl *O*-(4-nitrophenyl) benzenethionophosphonate; Ethyl *p*-nitrophenyl benzenethionophosphonate; Ethyl *p*-nitrophenyl benzenethiophosphonate; *O*-Ethyl *O*-(4-nitrophenyl) phenyl phosphonothioate; *O*-Ethyl *O*,*p*-nitrophenyl phenyl phosphonothioate; Ethyl *p*-nitrophenyl phenylphosphonothioate; Ethyl *p*-nitrophenyl thionobenzenephosphate; *O*-Ethyl phenyl-*p*-nitrophenyl thiophosphonate; Pin; Santox; Thionobenzenephosphonic acid ethyl *p*-nitrophenyl ester

CAS Registry Number: 2104-64-5

HSDB Number: 4049

RTECS Number: TB1925000

UN/NA & ERG Number: (PIH) UN3018 (organophosphorus pesticide, liquid, n.o.s.)/152; UN2783 (organophosphorus pesticides, solid, toxic)/152; UN2811 (toxic solid, organic, n.o.s.)/153

EC Number: 218-276-8 [*Annex I Index No.:* 015-036-00-2]

Regulatory Authority and Advisory Information

Hazard Alert: Poison inhalation hazard: exposure can be lethal, Neurotoxin (cumulative), Combustible, Drug; Suspected of causing genetic defects, Primary irritant (w/o allergic reaction), Environmental hazard.

Banned or Severely Restricted (several countries) (UN)[13]

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)

United States DOT 49CFR172.101, Inhalation Hazardous Chemical, as organic phosphate, Substance ID: EDF-041

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), severe pollutant.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, N; risk phrases: R27/28; R33; R50/53; R62; safety phrases: S1/2; S22; S36/37; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)]

Description: EPN is a light yellow crystalline solid with an aromatic odor (as a pesticide) or a brown liquid above 36°C. Molecular weight = 323.32; freezing/melting point = 36°C; vapor pressure = 3.4×10^{-7} mmHg @ 20°C. Hazard identification (based on NFPA-704 M Rating System): Health 4, Flammability 1, Reactivity 0. Insoluble in water.

Potential Exposure: EPN is used in preparation of emulsifiable, granular or wettable powder insecticides for cotton. A potential danger to those involved in the manufacture, formulation and application of this material.

Incompatibilities: Contact with oxidizers may cause the release of phosphorous oxides. Contact with strong reducing agents, such as hydrides; may cause the formation of flammable and toxic phosphine gas. Contact with alkalies causes decomposition (hydrolysis) producing *p*-nitrophenol.

Permissible Exposure Limits in Air

NIOSH IDLH = 5 milligram per cubic meter

OSHA PEL: 0.5 milligram per cubic meter TWA [skin]

NIOSH REL: 0.5 milligram per cubic meter TWA [skin]

ACGIH TLV [1]: 0.1 milligram per cubic meter TWA inhalable fraction [skin]; not classifiable as a human carcinogen (2000); BEIA issued as Acetylcholinesterase inhibiting pesticides.

PAC Ver. 29[138]

PAC-1: 0.45 milligram per cubic meter

PAC-2: 5 milligram per cubic meter

PAC-3: 50 milligram per cubic meter

DFG MAK: 0.5 milligram per cubic meter measured as the, inhalable fraction TWA; Peak Limitation Category II(2) [skin].

Australia: TWA 0.5 milligram per cubic meter, [skin], 1993; Austria: MAK 0.5 milligram per cubic meter, [skin], 1999; Belgium: TWA 0.5 milligram per cubic meter, [skin], 1993; Denmark: TWA 0.5 milligram per cubic meter, [skin], 1999; France: VME 0.5 milligram per cubic meter, [skin], 1999; the Philippines: TWA 0.5 milligram per cubic meter, [skin], 1993; Norway: TWA 0.5 milligram per cubic meter, 1999; Switzerland: MAK-W 0.5 milligram per cubic meter, [skin], 1999; the Netherlands: MAC-TGG 0.1 milligram per cubic meter, [skin], 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Several states have set guidelines or standards for EPN in ambient air[60] ranging from 5.0 μ/m^3 (North Dakota) to 10.0 μ/m^3 (Connecticut) to 12.0 μ/m^3 (Nevada).

Determination in Air: Use NIOSH (IV), Method #5012.

Permissible Concentration in Water: Japan[35] has set a effluent maximum of 1 mg/L and an environmental water quality standard of zero.

Determination in Water: Fish Tox = 1.51635000 ppb MATC (HIGH). Octanol-water coefficient: Log $K_{ow} = > 5.0$.

Determination in Soil: Soil Adsorption Index (Koc) = 4000 (Estimate).

Routes of Entry: Inhalation, ingestion, skin absorption, and skin and/or eye contact. Passes through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: A cholinesterase inhibitor. EPN can affect the nervous system; causing convulsions and possible respiratory failure. Exposure may result in unconsciousness or death. The effects may be delayed. Medical observation is indicated. This material may be fatal if swallowed. It is poisonous if inhaled and extremely hazardous by skin contact. Repeated exposure may, without symptoms, be increasingly hazardous. The estimated fatal oral dose is 0.3 grams for a 150 lb (70 kg) person. Acute exposure to EPN may produce the following signs and symptoms: pinpoint pupils; blurred vision; headache, dizziness, muscle spasms, and profound weakness. Vomiting, diarrhea, abdominal pain; seizures, and coma may also occur. The heart rate may decrease following oral exposure or increase following dermal exposure. Hypertension (high blood pressure) is not uncommon. Respiratory symptoms include dyspnea (shortness of breath), respiratory depression and respiratory paralysis. Giddiness, slurred speech; confusion, and psychosis may also be observed. A rebuttable presumption against pesticide registration was issued for EPN on September 19, 1979 by EPA on the basis of neurotoxicity. Human Tox = 0.07000 ppb (EXTRA HIGH).

Long-Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. EPN may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, cardiovascular system, CNS, eyes, skin, and blood cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1–2 weeks while red blood cell levels may be reduced for 1–3 months. When cholinesterase enzyme levels are reduced by 25% or more below pre-employment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates. NIOSH lists the following tests: Cholinesterase: blood serum, red blood cells/count; cholinesterase: red blood cells/count.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Up to 5 milligram per cubic meter Sa (APF = 10) (any supplied-air respirator); or SCBA (any SCBA with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with EPN all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area away from oxidizers.

Shipping: UN2783 Organophosphorus pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN3018 Organophosphorus pesticides, liquid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling:

Initial Isolation and Protective Action Distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24 h response line).

Small Spills (from a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.3/0.4
Night 0.8/1.2

Large Spills (from a large package or from many small packages)

First: Isolate in all directions (ft/m) 600/200
Then: Protect persons downwind (mi/km)
Day 1.4/2.3
Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Do not touch spilled material. Do not breathe vapors. Stay upwind; keep out of low areas. Remove all ignition sources. Ventilate area of spill or leak. This material is a combustible liquid. For a spill or leak of a combustible liquid, shut off ignition sources; no flares, smoking or flames in hazard area. Stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: Absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: Dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material may burn but does not ignite readily. Thermal decomposition products may include oxides of phosphorus, sulfur, nitrogen and carbon. For small fires, use dry chemicals, carbon dioxide; water spray; or foam. For large fires, use water spray, fog, or foam. Stay upwind; keep out of low areas. Move containers from fire area if you can do it without risk. Dike fire control water for later disposal; do not scatter the material. Wear positive pressure breathing apparatus and special protective clothing. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Fight fire from maximum distance. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: EPN plant wastes are treated by preaeration, activated sludge treatment; recycle, chlorination and final polishing where additional natural biological stabilization occurs. EPN is also relatively rapidly hydrolyzed in alkaline solution to benzene thiophosphoric acid; alcohol and *p*-nitrophenol and soil burial with alkali may be used. For large quantities, however, incineration is recommended[22]. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (80); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: *EPN*, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: EPN*, Trenton NJ (May 1999)

Epoxy ethyloxy propane E:0180

Formula: $C_5H_{10}O_2$

Synonyms: 1,2-Epoxy-3-ethoxy-propane (DOT); (Ethoxymethyl)oxirane; Ethyl glycidyl ether; Oxirane, (ethoxymethyl); Ppropane, 1,2-epoxy-3-ethoxy-

CAS Registry Number: 4016-11-9

HSDB Number: 6080
RTECS Number: TZ3200000
UN/NA & ERG Number: UN2752/127
EC Number: 223-671-3

Regulatory Authority and Advisory Information

Hazard Alert: Suspected reprotoxic hazard.

Hazard symbols, risk, & safety statements: Hazard symbol: Xi, Xn, N; risk phrases: R10; R22; R36/37/38; R51/53; safety phrases: S16; S26; 37/39; S61; S41 (see Appendix 4). WGK[100] (German Aquatic Hazard Class): No value found. [2-Hazard to water. (est.)]

Description: Epoxy ethyloxy propane is a colorless, highly flammable, polymerizable liquid. Molecular weight = 102.15. Flash point = (approx.) 37°C. Mixes with water; may partially decompose.

Potential Exposure: It has limited commercial use in organic synthesis.

Incompatibilities: Polymerizable. Keep away from strong oxidizers, heat, flames.

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Routes of Entry: Epoxy ethyloxy propane can affect you when breathed in and by passing through your skin.

Harmful Effects and Symptoms

Short-Term Exposure: Contact can irritate or burn the eyes and skin with possible permanent damage. Exposure can irritate the eyes, nose and throat. Higher levels can irritate the lungs, causing coughing and/or shortness of breath. Very high levels could cause you to feel dizzy, lightheaded, and pass out. Pulmonary edema may develop.

Long-Term Exposure: Epoxy ethyloxy propane can cause a skin allergy to develop. Similar very irritating substances can affect the lungs.

Points of Attack: Skin, and lungs.

Medical Surveillance: For those with frequent or potentially high exposure, the following are recommended before beginning work and at regular times after that. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid, unless full facepiece respiratory protection is worn. Wear dust-proof goggles and face shield when working with powders or dust, unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures to epoxy ethyloxy propane exists, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where epoxy ethyloxy propane is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: UN2752 1,2-Epoxy-3-ethoxypropane, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Keep 1,2-epoxy-3-ethoxypropane out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Epoxy Ethyloxy Propane*, Trenton, NJ (May 2000)

EPTC E:0185

Formula: $C_9H_{19}NOS$

Synonyms: Alirox; Carbamic acid, dipropylthio-, *S*-ethyl ester; Carbamothioic acid, dipropyl -, *S*-ethyl ester; Caswell No. 435; Dipropylcarbamothioic acid *S*-ethyl ester; EPTAM 2.3G (granular, 2.3% by weight); EPTAM 10G (granular, 10% by weight); EPTAM; EPTAM 6E; Eradicane; Ethyl di-*N*-Propylthiolcarbamate; Ethyl *N,N*-di-*N*-propylthiolcarbamate; Ethyl *N,N*-dipropylthiolcarbamate; Ethyl *N,N*-dipropylthiocarbamate; Ethyl dipropylthiocarbamate; FDA 1541; GENEP EPTC; *N,N*-Dipropylthiocarbamic acid *S*-ethyl ester; NSC 40486; R-1608; *S*-Ethyl dipropylcarbamothioate; *S*-Ethyl dipropylthiocarbamate; *S*-Ethyl-*N,N*-Di-*N*-propylthiocarbamate; *S*-Ethyldipropylthiocarbamate; Shortstop; Stauffer R 1608; Torbin

CAS Number: 759-94-4

HSDB Number: 394 as EPTAM

RTECS Number: FA4550000

UN/NA & ERG Number: UN2902 (Pesticides, liquid, toxic, n.o.s)/151

EC Number: 212-073-7 [*Annex I Index No.:* 006-030-00-0]

Regulatory Authority and Advisory Information

Carcinogenicity[83]: EPA, Not likely to be carcinogenic to humans.

California Proposition 65 Chemical[102]: Developmental/ Reproductive toxin (4/27/1999)

Hazard Alert: Poison, Neurotoxin (cumulative), Suspected of causing genetic defects, Developmental toxin (TRI), Water reactive, Agricultural chemical.

Potential Ground water Pollutant [California FAC Section 13145(d)/12811, active]

EPA Hazardous Waste Number (RCRA No.): U390

RCRA Universal Treatment Standards: Wastewater (mg/L), 0.003; Non-wastewater (mg/kg), 1.4

EPCRA Section 313 Form R *de minimus* concentration reporting level: 1.0%

Hazard symbols, risk, & safety statements: Hazard symbol: Xn; risk phrases: R22; R50/53; safety phrases: S2; S23 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Light yellow liquid or yellow granular material. Commercial products may be in the form of dusts, sprays, solutions, wettable powder suspensions or emulsions. Molecular weight = 189.35; specific gravity (H_2O:1) = 0.995 @ 20°C; boiling point = 127.22°C at 20 mmHg[88]; vapor pressure = 0.034 mmHg @ 35°C[88]; 2.4×10^{-2} mmHg @ 25°C[83,161]; flash point = 115°C. ₩ Low solubility in water; solubility = < 1 mg/mL@ 22.5°C[88]; 370 ppm. Slow decomposition in water, releasing carbon disulfide and propyl amine. Physical and toxicological properties may be affected by carrier solvents in commercial formulations.

Potential Exposure: EPTC is a pre-emergence and early postemergence thiocarbamate herbicide used to control the growth of germinating annual weeds, including broadleaves, grasses, and sedges. It is used in every region of the United States in the production of a wide variety of food crops. The heaviest usage is in the Corn Belt, Northeastern and Mid-Atlantic states, Coastal and Northern Great Plains and in the Pacific Northwest on corn, potatoes, sweet potatoes, dry beans, peas, alfalfa, and snap beans. EPTC is also used on home-grown vegetables and ornamentals. Some formulations are Restricted Group Pesticides (RUP)

Incompatibilities: Thiocarbamate esters are combustible. They react violently with powerful oxidizers such as calcium hypochlorite. Thermal decomposition of thiocarbamate compounds include carbon disulfide, oxides of sulfur, oxides of nitrogen, hydrogen sulfide, ammonia, and methylamine. Thio and dithiocarbamates slowly decompose in aqueous solution to form carbon disulfide and methylamine or other amines. Such decompositions are accelerated by acids. Flammable gases are generated by the combination of thiocarbamates with aldehydes, nitrides, and hydrides. Thiocarbamates are incompatible with acids, peroxides, and acid halides.

Determination in Water: Octanol-water coefficient: Log $K_{ow} = >3.0$. Values at or above 3.0 are likely to bioaccumulate in marine organisms. Fish toxicity (threshold)[101]: Very low−1848.27939 ppb, MATC (Maximum Acceptable Toxicant Concentration).

Routes of Entry: Inhalation, ingestion, and dermal and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Unlike carbamates the thiocarbamates are not cholinesterase inhibitors, but some of them may react with recently ingested alcohol or alcohol-containing products including wine, medications, and cold remedies such as cough-sirups. Low toxicity. Concentrated solutions are slightly corrosive to eyes and mucous membranes. Dust inhalation can cause irritation of the respiratory system with sneezing. Eye contact can cause irritation, watering, pain, and inflammation of the eyelids. Dermal contact can cause irritation and minor ulceration. Ingestion can cause nausea, vomiting, fever, muscle twitching, seizure, rapid respiration, slow heartbeat. Severe exposure may result in death. LD_{50} (oral, rat) = 900−1000 mg/kg; LD_{50} (dermal, rat) = > 3000 mg/kg.

Long-Term Exposure: A cholinesterase inhibitor. A neurotoxin. Human toxicity (long term)[101]: Very low−175.00 ppb, Health advisory.

Points of Attack: Respiratory system, CNS, cardiovascular system, skin, and eyes.

Medical Surveillance: Preliminary medical exam to detect chronic diseases of CNS, liver, heart, kidneys, lung and skin, as well as endocrinological or immunological disturbances, should protect susceptible individuals. Periodical medical exams of internal organs, skin and eyes are important to avoid chronic occupational intoxications. They should include lab and patch tests when necessary[83]. Comprehensive physical examination with emphasis on the genito-urinary tract analysis to include sperm count, motility and morphology. Other tests, such as serum testosterone, serum follicle stimulating hormone (FSH), and serum lutenizing hormone (LH) may be carried out if, in the opinion of a physician, they are indicated. Medical observation is recommended for 24 to 48 hours following breathing overexposure, as pulmonary edema may be delayed. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. Before employment and at regular times after that, the following are recommended: If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider complete blood count (CBC) and chest x-ray following acute overexposure

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious and able to swallow, have victim drink four to eight ounces of water. Do not induce vomiting. *Note to physician or authorized medical personnel*: Medical observation is recommended for 24 to 48 hours following breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic might consider administering a drug or other inhalation therapy. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure.

Personal Protective Methods: Reacts with the following absorbent materials: Cellulose-Based; Mineral-and Clay-Based; Dirt/Earth[88]. Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of dermal and/or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100 F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code-Blue: Health Hazard/Poison. Store in a secure poison location. Prior to working with diallate all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area away from alkalies. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN2902 Pesticides, liquid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: A combustible liquid. Thermal decomposition products may include oxides of nitrogen, sulfur, and carbon. *On a small fire:* Use dry chemical, CO_2 or water spray. On a large fire: Use water spray, fog or regular foam. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal; do not scatter the material. Use water spray or fog; do not use straight streams. *Fire involving storage or vehicular tanks:* Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Do not get water inside containers. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. ALWAYS stay away from tanks engulfed in fire. For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. A pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Land burial is acceptable for small quantities. Larger quantities can be incinerated. (EPTC is combustible and could be incinerated. Recommendable method: Incineration. Peer-review: Incineration in a unit with effluent gas scrubbing is recommendable for large amount. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(102); (31); (173); (101); (138); (100).

EXTOXNET, Extension Toxicology Network, "*Pesticide Information Profile, EPTC*," Oregon State University, Corvallis, OR (June 1996). http://extoxnet.orst.edu/pips/eptc.htm

United States Environmental Protection Agency, "*Reregistration Eligibility Decision (RED), Facts EPTC*," Office of Prevention, Pesticides and Toxic Substances, Washington, DC (September 1999). http://www.epa.gov/REDs/factsheets/0064fact.pdf

Ergocalciferol E:0190

Formula: $C_{28}H_{44}O$

Synonyms: Activated ergosterol; D-Arthin; Calciferol; Calciferon; Candacaps; Condocaps; Condol; Crtron; Crystallina; Dacitin; Daral; Davitamon D; Decaps; Dee-Osterol; Dee-Ron; Dee-Ronal; Dee-Roual; Deltalin; Deratol; Detalup; Diactol; Ergorone; Ergosterol; Ergosterol, activated; Ertron; 1,2-Ethylidene dichloride; Fortodyl; Geltabs; Hi-Deratol; Infron; Irradiated; Irradiated ergosta-5,7,22,-trien-3-β-ol; Metadee; Mulsiferol; Mykostin; Oleovitamin D; Ostelin; Radiostol; Radsterin; 9,10, Secoergosta-5,7,10(19), 22-tetraen-3-β-ol; Shock-Ferol; Sterogly; Vigantol; Viosterol; Vitamin D2; Vitavel-D

CAS Registry Number: 50-14-6

HSDB Number: 819

RTECS Number: KE1050000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154; UN3249 (Medicines, toxic, solid, n.o.s.)/151

EC Number: 200-014-9 [*Annex I Index No.:* 603-179-00-9]

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Natural Product (Ergosterol); Suspected of causing genetic defects. DOT regulated (see 49CFR173.4); small quantity provisions apply.

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 1000/10,000 lb (454/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1000 lb (454 kg).

Hazard symbols, risk, & safety statements: Hazard symbol: T+; risk phrases: R24/25; R26; R48/25; R51; safety phrases: S1/2; S28; S36/37; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [2-Hazard to water. (est.)].

Description: Ergocalciferol is an odorless white crystalline solid. Molecular weight = 396.72; freezing/melting point = 116°C. Practically insoluble in water.

Potential Exposure: Used as a nutrient and/or dietary supplement food additive.

Incompatibilities: Dust may be combustible and may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides.

Permissible Exposure Limits in Air

PAC Ver. 27, no values found in Ver. 29[138]

PAC-1: 3.6 milligram per cubic meter

PAC-2: 40 milligram per cubic meter

PAC-3: 40 milligram per cubic meter

Routes of Entry: Inhalation and skin or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Highly toxic. Ergocalciferol in a single acute ingestion presents no toxic hazard. Daily ingestion in excess of 5000 units/day in children or 7500 units/day in adults will produce toxic symptoms associated with hypervitaminosis D. Initial symptoms of ergocalciferol poisoning include anorexia, nausea and vomiting. It often mimics hyperparathyroidism with thirst, muscular weakness, nervousness, kidney impairment, hypertension, and excessive urination. LD_{50} = (oral-rat) 10 mg/kg.

Long-Term Exposure: Ergocalciferol poisoning disturbs calcium metabolism and causes kidney damage.

Medical Surveillance: Kidney and other organ function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN3249 Medicine, solid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft[70]. Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Oil-skimming equipment may be used to remove slicks from water. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide; water spray; or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dispose of contents and container to an approved waste disposal plant. All federal, state, and local environmental regulations must be observed. It is inappropriate and possibly dangerous to the environment to dispose of expired or waste drugs and pharmaceuticals by flushing them down the toilet or discarding them to the trash. Household quantities of expired or waste pharmaceuticals may be mixed with wet cat litter or coffee grounds, double-bagged in plastic, discard in trash. Larger quantities shall carefully take into consideration applicable DEA, EPA, and FDA regulations. If possible return the pharmaceutical to the manufacturer for proper disposal being careful to properly label and securely package the material. Alternatively, the waste pharmaceutical shall be labeled, securely packaged and transported by a state licensed medical waste contractor to dispose by burial in a licensed hazardous or toxic waste landfill or incinerator.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: *Ergocalciferol*, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Ergocalciferol*, #2391, Trenton, NJ, (April 20071998)

Ergotamine tartrate E:0200

Formula: $C_{70}H_{76}N_{10}O_{16}$; $C_{66}H_{70}N_{10}O_{10} \cdot C_4H_6O_6$

Synonyms: Ercal; Ergam; Ergate; Ergomar; Ergostat; Ergotamine bitartrate; Ergotartrate; Etin; Exmigra; Femergin; Gotamine tartrate; Gynergen; Lingraine; Lingran; Medihaler ergotamine; Migraine Dolviran; Neo-Ergotin; Rigetamin; Secagyn; Secupan; Tartrato de ergosterol (Spanish)

CAS Registry Number: 379-79-3

HSDB Number: 4076

RTECS Number: KE8225000

UN/NA & ERG Number: UN1544 (Alkaloids, solid, n.o.s.)/151; UN2811 (Toxic solid, organic, n.o.s.)/154

EC Number: 206-835-9

Regulatory Authority and Advisory Information

California Proposition 65 Developmental/Reproductive toxin 4/1/90 Hazard Alert: Poison, Combustible, Reproductive toxin,

List 1, DEA Chemical Code 8676 (Title 21 CFR1310.02), Ergotamine and its salts

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg)

Description: Ergotamine tartrate is a crystalline solid. Molecular weight = 1313.56; freezing/melting point = (decomposes) 203°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Slightly soluble in water; solubility = < 1 mg/mL @ 20°C.

Potential Exposure: (Toxicity evaluation)[77]; Suspected reprotoxic hazard, Suspected of causing genetic defects. The major uses of the ergot alkaloids fall into two categories: applications in obstetrics and treatment of migraine headaches. May be used in the production of “street” drugs.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, light, and heat.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 0.91 milligram per cubic meter

PAC-2: 10 milligram per cubic meter

PAC-3: 32 milligram per cubic meter

Routes of Entry: Inhalation and ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Has high oral toxicity and acts as a convulsant in humans. People with liver damage are at a greater risk. Nausea and vomiting occur in some patients after oral administration. Weakness in the legs is common and muscle pains in the extremities may occur. Numbness and tingling of the fingers and toes may also occur.

Long-Term Exposure: May cause liver damage.

Points of Attack: Liver, nervous system, and cardiovascular system.

Medical Surveillance: Liver function tests.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft[70]. Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Stay upwind; keep out of low areas. Do not touch spilled material; stop leak if you can do so without risk. Use water vapor to reduce vapors. Absorb spills with sand or other noncombustible absorbent material. *Small dry spills*: With clean shovel place material into clean, dry container and cover; move containers from spill area. For *large spills*, dike far ahead of spill for later disposal. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Thermal decomposition products may include oxides of nitrogen and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138).

United States Environmental Protection Agency, Chemical Hazard Information Profile: *Ergotamine Tartrate*, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 3, 64–65 (1981)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Eergotamine tartrate*, Trenton, NJ (June 2002)

Esfenvalerate E:0207

Formula: $C_{25}H_{22}ClNO_3$

Synonyms: Americare; Asana; Asana DPX-YB656-84; Asana-XL; Benzeneacetic acid, 4-chloro-α-(1-methylethyl)-cyano (3-phenoxyphenyl)methyl ester, [*s*-(R*,R*)]-; [*S*-(R*, R*)]-4-Chloro-α-(1-methylethyl)benzeneacetic acid, cyano (3-phenoxyphenyl)methyl ester; (*S*)-α-Cyano-3-phenoxybenzyl (*S*)-2-(4-chlorophenyl)isovalerate; Enforcer; Evercide; Fenvalerate A-α; HalmarK; OMS-3023; *s*-(R*, R*)-Cyano (3-phenoxyphenyl) methyl 4-chloro-2-(1-methylethyl) benzene-; S-1844; S-5602 ALPHA; *s*-Fenvalerate (*S*)-α-cyano-3-phenoxybenzyl (*S*)-2-(4-chlorophenyl)-3-methylbutyrate; SS-Pydrin; SUMI-ALFA; SUMI-ALPHA; Sumicidin A-ALPHA

CAS Number: 66230-04-4

HSDB Number: 6625

UN/NA & ERG Number: UN3352 (liquid)/151; UN3349 (pyrethroid pesticide, solid, toxic)/151

EC Number: [*Annex I Index No.:* 608-058-00-4]

Regulatory Authority and Advisory Information

Carcinogenicty: EPA Group E, Evidence of noncarcinogenicity for humans.

Hazard Alert: Poison, Environmental hazard, Sensitization hazard, Possible endocrine disruptor.

Permissible Exposure Limits for Chemical Contaminants (CAL/OSHA) as pyrethrum

Clean water act: Section 311 Hazardous Substances/RQ (same as CERCLA) as pyrethrins

Hazardous to aquatic life or environment, with possible long lasting effects[291,292].

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xi, N; risk phrases: R23/25; R43; R50/53; safety phrases: S1/2; S24; S29/35; S36/37/39; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Viscous yellow or amber liquid or white or amber crystalline solid. Molecular weight = 419.9; specific gravity (H 2 O:1) = 1.175 @ 25°C; boiling point = 160°C; freezing/melting point = 59.7°C; vapor pressure = 1.1×10^{-8} mmHg @ 20°C; 0.037 mmHg @ 25°C. Soluble in water; solubility = < 1 ppm @ 20°C.

Potential Exposure: Esfenvalerate is a synthetic pyrethroid Insecticide used to control wide range of pests such as moths, flies, beetles, and other insects. It is used on vegetable crops (soya beans, sugar cane), tree fruit, cotton, maize, sorghum and nut crops, and noncrop lands. It also is used on a wide variety of household pests. It is usually mixed with a wide variety of other types of pesticides such as carbamate compounds or organophosphates and has the naturally occurring compound fenvalerate for use in the United States Esfenvalerate is almost identical to fenvalerate. Much of the data for fenvalerate is applicable to the pesticide esfenvalerate (E:0207) because the two compounds contain the same components. The only differences in the two products are the relative proportions of the four separate constituents (isomers). Esfenvalerate has become the preferred compound because it requires lower applications rates than fenvalerate, is less chronically toxic, and is a more powerful insecticide. A United States Environmental Protection Agency Restricted Use Pesticide (RUP).

Incompatibilities: Oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); strong acids. Moisture may cause hydrolysis/decomposition.

Permissible Exposure Limits in Air:
NIOSH[2] IDLH = 5000 ppm
OSHA PEL: 5 milligram per cubic meter TWA
NIOSH REL: 5 milligram per cubic meter TWA
ACGIH TLV[1]: 5 milligram per cubic meter TWA
STEL set by HSE[33] = 10 milligram per cubic meter.

Determination in Air: Filter; none; Gravimetric; NIOSH IV[18] [Particulates NOR; #0500 (total), #0600 (respirable)]. Collection by impinger or fritted bubbler, analysis by gas liquid chromatography/ultraviolet. See NIOSH IV, Method #5008[18], pyrethrum.

Permissible Concentration in Water: Acceptable Daily Intake (ADI) = 0.02 mg/kg as pyrethroid

Determination in Water: Collection by impinger or fritted bubbler, analysis by gas liquid chromatography/ultraviolet. See NIOSH IV, #5008[18], pyrethrum. Octanol-water coefficient: Log $K_{ow} = > 6.0$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation and absorbed through the skin

Harmful Effects and Symptoms

Short-Term Exposure: Pyrethroids can affect you when breathed in and by passing through your skin. Irritates the eyes and respiratory tract. High exposure can affect the nervous system causing headache, nausea, vomiting, fatigue, and restlessness, rhinorrhea (discharge of thin nasal mucous). Highly toxic. May cause nausea, vomiting and abdominal pain if ingested. LD_{50} (oral, rat) = 90−450 mg/kg; LD_{50} (dermal, rat) = > 5 g/kg.

Long-Term Exposure: High or repeated exposure can cause lung allergy (with cough, wheezing and/or shortness of breath) or hay fever symptoms (sneezing, runny or stuffy nose). Allergic "pneumonia" can also occur with cough, chest pain, breathing difficulty and abnormal chest x-ray. Repeated attacks may lead to permanent scarring. Skin sensitizer; allergy may also develop with rash and itching, even with lower exposures. Dermal contact can cause rash with redness, blisters and intense itching. A severe generalized allergy can occur with weakness and collapse. May cause endocrine effects. May cause tumors.

Points of Attack: Respiratory system, skin (sensitizer), and CNS.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended: Employees should be screened for history of certain medical conditions which might place the employee at increased risk from pyrethroid exposure. Chronic respiratory disease: In persons with chronic respiratory disease, especially asthma, the inhalation of pyrethroids might cause exacerbation of symptoms due to its sensitizing properties. Lung function tests. These may be normal if the person is not having an attack at the time of the test. Consider chest x-ray if lung symptoms are present. Skin disease: Pyrethroids can cause dermatitis which may be allergic in nature. Persons with pre-existing skin disorders may be more susceptible to the effects of this agent. Evaluation by a qualified allergist, including exposure history and testing, may help diagnose allergy. Any employee developing the above-listed conditions should be referred for further medical examination[9].

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. *Do not induce vomiting when formulations containing petroleum solvents are ingested.* Otherwise, give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Applicators and other handlers must wear: Coveralls worn over long-sleeved shirt and long pants; Chemical-resistant gloves such as DuPont Tychem suit fabrics, barrier laminate, or Viton; Chemical-resistant footwear plus socks; Protective eye wear; Chemical-resistant headgear for overhead exposure; Chemical-resistant apron when cleaning equipment, mixing, or loading[83]. Agricultural Use/Engineering Controls: When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the Worker Protection Standard (WPS) for agricultural pesticides, 40 CFR 170.240(d)(4−6), the handler PPE requirements may be reduced or modified as specified in the Worker Protection Standard. Firefighters should wear NIOSH approved SCBA and full protective clothing.

Respirator Selection: NIOSH/OSHA *for pyrethrum*: 50 milligram per cubic meter: CcrOv95 (APF = 10) [any air-purifying half-mask respirator equipped with an organic vapor cartridge(s) in combination with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). 125 milligram per cubic meter*:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOvHie (APF = 25) (any air-purifying full facepiece respirator equipped with an organic vapor cartridge in combination with a high-efficiency particulate filter).250 milligram per cubic meter*:* CcrFOv100 (APF = 50) [any air-purifying full facepiece respirator equipped with organic vapor cartridge(s) in combination with an N100, R100, or P100 filter]; or PaprTOvHie (APF = 50) [any powered, air-purifying respirator with a tight-fitting facepiece and organic vapor cartridge(s) in combination with a high-efficiency particulate filter]; or SCBAF (APF = 50) (any SCBA with full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). 5000 milligram per cubic meter: SaF:Pd, Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd, Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code-Blue: Health Hazard/Poison. Store in a secure poison location at temperature <35°C and away from alkaline materials. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN3349 Pyrethroid pesticide, solid toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous material. UN3352 Pyrethroid pesticide, liquid toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: First remove all sources of ignition. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Ventilate area of spill or leak. Use water spray to reduce vapor.

Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include hydrogen chloride and oxides of sulfur and carbon. *On a small fire:* Use dry chemical, CO_2 or water spray. On a large fire: Use water spray, fog or regular foam. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal; do not scatter the material. Use water spray or fog; do not use straight streams. *Fire involving storage or vehicular tanks:* Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Do not get water inside containers. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. ALWAYS stay away from tanks engulfed in fire. For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies.

Disposal Method Suggested: Incineration would be an effective disposal procedure where permitted. If an efficient incinerator is not available, the product should be mixed with large amounts of combustible material and contact with the smoke should be avoided. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers.

References

(31); (173); (101); (138); (100).

EXTOXNET, Extension Toxicology Network, "*Pesticide Information Profile, Esfenverate*," Oregon State University, Corvallis, OR (June 1996). http://extoxnet.orst.edu/pips/esfenval.htm

United States Environmental Protection Agency, Office of Pesticide Programs, *Pesticide Residue Limits: "Esfenvalerate,"* 40 CFR 180.533, http://www.epa.gov/pesticides/food/viewtols.htm

Estradiol 17b E:0210

Formula: $C_{18}H_{24}O_2$

Synonyms: Altrad; Bardiol; Dihydroxyestrin; Dihydroxy follicular hormone; Oestra-1,3,5(10)triene-3,17-β-diol; Syndiol

CAS Registry Number: 50-28-2; 57-63-6 (Estradiol, 17-ethynyl-)
HSDB Number: 3589
RTECS Number: KG2975000
UN/NA & ERG Number: UN3249 (Medicine, solid, toxic, n.o.s.)/151
EC Number: 200-023-8; 200-342-2 (Estradiol, 17-ethynyl-)

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human Sufficient Evidence; Animal Limited Evidence (Equigyne), *carcinogenic to humans*, Group 1, 1998; NTP 13th Report on Carcinogens[10]
California Proposition 65 Chemical[102]: Cancer 1/1/1988.
Hazard Alert: Poison, Combustible.

Description: Estradiol, 17-β-is an odorless white to yellow crystalline substance. Molecular weight = 272.42; boiling point = (decomposes); freezing/melting point = 173°C−179°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Insoluble in water.

Potential Exposure: The working environment may be contaminated during sex hormone manufacture, especially during the extraction and purification of natural steroid hormones; grinding of raw materials; handling of powdered products and recrystallization. Airborne particles of sex hormones may be absorbed through the skin, ingested or inhaled. Enteric absorption results in quick inactivation of sex hormones in the liver. The rate of inactivation is decreased for the oral, alkylated steroid hormones (methyl testosterone, anabolic steroids, etc.). Sex hormones may accumulate and reach relatively high levels even if their absorption is intermittent. Consequently, repeated absorption of small amounts may be detrimental to health. Intoxication by sex hormones may occur in almost all the exposed workers if preventive measures are not taken. The effect in the industrial sector is more successful than the agricultural one (chemical caponizing of cockerels by stilbestrol implants and incorporation of estrogens in feed for body weight gain promotion in beef cattle), where measures taken are summary and the number of cases of intoxication is consequently bigger.

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices. *Note:* An industrial guideline of 0.05 μg airborne (estrogen dust)/m^3 TWA (8 h work-day) was adopted at one manufacturing company.

Routes of Entry: Ingestion and inhalation.

Harmful Effects and Symptoms

Adverse Effects of Estrogens in Men: Anorrhexia, nausea, vomiting, edema; a feminization syndrome characterized by gynecomastia (uni-or bi-lateral); increased pigmentation of the areollae; tenderness of the nipples, with or without secretion, slight loss of libido with difficulty in erection, with or without involution of the secondary sex organs; and sterility (by inhibition of spermatogenesis), may occur. Urinary estrogens are increased. A differential diagnosis of breast tumors in men occupationally exposed to estrogen is needed. Gynecomastia may occur in cases of functional insufficiency of organs involved in the metabolism of estrogens (chronic liver or kidney diseases); or of increased endogenous estrogen synthesis by neoplastic growths, such as pituitary, adrenal and testicular tumors or ectopic secretion of gonadotropins or prolactin by lung tumors. Endocrinopathies may be accompanied by gynecomastia. The conversion of androgen into estrogen may explain the occurrence of gynecomastia in the case of gonadotropin or androgen excess in men. Some drugs (spironolactone, digitalis, etc.) may induce gynecomastia. Physiological gynecomastia at birth, puberty and old age; as well as the possibility of the occurrence of breast cancer in men, should be also considered.

Adverse Effects of Estrogen in Women: Prolonged estrogen therapy has caused malignant endometrial changes in predisposed persons. Endometrial hyperplasia and endometrial carcinoma occurred also, after exposure to diethylstilbestrol. Clear cell adenocarcinoma of the vagina and cervix uteri occurred in young women exposed prenatally to diethylstilbestrol or other nonsteroidal estrogens. Women treated with estrogen may complain of menstrual disorders; nausea, headaches, etc. Similar effects were observed during occupational exposure to natural or synthetic estrogens and oral contraceptives. Menstrual disorders were frequent. Menorrhagia occurred in women workers with endometrial hyperplasia. In menopausal women, diethylstilbestrol may produce abnormal uterine bleeding, which often leads to suspicion of cancer of the uterine body. Manifestations like metrorrhagia, nausea and headache usually disappear after discontinuance of exposure. Excess of progesterone may be responsible for weight gain, acne, mastalgia, breast enlargement and recurrent monilial virginities. Toxicity may also include headache, nausea, chloasma, breakthrough bleeding; weight gain; loss of libido; cholestatic liver damage; sterility may also occur.

Medical Surveillance: Persons directly involved in the hazardous sectors of manufacture should be examined every 2 weeks. Persons engaged in the pharmaceutical stage of manufacture should be examined monthly. The frequency of the physical examination of the employees should increase with the age of the worker. Feminization in men, masculinization or menstrual disorders in women; changes in certain metabolic parameters and other symptoms detrimental to health, are indications for changing the workplace. Before admission of a new employee a very careful health examination will serve to exclude persons at risk, namely women of childbearing age, epileptics (steroid hormones may increase the frequency of seizures by changes in fluid retention) and persons with hepatic insufficiency, for example.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately

with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Adequate preventive measures, taken in the pharmaceutical industry, have succeeded in eliminating the occurrence of intoxications almost completely. The airpolluting processes are isolated in areas having adequate exhaust facilities and hermetically sealed machines. The isolated areas are entered only by workers wearing special clothing including underwear, stockings; long-sleeved overalls (with no pockets) buttoned to the neck and with ties at the bottom of the trousers for tying over the boots, rubber gloves, head cover and dust respirators. Air-supplied vinyl suits may be used by the groups at highest risk. When workers leave the polluted area they should undress, take a shower; wash their hair; clean their nails and put on their own clothes if the working day is over. Workers indirectly exposed to hormonal dust (i.e., mechanics who change the filters in the ventilation system) must also be provided with adequate protective equipment. The contaminated work clothing should be thoroughly cleaned. Disposable paper garments can be burned. Gloves should be rinsed with acetone or methanol, then washed and dried. Respiratory protection equipment should also be cleaned before reuse. Workrooms must be kept very clean. An alkaline detergent has been found to be most suitable for washing clothes and wiping surfaces. Mixers, stirring rods, spatulas, glassware, dishes, etc., should be rinsed after use with acetone or methanol in a hood or near a vacuum; and then washed in the conventional manner. Methanol should be used on plastic items. It is important to inform workers of the risk represented by the work-place and to win their cooperation in lowering of occupational exposure; for example, not putting on rubber gloves after having worked barehanded; not rubbing the face or nose with contaminated gloves; not contaminating the inside of respirators by leaving them exposed to processing dust; not using outside the work area items which have been inside it (cigarettes, pipes, and handkerchiefs); and being alert to detect deficiencies in preventive measures. In some pharmaceutical companies, the workers alternate 1 week in the polluted areas with 2 weeks in another place of work. In other companies rotation is carried out only when signs of intoxication occur. If women are employed, the alternating work environment should respect their cyclic hormonal pattern. Workers who develop symptoms of chronic intoxication in the presence of a low concentration of hormones in the air must be FORBIDDEN to return to the polluted area. The effectiveness of preventive measures should be checked by analyses of the amount of hormonal compounds in the air of the working environment, and in the plasma of the employees; and by clinical examinations. The fact that cases of chronic intoxication may occur in spite of considerable efforts to minimize occupational exposure to sex hormones suggests the need for a closed system of the entire production process.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN3249 Medicine, solid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(109); (102); (31); (173); (101); (138).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 4, 59–60 (1981)

Parmeggiani, L., Ed., *Encyclopedia of Occupational Health & Safety*, Third Edition, Vol. 1, pp 1049–1052, Geneva, International Labor Office (1983)

Estrone E:0220

Formula: $C_{18}H_{22}O_2$
Synonyms: Follicular hormone; 3-Hydroxyestra-1,3, 5(10)-trien-17-one; 3-Hydroxy-17-keto-estra-1,3,5-triene; 3-Hydroxy-17-ketoestra-1,3,5-triene; 3-Hydroxy-1,3, 5(10)-oestratrien-17-one; 3-Hydroxy-oestra-1,3,5(10)-trien-17-one
CAS Registry Number: 53-16-7
HSDB Number: 3324
RTECS Number: KG8575000
UN/NA & ERG Number: UN3249 (Medicine, solid, toxic, n.o.s.)/151
EC Number: 200-164-5
Regulatory Authority and Advisory Information
Carcinogenicity: IARC: Human Sufficient Evidence; Animal Limited Evidence (Equigyne), *carcinogenic to humans*, Group 1, 1998; NTP 13th Report on Carcinogens[10]
California Proposition 65 Chemical[102]: Cancer 1/1/1988.
Hazard Alert: Poison, Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Drug.
Hazard symbols, risk, & safety statements: Hazard symbol: T, Xi; risk phrases: R45; R23/24/25; R34; R43; R60; R62; R63; safety phrases: S41; S45; S53 (see Appendix 4).
Description: Estrone is an odorless white crystalline powder. Molecular weight = 270.40; freezing/melting point = 258°C−262°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Insoluble in water.
Potential Exposure: Synthesized from ergosterol. Used in combination with progestogen as an oral contraceptive.
Incompatibilities: May react exothermically with reducing agents to generate flammable gaseous hydrogen. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides.
Permissible Exposure Limits in Air
No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices. *Note*: An industrial guideline of 0.05 μg airborne (estrogen dust)/m^3 TWA (8 h work-day) was adopted at one manufacturing company.
Routes of Entry: Ingestion and inhalation.
Harmful Effects and Symptoms
Adverse Effects of Estrogens in Men: Anorrhexia, nausea, vomiting, and edema; a feminization syndrome characterized by gynecomastia (uni-or bi-lateral); increased pigmentation of the areollae; tenderness of the nipples, with or without secretion; slight loss of libido with difficulty in erection; with or without involution of the secondary sex organs; and sterility (by inhibition of spermatogenesis) may occur. Urinary estrogens are increased. A differential diagnosis of breast tumors in men occupationally exposed to estrogen is needed. Gynecomastia may occur in cases of functional insufficiency of organs involved in the metabolism of estrogens (chronic liver or kidney diseases); or of increased endogenous estrogen synthesis by neoplastic growths, such as pituitary, adrenal and testicular tumors; or ectopic secretion of gonadotropins or prolactin by lung tumors. Endocrinopathies may be accompanied by gynecomastia. The conversion of androgen into estrogen may explain the occurrence of gynecomastia in the case of gonadotropin or androgen excess in men. Some drugs (spironolactone, digitalis, etc.) may induce gynecomastia. Physiological gynecomastia at birth, puberty and old age, as well as the possibility of the occurrence of breast cancer in men, should be also considered.
Adverse Effects of Estrogen in Women: Prolonged estrogen therapy has caused malignant endometrial changes in predisposed persons. Endometrial hyperplasia and endometrial carcinoma occurred also after exposure to diethylstilbestrol. Clear cell adenocarcinoma of the vagina and cervix uteri occurred in young women exposed prenatally to diethylstilbestrol or other nonsteroidal estrogens. Women treated with estrogen may complain of menstrual disorders; nausea, headaches, etc. Similar effects were observed during occupational exposure to natural or synthetic estrogens and oral contraceptives. Menstrual disorders were frequent. Metrorrhagia was observed in women who started to work. Menorrhagia occurred in women workers with endometrial hyperplasia. In menopausal women, diethylstilbestrol may produce abnormal uterine bleeding, which often leads to suspicion of cancer of the uterine body. Manifestations like metrorrhagia, nausea and headache, usually disappear after discontinuance of exposure. Excess of progesterone may be responsible for weight gain, acne, mastalgia and breast enlargement and recurrent monilial virginities. Toxicity may also include headache, nausea, chloasma, breakthrough bleeding; weight gain; loss of libido; cholestatic liver damage; sterility may also occur.
Long-Term Exposure: Confirmed carcinogen.
Medical Surveillance: Persons directly involved in the hazardous sectors of manufacture should be examined every 2 weeks. Persons engaged in the pharmaceutical stage of manufacture should be examined monthly. The frequency of the physical examination of the employees should increase with the age of the worker. Feminization in men, masculinization or menstrual disorders in women, changes in certain metabolic parameters and other symptoms detrimental to health, are indications for changing the workplace.

Before admission of a new employee a very careful health examination will serve to exclude persons at risk, namely women of childbearing age, epileptics (steroid hormones may increase the frequency of seizures by changes in fluid retention) and persons with hepatic insufficiency, for example.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the

skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Adequate preventive measures, taken in the pharmaceutical industry, have succeeded in eliminating the occurrence of intoxications almost completely. The air polluting processes are isolated in areas having adequate exhaust facilities and hermetically sealed machines. The isolated areas are entered only by workers wearing special clothing including underwear, socks, long-sleeved overalls (with no pockets) buttoned to the neck and with ties at the bottom of the trousers for tying over the boots, rubber gloves, head cover, and dust respirators. Air-supplied vinyl suits may be used by the groups at highest risk. When workers leave the polluted area they should undress, take a shower; wash their hair; clean their nails and put on their own clothes if the working day is over. Workers indirectly exposed to hormonal dust (i.e., mechanics who change the filters in the ventilation system) must also be provided with adequate protective equipment. The contaminated work clothing should be thoroughly cleaned. Disposable paper garments can be burned. Gloves should be rinsed with acetone or methanol, then washed and dried. Respiratory protection equipment should also be cleaned before re-use. Workrooms must be kept very clean. An alkaline detergent has been found to be most suitable for washing clothes and wiping surfaces. Mixers, stirring rods, spatulas, glassware, dishes, etc., should be rinsed after use with acetone or methanol in a hood or near a vacuum, and then washed in the conventional manner. Methanol should be used on plastic items.

It is important to inform workers of the risk represented by the work-place and to win their cooperation in lowering of occupational exposure; for example, not putting on rubber gloves after having worked barehanded; not rubbing the face or nose with contaminated gloves, not contaminating the inside of respirators by leaving them exposed to processing dust; not using outside the work area items which have been inside it (cigarettes, pipes, and handkerchiefs), and being alert to detect deficiencies in preventive measures. In some pharmaceutical companies, the workers alternate 1 week in the polluted areas with 2 weeks in another place of work. In other companies rotation, is carried out only when signs of intoxication occur. If women are employed, the alternating work environment should respect their cyclic hormonal pattern. Workers who develop symptoms of chronic intoxication in the presence of a low concentration of hormones in the air must be FORBIDDEN to return to the polluted area. The effectiveness of preventive measures should be checked by analyses of the amount of hormonal compounds in the air of the working environment, and in the plasma of the employees, by clinical examinations. The fact that cases of chronic intoxication may occur in spite of considerable efforts to minimize occupational exposure to sex hormones suggests the need for a closed system of the entire production process.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN3249 Medicine, solid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(109); (102); (31).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 4, 63–64 (1981)

Parmeggiani, L., Ed., *Encyclopedia of Occupational Health & Safety*, Third Edition, Vol. 1, pp 1049–1052, Geneva, International Labor Office (1983)

Ethalfluralin E:0225

Formula: $C_{13}H_{14}F_3N_3O_4$

Synonyms: Benzenamine, *N*-ethyl-*N*-(2-methyl-2-propenyl)-2,6-dinitro-4-(trifluoromethyl)-; Compound 94961; Cobex; El 161; *N*-Ethyl-*N*-(2-methyl-2-propenyl)-2,6-dinitro-4-(trifluoromethyl)benzenamine; Somilan; Sonalan; Sonalen

CAS Number: 55283-68-6

HSDB Number: 7545

RTECS Number: XU6200000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 259-564-3

Regulatory Authority and Advisory Information

Carcinogenicity: EPA. Group C, possible human carcinogen

Hazard Alert: Combustible, Possible sensitization hazard (skin), Possible environmental hazard.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N, Xi; risk phrases: R45; R29/35; R43; R50/53; R61; safety phrases: S29/35; S60; S61 (see Appendix 4) R43

Description: Yellow-orange crystalline solid. Mild amine odor. Commercial products and mixtures may contain flammable carriers (such as xylene); these may be red-orange liquids with a mild aromatic odor. Molecular weight = 333.26; specific gravity (H_2O:1) = 1.15; boiling point = [decomposes; may be dangerous above 200°C (solid); 70°C (liquid)]; freezing/melting point = 55°C−58°C; vapor pressure = 9×10^{-8} mmHg @ 25°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 1. Very slightly soluble in water; solubility = 0.35 ppm. @ 25°C. Physical and toxicological properties may be affected by carrier solvents in commercial formulations.

Potential Exposure: Ethalfluralin is a 2,6-fluorodinitrotoluidine selective herbicide used for the pre-emergence control of annual grasses and broadleaf weeds in certain food and feed crops. Ethalfluralin may be used in growing a variety of grain, seed, and cucurbit crops. The greatest amounts of ethalfluralin are used in growing soybeans, dry beans, and sunflower seeds. Ethalfluralin is used only outdoors, in agriculture; no residential uses were registered. Not used in EU countries.

Incompatibilities: Sensitive to heat. Dintroanilines can be explosive and are strong oxidizers. Contact with reducing agents, other strong oxidizers or, nitrosylsulfuric acid may cause fire or explosion.

Permissible Exposure Limits in Air: No standards or PAC available.

Determination in Air: Filter; none; Gravimetric; NIOSH IV [Particulates NOR; #0500 (total), #0600 (respirable)][18].

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guidelines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg [F]/L. Safe Drinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg[F]/L; SMCL = 2 mg/F/L, as Fluoride.

Determination in Water: Octanol-water coefficient: Log $K_{ow} = > 5$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Absorbed through the skin, inhalation, and ingestion

Harmful Effects and Symptoms

Short-Term Exposure: Corrosive. Eye or dermal contact may cause severe irritation and serious damage. May be absorbed through the skin. Inhalation of vapor or mists should be avoided. Harmful if swallowed. May cause nausea and vomiting. May cause shortness of breath (dyspnea). LD_{50} (oral, rat) = 3000 to >5000[83] mg/kg; LD_{50} (dermal, rabbit) = > 2 g/kg.

Long-Term Exposure: May cause loss of appetite and anorexia nervosa. Ethalfluralin has caused birth defects in laboratory animals as well as liver, thyroid, kidney and blood effects

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Preliminary medical exam to detect chronic diseases of CNS, liver, heart, kidneys, lung and skin, as well as endocrinological or immunological disturbances, should protect susceptible individuals. Periodical medical exams of internal organs, skin and eyes are important to avoid chronic occupational intoxications. They should include lab and patch tests when necessary[83].

Contact physician if poisoning is suspected or if redness, itching, or a burning sensation develops in the eyes or skin. May cause sensitization.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Evaluation by a qualified allergist, including exposure history and testing, may help diagnose allergy.

Personal Protective Methods: Dinitroanilines react with cellulose-based and expanded polymeric absorbents[88]. Prevent any reasonable probability of dermal and/or eye contact. Wear protective eye wear/goggles or face shield and protective clothing such as coveralls over long-sleeved shirt and full length pants; impermeable, chemical-resistant gloves when handling this product[83]. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material (such as DuPont Viton gloves and Tychem suit fabrics) for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Based on potential carcinogenicity the following is recommended by NIOSH: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100 F (APF = 50) (any air purifying, full-face-piece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: (1) Color code-Yellow Stripe: Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. (2) Color code-Blue: Health Hazard/Poison. Store in a secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well ventilated area away from oxidizers, strong acids; strong bases and other incompatible materials listed above. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. If this material contains a flammable carrier, sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Storage: Color code-Blue: Health Hazard/Poison: Store in a tightly closed container in a dry, well-ventilated and secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Where possible, automatically transfer material from other storage containers to process containers. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN3082 Environmentally hazardous substances, liquid, n.o.s., Hazard class: 9; Labels: 9- Miscellaneous hazardous material, Technical Name Required. UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: For dinitroaniline solids, isolate spill or leak area in all directions for at least 50 m/150 ft. Increase, in the downwind direction, as necessary. *If tank, rail car, or tank truck is involved in spill*, isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Stop leak if you can do it without risk. Prevent entry into waterways, sewers, basements or confined areas. Cover with plastic sheet to prevent spreading. Absorb or cover with dry earth, sand or other noncombustible material and transfer to containers. Do not allow water to get inside containers.

Fire Extinguishing: This chemical is a combustible solid but does not readily ignite. Liquid formulations may be combustible or flammable. Thermal decomposition products may include hydrogen chloride, hydrogen fluoride and oxides of nitrogen and carbon. As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 m/150 ft for liquids and at least 25 m/75 ft for solids. *Fire involving storage or vehicular tanks:* Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. *On a small fire:* Use dry chemical, CO_2, water spray, or regular *foam. On a large fire:* Use water spray, fog, or regular foam. Do not scatter spilled material with high pressure streams of water. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal. *Fire involving tanks:* From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. Always stay away from tanks engulfed in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Do not discharge into drains or sewers. Dispose of waste material as hazardous waste using a licensed disposal contractor to an approved landfill. Contact a licensed disposal facility about surplus and non-recyclable solutions. Burn in a chemical incinerator equipped with an afterburner and scrubber. Extra care must be exercised as the material in an organic solvent is highly flammable. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Incineration with effluent gas scrubbing is recommended. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office. Do not reuse container.

References

(31); (173); (101); (138); (179); (122).

United States Environmental Protection Agency, "*Reregistration Eligibility Decision (RED), Ethalfluralin*" Office of Prevention, Pesticides and Toxic Substances, Washington, DC (March 1995). http://www.epa.gov/REDs/2260.pdf

Ethane E:0230

Formula: C_2H_6

Synonyms: Bimethyl; Dimethyl; Etano (Spanish); Ethyl hydride; Methylmethane

CAS Registry Number: 74-84-0

HSDB Number: 941

RTECS Number: KH3800000

UN/NA & ERG Number: UN1035 (compressed gas)/115; UN1961 (refrigerated liquid)/115

EC Number: 200-814-8 [*Annex I Index No.:* 601-002-00-X]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Hazard Alert: Extremely flammable gas, Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated.

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg).

Hazard symbols, risk, & safety statements: Hazard symbol: F+ ; risk phrases: R5; R12; R16; R18; R21; safety phrases: S1; S2; S9; S16; S33; S38; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): Nonhazard to water.

Description: Ethane is a compressed, liquefied, colorless gas. Mild, gasoline-like odor. Odorless when pure. Molecular weight = 30.08; specific gravity (H_2O:1) = 0.45 @ 20°C (liquid); boiling point = −89°C; freezing/melting point = −172°C; flash point = flammable gas; autoignition temperature = 472°C. Explosive limits: LEL: 3.0%; UEL: 12.5%. Hazard identification (based on NFPA-704 M Rating System): Health 1, Flammability 4, Reactivity 0. Insoluble in water. An aliphatic hydrocarbon gas (C1−C4).

Potential Exposure: Ethane is used as a fuel, in making chemicals or as a freezing agent. The health effects caused by ethane exposure are much less serious than the fire and explosion risk posed by this chemical.

Incompatibilities: Flammable gas; forms explosive mixture with air. Strong oxidizers may cause fire and explosions. May accumulate static electrical charges, and may cause ignition of its vapors.

Permissible Exposure Limits in Air

Odor threshold = 899 ppm.

OSHA PEL: Simple asphyxiant (Shipyards, Construction)

ACGIH TLV[1]: 1000 ppm TWA *as aliphatic hydrocarbon gas (C1−C4)*

PAC Ver. 29[138]

PAC-1: 65,000 ppm

PAC-2: 2.30E + 05 ppm

PAC-3: 4.00E + 05 ppm

Australia: asphyxiant, 1993; Belgium: asphyxiant, 1993; Hungary: asphyxiant, 1993; Switzerland: MAK-W 10000 ppm (12500 milligram per cubic meter), 1999; United Kingdom: asphyxiant, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: Simple asphyxiant

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short-Term Exposure: Exposure can cause headache, dizziness and make you feel lightheaded. Very high levels can cause suffocation from lack of oxygen. Contact with liquid ethane can cause frostbite. Ethane is highly flammable. It is a dangerous fire hazard.

Long-Term Exposure: Chronic health effects are unknown at this time.

First Aid: Remove the person from exposure. Begin (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Polyethylene is among the recommended protective materials. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Wear gas-proof goggles, unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Chemical cartridge respirators should not be used where ethane exposure occurs. For high exposures use air-supplied respirators. Exposure to ethane is dangerous because it can replace oxygen and lead to suffocation. Only NIOSH/MSHA or European Standard EN 149-approved SCBA with a full facepiece operated in the positive-pressure mode should be used in oxygen deficient environments.

Storage: Check oxygen content prior to entering storage area. Flammable gas. Color code-Red Stripe: Flammability Hazard: Store separately from all other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1 hour fire wall from flammable or reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Ethane must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates), since violent reactions occur. Sources of ignition, such as smoking and open flames are prohibited where ethane is handled, used, or stored. Use only nonsparking tools and equipment, especially when opening and closing containers of ethane. Wherever ethane is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Piping should be electrically bonded and grounded. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: UN1035 (compressed gas); UN1961 (refrigerated liquid): Ethane, Hazard Class: 2.1; Labels: 2.1-Flammable gas. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: If in a building, evacuate building and confine vapors by closing doors and shutting down HVAC systems. Restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit and to disperse the gas. Wear chemical protective suit with SCBA to combat spills. Stay upwind and use water spray to "knock down" vapor; contain runoff. Stop the flow of gas, if it can be done safely from a distance. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place, and repair leak or allow cylinder to empty. Keep this chemical out of confined spaces, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Ethane is a flammable gas. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of leak to disperse the gas. Stop the flow of gas if it can be done safely. If source of leak is a cylinder and the leak cannot be stopped in place, remove leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. Keep this chemical out of confined space, such as a sewer because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Ethane*, Trenton, NJ (June 2003)

Ethanolamines E:0240

Formula: C_2H_7NO; $C_4H_{11}NO$; $C_6H_{15}NO_3$; $H_2NCH_2CH_2OH$; $HN(CH_2CH_2OH)_2$; $N(CH_2CH_2OH)_3$

Synonyms: *Monoethanolamine:* 2-Aminoethanol; β-Aminoethyl alcohol; Colamine; Ethylolamine; 2-Hydroxyethylamine; MEA; Monoethanolamine

Diethanolamine: see separate entry D:0770.

Triethanolamine: Daltogen; 2,2′,2″-Nitrilo-triethanol; TEA; Thiofaco T-35; Triethylolamine; Tri(2-hydroxyethyl)amine;

Tri(hydroxytriethyl)amine; Tris(hydroxyethyl)amine; Trolamine

CAS Registry Number: 141-43-5 *(mono-)*; 111-42-2 (*di*-); 102-71-6 (*tri*-or 2,2′,2″-)

HSDB Number: 531 as2-aminoethanol

RTECS Number: KJ5775000 *(mono-)*; KL9275000 (*tri*-)

UN/NA & ERG Number: UN2491/153

EC Number: 205-483-3 [*Annex I Index No.:* 603-030-00-8] (*mono*-or 2-); 203-868-0 [*Annex I Index No.:* 603-071-00-1] (*di*-or 2,2′-); 203-049-8 (*tri*-or *2,2′,2″*-)

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Theft hazard* 220 (≥80.00% concentration). *Triethanolamine*

Carcinogenicity: *(tri-)* IARC: Human Inadequate Evidence; Animal Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1987; NCI (*tri* -): Carcinogenesis Studies (derm); equivocal evidence: rat; inadequate study: mouse; on test (2 year studies), October 2000

Hazard Alert: Flammable, Corrosive, (*mono*-): Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction), (*tri*-) Agricultural chemical, Possible risk of forming tumors, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction).

United States Environmental Protection Agency, FIFRA1998 Status of Pesticides (*tri*-): Canceled

Hazardous to aquatic life or environment, with possible long lasting effects[194]. Harmful to aquatic life with long lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T; risk phrases: R11; R62;?; safety phrases: S1; (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Ethanolamines can be detected by odor as low as 2−3 ppm. *Monoethanolamine* is a colorless, viscous liquid or solid (below 111°C) with an unpleasant, ammonia-like odor. Molecular weight = 61.08; specific gravity (H_2O:1) = 1.02 @ 20°C; boiling point = 170.6°C; freezing/melting point = 10.5°C; vapor pressure = 0.4 mmHg @ 20°C; 0.75 mmHg @ 35°C; flash point = 85°C (cc); autoignition temperature = 410°C. Explosive limits: LEL: 3.0% (@140°C); UEL: 23.5%. Hazard identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 0. Soluble in water. *Triethanolamine* has only a faint nonammonia odor. Molecular weight = 149.22; boiling point = 343°C; freezing/melting point = 21°C; flash point = 179°C (cc). Hazard identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 1. Soluble in water. All three compounds are water soluble liquids.

Potential Exposure: Monoethanolamine is widely used in industry for scrubbing acid gases and in production of detergents and alkanolamide surfactants; to remove carbon dioxide and hydrogen from natural gas, to remove hydrogen sulfide and carbonyl sulfide; as an alkaline conditioning agent; as an intermediate for soaps, detergents, dyes, and textile agents. *Diethanolamine* is an absorbent for gases; a solubilizer for 2,4- dichlorophenoxyacetic acid (2,4-D); and a softener and emulsifier intermediate for detergents. It also finds use in the dye and textile industry. *Triethanolamine* is used as plasticizers, neutralizer for alkaline dispersions; lubricant additive; corrosion inhibitor; and in the manufacture of soaps, detergents, shampoos, shaving preparations; face and hand creams; cements, cutting oils, insecticides, surface active agents; waxes, polishes, and herbicides.

Incompatibilities: *Monoethanolamine:* This chemical is a medium-strong base. Reacts violently with strong oxidizers, acetic acid; acetic anhydride; acrolein, acrylic acid; acrylonitrile, cellulose nitrate; chlorosulfonic acid; epichlorohydrin, hydrochloric acid; hydrogen fluoride; mesityl oxide; nitric acid; oleum, sulfuric acid; β-propiolactone; and vinyl acetate. Reacts with iron. May attack copper, aluminum, and their alloys, and rubber. *Di-isomer*: Oxidizers, strong acids; acid anhydrides; halides. Reacts with CO_2 in the air. Hygroscopic (i.e., absorbs moisture from the air). Corrosive to copper, zinc, and galvanized iron (di-). The aqueous solution is a medium strong base. Attacks copper, zinc, aluminum, and their alloys.

Permissible Exposure Limits in Air

NIOSH IDLH = 30 ppm

Conversion factor: 1 ppm = 2.50 milligram per cubic meter @ 25°C & 1 atm

141-43-5 monoethanolamine

OSHA PEL: 3 ppm/6 milligram per cubic meter TWA

NIOSH REL: 3 ppm/8 milligram per cubic meter TWA; 6 ppm/15 milligram per cubic meter STEL

ACGIH TLV[1]: 3 ppm/7.5 milligram per cubic meter TWA; 6 ppm/15 milligram per cubic meter STEL

DFG MAK: 2 ppm/5.1 milligram per cubic meter TWA; Peak Limitation Category II(2); Pregnancy Risk Group C, *as 2-aminoethanol*

PAC Ver. 29[138]

PAC-1: 6 ppm PAC-2: 170 ppm

PAC-3: 1000 ppm

Arab Republic of Egypt: TWA 3 ppm (6 milligram per cubic meter), 1993; Australia: TWA 3 ppm (8 milligram per cubic meter); STEL 6 ppm, 1993; Austria: MAK 3 ppm (8 milligram per cubic meter), 1999; Belgium: TWA 3 ppm (7.5 milligram per cubic meter); STEL 6 ppm (15 milligram per cubic meter), 1993; Denmark: TWA 3 ppm (6 milligram per cubic meter), 1999; Finland: TWA 3 ppm (7.5 milligram per cubic meter); STEL 6 ppm (15 milligram per cubic meter), 1999; France: VME 3 ppm (8 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 2.5 milligram per cubic meter, [skin], 2003; Norway: TWA 3 ppm (8 milligram per cubic meter), 1999; the Philippines: TWA 3 ppm (6 milligram per cubic meter), 1993; Poland: TWA 3 milligram per cubic meter; STEL 10 milligram per cubic meter, 1999; Russia: TWA 3 ppm; STEL 0.5 milligram per cubic meter, [skin], 1993; Sweden: TWA 3 ppm (8 milligram per cubic meter); STEL 6 ppm (15 milligram per cubic meter), [skin], 1999; Switzerland: TWA 3 ppm (8 milligram per cubic meter); STEL 6 ppm (15 milligram per cubic meter), [skin], 1999; United Kingdom: TWA 3 ppm (7.6 milligram per cubic meter); STEL 5 ppm (15 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: STEL 6 ppm

102-71-6 triethanolamine

ACGIH TLV[1]: 5 ppm TWA

DFG MAK: 5 ppm, inhalable fraction TWA; Peak Limitation Category I(4); Pregnancy Risk Group D PAC Ver. 29[138]

PAC-1: 15 milligram per cubic meter

PAC-2: 240 milligram per cubic meter

PAC-3: 1500 milligram per cubic meter

Denmark: TWA 0.5 ppm (3.1 milligram per cubic meter), 1999; Sweden: NGV 5 milligram per cubic meter, KTV 10 milligram per cubic meter 1999; the Netherlands: MAC-TGG 5 milligram per cubic meter, 2003

111-42-2 diethanolamine

PAC Ver. 29[138]

PAC-1: 3 milligram per cubic meter

PAC-2: 28 milligram per cubic meter

PAC-3: 130 milligram per cubic meter

Several states have set guidelines or standards for diethanolamine in ambient air[60] ranging from 150 μ/m^3 (North Dakota) to 250 μ/m^3 (Virginia) to 300 μ/m^3 (Connecticut) to 357 μ/m^3 (Nevada). A large number of states have set guidelines or standards for monoethanolamine in ambient air[60] ranging from 19.048 μ/m^3 (Kansas) to 26.7 μ/m^3 (New York) to 80.0 μ/m^3 (Florida) to 80.0–150.0 μ/m^3 (North Dakota) to 120 μ/m^3 (Connecticut) to 130.0 μ/m^3 (Virginia) to 190.0 μ/m^3 (Nevada) to 200.0 μ/m^3 (South Carolina).

Determination in Air: *Monoethanolamine*: Use NIOSH Analytical Method: Aminoethanol compounds I: 2007; or OSHA Analytical Method PV-2111

Permissible Concentration in Water: EPA[32] has suggested permissible ambient limits of 83 μg/L. Russia[43] has set MAC values in water bodies used for domestic purposes of 0.8 mg/L for diethanolamine and 1.4 mg/L for triethanolamine but no MAC for monoethanolamine.

Determination in Water: No tests listed. Octanol-water coefficient: Log $K_{ow} = -1.3$.

Routes of Entry: Inhalation of vapor, percutaneous absorption, ingestion, and skin and/or eye contact.

Harmful Effects and Symptoms

The LD$_{50}$ oral-rat for the isomers is as follows: *mono*-2050 mg/kg (slightly toxic); *di* −710 mg/kg (slightly toxic); *tri*-8000 mg/kg (insignificantly toxic). All three compounds cause irritation to nose, throat and lungs upon inhalation. Skin contact causes irritation, stinging and burns. Eye contact can cause severe irritation. Ingestion can cause nausea and intestinal irritation. Fatal doses are estimated by NY State to be 6 g of monethanolamine for a 150-pound man.

Short-Term Exposure: *Monoisomer:* Corrosive to the eyes and irritates the skin and respiratory tract. Inhalation may cause asthmatic reactions. May affect CNS and may cause unconsciousness. *Di-isomer:* Corrosive to the eyes. Irritates the eyes, skin, and respiratory tract.

Long-Term Exposure: *Monoisomer:* Repeated or prolonged contact with skin may cause dermatitis and ulceration and lungs may be affected. May affect the CNS; kidneys, liver, and blood, causing asthenia, hematological changes, and tissue lesions. *Di-isomer:* May affect the kidneys and liver.

Points of Attack: Eyes, skin, respiratory system, and CNS

Medical Surveillance: With monoethanolamine, if symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function tests. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

With diethanolamine: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following is recommended. Lung function tests. If symptoms develop or overexposure is suspected the following may be useful: Skin testing with dilute diethanolamine may help diagnose allergy if done by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. 8 hours: Neoprene rubber gloves, suits, boots; nitrile rubber gloves, suits, boots; Viton gloves, suits; 4 H and Silver Shield gloves, Tychem 1000 suits; 4 hours: polyvinyl chloride gloves, suits, and boots. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Monoethanolamine:* Up to 30 ppm: CcrS * (APF = 10) [any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern]; or GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted canister providing protection against the compound of concern]; or PaprS (APF = 25) [any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern]; or Sa (APF = 10) (any supplied-air respirator); * or SCBAF (APF = 50) (any SCBA with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus). *Escape:* GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted canister providing protection against the compound of concern]; or SCBAE (any appropriate escape-type, SCBA). *Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code-White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Ethanolamine must be stored to avoid contact with strong oxidizers (such as chlorine and bromine) and strong acids, (such as hydrochloric, sulfuric and nitric acids), because violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames are prohibited where ethanolamine is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2491 Ethanolamine or Ethanolamine solutions, Hazard class: 8; Labels: 8-Corrosive material.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Controlled incineration; incinerator equipped with a scrubber or thermal unit to reduce nitrogen oxides emissions.

References

(31); (173); (101); (138); (2); (80); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: *Ethanolamines*, Washington, DC (April 14, 1978)

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 4, No. 1, 66–69 (1984) (Mono-)

New York State Department of Health, *Chemical Fact Sheet: Ethanolamine*, Bureau of Toxic Substance Assessment, Albany, NY (March 1986)

New York State Department of Health, *Chemical Fact Sheet: Diethanolamine*, Bureau of Toxic Substance Assessment, Albany, NY (March 1986)

New York State Department of Health, *Chemical Fact Sheet: Triethanolamine*, Bureau of Toxic Substance Assessment, Albany, NY (April 1986)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Ethanolamine*, Trenton, NJ (August 2002)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Diethanolamine*, Trenton, NJ (June 2003)

Ethephon E:0245

Formula: $C_2H_6ClO_3P$

Synonyms: AMCHEM 68-250; Arvest; Base 250; Boll'd; Bromeflor; Bromoflor; Camposan; CEP; 2-CEPA; Cepha; Cepha 10ls; Cerone; Chipco florel pro; 2-Chloroethyl)phosphonic acid; Chlorethephon; 2-Chlorethylphosphonic acid; 2-Chloroethanephosphonic acid; Ethefon; Ethepon; Ethel; Etheverse; Ethrel; Finish; Flordimex; Florel; G-996; Kamposan; Prep; Phosphonic acid, (2-chloroethyl)-; Rollfruct; Terpal (with mepiquat chloride); T-extra; Tomathrel

CAS Number: 16672-87-0

HSDB Number: 2618

RTECS Number: SZ7100000

UN/NA & ERG Number: UN2928 (Toxic solids, corrosive, organic, n.o.s.)/154

EC Number: 240-718-3 [*Annex I Index No.:* 015-514-00-4]

Regulatory Authority and Advisory Information: Carcinogenicity[83]: EPA Group D, Not classifiable as a human carcinogen

Hazard Alert: Poison, Neurotoxin (cumulative), Corrosive (resp.), Environmental hazard, Agricultural chemical.

Hazardous to aquatic life or environment, with possible long lasting effects[293]. Toxic to aquatic life with long lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: Xn, C, H, N; risk phrases: R20/21; R34; R52/53; safety phrases: S1/2; S26; S28; S29/35; S36/37/39; S45; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Ethephon is a white to tan powder. Commercial product is a white, waxy solid. Commercial products may be available as aqueous solutions or soluble concentrates. Molecular weight = 144.49; specific gravity (H 2 O:1) = 1.2; 1.65; boiling point = (decomposes) 265°C; freezing/melting point = 73−74°C; vapor pressure = 1.1×10^{-7} mmHg @ 20°C; <0.01 mmHg @ 20°C. High solubility in water; solubility = <1 kg/L. Physical and toxicological properties may be affected by carrier solvents in commercial formulations.

Potential Exposure: Ethephon is an organophosphonate plant growth regulator used to promote fruit ripening, abscission, flower induction, and other responses. It is registered for use on a number of food, animal feed and nonfood crops (rubber plants, flax), greenhouse nursery stock, and outdoor residential ornamental plants, but is used primarily on cotton. Ethephon is applied to plant foliage by either ground or aerial equipment. It also may be applied by hand sprayer to certain home garden vegetables and ornamentals. Use practice limitations include prohibitions against applying ethephon through any type of irrigation system; feeding or grazing livestock in treated areas; and treating within 2 to 60 days of harvest, depending on the crop.

Incompatibilities: Hygroscopic. Aqueous solutions are highly acidic. May cause corrosion if metals, especially when moisture is present. Contact with flammable material may cause fire and explosions. Contact with combustible or oxidizable materials may form heat-, shock-, and friction-sensitive explosive mixtures. Static electricity may also cause explosions. Keep away from all acids, especially dibasic organic acids, ammonium compounds, antimony sulfide, arsenic trioxide, metal sulfides, powdered metals, calcium aluminum hydride, cyanides, manganese dioxide, phosphorus, selenium, sulfur, thiocyanates, and zinc.

Determination in Water: Octanol-water coefficient: Log $K_{\mathrm{ow}} = -0.22$[83,161]. Unlikely to bioaccumulate in marine organisms. Fish toxicity (threshold)[101]: Very low−26627.94738 ppb, MATC (Maximum Acceptable Toxicant Concentration)

Harmful Effects and Symptoms

Ethephon is an organophosphonate or salt of a phosphonic acid. Unlike organophosphates, it may not inhibit activity of the enzyme acetylcholinesterase that is essential for transmission of nerve signals in animals and insects. Nevertheless, the metal ions may act as a neurotoxin.

Short-Term Exposure: Highly corrosive. Because this material has a low vapor pressure and volatility, significant inhalation of vapors is unlikely at ordinary temperatures. Delayed pulmonary edema may occur after inhalation. LD_{50} (oral, rat) = >3 g/kg; LD_{50} (dermal, rabbit) = >5 g/kg.

Long-Term Exposure: A cholinesterase inhibitor. A neurotoxin. May cause heart problems. Human toxicity (long term)[101]: Very low−126.0 ppb, Health advisory

Points of Attack: CNS, cardiovascular system, skin, and eyes.

Medical Surveillance: Medical observation is recommended for 24 to 48 hours following breathing overexposure, as pulmonary edema may be delayed. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. Routine biological monitoring of pesticide applicators and field workers includes testing of plasma and red blood cell acetylcholinesterase levels (for enzyme poisoned by this chemical). These tests are normally accurate only if done within about 2 hours of exposure. If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When acetylcholinesterase enzyme levels are reduced by 25% or more below pre-employment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate pesticides is recommended until enzyme levels recover. Do not drink any alcoholic beverages before or during use as it promotes absorption of organophosphates.

First Aid Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure.

Respirator Selection: Wherever and whenever workplace conditions warrant respirator use, a respiratory protection program must be followed that meets one or more of the following government standards: OSHA's 29 CFR 1910.134, ANSI Z88.2, or European Standard EN 149.

Storage: (1) Color code-Blue: Health Hazard/Toxics/ Poisons: Store in a secure poison location. (2) Color code-White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. (3) Color code-Yellow Stripe: Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Store in tightly closed containers in a cool, well-ventilated area. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well ventilated area away from oxidizers, strong acids; strong bases and other incompatible materials listed above. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. If this material contains a flammable carrier, sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN2928 Toxic solids, corrosive, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, 8-Corrosive material, Technical Name Required.

Spill Handling: First remove all sources of ignition. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Stay upwind; keep out of low areas. Ventilate area of spill or leak. Remove and isolate contaminated clothing at the site. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills:* Absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills:* Dike far ahead of spill for later disposal. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24 h response line).

Fire Extinguishing: Decomposes starts above 250°C releasing oxides of nitrogen, sulfur, phosphorus, and carbon. May be fatal if inhaled, ingested or absorbed through skin. Inhalation or contact with some of these materials will irritate or burn skin and eyes. Vapors may cause dizziness or suffocation. *Fire involving storage or vehicular tanks:* Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. *Small fire:* Dry chemical, carbon dioxide or water spray. *Large fire:* Dry chemical, carbon dioxide, alcohol-resistant foam or water spray. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal; do not scatter the material. *Fire involving tanks or car/trailer loads:* Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Do not get water inside containers. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. Always stay away from tanks engulfed in fire. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Destruction by alkali hydrolysis or incineration. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (100).

EXTOXNET, Extension Toxicology Network, "*Pesticide Information Profile: Ethephon*," Oregon State University, Corvallis, OR (September 1995). http://extoxnet.orst.edu/pips/ethephon.htm

United States Environmental Protection Agency, "*Reregistration Eligibility Decision (RED): Ethephon*" Office of Prevention, Pesticides and Toxic Substances, Washington, DC (April 1995). http://www.epa.gov/REDs/0382.pdf

United States Environmental Protection Agency, Office of Pesticide Programs, *Pesticide Residue Limits, "Ethephon,"* 40 CFR 180.300, http://www.epa.gov/pesticides/food/viewtols.htm

Ethinylestradiol E:0250

Formula: $C_{20}H_{24}O_2$

Synonyms: 3,17-β-Dihydroxy-17-α-ethynyl-1,3,5(10)-estratriene; 3,17-β-Dihydroxy-17-α-ethynyl-1,3,5(10)-oestratriene; Estrogen; 17-α-Ethinyl-3,17-dihydroxy-d1,3,5-estratriene; 17-α-Ethinyl-3,17-dihydroxy-d1,3,5-oestratriene; 17-α-Ethinyl-17-β-estradiol; 17-α-Ethinylestradiol; 17-Ethinyl-

3,17-estradiol; 17-Ethinylestradiol; 17-α-Ethinylestra-1,3,5(10)-triene-3,17-β-diol; Ethinylestriol; 17-Ethinyl-3,17-oestradiol; Ethinyloestradiol; Ethinyl-oestranol; 17-α-Ethinyl-d1,3,5(10) oestratriene-3,17-β-diol; 17-α-Ethinyloestra-1,3,5(10)-triene-3,17-β-diol; Ethinyloestriol; 17-Ethynyl-3,17-dihydroxy-1,3,5-oestratriene; 17-α-Ethynylestradiol; 17-α-Ethynylestradiol -17-b; Ethynylestradiol; 17-α-Ethynyl-1,3,5(10)-estratriene-3, 17- β-diol; 17-α-Ethynylestra-1,3,5(10)-triene-3,17-β-diol; 17-α-Ethynyl-17-β-oestradiol; 17-α-Ethynyloestradiol; 17-α-Ethynyloestradiol-17-b; 17-Ethynyloestradiol; Ethynyloestradiol; 17-α-Ethynyl-1,3,5(10)-oestratriene-3,17-β-diol; 17-α-Ethynyl-1,3,5-oestratriene-3,17-β-diol; 17-α-Ethynyloestra-1,3,5(10)-triene-3,17-β-diol; 17-Ethynyloestra-1,3,5(10)-triene-3,17-β-diol; (17-a)-19-Norpregna-1,3,5(10)-trien-20-yne-3,17, diol; 19-Nor-17-α-pregna-1,3,5(10)-trien-2-yne-3,17-diol

CAS Registry Number: 57-63-6

HSDB Number: 3587

RTECS Number: RC8925000

UN/NA & ERG Number: UN3249 (Medicine, solid, toxic, n.o.s.)/151

EC Number: 200-342-2

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human Sufficient Evidence; Animal Limited Evidence (Equigyne), *carcinogenic to humans*, Group 1, 1998; NTP 13th Report on Carcinogens[10]

California Proposition 65 Chemical[102]: Cancer 1/1/1988; Developmental/Reproductive toxin 1/1/1990.

Hazard Alert: Poison, Combustible, Possible risk of forming tumors, Reproductive toxin: possible risk of gene damage/impaired fertility; Suspected reprotoxic hazard, Drug.

Hazard symbols, risk, & safety statements: Hazard symbol: T; risk phrases: R45; R23/24/25; R34; R60; R62; R63; safety phrases: S41; S45; S53 (see Appendix 4).

Description: Ethinylestradiol is a white to creamy-white powder. Odorless. Molecular weight = 296.44; freezing/melting point = 142°C−146°C. Hazard identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 0.

Potential Exposure: A synthetic steroid. Used in medicine, in combination with progestogen, as an estrogenic hormone and as an oral contraceptive.

Incompatibilities: May react exothermically with reducing agents to generate flammable gaseous hydrogen. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides.

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices. *Note:* An industrial guideline of 0.05 μg airborne estrogen dust)/m^3 TWA (8 h work-day) was adopted at one manufacturing company.

Harmful Effects and Symptoms

Short-Term Exposure: Nausea, vomiting, abdominal cramps; bloating, cholasma, cholestatic jaundice; skin eruptions; loss of scalp hair; hirsutism, changes in menstrual flow; headache, migraine, dizziness, mental depression, increase or decrease in weight, edema, changes in libido, and breast enlargement.

Long-Term Exposure: A confirmed carcinogen. May have teratogenic effects and reproductive effects. Human mutation data reported.

First Aid: *Skin Contact:*[52] Flood all areas of body that have contacted the substance with water. Don't wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others. *Eye Contact:* Remove any contact lenses at once. Immediately flush eyes well with copious quantities of water or normal saline for at least 20−30 minutes. Seek medical attention. *Inhalation:* Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion:* Contact a physician, hospital or poison center at once. If the victim is unconscious or convulsing, do not induce vomiting or give anything by mouth. Assure that the patient's airway is open and lay him on his side with his head lower than his body and transport immediately to a medical facility. If conscious and not convulsion, give a glass of water to dilute the substance. Vomiting should not be induced without a physician's advice.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in a refrigerator under an inert atmosphere and protect from exposure to light.

Shipping: UN3249 Medicine, solid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-

up is complete. Remove all ignition sources and dampen spilled material with 60%−70% ethanol. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: It is inappropriate and possibly dangerous to the environment to dispose of expired or waste drugs and pharmaceuticals by flushing them down the toilet or discarding them to the trash. Household quantities of expired or waste pharmaceuticals may be mixed with wet cat litter or coffee grounds, double-bagged in plastic, discard in trash. Larger quantities shall carefully take into consideration applicable DEA, EPA, and FDA regulations. If possible return the pharmaceutical to the manufacturer for proper disposal being careful to properly label and securely package the material. Alternatively, the waste pharmaceutical shall be labeled, securely packaged and transported by a state licensed medical waste contractor to dispose by burial in a licensed hazardous or toxic waste landfill or incinerator.

References

(109); (102); (31); (173); (101); (138).

Ethion E:0260

Formula: $C_9H_{22}O_4P_2S_4$

Synonyms: AC 3422; Bis[S-(diethoxy-phosphinothioyl)mercapto]methane; Bis (dithiophosphatede *O,O*-diethyle) de *S, S′*-methylene (French); Bladan; Diethion; Embathion; ENT 24,105; Ethanox; Ethiol; Ethodan; Ethyl methylene phosphorodithioate; Etion (Spanish); FMC-1240; Fosfono 50; Hylemox; Itopaz; Kwit; Methanedithiol, *S,S*-diester with *O,O*-diethyl phosphorodithioate acid; Methylene-*S,S′*-bis(*O, O*-diaethyl-dithiophosphat) (German); *S,S′*-Methylene *O,O, O′,O′*-tetraethyl ester phosphorodithioic acid; *S,S′*-Methylene *O,O,O′,O′*-tetraethyl phosphorodithioate; NIA 1240; Niagara 1240; Nialate; Phosphorodithioic acid, *O,O*-diethyl ester, *S, S*-diester with methanedithiol; Phosphotox E; Rhodiacide; Rhodocide; Rodocid; RP 8167; Soprathion; STCC 4921565; *O,O,O′,O′*-Tetraaethyl-bis(dithiophosphat) (German); *O,O, O′,O′*-Tetraethyl *S,S′*-methylenebis(dithiophosphate); *O,O,O′, O′*-Tetraethyl *S,S′*-methylenebisphosphordithioate; Tetraethyl *S,S′*-methylene bis(phosphorothiolothionate); *O,O,O′,O′*-Tetraethyl *S,S′*-methylene di(phosphorodithioate); Vegfru Fosmite; Vegfrufosmite

CAS Registry Number: 563-12-2

HSDB Number: 399

RTECS Number: TE4550000

UN/NA & ERG Number: (PIH) UN3018 (organophosphorus pesticide, liquid, toxic)/152; UN2783 (organophosphorus pesticides, solid, toxic)/152; UN2810 (toxic liquids, organic, n.o.s.)/153

EC Number: 209-242-3 [*Annex I Index No.:* 015-047-00-2]

Regulatory Authority and Advisory Information

United States Environmental Protection Agency Gene-Tox Program, Negative: Histidine reversion-Ames test Negative: In vitro UDS-human fibroblast; TRP reversion Negative: *S. cerevisiae-homozygosis* Inconclusive: *B. subtilis* rec assay; *E. coli polA* without S9.

Hazard Alert: Poison inhalation hazard, Possible cumulative neurotoxin, Combustible, Suspected of causing genetic defects, Environmental hazard.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg)

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), severe pollutant

United States DOT 49CFR172.101, Inhalation Hazardous Chemical, as organic phosphate, Substance ID: EDF-041. Hazardous to aquatic life or environment, with possible long lasting effects[291,292].

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R21; R25; R33; R50/53; R62; safety phrases: S1/2; S25; S29/35; S36/37; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)]

Description: Ethion is a colorless to amber-colored, odorless liquid. The technical product has a very disagreeable odor; freezing/melting point = −13°C − 12°C. Molecular weight = 384.49; boiling point = 164°C; vapor pressure = 0.0000015 mmHg @ 20°C; flash point = 176°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Practically insoluble in water; solubility = 0.0001%.

Potential Exposure: An organothiophosphate. A potential danger to those involved in the manufacture, formulation and application of this insecticide and acaricide. Ethion is a preharvest topical insecticide used primarily on citrus fruits, deciduous fruits, nuts, and cotton. It is also used as a cattle dip for ticks and as a treatment for buffalo flies.

Incompatibilities: Incompatible with alkaline formulations and strong acids. Decomposes violently when heated above 150°C. Mixtures with magnesium may be explosive. Contact with oxidizers may cause the release of phosphorous oxides. Contact with strong reducing agents, such as hydrides; may cause the formation of flammable and toxic phosphine gas.

Permissible Exposure Limits in Air

OSHA PEL: None

NIOSH REL: 0.4 milligram per cubic meter [skin]

ACGIH TLV [1]: 0.05 milligram per cubic meter TWA, inhalable fraction and vapor [skin]; not classifiable as a human carcinogen; BEIA issued as Acetylcholinesterase inhibiting pesticides.

PAC Ver. 29[138]

PAC-1: 1.2 milligram per cubic meter

PAC-2: 13 milligram per cubic meter

PAC-3: 38 milligram per cubic meter

Australia: TWA 0.4 milligram per cubic meter, [skin], 1993; Belgium: TWA 0.4 milligram per cubic meter, [skin], 1993; Denmark: TWA 0.4 milligram per cubic meter, [skin], 1999; France: VME 0.4 milligram per cubic meter, [skin], 1999; Switzerland: MAK-W 0.4 milligram per cubic meter, [skin], 1999; the Netherlands: MAC-TGG 0.4 milligram per cubic meter, [skin], 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Several states have set guidelines or standards for Ethion in ambient air[60] ranging from 4.0 μ/m^3 (North Dakota) to 6.0 μ/m^3 (Connecticut) to 9.0 μ/m^3 (Nevada).

Determination in Air: Use NIOSH (IV), Method #5600, Organophosphorus Pesticide.

Permissible Concentration in Water: California[61] has set a guideline for Ethion in drinking water of 35 μg/L.

Determination in Water: No tests listed. Octanol-water coefficient: Log $K_{ow} = 5.1$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Harmful Effects and Symptoms

Symptoms may include nausea, vomiting, abdominal cramps; diarrhea, excessive salivation; headache, giddiness, weakness, muscle twitching; difficult breathing; blurring or dimness of vision; and loss of muscle coordination. Death may occur from failure of the respiratory center, paralysis of the respiratory muscles; intense bronchoconstriction, or all three. This material is very toxic; the probable oral lethal dose for humans is 50–500 mg/kg, which is between one teaspoonful and one ounce for a 150 lb person.

Short-Term Exposure: Organic phosphorus insecticides are absorbed by the skin, as well as by the respiratory and GI tracts. They are cholinesterase inhibitors. Symptoms of exposure include headache, giddiness; blurred vision; nervousness, weakness, nausea, cramps, diarrhea, and discomfort in the chest. Signs include sweating, tearing, salivation, vomiting, cyanosis, convulsions, coma, loss of reflexes and loss of sphincter control. Exposure may cause unconsciousness and death. The effects may be delayed and medical observation is recommended.

Long-Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. Ethion may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, CNS, cardiovascular system, skin, eyes, plasma, and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1–2 weeks while red blood cell levels may be reduced for 1–3 months. When cholinesterase enzyme levels are reduced by 25% or more below pre-employment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Effects may be delayed. Keep victim under observation.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. 4 hours: Teflon gloves, suits, boots. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid or wear dust-proof goggles when working with powders or dusts, unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures over 0.4 milligram per cubic meter, use an NIOSH/MSHA or European Standard EN 149-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use an NIOSH/MSHA or European Standard EN 149-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area away from alkaline material, strong acids and other incompatible materials listed above. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: UN3018 Organophosphorus pesticides, liquid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN2783 Organophosphorus pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN2810 Toxic liquids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling:

Initial Isolation and Protective Action Distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424−9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24 h response line).

Small Spills (from a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.3/0.4
Night 0.8/1.2

Large Spills (from a large package or from many small packages)

First: Isolate in all directions (ft/m) 600/200
Then: Protect persons downwind (mi/km)
Day 1.4/2.3
Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Do not touch spilled material. Do not breathe vapors. Stay upwind; keep out of low areas. Remove all ignition sources. Ventilate area of spill or leak. This material is a combustible liquid. For a spill or leak of a combustible liquid, shut off ignition sources; no flares, smoking or flames in hazard area. Stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: Absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: Dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of phosphorus, sulfur, nitrogen and carbon. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Do not empty into drains or sewage system. Small amounts can be burned with alkali[22]. For larger amounts, the suggested method is incineration with added solvent in furnace equipped with afterburner and alkali scrubber. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, *S,S′-Methylene-O,O,O′,O′-Tetraethyl Phosphorodithioate, Health and Environmental Effects Profile No. 127*, Washington, DC, Office of Solid Waste (April 30, 1980)

Sax, N. I., Ed., “*Dangerous Properties of Industrial Materials Report*,” 4, No. 1, 69−74 (1984) and 7, No. 1, 9−37 (1987)

United States Environmental Protection Agency, Chemical Hazard Information Profile: *Ethion*, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Ethion*, Trenton, NJ (December 1998)

Ethofumesate E:0265

Formula: $C_{13}H_{18}O_5S$

Synonyms: Batamix progress; 5-Benzofuranol, 2-ethoxy-2,3-dihydro-3,3-dimethyl-, methanesulfonate (+)-; Betanal; Ethosat 500; 2-Ethoxy-2,3-dihydro-3,3-dimethyl-5-benzofuranyl methanesulfonate,(+)-; 2-Ethoxy-2,3-dihydro-3,3-dimethylbenzofuran-5-yl methanesulfonate; Kemiron; Nortron; NC-8438; Powertwin; Prograss; Progress; Tandem; Torero

CAS Number: 26225-79-6

HSDB Number: 7451

RTECS Number: DF7716500

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 247-525-3 [*Annex I Index No.:* 607-314-00-2]

Potential Exposure: Benzofuran herbicide used to control weeds in sugar beet crops.

Regulatory Authority and Advisory Information

Carcinogenicity[83]: EPA Group D, Not classifiable as a human carcinogen

Hazard Alert: Combustible, Environmental hazard.

Potential Ground water Pollutant [California FAC Section 13145(d)/12811, active]

Hazardous to aquatic life or environment, with possible long lasting effects[293]. Toxic to aquatic life with long lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: N; risk phrases: R51/53; safety phrases: S2; S29; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [2-Hazard to waters (est.)]

Description: Colorless to white crystalline solid. Commercial formulations include flowable concentrate, emulsifiable concentrate, and granular products. Mild aromatic odor. Molecular weight = 286.33; freezing/melting point = 71°C; boiling point = (decomposes); specific gravity (H_2O:1) = 1.25 @ 20°C; vapor pressure = 4.9×10^{-6} mmHg @ 20°C; 8.6×10^{-7} mmHg @ 25°C; flash point = 80°C; 100°C[lit.]. Hazard identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 0. Soluble in water; solubility = 110 ppm @ 25°C. Physical and toxicological properties may be affected by the carrier solvents used in commercial formulations.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides.

Permissible Exposure Limits in Air: No standards or PAC available.

Determination in Air: Filter; none; Gravimetric; NIOSH IV [Particulates NOR; #0500 (total), #0600 (respirable)][18].

Determination in Water: Octanol-water coefficient: Log $K_{ow} = \sim 2.7$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood. Fish toxicity (threshold)[101]: Intermediate—58.73095 ppb, MATC (Maximum Acceptable Toxicant Concentration)

Routes of Entry: Inhalation, ingestion, and dermal and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: May irritate eyes, skin, and respiratory tract. May be harmful if inhaled. May be harmful if swallowed. LD_{50} (oral, rat) = < 1200 mg/kg; LD_{50} (dermal, rat) = > 1200 mg/kg.

Long-Term Exposure: Possible eye problems. Human toxicity (long term)[101]: Very low—2800.00 ppb, Health advisory

Points of Attack: Liver, kidney, and cornea.

Medical Surveillance: Preliminary medical exam to detect chronic diseases of CNS, liver, heart, kidneys, lung and skin, as well as endocrinological or immunological disturbances, should protect susceptible individuals. Periodical medical exams of internal organs, skin and eyes are important to avoid chronic occupational intoxications. They should include lab and patch tests when necessary[83].

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Applicators and other handlers must wear: Coveralls worn over long-sleeved shirt and long pants; Chemical-resistant gloves such as DuPont Tychem suit fabrics, barrier laminate, or Viton; Chemical-resistant footwear plus socks; Protective eye wear; Chemical-resistant headgear for overhead exposure; Chemical-resistant apron when cleaning equipment, mixing, or loading[83]. Agricultural Use/Engineering Controls: When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the Worker Protection Standard (WPS) for agricultural pesticides, 40 CFR 170.240(d)(4-6), the handler PPE requirements may be reduced or modified as specified in the Worker Protection Standard. Firefighters should wear NIOSH approved SCBA and full protective clothing.

Respirator Selection: Wherever and whenever workplace conditions warrant respirator use, a respiratory protection program must be followed that meets one or more of the following government standards: OSHA's 29 CFR 1910.134, ANSI Z88.2, or European Standard EN 149.

Storage: Color code-Blue: Health Hazard/Poison. Store in a secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: First remove all sources of ignition. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Ventilate area of spill or leak. Use water spray to reduce vapor. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include toxic oxides of sulfur and carbon. As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 m/150 ft for liquids and at least 25 m/75 ft for solids. *Fire involving storage or vehicular tanks:* Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. *On a small fire:* Use dry chemical, CO_2, water spray or regular *foam. On a large fire:* Use water spray, fog or regular foam. Do not scatter spilled material with high pressure streams of water. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal. *Fire involving tanks:* From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. Always stay away from tanks engulfed in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Do not discharge into drains or sewers. Dispose of waste material as hazardous waste using a licensed disposal contractor to an approved landfill. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. If allowed, Incineration with effluent gas scrubbing is recommended. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (100).

United States National Library of Medicine, *ChemIDplus Advanced*, Bethesda MD, http://chem.sis.nlm.nih.gov/chemidplus/rn/26225-79-6

Ethoprophos E:0270

Formula: $C_8H_{19}O_2PS_2$

Synonyms: AI3-27318; Caswell No.434C; ENT 27,318; EPA pesticide chemical code 041101; Ethoprop; *O*-Ethyl *S, S*-dipropyl dithiophosphate; *O*-Ethyl *S,S*-dipropyl phosphorodithioate; Jolt; Mobil V-C 9-104; Mocap; Mocap 10G; Phosethoprop; Phosphorodithioic acid, *O*-ethyl *S,S*-dipropyl ester; V-C 9-104; V-C Chemical V-C 9-104; Virginia-Carolina VC 9-104

CAS Registry Number: 13194-48-4

HSDB Number: 1715

RTECS Number: TE4025000

UN/NA & ERG Number: (PIH) UN3018 (organophosphorus pesticide, liquid, toxic)/152; UN2810 (toxic liquids, organic, n.o.s.)/153

EC Number: 236-152-1[*Annex I Index No.:* 015-107-00-8]

Regulatory Authority and Advisory Information

Carcinogenicity[83]: EPA, Likely to be carcinogenic to humans.

California Proposition 65 Chemical[102]: Cancer, 2/27/01.

Hazard Alert: Poison inhalation hazard, Neurotoxin (cumulative), Combustible, Nerve Toxin; Skin sensitization, Environmental hazard.

Banned or Severely Restricted (Malaysia, Philippines) (UN)[13]

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1000 lb (454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

United States DOT 49CFR172.101, Inhalation Hazardous Chemical, as organic phosphate, Substance ID: EDF-041

Hazard symbols, risk, & safety statements: Hazard symbol: T+, N, Xi; risk phrases: R45; R23/24/25; R26/27; R29/35; R33; R43; R50/53; safety phrases: S1/2; S27/28; S36/37/39; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Ethoprophos is a pale yellow liquid. Molecular weight = 242.36; boiling point = 88°C @ 0.2 mmHg; vapor pressure = 0.0004 mmHg. Hazard identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Slightly soluble in water.

Potential Exposure: A potential danger to those involved in the manufacture, formulation and application of this nematocide and soil insecticide.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides. Strong oxidizers may cause release of toxic phosphorus oxides. Organophosphates, in the presence of strong reducing agents such as hydrides, may form highly toxic and flammable phosphine gas. Keep away from alkaline materials.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 0.14 milligram per cubic meter

PAC-2: 1.6 milligram per cubic meter

PAC-3: 9.3 milligram per cubic meter

Determination in Air: OSHA versatile sampler-2; Toluene/Acetone; Gas chromatography/Flame photometric detection for sulfur, nitrogen, or phosphorus; NIOSH Analytical Method (IV) Method #5600, Organophosphorus Pesticides.

Determination in Water: Fish Tox = 0.47783000 ppb (EXTRA HIGH)

Determination in Soil: Soil Adsorption Index (Koc) = 70

Routes of Entry: Inhalation, ingestion, and skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Symptoms are similar to parathion and may include nausea, vomiting, abdominal cramps; diarrhea, excessive salivation; headache, giddiness, weakness, muscle twitching; difficult breathing; blurring or dimness of vision; and loss of muscle coordination. Death may occur from failure of the respiratory center, paralysis of the respiratory muscles, intense bronchoconstriction, or all three. Human Tox = 12.45550 ppb (INTERMEDIATE). It is a cholinesterase inhibitor which affects the nervous system.

Long-Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, CNS; cardiovascular system, skin, eyes, plasma, and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1–2 weeks while red blood cell levels may be reduced for 1–3 months. When cholinesterase enzyme levels are reduced by 25% or more below pre-employment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Remove and isolate contaminated clothing and shoes at the site. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and

storage. Store in tightly closed containers in a cool, well ventilated area. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: UN3018 Organophosphorus pesticides, liquid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN2810 Toxic liquids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling:

Initial Isolation and Protective Action Distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24 h response line).

Small Spills (from a small package or a small leak from a large package)

First: Isolate in all directions (ft/m)	100/30
Then: Protect persons downwind (mi/km)	
Day	0.3/0.4
Night	0.8/1.2

Large Spills (from a large package or from many small packages)

First: Isolate in all directions (ft/m)	600/200
Then: Protect persons downwind (mi/km)	
Day	1.4/2.3
Night	2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Do not touch spilled material. Do not breathe vapors. Stay upwind; keep out of low areas. Remove all ignition sources. Ventilate area of spill or leak. This material is a combustible liquid. For a spill or leak of a combustible liquid, shut off ignition sources; no flares, smoking or flames in hazard area. Stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: Absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: Dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material may burn but does not ignite readily. Thermal decomposition products may include oxides of phosphorus, sulfur, nitrogen and carbon. *For small fires*, use dry chemical, carbon dioxide; water spray; or foam. *For large fires*, use water spray, fog, or foam. Stay upwind; keep out of low areas. Move containers from fire area if you can do it without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Wear positive pressure breathing apparatus and special protective clothing. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR 165 recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(102); (31); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 2, No. 4, 85–88 (1982)

United States Environmental Protection Agency, Chemical Hazard Information Profile: *Ethoprophos*, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

2-Ethoxyethanol E:0280

Formula: $C_4H_{10}O_2$: $C_2H_5OCH_2CH_2OH$

Synonyms: Athylenglykol-monoathylather (German); Cellosolve; Cellosolve solvent; DAG 154; Developer 1002; Dowanol E; Dowanol EE; Dynasolve MP -500; Dynasolve MP aluminum grade; 2EE; Ektasolve EE; Emkanol; Ethanol, 2- ethoxy-; Ether monoethylique de l'ethylene glycol (French); β-Ethoxyethanol; 2-Ethoxyethyl alcohol; Ethyl cellosolve; Ethylene glycol ethyl ether; Ethylene glycol monoethyl ether; 2-Etoxietanol (Spanish); Glycol ethyl ether; Glycol monoethyl ether; Hydroxy ether; Jeffersol EE; Justrite thinner and cleaner; NCI-C54853; Oxitol; Poly-Solv E; Poly-Solv EE; Pyralin PI 2563; Ultramac 55

CAS Registry Number: 110-80-5; *(alt.)* 96231-36-6

HSDB Number: 54 as ethylene glycol monoethyl ether

RTECS Number: KK8050000

UN/NA & ERG Number: UN1171/127

EC Number: 203-804-1[*Annex I Index No.:* 603-012-00-X]

Regulatory Authority and Advisory Information

California Proposition 65 Chemical[102]: Developmental/ Reproductive toxin, male 1/1/1989.

Hazard Alert: Flammable, Possible risk of forming tumors, Reproductive toxin, Reproductive toxin: possible risk of gene damage/impaired fertility; Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction).

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U359

United States Environmental Protection Agency TSCA Section 8(e) Risk Notification, 8EHQ-0892-9072 RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1000 lb (454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, F; risk phrases: R10; R60; R61; R10; R20/21/22; R61; R62; R63; safety phrases: S53; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: 2-Ethoxyethanol is a colorless, viscous liquid with a sweetish odor. Molecular weight = 90.12; specific gravity (H 2O:1) = 0.93 @ 20°C; boiling point = 135°C; freezing/melting point = −70°C; vapor pressure = 4 mmHg @ 20°C; 7.5 mmHg @ 30°C; flash point = 43.3°C; autoignition temperature = 235°C. Explosive limits: LEL: 1.7% @ 93°C; UEL: 15.6% @ 93°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 0. Soluble in water.

Potential Exposure: This material is used as a solvent for nitrocellulose and alkyd resins in lacquers; as a solvent for printing inks; in dyeing leathers and textiles; in the formulation of cleaners and varnish removers; as an anti-icing additive in brake fluids and auto and aviation fuels.

Incompatibilities: May form explosive mixture with air. Strong oxidizers may cause fire and explosions. Attacks some plastics, rubber and coatings. Able to form peroxides. Incompatible with strong acids; aluminum and its alloys.

Permissible Exposure Limits in Air

NIOSH IDLH = 500 ppm

Odor threshold = 2.7 ppm.

OSHA PEL: 200 ppm/740 milligram per cubic meter TWA [skin]

NIOSH REL: 0.5 ppm/1.8 milligram per cubic meter TWA [skin]

ACGIH TLV[1]: 5 ppm/ 18 milligram per cubic meter TWA [skin]; BEI: 100 mg[2-ethoxyacetic acid]/g creatinine in urine at end of work-week

PAC Ver. 29[138]

PAC-1: 15 ppm

PAC-2: 1000 ppm

PAC-3: 6000 ppm

DFG MAK: 5 ppm/19 milligram per cubic meter TWA; Peak Limitation Category II(8) [skin]; BAT: 50 mg [Ethoxyacetic acid]/g creatinine in urine at end-of-shift; after several shifts (long term); Pregnancy Risk Group B

Australia: TWA 5 ppm (19 milligram per cubic meter), [skin], 1993; Austria: MAK 20 ppm (75 milligram per cubic meter), [skin], 1999; Belgium: TWA 5 ppm (18 milligram per cubic meter), [skin], 1993; Denmark: TWA 5 ppm (18.5 milligram per cubic meter), [skin], 1999; Finland: TWA 50 ppm (185 milligram per cubic meter); STEL 100 ppm (370 milligram per cubic meter), [skin], 1999; France: VME 5 ppm (19 milligram per cubic meter), [skin], 1999; Hungary: TWA 70 milligram per cubic meter; STEL 140 milligram per cubic meter, [skin], 1993; the Netherlands: MAC-TGG 19 milligram per cubic meter, [skin], 2003; Norway: TWA 5 ppm (18 milligram per cubic meter), 1999; the Philippines: TWA 200 ppm (740 milligram per cubic meter), [skin], 1993; Poland: MAC (TWA) 20 milligram per cubic meter, MAC (STEL) 80 milligram per cubic meter, 1999; Russia: TWA 5 ppm; STEL 5 milligram per cubic meter, 1993; Sweden: NGV 5 ppm (19 milligram per cubic meter), KTV 10 ppm (40 milligram per cubic meter), [skin], 1999; Switzerland: MAK-W 5 ppm (19 milligram per cubic meter), KZG-W 10 ppm (38 milligram per cubic meter), [skin], 1999; Turkey: TWA 200 ppm (740 milligram per cubic meter), 1993; United Kingdom: TWA 10 ppm (37 milligram per cubic meter), [skin], 2000; New Zealand, Singapore, and Vietnam: ACGIH TLV: TWA 5 ppm [skin]. Finally, Russia[43] set a MAC in ambient air in residential areas of 0.7 milligram per cubic meter on a once daily basis[35]. Several states have set guidelines or standards for ethoxyethanol in ambient air[60] ranging from 120−190 μ/m^3 (North Carolina) to 180 μ/m^3 (Florida and New York) to 190 μ/m^3 (North Dakota) to 320 μ/m^3 (Virginia) to 380 μ/m^3 (Connecticut) to 452 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #1403, alcohols IV or OSHA Analytical Methods 53 or 79.

Permissible Concentration in Water: Russia set a MAC in surface water of 1.0 mg/L.

Determination in Water: No tests listed. Octanol-water coefficient: Log $K_{ow} = -0.5$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, skin absorption, ingestion, and skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: 2-Ethoxyethanol can affect you when breathed in and by passing through your skin. Irritates the eyes, skin and respiratory tract. High levels may cause headache, drowsiness, dizziness, lightheadedness and even passing out. Exposure may cause CNS depression, liver, and kidney damage. LD_{50} = (oral-rat) 2125 mg/kg (slightly toxic). Medical observation is recommended.

Long-Term Exposure: 2-Ethoxyethanol should be handled as a teratogen-with extreme caution. It may damage the testes, resulting in decreased fertility. Exposure may affect blood cells, causing a low blood count (anemia) and lesions of blood cells. Prolonged or repeated contact defats the skin. May cause liver and kidney damage.

Points of Attack: Eyes, respiratory system, blood, kidneys, liver, reproductive system, and hematopoietic system

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater, or significant skin contact) the following are recommended before beginning work and at regular times after that: complete blood count. If symptoms develop or overexposure is suspected, the following may be useful: kidney function tests. Liver function tests. NIOSH lists the following test: urine (chemical/metabolite) End-of-shift at end-of-work-week.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim under medical observation.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. 8 hours: Saranex coated suits; Responder suits; 4 hours: 4 H and Silver Shield gloves. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: Up to 5 ppm: Sa (APF = 10) (any supplied-air respirator). Up to 12.5 ppm: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). Up to 25 ppm: SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). Up to 500 ppm: Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-, mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code-Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. 2-Ethoxyethanol must be stored to avoid contact with strong oxidizers, such as nitrates, permanganates, chlorine, bromine, or chlorine dioxide, since violent reaction occur. Store in tightly closed containers in a dark, cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames are prohibited where 2-ethoxyethanol is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Keep in dark because of possible formation of explosive peroxides.

Shipping: UN1171 Ethylene glycol monoethyl ether, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed[22]. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(102); (31); (173); (101); (138); (2); (100).

National institute for Occupational Safety and Health (NIOSH), *Glycol Ethers: 2-Methoxyethanol and 2-Ethoxyethanol*, Current Intelligence Bulletin No. 39, Cincinnati, Ohio (May 2, 1983)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: 2-Ethoxyethanol*, Trenton, NJ (April 2002)

2-Ethoxyethyl acetate E:0290

Formula: $C_6H_{12}O_3$; $C_2H_5OCH_2CH_2OCOCH_3$

Synonyms: Acetato de 2-etoxietilo (Spanish); Acetic acid, 2-ethoxyethyl ester; 1-Acetoxy-2-ethoxyethane; Aristoline(+); AZ 1310-SF(+); AZ 1312-SFD(+); AZ 1318-SFD(+); AZ 1350 J(+); AZ 1370(+); AZ 1370-SF(+); AZ 1375(+); AZ 1470(+); AZ 4140(+); AZ 4210(+); AZ 4330(+); AZ 4620(+); AZ protective coating; AZ thinner; Cellosolve acetate; EE acetate; EGEEA; EGMEA; Ethanol, 2-ethoxy-, acetate; Ethoxyethanol acetate; β-Ethoxyethyl acetate; Ethoxyethyl acetate; Ethyl cellosolve acetate; Ethylene glycol acetate monoethyl ether; Ethylene glycol ethyl ether acetate; Ethylene glycol monoethyl ether acetate; Ethylene glycol monoethyl ether monoacetate; Ethyloxitol acetate; Glycol monoethyl ether acetate; H.M.D.S. III; Hydroxy ether; Kodak MX-936; Kodak photoresist developer; KTI 1300 thinner; KTI 1350 J(+); KTI 1370; KTI 1375(+); KTI 1470(+); KTI 820(+); KTI 820 J (+); KTI 9000; KTI 9000 K; KTI 9010(+); KTI II; Liquid alkaline strip 7463; Markem thinner XF; Microposit 111 S(+); Microposit 119 S(+); Microposit 119 thinner; Microposit 1375(+); Microposit 1400-33(+); Microposit 1400 S(+); Microposit 1450 J(+); Microposit 1470(+); Microposit Sal 601-ER7(+); Microposit XP-6009(+); Microposit XP-6012(+); MS-470 urethane coating; OFPR-800 AR-15(+); Poly-Solv EE acetate; PR-21 Resist; PR-55 Resist; Selectilux P-15(+); Sensolve EEA; Thinner E; TSMR 8800(+); Ultamac PR-68 Resin; Ultramac PR-1024 MB-628 Resin; Waxivation compound; Waycoat 204(+); Waycoat 207(+); Waycoat HPR 205; Waycoat RX 507(+); Xanthochrome(+)

CAS Registry Number: 111-15-9

HSDB Number: 539

RTECS Number: KK8225000

UN/NA & ERG Number: UN1172/139

EC Number: 203-839-2 [*Annex I Index No.:* 607-037-00-7]

Regulatory Authority and Advisory Information

California Proposition 65 Chemical[102]: Developmental/Reproductive toxin, male, 1/1/1993

Hazard Alert: Flammable, Reproductive toxin: Suspected of causing genetic defects, Primary irritant (w/o allergic reaction).

United States Environmental Protection Agency TSCA Section 8(e) Risk Notification, 8EHQ-0693-9068

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, F, Xi; risk phrases: R10; R20/21/22; R36/37/38; R60; R61; R10; R20/21/22; R62; safety phrases: S53; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: 2-Ethoxyethyl acetate is a colorless liquid with a mild, nonresidual odor. The Odor Threshold is 0.056 ppm in air. Molecular weight = 132.16; specific gravity (H_2O:1) = 0.97 @ 20°C; boiling point = 156°C; freezing/melting point = −61.7°C; vapor pressure = 2 mmHg @ 20°C; 0.75 mmHg @ 14°C; flash point = 47°C; autoignition temperature = 380°C. Explosive limits: LEL: 1.7%; UEL: 12.7%. The UEL is also reported as 14%. Hazard identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 0. Soluble in water; solubility = 23%.

Potential Exposure: This material is used as a solvent for many different purposes; including for nitrocellulose and other resins. Used in automobile lacquers to retard evaporation and impart a high gloss.

Incompatibilities: May form explosive mixture with air. Incompatible with strong acids; strong alkalies; nitrates. Violent reaction with oxidizers. May form unstable peroxides. Softens many plastics. Attacks some plastics, rubber, and coatings.

Permissible Exposure Limits in Air

NIOSH IDLH = 500 ppm

Conversion factor: 1 ppm = 5.41 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 100 ppm/540 milligram per cubic meter TWA [skin]

NIOSH REL: 0.5 ppm/2.7 milligram per cubic meter TWA [skin]

ACGIH TLV[1]: 5 ppm/27 milligram per cubic meter TWA [skin]; BEI: 100 mg[2-Ethoxyacetic acid]/g creatinine in urine at end of work-week

PAC Ver. 29[138]

PAC-1: 15 ppm

PAC-2: 420 ppm

PAC-3: 2500 ppm

DFG MAK: 2 ppm/11 milligram per cubic meter TWA; Peak Limitation Category II(8); [skin]; BAT: 50 mg [Ethoxyacetic acid]/g creatinine in urine at end-of-shift; after several shifts (long term); Pregnancy Risk Group B

Australia: TWA 5 ppm (27 milligram per cubic meter), [skin], 1993; Austria: MAK 20 ppm (110 milligram per cubic meter), [skin], 1999; Belgium: TWA 5 ppm (27 milligram per cubic meter), [skin], 1993; Denmark: TWA

5 ppm (27.0 milligram per cubic meter), [skin], 1999; Finland: TWA 50 ppm (270 milligram per cubic meter); STEL 100 ppm (540 milligram per cubic meter), [skin], 1999; France: VME 5 ppm (27 milligram per cubic meter), [skin], 1999; Hungary: TWA 25 milligram per cubic meter; STEL 50 milligram per cubic meter, [skin], 1993; the Netherlands: MAC-TGG 27 milligram per cubic meter, [skin], 2003; Norway: TWA 5 ppm (27 milligram per cubic meter), 1999; the Philippines: TWA 100 ppm (540 milligram per cubic meter), [skin], 1993; Poland: MAC (TWA) 100 milligram per cubic meter, 1999; Russia: TWA 5 ppm, 1993; Sweden: NGV 5 ppm (30 milligram per cubic meter), KTV 10 ppm (50 milligram per cubic meter), [skin], 1999; Switzerland: MAK-W 5 ppm (27 milligram per cubic meter), KZG-W 10 ppm (54 milligram per cubic meter), [skin], 1999; Turkey: TWA 100 ppm (540 milligram per cubic meter), 1993; United Kingdom: TWA 10 ppm (55 milligram per cubic meter), [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: TWA 5 ppm [skin]. Several states have set guidelines or standards for ethoxyethyl acetate in ambient air[60] ranging from 270 μ/m^3 (North Dakota) to 450 μ/m^3 (Virginia) to 540 μ/m^3 (Connecticut and South Dakota) to 643 μ/m^3 (Nevada).

Determination in Air: Charcoal adsorption, workup with CS2, analysis by gas chromatography /flame ionization. Use NIOSH Analytical Method #1450 or OSHA Analytical Methods 53 and 79.

Determination in Water: No tests listed. Octanol-water coefficient: Log $K_{ow} = < 0.3$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion, and eyes and skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: 2-Ethoxyethylacetate can affect you when breathed in and by passing through your skin. Exposure can irritate the eyes, nose and throat. High levels could cause you to become dizzy, lightheaded, and to pass out. Very high exposures could cause kidney damage and even death. May affect the blood and CNS.

Long-Term Exposure: 2-Ethoxyehylacetate may damage the developing fetus. It may damage the testes (male reproductive glands), resulting in decreased fertility. It may affect the blood, liver, and kidneys. Many similar petroleum-based solvents have been shown to cause brain and nerve damage.

Points of Attack: Inhalation, skin absorption, ingestion, and skin and/or eye contact

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: kidney function tests. Complete blood count. Evaluate for brain effects and consider evaluation of the nervous systems.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. 8 hours: Barricade coated suits; Responder suits; 4 hours: polyvinyl alcohol gloves; 4 H and Silver Shield gloves. Safety equipment suppliers/ manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Neoprene is among the recommended protective materials. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: 5 ppm: CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)]; Sa (APF = 10) (any supplied-air respirator). 12.5 ppm: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]. 25 ppm: CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)]; GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted acid gas canister]; PaprTOv (APF = 50) [any powered, air-purifying respirator with a tight-fitting facepiece and organic vapor cartridge(s)]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). 500 ppm: Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code-Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. 2-Ethoxyethylacetate must be stored to avoid contact with strong oxidizers, such as nitrates, permanganates, bromine, chlorine, and chlorine dioxide; strong alkalis, such as sodium hydroxide and potassium hydroxide; and strong acids, such as nitric, hydrochloric, and sulfuric acids, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames are prohibited where 2-ethoxyethylacetate is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN1172 Ethylene glycol monoethyl ether acetate, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(102); (31); (173); (101); (138); (2); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 4, No. 2, 64–67 (1984)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: 2-Ethoxyethyl Acetate*, Trenton, NJ (July 2002)

Ethoxyquin E:0295

Formula: $C_{14}H_{19}NO$

Synonyms: Chemley; Deccoquin 305; 1,2-Dihydro-6-ethoxy-2,2,4-trimethylquinoline; 1,2-Dihydro-2,2,4-trimethyl-6-ethoxyquinoline; EMQ; EQ; 6-Ethoxy-1,2-dihydro-2,2,4-trimethyl quinoline; Ethoxyquine; 6-Ethoxy- 2,2,4-trimethyl-1,2-dihydroquinoline; Niflex; Nix-scald; Santoflex a; Santoflex aw; Santoquin; Santoquine; Stop-scald; 2,2,4-Trimethyl-6-ethoxy-1,2-dihydroquinoline

CAS Number: 91-53-2

HSDB Number: 400

RTECS Number: VB8225000

UN/NA & ERG Number: UN3082 (environmentally hazardous substances, liquid, n.o.s.)/171

EC Number: 202-075-7 [*Annex I Index No.:*613-014-00-2]

Regulatory Authority and Advisory Information

Hazard Alert: Combustible, Suspected reprotoxic hazard

Hazard symbols, risk, & safety statements: Hazard symbol: Xn; risk phrases: R19; R22; R61; safety phrases: S2; S24 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Transparent yellow or brown viscous liquid. Molecular weight = 217.32; specific gravity (H_2O:1) = 1.032 @ 25°C; boiling point = 124°C; 150°C @ 2 mmHg (decomposes); freezing/melting point = −20°C; specific gravity (H_2O:1) = 1.029 @ 25°C; vapor pressure = 2.56×10^{-4} mmHg @ 25°C Flash point = 143°C(oc). Hazard identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Practically insoluble in water; solubility = < 1 mg/L @25°C.

Potential Exposure: Quinoline insecticide, fungicide and plant growth regulator. Also and ingredient in other products. Used for preharvest or postharvest preservation of color in apples and pears. It is used as an anti-oxidant to preserve color in paprika and ground and powdered chili. Ethoxyquin also is a chemical preservative used in animal feed to prevent ingredients from reacting with oxygen and becoming rancid. It has been known to cause birth defects in pet birds and dogs.

Incompatibilities: Polymerization can occur on contact with strong light and/or water. Decomposes in temperatures above 150°C. Keep away from oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); strong acids.

Determination in Air: No occupational or safety limits found.

Determination in Water: Octanol-water coefficient: Log K_{ow} = > 3.0. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, ingestion, and eye and/or dermal contact.

Harmful Effects and Symptoms

Short-Term Exposure: This chemical can irritate skin, eyes and respiratory tract. Harmful if swallowed. May cause reversible liver problems. Overexposure may cause irritation of the GI tract. May affect CNS and behavior causing respiratory problems, convulsions, coma, loss of voluntary muscle control; lack of balance and coordination; drowsiness. LD_{50} (oral, rat) = 800− > 1725 mg/kg.

Long-Term Exposure: May cause dermatitis. Possible blood, bladder, liver and kidney toxin. May be a skin sensitizer; causing allergic skin reaction. May affect metabolism, blood resulting in a change in clotting factor. May be mutagenic.

Points of Attack: Skin, lungs, liver, and kidney

Medical Surveillance: With ethoxyquin, if symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function tests; routine blood analysis. Evaluation by a qualified allergist, including exposure history and testing, may help diagnose allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Applicators and other handlers must wear: Coveralls worn over long-sleeved shirt and long pants; Chemical-resistant gloves such as DuPont Tychem suit fabrics, barrier laminate, or Viton; Chemical-resistant footwear plus socks; Protective eye wear; Chemical-resistant headgear for overhead exposure; Chemical-resistant apron when cleaning equipment, mixing, or loading[83]. Agricultural Use/Engineering Controls: When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the Worker Protection Standard (WPS) for agricultural pesticides, 40 CFR 170.240(d)(4-6), the handler PPE requirements may be reduced or modified as specified in the Worker Protection Standard. Firefighters should wear NIOSH approved SCBA and full protective clothing.

Respirator Selection: Wherever and whenever workplace conditions warrant respirator use, a respiratory protection program must be followed that meets one or more of the following government standards: OSHA's 29 CFR 1910.134, ANSI Z88.2, or European Standard EN 149.

Storage: Color code-Blue: Health Hazard/Poison. Store in a secure, locked poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN3082 Environmentally hazardous substances, liquid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required

Spill Handling: First remove all sources of ignition. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Ventilate area of spill or leak. Use water spray to reduce vapor. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include toxic oxides of nitrogen and carbon. As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 m/150 ft for liquids and at least 25 m/75 ft for solids. *Fire involving storage or vehicular tanks:* Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. *On a small fire:* Use dry chemical, CO_2, water spray or regular *foam. On a large fire:* Use water spray, fog or regular foam. Do not scatter spilled material with high pressure streams of water. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal. *Fire involving tanks:* From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. Always stay away from tanks engulfed in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Do not discharge into drains or sewers. Dispose of waste material as hazardous waste using a licensed disposal contractor to an approved landfill. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. If allowed, Incineration with effluent gas scrubbing is recommended. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Office of Pesticide Programs, Pesticide Residue Limits, "*Ethoxyquin*," 40 CFR 180.178, http://www.epa.gov/pesticides/food/viewtols.htm

Ethyl acetate E:0300

Formula: $C_4H_8O_2$: $CH_3COOC_2H_5$

Synonyms: Acetato de etilo (Spanish); Acetic acid, ethyl ester; Acetic ester; Acetic ether; Acetidin; Acetoxyethane; Aethylacetat (German); Arsenosilica film 0308; AS-1; AS 1400; AS 18CZ10A; AS 18CZ5E; AS 18CZ6E; AS 1CE; AS 5CE; B446; Essigester (German); Ethyl acetic ester; Ethyle (acetate d') (French); Ethyl ester of acetic acid; Ethyl ethanoate; KTI 1470(+); Vinegar naphtha

CAS Registry Number: 141-78-6

HSDB Number: 83

RTECS Number: AH5425000

UN/NA & ERG Number: UN1173/129

EC Number: 205-500-4 [*Annex I Index No.:* 607-022-00-5]

Regulatory Authority and Advisory Information

United States Environmental Protection Agency Gene-Tox Program, Inconclusive: *B. subtilis* rec assay.

Hazard Alert: Suspected of causing genetic defects, Primary irritant (w/o allergic reaction).

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U112

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.34; Nonwastewater (mg/kg), 33

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 5000 lb (2270 kg)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xi; risk phrases: R11; R36/37/38; R66; R62; R67; safety phrases: S2; S16; S21; S26; S33; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Ethyl acetate is a colorless liquid. Pleasant, fruity odor. Molecular weight = 88.11; specific gravity (H_2O:1) = 0.90; boiling point = 77°C; freezing point = −82.8; vapor pressure = 75 mmHg @ 20.4°C; flash point = −4.4°C; autoignition temperature = 426°C. Explosive limits: LEL: 2.0%; UEL: 11.5%. Hazard identification (based on NFPA-704 M Rating System): Health 1, Flammability 3, Reactivity 0. Slightly soluble in water; solubility = 0.9%.

Potential Exposure: This material is used as a solvent for nitrocellulose and lacquer. It is also used in making dyes, flavoring and perfumery, and in smokeless powder manufacture.

Incompatibilities: May form explosive mixture with air. Heating may cause violent combustion or explosion. Incompatible with strong acids; strong alkalies; nitrates, strong oxidizers; chlorosulfonic acid; lithium aluminum hydride; oleum will hydrolyze on standing forming acetic acid and ethyl alcohol. This reaction is greatly accelerated by alkalies. Decomposes under influence of UV light, bases, and acids. Attacks aluminum and plastics.

Permissible Exposure Limits in Air

NIOSH IDLH = 2000 ppm [LEL]

Conversion factor: 1 ppm = 3.60 milligram per cubic meter @ 25°C & 1 atm

Odor Threshold = 3.9 ppm in air

OSHA PEL: 400 ppm/1400 milligram per cubic meter TWA

NIOSH REL: 400 ppm/1400 milligram per cubic meter TWA

ACGIH TLV[1]: 400 ppm/1440 milligram per cubic meter TWA

PAC Ver. 29[138]

PAC-1: 1200 ppm

PAC-2: 1700 ppm

PAC-3: 10,000 ppm

DFG MAK: 400 ppm/1500 milligram per cubic meter TWA; Peak Limitation Category I(2); Pregnancy Risk Group C

Australia: TWA 400 ppm (1400 milligram per cubic meter), 1993; Austria: MAK 400 ppm (1400 milligram per cubic meter), 1999; Belgium: TWA 400 ppm (1440 milligram per cubic meter), 1993; Denmark: TWA 150 ppm (540 milligram per cubic meter), 1999; Finland: TWA 300 ppm (1100 milligram per cubic meter); STEL 500 ppm (1800 milligram per cubic meter), 1993; France: VME 400 ppm (1400 milligram per cubic meter), 1999; Hungary: TWA 400 milligram per cubic meter; STEL 1200 milligram per cubic meter, 1993; the Netherlands: MAC-TGG 550 milligram per cubic meter, 2003; Norway: TWA 150 ppm (550 milligram per cubic meter), 1999; the Philippines: TWA 400 ppm (1400 milligram per cubic meter), 1993; Poland: MAC (TWA) 200 ppm, MAC (STEL) 600 milligram per cubic meter, 1999; Russia: TWA 400 ppm; STEL 200 milligram per cubic meter, 1993; Sweden: NGV 150 ppm (500 milligram per cubic meter), KTV 300 ppm (1100 milligram per cubic meter), 1999; Switzerland: MAK-W 400 ppm (1400 milligram per cubic meter), KZG-W 800 ppm (2800 milligram per cubic meter), 1999; Turkey: TWA 400 ppm (1400 milligram per cubic meter), 1993; United Kingdom: TWA 400 ppm (1460 milligram per cubic meter), 2000; New Zealand, Singapore, and Vietnam: ACGIH TLV: TWA 400 ppm. the Czech Republic:[35] 400 milligram per cubic meter, Russia[35,43] set a MAC value in the ambient air of residential areas of 0.1 milligram per cubic meter on either a momentary or a daily average basis. Several States have set guidelines or standards for ethyl acetate in ambient air[60] ranging from 2.0 milligram per cubic meter (Massachusetts) to 14.0 milligram per cubic meter (North

Dakota) to 23.0 milligram per cubic meter (Virginia) to 28.0 milligram per cubic meter (Connecticut, Florida, New York and South Dakota) to 33.333 milligram per cubic meter (Nevada) to 140.0 milligram per cubic meter (North Carolina).

Determination in Air: Use NIOSH Analytical Method #1450 or OSHA Analytical Method 7.

Permissible Concentration in Water: Russia set a MAC in surface water of 0.2 mg/L.

Routes of Entry: Inhalation, ingestion, and eye and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Ethyl acetate can affect you when breathed in and by passing through your skin. Exposure to high levels can cause you to feel dizzy and lightheaded. Very high levels could cause you to pass out. Repeated contact can cause drying and cracking of the skin. The vapor can irritate the eyes and respiratory tract. Ethyl acetate is a flammable liquid and a fire hazard. May affect the CNS. Very high exposure may result in death.

Long-Term Exposure: May decrease the fertility in males. Repeated contact can cause drying and cracking of the skin. Many similar petroleum-based chemicals can cause brain and nerve damage.

Points of Attack: Eyes, skin, and respiratory system.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Evaluate for brain and nervous system damage.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. 8 hours: 4 H and Silver Shield gloves; Barricade coated suits; CPF3 suits; Responder suits, Trellchem HPS suits; Trychem 1000 suits, 4 hours: polyvinyl alcohol gloves; Teflon gloves, suits, boots. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: 2000 ppm: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]; or CcrFOv (APF = 50) [any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s)]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted acid gas canister]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:*

SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-, mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance causes eye irritation or damage; eye protection needed.

Storage: Color code-Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Ethyl acetate must be stored to avoid contact with nitrates; strong oxidizers; such as chlorine, bromine, chlorine dioxide, nitrates, and permanganates; strong alkalis, such as sodium hydroxide and potassium hydroxide; or strong acids, such as sulfuric acid, hydrochloric acid, and nitric acid, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames are prohibited where ethyl acetate is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of five gallons or more of ethyl acetate should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of ethyl acetate. Store in containers that are properly labeled with health hazard information and safe handling procedures. Wherever ethyl acetate is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1173 Ethyl acetate, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive

limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed[22]. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (173); (101); (80); (100)

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 4, No. 1, 75−78 (1984)(2).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Ethyl Acetate*, Trenton, NJ (July 2002).

Ethyl acetylene E:0310

Formula: C_4H_6; $C_2H_5C{\equiv}CH$

Synonyms: 1-Butine; 1-Butino (Spanish); 1-Butyne; Ethylacetylene; Ethyl ethyne

CAS Registry Number: 107-00-6

RTECS Number: ER9553000

UN/NA & ERG Number: UN2452 (stabilized)/116 (P)

EC Number: 203-451-3

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Hazard Alert: Extremely flammable gas, Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated, Polymerization hazard.

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg).

Hazard symbols, risk, & safety statements: Hazard symbol: F + , risk phrases: R5; R12; R18; R19; R21; safety phrases: S1; S9; S16; S23; S33; S38; S45.

Description: Ethyl acetylene is a colorless, compressed gas or liquid. Molecular weight = 54.0; boiling point = 8.1°C; freezing/melting point = −130°C; flash point ≤ −7°C. Hazard identification (based on NFPA-704 M Rating System): Health 1, Flammability 4, Reactivity 2. Practically insoluble in water.

Potential Exposure: A simple asphyxiant. Ethyl acetylene is used as a fuel and as a chemical intermediate.

Incompatibilities: Extremely flammable; forms explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, copper and its alloys, and various plastics including Teflon. May undergo violent polymerization when subjected to heat, direct sunlight, or contamination.

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Determination in Water: Octanol-water coefficient: Log $K_{ow} = < 2$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short-Term Exposure: Ethyl acetylene can affect you when breathed in. Exposure can cause you to feel dizzy, lightheaded and to pass out. Exposure to very high levels can cause suffocation and death due to lack of oxygen.

Long-Term Exposure: Unknown at this time.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce

vomiting. Do not make an unconscious person vomit. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid unless full facepiece respiratory protection is worn. Wear gas-proof goggles and face shield, unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Exposure to ethyl acetylene is dangerous because it can replace oxygen and lead to suffocation. Only NIOSH/MSHA or European Standard EN 149-approved SCBA with a full facepiece operated in positive-pressure mode should be used in oxygen deficient environments.

Storage: Check oxygen content prior to entering storage area. Flammable gas. Color code-Red Stripe: Flammability Hazard: Store separately from all other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1 hour fire wall from flammable or reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Ethyl acetylene must be stored to avoid contact with strong oxidizers (such as chlorine, bromine and fluorine), since violent reactions occur. Protect cylinders from physical damage and store away from potential heat sources. Sources of ignition, such as smoking and open flames, are prohibited where ethyl acetylene is handled, used, or stored. Wherever ethyl acetylene is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: UN2452 Ethylacetylene, stabilized, Hazard Class: 2.1; Labels: 2.1-Flammable gas. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: Restrict persons not wearing protective equipment from area of leak until clean-up is complete. Remove all ignition sources. Ventilate area of leak to disperse the gas. Stop flow of gas. If source of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. Water spray may be used to reduce vapors. Keep ethyl acetylene out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations.

Fire Extinguishing: This chemical is an unstable, flammable gas. Thermal decomposition products may include oxides of carbon and flammable hydrogen gas. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier.

References

(31); (101); (138).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Ethyl Acetylene*, Trenton, NJ (February 2000)

Ethyl acrylate E:0320

Formula: $C_5H_8O_2$: $CH_2 = CHCOOC_2H_5$

Synonyms: Acrilato de etilo (Spanish); Acrylate d'ethyle (French); Acrylic acid, ethyl ester; Acrylsaeuraethylester (German); Aethylacrylat (German); Ethoxy carbonyl ethylene; Ethyl 2-propenoate; Ethyl propenoate; NCI-C50384; 2-Propenoic acid, ethyl ester

CAS Registry Number: 140-88-5

HSDB Number: 193

RTECS Number: AT0700000

UN/NA & ERG Number: UN1917 (stabilized)/129 (P)

EC Number: 205-438-8 [*Annex I Index No.:* 607-032-00-X]

Regulatory Authority and Advisory Information

Carcinogenicity: NCI: Carcinogenesis Studies (gavage); clear evidence: mouse, rat; IARC: Animal Sufficient Evidence; Human No Adequate Data, *possibly carcinogenic to humans*, Group 2B, 1999; NIOSH: Potential occupational carcinogen.

California Proposition 65 Chemical[102]: Cancer 7/1/1989.

Hazard Alert: Highly flammable liquid, Polymerization hazard (nonstabilized), Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Sensitization hazard (skin), Primary irritant (w/o allergic reaction), Environmental hazard.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U113 RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1000 lb (454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

United States DOT Regulated marine pollutant (49CFR172.101, Appendix B)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long lasting effects[194]. Harmful to aquatic life with long lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, F, Xn, Xi; risk phrases: R45; R11; R19; R20/21/22; R36/37/38; R43; R62; R63; safety phrases: S2; S9; S16; S21; S29/35; S33; S36/37; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Ethyl acrylate is a colorless liquid. Sharp, acrid odor. The Odor Threshold is 0.00024−0.0009 ppm. Molecular weight = 100.12; boiling point = 99.4°C; freezing/melting point = −71°C; vapor pressure = 29 mmHg @ 20°C; vapor pressure = 75 mmHg @ 38.5°C; flash point = 10°C (oc); autoignition temperature = 372°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, Flammability 3, Reactivity 2. Explosive limits: LEL: 1.4%; UEL: 14%. Slightly soluble in water.

Potential Exposure: This material is used in emulsion polymers for paints, textiles, adhesives, coatings and binders; as a monomer in the manufacture of homopolymer and copolymer resins for the production of paints and plastic films.

Incompatibilities: May form explosive mixture with air. Atmospheric moisture and strong alkalies may cause fire and explosions unless properly inhibited (*Note:* Inert gas blanket not recommended). Heat, light or peroxides can cause polymerization. Incompatible with oxidizers (may be violent), peroxides, polymerizers, strong alkalis; moisture, chlorosulfonic acid, strong acids; amines. May accumulate static electrical charges, and may cause ignition of its vapors. Polymerizes readily unless an inhibitor, such as hydroquinone is added. Uninhibited vapors may plug vents by the formation of polymers.

Permissible Exposure Limits in Air

NIOSH IDLH = 300 ppm, Potential occupational carcinogen

OSHA PEL: 25 ppm/100 milligram per cubic meter TWA [skin]

NIOSH REL: Potential occupational carcinogen. Limit exposure to lowest feasible concentration; See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV[1]: 5 ppm/20 milligram per cubic meter TWA; 15 ppm/61 milligram per cubic meter STEL; [skin], not classifiable as a human carcinogen

PAC* Ver. 29[138]

PAC-1: **8.3**$_{\mathbf{A}}$ ppm

PAC-2: **36**$_{\mathbf{A}}$ ppm

PAC-3: **240**$_{\mathbf{A}}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

DFG MAK: 5 ppm/21 milligram per cubic meter; [skin] danger of skin sensitization; Pregnancy Risk Group C

Australia: TWA 5 ppm (20 milligram per cubic meter), 1993; Austria: MAK 5 ppm (20 milligram per cubic meter), 1999; Belgium: TWA 5 ppm (20 milligram per cubic meter); STEL 25 ppm (100 milligram per cubic meter), 1993; Denmark: TWA 5 ppm (20 milligram per cubic meter), [skin] 1999; Finland: TWA 5 ppm (20 milligram per cubic meter); STEL 10 ppm (40 milligram per cubic meter), [skin] 1993; France: VME 5 ppm (20 milligram per cubic meter), [skin] 1999; Hungary: STEL 10 milligram per cubic meter, [skin] carcinogen, 1993; the Netherlands: MAC-TGG 20 milligram per cubic meter, [skin] 2003; Norway: TWA 5 ppm (20 milligram per cubic meter), 1999; the Philippines: TWA 25 ppm (100 milligram per cubic meter), [skin] 1993; Poland: TWA 20 milligram per cubic meter; STEL 80 milligram per cubic meter, 1999; Russia: STEL 5 milligram per cubic meter, 1993; Sweden: NGV 5 ppm (20 milligram per cubic meter), KTV 10 ppm (40 milligram per cubic meter), [skin] 1999; Switzerland: MAK-W 5 ppm (20 milligram per cubic meter), KZG-W 10 ppm (40 milligram per cubic meter), 1999; Turkey: TWA 25 ppm (100 milligram per cubic meter), [skin] 1993; United Kingdom: TWA 5 ppm (21 milligram per cubic meter); STEL 15 ppm (62 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: STEL 15 ppm. The Czech Republic[35] and Russia[43] have set MAC values in ambient air of residential areas at 0.05 milligram per cubic meter (50 μ/m^3). Several states have set guidelines or standards for ethyl acrylate in ambient air[60] ranging from 0.28 μ/m^3 (Massachusetts) to 350.0 μ/m^3 (Virginia) to 400 μ/m^3 (Connecticut) to 200−1000 μ/m^3 (North Dakota) to 476.0 μ/m^3 (Nevada).

Determination in Air: Charcoal adsorption, workup with CS2, analysis by gas chromatography/flame ionization. Use NIOSH Analytical Method #1450 or OSHA Analytical Method 92.

Permissible Concentration in Water: Russia[35,43] set a MAC in water bodies used for domestic purposes of 0.005 mg/L (5 μg/L).

Determination in Water: No tests listed. Octanol-water coefficient: Log $K_{ow} = 1.3$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion, and eye and/or skin contact. Passes through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Ethyl acrylate can affect you when breathed in and by passing through your skin. Ethyl acrylate is corrosive and can severely irritate and burn the eyes and skin. Inhalation can cause severe irritation and pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Breathing very high levels of ethyl acrylate can cause dizziness, difficulty breathing and even death. Contact may cause a skin allergy.

Long-Term Exposure: Repeated or prolonged contact with skin may cause dermatitis and skin allergy. May affect the liver and kidneys. This chemical may be a human carcinogen; it has been shown to cause stomach cancer in animals. May damage the developing fetus. Highly irritating substances may cause lung damage.

Points of Attack: Eyes, skin, and respiratory system. Cancer site in animals: tumors of the fore-stomach.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Liver function tests. Kidney function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. 8 hours: polyvinyl alcohol gloves; Teflon gloves, suits, boots; Responder suits; Trychem 1000 suits, 4 hours: 4 H and Silver Shield gloves. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Remove clothing immediately if wet or contaminated to avoid flammability hazard. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-, mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code-Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Ethyl acrylate must be stored to avoid contact with oxidizers (such as peroxides, perchlorates, chlorates, nitrates and permanganates); strong alkalis (such as sodium hydroxide and potassium hydroxide) and moisture, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Heat can cause ethyl acrylate to react by itself. If this takes place in a closed container, an explosion could occur. Ethyl acrylate usually contains as inhibitor, such as hydroquinone or its methyl ether to prevent a self-reaction. If it does not contain an inhibitor, the reaction may occur without the application of heat. Sources of ignition, such as smoking and open flames, are prohibited where ethyl acrylate is handled, used, or stored. Metal containers involving the transfer of five gallons or more of ethyl acrylate should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of ethyl acrylate. Wherever ethyl acrylate is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1917 Ethyl acrylate, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of carbon. May polymerize and cause container to explode. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration[22] or by absorption and landfill disposal[22].

References

(102); (31); (173); (101); (138); (2); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 2, 35−37 (1980)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Ethyl Acrylate*, Trenton, NJ (April 2002)

Ethyl alcohol E:0330

Formula: C_2H_6O; CH_3CH_2OH

Synonyms: Absolute ethanol; Aethanol (German); Aethyldlkohol (German); Alcohol; Alcohol, anhydrous; Alcohol C-2; Alcohol, dehydrated; Alcool ethylique (French); Algrain; Alkohol (German); Anhydrol; Cologne spirit; Cologne spirits; Ethanol; Ethanol 200 proof; Ethyl alcohol anhydro-S; Ethyl hydrate; Ethyl hydroxide; Fermentation alcohol; Grain alcohol; Jaysol S; Methyl carbinol; Molasses alcohol; NCI-CO3134; Potato alcohol; Pure grain alcohol; SD alcohol 23-hydrogen; Spirit; Spirits of wine; Tescol

CAS Registry Number: 64-17-5

HSDB Number: 82

RTECS Number: KQ6300000

UN/NA & ERG Number: UN1170/127

EC Number: 200-578-6 [*Annex I Index No.:* 603-002-00-5]

Regulatory Authority and Advisory Information

Carcinogenicity: Alcoholic Beverage Consumption, NTP 13th Report on Carcinogens, Known to be a Human Carcinogen. United States Environmental Protection Agency Gene-Tox Program, Positive: Rodent dominant lethal; Negative: Aspergillus-forward mutation; SHE-clonal assay; Negative: Cell transformation-RLV F344 rat embryo; Negative: In vitro cytogenetics-nonhuman; Mammalian micronucleus; Negative: *N. crassa-aneuploidy*; Histidine reversion-Ames test; Negative: In vitro SCE-human lymphocytes; In vitro SCE-human; Negative: In vitro SCE-nonhuman; Sperm morphology-mouse; Negative/limited: Carcinogenicity-mouse/rat

California Proposition 65 Chemical[102]: Cancer (alcoholic beverages, when associated with alcohol abuse).

Hazard Alert: Highly flammable, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction).

FDA-over the counter and proprietary drug

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1 (carcinogen); Class B2, D2A, D2B.

Hazard symbols, risk, & safety statements: Hazard symbol: T, F; risk phrases: R11; R36/37/38; R62; R63; safety phrases: S2; S7; S16; S21; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Ethyl alcohol is a colorless, volatile, flammable liquid with a sweet, fruity odor. The Odor Threshold is 0.135−5 ppm. Molecular weight = 46.07; specific gravity (H_2O:1) = 0.79 @ 20°C; boiling point = 78.3°C; freezing/melting point = −113.9°C; vapor pressure = 75 mmHg @ 29.2°C; flash point = 12.8°C (96%). Explosive limits: LEL: 3.3%; UEL: 19.0%; autoignition temperature = 363°C. Hazard identification (based on NFPA-704 M Rating System): Health 0, Flammability 3, Reactivity 0. Soluble in water.

Potential Exposure: Ethyl alcohol is used, topical anti-infective agent; solvent to make beverages; in the chemical synthesis of a wide variety of compounds, such as acetaldehyde, ethyl ether, ethyl chloride, and butadiene. It is a solvent or processing agent in the manufacture of pharmaceuticals; plastics, lacquers, polishes, plasticizers, perfumes, cosmetics, rubber accelerators; explosives, synthetic resins; nitrocellulose, adhesives, inks, and preservatives. It is also used as an antifreeze and as a fuel. It is an intermediate in the manufacture of many drugs and pesticides.

Incompatibilities: May form explosive mixture with air. May accumulate static electrical charges, and may cause ignition of its vapors. Reactions may be violent with oleum, sulfuric acid; nitric acid, bases, aliphatic amines;

isocyanates, strong oxidizers. Also incompatible with potassium dioxide, bromine pentafluoride; acetyl bromide; acetyl chloride; platinum, sodium.

Permissible Exposure Limits in Air

NIOSH IDLH = 3300 ppm [LEL]

OSHA PEL: 1000 ppm/1900 milligram per cubic meter TWA

NIOSH REL: 1000 ppm/1900 milligram per cubic meter TWA

ACGIH TLV[1]: 1000 ppm/1880 milligram per cubic meter STEL; not classifiable as a human carcinogen

PAC* Ver. 29[138]

PAC-1: **1800** $_{\mathbf{A}}$ ppm

PAC-2: **3300** $_{\mathbf{A}}$ ppm

PAC-3: 15,000 ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

DFG MAK: 500 ppm/960 milligram per cubic meter TWA; Peak Limitation Category II(2); Carcinogen Category 5; Pregnancy Risk Group C

Australia: TWA 1000 ppm (1900 milligram per cubic meter), 1993; Austria: MAK 1000 ppm (1900 milligram per cubic meter), 1999; Belgium: TWA 1000 ppm (1880 milligram per cubic meter), 1993; Denmark: TWA 1000 ppm (1900 milligram per cubic meter), 1999; Finland: TWA 1000 ppm (1900 milligram per cubic meter); STEL 1250 ppm (2400 milligram per cubic meter), 1999; France: VME 1000 ppm (1900 milligram per cubic meter), VLE 5000 ppm, 1999; Hungary: TWA 1000 milligram per cubic meter; STEL 3000 milligram per cubic meter, 1993; the Netherlands: MAC-TGG 1000 milligram per cubic meter, 2003; Norway: TWA 500 ppm (950 milligram per cubic meter), 1999; the Philippines: TWA 1000 ppm (1900 milligram per cubic meter), 1993; Poland: MAC (TWA) 1000 milligram per cubic meter, MAC (STEL) 3000 milligram per cubic meter, 1999; Russia: STEL 1000 milligram per cubic meter, 1993; Sweden: NGV 500 ppm (1000 milligram per cubic meter), KTV 1000 ppm (1900 milligram per cubic meter), 1999; Switzerland: MAK-W 1000 ppm (1900 milligram per cubic meter), 1999; Thailand: TWA 1000 ppm (1900 milligram per cubic meter), 1993; Turkey: TWA 1000 ppm (1900 milligram per cubic meter), 1993; United Kingdom: TWA 1000 ppm (1950 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Russia[43] set a MAC in ambient air of residential areas of 5.0 milligram per cubic meter on either a momentary or a daily average basis. Several states have set guidelines or standards for ethanol in ambient air[60] ranging from 0.26 milligram per cubic meter (Massachusetts) to 16.0 milligram per cubic meter (Virginia) to 19.0 milligram per cubic meter (North Dakota) to 38.0 milligram per cubic meter (Connecticut and South Dakota) to 45.238 milligram per cubic meter (Nevada).

Determination in Air: Collection by charcoal tube, 2-butanol/CS2; analysis by gas chromatography/flame ionization detection; NIOSH Analytical Method (IV) #1400, alcohols I

Permissible Concentration in Water: No criteria set, but EPA[32] has suggested a permissible ambient goal of 26,000 μg/L based on health effects.

Determination in Water: Octanol-water coefficient: Log $K_{\mathrm{ow}} = -0.32$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation of vapor, percutaneous absorption, ingestion, and skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: *Inhalation:* Levels of 5000−10,000 ppm may result in irritation of mouth, nose, throat and coughing, leading to sleep and stupor. *Skin:* Pure ethyl alcohol may cause drying, redness and irritation. May be absorbed through damaged skin. *Eyes:* Irritation and tearing may result @ 5000 ppm of vapor. Contact with liquid may cause severe irritation. *Ingestion:* One ounce of pure ethyl alcohol may cause reddening of face and neck and an exaggerated feeling of well-being. Three ounces of pure ethyl alcohol may cause an initial burst of excitement and activity followed by increasing loss of coordination; slurred speech; nausea and drowsiness. This may proceed to stupor, coma and death. Lethal dose of ethyl alcohol ranges from two to five ounces, depending on age and size of the individual. *Note:* Many denatured alcohols contain additives which are extremely poisonous and cannot be removed by normal methods. Ingestion of denatured alcohol will produce much more serious poisoning.

Long-Term Exposure: Prolonged inhalation of concentrations above 5000 ppm may produce symptoms listed under inhalation and the additional symptoms of headache, dizziness, tremor, and fatigue. Additives in denatured alcohol may result in other more severe symptoms. Alcohol has been linked to birth defects in humans. Ethyl alcohol may cause mutations. Repeated exposure (including alcoholic beverages) may cause spontaneous abortions; as well as birth defects and other developmental problems; including "fetal alcohol syndrome." Chronic use of ethanol may cause cirrhosis of the liver. *Alcoholic Beverage Consumption* is on the NTP 13th Report on Carcinogens, Known to be a Human Carcinogen

Points of Attack: Eyes, skin, respiratory system, CNS, liver, blood, and reproductive system.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater, or significant skin contact), the following are recommended before beginning work and at regular times after that: Liver function tests. Ethyl alcohol can be measured in the blood, urine, and exhaled breath. NIOSH lists the following tests: whole blood (chemical/metabolite), expired air, urine (chemical/metabolite) End-of-shift.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if

heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. 8 hours: Viton gloves, suits; 4 H and Silver Shield gloves; 4 hours: Neoprene rubber gloves, suits, boots; Teflon gloves, suits, boots. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: 3300 ppm: Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* SCBAE (any appropriate escape-type, SCBA).

Storage: Color code-Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Ethyl alcohol must be stored to avoid contact with oxidizers, such as perchlorates, peroxides, chlorates, nitrates, and permanganates, because violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat or flame. Sources of ignition, such as smoking and open flames are prohibited where ethyl alcohol is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of five gallons or more of ethyl alcohol should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of ethyl alcohol.

Shipping: UN1170 Ethyl alcohol or Ethanol or Ethanol solutions or Ethyl alcohol solutions, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(109); (102); (31); (173); (101); (138); (80); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 7, 55–57 (1981)

New York State Department of Health, *Chemical Fact Sheet: Ethyl Alcohol*, Bureau of Toxic Substance Assessment, Albany, NY (March 1986)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Ethyl Alcohol*, Trenton, NJ (April 2002)

Ethylamine E:0340

Formula: C_2H_7N; $C_2H_5NH_2$

Synonyms: Aethylamine (German); 1-Aminoethane; Aminoethane; EA; Etanamina (Spanish); Ethanamine; Etilamina (Spanish); MEA; Monoethylamine

CAS Registry Number: 75-04-7
HSDB Number: 803
RTECS Number: KH2100000
UN/NA & ERG Number: UN1036/118; UN2270 [aqueous solution with not <50% but not > 70% ethylamine]/132
EC Number: 200-834-7 [*Annex I Index No.:* 612-002-00-4]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

List 1, DEA chemical code 8678 (Title 21 CFR1310.02), as Ethylamine and its salts.

Hazard Alert: Extremely flammable gas, Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated, Primary irritant (w/o allergic reaction).

OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 7500 lb

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg)

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: F+, Xi; risk phrases: R5; R12; R21; R36/3738; safety phrases: S1; S2; S9; S16; S26; S33; S38; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Ethylamine is a colorless gas or water-white liquid (below 17°C). Strong, ammonia-like odor. Shipped as a liquefied compressed gas. Molecular weight = 45.10; specific gravity (H_2O:1) = 0.66 @ 20°C (liquid); boiling point = 16.7°C; freezing/melting point = −81°C; vapor pressure = 400 mmHg @ 20°C; Flash point ≤ −18°C; autoignition temperature = 385°C. Explosive limits: LEL: 3.5%; UEL: 14.0%. Hazard identification (based on NFPA-704 M Rating System): Health 3, Flammability 4, Reactivity 0. Soluble in water.

Potential Exposure: Monoethylamine (MEA) is used as an intermediate in the manufacture of the following chemicals: triazine herbicides, 1,3-diethylthiourea (a corrosion inhibitor); ethylamino-ethanol; 4-ethylmorpholine (urethane foam catalyst); ethyl isocyanate; and dimethylolethyltriazone (agent used in wash-and-wear fabrics). The cuprous chloride salts of MEA are used in the refining of petroleum and vegetable oil.

Incompatibilities: The aqueous solution is a strong base. May form explosive mixture with air. Reacts violently with strong acids; strong oxidizers; cellulose nitrate; and organic compounds; causing fire and explosion hazard. Also incompatible with organic anhydrides; isocyanates, vinyl acetate; acrylates, substituted allyls; alkylene oxides; epichlorohydrin, ketones, aldehydes, alcohols, glycols, phenols, cresols, caprolactum solution. Attacks nonferrous metals: aluminum, copper, lead, tin, zinc, and alloys; some plastics, rubber, and coatings.

Permissible Exposure Limits in Air

NIOSH IDLH = 600 ppm

Conversion factor: 1 ppm = 1.85 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 10 ppm/18 milligram per cubic meter TWA

NIOSH REL: 10 ppm/18 milligram per cubic meter TWA

ACGIH TLV[1]: 5 ppm/9.2 milligram per cubic meter TWA; 15 ppm/27.6 milligram per cubic meter STEL [skin]

PAC* Ver. 29[138]

PAC-1: **7.5** $_{\mathbf{A}}$ ppm

PAC-2: **49** $_{\mathbf{A}}$ ppm

PAC-3: **270** $_{\mathbf{A}}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

DFG MAK: 5 ppm/9.4 milligram per cubic meter TWA; Peak Limitation Category I(2) a momentary value of 10 ml/m^3/19 milligram per cubic meter should not be exceeded; Pregnancy Risk Group D

Australia: TWA 10 ppm (18 milligram per cubic meter), 1993; Austria: MAK 10 ppm (18 milligram per cubic meter), 1999; Belgium: TWA 10 ppm (18 milligram per cubic meter), 1993; Denmark: TWA 10 ppm (18 milligram per cubic meter), [skin], 1999; Finland: TWA 10 ppm (18 milligram per cubic meter); STEL 20 ppm (37 milligram per cubic meter), [skin], 1999; France: VME 10 ppm (18 milligram per cubic meter), VLE 15 ppm (27 milligram per cubic meter), 1999; Japan: 10 ppm (18 milligram per cubic meter), 1993; the Netherlands: MAC-TGG 9 milligram per cubic meter, 2003; Norway: TWA 10 ppm (18 milligram per cubic meter), 1999; the Philippines: TWA 10 ppm (18 milligram per cubic meter), 1993; Poland: MAC (TWA) 5 milligram per cubic meter, MAC (STEL) 15 milligram per cubic meter, 1999; Russia: TWA 10 ppm, 1993; Sweden: NGV 10 ppm (18 milligram per cubic meter), KTV 15 ppm (30 milligram per cubic meter), [skin], 1999; Switzerland: MAK-W 10 ppm (18 milligram per cubic meter), KZG-W 20 ppm (36 milligram per cubic meter), 1999; Turkey: TWA 10 ppm (18 milligram per cubic meter), 1993; United Kingdom: TWA 2 ppm (3.8 milligram per cubic meter; STEL 6 ppm (11 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: STEL 15 ppm [skin]. Russia set a MAC in ambient air in residential areas of 0.01 milligram per cubic meter on both a momentary and a daily average basis. Several states have set guidelines or standards for monoethylamine in ambient air[60] ranging from 180 μ/m^3 (North Dakota) to 300 μ/m^3 (Virginia) to 360 μ/m^3 (Connecticut) to 429 μ/m^3 (Nevada).

Determination in Air: Use NIOSH [II(3)] Method #S144 or OSHA Analytical Method 36.

Permissible Concentration in Water: EPA[32] has suggested an ambient environmental goal of 248 μg/L on a health basis. Russia[35] set a MAC in water bodies used for domestic purposes of 0.5 mg/L.

Determination in Water: Octanol-water coefficient: Log K_{ow} = −0.27/−0.08 (calculated) Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, skin absorption (liquid), ingestion (liquid), and skin and/or eye contact (liquid).

Harmful Effects and Symptoms

Short-Term Exposure: Ethylamine can affect you when breathed in and by passing through your skin. Contact can severely burn the eyes and skin. Inhalation can severely irritate the eyes, nose, throat and lungs; causing cough, wheezing, and/or shortness of breath. Repeated exposure may damage the lungs, kidneys and heart.

Long-Term Exposure: Repeated exposure can cause damage to the kidneys, liver and heart. Can affect the eyes; causing blurred vision and/or cause the victim to see halos around lights; and result in permanent damage. Repeated exposure can affect the lungs, causing bronchitis; and tissue lesions.

Points of Attack: Eyes, skin, respiratory system, liver, and kidneys.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended. Lung function tests. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Exam of the eyes and vision. If symptoms develop or overexposure is suspected, the following may be useful: exam of the heart. Kidney function tests. Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. 8 hours: butyl rubber gloves, suits, boots; 4 hours: Teflon gloves, suits, boots; Responder suits. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: 250 ppm: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprS (APF = 25) [any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern]. 500 ppm: CcrFS (APF = 50) [any chemical cartridge respirator with a full facepiece and cartridge(s) providing protection against the compound of concern] organic vapor and acid gas cartridge(s); or GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted canister providing protection against the compound of concern]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). 600 ppm: SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted canister providing protection against the compound of concern]; or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance causes eye irritation or damage; eye protection needed.

Storage: Check oxygen content prior to entering storage area. Flammable gas.(1) Color code-Red: Flammability Hazard: Store in a flammable (liquid or solid materials) storage area or approved cabinet away from sources if ignition. (2) Color code-White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location; keep acids away from bases and red, yellow, and blue-coded chemicals. Ethylamine must be stored to avoid contact with strong acids (such as hydrochloric, sulfuric and nitric); or strong oxidizers (such as chlorine and bromine) because violent reactions occur. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where ethylamine is handled, used, or stored. Metal containers used in the transfer of five gallons or more of ethylamine should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of ethylamine. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: UN1036, Ethylamine, Hazard Class: 2.1; Labels: 2.1-Flammable gas. Ethylamine, aqueous solution with not

<50% but not >70% ethylamine, Hazard Class: 3; Labels: 3-Flammable liquid, 8-Corrosive material. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: *Gas:* This chemical is flammable. Thermal decomposition products may include oxides of nitrogen and carbon. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Solution: This chemical is flammable. Thermal decomposition products may include oxides of nitrogen and carbon. Shut off supply. If not possible, and at no risk to surroundings, let the fire burn itself out; in other cases use dry chemical or carbon dioxide. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Controlled incineration; incinerator equipped with a scrubber or thermal unit to reduce nitrogen oxides emissions[22].

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: *Ethylamines*, Washington, DC (April 1, 1978)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Ethylamine*, Trenton, NJ (April 2003)

2-Ethylaniline E:0360

Formula: $C_8H_{11}N$

Synonyms: 2-Aethylanilin (German); *o*-Aminoethylbenzene; Aniline, *o*-ethyl-; Benzenamine, 2-ethyl-; 2-Ethyl aniline; 2-Ethylbenzenamine; 2-Ethylbenzenamino; 2-Etilanilina (Spanish)

CAS Registry Number: 578-54-1

HSDB Number: 5698

RTECS Number: BX9800000

UN/NA & ERG Number: UN2273/153

EC Number: 209-424-2

Regulatory Authority and Advisory Information

Carcinogenicity: No tests or studies found.

Hazard Alert: Poison, Flammable liquid.

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xn; risk phrases: R10; R23/24/25; R36/37/38; R51; safety phrases: S36/37/39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: 2-Ethylaniline is a yellow liquid that turns brown on standing in air. Molecular weight = 121.20; boiling point = 215°C; 210°C @ 760 mmHg; freezing/melting point = 44°C; vapor pressure = 0.11 mmHg @ 20°C; flash point = 85°C (oc). Hazard identification (based on NFPA-704 M Rating System): Health 1, Flammability 2, Reactivity 0. Insoluble in water.

Potential Exposure: This material is used in making drugs, dyes, and pesticides.

Incompatibilities: Combustible; vapor may form explosive mixture with air above 80°C. Decomposes on contact with light or air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, anhydrides, and chloroformates. Contact with metals may evolve flammable hydrogen gas.

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Determination in Water: Octanol-water coefficient: Log $K_{ow} = < 2$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, passing through the unbroken skin, and absorption of fumes through the mouth.

Harmful Effects and Symptoms

Short-Term Exposure: *n*-Ethylaniline can affect you when breathed in and by passing through your skin. High exposure can reduce the blood's ability to supply oxygen to the body (methemoglobinemia) and can cause the skin and lips to turn a blue color. Headache, weakness and passing out may occur. Death could result from high exposures to skin or breathing. Contact can irritate or burn skin and eyes.

Long-Term Exposure: Exposure can cause skin allergy to develop, with rash and itching. Once allergy is present, even low exposures may trigger symptoms. May affect the nervous system causing headache, drowsiness, irritability, and confusion. May cause liver and bladder damage.

Points of Attack: Skin, blood, bladder, and nervous system.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: blood test for methemoglobin (the blood change caused by ethylaniline). Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Liver and bladder function tests.

First Aid: *Eye Contact:* Immediately remove any contact lenses and flush with large amounts of water for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention if any symptoms are present. *Skin Contact:* Quickly remove contaminated clothing. Immediately wash area with large amounts of soap; promptly seek medical attention. *Breathing:* Remove the person from exposure. Begin (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility.

Note to Physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposure to ethylaniline use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. 2-Ethylaniline must be stored to avoid contact with strong acids (such as hydrochloric, sulfuric and nitric); strong oxidizers; acid anhydrides (such as maleic anhydride) and chloroformates, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where 2-ethylaniline is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2273 2-Ethylaniline, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep 2-ethylaniline out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include aniline and oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the

containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: 2-Ethylaniline*, Trenton, NJ (July 2002)

N-Ethylaniline E:0370

Formula: $C_8H_{11}N$; $C_6H_5NHC_2H_5$

Synonyms: Aethylanilin (German); Anilinoethane; Benzenamine, *n*-ethyl-; *n*-Ethylaminobenzene; Ethylaniline; *n*-Ethylbenzenamine; *n*-Ethylbenzenamino; Ethylphenylamine; *n*-Etilanilina (Spanish)

CAS Registry Number: 103-69-5

HSDB Number: 5354

RTECS Number: BX9780000

UN/NA & ERG Number: UN2272/153

EC Number: 203-135-5

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Flammable liquid, Suspected reprotoxic hazard.

Hazard symbols, risk, & safety statements: Hazard symbol: T; risk phrases: R10; R23/24/25; R33; R63; safety phrases: S28; S37; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: *N*-Ethylaniline is yellow-brown oil with a weak fishy odor. Molecular weight = 121.20; boiling point = 205°C; freezing/melting point = −64°C; flash point = 85°C (oc). Flammable limits: LEL 1.6%; UEL 9.5%. Hazard identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 0. Insoluble in water.

Potential Exposure: This material is used as an intermediate in dyes, pharmaceuticals and explosives; in organic synthesis.

Incompatibilities: May form explosive mixture with air. Decomposes on contact with light or air. Reacts with many materials. Neutralizes acids in exothermic reactions to form salts plus water. Flammable gaseous hydrogen may be generated in combination with strong reducing agents such as hydrides, nitrides, alkali metals, and sulfides. Contact with strong oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials; strong acids, such as nitric acid, can cause fire; explosions with formation of toxic vapors of aniline and oxides of nitrogen; strong bases, isocyanates, halogenated organics, phenols (acidic), epoxides, anhydrides, and acid halides.

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Routes of Entry: Inhalation and passing through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: *n*-ethylaniline can affect you when breathed in and by passing through your skin. High exposure can reduce the blood's ability to supply oxygen to the body (methemoglobinemia) and can cause the skin and lips to turn a Blue color. Headache, weakness and passing out may occur. Death could result from high exposures to skin or breathing. Contact can irritate or burn skin and eyes.

Long-Term Exposure: Exposure can cause skin allergy to develop, with rash and itching. Once allergy is present, even low exposures may trigger symptoms. May affect the nervous system causing headache, drowsiness, irritability, and confusion.

Points of Attack: Skin, blood, and nervous system.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: blood test for methemoglobinemia. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: *Eye Contact:* Immediately remove any contact lenses and flush with large amounts of water for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention if any symptoms are present.

Skin Contact: Quickly remove contaminated clothing. Immediately wash area with large amounts of soap, promptly seek medical attention.

Breathing: Remove the person from exposure. Begin (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility.

Note to Physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles

and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposure to ethylaniline use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Ethylaniline must be stored to avoid contact with strong acids (such as hydrochloric, sulfuric, and nitric), and strong oxidizers, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where ethylaniline is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2272 *N*-Ethylaniline, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep ethylaniline out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120 (q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include aniline and oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Ethylaniline*, Trenton, NJ (June 2003)

Ethylbenzene E:0380

Formula: C_8H_{10}; $C_6H_5CH_2CH_3$

Synonyms: Aethylbenzol (German); Aristoline(+); AZ 1470(+); AZ 4210(+); Benzene, ethyl-; CEM 388; EB; Ethylbenzol; Etilbenceno (Spanish); KTI 1350 J(+); KTI photoresist standard (−); α-Methyltoluene; NCI-C56393; Phenylethane

CAS Registry Number: 100-41-4

HSDB Number: 84

RTECS Number: DA0700000

UN/NA & ERG Number: UN1175/130

EC Number: 202-849-4 [*Annex I Index No.:* 601-023-00-4]

Regulatory Authority and Advisory Information

Carcinogenicity: NCI: Carcinogenesis Studies (inhalation); clear evidence: rat; some evidence: mouse; NCI: Carcinogenesis Studies (inhalation); equivocal evidence: mouse; IARC: Animal Sufficient Evidence; Human Inadequate evidence, *possibly carcinogenic to humans*, Group 2B, 1977; EPA: Not Classifiable as to human carcinogenicity. United States Environmental Protection Agency Gene-Tox Program, Negative: Cell transform-SA7/SHE.

California Proposition 65 Chemical[102]: Cancer, June 11, 2004.

Hazard Alert: Highly flammable, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction), Environmental hazard. Listed for Tier 1 screening as an endocrine disruptor[88].

NTP: Toxicity studies, RPT#TOX-10, October 2000

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

United States National Primary Drinking Water Regulations: MCLG = 0.7 mg/L; MCL = 0.7 mg/L

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/1992); 40CFR401.15 Section 307 Toxic Pollutants

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.057; Nonwastewater (mg/kg), 10

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8020 (2); 8240 (5)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1000 lb (454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%

Hazardous to aquatic life or environment, with possible long lasting effects[194]. Harmful to aquatic life with long lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xn; risk phrases: R11; R20; R62; R63; safety phrases: S2; S16; S21; S24/25; S29; S41; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Ethylbenzene is a colorless liquid. Pungent aromatic odor. The Odor Threshold is 0.092−0.60 ppm. Molecular weight = 106.18; specific gravity (H_2O:1) = 0.87 @ 20°C; boiling point = 136°C; freezing/melting point = −95°C; vapor pressure = 10 mmHg @ 26°C; flash point = 12.8°C; explosive limits: LEL: 20.000 ppm; UEL: unknown. Autoignition temperature = 432°C. Explosive limits: LEL: 0.8%; UEL: 6.7%. Hazard identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 0. Practically insoluble in water; solubility = 0.7%.

Potential Exposure: Ethyl benzene is used in styrene manufacture and in synthesis of *p*-nitroacetophenone; in the manufacture of cellulose acetate, and synthetic rubber. It is also used as a solvent or diluent; and as a component of automotive and aviation gasoline. Significant quantities of EB are present in mixed xylenes. These are used as dilatants in the paint industry, in agricultural sprays for insecticides and in gasoline blends (which may contain as much as 20% EB). In light of the large quantities of EB produced and the diversity of products in which it is found, there may exist environmental sources for ethylbenzene, e.g., vaporization during solvent use; pyrolysis of gasoline and emitted vapors at filling stations. Groups of individuals who are exposed to EB to the greatest extent and could represent potential pools for the expression of EB toxicity include: (1) individuals in commercial situations where petroleum products or by-products are manufactured e.g., rubber or plastics industry); (2) individuals residing in areas with high atmospheric smog generated by motor vehicle emissions.

Incompatibilities: Vapors may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides. Attacks plastics and rubber. May accumulate static electrical charges, and may cause ignition of its vapors.

Permissible Exposure Limits in Air

NIOSH IDLH = 800 ppm [LEL]

Conversion factor: 1 ppm = 4.34 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 100 ppm/435 milligram per cubic meter TWA

NIOSH REL: 100 ppm/435 milligram per cubic meter TWA; 125 ppm/545 milligram per cubic meter STEL

ACGIH TLV[1]: 100 ppm/434 milligram per cubic meter TWA; 125 ppm/543 milligram per cubic meter STEL; BEI: 1.5 g [Mandelic acid]/g creatinine in urine at end-of-shift at end of work-week; 2 ppm [ethyl benzene]in end-exhaled air prior to next shift

PAC* Ver. 29[138]

PAC-1: **33** $_{\mathbf{A}}$ ppm

PAC-2: **1100** $_{\mathbf{A}}$ ppm

PAC-3: **1800** $_{\mathbf{A}}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

DFG MAK: [skin] Germ Cell Mutagen Category 3 A (2006)

Australia: TWA 100 ppm (435 milligram per cubic meter); STEL 125 ppm, 1993; Austria: MAK 100 ppm (440 milligram per cubic meter), 1999; Belgium: TWA 100 ppm (434 milligram per cubic meter); STEL 125 ppm (543 milligram per cubic meter), 1993; Denmark: TWA 50 ppm (217 milligram per cubic meter), 1999; Finland: TWA 100 ppm (435 milligram per cubic meter); STEL 150 ppm (655 milligram per cubic meter), 1999; France: VME 100 ppm (435 milligram per cubic meter), 1999; Hungary: TWA 100 milligram per cubic meter; STEL 200 milligram per cubic meter, [skin], 1993; the Netherlands: MAC-TGG 215 milligram per cubic meter, [skin], 2003; Norway: TWA 50 ppm (220 milligram per cubic meter), 1999; the Philippines: TWA 100 ppm (435 milligram per cubic meter), 1993; Poland: MAC (TWA) 100 milligram per cubic meter, MAC (STEL) 350 milligram per cubic meter, 1999; Russia: TWA 100 ppm; STEL 50 milligram per cubic meter, 1993; Sweden: NGV 50 ppm (200 milligram per cubic meter), KTV 100 ppm (450 milligram per cubic meter), 1999; Switzerland: MAK-W 100 ppm (435 milligram per cubic meter), KZG-W 500 ppm (2175 milligram per cubic meter), [skin], 1999; Turkey: TWA 100 ppm (435 milligram per cubic meter), 1993; United Kingdom: TWA 100 ppm (441 milligram per cubic meter); STEL 125 ppm (552 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: STEL 125 ppm. The Czech Republic: TWA 200 milligram per cubic meter. Russia[35,43] set a MAC in the ambient air in residential areas of 0.02 milligram per cubic meter on either a momentary or a daily average basis. Several states have set guidelines or standards for ethylbenzene in ambient air[60] ranging from 0.12 milligram per cubic meter (Massachusetts) to 1.45 milligram per cubic meter (New York) to 4.35 milligram per cubic meter (Florida, South Carolina) to 4.35−5.45 milligram per cubic meter (North Dakota) to 7.25 milligram per cubic meter (Virginia) to 8.7 milligram per cubic meter (Connecticut) to 10.357 milligram per cubic meter (Nevada).

Determination in Air: Charcoal adsorption, workup with CS2, analysis by gas chromatography/flame ionization. NIOSH Analytical Method #1501 for aromatic hydrocarbons.

Permissible Concentration in Water: Safe Drinking Water Act (47FR 9352): MCL, 0.7 mg/L; MCLG, 0.7 mg/L. Federal Drinking Water Standards: EPA 700 μg/L; Federal Drinking Water Guidelines: EPA 750 μg/L; State Drinking Water Standards: California 300 μg/L; Massachusetts 5 μg/L; State Drinking Water Guidelines: Arizona 680 μg/L; Florida 30 μg/L; Maine 70 μg/L; Minnesota 700 μg/L.

Determination in Water: Inert gas purge followed by gas chromatography and photoionization detection (EPA Method 602) or gas chromatography plus mass spectrometry (EPA Method 624).

Routes of Entry: Inhalation, ingestion, and eye and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Ethyl benzene irritates the eyes, skin, and respiratory tract. Exposure to high concentrations can cause dizziness, lightheadedness and unconsciousness. Very high exposures (above the OEL) can cause difficult breathing; narcosis, coma, and even death. Swallowing the liquid may cause aspiration into the lungs, resulting in chemical pneumonitis. May affect the CNS. Concentration of 200 ppm can cause irritation.

Long-Term Exposure: May cause liver and kidney problems. Repeated or prolonged exposure to the skin may cause drying, scaling and blistering.

Points of Attack: Eyes, skin, respiratory system, and CNS.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Liver function tests. Kidney function tests. Evaluate for brain and nervous system effects. NIOSH lists the following tests: whole blood (chemical/metabolite); during exposure, expired air, expired air: prior to next shift; urine (chemical/metabolite); urine (chemical/metabolite) End-of-shift; urine (chemical/metabolite) End-of-shift, end of work-week; urine (chemical/metabolite) Last 2 hours of 8 hour exposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. 8 hours: Viton gloves, suits, Barricade coated suits; Responder suits; Trychem 1000 suits, 4 hours: Teflon gloves, suits, boots All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: 800 ppm: CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted acid gas canister]; or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]; or Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code-Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Protect against physical damage. Outside or detached storage is preferable. Inside storage should be in a standard flammable liquids storage room or cabinet. Isolate from acute fire hazards and oxidizing agents. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of five gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical.

Shipping: UN1175 Ethylbenzene, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources.

Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep EB out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed[22].

References

(102); (31); (173); (101); (138); (100).

United States Environmental Protection Agency, *Ethylbenzene: Ambient Water Quality Criteria*, Washington, DC (1980)

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 2, No. 6, 57−60 (1982) and 7, No. 2, 13−35 (1987)

New York State Department of Health, *Chemical Fact Sheet: Ethyl Benzene*, Bureau of Toxic Substance Assessment, Albany, NY (March 1986)

Ethylbis(2-chloroethyl)amine (Agent HN-1) E:0400

Formula: $C_6H_{13}C_{12}N$; $C_2H_5N(CH_2CH_2Cl)_2$

Synonyms: AI3-16200; 2-Chloro-*N*-(2-chloroethyl)-*N*-ethylethanamine; 2,2'-Dichlorotriethylamine; Ethanamine, 2-chloro-*N*-(2-chloroethyl)-*N*-ethyl-; Ethyl-S; Ethylbis (β-chloroethyl)amine; HN-1 (military designation); Nitrogen mustard-1; TL 1149; TL329; Triethylamine, 2,2'-dichloro-

CAS Registry Number: 538-07-8

HSDB Number: 6392

RTECS Number: YE1225000

UN/NA & ERG Number: (PIH) UN2810 (toxic liquids, organic, n.o.s.)/153

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity: *Theft hazard:* CUM 100 g.

Carcinogenicity: According to NIOSH, HN-1 is a known carcinogen, developmental toxin, and reproductive toxin[77].

Hazard Alert: Poison inhalation hazard: exposure can be lethal, Blister agent (HN-1), Combustible, Primary irritant (w/o allergic reaction), Drug

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500 lb (227 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg)

United States DOT 49CFR172.101, Inhalation Hazardous Chemical (PIH).

Hazard symbols, risk, & safety statements: Hazard symbol: T+, Xi; risk phrases: R27/28; R35/36/337; R50/53; safety phrases: S1; S13; S28; S36/37/39; S41; S45 (see Appendix 4)

Description: Nitrogen mustard is a pale yellow, oily, mobile liquid. HN-1 is a mustard blister agent (vesicant) that has a faint musty or fishy odor. *Nitrogen mustards* are colorless when pure but are typically a yellow to brown oily substance. Odors are variably described as; sweet, agreeable, slightly garlic-or mustard-like. It evaporates slowly. Molecular weight = 170.11; 170.08[77]; specific gravity 1.09 g/cm^3 @ 25°C; boiling point = (decomposes) 194°C; freezing/melting point = − 3.4°C; volatility = 2.29 mg/L @ 25°C; vapor density (air = 1) = 5.9; vapor pressure = 0.25 mmHg @ 25°C. Hazard identification (based on NFPA- 704 M Rating System): Health 4, Flammability 2, Reactivity 0. Slightly soluble in water. 160 mg/L @ 25°C. Dissolved in water, nitrogen mustard forms a strong base. Toxic intermediate products are produced during hydrolysis of HN-1.

Potential Exposure: Sulfur mustards were formerly used as a gas warfare agent. Nitrogen mustards have not previously been used in warfare[77]. HN-1 can be used as a delayed-action military casualty agent. Exposure to nitrogen mustard damages the eyes, skin, and respiratory tract and suppresses the immune system. Although the nitrogen mustards cause cellular changes within minutes of contact, the onset of pain and other symptoms is delayed. Exposure to large amounts can be fatal[77].

Persistence of Chemical Agent: HN: Summer: 3 days to 1 week; Winter: May last for weeks.

Incompatibilities: Avoid contamination with oxidizing agents, e.g., nitrates, oxidizing acids; chlorine bleaches;

swimming pool chlorine; hypochlorites which form compounds that may result in ignition or explosions. Toxic intermediate products are produced during hydrolysis of HN-1[77]. Unstable in the presence of light and heat and forms dimers at temperatures above 122°F/50°C. HN-1: When dissolved in water this chemical forms a strong base; keep away from acids and oxidizers. Corrosive to ferrous alloys beginning at 149°F/65°C. Solution attacks copper, copper alloys, and copper compounds. Contact with metals may evolve flammable hydrogen gas. Polymerizes slowly; munitions would be effective and dangerous for several years.

Permissible Exposure Limits in Air

PAC* Ver. 29[138]

HN-1

PAC-1: 0.002 milligram per cubic meter

PAC-2: **0.022** $_{\mathbf{A}}$ milligram per cubic meter

PAC-3: **0.37** $_{\mathbf{A}}$ milligram per cubic meter

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

Determination in Water: HN-1 is a water contaminant. Octanol-water coefficient: Log K_{ow} = (estimated) ~2. Unlikely to bioaccumulate in marine organisms.

Harmful Effects and Symptoms

Nitrogen mustard is a blister agent (vesicant) that causes delayed severe damage to the respiratory tract. It is an alkylating agent that damages the cells within the bone marrow that are necessary for making blood cells. Clinical effects do not appear until hours after exposure. Nitrogen mustards penetrate and bind quickly to cells of the body; their health effects develop slowly. The full extent of cellular injury may not be known for days. The sooner after exposure that health effects occur, the more likely it is that the patient/victim was exposed to a high concentration of HN-2. Similarly, the sooner that health effects occur, the more likely it is that they will progress and become severe. *Eye exposure*: The eyes are the organs that are most sensitive to mustard vapor; eye injury may occur within 1 to 2 hours after severe exposure, or 3 to 12 hours after a mild to moderate exposure. Inhalation exposure: Airway injury may occur within 2 to 6 hours after severe exposure and within 12 to 24 hours after mild exposure. Skin exposure: The symptom-free (latent) period is 6 to 12 hours in temperate conditions; hot, humid weather strikingly increases the action of nitrogen mustards. Some skin injury may appear as late as 48 hours after exposure[77]. This compound is a nitrogen mustard. It is highly irritating to skin, eyes, and mucous membranes. Nitrogen mustards have preferential toxicity for rapidly dividing cells. Workers exposed briefly to estimated concentrations of 10−100 ppm by inhalation became severely ill. The median lethal dosage is 1500 mg-minute/m^3 [88, 136].

Short-Term Exposure: Poisonous by all routes. HN-1is a nitrogen mustard. It is highly irritating to skin, eyes, and mucous membranes. Nitrogen mustards have preferential toxicity for rapidly dividing cells. Workers exposed briefly to estimated concentrations of 10−100 ppm by inhalation became severely ill. The median lethal dosage is 1500 mg-minute/m^3. Irritate the eyes in quantities which do not significantly damage the skin or respiratory tract, insofar as single exposures are concerned. After mild vapor exposure, there may be no skin lesions. After severe vapor exposures, or after exposure to the liquid, erythema may appear. Irritation and itching may occur. Later, blisters may appear in the erythematous areas. Effects on the respiratory tract include irritation of the nose and throat, hoarseness progressing to loss of voice, and a persistent cough. Fever, labored respiration, and moist riles develop. Bronchial pneumonia may appear after the first 24 hours. Following ingestion or systemic absorption, material causes inhibition of cell mitosis, resulting in depression of the blood-forming mechanism and injury to other tissues. Severe diarrhea, which may be hemorrhagic, occurs. Lesions are most marked in the small intestine and consist of degenerative changes and narcosis in the mucous membranes. Ingestion of 2−6 milligrams causes nausea and vomiting.

Long-Term Exposure: Following significant whole-body (systemic) absorption of nitrogen mustard, injury to the bone marrow, lymph nodes, and spleen may cause a drop in white blood cell counts (beginning on days 3 to 5), which can result in an increased risk for developing (life-threatening) infections. Counts of red blood cells and platelets may also fall due to bone marrow damage.

First Aid: There is no antidote for nitrogen mustard toxicity. Decontamination of all potentially exposed areas within minutes after exposure is the only effective means of decreasing tissue damage[77]. Because health effects due to nitrogen mustard may not occur until several hours after exposure, patients/victims should be observed in a hospital setting for at least 24 hours. Gastric lavage is contraindicated following ingestion of this agent due to the risk of perforation of the esophagus or upper airway. Stop exposure and treat symptomatically. Move victim to fresh air; call emergency medical care. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. In case of contact with material, immediately flush skin or eyes with running water for at least 15 minutes. Speed in removing material from skin is of extreme importance. Remove and isolate contaminated clothing and shoes at the site. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Decontamination: Decontamination of all potentially exposed areas within minutes after exposure is the only effective means of decreasing tissue damage[77]. Remove clothes and place contaminated clothes and personal belongings in a sealed double bag. Decontamination of mustard-exposed victims by either vapor or liquid should be performed within the first 2 minutes following the exposure to prevent tissue damage. If not accomplished within the first several minutes, decontamination should still be performed to ensure any residual liquid mustard is removed from the skin or clothes, or to ensure any trapped mustard vapor is removed with the clothing. Removing trapped mustard vapor will prevent vapor off-gassing or subsequent cross-contamination of other emergency responders/healthcare providers or the healthcare facility. Physical removal of the mustard agent, rather than detoxification or neutralization, is the most important principle in patient decontamination. Mustard is not detoxified by water alone and will remain in decontamination effluent (in dilute concentrations) if hydrolysis has not taken place.

(1) Patients exposed to vapor should be decontaminated by removing all clothing in a clean air environment and shampooing or rinsing the hair to prevent vapor off-gassing. (2) Patients exposed to liquid should be decontaminated by

(a) Washing in warm or hot water at least three times. Use liquid soap (dispose of container after use and replace), large volumes of water, and mild to moderate friction with a single-use sponge or washcloth in the first and second washes. Scrubbing of exposed skin with a brush is discouraged, because skin damage may occur which may enhance absorption. The third wash should be to rinse with large amounts of warm or hot water. Shampoo can be used to wash the hair. The rapid physical removal of a chemical agent is essential. If warm or hot water is not available, but cold water is, use cold water. Do not delay decontamination to obtain warm water. (b) Rinse the eyes, mucous membranes; or open wounds with sterile saline or water.

(3) The healthcare provider should (a) Check the victim after the three washes to verify adequate decontamination before allowing entry to the medical treatment facility. If the washes were inadequate, repeat the entire process. (b) Be prepared to stabilize conventional injuries during the decontamination process. Careful decontamination can be a time consuming process. The healthcare provider may have to enter the contaminated area to treat the casualty during this process. Medical personnel should wear the proper PPE and evaluate the exposed workers.

Personal Protective Methods:

General information: first responders should use a NIOSH-certified chemical, biological, radiological, and nuclear (CBRN) SCBA with a level a protective suit when entering an area with an unknown contaminant or when entering an area where the concentration of the contaminant is unknown. Level a protection should be used until monitoring results confirm the contaminant and the concentration of the contaminant. *Note:* Safe use of protective clothing and equipment requires specific skills developed through training and experience.

LEVEL A: (*RED ZONE*): select when the greatest level of skin, respiratory, and eye protection is required. This is the maximum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than the AEGL-2. A NIOSH-certified CBRN full-face-piece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle. A totally encapsulating chemical protective (TECP) suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, and a hard hat worn under the TECP suit are optional items.

LEVEL B: (RED ZONE): Select when the highest level of respiratory protection is necessary but a lesser level of skin protection is required. This is the minimum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than AEGL-2. It differs from Level A in that it incorporates a nonencapsulating, splash-protective, chemical-resistant splash suit that provides Level A protection against liquids but is not airtight. A NIOSH-certified CBRN full-face-piece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL C: (YELLOW ZONE): Select when the contaminant and concentration of the contaminant are known and the respiratory protection criteria factors for using Air Purifying Respirators (APRs) or Powered Air Purifying Respirators (PAPRs) are met. This level is appropriate when decontaminating patient/victims. A NIOSH-certified CBRN tight-fitting APR with a canister-type gas mask or CBRN PAPR for air levels greater than AEGL-2. A NIOSH-certified CBRN PAPR with a loose-fitting face-piece, hood, or helmet and a filter or a combination organic vapor, acid gas, and particulate cartridge/filter combination or a continuous flow respirator for air levels greater than AEGL-1. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Escape mask, face shield, coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL D: (GREEN ZONE): Select when the contaminant and concentration of the contaminant are known and the concentration is below the appropriate occupational exposure limit or less than AEGL-1 for the stated duration times. Limited to coveralls or other work clothes, boots, and gloves.

Notes: Take all necessary precautions to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: When used as a weapon, use SCBA Respirator Certified by NIOSH for CBRN Environments. Where a potential exposure to the chemical exists, use a NIOSH-certified CBRN full facepiece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA (SCBA) with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well ventilated area separated from strong oxidants, strong bases; strong acids. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2810 Toxic liquids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. Military driver shall be given full and complete information regarding shipment and conditions in case of emergency. AR 50-6 deals specifically with the shipment of chemical agents. Shipments of agent will be escorted in accordance with AR 740-32.

Spill Handling:

UN2810 Toxic liquids, organic, n.o.s.

Initial Isolation and Protective Action Distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24 h response line).

Small Spills (from a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 0.7/1.2

Large Spills (from a large package or from many small packages)

First: Isolate in all directions (ft/m) 1000/300
Then: Protect persons downwind (mi/km)
Day 1.1/1.8
Night 2.8/4.5

HN-1, when used as a weapon

Initial Isolation and Protective Action Distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24 h response line).

Small Spills (from a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 0.3/0.5

Large Spills (from a large package or from many small packages)

First: Isolate in all directions (ft/m) 600/180
Then: Protect persons downwind (mi/km)
Day 0.7/1.1
Night 1.1/1.8

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Avoid inhalation and skin contact. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: Absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: Dike far ahead of spill for later disposal. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: When heated to decomposition, it emits hydrogen chloride and oxides of nitrogen and carbon. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Principles and methods for destruction of chemical weapons: "Destruction of chemical weapons" means a process by which chemicals are converted in an essentially irreversible way to a form unsuitable for production of chemical weapons, and which in an irreversible manner renders munitions and other devices unusable as such. Each nation shall determine how it shall destroy chemical weapons, except that the following processes may not be used: dumping in any body of water, land burial or open-pit burning. It shall destroy chemical weapons only at specifically designated and appropriately designed and equipped facilities. Each nation shall ensure that its chemical weapons destruction facilities are constructed and operated in a manner to ensure the destruction of the chemical weapons; and that the destruction process can be verified under the provisions of this Convention (Organization for the Prohibition of Chemical Weapons; Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and Their Destruction).

References

(31); (173); (101); (138); (85); (86); (87); (169); (93); (94); (103); (105); (163); (176).

United States Environmental Protection Agency, Chemical Hazard Information Profile: *Ethylbis(2-Chloroehtyl)Amine*, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

Ethyl bromide E:0410

Formula: C_2H_5Br

Synonyms: Bromic ether; Bromoethane; Bromure d'ethyle (French); Halon 2001; Hydrobromic ether; Monobromoethane; NCI-C55481

CAS Registry Number: 74-96-4

HSDB Number: 532

RTECS Number: KH6475000

UN/NA & ERG Number: UN1891/131

EC Number: 200-825-8 [*Annex I Index No.:* 602-055-00-1]

Regulatory Authority and Advisory Information

Carcinogenicity: NCI: Carcinogenesis Studies (inhalation); clear evidence: mouse; equivocal evidence: rat; NTP: Carcinogenesis Studies (inhalation); some evidence: rat; IARC: Human No Adequate Evidence; Animal Limited Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1999. United States Environmental Protection Agency Gene-Tox Program, Inconclusive: *D. melanogaster* sex-linked lethal

California Proposition 65 Chemical[102]: Cancer 12/22/2000.

Hazard Alert: Poison, Highly flammable, Possible risk of forming tumors, Suspected reprotoxic hazard.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xn; risk phrases: R11; R20/21/22; R40; R61; safety phrases: S2; S21; S36/37; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Ethyl bromide is a colorless liquid (turns yellow on contact with air) with an ethereal odor and a burning taste. A gas above the boiling point. Molecular weight = 108.98; specific gravity (H_2O:1) = 1.46 @ 20°C; boiling point = 38.4°C; freezing/melting point = − 118.9; vapor pressure = 400 mmHg @ 21°C; flash point = < − 15.6°C; autoignition temperature = 511°C. Explosive limits: LEL: 6.8%; UEL: 8.0%. Hazard identification (based on NFPA-704 M Rating System): Health 3, Flammability 3, Reactivity 0. Slightly soluble in water; solubility = 0.9%.

Potential Exposure: This chemical is used as an industrial chemical, pharmaceutical, and veterinary drug; as an ethylating agent in organic synthesis and gasoline; as a refrigerant; and as an extraction solvent. It has limited use as a local anesthetic.

Incompatibilities: May form explosive mixture with air. Hydrolyzes in water, forming hydrogen bromide (HBr). Oxidizers may cause fire or explosions. Fire and explosions may be caused by contact with chemically active metals: aluminum, magnesium or zinc powders; lithium, potassium, sodium. Attacks some plastic, rubber and coatings. *Note:* Chlorinating agents destroy nitrogen mustards. Dry chlorinated lime and chloramines with a high content of active chlorine, vigorously chlorinate nitrogen mustards to the carbon chain, giving low toxicity products. In the presence of water this interaction proceeds less actively. They are rapidly oxidized by peracids in aqueous solution at weakly alkaline pH. In acid solution the oxidation is much slower.

Permissible Exposure Limits in Air

NIOSH IDLH = 2000 ppm

Conversion factor: 1 ppm = 4.46 milligram per cubic meter @ 25°C & 1 atm

Odor threshold = 3.1 ppm.

OSHA PEL: 200 ppm/890 milligram per cubic meter TWA

NIOSH REL: None

ACGIH TLV[1]: 5 ppm/22 milligram per cubic meter TWA [skin]; confirmed animal carcinogen with unknown relevance to humans.

PAC Ver. 29[138]

PAC-1: 15 ppm

PAC-2: 370 ppm

PAC-3: 3500 ppm

DFG MAK: [skin] Carcinogen Category 2

Australia: TWA 200 ppm (890 milligram per cubic meter); STEL 250 ppm, 1993; Austria: carcinogen, 1999; Belgium: TWA 200 ppm (891 milligram per cubic meter); STEL 250 ppm (1100 milligram per cubic meter), 1993; Denmark: TWA 5 ppm (22 milligram per cubic meter), [skin], 1999; Finland: TWA 200 ppm (890 milligram per cubic meter); STEL 250 ppm (1115 milligram per cubic meter), 1999; France: VME 288 ppm (890 milligram per cubic meter), 1999; Hungary: TWA 50 milligram per cubic meter; STEL 100 milligram per cubic meter, [skin], 1993; the Netherlands: MAC-TGG 22 milligram per cubic meter, [skin], 2003; Norway: TWA 5 ppm (22 milligram per cubic meter), 1999; the Philippines: TWA 300 ppm (890 milligram per cubic meter), 1993; Poland: MAC (TWA) 50 milligram per cubic meter, MAC (STEL) 400 milligram per cubic meter, 1999; Russia: STEL 5 milligram per cubic meter, 1993; Switzerland: MAK-W 5 ppm (22 milligram per cubic meter), [skin], carcinogen, 1999; Turkey: TWA 200 ppm (890 milligram per cubic meter), 1993; United Kingdom: TWA 200 ppm (906 milligram per cubic meter); STEL 250 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: confirmed animal carcinogen with unknown relevance to humans. Several states have set guidelines for ethyl bromide in ambient air[60] ranging from 8.9−11.1 milligram per cubic meter (North Dakota) to 14.8 milligram per cubic meter (Virginia) to 17.8 milligram per cubic meter (Connecticut) to 21.19 milligram per cubic meter (Nevada).

Determination in Air: Charcoal adsorption, workup with isopropanol, analysis by gas chromatography/flame ionization. Use NIOSH Analytical Method #1011.

Routes of Entry: Inhalation, ingestion, and skin and/or eye contact. Passes through the skin.

Harmful Effects and Symptoms

Nitrogen Mustard is a blister agent (vesicant) that causes delayed severe damage to the respiratory tract. It is an alkylating agent that damages the cells within the bone marrow that are necessary for making blood cells.

Short-Term Exposure: Irritates the skin, eyes, and respiratory tract. Inhalation can cause lung irritation with coughing and/or shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Exposure can cause CNS depression, headache, nausea, dizziness, loss of balance; slurred speech; numbness, unconsciousness and death. Exposure to high concentrations can cause cardiac arrhythmia. This can be fatal.

Points of Attack: Skin, liver, kidneys, respiratory system, lungs, cardiovascular system, and CNS.

Medical Surveillance: Liver and kidney function tests. EKG. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Polyvinyl alcohol is among the recommended protective materials. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: OSHA: Up to 2000 ppm: Sa (APF = 10) (any supplied-air respirator); or SCBA (any SCBA with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well ventilated area separated from strong oxidants, strong bases; strong acids. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN1891 Ethyl bromide, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep ethyl bromide out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of carbon and hydrogen bromide. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Controlled incineration with adequate scrubbing and ash disposal facilities.

References

(102); (31); (173); (101); (138); (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Ethyl Bromide*, Trenton, NJ, (March 1999)

Ethyl bromoacetate E:0420

Formula: $C_4H_7BrO_2$

Synonyms: Acetic acid, bromo-, ethyl ester; Antol; Bromoacetic acid, ethyl ester; Ethoxycarbonylmethyl bromide; Ethyl α-bromoacetate; Ethyl bromoacetate; Ethyl monobromoacetate

CAS Registry Number: 105-36-2

HSDB Number: 5069

RTECS Number: AF6000000

UN/NA & ERG Number: UN1603/155

EC Number: 203-290-9 [*Annex I Index No.:* 607-069-00-1]

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Flammable liquid, Poison, Possible risk of forming tumors.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, F; risk phrases: R10; R26/27/28; safety phrases: S1/2; S7/9; S26; S41; S45 (see Appendix 4).

Description: Ethyl bromoacetate is a clear, colorless to light-yellow liquid. Molecular weight = 167.02; specific gravity (H_2O:1) = 1.5 @ 20°C; boiling point = 159°C. freezing point ≤ -20°C; vapor pressure = 2.6 mmHg @ 25°C; flash point = 48°C. Explosive limits: LEL: 14,000 ppm; UEL: unknown. Hazard identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 1. Insoluble in water.

Potential Exposure: Used for making pharmaceuticals; as a warning gas in poisonous, odorless gasses; as a tear gas.

Incompatibilities: Vapor may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, and reducing agents. Esters are generally incompatible with nitrates. Moisture may cause hydrolysis or other forms of decomposition.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 0.18 ppm

PAC-2: 1.9 ppm

PAC-3: 12 ppm

Routes of Entry: Inhalation and absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Inhalation can irritate the respiratory tract and cause headache, nausea, and vomiting. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Can irritate the skin causing rash or a burning sensation on contact. Can cause severe eye burns leading to permanent damage.

Long-Term Exposure: May cause skin allergy and irritate the lungs, causing bronchitis to develop with cough, phlegm, and/or shortness of breath.

Points of Attack: Lungs and skin.

Medical Surveillance. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Evaluation by a qualified allergist. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: (1) Color code-Blue: Health Hazard/Poison: Store in a secure poison location. (2) Color code-Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Protect against physical damage. Outside or detached storage is preferable. Inside storage should be in a standard flammable liquids storage room or cabinet. Isolate from acute fire hazards and oxidizing agents. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of five gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical.

Shipping: UN1603 Ethyl bromoacetate, Hazard class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include hydrogen bromide and oxides of carbon. Use dry chemical, carbon dioxide; alcohol foam; or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Ethyl Bromoacetate*, Trenton, NJ (April 1999)

Ethylbutanol E:0430

Formula: $C_6H_{14}O$

Synonyms: 2-Ethyl-1-butanol; 2-Ethylbutanol-1; 2-Ethylbutyl alcohol; *sec*-Hexanol; *sec*-Hexyl alcohol; 3-Methylolpentane; *sec*-Pentylcarbinol; 3-Pentylcarbinol; Pseudohexyl alcohol

CAS Registry Number: 97-95-0

HSDB Number: 2840

RTECS Number: EL3850000
UN/NA & ERG Number: UN2275/129
UN/NA & ERG Number: 97-95-0 [*Annex I Index No.:* 603-051-00-2]

Regulatory Authority and Advisory Information

Hazard Alert: Flammable, Primary irritant (w/o allergic reaction).

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xn; risk phrases: R10; R21/22; safety phrases: S2; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Ethylbutanol is a colorless liquid with a mild, alcoholic odor. Molecular weight = 102.20; boiling point = 149°C. freezing/melting point = −114°C; vapor pressure = 0.89 mmHg @ 20°C; flash point = 58°C (oc). Hazard identification (based on NFPA-704 M Rating System): Health 1, Flammability 2, Reactivity 0. Slightly soluble in water.

Potential Exposure: Used as a solvent; for making dyes, perfumes, flavorings, and drugs.

Incompatibilities: May form explosive mixture with air. Incompatible with oxidizers, strong acids; caustics, isocyanates, amines, isocyanates.

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Routes of Entry: Inhalation, eyes, and through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Contact can cause skin irritation. Eye contact can cause severe irritation and burns; possible permanent damage. Inhalation can cause irritation of the respiratory tract causing coughing and wheezing. Exposure can cause headache, dizziness, nausea, and vomiting.

Long-Term Exposure: Unknown at this time.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well ventilated area separated from strong oxidants, strong bases; strong acids. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2275 Ethylbutanol, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Oil-skimming equipment may be used to remove slicks from water. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of

carbon. Use dry chemical, carbon dioxide; alcohol foam; or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration by spraying or in paper packaging. Flammable solvent may be added.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Ethylbutanol*, Trenton, NJ (March 1999)

Ethyl butyl ether E:0440

Formula: $C_6H_{14}O$

Synonyms: Butane, 1-ethoxy-; Butyl ethyl ether; Ether ethylbutylique (French); Ethyl-*n*-butyl ether

CAS Registry Number: 628-81-9

RTECS Number: KN4725000

UN/NA & ERG Number: UN1179/127 (P)

EC Number: 211-055-7

Regulatory Authority and Advisory Information

Hazard Alert: Highly flammable liquid, Possible polymerization hazard (nonstabilized),

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xn; risk phrases: R11; R19; R22; R33; safety phrases: S16; S21; S23; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Ethyl butyl ether is a colorless liquid. Molecular weight = 102.21; boiling point = 92°C; freezing/melting point = −124°C; flash point = 4°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 1. Slightly soluble in water.

Potential Exposure: Used as a solvent for extraction and in making other chemicals

Incompatibilities: May form explosive mixture with air. Heat or prolonged storage may cause the formation of unstable peroxides. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides. Attacks some plastics, rubber and coatings. May accumulate static electrical charges, and may cause ignition of its vapors.

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Routes of Entry: Inhalation, ingestion, eyes, and through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin and respiratory tract with coughing and wheezing. High levels can cause dizziness and loss of consciousness.

Long-Term Exposure: Repeated or high exposures may affect the nervous system. Repeated exposure may remove the oils from the skin causing dryness, rash or cracking.

Points of Attack: Skin and nervous system.

Medical Surveillance: Test the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear solvent-resistant gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well ventilated area separated from strong oxidants, strong bases; strong acids. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN1179 Ethyl butyl ether, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Ethylbutyl Ether*, Trenton, NJ (March, 1999)

Ethyl butyl ketone E:0450

Formula: $C_7H_{14}O$; $C_2H_5COC_4H_9$

Synonyms: *n*-Butyl ethyl ketone; Butyl ethyl ketone; 3-Heptanone; Heptan-3-one

CAS Registry Number: 106-35-4

HSDB Number: 1816

RTECS Number: MJ5250000

UN/NA & ERG Number: UN1224/127

EC Number: 203-388-1 [*Annex I Index No.:* 606-003-00-9]

Regulatory Authority and Advisory Information

Hazard Alert: Flammable, Primary irritant (w/o allergic reaction).

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xn; risk phrases: R10; R20; R36; safety phrases: S2; S24; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Ethyl butyl ketone is a colorless liquid with a powerful, fruity odor. Molecular weight = 114.21; specific gravity (H 2 O:1) = 0.82 @ 20°C; boiling point = 147.8°C; freezing/melting point = −36.7°C; vapor pressure = 4 mmHg @ 20°C; flash point = 46°C (oc). Hazard identification (based on NFPA-704 M Rating System): Health 1, Flammability 2, Reactivity 0. Insoluble in water; solubility = 1%.

Potential Exposure: Ethyl butyl ketone is used as a solvent and as an intermediate in organic synthesis. It is a solvent for vinyl and nitrocellulose resins. It is used in food flavoring.

Incompatibilities: May form explosive mixture with air. Violent reaction with strong oxidizers, acetaldehyde, perchloric acid. Attacks some plastics, rubber and coatings.

Permissible Exposure Limits in Air

NIOSH IDLH = 1000 ppm

OSHA PEL: 50 ppm/230 milligram per cubic meter TWA

NIOSH REL: 50 ppm/230 milligram per cubic meter TWA

ACGIH TLV[1]: 50 ppm/234 milligram per cubic meter TWA; 75 ppm/350 milligram per cubic meter STEL

PAC Ver. 29[138]

PAC-1: 75 ppm

PAC-2: 500 ppm

PAC-3: 3000 ppm

DFG MAK: 10 ppm/47 milligram per cubic meter TWA; Peak Limitation Category I(2) [skin]; Pregnancy Risk Group D
Australia: TWA 50 ppm (230 milligram per cubic meter), 1993; Austria: MAK 50 ppm (230 milligram per cubic meter), 1999; Belgium: TWA 50 ppm (234 milligram per cubic meter), 1993; Denmark: TWA 50 ppm (230 milligram per cubic meter), 1999; Finland: TWA 50 ppm (230 milligram per cubic meter); STEL 75 ppm (345 milligram per cubic meter), 1999; France: VME 50 ppm (230 milligram per cubic meter), 1999; Norway: TWA 25 ppm (115 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 163 milligram per cubic meter, 2003; Sweden: TWA 25 ppm (120 milligram per cubic meter); STEL 50 ppm (250 milligram per cubic meter), 1999; Switzerland: MAK-W 50 ppm (230 milligram per cubic meter), 1999; United Kingdom: TWA 50 ppm (237 milligram per cubic meter); STEL 100 ppm [skin] 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: STEL 75 ppm. Several states have set guidelines or standards for ethyl butyl ketone in ambient air[60] ranging from 2.3−3.45 milligram per cubic meter (North Dakota) to 3.8 milligram per cubic meter (Virginia) to 4.6 milligram per cubic meter (Connecticut) to 5.476 milligram per cubic meter (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #1301, #2553, or OSHA Analytical Method 7.

Routes of Entry: Inhalation, ingestion, and skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Ethyl butyl ketone irritates the eyes, skin, and respiratory tract. Exposure to high concentrations can affect the CNS; cause dizziness, lightheadedness, and to lose consciousness.

Long-Term Exposure: Repeated or prolonged contact with skin may cause dryness and cracking.

Points of Attack: Eyes, skin, respiratory system, and CNS.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Repeated or prolonged skin contact. Wear eye protection to prevent any reasonable probability of eye contact. Employees should wash promptly when skin is wet or contaminated. Remove nonimpervious clothing promptly if wet or contaminated.

Respirator Selection: 500 ppm: CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge (s)]; or Sa (APF = 10) (any supplied-air respirator). 1000 ppm: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]; or CcrFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted acid gas canister]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted acid gas canister]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-, mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code-Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Ethyl butyl ketone must be stored to avoid contact with oxidizers, such as peroxides, chlorates, perchlorates, permanganates, and nitrates, because violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames are prohibited where ethyl butyl ketone is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN1224 Ketones, liquid, n.o.s., Hazard Class: 3; Labels: 3-Flammable liquid, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources.

Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep ethyl butyl ketone out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (2); (100).

National institute for Occupational Safety and Health (NIOSH), "*Criteria for a Recommended Standard: Occupational Exposure to Ketones*," NIOSH Document Number 78-173, Cincinnati OH (1978)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Ethyl Butyl Ketone*, Trenton, NJ (April 2002)

Ethyl butyraldehyde E:0460

Formula: $C_6H_{12}O$; $(C_2H_5)_2CHCHO$

Synonyms: Aldehyde-2-ethylbutyrique (French); Butyraldehyde, 2-ethyl-; Diethyl acetaldehyde; 2-Ethylbutanal; α-Ethylbutyraldehyde; 2-Ethylbutyraldehyde; Ethylbutyraldehyde; 2-Ethylbutyric aldehyde

CAS Registry Number: 97-96-1

RTECS Number: ES2625000

UN/NA & ERG Number: UN1178/130 (P)

EC Number: 202-623-5

Regulatory Authority and Advisory Information

Hazard Alert: Highly flammable liquid, Polymerization hazard.

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xi; risk phrases: R5; R11; R19; R36/38; safety phrases: S2; S16; S21; S26; S36 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Ethyl butyraldehyde is a colorless liquid. Molecular weight = 100.18; boiling point = 116.8°C; freezing/melting point = −89°C; flash point = 21°C (oc). Explosive limits: LEL: 1.2%; UEL: 7.7%. Hazard identification (based on NFPA-704 M Rating System): Health 3, Flammability 3, Reactivity 0. Insoluble in water.

Potential Exposure: Used in organic synthesis of pharmaceuticals and rubber chemicals.

Incompatibilities: Vapors may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, and reducing agents. Aldehydes are frequently involved in self-condensation or polymerization reactions. These reactions are exothermic; they are often catalyzed by acid. Aldehydes are readily oxidized to give carboxylic acids. Flammable and/or toxic gases are generated by the combination of aldehydes with azo, diazo compounds, dithiocarbamates, nitrides, and strong reducing agents. Aldehydes can react with air to give first peroxo acids, and ultimately carboxylic acids. These autoxidation reactions are activated by light, catalyzed by salts of transition metals, and are autocatalytic (catalyzed by the products of the reaction). The addition of stabilizers (antioxidants) to shipments of aldehydes retards autoxidation[101].

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Routes of Entry: Inhalation and skin.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the skin and eyes on contact. Inhalation may irritate the respiratory tract causing coughing and wheezing.

Long-Term Exposure: Unknown at this time.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if

heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well ventilated area separated from strong oxidants, strong bases; strong acids. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN1178 2-Ethyl butyraldehyde, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, polyurethane foams, or a similar material and deposit in sealed containers. Keep ethyl butyraldehyde out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Water may be ineffective. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (101); (138); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 8, 69−71 (1981) and 3, No 2, 85−87 (1983)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Ethylbutyraldehyde*, Trenton, NJ (March 1999)

Ethyl butyrate E:0470

Formula: $C_6H_{12}O_2$: $C_3H_7COOC_2H_5$

Synonyms: Butonic acid, ethyl ester; Butyric acid, ethyl ester; Butyric ether; Ethyl butanoate; Ethyl *n*-butyrate

CAS Registry Number: 105-54-4

HSDB Number: 406

RTECS Number: ET1660000

UN/NA & ERG Number: UN1180/130 (P); UN1178/130 (P)

EC Number: 203-306-4

Regulatory Authority and Advisory Information

Hazard Alert: Highly flammable liquid, Polymerization hazard.

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xi; risk phrases: R11; R19; R36/37/38; safety phrases: S16; S21; S26; S36; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Ethyl butyrate is a colorless liquid. Pineapple odor. The Odor Threshold is 0.015 ppm[41]. Molecular weight = 116.16; boiling point = 120°C; flash point = 24°C; autoignition temperature = 463°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 0. Insoluble in water.

Potential Exposure: Ethyl butyrate, and aldehyde, is used in flavorings, extracts, perfumery, and as a solvent.

Incompatibilities: Vapor explosive mixture with air. Ethers can act as bases. They form salts with strong acids and addition complexes with Lewis acids. The complex between diethyl ether and boron trifluoride is an example. Ethers may react violently with strong oxidizing agents. In other reactions, which typically involve the breaking of the carbon-oxygen bond, ethers are relatively inert[101]. Incompatible with alkaline materials, strong acids, oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from strong bases and heat.

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Routes of Entry: Inhalation and passes through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Ethyl butyrate can affect you when breathed in and by passing through your skin. Contact can irritate the skin and eyes. The vapor irritates the eyes, nose, throat and lungs. Symptoms may include nosebleeds, sore throat; cough with phlegm; and/or difficulty breathing. Overexposure may cause headaches and make you feel dizzy and lightheaded. Higher levels can make you pass out.

Long-Term Exposure: Unknown at this time.

Points of Attack: Lungs.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: consider lung function tests, especially with irritation symptoms. Consider liver function tests after suspected overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to ethyl butyrate exists, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Ethyl butyrate is incompatible with oxidizers (such as perchlorates, peroxides, permanganates, chlorates and nitrates); strong acids (such as hydrochloric, sulfuric and nitric); bases, and heat. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where ethyl butyrate is handled, used, or stored. Metal containers involving the transfer of five gallons or more of ethyl butyrate should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of ethyl butyrate.

Shipping: UN1180; UN1178 Ethyl butyrate, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill. Cover spill with activated carbon adsorbent, take up and deposit in sealed containers. Keep ethyl butyrate out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include carbon monoxide. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Ethyl Butyrate*, Trenton, NJ (December 1998)

Ethyl chloride E:0480

Formula: C_2H_5Cl; CH_3CH_2Cl

Synonyms: Aethylchlorid (German); Aethylis; Aethylis chloridum; Anesthetic chloryl; Anodynon; Chelen; Chlorene; Chlorethyl; Chloridum; Chlorure d'ethyle (French); Chloryl; Chloryl anesthetic; Cloretilo; Cloroetano (Spanish); Dublofix; Ethane, chloro-; Ether chloratus; Ether hydrochloric; Ether muriatic; Hydrochloric ether; Kelene; Monochlorethane; Monochloroethane; Muriatic ether; Narcotile; NCI-C06224

CAS Registry Number: 75-00-3

HSDB Number: 533

RTECS Number: KH7525000

UN/NA & ERG Number: UN1037/115; UN1993 (flammable liquids, n.o.s.)/128

EC Number: 200-830-5 [*Annex I Index No.:* 602-009-00-0]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 ($\geq$1.00% concentration).

Carcinogenicity: NCI: Carcinogenesis Studies (inhalation); clear evidence: mouse; equivocal evidence: rat; IARC: Human No Adequate Evidence; Animal Limited Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1999

California Proposition 65 Chemical[102]: Cancer, 1/1/1990.

Hazard Alert: Extremely flammable gas, Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Environmental hazard.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg)

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/1992); 40CFR401.15 Section 307 Toxic Pollutants as chlorinated ethanes

Clean Water Act: Section 307(a)(1)Toxic Pollutants subject to effluent limitations as chlorinated ethanes

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.27; Nonwastewater (mg/kg), 6.0

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8010 (5); 8240 (10)

Safe Drinking Water Act (47FR 9352): Priority List (55 FR 1470)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long lasting effects[194]. Harmful to aquatic life with long lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, F + , N, Xn; risk phrases: R45; R5; R12; R19; R20/21/22; R23/24/25; R26/28; R36/37/38; R39/23/24/25; R51/53; R61; R62; R63; R66; R67; safety phrases: S1; S7; S9; S16; S26; S28; S29; S33; S36/37/39/; S38; S41; S45; S53; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Ethyl chloride is a colorless gas or liquid (below 12°C) with a pungent, ethereal odor and a burning taste. Shipped as a liquefied compressed gas. Molecular weight = 64.51; specific gravity (H_2O:1) = 0.92 (liquid @ 0°C); boiling point = 12.3°C; freezing/melting point = −138.4; vapor pressure = 1000 mmHg @ 20°C; 750 mmHg @ 12°C; flash point = −50°C (liquid); autoignition temperature = 519°C. Explosive limits: LEL: 3.8%, 8000 ppm[138]; UEL: 15.4%. Hazard identification (based on NFPA-704 M Rating System): Health 2, Flammability 4, Reactivity 0. Slightly soluble in water; solubility = 0.6%.

Potential Exposure: Ethyl chloride is used as an ethylating agent in the manufacture of tetraethyl lead, dyes, drugs, and ethyl cellulose; as a pharmaceutical, solvent; alkylating agent; as a refrigerant and as a local anesthetic (freezing).

Incompatibilities: Flammable gas. Slow reaction with water; forms hydrogen chloride gas. Contact with moisture (water, steam) forms hydrochloric acid and/or fumes of hydrogen chloride. May accumulate static electrical charges, and may cause ignition of its vapors. May form explosive mixture with air. Contact with chemically active metals: aluminum, lithium, magnesium, sodium, potassium, zinc may cause fire and explosions. Attacks some plastics and rubber.

Permissible Exposure Limits in Air

NIOSH IDLH = 3800 [LEL]

Conversion factor: 1 ppm = 2.64 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 1000 ppm/2600 milligram per cubic meter TWA

NIOSH REL: Handle with caution in the work-place. NIOSH considers chloroethanes to be potential occupational carcinogens. See *NIOSH Pocket Guide*, Appendix C.

ACGIH TLV[1]: 100 ppm [skin]; confirmed animal carcinogen with unknown relevance to humans.

PAC Ver. 29[138]

PAC-1: 300 ppm

PAC-2: 5100 ppm

PAC-3: 20,000 ppm (LEL, lower explosive limit)

DFG MAK: [skin] Carcinogen Category 3B

Australia: TWA 1000 ppm (2600 milligram per cubic meter), 1993; Austria Suspected: carcinogen, 1999; Belgium: TWA 1000 ppm (2640 milligram per cubic meter), 1993; Denmark: TWA 1000 ppm (2600 milligram per cubic meter), 1999; Finland: TWA 500 ppm (1300 milligram per cubic meter); STEL 625 ppm (1625 milligram per cubic meter), 1999; France: VME 1000 ppm (2600 milligram per cubic meter), 1999; Hungary: TWA 100 milligram per cubic meter; STEL 300 milligram per cubic meter, 1993; the Netherlands: MAC-TGG 2600 milligram per cubic meter, 2003; Norway: TWA 500 ppm (1300 milligram per cubic meter), 1999; the Philippines: TWA 1000 ppm (2600 milligram per cubic meter), 1993; Poland: MAC (TWA) 200 milligram per cubic meter, MAC (STEL) 1600 milligram per cubic meter, 1999; Russia: TWA 1000 ppm; STEL 50 milligram per cubic meter, 1993; Sweden: NGV 500 ppm (1300 milligram per cubic meter), KTV 700 ppm (1900 milligram per cubic meter), 1999; Switzerland: MAK-W 1000 ppm (2600 milligram per cubic meter), 1999; Turkey: TWA 1000 ppm (2600 milligram per cubic meter), 1993; United Kingdom: TWA 1000 ppm (2700 milligram per cubic meter); STEL 1250 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: confirmed animal carcinogen with unknown relevance to humans. Russia[35,43] set a MAC in work-place air of 50 milligram per cubic meter. Limits on ambient air in residential areas have been set by Russia[35] at 0.2 milligram per cubic meter on a daily average basis and by the Czech Republic at 0.1 milligram per cubic meter on a daily average basis. Several states have set guidelines or standards for ethyl chloride in ambient air[60] ranging from zero (Virginia) to 0.36 milligram per cubic meter (Massachusetts) to 26.0 milligram per cubic meter (North Dakota) to 52.0 milligram per cubic meter (Connecticut, Florida, New York) to 61.88 milligram per cubic meter (Nevada).

Determination in Air: Use NIOSH Analytical Method 2519[18].

Permissible Concentration in Water: No criteria set due to volatility and low specific gravity.

Determination in Water: Octanol-water coefficient: Log $K_{ow} = 1.53$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation of gas, slight percutaneous absorption, ingestion, and skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Ethyl chloride irritates eyes, skin, and respiratory tract. Inhalation of vapor may have a narcotic effect. Skin contact with the liquid may cause frostbite. Ethyl chloride exposure may produce headache, dizziness, lack of coordination; stomach cramps; and eventual loss of consciousness. In high concentrations, it is a respiratory tract irritant, and death due to cardiac arrest has been recorded. Renal damage has been reported in animals.

Long-Term Exposure: There is limited evidence that ethyl chloride causes skin or uterine cancer in animals. May affect the nervous system; liver, and kidneys.

Points of Attack: Liver, kidneys, respiratory system, and cardiovascular system.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: Special 24 hours EKG (Holter monitor) to look for irregular heartbeat. Tests of liver and kidney function.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. 4 hours: Teflon gloves, suits, boots. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles

and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: OSHA: Up to 3800 ppm: Sa (APF = 10) (any supplied-air respirator); * or SCBAF (APF = 50) (any SCBA with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Check oxygen content prior to entering storage area. Color code-Red Stripe: Flammability Hazard: Store separately from all other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1 hour fire wall from flammable or reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Ethyl chloride must be stored to avoid contact with oxidizers (such as peroxides, chlorates, perchlorates, nitrates, and permanganates) or chemically active metals (such as sodium, potassium, calcium, powdered aluminum, zinc, and magnesium) because violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames are prohibited where ethyl chloride is handled, used, or stored. Metal containers used in the transfer of five gallons or more of ethyl chloride should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of ethyl chloride. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: UN1037 Ethyl chloride, Hazard Class: 2.1; Labels: 2.1-Flammable gas. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. *If ethyl chloride gas is leaked*, take the following steps: Restrict persons not wearing protective equipment from area of leak until cleanup is complete. Remove all ignition sources. Ventilate area of leak to disperse the gas. Stop flow of gas. If source of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. Keep ethyl chloride out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid or gas. Thermal decomposition products may include hydrogen chloride and oxides of carbon. *Liquid:* Establish forced ventilation to keep levels below explosive limit. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode. *Gas:* Establish forced ventilation to keep levels below explosive limit. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced[22].

References

(102); (31); (173); (101); (138); (2); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: *Chloroethane*, Washington, DC (1979)

United States Environmental Protection Agency, *Chloroethanes: Ambient Water Quality Criteria*, Washington, DC (1980)

United States Environmental Protection Agency, *Chloroethane, Health and Environmental Effects Profile No. 44*, Washington, DC, Office of Solid Waste (April 30, 1980)

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 4, 64–66 (1981)

United States Public Health Service, "*Toxicological Profile for Chloroethane*," Atlanta, Georgia, Agency for Toxic Substances and Disease Registry (December 1988)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Ethyl Chloride*, Trenton, NJ (July 2002)

Ethyl chloroacetate E:0490

Formula: $C_4H_7ClO_2$: $CH_3CH_2OCO \cdot CH_2Cl$

Synonyms: Chloroacetic acid, ethyl ester; Ethyl α-chloroacetate; Ethyl chloroacetate; Ethyl chloroethanoate; Ethyl monochloracetate; Ethyl monochloroacetate

CAS Registry Number: 105-39-5

HSDB Number: 408

RTECS Number: AF9110000

UN/NA & ERG Number: UN1181/155

EC Number: 203-294-0 [*Annex I Index No.:* 607-070-00-7]

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Highly flammable, Possible risk of forming tumors, Primary irritant (w/o allergic reaction).

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, F, N; risk phrases: R11; R23/24/25; R50; safety phrases: S1/2; S7/9; S21; S41; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Ethyl chloroacetate is a water-white liquid with a pungent, fruity odor. Molecular weight = 122.56; specific gravity (H_2O:1) = 1.2 @ 20°C; boiling point = 144°C; freezing point = −27°C; vapor pressure = 10 mmHg @ 37.5°C; flash point = 64°C. Hazard identification (based on NFPA-704 M Rating System): Health: 3, Flammability 3, Reactivity 0. Insoluble in water.

Potential Exposure: Used to make rodenticides, dyes, and other chemicals. Also used as a military poison.

Incompatibilities: May form explosive mixture with air. Incompatible with strong bases; strong acids; reducing agents. Moisture, water, and steam contact forms toxic and corrosive fumes. Violent reaction with oxidizers, alkaline earth metals (barium, calcium, magnesium, strontium, etc.), alkaline metals, sodium cyanide. Attacks metals in the presence of moisture.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 0.11 ppm

PAC-2: 1.2 ppm

PAC-3: 7.1 ppm

Routes of Entry: Inhalation, eyes, and through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Contact can severely irritate and burn eyes and skin. Inhalation can irritate the respiratory tract with coughing and wheezing. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Exposure can cause headache, nausea, and vomiting.

Long-Term Exposure: Very irritating substances may cause lung damage.

Points of Attack: Lungs.

Medical Surveillance. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately

with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to this chemical exists, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: (1) Color code-Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. (2) Color code-Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. (2) Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area away from oxidizers, strong acids; strong bases; reducing agents; heat and sources of ignition. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1181 Ethylchloroacetate, Hazard class: 6.1; Labels: 6.1-Poisonous materials, 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include hydrogen chloride and carbon monoxide. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Ethyl Chloroacetate*, Trenton, NJ (March 1999)

Ethyl chloroformate E:0495

Formula: $C_3H_5ClO_2$

Synonyms: Carbonochloridic acid, ethyl ester; Cathyl chloride; Chlorocarbonate d'ethyle (French) * Chloroformic acid ethyl ester; Chlorameisensaeureaethylester; ECF; Ethyl chlorocarbonate; Ethyle, chloroformiat d' (French);

Etil clorocarbonato (Spanish); Etil cloroformiato (Spanish); Formic acid, chloro-, ethyl ester; TL 423

CAS Registry Number: 541-41-3

HSDB Number: 409

RTECS Number: LQ6125000

UN/NA & ERG Number: (PIH) UN1182/155

EC Number: 208-778-5

Regulatory Authority and Advisory Information

Hazard Alert: Poison inhalation hazard: exposure can be lethal, Air reactive (with moisture), Extremely flammable liquid, Sensitization hazard, Corrosive, Lacrimator, Electrostatic hazard, Dangerously water reactive (exothermic).

EPCRA Section 313 Form R de minimus concentration reporting level: 1.0%.

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Hazard symbols, risk, & safety statements: Hazard symbol: T+, F; risk phrases: R11; R14; R22; R26; R34; R36/37/38; R43; R45; R22; R24; R26; safety phrases: S9; S16; S21; S26; S28; S33; S36/37/39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: A colorless to light yellow liquid. Sharp, pungent odor, similar to HCl. Molecular weight = 108.53; specific gravity (H_2O:1) = 1.135 @ 20°C; boiling point = 94°C; freezing/melting point = −81°C; vapor pressure = 23 mmHg @ 25°C; Flash point = 16−18°C; autoignition temperature = ~500°C. Hazard identification (based on NFPA-704 M Rating System): Health 4, Flammability 3, Reactivity 1 ₩. Water reactive, releasing hydrogen chloride, carbon dioxide and ethanol.

Potential Exposure: Heavily used in industry for various processes; in ore processing, photography, making other chemicals including amines, carbamates, isocyanates; polymers, diethyl carbonate; nitriles, etc.[193].

Incompatibilities: Highly flammable; Vapors may form explosive mixture with air. Emits fumes containing HCl on contact with moist air. Decomposes exothermically but slowly in water. Ethyl chloroformate decomposes slowly in water forming ethanol, hydrogen chloride and carbon dioxide. May react vigorously, possibly explosively, if mixed with di-isopropyl ether or other ethers in the presence of trace amounts of metal salts. Reacts with acids, alkalies, amines, alcohols, oxidizers and water. Corrosive to metals especially in the presence of moisture.

Permissible Exposure Limits in Air:

PAC* Ver. 29[138]

PAC-1: 0.15 ppm

PAC-2:1.6 ppm

PAC-3:4.8 ppm

Routes of Entry: Inhalation, ingestion, and dermal contact.

Harmful Effects and Symptoms

Short-Term Exposure: Poison inhalation hazard. Vapor causes severe lachrymation; liquid causes acid-type burns of eyes and skin, like those of hydrochloric acid. Inhalation causes irritation of the mucous membrane with severe irritation, coughing, and sneezing. Ingestion causes severe burns of mouth and stomach. Very toxic by inhalation; capable of producing delayed pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Vapors are heavier than air. Corrosive to tissue: eyes, skin and respiratory system. LD_{50} = (oral-rat) <50 mg/kg[136].; LD_{50} = (oral-rat) <300 mg/kg.

Long-Term Exposure: Prolonged exposure to low concentrations or short exposure to high concentrations may have adverse health effects from inhalation. Skin sensitization may occur. If skin or lung sensitization is suspected, consider evaluation by a qualified allergist, including exposure history and testing, may help diagnose allergy.

Points of Attack: Lungs, skin, and eyes

Medical Surveillance: Special attention should be given to the eyes and respiratory tract in medical exam[193] [Pattty's].

First Aid: *Inhalation:* remove to fresh air; use artificial respiration if breathing has stopped; call a doctor; keep victim quiet and administer oxygen if needed. *Eyes*: flush with water for at least 15 min.; see a doctor. *Skin*: wash liberally with water for at least 15 min., then apply dilute solution of sodium bicarbonate or commercially prepared neutralizer. *Ingestion*: do NOT induce vomiting; give large amount of water; get medical attention.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Poison inhalation hazard, Where there is potential exists for exposure to this compound, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA (SCBA) with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Poison inhalation hazard (PIH) chemical; check oxygen content prior to entering storage area.(1) Color code-Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. (2) Color code-Red: Flammability Hazard: Store in a flammable (liquid or solid materials) storage area or approved cabinet away from sources if ignition. (3) Color code-White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location; keep acids away from bases and red, yellow, and blue-coded chemicals. Store refrigerated (preferred) or in a cool, dry, well-ventilated atmosphere and location. Normally refrigerated[193]. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area away from oxidizers, strong acids; strong bases; reducing agents; heat and sources of ignition.

Shipping: UN1182 Ethyl chloroformate, Hazard class: 6.1; Labels: 6.1-Poison Inhalation Hazard, 3-Flammable liquid, 8-Corrosive material Inhalation Hazard Zone B

Spill Handling:

Ethyl chloroformate

Initial Isolation and Protective Action Distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24 h response line).

Small Spills (from a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.1/0.2

Large Spills (from a large package or from many small packages)

First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.2/03
Night 0.4/0.6

Releases may require immediate isolation or evacuation. Eliminate all ignition sources (no smoking, flares, sparks or flames in immediate area). All equipment used when handling the product must be grounded. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Stop leak if you can do it without risk. A vapor suppressing foam may be used to reduce vapors.

Fire Extinguishing: Thermal decomposition products may include phosgene, hydrogen chloride and oxides of carbon. *Note:* Most foams will react with the material and release corrosive/toxic gases. *Note:* Most foams will react with the material and release corrosive/toxic gases. *Small fire*: CO_2, dry chemical, dry sand, alcohol-resistant foam. *Large fire:* Water spray, fog or alcohol-resistant foam. For chlorosilanes, do not use water; use AFFF alcohol-resistant medium-expansion foam. Move containers from fire area if you can do it without risk. Use water spray or fog; do not use straight streams. *Fire involving tanks or car/trailer loads*: Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Do not get water inside containers. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. Always stay away from tanks engulfed in fire[31].

Disposal Method Suggested: Use a licensed professional waste disposal service to dispose of this material. All federal, state, and local environmental regulations must be observed. Consult with environmental regulatory agencies for guidance on acceptable disposal practices.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Ethyl Chloroformate*, Trenton, NJ, (March 2000)

Ethyl 2-chloropropionate E:0500

Formula: $C_5H_9ClO_2$: $CH_3CHClCOOC_2H_5$

Synonyms: 2-Chloropropionic acid, ethyl ester; Propanoic acid, 2-chloro-, ethyl ester

CAS Registry Number: 535-13-7

RTECS Number: UE8870000

UN/NA & ERG Number: UN2935/129

EC Number: 208-610-0

Regulatory Authority and Advisory Information

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xi; risk phrases: R11; R36/37/38; R52; safety phrases: S16; S26; S36/37/39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Ethyl-2-chloropropionate is a liquid with a pleasant odor. Molecular weight = 136.8; boiling point = 147°C; freezing/melting point = < -20°C; flash point = 41.8°C; ignition temperature = ~400°C. Practically insoluble in water.

Potential Exposure: This material is used in organic synthesis.

Incompatibilities: Flammable liquid; forms explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, and reducing agents. Esters are generally incompatible with nitrates. Moisture may cause hydrolysis or other forms of decomposition. Esters react with acids releasing heat in addition to alcohols and acids. Contact with caustic solutions generate heat. Contact with esters with alkali metals and hydrides releases flammable hydrogen.

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Routes of Entry: Inhalation and dermal contact.

Harmful Effects and Symptoms

Short-Term Exposure: Ethyl-2-chloropropionate can affect you when breathed in. Eye or skin contact may irritate the nose, throat and bronchial tubes. High exposures might cause a dangerous fluid build-up in the lungs (pulmonary edema); a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: Some related chemicals may cause skin allergy. Very irritating substances may cause lung problems.

Points of Attack: Respiratory tract.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: consider lung function tests, especially if lung symptoms are present. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposure to ethyl-2-chloropropionate, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from acids, bases, oxidizing and reducing agents. Sources of ignition, such as smoking and open flames, are prohibited where ethyl-2-chloropropionate is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2935 Ethyl 2-chloropropionate, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120 (q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include chlorides, are released in fire including hydrogen chloride and oxides of carbon. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Ethyl-2-Chloropropionate*, Trenton, NJ (October 2000).

Ethyl chlorothioformate E:0505

*xxxxxx ***Formula:*** $C_3H_5ClO_2S$; $CH_3CH_2SC(O)Cl$

Synonyms: Carbonic acid, thio-, anhydrosulfide with thiohypochlorous acid, ethyl ester; Carbonochloridothioic acid, s-ethyl ester; Chlorothioformic acid ethyl ester; Ethoxycarbonylsulfenyl chloride; Ethyl (chlorosulfenyl)formate; Ethyl (chlorothio)formate; Ethyl chlorothioformate; Ethyl chlorothioloformate; Ethyl thiochloroformate; Formic acid, chlorothio-, S-ethyl ester; *S*-Ethyl carbonochloridothioate; *S*-Ethyl chlorothiocarbonate; *S*-Ethyl chlorothioformate; *S*-Ethyl thiochloroformate; Thiohypochlorous acid, anhydrosulfide with *o*-ethyl thiocarbonate

CAS Registry Number: 2941-64-2

HSDB Number: 5906

RTECS Number: FG3055000

UN/NA & ERG Number: UN2826/155

EC Number: 220-928-1

Regulatory Authority and Advisory Information

Hazard Alert: Poison Inhalation hazard, Neurotoxin, Corrosive, Flammable liquid, Water reactive, Environmental hazard.

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Hazard symbols, risk, & safety statements: Hazard symbol: C, T+, F, N; risk phrases: R10; R22;, R26; R20/21/22; R34; R36/37; R50/53; safety phrases: S16; S24/25; S26; S27; S28; S29/35; S36/37/39; S41; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Ethyl chlorothioformate is a flammable clear yellow or amber-colored liquid. Pungent, penetrating odor. Molecular weight = 124.59[136]; 132.56[138]; specific gravity (H_2O:1) = 1.195 @ 20°C; boiling point = 132.2°C; freezing/melting point = −55°C; flash point = 51.7°C. Practically insoluble in water; solubility = < 1 mg/L @ 19°C. Hazard identification (based on NFPA-704 M Rating System): Health 4, Flammability 2, Reactivity 0 ₩. Reacts with water, releasing corrosive hydrogen chloride gas. Sinks in water and vapors are heavier than air.

Potential Exposure: Used for making other chemicals. A pharmaceutical intermediate.

Incompatibilities: Corrosive to metals. Flammable vapors may form explosive mixture with air. Contact with moisture releases highly corrosive and toxic hydrogen chloride gas. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides.

Permissible Exposure Limits in Air:

PAC* Ver. 29[138]

PAC-1: 0.024 ppm

PAC-2: **0.26** $_{\mathbf{A}}$ ppm

PAC-3: **0.79** $_{\mathbf{A}}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

Routes of Entry: Inhalation and ingestion. May pass through unbroken skin.

Harmful Effects and Symptoms

Short-Term Exposure: Very toxic by inhalation; and a nervous system toxin. Corrosive to all body tissues. Eye, skin, and respiratory tract irritant. GI tract-acute effects; Nervous system toxin-acute effects. Exposure may cause a dangerous fluid build-up in the lungs (pulmonary edema); a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: May cause respiratory and nervous system effects.

Points of Attack: Nervous system and respiratory system.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: consider lung function tests, especially if lung symptoms are present. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Full impervious protective clothing, including boots and gloves. Where splashing is possible wear full face shield or chemical safety goggles. Use approved respirator to protect against vapors.

Respirator Selection: Where there is potential exists for exposure to Maneb, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Poison inhalation chemical (PIH); check oxygen content prior to entering storage area.(1) Color code-White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location; keep acids away from bases and red, yellow, and blue-coded chemicals. (2) Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Color code-Red: Flammability Hazard: Store in a flammable (liquid or solid materials) storage area or approved cabinet away from sources if ignition.

Shipping: UN2826 Ethyl chlorothioformate, Hazard Class: 8; Labels: 8-Corrosive material, 6.1-Poison Inhalation Hazard, 3-Flammable liquid; Inhalation Hazard Zone B

Spill Handling:

Initial Isolation and Protective Action Distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24 h response line).

Small Spills (from a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.1/0.2

Large Spills (from a large package or from many small packages)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.3/0.5
Night 0.4/0.6

Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources and dampen spilled material with toluene to avoid airborne dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. Stop discharge; Collection Systems: Dredge; Do not burn. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Highly flammable liquid. Thermal decomposition products may include vapors and toxic gases, including hydrogen chloride and oxides of sulfur and carbon. Vapors can flow along surfaces to distant ignition source and flash back. *Note:* Most foams will react with the material and release corrosive/toxic gases. *Small fire*: CO_2, dry chemical, dry sand, alcohol-resistant foam. *Large fire:* Water spray, fog or alcohol-resistant foam. For chlorosilanes, do not use water; use AFFF alcohol-resistant medium-expansion foam. Move containers from fire area if you can do it without risk. Use water spray or fog; do not use straight streams. *Fire involving tanks or car/trailer loads*: fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Do not get water inside containers. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. Always stay away from tanks engulfed in fire[31].

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Controlled incineration (oxides of nitrogen are removed from the effluent gas by scrubbers and/or thermal devices).

References

(31); (173); (101); (138) (100).

Ethyl cyanoacetate E:0510

Formula: $C_5H_7NO_2$

Synonyms: Acetic acid, cyano-, ethyl ester; Cyanacetate ethyle (German); Cyanoacetic acid ethyl ester; Cyanoacetic ester; Estere cianoacetico; Ethyl cyanoacetate; Ethyl cyanoethanoate; Malonic acid, ethyl ester nitrile

CAS Registry Number: 105-56-6

HSDB Number: 2769

RTECS Number: AG4110000

UN/NA & ERG Number: UN3276/151

EC Number: 203-309-0

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Combustible, Possible polymerization hazard (nitriles), Environmental hazard.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants as cyanide, total

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as cyanide mixtures, cyanide solutions.

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Ethyl cyanoacetate is a colorless to straw colored liquid with a mild pleasant odor. Molecular weight = 113.14; boiling point = 207°C; freezing/melting point = −23°C; vapor pressure = 1 mmHg @ 68°C; flash point = 110°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Practically insoluble in water.

Potential Exposure: A nitrile used to manufacture dyes, pharmaceuticals, and other chemicals.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, and reducing agents. Nitriles may polymerize in the presence of metals and some metal compounds. They are incompatible with acids; mixing nitriles with strong oxidizing acids can lead to extremely violent reactions. Nitriles are generally incompatible with other oxidizing agents such as peroxides and epoxides. The combination of bases and nitriles can produce hydrogen cyanide. Nitriles are hydrolyzed in both aqueous acid and base to give carboxylic acids (or salts of carboxylic acids). These reactions generate heat. Peroxides convert nitriles to amides. Nitriles can react vigorously with reducing agents. Acetonitrile and propionitrile are soluble in water, but nitriles higher than propionitrile have low aqueous solubility. They are also insoluble in aqueous acids[101]. Reacts with moisture, water, and steam, forming toxic fumes.

Permissible Exposure Limits in Air

NIOSH REL: (*nitriles*) 2 ppm, Ceiling Concentration, not to be exceeded in any 15 minute work period. PAC not available.

Determination in Air: See NIOSH Criteria Document 78-212, NITRILES.

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 200 μg[CN]/L; State Drinking Water Standards: California 150 μg[CN]/L; State Drinking Water Guidelines: Arizona 220 μg[CN]/L; Maine. 140 μg [CN]/L; Minnesota 100 μg[CN]/L. United States Army field drinking-water standards for cyanide: 2 mg[CN]/L assuming a water consumption of 15 L/day and 6 mg[CN]/L assuming a water consumption of 5 L/day. United States Army field drinking-water standards for cyanide, long-term consumption 0.5 mg[CN]/L; short-term consumption; raw water constituents (maximum) 20 mg[CN]/L.

Routes of Entry: Inhalation. May be absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: An organic cyanide compound. Irritates the eyes, skin, and respiratory tract. Exposure can cause headache, nausea, and vomiting. Poisonous if ingested.

Long-Term Exposure: Unknown at this time.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See NIOSH Criteria Document 212 *Nitriles*.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode. NIOSH (*as cyanides)*: 25 milligram per cubic meter: Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted canister providing protection against the compound of concern and having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area away from oxidizers, strong bases; strong acids; reducing agents; moisture and sources of ignition. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: UN3276 Nitriles, liquid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required, Potential Inhalation Hazard (Special Provision 5).

Spill Handling:

Nitriles spill

Initial Isolation and Protective Action Distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24 h response line).

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.1/0.2

Large Spills (from a large package or from many small packages)

First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.3/0.5
Night 0.5/0.8

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition include cyanide and oxides of nitrogen and carbon. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (173); (101); (138). (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Ethyl Cyanoacetate*, Trenton, NJ (March 1999)

Ethyl dichloroarsine (Agent ED)

E:0525

*xxxxxx ***Formula:*** $C_2H_5As \cdot Cl_2$

Synonyms: Arsenic dichloroethane; Arsine, dichloroethy-; Arsonous dichloride, ethyl-; Dichloroethylarsine; DICK; ED; Ethylarsonous dichloride; Ethyldichlorarsine; TL 214

CAS Registry Number: 598-14-1

HSDB Number: 424

RTECS Number: CH3500000

UN/NA & ERG Number: UN1892/151

EC Number: 209-919-3 [*Annex I Index No.:* 033-002-00-5]

Regulatory Authority and Advisory Information

Hazard Alert: Poison inhalation hazard (organic arsenical), Nervous system toxin, Delayed-action blister/vesicants, Environmental hazard, Organometallic, Strong reducing agent, Water reactive, Air reactive, Agricultural chemical (organoarsenic).

CLEAN AIR ACT: Hazardous Air Pollutants (Title I, Part A, Section 112) as arsenic compounds

Clean Water Act: Toxic pollutant designated pursuant to section 307(a)(1) of the Federal Water Pollution Control Act and is subject to effluent limitations: 40 CFR 401.15 (7/1/2001).

RCRA Section 261 Hazardous Constituents, waste number D004

EPCRA Section 304 RQ: CERCLA, 1 lb (0.454 kg)

EPCRA (Section 313): Includes any unique chemical substance that contains arsenic as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: (inorganics) 0.1%; organics 1.0%

United States DOT Regulated marine pollutant (49CFR172.101, Appendix B) as arsenates, liquid, n. o. s; arsenates, solid, n. o. s; arsenical pesticides liquid, toxic, flammable, n. o. s.

California EPA AB2588-Air Toxics "Hot Spots" Chemicals (CAL) as arsenic compounds Permissible Exposure Limits for Chemical Contaminants (CAL/OSHA) as arsenic compounds. The "Director's List" (CAL/OSHA) as arsenic compounds

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements:: Hazard symbol: T, Xi, N; risk phrases: R20/22; R36/37/38; safety phrases: S1; S29/35; S41; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: A colorless mobile liquid. Acrid, biting, irritating, fruit-like odor. Molecular weight = 174.89; specific gravity (H_2O:1) = 1.742 @ 14°C; freezing/melting point = −65°C; vapor pressure = 2.29 mmHg @ 21.5°C. Insoluble in water. ₩ Water reactive, quick hydrolysis, forming hydrochloric acid and ethylarsine chloride.

Potential Exposure: Organoarsenic compound, Organometallic.

Incompatibilities: Reacts with water or moist air releasing hydrochloric acid and/or corrosive fumes of hydrogen chloride (HCl). A strong reducing agent; incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides. Attacks some metals; brass, but not ferrous metals.

Permissible Exposure Limits in Air:

PAC* Ver. 29[138]

PAC-1: 0.0026 milligram per cubic meter

PAC-2: **0.029** $_{\mathbf{A}}$ milligram per cubic meter

PAC-3: **0.086** $_{\mathbf{A}}$ milligram per cubic meter

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

Determination in Air: Filter; Reagent: Ion chromatography/hydride atomic absorption: NIOSH IV [#5022, Arsenic, organo-][18].

Permissible Concentration in Water: EPA[6] recommends a zero concentration of arsenic for human health reasons. Federal Drinking Water Guidelines: EPA 10 μg/L; State Drinking Water Guidelines: Arizona 10 μg/L; Connecticut 10 μg/L. Toxic pollutant designated pursuant to section 307 (a) (1) of the Clean Water Act and is subject to effluent limitations (arsenic and inorganic and organic arsenic) [40 CFR 401.15 (7/1/1987)]. Canadian Drinking Water Standards: IMAC 0.025 [As] mg/L. Runoff from spills or fire control may cause water pollution.

Determination in Water: See OSHA Analytical Method ID-105 for arsenic. The atomic absorption graphite furnace technique is often used for measurement of total arsenic in water. It also has been standardized by EPA. Total arsenic may be determined by digestion followed by silver diethyldithiocarbamate; an alternative is atomic absorption; another is inductively coupled plasma (ICP) optical emission spectrometry.

Routes of Entry: Inhalation, ingestion, and skin absorption

Harmful Effects and Symptoms

Short-Term Exposure: Liquid and vapors are extremely toxic by inhalation, ingestion, skin absorption. Severe eye irritant. The vapor is a powerful lacrimatory irritant of the eyes, skin and respiratory tract. It is corrosive to eye tissue and may cause permanent corneal opacity and conjunctival scarring. Severe exposure may result in overwhelming pulmonary edema. Respiratory toxin: acute effects other than severe or moderate irritation; Nervous system toxin: acute effects; GI tract-acute effects; Skin irritant-severe; Respiratory irritant-acute, severe, or moderate but not mild irritant effects; Eye-acute effects other than irritation[138]. Strong irritant: LCLo (inhalation-man) 14ppm/30 M.

Points of Attack: Respiratory system, eyes, and CNS

Medical Surveillance: Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Note to Physician: For severe poisoning BAL (British Anti-Lewisite), dimercaprol, dithiopropanol ($C_3H_8OS_2$) has been used to treat toxic symptoms of certain heavy metals poisoning—including arsenic. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5). For milder poisoning *penicillamine (NOT penicillin)* has been used, both with mixed success. Side effects occur with such treatment and it is never a substitute for controlling exposure. It can only be done under strict medical care.

Decontamination: This is very important, and you have to decontaminate as soon as you can. Extra minutes before decontamination might make a big difference. If you don't have the equipment and training, don't enter the hot or the warm zone to rescue and decontaminate victims. If the victim can't move, decontaminate without touching and without entering the hot or the warm zone. Use clean water from any source; if possible, use a hose (spray or fog to prevent injury to the victim) or other system so that you won't have to touch the victim; don't even wait for soap or for the victim to remove clothing, begin washing immediately. Immediately flush the eyes with water for at least 15 minutes. Use caution to avoid hypothermia in children and the elderly. Wash—strip—wash—evacuate up wind and uphill: The approach is to immediately wash with water, then have the victim (not the first responder) remove all the victim's clothing, then wash again (with soap if available) and then move away from the hot zone in an upwind and uphill direction. Wash the victim with warm water and soap. There are differing guidelines for decontamination and more research is needed to identify the optimal decontamination method. The effect of lewisite and mustard-lewisite can be prevented by rapid topical application of 2,3-dimercaptopropanol, known as British anti-lewisite (BAL) which reacts with Lewisite to form a stable nontoxic cyclic product. Decontaminate with diluted household bleach (0.5%, or one part bleach to 200 parts water), but don't let any get in the victim's eyes, open wounds, or mouth. Wash off the diluted bleach solution after 15 minutes. Be sure you've decontaminated the victims as much as you can before they leave the area so that they don't spread the Lewisite. Use the antidote "Anti-Lewisite." Use 5% solution of common bleach (sodium hypochlorite) or calcium hypochlorite solution (48 ounces per five gallons of water) to decontaminate scissors used in clothing removal, clothes and other items. *Note:* Decontamination wash water (effluent) will contain toxic arsenic.

Personal Protective Methods:

General information: first responders should use a NIOSH-certified CBRN SCBA with a level a protective suit when entering an area with an unknown contaminant or when entering an area where the concentration of the contaminant is unknown. Level a protection should be used until monitoring results confirm the contaminant and the concentration of the contaminant. *Note:* Safe use of protective clothing and equipment requires specific skills developed through training and experience.

LEVEL A: (*RED ZONE*): select when the greatest level of skin, respiratory, and eye protection is required. This is the maximum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than the AEGL-2. A NIOSH-certified CBRN full-face-piece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle. A TECP suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, and a hard hat worn under the TECP suit are optional items.

LEVEL B: (RED ZONE): Select when the highest level of respiratory protection is necessary but a lesser level of skin protection is required. This is the minimum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than AEGL-2. It differs from Level A in that it incorporates a nonencapsulating, splash-protective, chemical-resistant splash suit that provides Level A protection against liquids but is not airtight. A NIOSH-certified CBRN full-face-piece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL C: (YELLOW ZONE): Select when the contaminant and concentration of the contaminant are known and the respiratory protection criteria factors for using APRs or PAPRs are met. This level is appropriate when decontaminating patient/victims. A NIOSH-certified CBRN tight-fitting APR with a canister-type gas mask or CBRN PAPR for air levels greater than AEGL-2. A NIOSH-certified CBRN PAPR with a loose-fitting face-piece, hood, or helmet and a filter or a combination organic vapor, acid gas, and particulate cartridge/filter combination or a continuous flow respirator for air levels greater than AEGL-1. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Escape mask, face shield, coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL D: (GREEN ZONE): Select when the contaminant and concentration of the contaminant are known and the concentration is below the appropriate occupational exposure limit or less than AEGL-1 for the stated duration times. Limited to coveralls or other work clothes, boots, and gloves.

Notes: Take all necessary precautions to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear full facepiece respiratory protection. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Personal Protective Methods: A severe eye irritant; danger of blindness. Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100 F (APF = 50) (any air purifying, full-face-piece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: PIH; check oxygen content prior to entering storage area. Color code-Blue: Health Hazard/Poison: Store in a secure, locked, poison location. Prior to working with arsenic compounds all handlers should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN1892 Ethyldichloroarsine Hazard class: 6.1; Labels: 6.1-Poison Inhalation Hazard; Inhalation Hazard Zone B. Military driver shall be given full and complete information regarding shipment and conditions in case of emergency. AR 50-6 deals specifically with the shipment of chemical agents. Shipments of agent will be escorted in accordance with AR 740-32.

Spill Handling:

Initial Isolation and Protective Action Distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24 h response line)

Small Spills (from a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 500/150
Then: Protect persons downwind (mi/km)
Day 1.0/1.5
Night 1.5/2.4

Large Spills (from a large package or from many small packages)

First: Isolate in all directions (ft/m) 1500/500
Then: Protect persons downwind (mi/km)
Day 3.3/5.3
Night 6.1/9.7

ED when used as a weapon 500/150

Small Spills (from a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 500/150
Then: Protect persons downwind (mi/km)
Day 1.2/1.9
Night 1.8/2.8

Large Spills (from a large package or from many small packages)

First: Isolate in all directions (ft/m) 3000/1000
Then: Protect persons downwind (mi/km)
Day 6.5/10.5
Night 7.0 + /11.0 + *

*+ means distance can be larger in certain atmospheric conditions.

Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources and dampen spilled material with toluene to avoid airborne dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing:

Disposal Method Suggested: Use a licensed professional waste disposal service to dispose of this material. Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138). (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Ethyl Dichloroarsine*, #0871, Trenton, NJ, (March 2000)

Ethyl dichlorosilane E:0530

Formula: $C_2H_6Cl_2Si$; $Cl_2SiHC_2H_5$
Synonyms: Dichloroethylsilane; Ethyldichlorosilane; Monoethyldichlorosilane; Silane, dichloroethyl-
CAS Registry Number: 1789-58-8
HSDB Number: 4048
RTECS Number: VV3230000
UN/NA & ERG Number: UN1183/139
EC Number: 217-255-0
Regulatory Authority and Advisory Information
Check
Hazard Alert: Highly flammable, Pyrophoric hazard, Violently reactive with water.
Hazard symbols, risk, & safety statements: Hazard symbol: T, F+, C; risk phrases: R11; R14/15; R17; R29; R34; R37; safety phrases: S7; S16; S21; S26; S36/37/39; S43; S41; S45 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.
Description: Ethyl dichlorosilane is a colorless liquid. Sharp, irritating odor. Molecular weight = 129.07; boiling point = 75.5°C; flash point = −1°C. Explosive Limits: LEL: 2.9%; UEL: unknown. Hazard identification (based on NFPA-704 M Rating System): Health 3, Flammability 3, Reactivity 2 ₩. Dangerously reactive with water, rapidly releasing hydrogen chloride gas.
Potential Exposure: This material is used in silicone polymer manufacture.
Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides. Chlorosilanes react vigorously with bases and both organic and inorganic acids generating toxic and/or flammable gases. Chlorosilanes react with water, moist air, or steam to produce heat and toxic, corrosive fumes of hydrogen chloride. They may also produce flammable gaseous hydrogen. Attacks metals in the presence of moisture.
Permissible Exposure Limits in Air
No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.
Routes of Entry: Inhalation.
Harmful Effects and Symptoms
Short-Term Exposure: Ethyl dichlorosilane is corrosive. It can affect you when breathed in. Exposure can irritate the lungs, causing coughing and/or shortness of breath. Higher exposures can cause a build-up of fluid in the lungs (pulmonary edema), a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Ethyl dichlorosilane is a corrosive chemical and contact can cause severe skin and eye burns leading to permanent eye damage.
Long-Term Exposure: This chemical can irritate the lungs. Repeated exposure may cause bronchitis with cough, phlegm, and/or shortness of breath.
Medical Surveillance: For those with frequent or potentially high exposure, the following are recommended before beginning work and at regular times after that. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed.
Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: Where there is potential for exposure to ethyl dichlorosilane exists, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.
Storage: (1) Color code-Red Stripe: Dangerous when wet materials release flammable gases on contact with water. Do not store this material in a room protected by water sprinkler systems. Do not store in the same area as other

flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1 hour fire wall from flammable or reactive materials. Do not store in a basement. (2) Color code-White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Ethyl dichlorosilane must be stored to avoid contact with moisture and oxidizers (such as perchlorates, peroxides, permanganates, chlorates and nitrates), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from water, steam and moisture, because toxic and corrosive chloride gases, including hydrogen chloride can be produced. Sources of ignition, such as smoking and open flames, are prohibited where ethyl dichlorosilane is handled, used or stored. Metal containers involving the transfer of five gallons or more of ethyl dichlorosilane should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of ethyl dichlorosilane.

Shipping: UN1183 Ethyldichlorosilane, Hazard Class: 4.3; Labels: 4.3-Dangerous when wet material; 8-Corrosive material.

Spill Handling:

Initial Isolation and Protective Action Distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24 h response line).

Small Spills (from a small package or a small leak from a large package)

When Spilled in Water

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.2/0.3

Large Spills (from a large package or from many small packages)

First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.4/0.6
Night 1.4/2.3

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include phosgene and hydrogen chloride. Use dry chemical. *Do not use water* (forms hydrogen chloride gas). Fire may restart after it has been extinguished. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (170); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Ethyl Dichlorosilane*, Trenton, NJ (December 1998)

Ethylene E:0540

Formula: C_2H_4

Synonyms: Acetene; Athylen (German); Bicarburretted hydrogen; Dicarburetted hydrogen; Elayl; Eteno (Spanish); Ethene; Etherin; Heavy carburetted hydrogen; Olefiant gas

CAS Registry Number: 74-85-1; *(alt.)* 33060-30-9; *(alt.)* 87701-64-2; *(alt.)* 87701-65-3

HSDB Number: 168

RTECS Number: KU5340000

UN/NA & ERG Number: UN1038 (liquid)/115 (P); UN1962 (compressed)/116

EC Number: 200-815-3 [*Annex I Index No.:* 601-010-00-3]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Carcinogenicity: IARC: Human Inadequate Evidence; Animal No Adequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1994.

Hazard Alert: Extremely flammable gas, Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated, Polymerization hazard, Possible risk of forming tumors.

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: F+; risk phrases: R3; R5; R12; R19; R21; R67; safety phrases: S1; S2; S9; S16; S33; S38; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): Nonhazard to water.

Description: Ethylene, an alkene is a colorless gas (at room temperature). Sweet odor. Minimum detectable odor = 260 ppm. Molecular weight = 28.06; boiling point = −104°C; freezing/melting point = −169°C; autoignition temperature = 450°C−490°C. Explosive limits: LEL = 2.7%; UEL: 36.0%[17]. Hazard identification (based on NFPA-704 M Rating System): Health 2, Flammability 4, Reactivity 2. Insoluble in water.

Potential Exposure: Ethylene is used in production of fabricated plastics, antifreeze; making fibers; to manufacture ethylene oxide, polyethylene for plastics, alcohol, mustard gas and other organics. It is used to accelerate ripening of fruit; as an anesthetic; and for oxyethylene welding and cutting of metals.

Incompatibilities: A highly flammable gas at room temperature. Contact with oxidizers may cause explosive polymerization and fire. May be spontaneously explosive in sunlight or ultraviolet light when mixed with chlorine. Reacts violently with mixtures of carbon tetrachloride and benzoyl peroxide; bromotrichloromethane; aluminum chloride and ozone. Incompatible with acids, halogens, nitrogen oxides; hydrogen bromide; aluminum chloride; chlorine dioxide; nitrogen dioxide. May accumulate static electrical charges, and may cause ignition of its vapors.

Permissible Exposure Limits in Air

Minimum detectable odor = 260 ppm.

OSHA PEL (*construction & shipyards only*): Simple asphyxiants-inert gas and vapor

NIOSH REL: None

ACGIH TLV[1]: 200 ppm/230 milligram per cubic meter TLV; not classifiable as a human carcinogen (2001); *Excursion Limit Recommendation:* Excursions in worker exposure levels may exceed three times the TLV-TWA for no more than a total of 30 minutes during a work day, and under no circumstances should they exceed five times the TLV-TWA, provided that the TLV-TWA is not exceeded.

PAC Ver. 29[138]

PAC-1: 600 ppm

PAC-2: 6600 ppm (> = 10% LEL; <50% LEL)*

PAC-3: 40,000 ppm (> = 100% LEL; LEL = 27,000 ppm)

DFG MAK: Carcinogen Category 3B

Australia: asphyxiant, 1993; Belgium: asphyxiant, 1993; Hungary: asphyxiant, 1993; Russia: STEL 100 milligram per cubic meter, 1993; Switzerland: MAK-W 10000 ppm (11500 milligram per cubic meter), 1999; United Kingdom: asphyxiant, 2000; the Netherlands: MAC-TGG 330 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Russia cites a MAC for ambient air of residential areas of 3 milligram per cubic meter on either a momentary or a daily average basis. Virginia[60] has set a guideline for ethylene in ambient air of 3.0 μ/m^3.

Permissible Concentration in Water: Russia[43] gives a MAC in water bodies used for domestic purposes of 0.5 mg/L.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short-Term Exposure: *Inhalation:* Increasingly severe exposures may cause faintness, a lack of coordination; excitement, stupor, unconsciousness, convulsions, stopped breathing, paralysis, and heart, liver, and kidney damage. 20%−25% (200,000−250,000 ppm) gas has caused loss of sense of pain. 80%−90% (800,000−900,000 ppm) has caused anesthesia. *Skin:* Contact with liquid can cause a "freezing burn." *Eyes:* Same as skin. *Ingestion:* No information available.

Long-Term Exposure: Inhalation may cause loss of appetite and weight, irritability, insomnia, increase in red blood cell count, and inflammation of the kidneys.

Points of Attack: Kidneys

Medical Surveillance: Kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming

frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Exposure to ethylene gas is dangerous because it can replace oxygen and lead to suffocation. Only NIOSH/MSHA or European Standard EN 149-approved SCBA with a full facepiece operated in positive-pressure mode should be used in oxygen deficient environments.

Storage: Check oxygen content prior to entering storage area. Flammable gas. Color code-Red Stripe: Flammability Hazard: Store separately from all other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1 hour fire wall from flammable or reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from chlorine compounds, oxidizing agents, and combustible materials. Sources of ignition, such as smoking and open flames are prohibited where ethylene is handled, used, or stored, Use only nonsparking tools and equipment, especially when opening and closing containers of ethylene. Wherever ethylene is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Piping should be electrically bonded and grounded. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: UN1962 Ethylene, Hazard Class: 2.1; Labels: 2.1-Flammable gas; UN1038 Ethylene, refrigerated liquid (cryogenic liquid), Hazard Class: 2.1; Labels: 2.1-Flammable gas. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: Restrict persons not wearing protective equipment from area of leak until clean-up is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit and to disperse the gas. Stop flow of gas if it can be done safely. If source of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible gas or liquid. Thermal decomposition products may include oxides of carbon. *Liquid:* Use dry chemical, carbon dioxide; or water spray in large amounts. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Gas: Ventilate area of leak to disperse gas. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for

firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier.

References

(31); (173); (101); (138). (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 4, No. 1, 79−81 (1984)

New York State Department of Health, *Chemical Fact Sheet: Ethylene*, Bureau of Toxic Substance Assessment, Albany, NY (March 1986)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Ethylene*, Trenton, NJ (August 2002)

Ethylene chlorohydrin E:0550

Formula: C_2H_5ClO; CH_2ClCH_2OH

Synonyms: Aethylenechlorhydrin (German); 2-Chlorethanol (German); Chloroethanol; Chloroethanol; 2-Chloroethyl alcohol; 2-Cloroetanol Chloroethanol; Ethanol, 2-chloro-; Ethylene chlorohydrine; Glycol Monochlorhydrine du glycol (French); 2-Monochloroethanol; NCI-C50135

β-Chlorethyl alcohol; *β*-Chloroethanol; 2-(Spanish); Cloroetanol (Spanish); delta-chlorohydrin; Glycol monochlorohydrin

CAS Registry Number: 107-07-3

HSDB Number: 426

RTECS Number: KK0875000

UN/NA & ERG Number: (PIH) UN1135/131

EC Number: 203-459-7 [*Annex I Index No.:* 603-028-00-7]

Regulatory Authority and Advisory Information

Carcinogenicity: NCI: Carcinogenesis Studies (dermal); no evidence: mouse, rat. United States Environmental Protection Agency Gene-Tox Program, Positive: *E. coli polA* without S9; Histidine reversion-Ames test EPA; Negative: Sperm morphology-mouse; *S. cerevisiae* gene conversion EPA; Negative: *S. pombe*-forward mutation.

Hazard Alert: Poison inhalation hazard: exposure can be lethal, Flammable, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction).

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500 lb (227 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 500 lb (227 kg)

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, F, N; risk phrases: R10; R26/27/28; R61; R62; R63; safety phrases: S1/2; S7/9; S28; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Ethylene chlorohydrin is a colorless liquid with a faint, ethereal odor. Molecular weight = 80.52; specific gravity (H_2O:1) = 1.20; boiling point = 127.8°C; freezing/melting point = −67.8°C; vapor pressure = 5 mmHg @ 20°C; Flash point = 60°C (cc); autoignition temperature = 425°C. Explosive limits: LEL = 4.9%; UEL: 15.9%. Hazard identification (based on NFPA-704 M Rating System): Health 4, Flammability 2, Reactivity 0. Soluble in water.

Potential Exposure: Ethylene chlorohydrin is used as a solvent and emulsifier; in the synthesis of ethylene glycol, ethylene oxide, amines, carbitols, indigo, malonic acid, novocaine, and in other reactions where the hydroxyethyl group is introduced into organic compounds; for the separation of butadiene from hydrocarbon mixtures; in dewaxing and removing cycloalkanes from mineral oil; in the refining of rosin; in the manufacture of certain pesticides and in the extraction of pine lignin. In the lacquer industry, it is used as a solvent for cellulose acetate, cellulose esters, resins and waxes; and in the dyeing and cleaning industry, it is used to remove tar spots; as a cleaning agent for machines; and as a solvent in fabric dyeing. It has also found use in agriculture in speeding up sprouting of potatoes and in treating seeds to inhibit biological activity. Making chemical warfare agents.

Incompatibilities: May form explosive mixture with air. Strong oxidizers may cause fire and explosions. Incompatible with strong caustics (formation of ethylene gas), strong acids; alkaline metals; aliphatic amines; isocyanates. Violent reaction with ethylene diamine, chlorosulfonic acid. Attacks some plastics, rubber and coatings. Reacts with water or steam producing toxic and corrosive fumes.

Permissible Exposure Limits in Air

NIOSH IDLH = 7 ppm

Conversion factor: 1 ppm = 3.29 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 5 ppm/16 milligram per cubic meter TWA [skin]

NIOSH REL: 1 ppm/3 milligram per cubic meter Ceiling Concentration [skin]

ACGIH TLV[1]: 1 ppm/3.3 milligram per cubic meter Ceiling Concentration [skin]; not classifiable as a human carcinogen

PAC* Ver. 29[138]

PAC-1: 0.11 ppm

PAC-2: **1.2** $_A$ ppm

PAC-3: **3.5** $_A$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

DFG MAK: 1 ppm/3.3 milligram per cubic meter Peak Limitation Category II(1) [skin]; Pregnancy Risk Group C

Australia: TWA 1 ppm (3 milligram per cubic meter), [skin], 1993; Austria: MAK 1 ppm (3 milligram per cubic meter), [skin], 1993; Belgium: STEL 1 ppm (3.3 milligram per cubic meter), [skin], 1993; Denmark: TWA 1 ppm (3 milligram per cubic meter), [skin], 1999; Finland: STEL 1 ppm (3 milligram per cubic meter), [skin], 1999; France: VLE 1 ppm (3 milligram per cubic meter), [skin], 1999; the

Netherlands: MAC 3 milligram per cubic meter, [skin], 2003; the Philippines: TWA 5 ppm (16 milligram per cubic meter), [skin], 1993; Poland: MAC (TWA) 1 milligram per cubic meter; STEL 3 milligram per cubic meter, 1999; Russia: STEL 0.5 milligram per cubic meter, [skin], 1993; Sweden: TGV 1 ppm (3.5 milligram per cubic meter), [skin], 1999; Switzerland: MAK-W 1 ppm (3 milligram per cubic meter), KZG-W 5 ppm (15 milligram per cubic meter), [skin], 1999; Turkey: TWA 5 ppm (16 milligram per cubic meter), 1993; United Kingdom: STEL 1 ppm (3.4 milligram per cubic meter), [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: Ceiling Concentration 1 ppm [skin]. Several states have set guidelines or standards for 2-chloroethanol in ambient air[60] ranging from 30 μ/m^3 (North Dakota) to 71 μ/m^3 (Nevada) to 320 μ/m^3 (Connecticut).

Determination in Air: Use NIOSH Analytical Method (IV) #2513 or OSHA Analytical Method 7[18].

Permissible Concentration in Water: Russia[43] set a MAC in water bodies used for domestic purposes of 0.7 mg/L.

Determination in Water: Octanol-water coefficient: Log $K_{ow} = -0.06$.

Routes of Entry: Inhalation of vapor, percutaneous absorption of liquid, ingestion, and skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin and respiratory tract. Inhalation can cause severe irritation, with cough and/or shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Exposure to 18 ppm has resulted in vomiting and shock. Additional symptoms may include irritation of the nose, throat and lungs. Poor coordination, numbness, visual disturbance; headache, difficult breathing and unconsciousness, may also occur. Death has resulted from inhalation of 300 ppm for 2½ hours. Signs and symptoms of acute exposure to this chemical may include weakness, dizziness, confusion, visual disturbances; shock, seizures, and coma. Weak pulse, Hypotension (low blood pressure), and cyanosis (blue tint to the skin and mucous membranes) may be observed. Nausea, vomiting, and hematuria (bloody urine) may be seen after exposure. Chloroethanol affect the CNS; cardiovascular system; liver and kidneys. This chemical readily absorbed through the skin even though no irritation occurs and may cause symptoms listed above. Death has occurred from skin absorption of one teaspoon of liquid. Ingestion can cause irritation to the throat. May cause symptoms listed under inhalation. About 1/5 ounce may be lethal to a 150 pound adult.

Long-Term Exposure: Can cause damage to the kidneys, liver, cardiovascular system, and nervous system. May cause reproductive damage. Can irritate the lungs. Repeated exposure may cause bronchitis. High or repeated exposure can cause disturbed sleep; with loss of coordination in arms and legs.

Points of Attack: Respiratory system, liver, kidneys, CNS, cardiovascular system, and eyes.

Medical Surveillance: Preplacement examination, including a complete history and physical should be performed. Examination of the respiratory system, liver, kidneys, and CNS should be stressed. The skin should be examined. A chest X-ray should be taken and pulmonary function tests performed (FVC-FEV). The above procedures should be repeated on an annual basis, except that the X-ray is needed only when indicated by pulmonary function testing. NIOSH lists the following tests: Expired Air; liver function tests; urinalysis (routine)

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. *Beware:* the liquid penetrates rubber. 8 hours: Viton gloves, suits, polyvinyl alcohol gloves; Barricade coated suits; 4 hours: 4 H and Silver Shield gloves. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Wear eye protection to prevent any possibility of eye contact. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: 7 ppm: Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-, mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: PIH; check oxygen content prior to entering storage area. Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Keep in a cool, well-ventilated area, protected from physical damage, ignition sources; and separated from strong oxidizers or caustics. Sources of ignition, such as smoking and open flames are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of five gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical.

Shipping: UN1135 Ethylene chlorohydrin, Hazard class: 6.1; Labels: 6.1-Poison Inhalation Hazard, 3-Flammable liquid, Inhalation Hazard Zone B

Spill Handling:

Initial Isolation and Protective Action Distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24 h response line).

Small Spills (from a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.1/0.2

Large Spills (from a large package or from many small packages)

First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 0.3/0.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include phosgene and hydrogen chloride. Use dry chemical, carbon dioxide; alcohol foam, or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced.

References

(31); (173); (101); (138). (2); (80); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: *Chloroethanol*, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

New York State Department of Health, Chemical Fact Sheet: *Ethylene Chlorohydrin*, Bureau of Toxic Substance Assessment, Albany, NY (April 1999).

Ethylenediamine E:0560

Formula: $C_2H_8N_2$; $H_2NCH_2CH_2NH_2$

Synonyms: Aethaldiamin (German); Aethylenediamin (German); β-Aminoethylamine; 1,2-Diaminoaethan (German); 1,2-Diaminoethane, anhydrous; Dimethylenediamine; 1,2-Ethanediamine; 1,2-Ethylenediamine; Etilendiamina (Spanish); NCI-C60402; Sel-Rex circuitprep SC replinisher/makeup; Sel-Rex XR-170A pretreatment

CAS Registry Number: 107-15-3

HSDB Number: 535

RTECS Number: KH8575000
UN/NA & ERG Number: UN1604/132
EC Number: 203-468-6 [*Annex I Index No.:* 612-006-00-6]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 20,000 United States Environmental Protection Agency Gene-Tox Program, Negative: CHO gene mutation.

Hazard Alert: Flammable liquid, Corrosive, Suspected reprotoxic hazard, Suspected of causing genetic defects, Sensitization hazard (skin), Primary irritant (w/o allergic reaction).

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 20,000 lb (9080 kg)

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 10,000 lb (4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 5000 lb (2270 kg).

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%.

Hazard symbols, risk, & safety statements: Hazard symbol: F, C, Xi; risk phrases: R10; R21/22; R34; r36/37/38; R42; R61; R62; safety phrases: S1/2; S23-S26-S36/37/39-S45.

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Ethylenediamine, a polyamine, is a strongly alkaline, colorless, clear, thick liquid. Ammonia odor. A solid below 8.5°C. The Odor Threshold is 1.0 ppm. Molecular weight = 60.12; specific gravity (H_2O:1) = 0.9 @ 20°C; boiling point = 117°C; freezing/melting point = 8.5°C; vapor pressure = 11 mmHg @ 20°C; flash point = 33.9°C; autoignition temperature = 385°C. Explosive limits: LEL = 2.5% @ 100°C; UEL: 12% @ 100°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 0. Soluble in water. Hygroscopic; reacts releasing fumes.

Potential Exposure: Ethylenediamine is used as an intermediate; as a urine acidifier; as a solvent; an emulsifier for casein and shellac solutions; a stabilizer in rubber late. A chemical intermediate in the manufacture of dyes; corrosion inhibitors; synthetic waxes; fungicides, resins, insecticides, asphalt wetting agents; and pharmaceuticals. Ethylenediamine is a degradation product of the agricultural fungicide Maneb.

Incompatibilities: Vapor may form explosive mixture with air. Ethylenediamine is a medium strong base. Violent reaction with strong acids; strong oxidizers; chlorinated organic compounds; acetic acid; acetic anhydride; acrolein, acrylic acid; acrylonitrile, allyl chloride; carbon disulfide; chlorosulfonic acid; epichlorohydrin, ethylene chlorohydrin, oleum, methyl oxide; vinyl acetate. Also incompatible with silver perchlorate, 3-propiolactone, mesityl oxide; ethylene dichloride; organic anhydrides; isocyanates, acrylates, substituted allyls; alkylene oxides; ketones, aldehydes, alcohols, glycols, phenols, cresols, caprolactum solution. Attacks aluminum, copper, lead, tin, zinc, and alloys; some plastics, rubber, and coatings.

Permissible Exposure Limits in Air

NIOSH IDLH = 1000 ppm

Conversion factor: 1 ppm = 2.46 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 10 ppm/25 milligram per cubic meter TWA

NIOSH REL: 10 ppm/25 milligram per cubic meter TWA

ACGIH TLV[1]: 10 ppm/25 milligram per cubic meter TWA [skin]; not classifiable as a human carcinogen

PAC* Ver. 29[138]
PAC-1: 0.88 ppm
PAC-2: **9.7** $_{\mathbf{A}}$ ppm
PAC-3: **20** $_{\mathbf{A}}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

DFG MAK: previous MAK suspended 2004; [skin] Danger of sensitization of the airways and skin.

Australia: TWA 10 ppm (25 milligram per cubic meter), 1993; Austria: MAK 10 ppm (25 milligram per cubic meter), 1999; Belgium: TWA 10 ppm (25 milligram per cubic meter), 1993; Denmark: TWA 10 ppm (25 milligram per cubic meter), 1999; Finland: TWA 10 ppm (25 milligram per cubic meter); STEL 20 ppm (50 milligram per cubic meter), 1999; France: VME 10 ppm (25 milligram per cubic meter), VLE 15 ppm (35 milligram per cubic meter), 1999; Japan; 10 ppm (25 milligram per cubic meter) [skin] 1999; the Netherlands: MAC-TGG 18 milligram per cubic meter, 2003; Norway: TWA 10 ppm (25 milligram per cubic meter), 1999; the Philippines: TWA 10 ppm (25 milligram per cubic meter), 1993; Poland: MAC (TWA) 2 milligram per cubic meter, MAC (STEL) 6 milligram per cubic meter, 1999; Russia: TWA 10 ppm; STEL 2 milligram per cubic meter, 1993; Sweden: NGV 10 ppm (25 milligram per cubic meter), KTV 15 ppm (35 milligram per cubic meter), 1999; Switzerland: MAK-W 1000 ppm (6400 milligram per cubic meter), 1999; Turkey: TWA 10 ppm (25 milligram per cubic meter), 1993; United Kingdom: TWA 10 ppm (25 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Several states have set guidelines or standards for ethylenediamine in ambient air[60] ranging from 250 μ/m^3 (North Dakota) to 300−2500 μ/m^3 (North Carolina) to 400 μ/m^3 (Virginia) to 500 μ/m^3 (Connecticut) to 595 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #2540 or OSHA Analytical Method 60.

Permissible Concentration in Water: Russia[43] set a MAC of 0.7 mg/L in water bodies used for domestic purposes.

Determination in Water: Octanol-water coefficient: Log $K_{ow} = -1.2$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, skin absorption, ingestion, and skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Ethylenediamine is corrosive to the eyes, skin, and respiratory tract. Skin contact can cause blistering. Eye contact can cause pain, serious injury and permanent damage. Inhalation can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Acute exposure to ethylenediamine may result in cough, difficulty in breathing; irritation of the lungs, and pneumonia. Nausea, vomiting, and diarrhea are often seen. Contact with ethylenediamine may result in redness, pain, irritation, and burns. Vapor inhalation at a concentration of 200 ppm for 5−10 minutes will lead to nasal irritation and produce a tingling sensation. Inhalation at concentrations of 400 ppm or greater leads to severe nasal irritation. Respiratory irritation may result. Many individuals are hypersensitive to ethylenediamine exposure; therefore, safe threshold limits are difficult to set.

Long-Term Exposure: Repeated or prolonged contact with skin may cause skin allergy. Repeated or prolonged exposure can cause an asthma-like allergy. Repeated high exposure may cause liver, kidney, and lung damage.

Points of Attack: Respiratory system, liver, kidneys, and skin.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that. Lung function tests. These may be normal if the person is not having an attack at the time of the test. If symptoms develop or overexposure is suspected, the following may be useful: kidney function tests. Liver function tests. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. 8 hours: Saranex coated suits; Responder suits; 4 hours: Teflon gloves, suits, boots. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash if liquids containing >5% contaminants are involved.

Respirator Selection: 250 ppm: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprS (APF = 25) [any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern]. 500 ppm: CcrFS (APF = 50) [any chemical cartridge respirator with a full facepiece and cartridge(s) providing protection against the compound of concern] organic vapor and acid gas cartridge(s); or GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted canister providing protection against the compound of concern]; or PaprTS (APF = 50) [any powered, air-purifying respirator with a tight-fitting facepiece and cartridge(s) providing protection against the compound of concern]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). 1000 ppm: SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted canister providing protection against the compound of concern]; or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: (1) Color code-White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. (2) Color code-Red: Flammability Hazard: Store in a flammable (liquid or solid materials) storage area or approved cabinet away from sources if ignition.

(3) Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Ethylenediamine must be stored to avoid contact with acetic acid, acetic anhydride; acrolein, acrylic acid; acrylonitrile, allyl chloride; carbon disulfide; chlorosulfonic acid; epichlorhydrin, ethylene chlorohydrin; oleum, methyl oxide; vinyl acetate; hydrogen chloride and sulfuric; acid, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from

oxidizers (such as perchlorates, peroxides, permanganates, chlorates and nitrates). Detached outdoor storage is preferred. Sources of ignition, such as smoking and open flames, are prohibited where ethylenediamine is handled, used, or stored. Metal containers involving the transfer of five gallons or more of ethylenediamine should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of ethylenediamine.

Shipping: UN1604 Ethylenediamine, Hazard class: 8; Labels: 8-Corrosive material, 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Stay upwind and keep out of low areas. Isolate area for 1/2 mi in all directions if tank car or truck is involved in fire. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of nitrogen and carbon. Use water spray, dry chemical, alcohol foam, or carbon dioxide. Wear full protective clothing including gloves and boots. If necessary to enter closed area, wear full-faced gas masks with SCBA. *Do not use water* in case of drum or tank fires. If a leak or spill has not ignited, use water spray to reduce the vapors and dilute spills to nonflammable mixtures. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Controlled incineration (oxides of nitrogen are removed from the effluent gas by scrubbers and/or thermal devices).

References

(31); (173); (101); (80)(100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: *Ethylenediamine*, Washington, (2). DC (May 9, 1978)

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 4, No. 2, 54–57 (1984)

United States Environmental Protection Agency, Chemical Hazard Information Profile: *Ethylenediamine*, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Ethylene Diamine*, Trenton, NJ (May 2001).

Ethylenediamine tetraacetic acid (ETDA) E:0570

Formula: $C_{10}H_{16}N_2O$

Synonyms: Acetic acid (ethylenedinitrilo)tetra-; Acide ethylenediaminetetracetique (French); Acido etilendiaminotetraacetico (Spanish); Aroquest 75; Celon A; Celon ATH; Cheelox; Chemcolox 340; Complexon II; 3,6-Diazaoctanedioic acid, 3,6-bis(carboxymethyl)-; Edathamil; Edetic; Edetic acid; EDTA; EDTA acid; Endrate; Ethylenediamine tetraacetate; Ethylenediamine-*N*,*N*,*N*′,*N*′-tetraacetic acid; Ethylenediaminetetraacetic acid; Ethylenedinitrilotetraacetic acid; Glycine, *N*,*N*′-1,2-ethanediylbis[*N*-(carboxymethyl)-9CI]; Hamp-ENE acid; Havidote; Kalex acids; Metaquest A; Nervanaid B acid; Nullapon B acid; Nullapon BF acid; Perma Kleer 50 acid; Questric acid 5286; SEQ-100; Sequestrene AA; Sequestric acid; Sequestrol; Tetrine acid; Titriplex; Tricon BW; Trilon B; Trilon BS; Trilon BW; Versene; Versene acid; Warkeelate acid

CAS Registry Number: 60-00-4

HSDB Number: 809

RTECS Number: AH4025000

UN/NA & ERG Number: UN3082 (environmentally hazardous substances, liquid, n.o.s.)/171

EC Number: 200-449-4 [*Annex I Index No.:* 607-429-00-8]

Regulatory Authority and Advisory Information

Hazard Alert: Combustible, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 5000 lb (2270 kg).

Hazard symbols, risk, & safety statements: Hazard symbol: Xi; risk phrases: R20/21/22: R36; R51; R61; R62; safety phrases: S2; S26; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: EDTA is a white, odorless, crystalline material or white powder. Molecular weight = 292.24; boiling point = 150°C (decomposes). Hazard identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 0. Slightly soluble in water.

Potential Exposure: EDTA is a general purpose chelating agent; as a drug; food additive; in cosmetics; household and textile articles; in pharmaceutical products; and in biochemicals. It is also used as a laboratory chemical in research; in photographic processing.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, copper, copper alloys, and nickel.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 4.1 milligram per cubic meter

PAC-2: 45 milligram per cubic meter

PAC-3: 200 milligram per cubic meter

Determination in Air: None available.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short-Term Exposure: EDTA irritates the eyes, skin, and respiratory tract. Skin contact may cause a burning sensation and rash. May affect the kidneys.

Long-Term Exposure: May cause kidney damage. May damage the developing fetus.

Points of Attack: Kidneys.

Medical Surveillance: Kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Green: General storage may be used. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area away from oxidizers.

Shipping: UN3082 Environmentally hazardous substances, liquid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. It does not easily ignite. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; water spray; alcohol foam or polymer foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (80); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Ethylenediamine Tetraacetic Acid*, Trenton, NJ (January 1999)

Ethylene dibromide E:0580

Formula: $C_2H_4Br_2$; $BrCH_2CH_2Br$
Synonyms: Aadibroom; Aethylenbromid (German); Bromofume; Celmide; DBE; 1,2-Dibromaethan (German); 1,2-Dibromoetano (Spanish); α,β-Dibromoethane; *sym*-Dibromoethane; 1,2-Dibromoethane; Dibromoethane; Dibromudo de etileno (Spanish); Dibromure d'ethylene (French); Dowfume 40; Dowfume EDB; Dowfume W-8; Dowfume W-85; EDB; EDB-85; E-D-BEE; ENT 15,349; Ethane, 1,2-dibromo-; Ethylene bromide; 1,2-Ethylene dibromide; Fumo-gas; Glycol bromide; Glycol dibromide; Iscobrome D; Kopfume; NCI-C00522; Nefis; Nephis; Pestmaster; Pestmaster EDB-85; Sanhyuum; Soilbrom; Soilbrom-40; Soilbrom-85; Soilbrom-90EC; Soilbrome-85; Soilfume; Unifume
CAS Registry Number: 106-93-4
HSDB Number: 536
RTECS Number: KH9275000
UN/NA & ERG Number: (PIH) UN1605/154
EC Number: 203-444-5 [*Annex I Index No.:* 602-010-00-6]
Regulatory Authority and Advisory Information
Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Human Inadequate Evidence, animal Sufficient Evidence, *probably carcinogenic to humans*, Group 2 A, 1999; EPA: Likely to produce cancer in humans; NCI: Carcinogenesis Studies (inhalation); clear evidence: mouse, rat; NTP: Carcinogenesis Bioassay (inhalation); clear evidence: mouse, rat; Reasonably anticipated to be a human carcinogen; NIOSH: Potential occupational carcinogen.
California Proposition 65 Chemical[102]: Cancer 1/1/87; Developmental/Reproductive toxin 5/15/1998.
Hazard Alert: Poison inhalation hazard, Possible risk of forming tumors, Reproductive toxin: possible risk of gene damage/impaired fertility; Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction).
Banned or Severely Restricted (many countries) (UN)[3,35]
Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 20,000 lb (9080 kg)
United States National Primary Drinking Water Regulations: zero mg/L; MCL = 0.00005 mg/L.
Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)
United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U067 RCRA, 40CFR261, Appendix 8 Hazardous Constituents
RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.028; Nonwastewater (mg/kg), 15
RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8010 (10); 8240 (5)
Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 10,000 lb (4540 kg)
Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg)
EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.
United States DOT 49CFR172.101, Inhalation Hazardous Chemical
Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%.
Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)] [as 1,2-dibromoethane (EDB)].
Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R45; R23/24/25; R36/37/38; R50/53; R62; R63; safety phrases: S53; S41; S45; S61 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.
Description: Ethylene dibromide is a colorless nonflammable liquid or solid (below 10°C). Sweet, chloroform-like odor. The minimum concentration detectable by odor is 10 ppm. Molecular weight = 187.88;specific gravity (H_2O:1) = 2.17; boiling point = 131°C; freezing/melting point = 10°C; relative vapor density (air = 1) = 6.5; vapor pressure = 12 mmHg. Soluble in water.
Potential Exposure: Ethylene dibromide is used as a chemical intermediate; as a fumigant for ground pest control; as a constituent of ethyl gasoline (anti-knock agent). It is also used in fire extinguishers, gauge fluids, and waterproofing preparations; and it is used as a solvent for celluloid, fats, oils, and waxes. Pesticide not in use; TRI and/or IUR indicates importers or manufacturers are unlikely[88].
Incompatibilities: Reacts vigorously with chemically active metals; liquid ammonia, strong bases; strong oxidizers; causing fire and explosion hazard. Light, heat, and moisture can cause slow decomposition, forming hydrogen bromide. Attacks fats, rubber, some plastics and coatings.
Permissible Exposure Limits in Air
Minimum odor concentration detectable = 10 ppm.
NIOSH IDLH = 100 ppm, potential occupational carcinogen
Conversion factor: 1 ppm = 7.69 milligram per cubic meter @ 25°C & 1 atm
OSHA PEL: 20 ppm TWA; 30 ppm Ceiling Concentration; 50 ppm [5 minute maximum peak] [skin]. For Construction, Shipyards, and Federal Contractors: 25 ppm/190 milligram per cubic meter Ceiling Concentration [skin]
NIOSH REL: 0.045 ppm TWA; 0.13 ppm [15 minute] Ceiling Concentration; Potential occupational carcinogen. Limit exposure to lowest feasible concentration; See *NIOSH Pocket Guide*, Appendix A
ACGIH TLV[1]: [skin] confirmed animal carcinogen with unknown relevance to humans. PAC* Ver. 29[138]

PAC-1: $\mathbf{17_A}$ ppm
PAC-2: $\mathbf{24_A}$ ppm
PAC-3: $\mathbf{46_A}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

DFG MAK: [skin] Carcinogen Category 2

Arab Republic of Egypt: TWA 0.13 ppm (1 milligram per cubic meter), 1999; Australia: [skin], carcinogen, 1993; Austria [skin], carcinogen, 1999; Belgium: [skin], carcinogen, 1993; Finland: TWA 20 ppm (145 milligram per cubic meter); STEL 30 ppm, [skin], carcinogen, 1999; France: carcinogen, 1993; Hungary: STEL 0.8 milligram per cubic meter, [skin], carcinogen, 1993; the Netherlands: MAC-TGG 0.002 milligram per cubic meter, 2003; the Philippines: TWA 25 ppm (190 milligram per cubic meter), [skin], 1993; Poland: MAC (TWA) 0.5 milligram per cubic meter, 1999; Sweden: carcinogen, 1999; Switzerland: MAK-W 0.1 ppm (0.8 milligram per cubic meter), [skin], carcinogen, 1999; Thailand: TWA 20 ppm; STEL 30 ppm, 1993; Turkey: TWA 25 ppm (190 milligram per cubic meter), [skin], 1993; United Kingdom: TWA 0.5 ppm (3.9 milligram per cubic meter), [skin], carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: confirmed animal carcinogen with unknown relevance to humans. The Czech Republic[35] has set a TWA of 10 milligram per cubic meter with a ceiling value of 20 milligram per cubic meter. Several states have set guidelines or standards for ethylene dibromide in ambient air[60] ranging from zero (North Dakota and New York) to 0.045 μ/m^3 (North Carolina) to 2.47 μ/m^3 (Pennsylvania) to 720 μ/m^3 (Indiana) to 770 μ/m^3 (South Carolina) to 1500 μ/m^3 (Virginia) to 1550 μ/m^3 (Connecticut).

Determination in Air: Use NIOSH Analytical Method (IV) #1008 or OSHA Analytical Method 2.

Permissible Concentration in Water: Safe Drinking Water Act (47FR 9352): MCL, 0.00005 mg/L; MCGL, zero. Several states have set guidelines or standards for ethylene dibromide in drinking water[61] ranging from 0.005 μg/L (Kansas) to 0.008 μg/L (Minnesota) to 0.01 μg/L (Arizona) to 0.02 μg/L (California and Washington) to 0.04 μg/L (Massachusetts) to 0.10 μg/L (Connecticut and New Mexico) to 0.50 μg/L (Wisconsin) to 1.0 μg/L (Maine).

Determination in Water: Octanol-water coefficient: Log K_{ow} = 1.9. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation of the vapor, absorption through the skin, ingestion, and skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Contact can cause severe skin and eye burns, with permanent eye damage. Exposure to the vapor may also damage the eyes. Inhalation may irritate and damage the lungs. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. High exposure can cause dizziness, drowsiness, vomiting, unconsciousness, and death. High exposure can damage the liver or kidneys enough to cause death. *Inhalation:* Levels of 75 ppm may cause irritation of the nose, throat and lungs. 100−200 ppm for 1 hour may cause diarrhea, abdominal pain and vomiting. Other symptoms may include headache, loss of appetite; swollen glands; pale skin coloring; insomnia, dizziness and depression. Accidental high exposure has caused symptoms as listed above; internal bleeding and death. *Skin:* Contact with as little as 1 gram (1/28 ounce) may cause itching, swelling, redness, burning and blistering. May be absorbed through the skin and cause symptoms as listed under inhalation. *Eyes:* May cause irritation of eyes and eyelids.

Ingestion: May cause vomiting, diarrhea, abdominal pain; nausea and damage to the liver and kidneys. As little as 4.5 ml (about one teaspoon) has caused death.

Long-Term Exposure: may cause problems of the liver, stomach, reproductive system, or kidneys; increased risk of cancer. May cause irritation of the throat, headaches, loss of appetite; swollen glands; paleness, insomnia, vomiting, diarrhea, abdominal pain and damage to the liver and kidneys. Ethylene dibromide is a probable carcinogen in humans. It causes birth defects and changes in the genetic material of laboratory animals. It may damage the reproductive system, causing abnormal sperm in males and decreased fertility in females. Handle with extreme caution.

Points of Attack: Eyes, skin, respiratory system, liver, kidneys, and reproductive system. Cancer site in animals: skin and lung tumors.

Medical Surveillance: Pre-employment and periodic examinations should evaluate the skin and eyes, respiratory tract, and liver and kidney functions.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. 8 hours: polyvinyl alcohol gloves; Teflon gloves, suits, boots; Viton gloves, suits; 4 H and Silver Shield gloves; Barricade coated suits; Trychem 1000 suits. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

Storage: PIH; check oxygen content prior to entering storage area. Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Store in a cool, dry place that is well-ventilated. Keep in tightly sealed containers and away from light, heat, active metals and liquid ammonia. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN1605/154 Ethylene dibromide, Hazard Class: 6.1; Labels: 6.1-Poison Inhalation Hazard, Inhalation Hazard Zone B

Spill Handling:

Initial Isolation and Protective Action Distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24 h response line).

Small Spills (from a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.1/0.2

Large Spills (from a large package or from many small packages)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.1/0.2

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: EDB is a noncombustible liquid. Use an extinguishing agent suited to a surrounding fire. Thermal decomposition products may include bromine and hydrogen bromide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Controlled incineration with adequate scrubbing and ash disposal facilities[22].

References

(109); (102); (31); (173); (101); (138). (2); (80); (100).

Environmental Protection Agency, *Sampling and Analysis of Selected Toxic Substances, Task II-Ethylene Dibromide, Final Report*, Office of Toxic Substances, EPA, Washington, DC (September 1975)

Occupational Health and Safety Administration, "*Criteria for a Recommended Standard: Occupational Exposure to Ethylene Dibromide,*" NIOSH Document Number 77-221 (1977)

National institute for Occupational Safety and Health (NIOSH), *Current Intelligence Bulletin No. 3: Ethylene Dibromide*, Rockville, MD (July 7, 1975), and *Current Intelligence Bulletin No. 37, Ethylene Dibromide*, Cincinnati, Ohio (October 26, 1981)

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 5, 58–60 (1981)

New York State Department of Health, *Chemical Fact Sheet: Ethylene Dibromide*, Bureau of Toxic Substance Assessment, Albany, NY (March 1986 and Version 2)

Ethylene dichloride E:0590

Formula: $C_2H_4Cl_2$; $ClCH_2CH_2Cl$
Synonyms: Aethylenchlorid (German); 1,2-Bichloroethane; Bichlorure d'ethylene (French); Borer Sol; Brocide; Chlorure d'ethylene (French); Destruxol Borer-Sol; 1,2-Dichlor-aethan (German); Dichloremulsion; Di-chlor-mulsion; α,β-Dichloroethane; *sym*-Dichloroethane; 1,2-Dichloroethane; Dichloro-1,2-ethane (French); Dichloroethylene; 1,2-Dicloroetano (Spanish); Dutch liquid; Dutch oil; EDC; ENT 1656; Ethane dichloride; Ethane, 1,2-dichloro-; Ethylene chloride; 1,2-Ethylene dichloride; Ethylene dichloride; Freson 150; Glycol dichloride; NCI-C00511
CAS Registry Number: 107-06-2
HSDB Number: 65
RTECS Number: KI0525000
UN/NA & ERG Number: (PIH) UN1184/131
EC Number: 203-458-1 [*Annex I Index No.:* 602-012-00-7]
Regulatory Authority and Advisory Information
Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen: 1,2-dichloroethane; IARC: Animal Sufficient Evidence; Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B, 1999; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies; NIOSH: Potential occupational carcinogen. United States Environmental Protection Agency Gene-Tox Program, Positive: Carcinogenicity-mouse/rat; Cell transformation-SA7/SHE; Positive: *D. melanogaster*-whole sex chromosome loss; Positive: *D. melanogaster*-nondisjunction; *E. coli polA* without S9; Positive: Histidine reversion-Ames test; Positive: *D. melanogaster* sex-linked lethal; Positive: CHO gene mutation.
California Proposition 65 Chemical[102]: Cancer 1/1/1987.
Hazard Alert: Poison inhalation hazard, Highly flammable, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction), Environmental hazard. Listed for Tier 1 screening as an endocrine disruptor[88].
United States Environmental Protection Agency, FIFRA1998 Status of Pesticides: Canceled. Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)
United States National Primary Drinking Water Regulations: MCL = zero mg/L; MCL = 0.005 mg/L as 1,2-Dichloroethane.
Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/1992); Toxic Pollutant (Section 401.15)
United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U077, D028
RCRA, 40CFR261, Appendix 8 Hazardous Constituents
RCRA Toxicity Characteristic (Section 261.24), Maximum Concentration of Contaminants, regulatory level, 0.5 mg/L
RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.21; Nonwastewater (mg/kg), 6.0
RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8010 (0.5); 8240 (5)
Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)
United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)
United States DOT 49CFR172.101, Inhalation Hazardous Chemical as 1,2-Dichloroethane Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)].
Hazard symbols, risk, & safety statements: Hazard symbol: F, T; risk phrases: R45; F11; R22-36/37/38; R62; R63; safety phrases: S21; S41; S45; S53 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.
Description: 1,2-Dichloroethane is a colorless, flammable liquid which has a pleasant, chloroform-like odor, and a sweetish taste. Decomposes slowly: turns dark and acidic on contact with air, moisture, and light. The Odor Threshold is 100 ppm. Molecular weight = 98.96; specific gravity (H_2O:1) = 1.24; boiling point = 83.3°C; freezing/melting point = −35.6°C; vapor pressure = 64 mmHg @ 20°C; flash point = 13°C (cc); autoignition temperature = 413°C. Explosive limits: LEL = 6.2%; UEL: 16.0%. Hazard identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 0. Insoluble in water.
Potential Exposure: In recent years, 1,2-dichloroethane is used in the production of vinyl chloride and as a lead-scavenging agent in petrol; it has found wide use in the manufacture of ethylene glycol, diaminoethylene, polyvinyl chloride; nylon, viscose rayon; styrenebutadiene rubber, and various plastics. It is a solvent for resins, asphalt, bitumen, rubber, cellulose acetate; cellulose ester; and paint; a degreaser in the engineering, textile, and petroleum industries; and an extracting agent for soybean oil and caffeine. It is also used as an antiknock agent in gasoline; a pickling agent; a fumigant; and a dry-cleaning agent. It has found use in photography, xerography, and water softening; and also in the production of adhesives, cosmetics, pharmaceuticals, and varnishes.
Incompatibilities: May form explosive mixture with air. Reacts violently with strong oxidizers and caustics; chemically active metals, such as magnesium or aluminum powder, sodium and potassium; alkali metals; alkali amides; liquid ammonia. Decomposes to vinyl chloride and HCl above 600°C. Attacks plastics, rubber, coatings. Attacks many metals in presence of water.
Permissible Exposure Limits in Air
NIOSH IDLH = 50 ppm
Conversion factor: 1 ppm = 4.05 milligram per cubic meter @ 25°C & 1 atm
OSHA PEL: 50 ppm TWA; 100 ppm Ceiling Concentration; 200 ppm [5 min maximum peak in any 3 hours]. For Construction and Shipyards: 50 ppm/200 milligram per cubic meter TWA

NIOSH REL: 1 ppm/4 milligram per cubic meter TWA; 2 ppm/8 milligram per cubic meter STEL, a potential occupational carcinogen. Limit exposure to lowest feasible concentration, See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV[1]: 10 ppm, not classifiable as a human carcinogen as chloroethanes PAC* Ver. 29[138]

PAC-1: **50**$_{\mathbf{A}}$ ppm

PAC-2: **200**$_{\mathbf{A}}$ ppm

PAC-3: **300**$_{\mathbf{A}}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

DFG MAK: [skin] Carcinogen Category 2

Arab Republic of Egypt: TWA 5 ppm (2 milligram per cubic meter), 1993; Australia: TWA 10 ppm (40 milligram per cubic meter), 1993; Austria: carcinogen, 1999; Belgium: TWA 10 ppm (40 milligram per cubic meter), 1993; Finland: TWA 10 ppm (40 milligram per cubic meter); STEL 20 ppm (80 milligram per cubic meter), carcinogen, 1999; France: VME 10 ppm (40 milligram per cubic meter), continuous carcinogen, 1999; Hungary: STEL 4 milligram per cubic meter, carcinogen, 1993; the Netherlands: MAC-TGG 7 milligram per cubic meter, 2003; Norway: TWA 1 ppm (4 milligram per cubic meter), 1999; the Philippines: TWA 50 ppm (200 milligram per cubic meter), 1993; Poland: TWA 50 milligram per cubic meter; STEL 60 milligram per cubic meter, 1999; Russia: TWA 10 ppm, 1993; Sweden: NGV 1 ppm (4 milligram per cubic meter), KTV 5 ppm (20 milligram per cubic meter), [skin], carcinogen, 1999; Switzerland: MAK-W 5 ppm (20 milligram per cubic meter), carcinogen, 1999; Turkey: TWA 50 ppm (200 milligram per cubic meter), 1993; United Kingdom: TWA 5 ppm (21 milligram per cubic meter), [skin], carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Russia[43] has set MAC values in ambient air in residential areas of 3 milligram per cubic meter on a momentary basis and 1 milligram per cubic meter on a daily average basis. Several states have set guidelines or standards for ethylene dichloride in ambient air[60] ranging from 0−400 μ/m^3 (North Dakota) to 0.038 μ/m^3 (North Carolina) to 0.04 μ/m^3 (Rhode Island) to 0.2 μ/m^3 (New York) to 0.39 μ/m^3 (Massachusetts) to 20.0 μ/m^3 (Connecticut) to 148.0 μ/m^3 (Pennsylvania) to 200.0 μ/m^3 (South Carolina) to 650.0 μ/m^3 (Nevada) to 1000.0 μ/m^3 (Indiana).

Determination in Air: Use NIOSH Analytical Method (IV) #1003 for halogenated hydrocarbons or OSHA Analytical Method 3[18]

Permissible Concentration in Water: Safe Drinking Water Act (47FR 9352): MCL, 0.005 mg/L; MCLG, zero. Federal Drinking Water Standards: EPA 5 μg/L; State Drinking Water Standards: California 0.5 μg/L; Florida 3 μg/L; New Jersey 2 μg/L; State Drinking Water Guidelines: Arizona 0.38 μg/L; Connecticut 1 μg/L; Maine 4 μg/L; Minnesota 4 μg/L.

Determination in Water: Inert gas purge followed by chromatography with halide specific detection (EPA Method 601) or gas chromatography plus mass spectrometry (EPA Method 624). Octanol-water coefficient: Log $K_{ow} = 1.48$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation of vapor, skin absorption of liquid, ingestion, and skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin, and respiratory tract. Inhalation of the vapors can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Exposure can cause nausea, vomiting, headaches, drowsiness, and loss of consciousness. Overexposure to ethylene dichloride may damage the CNS; kidneys, liver. *Inhalation:* Levels of 10−30 ppm may cause dizziness, nausea, and vomiting. Levels up to 50 ppm may cause weakness, trembling, headaches, abdominal cramps; liver and kidney damage; and fluid buildup in lungs. May cause coma and death at high levels. *Skin:* Contact may cause irritation and skin rash, and irritates the eyes. *Eyes:* May cause redness, pain, and blurred vision. Vapor can damage the cornea. *Ingestion:* Ingestion of two ounces has resulted in nausea, vomiting, faintness, drowsiness, troubled breathing; pale skin, internal bleeding; kidney damage; and death due to respiratory failure. Other possible symptoms may include abdominal spasms, severe headache; lethargy, lowered blood pressure; diarrhea, shock, physical collapse, and coma.

Long-Term Exposure: Repeated or prolonged contact can chronically irritate the skin causing dryness, redness and a rash. Prolonged or repeated exposure may cause eye, nose and throat irritation; nerve damage; liver and kidney damage. This substance has been determined to cause cancer of the lung, stomach, breast and other sites in laboratory animals; and may be a human carcinogen. Can irritate the lungs and bronchitis may develop. Repeated or prolonged exposure can cause loss of appetite; nausea and vomiting; trembling and low blood sugar.

Points of Attack: Eyes, skin, kidneys, liver, CNS, and cardiovascular system. Cancer site in animals: fore-stomach, mammary gland, and circulatory system cancer.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended. Lung function tests. Liver and kidney function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. NIOSH lists the following tests: expired air; liver function tests; pulmonary function tests.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. 8 hours: Teflon gloves, suits, boots; Viton gloves, suits; 4 H and Silver Shield gloves; Barricade coated suits; CPF3 suits; Responder suits; Trychem 1000 suits; 4 hours: polyvinyl alcohol gloves. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code-Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers (such as perchlorates, peroxides, permanganates, chlorates and nitrates); strong acids (such as hydrochloric, sulfuric and nitric); chemically active metals (such as potassium, sodium, magnesium and zinc), strong caustics (such as sodium hydroxide) and dimethylaminopropylamine, since violent reactions occur. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN1184 Ethylene dichloride, Hazard Class: 3; Labels: 3-Flammable liquid, 6.1-Poisonous materials. *Note:* United States DOT 49CFR172.101, Inhalation Hazardous Chemical as 1,2-Dichloroethane

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep ethylene dichloride out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include phosgene and hydrogen chloride. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced[22].

References

(109); (102); (31); (173); (101); (138); (2); (80); (100).

National institute for Occupational Safety and Health (NIOSH), *Criteria for a Recommended Standard: Occupational Exposure to Ethylene Dichloride*, NIOSH Document Number 76-139, Cincinnati OH (1976)

National institute for Occupational Safety and Health (NIOSH), *Ethylene Dichloride, NIOSH Current Intelligence Bulletin No. 25*, Washington, DC (April 19, 1978)

National institute for Occupational Safety and Health (NIOSH), *Chloroethanes: Review of Toxicity, Current Intelligence Bulletin No. 27*, Washington, DC (August 21, 1978)

United States Environmental Protection Agency, Chemical Hazard Information Profile: *1,2-Dichloroethane*, Washington, DC (September 1, 1977)

United States Environmental Protection Agency, Chlorinated Ethanes: Ambient Water Quality Criteria, Washington, DC (1980)

United States Environmental Protection Agency, *1,2-Dichloroethane, Health and Environmental Effects Profile No. 70*, Washington, DC, Office of Solid Waste (April 31, 1980)

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 4, 50−52 (1981)

United States Environmental Protection Agency, "Health advisory: *1,2-Dichloroethane, Washington, DC, Office of Drinking Water* (March 31, 1987)

United States Public Health Service, *Toxicological Profile for 1,2-Dichloroethane*, Atlanta, Georgia, agency for Toxic Substance & Disease Registry (December 1988)

New York State Department of Health, *Chemical Fact Sheet: 1,2-Dichloroethane*, Bureau of Toxic Substance Assessment, Albany, NY (Version 2)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: 1,2-Dichloroethane*, Trenton, NJ (February 2001).

Ethylene fluorohydrin E:0600

Formula: C_2H_5FO; $HOCH_2CH_2F$

Synonyms: 2-Fluoetanol (Spanish); β-Fluoroethanol; 2-Fluroethanol; TL 741

CAS Registry Number: 371-62-0

HSDB Number: 6389

RTECS Number: KL1575000

UN/NA & ERG Number: UN3383/131

EC Number: 206-740-2

Regulatory Authority and Advisory Information

Hazard Alert: Poison, High acute toxicity, Highly flammable, Agricultural chemical.

OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 100 lb (45 kg)

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 10 lb (4.54 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg).

Hazard symbols, risk, & safety statements: Hazard symbol: T+, F; risk phrases: R11; R20; R23; R26/27/28; R36/37/38; R50; safety phrases: S16; S21; S23; S36/37/39; S45; 68/20 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Ethylene fluorohydrin is a colorless liquid. Molecular weight = 64.07; boiling point = 103.5°C; freezing/melting point = −26°C; flash point = 34°C; vapor pressure = 16 mmHg @ 20°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, Flammability 3, Reactivity 0. Soluble in water.

Potential Exposure: Ethylene fluorohydrin is used as a rodenticide, insecticide, and acaricide. It is not registered as a pesticide in the U.S.

Incompatibilities: Ethylene fluorohydrin vapor may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 0.0025 ppm

PAC-2: 0.027 ppm

PAC-3: 0.35 ppm

Routes of Entry: Inhalation, dermal contact, and ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Toxicity rating is the same as for fluoroacetate: super toxic. Symptoms include tremors, severe muscular weakness; nausea, headache, and slight swelling of the liver. Delayed convulsant. The probable oral lethal dose in humans is a taste (less than seven drops) for a 70 kg (150 lb) person. The chemical is highly toxic when inhaled or absorbed through the skin. Toxicity depends on its oxidation to fluoroacetate by tissue alcohol dehydrogenase. LD_{50} = (oral-rat) <10 mg/kg.

Long-Term Exposure: May cause liver and CNS problems.

Medical Surveillance: Liver function tests. Nervous system tests.

First Aid: Acute poisoning should be treated like poisoning by fluoroacetate. Ethylene fluorohydrin (2-fluoroethanol) is listed among the organic fluorine derivatives of fluoroacetic acid. The emergency procedures for fluoroacetic acid are: move victim to fresh air; call emergency medical care. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. In case of contact with material, immediately flush skin or eyes with running water for at least 15 minutes. Remove and isolate contaminated clothing and shoes at the site. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Personal Protective Methods: For emergency situations, wear a positive pressure, pressure-demand, full facepiece SCBA (SCBA) or pressure-demand supplied air respirator with escape SCBA and a fully encapsulating, chemical resistant suit. Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Employees should wash immediately with soap when

skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: PIH; check oxygen content prior to entering storage area.(1) Color code-Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. (2) Color code-Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well ventilated area separated from strong oxidants, strong bases; strong acids. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN3383 Poisonous Toxic by inhalation liquid, flammable, n.o.s. with an $LC_{50} \leq 200$ ml/m^3 and saturated vapor concentration ≥ 500 LC_{50}, Hazard class: 6.1; Labels: 6.1-Poisonous materials, 3-Flammable liquid, Technical Name Required, Inhalation Hazard Zone A.

Spill Handling:

Initial Isolation and Protective Action Distances: UN3383

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24 h response line).

Small Spills (from a small package or a small leak from a large package)

When Spilled in Water

First: Isolate in all directions (ft/m) 200/60

Then: Protect persons downwind (mi/km)

Day 0.5/0.8

Night 1.1/1.8

Large Spills (from a large package or from many small packages)

First: Isolate in all directions (ft/m) 1000/300

Then: Protect persons downwind (mi/km)

Day 2.5/4.1

Night 4.1/6.6

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include hydrogen fluoride and oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR 165 recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138). (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: *Ethylene Fluorohydrin*, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Ethylene Fluorohydrin*, Trenton, NJ, (September, 2000)

Ethylene glycol E:0610

Formula: $C_2H_6O_2$: $HOCH_2CH_2OH$
Synonyms: Athylenglykol (German); 1,2-Dihydroxyethane; Dowtherm SR 1; EG; ETG; 1,2-Ethanediol; Ethylene alcohol; Ethylene dihydrate; Etilenglicol (Spanish); Fridex; Glycol; Glycol alcohol; 2-Hydroxyethanol; Ilexan E; Lutrol- 9; Macrogol 400; Macrogol 400 BPC; MEG; Monoethylene glycol; NCI-C00920; Norkool; Ramp; Tescol; UCAR 17; Zerex
CAS Registry Number: 107-21-1
HSDB Number: 5012
RTECS Number: KW2795000
UN/NA & ERG Number: Not established or required. However a large spill of this commonly available industrial and consumer product could be an environmental hazard. UN3082 (environmentally hazardous substances, liquid, n.o.s.)/171
EC Number: 203-473-3
Regulatory Authority and Advisory Information
United States Environmental Protection Agency Gene-Tox Program, Negative: Cell transformation-SA7/SHE; *N. crassa-aneuploidy*; Negative: Histidine reversion-Ames test; Inconclusive: *D. melanogaster*-whole sex chromosome loss; Inconclusive: *D. melanogaster*-nondisjunction.
California Proposition 65 Chemical[102]: (ingested) developmental toxin, 6/19/2015
Hazard Alert: Combustible, Systemic agent (CNS, heart, kidneys); Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction). Listed for Tier 1 screening as an endocrine disruptor[88].
Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)
Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg)
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.
Hazard symbols, risk, & safety statements: Hazard symbol: T; risk phrases: R62; R63;?; safety phrases: S41 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.
Description: Ethylene glycol is a colorless, viscous, hydroscopic liquid with a sweetish taste. Often colored fluorescent yellow-green when used in automotive antifreeze. Ethylene glycol is odorless and does not provide any warning of inhalation exposure to hazardous concentrations. The Odor Threshold in air is 25 ppm. Molecular weight = 62.08; specific gravity (H_2O:1) = 1.1 @ 20°C; relative vapor density (air = 1) = 2.12; boiling point = 197°C; freezing/melting point = −12.7°C; vapor pressure = 0.06 mmHg @ 20°C; flash point = 111°C; autoignition temperature = 398°C. Explosive limit: LEL = 3.2%; UEL: 15.3%. Hazard identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 0. Soluble in water.
Potential Exposure: Ethylene glycol is used in antifreeze (especially as car radiator antifreeze) and in production of polyethylene terephthalate fibers and films; in hydraulic fluids; electrolytic condensers; and heat exchangers. It is also used as a solvent and as a chemical intermediate for ethylene glycol dinitrate, glycol esters; resins, and for pharmaceuticals.
Incompatibilities: Reacts with sulfuric acid, oleum, chlorosulfonic acid; strong oxidizing agents; strong bases; chromium trioxide; potassium permanganate; sodium peroxide. Hygroscopic (i.e., absorbs moisture from the air).
Permissible Exposure Limits in Air
OSHA PEL: None
NIOSH REL: After reviewing available published literature, NIOSH provided comments to OSHA on August 1, 1988, regarding the "*Proposed Rule on Air Contaminants*" (29 CFR 1910, Docket No. H-020). In these comments, NIOSH questioned whether the PELs proposed (Ceiling 50 ppm) were adequate to protect workers from recognized health hazards.
ACGIH TLV[1]: 100 milligram per cubic meter (hour) Ceiling Concentration; (aerosol only). Not classifiable as a human carcinogen. Proposed change: to aerosol, 10 milligram per cubic meter (hour) Ceiling Concentration; vapors, 25 ppm TWA; 50ppm STEL.
PAC Ver. 29[138]
PAC-1: 30 ppm
PAC-2: 150 ppm
PAC-3: 900 ppm
DFG MAK: 10 ppm/26 milligram per cubic meter TWA; Peak Limitation Category I(2) [skin]; Pregnancy Risk Group C
Australia: TWA 60 milligram per cubic meter; STEL 120 milligram per cubic meter, 1993; Austria: MAK 10 ppm (26 milligram per cubic meter), [skin], 1999; Belgium: STEL 50 ppm (127 milligram per cubic meter), 1993; Denmark: TWA 50 ppm (130 milligram per cubic meter), 1999; Finland: TWA 10 milligram per cubic meter; STEL 20 milligram per cubic meter, 1993; France: VLE 50 ppm (125 milligram per cubic meter), 1999; Hungary: STEL 50 milligram per cubic meter, [skin], 1993; the Netherlands: MAC-TGG 52 milligram per cubic meter (fume), 2003; MAC-TGG 10 milligram per cubic meter (drops), 2003; Norway: TWA 25 ppm (63 milligram per cubic meter), 1999; Poland: MAC (TWA) 15 milligram per cubic meter, MAC (STEL) 50 milligram per cubic meter, 1999; Russia: STEL 5 milligram per cubic meter, 1993; Sweden: NGV 10 ppm (25 milligram per cubic meter), KTV 20 ppm (50 milligram per cubic meter), [skin], 1999; Switzerland: MAK-W 50 ppm (125 milligram per cubic meter), 1999; United Kingdom: TWA 10 milligram per cubic meter, particulate; TWA 60 milligram per cubic meter; STEL 125 milligram per cubic meter, vapor, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam; ACGIH TLV: 100 milligram per cubic meter (hour) Ceiling Concentration. Several

states have set guidelines or standards for ethylene glycol in ambient air[60] ranging from 0.17 milligram per cubic meter (Massachusetts) to 1.0 milligram per cubic meter (Virginia) to 1.25 milligram per cubic meter (North Dakota) to 2.976 milligram per cubic meter (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #5523.

Permissible Concentration in Water: No criteria set, but EPA[32] has suggested a permissible ambient goal of 140 μg/L based on health effects and also a lifetime Health advisory: of 7000 μg/L[48]. Several states have set guidelines for ethylene glycol in drinking water[61] ranging from 100 μg/L (Connecticut) to 290 μg/L (New Jersey)[59] to 5500 μg/L (Arizona, Massachusetts and Maine).

Determination in Water: Octanol-water coefficient: Log $K_{ow} = -1.9$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Ingestion and inhalation. Poor skin absorption, but may contribute to intoxication.

Harmful Effects and Symptoms

In the body, ethylene glycol is chemically broken down into toxic compounds. It and its toxic byproducts first affect the CNS, then the heart, and finally the kidneys. Ingestion of sufficient amounts can be fatal[77].

Short-Term Exposure: Ethylene glycol irritates the eyes, skin, and respiratory tract. *Inhalation:* Mild throat irritation resulted from exposure of 28 milligram per cubic meter. Levels above 140 milligram per cubic meter resulted in more marked irritation, with levels of more than 250 milligram per cubic meter being unbreathable. These levels are only reached at elevated temperature. *Skin:* May cause mild irritation if not promptly removed. *Eyes:* Accidental eye contact with concentrated ethylene glycol resulted in extreme swelling of the eyes, cloudy vision and slow response to light. These symptoms lasted a month. *Ingestion:* May cause symptoms in the nervous system; heart, lungs and kidneys. Earliest effects are usually felt in the nervous system between 1/2−12 hours after ingestion. Symptoms from one liquid ounce may include nausea, vomiting, dizziness, loss of coordination and abdominal pain. Large amounts may cause stupor, coma, convulsions and death. Survival of this stage may lead to development of rapid heartbeat; enlarged heart and fluid in the lungs which, too, can lead to death usually after 1−3 days. Some individuals who drank 3−4 fluid ounces who survived both the above stages because of prompt medical treatment, later (3−17 days) died of kidney failure.

Long-Term Exposure: Occupational exposure to heated ethylene glycol has caused involuntary eye movement that may indicate nerve damage. Some individuals also reported attacks of unconsciousness lasting 5−10 minutes which went away when they stopped working with ethylene glycol. Ethylene glycol may affect the CNS and eyes. Has been shown to be a teratogen in animals. Ethylene glycol may damage the developing fetus. May cause kidney and brain damage.

Points of Attack: Eyes, skin, respiratory system, CNS, and heart, kidneys.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: kidney function test. Urine oxalate level. Exam of the nervous system. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods:

General information: first responders should use a NIOSH-certified CBRN SCBA with a level a protective suit when entering an area with an unknown contaminant or when entering an area where the concentration of the contaminant is unknown. Level a protection should be used until monitoring results confirm the contaminant and the concentration of the contaminant. *Note:* Safe use of protective clothing and equipment requires specific skills developed through training and experience.

LEVEL A: (*RED ZONE*): select when the greatest level of skin, respiratory, and eye protection is required. This is the maximum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than the AEGL-2. A NIOSH-certified CBRN full-face-piece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle. A TECP suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, and a hard hat worn under the TECP suit are optional items.

LEVEL B: (RED ZONE): Select when the highest level of respiratory protection is necessary but a lesser level of skin protection is required. This is the minimum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than AEGL-2. It differs from Level A in that it incorporates a nonencapsulating, splash-protective, chemical-resistant splash suit that provides Level A protection against liquids but is not airtight. A NIOSH-certified CBRN full-face-piece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL C: (YELLOW ZONE): Select when the contaminant and concentration of the contaminant are known and the respiratory protection criteria factors for using APRs or PAPRs are met. This level is appropriate when decontaminating patient/victims. A NIOSH-certified CBRN tight-fitting APR with a canister-type gas mask or CBRN PAPR for air levels greater than AEGL-2. A NIOSH-certified CBRN PAPR with a loose-fitting face-piece, hood, or helmet and a filter or a combination organic vapor, acid gas, and particulate cartridge/filter combination or a continuous flow respirator for air levels greater than AEGL-1. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Escape mask, face shield, coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL D: (GREEN ZONE): Select when the contaminant and concentration of the contaminant are known and the concentration is below the appropriate occupational exposure limit or less than AEGL-1 for the stated duration times. Limited to coveralls or other work clothes, boots, and gloves.

Notes: Take all necessary precautions to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. 8 hours: Natural, Neoprene rubber gloves, suits, boots; nitrile rubber gloves, suits, boots; polyethylene gloves, polyvinyl chloride gloves, suits, boots; Teflon gloves, suits, boots; Viton gloves, suits, Saranex coated suits; 4 H and Silver Shield gloves, Trellchem HPS suits; 4 hours: Responder suits. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures *over* 50 ppm; Use an NIOSH/MSHA or European Standard EN 149-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use an NIOSH/MSHA or European Standard EN 149-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Green: General storage may be used. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Ethylene glycol must be stored to avoid contact with sulfuric acid; since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from oxidizing agents (such as perchlorates, peroxides, permanganates, chlorates, and nitrates).

Shipping: UN3082 Environmentally hazardous substances, liquid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep ethylene glycol out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed. Alternatively, ethylene glycol can be recovered from polyester plant wastes.

References

(102); (31); (173); (101); (138). (2); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 4, No. 3, 70−74 (1984)

New York State Department of Health, *Chemical Fact Sheet: Ethylene Glycol*, Bureau of Toxic Substance Assessment, Albany, NY (January 1986)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Ethylene Glycol*, Trenton, NJ (July 2002)

Ethylene glycol diethyl ether E:0620

Formula: $C_6H_{14}O_2$: $C_2H_5OCH_2CH_2OC_2H_5$

Synonyms: 1,2-Diethoxyethane; Diethoxyethane; Diethyl cellosolve; Ethyl glyme

CAS Registry Number: 629-14-1

HSDB Number: 71

RTECS Number: KI1225000

UN/NA & ERG Number: UN1153/127

EC Number: 211-076-1[*Annex I Index No.:* 603-208-00-5]

Regulatory Authority and Advisory Information

Hazard Alert: Highly flammable, Possible polymerization hazard (glycol ethers), Reproductive toxins, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction).

Hazard symbols, risk, & safety statements: Hazard symbol: F, T; risk phrases: R61; R11; R19; R36; R51; R62; safety phrases: S21; S41; S45; S53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [2-Hazard to water. (est.)]

As Glycol Ethers:

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) includes mono-and di-ethers of ethylene glycol, diethyl glycol, and triethylene glycol R-(OCH2CH2)n-OR' where n = 1, 2, or 3; R = alkyl or aryl groups; R' = R, H, or groups which, when removed, yield glycol ethers with the structure: R-(OCH_2CH)n-OH. Polymers are excluded from the glycol category.

EPCRA Section 313: Certain glycol ethers are covered. R-(OCH_2CH_2) n-OR'; Where n = 1, 2, or 3; R = alkyl C 7 or less; or R = phenyl or alkyl substituted phenyl; R' + H, or alkyl C7 or less; or consisting of carboxylic ester, sulfate, phosphate, nitrate or sulfonate.

Form R *de minimis* concentration reporting level: 1.0%.

Description: Ethylene glycol diethyl ether is a colorless liquid. Molecular weight = 118.20; boiling point = 122°C; freezing/melting point = −74°C; flash point = 35°C; autoignition temperature = 406°C. Hazard identification (based on NFPA-704 M Rating System): Health 1, Flammability 3, Reactivity 0. Slightly soluble in water.

Potential Exposure: Ethylene glycol diethyl ether is used as an aprotic solvent; in chemical manufacturing; as a solvent for detergents and in other cleaning products.

Incompatibilities: Forms explosive mixture with air when heated. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides. Attacks some plastics, rubber and coatings. May slowly form unstable reactive peroxides during prolonged storage or on exposure to air and light. Also incompatible with strong acids; aluminum and its alloys.

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Harmful Effects and Symptoms

Short-Term Exposure: Ethylene glycol diethyl ether can affect you when breathed in and by passing through your skin. Exposure can irritate the eyes, nose and throat. Contact can irritate the skin and eyes. High levels can cause you to feel drowsy and dizzy. Very high levels could cause you to pass out. Repeated high or single very high exposures may damage the kidneys.

Long-Term Exposure: Repeated or high exposures may damage the kidneys. There is limited evidence that ethylene glycol diethyl ether may damage the developing fetus.

Points of Attack: Kidneys.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: CBC. Kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Glove manufacturers have recommended gloves of Neoprene or nitrile butyl rubber construction for protection against liquid ethylene glycol diethyl ether. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposure to ethylene glycol diethyl ether, use a NIOSH/

MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. May form peroxides in storage. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Ethylene glycol diethyl ether must be stored to avoid contact with strong oxidizers (such as chlorine, bromine and fluorine) and strong acids (such as hydrochloric, sulfuric and nitric), since violent reactions occur. Sources of ignition, such as smoking and open flames, are prohibited where ethylene glycol diethyl ether is handled, used, or stored. Metal containers involving the transfer of five gallons or more of ethylene glycol diethyl ether should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters.

Use only nonsparking tools and equipment, especially when opening and closing containers of ethylene glycol diethyl ether. Wherever ethylene glycol diethyl ether is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1153 Ethylene glycol diethyl ether, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. Keep ethylene glycol diethyl ether out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120 (q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition includes oxides of carbon. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Ethylene Glycol Diethyl Ether*, Trenton, NJ (June 2005)

Ethylene glycol dinitrate E:0630

Formula: $C_2H_4N_2O_6$; $O_2NOCH_2CH_2ONO_2$

Synonyms: EGDN; 1,2-Ethanediol dinitrate; Ethanediol dinitrate; Ethylene dinitrate; Ethylene nitrate; Glycol (dinitrate de) (French); Glycol dinitrate; Glykoldinitrat (German)

CAS Registry Number: 628-96-6

HSDB Number: 537

RTECS Number: KW5600000

UN/NA & ERG Number: UN0473 (Explosive)/112

EC Number: 211-063-0 [*Annex I Index No.:* 603-032-00-9]

Regulatory Authority and Advisory Information

United States National Primary Drinking Water Regulations: MCLG = 10 mg[N]/L; MCL = 10 mg/L as nitrates Explosive Substance (World Bank)[15]

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: E, T+; R3; R26/27/28; R33; safety phrases: S1/2; S27/28; S33; S35; S36/37; S41; S45 (see Appendix 4).

Description: Ethylene glycol dinitrate is a colorless to yellow, oily, odorless liquid. An explosive ingredient (60%−80%) in dynamite along with nitroglycerine (40%−20%). It may be detonated by mechanical shock, heat, or spontaneous chemical reaction. Molecular weight = 152.08; specific gravity (H_2O:1) = 1.49; boiling point = 197.2°C (explodes); freezing/melting point = −22.2°C; vapor pressure = 0.05 mmHg @ 20°C; flash point = 215°C. Very slightly water soluble; solubility = 0.48%.

Potential Exposure: An explosive ingredient (60%−80%) in dynamite along with nitroglycerine (40%−20%). Although ethylene glycol dinitrate is an explosive in itself, it is primarily used to lower the freezing/melting point of nitroglycerin; together these compounds are the major constituents of commercial dynamite, cordite, and blastine gelatin. Occupational exposure generally involves a mixture of the two compounds. Ethylene glycol dinitrate is 160 times more volatile than nitroglycerin.

Incompatibilities: Unstable; highly explosive. Heating may cause violent combustion or explosion producing toxic fumes (nitrogen oxides). May explosively detonate violently from heat above 200°C, mechanical shock, friction, impact or concussion. Not compatible with strong acids and alkalies.

Permissible Exposure Limits in Air

NIOSH IDLH = 75 milligram per cubic meter

Conversion factor: 1 ppm = 6.22 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 0.2 ppm/1 milligram per cubic meter Ceiling Concentration [skin]

NIOSH REL: 0.1 milligram per cubic meter STEL [skin]

ACGIH TLV[1]: 0.05 ppm/0.31 milligram per cubic meter TWA [skin]

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

DFG MAK: 0.05 ppm/0.32 milligram per cubic meter TWA; Peak Limitation Category II(1);[skin]; BAT: 0.3 μg/L in blood; end of exposure; end-of-shift

PAC* Ver. 29[138]

PAC-1: 0.016 ppm

PAC-2: 0.2 ppm

PAC-3: 80 ppm

Australia: TWA 0.05 ppm (0.3 milligram per cubic meter), [skin], 1993; Austria: MAK 0.05 ppm (0.3 milligram per cubic meter), [skin], 1999; Belgium: TWA 0.05 ppm (0.31 milligram per cubic meter), [skin], 1993; Denmark: TWA 0.02 ppm (0.12 milligram per cubic meter), [skin], 1999; Finland: TWA 0.1 ppm (0.6 milligram per cubic meter); STEL 0.3 ppm (2 milligram per cubic meter), [skin], 1999; France: VME 0.17 ppm (1 milligram per cubic meter), [skin], 1999; Japan: STEL 0.05 ppm (0.31 milligram per cubic meter), [skin], 1999; the Netherlands: MAC-TGG 0.3 milligram per cubic meter, [skin], 2003; Norway: TWA 0.03 ppm (0.18 milligram per cubic meter), 1999; the Philippines: TWA 0.2 ppm (1.2 milligram per cubic meter), [skin], 1993; Poland: TWA 0.3 milligram per cubic meter; STEL 0.4 milligram per cubic meter, 1999; Russia: TWA 0.05 milligram per cubic meter, 1993; Sweden: NGV 0.03 ppm (0.2 milligram per cubic meter), KTV 0.1 ppm (0.6 milligram per cubic meter), [skin], 1999; Switzerland: MAK-W 0.05 ppm (0.3 milligram per cubic meter), KZG-W 0.1 ppm, [skin], 1999; Thailand: TWA 0.2 ppm (1 milligram per cubic meter), 1993; Turkey: TWA 0.2 ppm (1 milligram per cubic meter), [skin], 1993; United Kingdom: TWA 0.2 ppm (1.3 milligram per cubic meter); STEL 0.2 ppm, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 0.05 ppm [skin]. Several states have set guidelines or standards for EGDN in ambient air[60] ranging from 3.0 μ/m^3 (North Dakota) to 6.0 μ/m^3 (Connecticut) to 7.0 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #2507 or OSHA Analytical Method 43.

Determination in Water: Octanol-water coefficient: Log $K_{ow} = <1.2$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation of dust or vapor, ingestion of dust, percutaneous absorption, and skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: EGDN can cause headache, dizziness, nausea, vomiting, and abdominal pain; and may affect the cardiovascular system, causing a fall in blood pressure. High levels can interfere with the blood's ability to carry oxygen (methemoglobinemia). Exposure may result in death. The effects may be delayed. Skin contact can cause a rash or burning feeling on contact. Exposure to small amounts of ethylene glycol dinitrate and/or nitroglycerin by skin exposure, inhalation, or swallowing may cause severe throbbing headaches. With large exposure, nausea, vomiting, cyanosis, palpitations of the heart; coma, cessation of breathing; and death may occur. A temporary tolerance to the headache may develop, but this is lost after a few days without exposure. On some occasions a worker may have anginal pains a few days after discontinuing repeated daily exposure.

Long-Term Exposure: EGDN can damage the heart causing pain in the chest and/or increased heart rate or cause arrhythmia (irregular heartbeat). This can be fatal. High exposure may affect the nervous system. May damage the red blood cells leading to anemia.

Points of Attack: Skin, cardiovascular system, blood, liver, and kidneys.

Medical Surveillance: Placement and periodic examinations should be concerned with CNS; blood, glaucoma; and especially history of alcoholism. Urinary and blood ethylene glycol dinitrate may be determined by gas chromatography. NIOSH lists the following tests: whole blood (chemical/metabolite); whole blood (chemical/metabolite), during exposure; complete blood count; electrocardiogram, expired air, during exposure; urine (chemical/metabolite).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to Physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Both EGDN and nitroglycerin are readily absorbed through the skin, lungs, and mucous membranes. It is, therefore, essential that adequate skin protection by providing for each worker: impervious clothing where liquids are likely to contaminate and full body clothing where dust creates the problem. All clothing should be discarded at the end of the shift and prior to changing to street clothing. In case of spill or splash that contaminates work clothing, the clothes should be changed at once and the skin area washed thoroughly. Masks of the dust type or organic vapor canister type may be necessary in areas of concentration of dust or vapors. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: Up to 1 milligram per cubic meter: Sa (APF = 10) (any supplied-air respirator).* up to 2.5 milligram per cubic meter*:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode).* up to 5 milligram per cubic meter: SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode);* or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). Up to 75 milligram per cubic meter*:* SAF: PD/PP (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry in unknown concentration or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA). *Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Explosive and Strong Oxidizer. Color code-Red Stripe: Flammability Hazard: Store separately from all other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1 hour fire wall from flammable or reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well ventilated area separated from strong oxidants, strong bases; strong acids. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN0473 Substances, explosive, n.o.s., Hazard Class: 1.1 A; Labels:1.1A-Explosive (with a mass explosion, hazard); A-Substances which are expected to mass detonate very soon after fire reaches them, Technical Name Required.

Spill Handling: Spread sodium bisulfate over the spill area and sprinkle with water. Then flush to sewer with water[22]. Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep EGDN out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Evacuate area of fire. Heat may cause violent combustion (explodes @ 114°C) or explosion. Fight fires only from a secure, explosion-resistant position. This chemical is a combustible liquid. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (2).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Ethylene Glycol Dinitrate*, Trenton NJ (March 1999)

Ethylene glycol monomethyl ether E:0640

Formula: $C_3H_8O_2$: $CH_3OCH_2CH_2OH$
Synonyms: Aethylengykol-monomethylaether (German); Dowanol EM; EGM; EGME; Ether monomethylique de l'ethylene-glycil (French); Ethylene glycol methyl ether; Glycol ether EM; Glycol methyl ether; Glycol monomethyl ether; Jeffersol EM; MECS; 2-Methoxyethanol; Methoxyhydroxyethane; Methyl Cellosolve (NIOSH); Methyl ethoxol; Methyl glycol; Methyl oxitol; Poly-Solv EM; Prist
CAS Registry Number: 109-86-4
HSDB Number: 97
RTECS Number: KL5775000
UN/NA & ERG Number: UN1188/127
EC Number: 203-713-7 [*Annex I Index No.:* 603-011-00-4]
Regulatory Authority and Advisory Information
California Proposition 65 Chemical[102]: Cancer; Developmental/Reproductive toxin 1/1/1989.
Hazard Alert: Flammable liquid, Possible polymerization hazard (glycol ethers), Possible risk of forming tumors, Reproductive toxin: possible risk of gene damage/impaired fertility; Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction). Listed for Tier 1 screening as an endocrine disruptor[88].
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%, 2-Methoxyethanol
Hazard symbols, risk, & safety statements: Hazard symbol: F, T; risk phrases: R10; R19; R60; R61; R10; R20/21/22; R61; R62; R63; safety phrases: S53; S45 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.
As Glycol Ethers:
Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) includes mono-and diethers of ethylene glycol, diethyl glycol; and triethylene glycol R-(OCH_2CH_2)n-OR' where n = 1, 2, or 3; R = alkyl or aryl groups; R' = R, H, or groups which, when removed, yield glycol ethers with the structure: R-(OCH_2CH)n-OH. Polymers are excluded from the glycol category
EPCRA Section 313: Certain glycol ethers are covered. R-(OCH_2CH_2)n-OR'; Where n = 1, 2, or 3; R = alkyl C7 or less; or R = phenyl or alkyl substituted phenyl; R' + H, or alkyl C7 or less; or' consisting of carboxylic ester, sulfate, phosphate, nitrate or sulfonate. Form R *de minimis* concentration reporting level: 1.0%.
Description: Ethylene glycol monomethyl ether is a colorless liquid with a slight ethereal odor. The Odor Threshold is 0.9–2.3 ppm. Molecular weight = 76.11; specific gravity (H_2O:1) = 0.97; boiling point = 124.5°C; freezing/melting point = −86.5°C; vapor pressure = 6.2 mmHg @20°C; flash point = 39°C; autoignition temperature = 285°C. Explosive limits: LEL = 1.8%; UEL: 14%, both @ STP. Hazard identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 0. Soluble in water.
Potential Exposure: Ethylene glycol monomethyl ether is used as a jet fuel additive; solvent for protective coating; and in chemical synthesis. Ethylene glycol ethers are used as solvents for resins used in the electronics industry, lacquers, paints, varnishes, gum, perfume; dyes and inks; and as a constituent of painting pastes, cleaning compounds; liquid soaps; cosmetics, nitrocellulose, and hydraulic fluids.
Incompatibilities: Vapors may form explosive mixture with air. Heat or oxidizers may cause the formation of unstable peroxides. Attacks many metals. Strong oxidizers may cause fire and explosions. Strong bases cause decomposition and the formation of toxic gas. Attacks some plastics, rubber and coatings. May accumulate static electrical charges, and may cause ignition of its vapors.
Permissible Exposure Limits in Air
NIOSH IDLH = 200 ppm
OSHA PEL: 25 ppm/80 milligram per cubic meter TWA [skin]
NIOSH REL: 0.1 ppm/0.3 milligram per cubic meter TWA [skin]
ACGIH TLV[1]: 0.1 ppm/0.3 milligram per cubic meter TWA [skin]; BEI issued.
PAC Ver. 29[138]
PAC-1: 0.3 ppm
PAC-2: 14 ppm
PAC-3: 2000 ppm
DFG MAK: 1 ppm/3.2 milligram per cubic meter (the sum of the concentrations of EGME and its acetate in air); Peak Limitation Category II(8) [skin]; Pregnancy Risk Group B
Australia: TWA 5 ppm (16 milligram per cubic meter), [skin], 1993; Austria: MAK 5 ppm (15 milligram per cubic meter), [skin], 1999; Belgium: TWA 5 ppm (16 milligram per cubic meter), [skin], 1993; Denmark: TWA 5 ppm (16 milligram per cubic meter), [skin], 1999; Finland: TWA 25 ppm (80 milligram per cubic meter); STEL 40 ppm (120 milligram per cubic meter), [skin], 1999; France: VME 5 ppm (16 milligram per cubic meter), [skin], 1999; Hungary: TWA 15 milligram per cubic meter; STEL 30 milligram per cubic meter, [skin], 1993; the Netherlands: MAC-TGG 1 milligram per cubic meter, [skin], 2003; Norway: TWA 5 ppm (16 milligram per cubic meter), 1999; the Philippines: TWA 25 ppm (80 milligram per cubic meter), [skin], 1993; Poland: MAC (TWA) 15 milligram per cubic meter, MAC (STEL) 60 milligram per cubic meter, 1999; Russia: TWA 5 ppm, 1993; Sweden: NGV 5 ppm (16 milligram per cubic meter), KTV 10 ppm (30 milligram per cubic meter), [skin], 1999; Switzerland: MAK-W 5 ppm (15 milligram per cubic meter), KZG-W 10 ppm (30 milligram per cubic meter), [skin], 1999; Turkey: TWA 25 ppm (80 milligram per cubic meter), 1993; United Kingdom: TWA 5 ppm (16 milligram per cubic meter), [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: TWA 5 ppm [skin]. The former USSR-UNEP/

IRPTC[35] set a MAC for ambient air in residential areas of 0.3 milligram per cubic meter (on a once daily basis). Several states have set guidelines or standards for 2-methoxyethanol in ambient air[60] ranging from 21.0 μ/m^3 (Massachusetts) to 53.3 μ/m^3 (New York) to 100 μ/m^3 (Rhode Island) to 160.0 μ/m^3 (Florida and North Dakota) to 270.0 μ/m^3 (Virginia) to 320.0 μ/m^3 (Connecticut) to 381.0 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #1403, alcohols I or OSHA Analytical Method 53 and 79.

Determination in Water: Octanol-water coefficient: Log $K_{\mathrm{ow}} = -0.5$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation of vapor, ingestion, and eye and/or skin contact, plus cutaneous absorption of liquid.

Harmful Effects and Symptoms

Short-Term Exposure: EGME irritates the eyes and the respiratory tract. More severe exposures may cause damage to brain, nervous system; liver and kidneys; and death. *Inhalation:* Exposure to levels above 25 ppm may cause headache, drowsiness, lethargy, weakness and tremors. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. *Skin:* Readily absorbed through the skin. May cause stinging and reddening upon contact; and cause or contribute to symptoms in the lungs. *Eyes:* Contact with liquid or high vapor concentrations may cause burning irritation and clouded vision. *Ingestion:* Three liquid ounces (100 ml) has been reported to cause confusion, nausea, weakness and rapid breathing. Symptoms were delayed 8−18 hours.

Long-Term Exposure: Prolonged exposure can cause anemia and lesions of blood cells. May cause symptoms listed under inhalation. Repeated exposure can cause headaches, weakness, drowsiness, personality changes; loss of weight; upset stomach and tremors. May cause kidney damage. Extended exposures of 25−75 ppm has caused anemia and nervous system effects, such as fatigue, weakness, loss of muscle control and mental changes. Ethylene glycol monomethyl ether has been shown to cause reproductive problems, damage to the testes, and cause birth defects in animal studies.

Points of Attack: Eyes, respiratory system, CNS, blood, kidneys, reproductive system, and hematopoietic system.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater, or significant skin contact), the following are recommended before beginning work and at regular times after that. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Complete blood count. Kidney function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Exam of the nervous system. NIOSH lists the following tests: complete blood count; urine (chemical/metabolite), end-of-shift

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin contact: 8 hours: butyl rubber gloves, suits, boots; Tychem 1000 suits. 4 hours: 4 H and Silver Shield gloves Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: Up to 1 ppm: Sa (APF = 10) (any supplied-air respirator).* up to 2.5 ppm: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode).* up to 5 ppm: SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). Up to 100 ppm: Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode).* up to 200 ppm: SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA). *Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code-Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. 2-Methoxyethanol must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates) and strong caustics, since violent reactions occur. Sources of ignition, such as smoking and open flames are prohibited where 2-methoxyethanol is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever 2-methoxyethanol is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1188 Ethylene glycol monomethyl ether, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Use water spray to reduce vapors. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep EGME out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Concentrated waste containing no peroxides: discharge liquid at a controlled rate near a pilot flame. Concentrated waste containing peroxides: perforation of a container of the waste from a safe distance followed by open burning[24].

References

(102); (31); (173); (101); (138); (2); (80); (100).

National institute for Occupational Safety and Health (NIOSH), *Profiles on Occupational Hazards for Criteria Document Priorities: Glycol Ethers*, pp. 110−115, Report PB 274,073, Cincinnati, OH (1977)

National institute for Occupational Safety and Health (NIOSH), *Glycol Ethers: 2-Methoxyethanol and 2-Ethoxyethanol, Current Intelligence Bulletin No. 39*, Cincinnati, Ohio (May 2, 1983)

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 4, No. 2, 67−70 (1984)

New York State Department of Health, *Chemical Fact Sheet: Ethylene Glycol Monomethyl Ether*, Bureau of Toxic Substance Assessment, Albany, NY (January 1986 and Version 2)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: 2-Methoxyethanol*, Trenton, NJ (April 2002)

Ethyleneimine E:0650

Formula: C_2H_5N

Synonyms: Aethylenimin (German); Aminoethylene; Azacyclopropane; Azirane; Aziridin (German); Aziridina (Spanish); Aziridine; Azirine; 1H-Azirine,dihydro-; Dihydro-1H-azirine; Dihydroazirine; Dimethyleneimine; Dimethylenimine; E-1; ENT 50,324; Ethyleneimine; Ethylimine; TL 337

CAS Registry Number: 151-56-4

HSDB Number: 540

RTECS Number: KX5075000

UN/NA & ERG Number: (PIH) UN1185 (stabilized)/131 (P)

EC Number: 205-793-9 [*Annex I Index No.:* 613-001-00-1]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Carcinogenicity: IARC: Animal Limited Data; Human No Adequate Data, *possibly carcinogenic to humans*, Group 2B, 1999. United States Environmental Protection Agency Gene-Tox Program, Positive: Aspergillus-reversion; In vitro cytogenetics-human; Positive: In vitro cytogenetics-human lymphocyte; Positive: *D. melanogaster*-reciprocal translocation; Positive: *N. crassa*-forward mutation;

N. crassa-reversion; Positive: Histidine reversion-Ames test; Positive: *D. melanogaster* sex-linked lethal; UDS in mouse germ cells; Positive: *S. cerevisiae* gene conversion; Positive: *S. cerevisiae*-forward mutation; *S. cerevisiae-homozygosis*; Positive: *S. pombe*-forward mutation; Positive/limited: Carcinogenicity-mouse/rat; Positive: CHO gene mutation.

California Proposition 65 Chemical[102]: Cancer 1/1/1988.

Hazard Alert: Poison inhalation hazard: exposure can be lethal, Highly flammable, Polymerization hazard (nonstabilized), Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction).

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR 1910.1012) Banned or Severely Restricted (Belgium, Sweden) (UN)[13]

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); Section 112(r), accidental Release Prevention/Flammable Substances (40CFR/68.130; 59 FR 4497), TQ = 10,000 lb (4550 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb(0.454 kg)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P054

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500 lb(228 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: F, T+, N; risk phrases R45; R11; R26/27/28; R34; R46; R50/53; R62; R63; safety phrases: S1; S21; S41; S45; S53; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Ethyleneimine is a colorless volatile liquid with an ammoniacal odor. Molecular weight = 43.07; specific gravity (H 2 O:1) = 0.83; boiling point = 56.1°C; freezing/melting point = −78°C; vapor pressure = 160 mmHg @ 20°C; 75 mmHg @ 41°C; flash point = −11°C (cc); autoignition temperature = 322°C. Explosive limits: LEL = 3.3%; UEL: 54.8%. Hazard identification (based on NFPA-704 M Rating System): Health 4, Flammability 3, Reactivity 3. Highly soluble in water.

Potential Exposure: Ethyleneimine is used in production of binding agents; formation of plastics; and improving paper strength; in many organic syntheses; as an intermediate and monomer for fuel oil and lubricating refining. The polymerization products, polyethyleneimines, are used as auxiliaries in the paper industry and as flocculation aids in the clarification of effluents. It is also used in the textile industry for increasing wet strength, flame-, water-, shrinkproofing, and stiffening.

Incompatibilities: May form explosive mixture with air. Ethyleneimine is a medium strong base. Contact with acids, aqueous acid conditions, oxidizers, aluminum, or carbon dioxide may cause explosive polymerization. Explosive silver derivatives may be formed with silver alloys e.g., silver solder). Self-reactive with heat or atmospheric carbon dioxide. May accumulate static electrical charges, and may cause ignition of its vapors. Attacks rubber, coatings, plastics, and chemically active metals. Ethyleneimine vapors are not inhibited and may form polymers in vents or flame arresters, resulting in stopping of the vents.

Permissible Exposure Limits in Air

NIOSH IDLH = 100 ppm. Potential occupational carcinogen.

Conversion factor: 1 ppm = 1.76 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: Cancer suspect agent. Exposures of workers to this chemical is to be controlled through the required use of engineering controls, work practices; and personal protective equipment, including respirators. See 29 CFR 1910.1003-1910.1016 for specific details of these requirements.

NIOSH REL: A potential occupational carcinogen. Limit exposure to lowest feasible concentration, See *NIOSH Pocket Guide*, Appendix A

ACGIH TLV[1]: 0.5 ppm/ 0.09 milligram per cubic meter TWA; 0.1 ppm/ 0.18 milligram per cubic meter [skin] confirmed animal carcinogen with unknown relevance to humans.

PAC* Ver. 29[138]

PAC-1: 0.1 ppm

PAC-2: **4.6**$_{\mathbf{A}}$ ppm

PAC-3: **9.9**$_{\mathbf{A}}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

DFG MAK: [skin] Carcinogen Category 2; Germ Cell Mutation Category 2

Australia: TWA 0.5 ppm (1 milligram per cubic meter), [skin], carcinogen, 1993; Austria: [skin], carcinogen, 1999; Denmark: TWA 0.5 ppm (1 milligram per cubic meter), [skin], 1999; Finland: STEL 0.5 ppm (1 milligram per cubic meter), [skin], carcinogen, 1999; Japan: 0.5 ppm (0.88 milligram per cubic meter), [skin], 1999; Norway: TWA 0.5 ppm (1 milligram per cubic meter), 1999; Russia: TWA 0.5 ppm; STEL 0.02 milligram per cubic meter, [skin], 1993; Sweden: carcinogen, 1999; Switzerland: MAK-W 0.5 ppm (0.9 milligram per cubic meter), [skin], carcinogen, 1999; Turkey: TWA 0.5 ppm (1 milligram per cubic meter), [skin], 1993; United Kingdom: carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: confirmed animal carcinogen with unknown relevance to humans. Russia[43] have set a MAC in ambient air of residential areas of 0.001 milligram per cubic meter on either a momentary or a daily average basis. Several states have set guidelines or standards for ethyleneimine in ambient air[60] ranging from zero (North Carolina) to 3.3 μ/m^3 (New York) to 5.0 μ/m^3 (South

Carolina) to 10.0 μ/m^3 (Florida and North Dakota) to 20.0 μ/m^3 (Connecticut) to 24.0 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #3514.

Permissible Concentration in Water: No criteria set, but EPA[32] has suggested a permissible ambient goal of 14 μg/L based on health effects.

Determination in Water: Octanol-water coefficient: Log $K_{ow} = -0.4$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation and percutaneous absorption, ingestion, and skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Ethyleneimine is corrosive to the eyes, skin, and respiratory tract. Eye contact can cause severe illness or death. Inhalation of the vapors can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Symptoms include tearing and burning of the eyes; sore throat; nausea, vomiting, coughing (may persist for weeks or months); and a slow healing dermatitis due to severe blistering. Ethyleneimine is classified as extremely toxic with a probable oral lethal dose of 5–50 mg/kg which is approximately seven drops to one teaspoonful for a 75 kg (150 lb) person. Ethyleneimine gives inadequate warning when over-exposure is by inhalation or skin absorption. It is a severe blistering agent, causing third degree chemical burns of the skin. Also, it has a corrosive effect on mucous membranes and may cause scarring of the esophagus. It is corrosive to eye tissue and may cause permanent corneal opacity and conjunctival scarring. Severe exposure may result in overwhelming pulmonary edema. Renal damage has been described. Hemorrhagic congestion of all internal organs has been observed. May affect the CNS; kidneys and liver.

Long-Term Exposure: May be a carcinogen in humans. May damage the developing fetus. May damage the testes. Repeated or prolonged contact with skin may skin allergy. May damage the liver and kidneys.

Points of Attack: Eyes, skin, respiratory system, liver, and kidneys. Cancer site in animals: lung and liver tumors.

Medical Surveillance: OSHA Mandated Tests: *Increased Risks* check for Reduced Immunologic Competence; steroid treatment; pregnancy; cigarette smoking. NIOSH lists the following tests: electrocardiogram, expired air, pulmonary function tests: forced vital capacity, forced expiratory volume (1 s); sputum cytology; pulmonary function tests: forced vital capacity, forced expiratory volume (1 s). If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 45 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately since eye splashes can cause severe illness or death. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. 8 hours: Tychem 1000 suits; 4 hours: Teflon gloves, suits, boots; Responder suits. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: OSHA: Employees engaged in handling operations involving this carcinogen must be provided with, and required to wear and use, a half-mask filter-type respirator for dusts, mists, and fumes. A respirator affording higher levels of protection than this respirator may be substituted. NIOSH: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

Storage: PIH; check oxygen content prior to entering storage area.(1) Color code-Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. (2) Color code-Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Ethyleneimine must be inhibited and stored to avoid contact with strong acids (such as hydrochloric, sulfuric and nitric) and oxidizers (such as perchlorates, peroxides, permanganates, chlorates and nitrates), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where ethyleneimine is handled, used, or stored. Metal containers involving the transfer of five gallons or more of ethyleneimine should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of ethyleneimine. Wherever ethyleneimine is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN1185 Ethyleneimine, stabilized, Hazard class: 6.1; Labels: 6.1-Poison Inhalation Hazard, 3-Flammable liquid, Inhalation Hazard Zone A. PGI.

Spill Handling:

Initial Isolation and Protective Action Distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24 h response line).

Small Spills (from a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.3/0.5

Large Spills (from a large package or from many small packages)

First: Isolate in all directions (ft/m) 300/100
Then: Protect persons downwind (mi/km)
Day 0.6/0.9
Night 1.3/2.0

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Avoid breathing vapors. Stay upwind, keep out of low areas. Avoid bodily contact with the material. *Do not* handle broken packages without protective equipment. Wash away any material which may have contacted the body with copious amounts of water or soap and water. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of nitrogen and carbon. Dry chemical, alcohol foam, or carbon dioxide are useful for small fires. For large fires: water spray, fog or foam. Do not extinguish fire unless flow can be stopped; use water in flooding quantities as a fog. Solid streams of water may be ineffective. Apply water from as far a distance as possible. If tank car or truck is involved in fire, isolate the surrounding area as shown above. May polymerize in fires with evolution of heat and container rupture. Runoff to sewer may create fire or explosion hazard. Ethyleneimine vapors are not inhibited and may form polymers in vents or flame arresters, resulting in stopping of the vents. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Controlled incineration; incinerator equipped with a scrubber or thermal unit to reduce nitrogen oxides emissions.

References

(102); (31); (2); (100).

Dermer, O. C. and Ham, G. E., *Ethyleneimine and Other Aziridines*, academic Press, NY (1969).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 2, 37–38 (1980)

United States Environmental Protection Agency, Chemical Hazard Information Profile: *Ethyleneimine*, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Ethyleneimine*, Trenton, NJ (March 2004)

Ethylene oxide E:0660

Formula: C_2H_4O

Synonyms: Aethylenoxid (German); Amprolene; Anprolene; Anproline; Dihydrooxirene; Dimethylene oxide; ENT 26,263; E.O.; 1,2-Epoxyaethan (German); 1,2-Epoxyethane; Epoxyethane; Ethene oxide; Ethylene (oxide d') (French); ETO; Merpol; NCI-C50088; Odido de etileno (Spanish); Oxacyclopropane; Oxane; α,β-Oxidoethane; Oxidoethane; Oxirane; Oxirane, dihydro-; Oxyfume; Oxyfume 12; Sterilizing gas ethylene oxide 100%; T-gas; UN1040

CAS Registry Number: 75-21-8; *(alt.)* 19034-08-3; 99932-75-9

HSDB Number: 170

RTECS Number: KX2450000

UN/NA & ERG Number: UN1040/119

EC Number: 200-849-9 [*Annex I Index No.:* 603-023-00-X]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 ($\geq$1.00% concentration).

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen; IARC: Human Limited Evidence, animal Sufficient Evidence, *carcinogenic to humans*, Group 1, 1994; NCI: Carcinogenesis Studies (inhalation); clear evidence: mouse; NIOSH: Potential occupational carcinogen; OSHA: Potential occupational carcinogen. United States Environmental Protection Agency Gene-Tox Program, Positive: Carcinogenicity-mouse/rat; Positive: *D. melanogaster*-reciprocal translocation; Positive: Rodent dominant lethal; Rodent heritable translocation; Positive: Mammalian micronucleus; *N. crassa*-reversion; Positive: Histidine reversion-Ames test; Positive: *D. melanogaster* sex-linked lethal; UDS in mouse germ cells; Negative: Mouse specific locus; Positive: CHO gene mutation.

California Proposition 65 Chemical[102]: Cancer 7/1/1987; female 2/27/1987; Developmental/Reproductive toxin (male) 8/7/2009.

Hazard Alert: Possible risk of forming tumors, Reproductive toxin: possible risk of gene damage/impaired fertility; Suspected reprotoxic hazard, Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated, Primary irritant (w/o allergic reaction).

United States Environmental Protection Agency TSCA Section 8(e) Risk Notification, 8EHQ-0892-9104

Banned or Severely Restricted (in agriculture) (Germany)[13]

Highly Reactive Substance and Explosive (World Bank)[15]

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR 1910.1047)

OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 5000 lb (2270 kg)

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (45,40 kg)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U115 RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.12; Nonwastewater (mg/kg), N/A

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

FDA tolerance limit, 50 ppm in ground spices

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%.

Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)].

Hazard symbols, risk, & safety statements: Hazard symbol: F+ ,T; risk phrases: R45; R5; R21; R6; R12; R23; R36/37/38; R46; R60; R61; R62; R63; safety phrases: S1; S9; S33; S38; S41; S45; S53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Ethylene oxide is a colorless, compressed, liquefied gas or liquid (below 11°C). Sweet odor; the odor threshold is 50 ppm. Molecular weight = 44.06; specific gravity (H_2O:1) = 0.82 (liquid @ 10°C); boiling point = 11°C; freezing/melting point = -112°C; vapor pressure = 1.46 atm; relative vapor density (air = 1) = 1.49; relative vapor density (air = 1) = 1.49; flash point = flammable gas (-20°C, liquid); autoignition temperature = 429°C. Explosive limits: LEL = 3.0%; UEL: 100%. Hazard identification (based on NFPA-704 M Rating System): Health 3, Flammability 4, Reactivity 3. Easily dissolved in water.

Potential Exposure: Ethylene oxide is a man-made chemical used in the production of glycols (ethylene glycol, polyglycols, glycol ethers, esters), nontonic surface-active agent; ethanolamines, acrylonitrile, plastics. It is also used as a fumigant for foodstuffs and textiles; an agricultural fungicide; and for sterilization, especially for surgical instruments. It is used in drug synthesis and as a pesticide intermediate.

Incompatibilities: May form explosive mixture with air. Chemically unstable. Dangerously reactive; may rearrange chemically and/or polymerize violently with evolution of heat; when in contact with highly active catalytic surfaces, such as anhydrous chlorides of iron, tin and aluminum; pure oxides of iron and aluminum; and alkali metal hydroxides. Even small amounts of strong acids; alkalis, or oxidizers can cause a reaction. Avoid contact with copper. Protect container from physical damage, sun and heat. Attacks some plastics, rubber or coatings.

Permissible Exposure Limits in Air

NIOSH IDLH = 800 ppm

Conversion factor: 1 ppm = 1.80 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 1 ppm/5 ppm [15 min excursion] TWA, cancer hazard, see 29CFR1910.1047(c).

NIOSH REL: <0.1 ppm/ <0.18 milligram per cubic meter TWA; 5 ppm/9 milligram per cubic meter [10 min/day] Ceiling Concentration; Potential carcinogen. Limit exposure to lowest feasible level, See *NIOSH Pocket Guide*, Appendix A

ACGIH TLV[1]: 1 ppm/1.8 milligram per cubic meter TWA, Suspected Human Carcinogen

PAC Ver. 29[138]

PAC-1: 5 ppm

PAC-2: $\mathbf{45_A}$ ppm (60 min.)

PAC-3: $\mathbf{200_A}$ ppm (60 min.)

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

DFG MAK: [skin]; Carcinogen Category 2; Germ Cell Mutagen Category 2; TRK: 1 ppm/1.83 milligram per cubic meter; Sampling time: not fixed; 90 μg[hydroxyethylvaline]/L blood.

Arab Republic of Egypt: TWA 10 ppm (20 milligram per cubic meter), 1993; Australia: TWA 1 ppm (2 milligram per cubic meter), carcinogen, 1993; Austria [skin], carcinogen, 1999; Belgium: TWA 1 ppm (1.8 milligram per cubic meter), carcinogen, 1993; Denmark: TWA 1 ppm (1.8 milligram per cubic meter), 1999; Finland: TWA 1 ppm (2.8 milligram per cubic meter), carcinogen, 1999; Hungary: STEL 1 milligram per cubic meter, carcinogen, 1993; the Netherlands: MAC-TGG 0.84 milligram per cubic meter, 2003; Norway: TWA 1 ppm, 1999; Poland: MAC (TWA) 1 milligram per cubic meter, MAC (STEL) 3 milligram per cubic meter, 1999; Russia: TWA 50 ppm; STEL 1 milligram per cubic meter, 1993; Sweden: NGV 1 ppm (2 milligram per cubic meter), KTV 5 ppm (9 milligram per cubic meter), [skin], carcinogen, 1999; Switzerland: MAK-W 1 ppm (2 milligram per cubic meter), [skin], carcinogen, 1999; Turkey: TWA 50 ppm (90 milligram per cubic meter), 1993; United Kingdom:; TWA 5 ppm (9.2 milligram per cubic meter), carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: Suspected Human Carcinogen. The Czech Republic: 1 milligram per cubic meter; Russia[35,43] set a MAC for ambient air in residential areas of 0.3 milligram per cubic meter on a momentary basis and 0.03 milligram per cubic meter on a daily average basis. Several states have set guidelines or standards for ethylene oxide in ambient air[60] ranging from zero (North Dakota) to 0.01 milligram per cubic meter (Rhode Island) to 0.1 μ/m^3 (North Carolina) to 4.87 μ/m^3 (Pennsylvania) to 6.67 μ/m^3 (New York) to 10.0 μ/m^3 (South Carolina) to 20.0 μ/m^3 (Connecticut, South Dakota and Virginia) to 48.0 μ/m^3 (Nevada) to 450.0 μ/m^3 (Indiana).

Determination in Air: Use NIOSH Analytical Method (IV) s #1614, Ethylene oxide; by portable GC #3800; passive monitor; OSHA Method 1010, Ver. 2 (Revised March 2014).

Determination in Water: Octanol-water coefficient: Log $K_{ow} = -0.29$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation of gas, ingestion, and eye and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Signs and symptoms of acute exposure to ethylene oxide may be severe and include dyspnea (shortness of breath), cough, pulmonary edema, pneumonia, and respiratory failure. Lethargy, headache, dizziness, twitching, convulsions, paralysis, and coma may be observed. Cardiac arrhythmias and cardiovascular collapse may also occur. GI effects of acute exposure may include nausea, vomiting, and abdominal pain. Ethylene oxide irritates the eyes, skin, and respiratory tract. Very high exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. *Inhalation:* Exposure to 500−700 ppm for 2−3 minutes, resulted in nausea, vomiting, headache, disorientation; fluid in the lungs, followed by seizures. Human volunteers breathing a concentration of about 2500 ppm experienced slight irritation of the respiratory tract; breathing in 12,500 ppm showed definite respiratory tract irritation within 10 seconds. Symptoms may not occur for hours after exposure. Other symptoms reported at unknown concentrations include headache, nausea, coughing, vomiting, difficult breathing; respiratory tract irritation; weakness, a lack of coordination; seizures and fluid in the lungs. *Skin:* The pure liquid may cause frostbite. A 1% water solution can cause irritation and redness. A 40%−80% water solution may cause extensive blister formation. Ethylene oxide may severely irritate or burn mucous membranes and moist skin. *Eyes:* May cause irritation and severe burns. May affect the eyes, causing delayed development of cataract. Eye contact may result in conjunctivitis (red, inflamed eyes) and erosion of the cornea. *Ingestion:* May cause gastric irritation and liver injury.

Long-Term Exposure: Repeated or prolonged contact with skin may cause skin allergy. ETO may affect the nervous system; kidneys, adrenal glands; skeletal muscles and cause reproductive effects. It may be carcinogenic to humans. Exposure to low concentrations of gaseous ETO may cause irritation to the respiratory tract and eyes; loss of sense of smell; and nausea and vomiting. Repeated skin exposure can cause scaling, cracking and redness. Exposure to 5−10 ppm for 11 years or to 1 ppm for 15 years has caused blood changes. ETO has caused cancer in several species of laboratory animals. It has also caused changes in genetic material and reproductive problems in laboratory animals. May damage the developing fetus. It may cause inheritable genetic damage in humans. There is an increased incidence of gynecological disorders and spontaneous abortions among workers in ethylene oxide production. Its role in this increase is unclear at this time. Increased incidence of leukemia and stomach cancer have been reported; however the evidence is not considered conclusive. Leukemia, brain tumors, lung tumors, and other cancers have been observed in laboratory animals (DHHS).

Points of Attack: Eyes, skin, respiratory system, liver, CNS, blood, kidneys, and reproductive system. *Cancer site:* peritoneal cancer and leukemia.

Medical Surveillance: OSHA Mandated Tests: complete blood count/white blood cells/differential, red blood cells/count, hematocrit, hemoglobin. NIOSH lists the following tests: blood gas analysis; whole blood (chemical/metabolite); complete blood count; expired air, pulmonary function tests: forced vital capacity, forced expiratory volume (1 s); red blood cells/count; sputum cytology; white blood cell count/differential. For those with frequent or potentially high exposure (half the tlv or greater), the following are recommended before beginning work and at regular times after that. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Liver and kidney function tests.

First Aid: If ethylene oxide gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. 8 hours: Barricade coated suits; Responder, Trellchem HPS suits; Trychem 1000 suits; 4 hours: Teflon gloves, suits, boots; 4 H and Silver Shield gloves. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas and splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Ethylene oxide (1910.1047): $<$ or = 50 ppm (parts per million) Full-facepiece respirator with ethylene oxide approved canister, front-or back-mounted. $<$ or = 2000 ppm (1) Positive-pressure supplied-air respirator equipped with full facepiece, hood, or helmet; or (2) Continuous-flow supplied-air respirator (positive-pressure) equipped with hood, helmet, or suit. $>$2000 ppm or unknown concentrations: (1) Positive-pressure SCBA equipped with full facepiece; or (2) Positive-pressure full-facepiece supplied-air respirator equipped with an auxiliary positive-pressure SCBA. *Firefighting*: Positive-pressure SCBA equipped with full facepiece. *Escape:* Any respirator described above.

Storage: Check oxygen content prior to entering storage area. Poison gas. (1) Color code-Blue: Health Hazard/Poison: Store in a secure poison location. This gas is highly toxic. Even slight exposure to these gasses can cause death. Store outdoors in a secure, restricted area that containing warning signs. This area must be roofed and shaded with the cylinders stored off the ground and separated from all other products assigned t

o other hazard categories and radiant heat sources on non-wooden floors. If indoors, store in a well-

ventilated areas in temperatures not to exceed 50°C. (2) Color code-Red Stripe: Flammability Hazard: Store separately from all other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1 hour fire wall from flammable or reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. It must be stored to avoid contact with even small amounts of acids (such as nitric or sulfuric acids); alkalis (such as sodium hydroxide or potassium hydroxide); catalytic anhydrous chlorides of iron, aluminum or tin; iron or aluminum oxide; or metallic potassium, since it may react by itself, liberating much heat and causing a

possible explosion. Ethylene oxide should not contact oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates) since an explosion could occur. Store in tightly closed containers in a cool, well-ventilated area away from heat, sparks, or sunlight. Sources of ignition, such as smoking and open flames are prohibited where ethylene oxide is handled, used, or stored. Metal containers involving the transfer of five gallons or more of ethylene oxide should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of ethylene oxide. Wherever ethylene oxide is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN1040 Ethylene oxide or Ethylene oxide with nitrogen up to a total pressure of 1 MPa (10 bar) at 50°C, Hazard Class: 2.3; Labels: 2.3-Poisonous gas, 2.1-Flammable gas, Inhalation Hazard Zone D. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling:

Initial Isolation and Protective Action Distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24 h response line).

Small Spills (from a small package or a small leak from a large package)

Ethylene oxide & Ethylene oxide or Ethylene oxide with nitrogen up to a total pressure of 1 MPa (10 bar) at 50°C

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.1/0.2

Large Spills (from a large package or from many small packages)

First: Isolate in all directions (ft/m) 500/150
Then: Protect persons downwind (mi/km)
Day 0.5/0.8
Night 1.3/2.0

***Attention:** If dealing with a large spill from the following containers: (1) Rail tank car, (2) Highway tank truck or trailer, (3) Multiple ton cylinders or (4) Multiple small cylinders or single ton cylinder see the following: "ERG Table 3: Initial Isolation and Protective Action Distances for Different Quantities of Six Common Toxic-by-Inhalation Gases." This chart shows isolation protective distances for the transport containers listed above (numbers 1 through 4) and various wind conditions: Low wind (<6 mph); Moderate wind (6 to 12 mph); High wind (>12 mph).

Gas: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Stop the flow of gas if it can be done safely. If source of leak is a cylinder and the leak cannot be stopped in place, remove leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. Keep this chemical out of confined space, such as a sewer because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations.

Liquid: For *small spills* flush area with flooding amounts of water. For *large spills* dike spill for later disposal. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Highly flammable. This gas is under pressure; containers may rupture and explode when heated. Thermal decomposition includes oxides of carbon. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Liquid: Highly flammable. Acrid and Thermal decomposition includes oxides of carbon. Use dry chemical, carbon dioxide, or foam extinguishers. Although soluble in water, solutions will continue to burn until diluted to approximately 22 volumes of water to one volume of ethylene oxide. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Concentrated waste containing no peroxides-discharge liquid at a controlled rate near a pilot flame. Concentrated waste containing peroxides-perforation of a container of the waste from a safe distance followed by open burning[22].

References

(109); (102); (31); (173); (101); (138); (2); (100).

Bogyo, D. A., Lande, S. S., Meylan, W. M., Howard, P. H., and Santodonate, J. (Syracuse Research Corp. Center for Chemical Hazard Assessment), *Investigation of Selected Potential Environmental Contaminants: Epoxides, Report 560/11-80-005*, Washington, DC, United States Environmental Protection Agency (March 1980)

National institute for Occupational Safety and Health (NIOSH), *Ethylene Oxide, Current Intelligence Bulletin N. 35*, DHHS (NIOSH), Publication No. 81-130, Cincinnati, Ohio (May 22, 1981)

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 4, No. 2, 70−73 (1984)

United States Environmental Protection Agency, Chemical Hazard Information Profile: *Ethylene Oxide*, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Ethylene Oxide*, Trenton, NJ (May 2001).

United States Department of Health and Human Services, Agency for Toxic Substances and Disease Registy (ATSDR), "*ToxFAQs, Ethylene Oxide*," Atlanta GA (July 1999)

Ethylene thiourea E:0670

Formula: $C_3H_6N_2S$

Synonyms: Accel 22; Akrochem ETU-22; 4,5-Dihydroimidazole-2(3 H)-thione; 4,5-Dihydro-2-mercaptoimidazole; *N,N′*-Ethylenethiourea; 1,3-Ethylenethiourea; Etilentiourea (Spanish); ETU; 2-Imidazolidinethione; Imidazolidinethione; 2-Imidazoline-2-thiol; Imidazoline-2-thiol; Imidazoline-2(3 H)-thione; 2-Mercapto-2-imidazoline; 2-Mercaptoimidazoline; Mercaptoimidazoline; Mercazin I; NA 22; NCI-C03372; Nocceler 22; Pennac CRA; Rhenogran ETU; Sodium-22 neoprene accelerator; Soxinol 22; Tetrahydro-2H-imidazole-2-thione; 2-Thioimidazolidine; 2-Thiol-dihydroglyoxaline; 2-Thionomidazolidine; Thiourea, *N,N′*-(1,2-ethanediyl)-; USAF EL-62; Vulkacit NPV/C2; Warecure C

CAS Registry Number: 96-45-7

HSDB Number: 1643

RTECS Number: NI9625000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 202-506-9 [*Annex I Index No.:* 613-039-00-9]

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; NCI: Carcinogenesis Studies (feed); clear evidence: mouse, rat; IARC: Human Inadequate Evidence; Animal Sufficient Evidence, *not classifiable as carcinogenic to humans*, Group 3, 2000. United States Environmental Protection Agency Gene-Tox Program, Positive: Carcinogenicity-mouse/rat; Rodent dominant lethal Positive: Host-mediated assay; Histidine reversion-Ames test Negative: Cell transformation-SA7/SHE; Sperm morphology-mouse Negative: TRP reversion Inconclusive: Mammalian micronucleus.

California Proposition 65 Chemical[102]: Cancer 1/1/1988; Developmental/Reproductive toxin 1/1/1993.

Hazard Alert: Poison, Possible risk of forming tumors, Reproductive toxin: possible risk of gene damage/impaired fertility; Suspected reprotoxic hazard, Alert: Combustible, Primary irritant (w/o allergic reaction). Listed for Tier 1 screening as an endocrine disruptor[88].

Banned or Severely Restricted (Sweden)[13]

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U116

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Safe Drinking Water Act (47FR 9352): Priority List (55 FR 1470)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%.

Hazard symbols, risk, & safety statements: Hazard symbol: T; risk phrases: R61; R22; R62; R63; safety phrases: S41; S45; S53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Ethylene thiourea is a white to light green, needle-like crystalline solid with a faint amine odor. Molecular weight = 102.17; boiling point = 230−312.8°C; freezing/melting point = 200°C; vapor pressure = 16 mmHg @ 20°C; flash point = 252.2°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Slightly soluble in cold water; solubility = 2%

@ 30°C; highly soluble in hot water. Commercial ethylene thiourea is available as a solid powder, as a dispersion in oil (which retards the formation of fine dust dispersions in workplace air), and "encapsulated" in a matrix of compatible elastomers. In this latter form, ethylene thiourea may be least likely to escape into the work-place air.

Potential Exposure: Ethylene thiourea is used extensively as an accelerator in the curing of polychloroprene (Neoprene) and other elastomers; as a vulcanizing accelerator in rubber processing; in electroplating baths. In addition, exposure to ethylene thiourea also results from the very widely used ethylene bisdithiocarbamate fungicides. Ethylene thiourea may be present as a contaminant in the ethylene bisdithiocarbamate fungicides and can also be formed when food containing the fungicides is cooked.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, acid anhydrides, and acrolein.

Permissible Exposure Limits in Air

OSHA PEL: None

NIOSH REL: A potential occupational carcinogen. Limit exposure to lowest feasible concentration Use encapsulated form.

PAC Ver. 29[138]

PAC-1: 0.085 milligram per cubic meter

PAC-2: 0.94 milligram per cubic meter

PAC-3: 110 milligram per cubic meter

DFG MAK: Carcinogen Category 3B

Finland: TWA 0.2 milligram per cubic meter; STEL 0.6 milligram per cubic meter, carcinogen, 1993; France: carcinogen, 1993; Sweden: carcinogen, 1999; the Netherlands: MAC-TGG 0.024 milligram per cubic meter, 2003. States which have set guidelines or standards for ethylene thiourea in ambient air[60] include North Dakota (zero level) and Pennsylvania (0.7 μ/m^3).

Determination in Air: Use NIOSH Analytical Method (IV) #5011 or OSHA Analytical Method 95.

Permissible Concentration in Water: Maine[61] has set a guideline for drinking water of 4.4 μg/L. The United States Environmental Protection Agency in a Health advisory: (see "References" below), has developed a no-observed-adverse-effect level (NOAEL) of 1.25 (31); (109); (102); mg/kg/day based on absence of thyroid effects in male rats exposed to(100). ETU in the diet for up to 12 months. This results(2) in a longer term. Health advisory: for an adult of 0.44 mg/L.

Determination in Water: Octanol-water coefficient: Log $K_{ow} = -0.7$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion, and skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Inhalation can cause irritation of the respiratory tract with soreness, hoarseness, cough and phlegm. High exposure can cause sweating, thirst, nausea; an increase in the heart rate and blood pressure that can last for hours or days. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Contact can cause irritation of the skin and eyes, and may cause eye burns. A related chemical, ziram, can cause brain swelling and hemorrhage with muscle weakness and liver, kidney effects.

Long-Term Exposure: Ethylene thiourea has been shown to be carcinogenic and teratogenic (causing malformation in offspring) in laboratory animals. May cause malformations in human babies. Ethylene thiourea may cause thyroid and liver damage. In addition, ethylene thiourea can cause myxedema (the drying and thickening of skin, together with a slowing down of physical and mental activity), goiter, and other effects related to decreased output of thyroid hormone. Maneb, a related fungicide, can cause nerve damage.

Points of Attack: Eyes, skin, thyroid, and reproductive system. Cancer site in animals: liver, thyroid, and lymphatic system tumors.

Medical Surveillance: Initial and routine employee exposure surveys should be made by competent industrial hygiene and engineering personnel. These surveys are necessary to determine the extent of employee exposure and to ensure that controls are effective. The *NIOSH Occupational Exposure Sampling Strategy Manual*, NIOSH Publication #77-173, may be helpful in developing efficient programs to monitor employee exposures to ethylene thiourea. The manual discusses determination of the need for exposure measurements, selection of appropriate employees for exposure evaluation, and selection of sampling times. Employee exposure measurements should consist of 8 hour TWA exposure estimates calculated from personal or breathing zone samples (air that would most nearly represent that inhaled by the employees). Area and source measurements may be useful to determine problem areas, processes, and operations. Thyroid function tests. Examination of the nervous system. Consider chest X-ray following acute overexposure.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: There are four basic methods of limiting employee exposure to ethylene thiourea. None of these is a simple industrial hygiene or management decision and careful planning and thought should be used prior to implementation of any of these.

Product Substitution: The substitution of an alternative material with a lower potential health and safety risk in one method. However, extreme care must be used when selecting possible substitutes. Alternatives to ethylene thiourea should be fully evaluated with regard to possible human effects. Unless the toxic effects of the alternative have been thoroughly evaluated, a seemingly safe replacement, possibly only after years of use, may be found to induce serious health effects.

Contaminant Control: The most effective control of ethylene thiourea, where feasible, is at the source of contamination by enclosure of the operation and/or local exhaust ventilation. If feasible, the process or operation should be enclosed with a slight vacuum so that any leakage will result in the flow of air into the enclosure. The next most effective means of control would be a well-designed local exhaust ventilation system that physically encloses the process as much as possible, with sufficient capture velocity to keep the contaminant from entering the work atmosphere. To ensure that ventilation equipment is working properly, effectiveness e.g., air velocity, static pressure, or air volume) should be checked at least every 3 months. System effectiveness should be checked soon after any change in production, process or control, which might result in significant increases in airborne exposures to ethylene thiourea.

Employee Isolation: A third alternative is the isolation of employees. It frequently involves the use of automated equipment operated by personnel observing from a closed control booth or room. The control room is maintained at a greater air pressure than that surrounding the process equipment so that air flow is out of, rather than into, the room. This type of control will not protect those employees that must do process checks, adjustments, maintenance, and related operations.

Personal Protective Equipment: The least preferred method is the use of personal protective equipment. This equipment, which may include respirators, goggles, gloves, and related items, should not be used as the only means to prevent or minimize exposure during routine operations. Exposure to ethylene thiourea should not be controlled with the use of respirators except: During the time necessary to install or implement engineering or work practice controls; or, in work situation in which engineering and work practice controls are technically not feasible; or, for maintenance; or, for operations which require entry into tanks or closed vessels; or, in emergencies.

Respirator Selection: *At Any Detectable Concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area away from strong oxidizers, acids, acid anhydrides; acrolein. Store in a refrigerator or a cool, dry place. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft[70]. Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. Keep ethylene glycol diethyl ether out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide; water spray; or foam extinguishers. Thermal decomposition products may include oxides of nitrogen, sulfur and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration in a furnace equipped with afterburner and scrubber[22].

References

(31); (173); (101); (138).

National institute for Occupational Safety and Health (NIOSH), *Ethylene Thiourea, Current Intelligence Bulletin 22*, Washington, DC (April 11, 1978)

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 2, 38−39 (1980); 7 No. 3, 106−111 (1987)

United States Environmental Protection Agency, "*Health Advisory: Ethylene Thiourea*," Washington, DC, Office of Drinking Water (August 1987)

Ethyl ether E:0680

Formula: $C_4H_{10}O$; $CH_3CH_2OCH_2CH_3$

Synonyms: Aether; Anaesthetic ether; Anesthesia ether; Anesthetic ether; Diaethylaether (German); Diethyl ether; Diethyl oxide; Eter etilico (Spanish); Ethane, 1,1'-oxybis-; Ether; Ether, ethyl; Ether ethylique (French); Ethoxyethane; Oxyde d'ethyle (French); Solvent ether; Sulfuric ether

CAS Registry Number: 60-29-7

HSDB Number: 70

RTECS Number: KI5775000

UN/NA & ERG Number: UN1155/127 (P)

EC Number: 200-467-2 [*Annex I Index No.:* 603-022-00-4]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration). United States Environmental Protection Agency Gene-Tox Program, Positive: *E. coli polA* without S9; Negative: Aspergillus-forward mutation; Sperm morphology-mouse; Inconclusive: Histidine reversion-Ames test.

Hazard Alert: Extremely flammable, Polymerization hazard, Possible risk of forming tumors, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction).

List II, DEA chemical code 6584 (Title 21 CFR1310.02)

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U117

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.12; Nonwastewater (mg/kg), 160

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: F+, Xn; risk phrases: R12; R19; R22; R62; R66; R67; safety phrases: S1; S2; S9; S16; S33 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Ethyl ether is a colorless, mobile, highly flammable, volatile liquid. Characteristic pungent odor. The Odor Threshold is 0.63 ppm[41]. Molecular weight = 74.12; specific gravity (H 2 O:1) = 0.71; boiling point = 34.5°C; freezing/melting point = −116°C; relative vapor density (air = 1) = 2.62; vapor pressure = 750 mmHg @ 34.1°C; 440 mmHg @ 20°C; flash point = −45°C; autoignition temperature = 180°C. Explosive limits: LEL = 1.9%; UEL: 36.0%[17]. Hazard identification (based on NFPA-704 M Rating System): Health 1, Flammability 4, Reactivity 0. Slightly soluble in water; solubility = 7%.

Potential Exposure: Ethyl ether is used as a solvent for waxes, fats, oils, perfumes, alkaloids, dyes, gums, resins, nitrocellulose, hydrocarbons, raw rubber, and smokeless powder. It is also used as an inhalation anesthetic; a refrigerant; in diesel fuels; in dry cleaning; as an extractant; and as a chemical reagent for various organic reactions.

Incompatibilities: May form explosive mixture with air. Incompatible with strong acids; strong oxidizers halogens, sulfur, sulfur compounds, causing fire and explosion hazard. Can form peroxides from air, heat, sunlight; may explode when container is unstoppered or otherwise opened. Attacks some plastics, rubber and coatings. Being a nonconductor, chemical may accumulate static electric charges that may result in ignition of vapor.

Permissible Exposure Limits in Air

NIOSH IDLH = 1900 ppm [LEL]

OSHA PEL: 400 ppm/1200 milligram per cubic meter TWA

NIOSH REL: None. See Appendix D (NIOSH Pocket Guide)

ACGIH TLV[1]: 400 ppm/1210 milligram per cubic meter TWA; 500 ppm/1560 milligram per cubic meter STEL

PAC Ver. 29[138]

PAC-1: 500 ppm

PAC-2: 3200 ppm

PAC-3: 19,000 ppm

DFG MAK: 400 ppm/1200 milligram per cubic meter TWA; Peak Limitation Category I(1); Pregnancy Risk Group D

Australia: TWA 400 ppm (1200 milligram per cubic meter); STEL 500 ppm, 1993; Austria: MAK 400 ppm (1200 milligram per cubic meter), 1999; Belgium: TWA 400 ppm (1210 milligram per cubic meter); STEL 500 ppm, 1993; Denmark: TWA 400 ppm (1200 milligram per cubic meter), 1999; Finland: TWA 400 ppm (1200 milligram per cubic meter); STEL 500 ppm (1500 milligram per cubic meter), 1999; France: VME 400 ppm (1200 milligram per cubic meter), VLE 500 ppm (1500 milligram per cubic meter), 1999; Hungary: TWA 300 milligram per cubic meter; STEL 600 milligram per cubic meter [skin] 1993; the Netherlands: MAC-TGG 308 milligram per cubic meter, 2003; Norway: TWA 200 ppm (600 milligram per cubic meter), 1999; the Philippines: TWA 400 ppm (1200 milligram per cubic meter), 1993; Poland: MAC

(TWA) 300 milligram per cubic meter, MAC (STEL) 1500 milligram per cubic meter, 1999; Russia: TWA 400 ppm; STEL 300 milligram per cubic meter, 1993; Switzerland: MAK-W 400 ppm (1200 milligram per cubic meter), KZG-W 800 ppm (2400 milligram per cubic meter), 1999; Turkey: TWA 400 ppm (1200 milligram per cubic meter), 1993; United Kingdom: TWA 400 ppm (1230 milligram per cubic meter); STEL 500 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: STEL 500 ppm.

The Czech Republic:[35] TWA 500 milligram per cubic meter; STEL 1500 milligram per cubic meter. Russia[35] set a MAC in the ambient air of residential areas of 1.0 milligram per cubic meter on a once-α-day basis and 0.6 milligram per cubic meter on a daily average basis. Several states have set guidelines or standards for ethyl ether in ambient air[60] ranging from 0.16 milligram per cubic meter (Massachusetts) to 12.0−15.0 milligram per cubic meter (North Dakota) to 20.0 milligram per cubic meter (Virginia) to 24.0 milligram per cubic meter (Connecticut, Florida, New York) to 28.571 milligram per cubic meter (Nevada).

Determination in Air: Use NIOSH Analytical Method #1610 or OSHA Analytical Method 7[18].

Permissible Concentration in Water: Russia[35,43] set a MAC in water bodies used for domestic purposes of 0.3 mg/L.

Determination in Water: Octanol-water coefficient: Log $K_{ow} = < 1$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation of vapor, ingestion, and skin and/or eye contact.

Harmful Effects and Symptoms

Local: Ethyl ether vapor is mildly irritating to the eyes, nose, and throat. Contact with liquid may produce a dry, scaly, fissured dermatitis. *Systemic:* Ethyl ether has predominantly narcotic properties. Overexposed individuals may experience drowsiness, vomiting, and unconsciousness. Death may result from severe overexposure. Chronic exposure results in some persons in anorexia, exhaustion, headache, drowsiness, dizziness, excitation, and psychic disturbances. Albuminuria has been reported. Chronic exposure may cause an increased susceptibility to alcohol. There is an association between exposure to anesthetic vapors and increased miscarriages and birth defects. Diethyl ether's role in these increased risks in unclear.

Short-Term Exposure: Ethyl ether irritates the eyes and respiratory tract. Inhalation can cause drowsiness, excitement, dizziness, vomiting, irregular breathing and increased saliva. Swallowing the liquid may cause chemical pneumonitis. High exposure can affect the CNS; causing unconsciousness and even death.

Long-Term Exposure: Repeated or prolonged contact can cause skin cracking, scaling and extreme drying. Repeated exposure may cause an addiction.

Points of Attack: CNS; skin, respiratory system, and eyes.

Medical Surveillance: Preplacement or periodic examinations should evaluate the skin and respiratory tract; liver, and kidney function. Persons with a past history of alcoholism may be at some increased risk due to possibility of ethyl ether addiction (known as "ether habit"). Tests for exposure may include expired breath for unmetabolized ethyl ether and blood for ethyl ether content by oxidation with chromate solution or by GC methods. NIOSH lists the following tests: whole blood (chemical/metabolite), expired air, urine (chemical/metabolite).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of salt water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. 8 hours: polyvinyl alcohol gloves; 4 H and Silver Shield gloves; Barricade coated suits; 4 hours: Teflon gloves, suits, boots; Responder suits, Trellchem HPS suits. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: OSHA: 1900 ppm: CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted acid gas canister]; or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]; or Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:*

SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-, mounted organic vapor canister];

or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code-Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. May form peroxides in storage. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Ethyl ether must be stored to avoid contact with strong oxidizers (such as bromine, chlorine, chlorine dioxide, and nitrates), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat and sunlight. Unstable peroxides may form if diethyl ether is exposed for a long time to air or sunlight, causing explosions. Sources of ignition, such as smoking and open flames are prohibited where ethyl ether is handled, used, or stored. Metal containers involving the transfer of five gallons or more of ethyl ether should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of ethyl ether. Wherever ethyl ether is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1155 Diethyl ether or Ethyl ether, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep diethyl ether out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is an extremely flammable liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Concentrated waste containing no peroxides-discharge liquid at a controlled rate near a pilot flame. Concentrated waste containing peroxides-perforation of a container of the waste from a safe distance followed by open burning[22]. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (173); (101); (138); (2); (100);

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 4, No. 1, 81–84 (1984)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Diethyl Ether*, Trenton, NJ (April 2002)

Ethyl formate E:0690

Formula: $C_3H_6O_2$: $HCOOC_2H_5$

Synonyms: Aethylformiat (German); Areginal; Ethyle (formiate d') (French); Ethyl formic ester; Ethyl methanoate; Formic acid, ethyl ester; Formic ether

CAS Registry Number: 109-94-4

HSDB Number: 943

RTECS Number: LQ8400000

UN/NA & ERG Number: UN1190/129

EC Number: 203-721-0 [*Annex I Index No.:* 607-015-00-7]

Regulatory Authority and Advisory Information

Hazard Alert: Highly flammable, Possible risk of forming tumors, Primary irritant (w/o allergic reaction). Banned or Severely Restricted (in agriculture) (UN)[13]

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xi; risk phrases: R11; R20/22; R36/37/38; safety phrases: S2; S9; S16; S21, S24; R26; S33; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Ethyl formate is a colorless liquid with a fruity odor. Molecular weight = 74.09; specific gravity (H_2O:1) = 0.92; boiling point = 54.4°C; freezing/melting point = −80.6; vapor pressure = 200 mmHg @ 20°C; flash point = −20°C; autoignition temperature = 440°C. Explosive limits:

LEL = 2.8%; UEL: 16.0%. Hazard identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 0. Solubility in water = 9% @ 18°C.

Potential Exposure: This material is used as an emulsifier; food and feed additive; flavor, packaging material; as a solvent for cellulose nitrate and acetate; it is used as a fumigant and in the production of synthetic flavors. It is also a raw material in pharmaceutical manufacture.

Incompatibilities: May form explosive mixture with air. Reacts violently with nitrates, strong oxidizers, strong alkalis, and strong acids. Decomposes slowly in water, forming ethyl alcohol and formic acid. May accumulate static electrical charges, and may cause ignition of its vapors.

Permissible Exposure Limits in Air

NIOSH IDLH = 1500 ppm

OSHA PEL: 100 ppm/300 milligram per cubic meter TWA

NIOSH REL: 100 ppm/300 milligram per cubic meter TWA

ACGIH TLV[1]: 100 ppm/303 milligram per cubic meter TWA

PAC Ver. 29[138]

PAC-1: 100 ppm

PAC-2: 1300 ppm

PAC-3: 8000 ppm

DFG MAK: 100 ppm/310 milligram per cubic meter TWA; Peak Limitation Category I(1);[skin]; Pregnancy Risk Group C

Australia: TWA 100 ppm (300 milligram per cubic meter), 1993; Austria: MAK 100 ppm (300 milligram per cubic meter), 1999; Belgium: TWA 100 ppm (303 milligram per cubic meter), 1993; Denmark: TWA 100 ppm (300 milligram per cubic meter), 1999; Finland: TWA 100 ppm (300 milligram per cubic meter), 1999; France: VME 100 ppm (300 milligram per cubic meter), 1999; Norway: TWA 50 ppm (150 milligram per cubic meter), 1999; Poland: MAC (TWA) 100 milligram per cubic meter, MAC (short-term exposure limit) 450 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 300 milligram per cubic meter, 2003; Turkey: TWA 100 ppm (300 milligram per cubic meter), 1993; United Kingdom: TWA 100 ppm (308 milligram per cubic meter), STWL 150 ppm, 2000: Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: TWA 100 ppm. Several states have set guidelines or standards for ethyl formate in ambient air[60] ranging from 3.0−4.5 milligram per cubic meter (North Dakota) to 5.0 milligram per cubic meter (Virginia) to 6.0 milligram per cubic meter (Connecticut) to 7.143 milligram per cubic meter (Nevada).

Determination in Air: Charcoal (tube) adsorption, workup with CS2; analysis by gas chromatography/flame ionization detection; NIOSH Analytical Method (IV) #1452.

Routes of Entry: Inhalation, ingestion, and eye and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Either contact or the vapor can cause skin and eye irritation. Inhalation irritates the respiratory tract. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Ethyl formate may affect the CNS. Exposure can cause headache, nausea, and vomiting.

Long-Term Exposure: Prolonged or repeated contact can cause skin dryness and cracking. May affect the nervous system.

Points of Attack: Eyes, respiratory system, and CNS.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Consider chest X-ray following acute overexposure. Nervous system tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Neoprene, Nitrile and styrene-butadiene rubber are among the recommended protective materials. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Up to 1500 ppm: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]; or CcrOv (APF = 10) [any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s)]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAF (APF = 50) (any SCBA with a

full facepiece); SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:*
SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code-Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well ventilated area away from oxidizers, strong bases; moisture and heat. Where possible, automatically pump liquid from drums or other storage containers to process containers. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1190 Ethyl formate, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition includes oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Spray into a furnace in admixture with a flammable solvent[24].

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Ethyl Formate*, Trenton NJ (March 1999)

2-Ethyl hexaldehyde E:0700

Formula: $C_8H_{16}O$; $(C_2H_5)(C_4H_9)CHCHO$

Synonyms: Butyl ethyl acetaldehyde; 2-Ethylcaproaldehyde; Ethylhexanal; 3-Formylheptane; Hexanal, 2-ethyl-; Octyl aldehyde; β-Propyl-α-ethylacrolein

CAS Registry Number: 123-05-7 (ethyl hexaldehydes)

HSDB Number: 5142

RTECS Number: MN7525000

UN/NA & ERG Number: UN1191/129

EC Number: 204-596-5

Regulatory Authority and Advisory Information

Hazard Alert: Flammable, Primary irritant (w/o allergic reaction).

Hazard symbols, risk, & safety statements: Hazard symbol: Xn, Xi; risk phrases: R10; R36/37/38; R43; R63; safety phrases: S26; S36/37 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Ethyl hexaldehyde is a colorless liquid with a mild, pleasant odor. Molecular weight = 128.24; boiling point = 163°C; flash point = 44.4°C; autoignition temperature = 190°C. Explosive limits: LEL = 0.85% @ 93°C; UEL: 7.2% @ 135°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 1. Slightly soluble in water.

Potential Exposure: It is used as a solvent extraction chemical; in organic synthesis; perfume formulation, disinfectant.

Incompatibilities: May form explosive mixture with air. Violent reaction with oxidizers. Incompatible with strong acids; caustics, ammonia, amines. May ignite spontaneously when spilled on clothing or other absorbent materials. May form unstable peroxides on contact with air; under certain conditions ignites spontaneously with air.

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Routes of Entry: Skin absorption, inhalation, and ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Skin or eye contact can cause severe irritation or burns. The vapors can irritate the eyes, throat and bronchial tubes, with coughing and difficulty breathing. Headaches and nausea may occur. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: Repeated exposure may cause bronchitis with cough, phlegm and shortness of breath.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Evaluation by a qualified allergist, including careful exposure history and special testing may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed.

Personal Protective Methods: Wear solvent-resistant gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures to ethyl hexaldehyde exists, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with ethyl hexaldehyde all handlers should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well ventilated area away from oxidizers, strong bases and combustible materials. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1191 Octyl aldehydes, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep ethyl hexaldehyde out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition includes oxides of carbon. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 8, 71−72 (1981) and 3, No. 2, 47−48 (1983)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Ethyl Hexaldehyde*, Trenton, NJ (January 1999)

2-Ethylhexyl acrylate E:0710

Formula: $C_{11}H_{20}O_2$: $CH_2 = CHCOOCH_2CH(C_2H_5)(C_4H_9)$

Synonyms: Acrilato de 2-etilhexilo (Spanish); Acrylic acid, 2-ethylhexyl ester; 2-Ethylhexyl 2-propenoate; Octyl acrylate; 2-Propenoic acid 2-ethylhexyl ester

CAS Registry Number: 103-11-7; *(alt.)* 78733-32-1; *(alt.)* 84948-57-2; *(alt.)* 93460-77-6

HSDB Number: 1121

RTECS Number: AT0855000

UN/NA & ERG Number: NA1993 (Combustible liquid, n. o.s.)/128 (P)

EC Number: 203-080-7 [*Annex I Index No.:* 607-107-00-7]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human Inadequate Evidence; Animal Limited Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1994.

Hazard Alert: Combustible, Polymerization hazard (nonstabilized), Possible risk of forming tumors, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction), Environmental hazard.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long lasting effects[194]. Harmful to aquatic life with long lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xi; risk phrases: R10; R19; R37/38; R43; R61; R62; safety phrases: S7; S16; S29/35; sensitization hazard, S36/37; S45; S46 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: 2-Ethylhexyl acrylate is a combustible, colorless liquid with a pleasant odor. Molecular weight = 184.31; specific gravity (H_2O:1) = 0.89 @ 20°C; boiling point = 214°C; freezing/melting point = −90°C; vapor pressure = 1 mmHg @ 50°C; flash point = 82°C; autoignition temperature = 252°C. Explosive limits: LEL = 0.8%; UEL: 6.4%. Hazard identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 2. Insoluble in water.

Potential Exposure: A potential danger to those involved in the use of this monomer as a feedstock for chemical syntheses; in the manufacture of plastics; protective coatings, including water-based paints; in paper treatment; the production of emulsion polymers.

Incompatibilities: Unless inhibited, sunlight, heat, contaminants, or peroxides can cause dangerous polymerization. Vapors are uninhibited and may polymerize, blocking vents. Violent reaction with strong oxidizers, with risk of fire and explosions. May form explosive mixture with air. Incompatible with strong acids; aliphatic amines; alkanolamines.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 15 ppm

PAC-2: 120 ppm

PAC-3: 150 ppm

DFG MAK: 5 ppm/38 milligram per cubic meter TWA; Peak Limitation Category I(1); Pregnancy Risk Group D; [skin] danger of skin sensitization

Poland: TWA 35 milligram per cubic meter; STEL 100 milligram per cubic meter, 1999; Russia: STEL 1 milligram per cubic meter, 1993.

Determination in Water: Octanol-water coefficient: Log $K_{ow} = > 3.6$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Skin absorption.

Harmful Effects and Symptoms

Short-Term Exposure: Severely irritates the eyes and skin. Irritates the respiratory tract. High exposure may cause respiratory difficulty and collapse. CNS stimulation following ingestion.

Long-Term Exposure: Repeated or prolonged contact may cause skin allergy.

Points of Attack: Skin.
Medical Surveillance: Evaluation by a qualified allergist.
First Aid: *Skin Contact:*[52] Flood all areas of body that have contacted the substance with water. Don't wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others. *Eye Contact:* Remove any contact lenses at once. Flush eyes well with copious quantities of water or normal saline for a least 20−30 minutes. Seek medical attention. *Inhalation:* If convulsions are not present, give a glass or two of water or milk to dilute the substance. Assure that the person's airway is unobstructed and contact a hospital or poison center immediately for advice on whether or not to induce vomiting. *Ingestion:* If convulsions are not present, give a glass or two of water or milk to dilute the substance. Assure that the person's airway is unobstructed and contact a hospital or poison center immediately for advice on whether or not to induce vomiting.
Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.
Storage: Color code-Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well ventilated area separated from strong oxidants, strong bases; strong acids. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.
Shipping: *Note:* Unless inhibited, this material is a polymerization hazard. May be classified as a NA1993 Combustible liquid, n.o.s. This class of compounds requires no particular shipping label. It falls in Hazard Class 3. Each reference to a Class 3 material is modified to read "COMBUSTIBLE LIQUID" when that material is reclassified in accordance with §173.150 (e) or (f) of this subchapter, or has a flash point above 60.5°C/141°F but below 93°C/200°F.
Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.
Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical or carbon dioxide. Water or foam may cause frothing[41]. Vapors are uninhibited and may polymerize, blocking vents. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.
Disposal Method Suggested: Spray into incinerator with added flammable solvent.
References

(31); (173); (101); (138). (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 7, 57−59 (1981) and 3, No. 2, 83−85 (1983)

Ethylidene norbornene E:0720

Formula: C_9H_{12}
Synonyms: ENB; 5-Ethylidenebicyclo(2,21)hept-2-ene; 5-Ethylidene-2-norbornene (stabilized)
CAS Registry Number: 16219-75-3
HSDB Number: 1160
RTECS Number: RB9450000
UN/NA & ERG Number: UN1993 (flammable liquids, n.o.s.)/128
EC Number: 240-347-7

Regulatory Authority and Advisory Information

Hazard Alert: Flammable liquid, Sensitization hazard, Suspected of causing genetic defects, Environmental hazard, Primary irritant (w/o allergic reaction).

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long lasting effects[293]. Toxic to aquatic life with long lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: F+, Xi, N; risk phrases: R2; R11; R62; safety phrases: S16; S29/35; S33; S41; S45(see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: 5-Ethylidene- 2-norbornene is a colorless liquid with a turpentine-like odor. The Odor Threshold is 0.007 ppm[41]. Molecular weight = 120.19; boiling point = 148°C; freezing/melting point = −80°C; vapor pressure = 4 mmHg; flash point = 38.3°C. Explosive limits: LEL = 8000 ppm; UEL: unknown. Hazard identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 0. Insoluble in water.

Potential Exposure: 5-Ethylidene-2-norbornene is used as the third monomer in terpolymer elastomers. Those engaged in the synthesis of pharmaceuticals; pesticides, or in the preparation of specialty resins.

Incompatibilities: May form explosive mixture with air. Reacts violently with strong oxidants. Violent reaction with oxygen and strong oxidizers. May accumulate static electrical charges, and may cause ignition of its vapors. The substance may polymerize. Inhibit peroxide formation with *tert*-butyl catechol. ENB should be stored in a nitrogen atmosphere since it reacts with oxygen.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 4.92 milligram per cubic meter @ 25°C & 1 atm
OSHA PEL: None
NIOSH REL: 5 ppm/25 milligram per cubic meter Ceiling Concentration
ACGIH TLV[11]: 5 ppm/25 milligram per cubic meter Ceiling Concentration
PAC* Ver. 29[138]8
PAC-1: $\mathbf{0.2}_{\mathbf{A}}$ ppm
PAC-2: $\mathbf{100}_{\mathbf{A}}$ ppm
PAC-3: $\mathbf{500}_{\mathbf{A}}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

Australia: TWA 5 ppm (25 milligram per cubic meter), 1993; Belgium: STEL 5 ppm (25 milligram per cubic meter), 1993; Denmark: TWA 5 ppm (25 milligram per cubic meter), 1999; Finland: TWA 5 ppm (25 milligram per cubic meter); STEL 10 ppm (50 milligram per cubic meter), 1999; France: VLE 5 ppm (25 milligram per cubic meter), 1999; Norway: TWA 5 ppm (25 milligram per cubic meter), 1999; Switzerland: MAK-W 5 ppm (25 milligram per cubic meter), 1999; the Netherlands: MAC 25 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: Ceiling Concentration 5 ppm. Several states have set guidelines on standards for ethylidene norbornene in ambient air[60] ranging from 200.0 μ/m^3 (Virginia) to 250.0 μ/m^3 (North Dakota) to 595.0 μ/m^3 (Nevada).

Determination in Air: No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Routes of Entry: Inhalation, skin absorption, ingestion, and skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Exposure can irritate the eyes, nose, and respiratory tract. Contact can irritate and may burn the skin and eyes. Exposure can cause headache, confusion, nausea and vomiting. Ingestion of the liquid may cause chemical pneumonitis. Exposure to high concentrations may cause unconsciousness and cause death.

Long-Term Exposure: Repeated or high exposure may damage the liver, lungs and kidneys. Ethylidene norbornene may damage the testes (male reproductive glands).

Points of Attack: Eyes, skin, respiratory system, CNS, liver, kidneys, urogenital system, and bone marrow

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function tests. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Reproductive history and possibly semen analysis with sperm count.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure,

begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures *over* 5 ppm; Use an NIOSH/MSHA or European Standard EN 149-approved full facepiece respirator with an organic vapor cartridge/canister. Increased protection is obtained from full facepiece powered APRs. *Where there is potential for high exposures exists*, use an NIOSH/MSHA or European Standard EN 149-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use an NIOSH/MSHA or European Standard EN 149-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Ethylidene norbornene should be stored in a nitrogen atmosphere. Do not allow it to come in contact with oxygen because violent reactions can occur.

Shipping: UN1993 Flammable liquids, n.o.s., Hazard Class: 3; Labels: 3-Flammable liquid, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition includes oxides of carbon. Use dry chemical, carbon dioxide; or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Ethylidene Norbornene*, Trenton, NJ (January 1999)

Ethyl isocyanate E:0730

Formula: C_3H_5NO; C_2H_5NCO

Synonyms: Isocyanatoethane; Isocyanic acid, ethyl ester

CAS Registry Number: 109-90-0

HSDB Number: 6318

RTECS Number: NQ8825000

UN/NA & ERG Number: (PIH) UN2481/155

EC Number: 203-717-9

Regulatory Authority and Advisory Information

Hazard Alert: Poison inhalation hazard, Highly flammable liquid, Water reactive, Sensitization hazard, Suspected of causing genetic defects.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, F, Xi; risk phrases: R11, R20/21; R22; R25; R29; R36/37/38; R42/43; R50/53; R62; safety phrases: S16; S21, S26; S36/37/39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Ethyl Isocyanate is a clear, colorless liquid with a pungent odor. Molecular weight = 71.08; specific gravity (H_2O:1) = 0.91 @ 20°C; boiling point = 60°C; vapor pressure = 100 mmHg @ 25°C; flash point = −10°C;

≤ 23°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, Flammability 3, Reactivity 2 ₩. Hydrolyzes in water, releasing carbon dioxide.

Potential Exposure: Ethyl isocyanate is used to make pharmaceuticals and pesticides.

Incompatibilities: Vapor may form explosive mixture with air. May form explosive mixture with air. Isocyanates are highly flammable and reactive with many compounds, even with themselves. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Reaction with moist air, water or alcohols may form amines and insoluble polyureas and react exothermically, releasing toxic, corrosive or flammable gases, including carbon dioxide; and, at the same time, may generate a violent release of heat increasing the concentration of fumes in the air. Incompatible with amines, aldehydes, alkali metals, ammonia, carboxylic acids, caprolactum, alkaline materials, glycols, ketones, mercaptans, hydrides, organotin catalysts, phenols, strong acids, strong bases, strong reducing agents such as hydrides, urethanes, and ureas. Elevated temperatures or contact with acids, bases, tertiary amines, and acyl-chlorides may cause explosive polymerization. Contact Attacks some plastics, rubber and coatings. Contact with metals may evolve flammable hydrogen gas. May accumulate static electrical charges, and may cause ignition of its vapors.

Permissible Exposure Limits in Air

PAC* Ver. 29[138]

PAC-1: 0.0031 ppm

PAC-2: $\mathbf{0.034_A}$ ppm

PAC-3: $\mathbf{0.10_A}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values. *Face*.

Routes of Entry: Inhalation and passes through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Ethyl isocyanate can irritate the eyes, skin and respiratory tract. Skin contact can cause a rash. Exposure can irritate the nose and throat. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: Similar chemicals cause lung and skin allergies. It is not known if ethyl isocyanate does this.

Points of Attack: Skin and lungs.

Medical Surveillance: For those with frequent or potentially high exposure, the following are recommended before beginning work and at regular times after that. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. These may be normal if the person is not having an attack at the time of the test. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures to ethyl isocyanate exists, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: PIH; check oxygen content prior to entering storage area.(1) Color code-Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. (2) Color code-Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames are prohibited where ethyl isocyanate is used, handled, or stored in a manner that could create a potential fire or exposition hazard. Use only non-sparking tools and equipment, especially when opening and closing containers of ethyl isocyanate. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association

Shipping: UN2481 Ethyl isocyanate, Hazard class: 6.1; Labels: 6.1-Poison Inhalation Hazard, 3-Flammable liquid, Inhalation Hazard Zone A. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling:

Initial Isolation and Protective Action Distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24 h response line).

Small Spills (from a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 500/150
Then: Protect persons downwind (mi/km)
Day 1.2/1.9
Night 3.7/5.6

Large Spills (from a large package or from many small packages)

First: Isolate in all directions (ft/m) 3000/1000
Then: Protect persons downwind (mi/km)
Day 7.0 + /11.0 +*
Night 7.0 + /11.0+ *

*+ means distance can be larger in certain atmospheric conditions.

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include hydrogen cyanide and oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Ethyl Isocyanate*, Trenton, NJ (September 2000)

Merck MSDS

Ethyl mercaptan E:0740

Formula: C_2H_6S; C_2H_5SH

Synonyms: Ethanethiol; Ethyl hydrosulfide; Ethyl sulfhydrate; Ethyl thioalcohol; LPG ethyl mercaptan 1010; Mercaptoethane; Thioethanol; Thioethyl alcohol

CAS Registry Number: 75-08-1

HSDB Number: 814

RTECS Number: KI9625000

UN/NA & ERG Number: UN2363/129 (P0

EC Number: 200-837-3 [*Annex I Index No.:* 016-022-00-9]

Regulatory Authority and Advisory Information

Hazard Alert: Extremely flammable liquid, Polymerization hazard, Primary irritant (w/o allergic reaction), Environmental hazard.

Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: F+, Xn, N; risk phrases: R12; R19; R20; R50/53; safety phrases: S2; S16; S25; S29; S41; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Ethyl mercaptan is a yellowish liquid (or a colorless gas above the BP). Strong, sharp odor of garlic or skunk-like odor. Molecular weight = 62.13; specific gravity (H 2 O:1) = 0.83 @ 20°C; boiling point = 35°C; freezing/melting point = -148°C; relative vapor density (air = 1) = 2.14; vapor pressure = 442 mmHg @ 20°C; 750 mmHg @ 34.7°C; flash point ≤ -18°C; autoignition temperature = 299.5°C. Explosive limits: LEL = 2.8%; UEL: 18.0%. Hazard identification (based on NFPA-704M Rating System): Health 2, Flammability 4, Reactivity 1. Practically insoluble in water; solubility = 0.7%.

Potential Exposure: This material is used as a warning odorant for liquefied petroleum gases. It is used as an intermediate in the manufacture of many pesticides and other organic chemicals.

Incompatibilities: May form explosive mixture with air. Slowly forms peroxides. This material is a weak acid. Reacts with oxidizers, causing fire and explosion hazard. Reacts with strong acids evolving toxic and flammable hydrogen sulfide. May accumulate static electrical charges, and may cause ignition of its vapors. Attacks some forms of plastics, coatings and rubber. Aldehydes are frequently involved in self-condensation or polymerization reactions. These reactions are exothermic; they are often catalyzed by acid. Aldehydes are readily oxidized to give carboxylic acids. Flammable and/or toxic gases are generated by the combination of aldehydes with azo, diazo compounds, dithiocarbamates, nitrides, and strong reducing agents. Aldehydes can react with air to give first peroxo acids, and ultimately carboxylic acids. These autoxidation reactions are activated by light, catalyzed by salts of transition metals, and are autocatalytic (catalyzed by the products of the reaction). The addition of stabilizers (antioxidants) to shipments of aldehydes retards autoxidation[101].

Permissible Exposure Limits in Air

NIOSH IDLH = 500 ppm

Conversion factor: 1 ppm = 2.54 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 10 ppm/25 milligram per cubic meter Ceiling Concentration (General Industry); 0.5 ppm/1.3 milligram per cubic meter TWA (Construction and Shipyards)

NIOSH REL: 0.5 ppm/1.3 milligram per cubic meter/15 min, Ceiling Concentration [15-min.]

ACGIH TLV[1]: 0.5 ppm/1.3 milligram per cubic meter TWA

PAC* Ver. 29[138]

PAC-1: $\mathbf{1.0_A}$ ppm

PAC-2: $\mathbf{120_A}$ ppm

PAC-3: $\mathbf{360_A}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

DFG MAK: 0.5 ppm/1.3 milligram per cubic meter TWA; Peak Limitation Category II(2); Pregnancy Risk Group D, *as ethanethiol.*

Australia: TWA 0.5 ppm (1 milligram per cubic meter), 1993; Austria: MAK 0.5 ppm (1 milligram per cubic meter), 1999; Belgium: TWA 0.5 ppm (1.3 milligram per cubic meter), 1993; Finland: STEL 0.5 ppm (1.3 milligram per cubic meter), 1999; France: VME 0.5 ppm (1 milligram per cubic meter), 1999; Hungary: STEL 1 milligram per cubic meter, 1993; the Netherlands: MAC-TGG 1 milligram per cubic meter, 2003; the Philippines: TWA 10 ppm (25 milligram per cubic meter), 1993; Poland: MAC (TWA) 1 milligram per cubic meter, MAC (STEL) 3 milligram per cubic meter, 1999; Russia: STEL 1 milligram per cubic meter [skin] 1993; Switzerland: MAK-W 0.5 ppm (1.3 milligram per cubic meter), KZG-W 1 ppm (2.6 milligram per cubic meter), 1999; Thailand: TWA 10 ppm (25 milligram per cubic meter), 1993; Turkey: TWA 10 ppm (25 milligram per cubic meter), 1993; United Kingdom: TWA 0.5 ppm (1.3 milligram per cubic meter); STEL 2 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: TWA 0.5 ppm. Several states have set guidelines or standards for ethyl mercaptan in ambient air[60] ranging from 3.3 μ/m^3 (New York) to 10.0 μ/m^3 (Florida, North Dakota, South Carolina) to 16.0 μ/m^3 (Virginia) to 20.0 μ/m^3 (Connecticut) to 24.0 μ/m^3 (Nevada) to 100.0 μ/m^3 (North Carolina).

Determination in Air: Collection filter (special); workup with hydrochloric acid/1,2-dichloroethane; analysis with gas chromatography/flame photometric detection for sulfur, nitrogen, or phosphorus; NIOSH Analytical Method (IV) #2542.

Permissible Concentration in Water: No criteria set but EPA[32] has suggested a permissible ambient goal or 13.8 μg/L based on health effects.

Determination in Water: Octanol-water coefficient: Log $K_{ow} = 1.5$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion, and eye and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Contact can cause skin and eye irritation. Inhalation can irritate the respiratory tract and pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Exposure can cause headaches, nausea, vomiting, diarrhea, muscle weakness, and tiredness. May affect the CNS; causing convulsions and respiratory failure. High levels may cause dizziness, lightheadedness, coma and death.

Long-Term Exposure: Repeated exposure can cause lung irritation and bronchitis. May cause liver and kidney damage. Repeated or long-term exposure may damage the red blood cells, causing anemia.

Points of Attack: Eyes, respiratory system, liver, kidneys, and blood.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Complete blood cell count (CBC). Liver and kidney function tests. Consider chest X-ray following acute overexposure. NIOSH lists the following tests: Blood Gas Analysis, electrocardiogram, expired air, pulmonary function tests; sputum cytology; white blood cell count/differential.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of salt water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. 4 hours: Teflon gloves, suits, boots. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: 5 ppm: CcrFOv (APF = 50) [any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s)]; or Sa (APF = 10) (any supplied-air respirator). 12.5 ppm: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]. 25 ppm: CcrFOv (APF = 50) [any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s)]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted acid gas canister]; or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTOv (APF = 50) [any powered, air-purifying respirator with a tight-fitting facepiece and organic vapor cartridge(s)]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). 500 ppm: Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-, mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code-Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well ventilated area separated from strong oxidants, strong bases; strong acids. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2363 Ethyl mercaptan, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Use SCBA during cleanup[57]. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable gas or liquid. Thermal decomposition products may include oxides of sulfur and carbon. *Liquid:* Use dry chemical, carbon dioxide; halon, or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode. *Gas:* Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration (1093°C) followed by scrubbing with a caustic solution[22].

References

(31); (173); (101); (138); (122); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Ethyl Mercaptan*, Trenton, NJ (March 1999)

Ethyl mercuric chloride E:0750

Formula: C_2H_5ClHg; C_2H_5HgCl

Synonyms: Ceresan; Chloroethyl mercury; EMC; Ethylmercuric chloride; Ethylmercury chloride; Granosan; Granozan

CAS Registry Number: 107-27-7

HSDB Number: 6424

RTECS Number: OV9800000

UN/NA & ERG Number: UN2025 (mercury compounds, solid, n.o.s.)/151; UN2777 (Mercury based pesticides, solid, toxic)/151

EC Number: 203-478-0 [*Annex I Index No.:* 080-00-2-6]

Regulatory Authority and Advisory Information

California Proposition 65 Developmental/Reproductive toxin (mercury and mercury compounds) 7/1/1990.

Hazard Alert: Poison, Organometallic, Strong reducing agent, Suspected reprotoxic hazard.

United States National Primary Drinking Water Regulations: MCLG = 0.002 mg[Hg]/L; MCL = 0.002 mg[Hg]/L as mercury.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, N; risk phrases: R6; R26; R48/23; R50/53; R61; R63; safety phrases: S53; S45; S60; S61.

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)]

Description: Ethyl mercuric chloride, an alkyl-organo mercury compound, is silvery white, forming leaf-like crystals. Molecular weight = 265; freezing/melting point = 192°C. Explosive limits: LEL = 17,000 ppm; UEL: unknown. Insoluble in water.

Potential Exposure: Ethyl mercuric chloride is used as an organic fungicide for seed treatment.

Incompatibilities: A strong reducing agent, Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides. Sensitive to light.

Permissible Exposure Limits in Air

NIOSH IDLH = 2 mg[Hg]/m^3

OSHA PEL: 0.01 mg[Hg]/m^3 TWA; 0.04 milligram per cubic meter Ceiling Concentration

NIOSH REL: 0.01 mg[organomercury]/m^3 TWA; 0.03 milligram per cubic meter STEL [skin]

ACGIH TLV[1]: 0.01 mg[Hg]/m^3 TWA; 0.03 milligram per cubic meter STEL [skin]

PAC Ver. 29[138]

PAC-1: 0.04 milligram per cubic meter

PAC-2: 0.53 milligram per cubic meter

PAC-3: 2.6 milligram per cubic meter

DFG MAK: 0.01 mg[Hg]/m^3 [skin] Danger of skin sensitization; Carcinogen Category 3

Russia[43] set a MAC in work-place air of 0.005 milligram per cubic meter and a MAC for ambient air in residential areas of 0.0009 milligram per cubic meter on a momentary basis and 0.0001 milligram per cubic meter on an average daily basis.

Determination in Air: No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Permissible Concentration in Water: A severe marring pollutant. Federal Drinking Water Standards: EPA 2 μg[Hg]/L; Federal Drinking Water Guidelines: EPA 2 μg[Hg]/L; State Drinking Water Guidelines: Arizona 3 μg[Hg]/L.

Routes of Entry: Inhalation, skin absorption, ingestion, and skin and/or eye contact.

Harmful Effects and Symptoms

Symptoms of exposure to this compound may include headache, paresthesia of the tongue, lips, fingers and toes, other nonspecific dysfunction, metallic taste, slight GI disturbances, excessive flatulence and diarrhea. Acute poisoning may cause irritation of the GI tract and renal failure. Nervous symptoms usually appear first. They include fine tremors of extended hands, loss of side vision and slight loss of coordination. Other symptoms include incoordination in speech, writing and gait. Incoordination progresses to inability to stand or carry out voluntary movements. Muscle atrophy, flexure contractions, generalized myoclinic movements, difficulty understanding speech, irritability and bad temper progressing to mania, stupor coma and mental retardation may occur. Symptoms of exposure to this type of compound include CNS effects, ataxia, chorea, athetosis and convulsions. Ingestion of this type of compound may cause urticaria, stomatitis, salivation, anemia, leukopenia and liver damage. Inhalation of this type of compound can cause salivation, stomatitis, loosening of the teeth, blue lines on gums, pain and numbness in the extremities, nephritis, anxiety, weight loss, anorexia, mental depression, insomnia, irritability, instability, hallucinations and evidences of mental deterioration. This class of compound is a primary skin irritant which may cause dermatitis, skin burns and sensitization[101].

Short-Term Exposure: Ethyl mercuric chloride is an extremely toxic chemical that can cause permanent brain damage weeks after exposure with little or no warning during exposure. LD_{50} = (oral-rat) 40 mg/kg. Severe poisoning can cause death. It enters the body through the lungs, skin and contaminated hands. Poisoning causes a "pins and needles" feeling, becoming clumsy and weak; hearing loss; abnormal walking; tremors, personality changes and other brain damage. Eye contact may cause severe irritation.

Long-Term Exposure: Ethyl mercuric chloride should be handled as a teratogen-with extreme caution. It may cause mutations. Handle with extreme caution. Mercury accumulates in the body. May cause kidney damage. It can take months or years for the body to get rid of excess mercury.

Points of Attack: Eyes, skin, CNS, peripheral nervous system, and kidneys.

Medical Surveillance: NIOSH lists the following tests: body hair/nail; whole blood (chemical/metabolite); neurologic Examination/Electromyography. Before first exposure and every 6−12 months after, a complete medical history and exam is strongly recommended, with: exam of the nervous system including handwriting. Visual exam, including "visual field" exam. Hearing tests. Test for mercury in hair and blood. After suspected illness or overexposure, repeat these tests promptly, again in 4−6 weeks and then as recommended by your doctor. Kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to Physician: For severe poisoning BAL, dimercaprol, dithiopropanol ($C_3H_8OS_2$) has been used to treat toxic symptoms of certain heavy metals poisoning—including mercury. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate [CAS: 134-72-5].

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Up to 0.1 milligram per cubic meter: Sa (APF = 10) (any supplied-air respirator). Up to 0.25 milligram per cubic meter*:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). Up to 0.5 milligram per cubic meter: SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). Up to 2 milligram per cubic meter*:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus). *Escape:* SCBAE (any appropriate escape-type, SCBA).

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers (such as perchlorates, peroxides, permanganates, chlorates and nitrates).

Shipping: UN2025 Mercury compounds, solid, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN2777 Mercury based pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Spills should be collected with special mercury vapor suppressant or special vacuums. Kits specific for clean-up of mercury spills should be available. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemicals appropriate for extinguishing metal fires. *Do not use water*. Thermal decomposition products may include corrosive hydrogen chloride and very toxic oxides of mercury (HgOx) and carbon and fumes of chloride ion and mercury. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR 165 recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (100).

For a related compound which is not regulated but which was on the United States Environmental Protection Agency Extremely Hazardous Chemical List in 1985 (dropped in 1988), see the following: United States Environmental Protection Agency, Chemical Hazard Information Profile: *Ethylmercuric Phosphate*, Washington, DC, Chemical Emergency Preparedness Program (October 31, 1985)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Ethyl Mercuric Chloride*, Trenton, NJ (January 2000)

Ethyl methacrylate E:0760

Formula: $C_6H_{10}O_2$: $CH_2 = C(CH_3)COOC_2H_5$

Synonyms: Ethyl 1-2-methacrylate; Ethyl α-methylacrylate; Ethyl 2-methyl-2-propenoate; Metacrilato de etilo (Spanish); Methacrylic acid, ethyl ester; 1-2-Methacrylic acid, ethyl ester; 2-Methyl-2-propenoic acid, ethyl ester; 2-Propenoic acid, 1-methyl-, ethyl ester; Rhoplex; Rhoplex AC-33 (Rohm & Haas)

CAS Registry Number: 107-27-7

HSDB Number: 6424

RTECS Number: OZ4550000

UN/NA & ERG Number: UN2277 (stabilized)/130 (P)

EC Number: 202-597-5 [*Annex I Index No.:* 607-071-00-2]

Regulatory Authority and Advisory Information

Hazard Alert: Highly flammable, Sensitization hazard, Polymerization hazard (nonstabilized), Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction).

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U118

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.14; Nonwastewater (mg/kg), 160

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8015 (10); 8240 (5)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1000 lb (454 kg)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%, methacrylic acid, ethyl ester

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xi; risk phrases: R11; R36/37/38; R43; R62; R63; safety phrases: S2; S9; S16; S21, S33; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Ethyl methacrylate is a colorless liquid. Molecular weight = 114.16; specific gravity (H_2O:1) = 0.9 @ 20°C; boiling point = 119°C; freezing/melting point ≤ -75°C; vapor pressure = 20.6 mmHg @ 20°C; flash point = 20°C; autoignition temperature = 393°C. Explosive limits: LEL = 1.8%; 28,000 ppm[138]; UEL: unknown. Hazard identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 2. Slightly soluble in water.

Potential Exposure: This chemical is used in manufacture of coatings, resins, and lacquers. Widely known as "Plexiglass" (in the polymer form), ethyl methacrylate is used to make polymers, which in turn are used for building, automotive, aerospace, and furniture industries. It is also used by dentists as dental plates, artificial teeth, and orthopedic cement.

Incompatibilities: May form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides. Corrodes some metals. Unless inhibited, violent polymerization can occur from heat, sunlight, and contact with strong oxidizers.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 0.04 ppm

PAC-2: 0.53 ppm

PAC-3: 2.6 ppm

DFG MAK: [skin] danger of skin sensitization.

Denmark: TWA 50 ppm (235 milligram per cubic meter), 1999; Norway: TWA 50 ppm (250 milligram per cubic meter), 1999; Russia: STEL 50 milligram per cubic meter, 1993; Sweden: NGV 50 ppm (250 milligram per cubic meter), KTV 75 ppm (350 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 48 milligram per cubic meter, 2003.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short-Term Exposure: A lacrimator. Exposure can irritate the eyes, skin, and respiratory tract. Very high vapor levels could cause you to feel dizzy, lightheaded and even to pass out. Contact can irritate the eyes and skin.

Long-Term Exposure: Repeated or prolonged contact with skin may cause allergy with rash and itching. May damage the nervous system. There is limited evidence that ethyl methacrylate may damage the developing fetus.

Points of Attack: Skin and CNS.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Exam of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. There is evidence that fluorinated ethylene propylene materials offer protection from ethyl methacrylate for up to 3 hours. Polyvinyl alcohol is also among the recommended protective materials. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures to ethyl methacrylate exists, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, (such as perchlorates, peroxides, permanganates, chlorates and nitrates). Sources of ignition, such as smoking and open flames, are prohibited where ethyl methacrylate is handled, used, or stored. Metal containers involving the transfer of five gallons or more of ethyl methacrylate should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of ethyl methacrylate.

Shipping: UN2277 Ethyl methacrylate, stabilized, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep ethyl methacrylate out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (173); (101); (138). (100).

United States Environmental Protection Agency, *Ethyl Methacrylate, Health and Environmental Effects Profile No. 101*, Washington, DC, Office of Solid Waste (April 30, 1980)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Methyl Methacrylate*, Trenton, NJ (July 2002)

Ethyl methane sulfonate E:0770

Formula: $C_3H_8O_3S$; $C_2H_5OSO_2CH_3$

Synonyms: EMS; ENT 26,396; Ethyl ester of methanesulfonic acid; Ethyl ester of methylsulfonic acid; Ethyl ester of methylsulphonic acid; Ethyl hydrosulfide; Ethyl mesylate; Ethyl methanesulphonate; Ethyl methansulfonate; Ethyl methansulphonate; Ethyl methyl sulfonate; Half-myderan; Methanesulphonic acid ethyl ester; Methylsulfonic acid, ethyl ester; NSC 26805

CAS Registry Number: 62-50-0

HSDB Number: 4007

RTECS Number: PB2100000

UN/NA & ERG Number: UN2810 (toxic liquid, organic, n.o.s.)/153

EC Number: 200-536-7

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Animal Sufficient Evidence; Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B, 1987.

California Proposition 65 Chemical[102]: Cancer 1/1/1988

Hazard Alert: Poison, Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Drug.

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U119

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T; risk phrases: R45; R22; R23/24/25; R36/37/38; R46; R50/53; R62; R63; safety phrases: S23; S26; S36/37/39; S41; S45; S53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Ethyl methane sulfonate is a clear liquid. Molecular weight = 124.17; specific gravity (H_2O:1) = 1.15 @ 20°C; boiling point = 213°C; vapor pressure = 0.33 mmHg @25°C; flash point = 100°C. Explosive limits: LEL = 20,000 ppm; UEL: unknown. Hazard identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 1. Soluble in water; solubility = 50 g/L @ 27°C.

Potential Exposure: Used as a research tool for mutagenesis and carcinogenesis studies. Was considered as a possible human male contraceptive. Also considered as a reversible male hemosterilant for insects and mammalian pests.

Incompatibilities: Vapors may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides. Contact with moisture may cause hydrolysis or other forms of decomposition.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 2.1 milligram per cubic meter

PAC-2: 23 milligram per cubic meter

PAC-3: 140 milligram per cubic meter

Determination in Air: No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Permissible Concentration in Water: Octanol-water coefficient: Log $K_{ow} = < 0.1$. Unlikely to bioaccumulate in marine organisms.

Harmful Effects and Symptoms

Short-Term Exposure: Harmful if swallowed. Irritation of skin, eyes and mucous membranes; sores and burns. LD_{50} = 470 mg/kg.

Long-Term Exposure: A carcinogen in animals. A possible mutagen, genetic effects; Suspected of causing genetic defects.

First Aid: *Skin Contact:*[52] Flood all areas of body that have contacted the substance with water. Don't wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others. *Eye Contact:* Remove any contact lenses at once. Flush eyes well with copious quantities of water or normal saline for at least 20−30 minutes. Seek medical attention. *Inhalation:* Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion:* If convulsions are not present, give a glass or two of water or milk to dilute the substance. Assure that the person's airway is unobstructed and contact a hospital or poison center immediately for advice on whether or not to induce vomiting.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100 F (APF = 50) (any air purifying, full-face-piece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA)

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in a cool, dry place or a refrigerator away from acids and acid fumes. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2810 Toxic liquids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. *Land spill:* Build dikes to contain the flow of spilled compound and fire-fighting water, if any. Absorb the compound on bentonite, sawdust, clay or carbon. Alternatively, add a 5% solution of sodium hydroxide. Collect the waste in barrels for later disposal or treatment. *Spill on water body:* If the spill occurs on a large flowing water body, add a 5% solution of sodium hydroxide. Collect the waste in barrels for later disposal or treatment. In case of spill on nonflowing small water body, add 5% caustic followed by carbon adsorption or biological treatment depending on the end uses of the water. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of sulfur and carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: It is inappropriate and possibly dangerous to the environment to dispose of lab chemicals, expired or waste drugs and pharmaceuticals by flushing them down the toilet or discarding them to the trash. Household quantities of expired or waste pharmaceuticals may be mixed with wet cat litter or coffee grounds, double-bagged in plastic, discard in trash. Larger quantities shall carefully take into consideration applicable DEA, EPA, and FDA regulations. If possible return the pharmaceutical to the manufacturer for proper disposal being careful to properly label and securely package the material. Alternatively, the waste pharmaceutical shall be labeled, securely packaged and transported by a state licensed medical waste contractor to dispose by burial in a licensed hazardous or toxic waste landfill or incinerator. Nonaqueous wastes may be treated in an incinerator, boiler, or cement kiln where temp and residence time are in excess of 1000°C and 25 seconds, respectively. Alternatively, the nonaqueous wastes may be disposed of in an RCRA-approved landfill. The detoxified aqueous waste may be treated using biological wastewater methods or disposed of through deep-well injection. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(109); (102); (31); (173); (101); (138). (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 7, No. 2, 67−74 (1987)

N-Ethylmorpholine E:0780

Formula: $C_6H_{13}NO$

Synonyms: Ethylmorpholine; 4-Ethylmorpholine; NEM

CAS Registry Number: 100-74-3

HSDB Number: 1644

RTECS Number: QE4025000

UN/NA & ERG Number: UN1993 (flammable liquids, n.o.s.)/128; UN2920 (corrosive liquid, flammable, n.o.s.)/132

EC Number: 202-885-0

Regulatory Authority and Advisory Information

Hazard Alert: Highly flammable liquid, Corrosive, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction).

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: F, T, C, Xi; risk phrases: R11; R21; R22; R34; R63; safety phrases: S16; S21, S26; S36/37/39; S45; S63; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: 4-Ethylmorpholine is a colorless liquid with an ammonia-like odor. Molecular weight = 115.20; specific gravity (H_2O:1) = 0.90; boiling point = 138.3°C; freezing/melting point = −62.8°C; vapor pressure = 6.2 mmHg @ 20°C; flash point = 28.3°C (oc); autoignition temp = 275°C. Explosive limits: LEL = 0.9%; UEL: 4.0%. Hazard identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 0. Soluble in water; aqueous solution is alkaline.

Potential Exposure: Primary irritant (without allergic reaction). This material is used as a catalyst in polyurethane foam production. It is a solvent for dyes and resins. It is used as an intermediate in surfactant, dye, pharmaceutical, and rubber chemical manufacture.

Incompatibilities: May form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides. Attacks some plastics, rubber and coatings.

Permissible Exposure Limits in Air

NIOSH IDLH = 100 ppm

Conversion factor: 1 ppm = 4.71 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 20 ppm/94 milligram per cubic meter TWA [skin]

NIOSH REL: 5 ppm/23 milligram per cubic meter TWA [skin]

ACGIH TLV[1]: 5 ppm/24 milligram per cubic meter TWA [skin]

No PAC available

Australia: TWA 5 ppm (23 milligram per cubic meter), [skin], 1993; Belgium: TWA 5 ppm (24 milligram per cubic meter), [skin], 1993; Denmark: TWA 5 ppm (23.5 milligram per cubic meter), [skin], 1999; Finland: TWA 5 ppm (47 milligram per cubic meter); STEL 10 ppm (50 milligram per cubic meter), [skin], 1999; France: VME 5 ppm (23 milligram per cubic meter), [skin], 1999; Norway: TWA 5 ppm (23 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 23 milligram per cubic meter, [skin], 2003; Russia: STEL 5 milligram per cubic meter, [skin], 1993; Sweden: NGV 5 ppm (25 milligram per cubic meter), KTV 10 ppm (50 milligram per cubic meter), [skin], 1999; Switzerland: MAK-W 20 ppm (70 milligram per cubic meter), KZG-W 40 ppm (140 milligram per cubic meter), [skin], 1999; United Kingdom: TWA 5 ppm (24 milligram per cubic meter); STEL 20 ppm, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea: ACGIH TLV: TWA 5 ppm [skin]. Several states have set guidelines or standards for *n*-ethylmorpholine in ambient air[60] ranging from 230 μ/m^3 (North Dakota) to 400 μ/m^3 (Virginia) to 460 μ/m^3 (Connecticut) to 548 μ/m^3 (Nevada).

Determination in Air: Adsorption on Si gel, workup with H_2SO_4 using ultrasonics; analysis by gas chromatography/flame ionization. See NIOSH (II-3) Method #S-146.

Routes of Entry: Inhalation, skin absorption, ingestion, and skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Can irritate and burn the skin and eyes. Exposure to high concentration of the vapor can cause drowsiness, foggy vision; visual disturbance; corneal edema; blue-gray vision; seeing colored halos around light.

Long-Term Exposure: Unknown at this time.

Points of Attack: Respiratory system, eyes, and skin.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately

with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: Up to 50 ppm: CcrOv* (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)];or Sa (APF = 10) (any supplied-air respirator).* up to 100 ppm: Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOv* (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]; or CcrFOv (APF = 50) [any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s)]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA). *Substance reported to cause eye irritation or damage; may require eye protection.

Storage: (1) Color code-White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. (2) Color code-Red: Flammability Hazard: Store in a flammable (liquid or solid materials) storage area or approved cabinet away from sources if ignition. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well ventilated area separated from strong oxidants, strong bases; strong acids. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2920 Corrosive liquids, flammable, n.o.s., Hazard class: 8; Labels: 8-Corrosive material, 3-Flammable liquid. UN1993 Flammable liquids, n.o.s., Hazard Class: 3; Labels: 3-Flammable liquid, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition include oxides of nitrogen and carbon. Water may be ineffective. Alcohol foam is recommended[17]. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Controlled incineration (oxides of nitrogen are removed from the effluent gas by scrubbers and/or thermal devices).

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: n-Ethyl Morpholine*, Trenton, NJ (December 2006)

Ethyl phenyl dichlorosilane E:0790

Formula: $C_8H_{10}C_{12}Si$; $C_2H_5(C_6H_5)SiC_{12}$

Synonyms: Dichloroethyl phenylsilane; Ethylphenyldichlorosilane

CAS Registry Number: 1125-27-5

HSDB Number: 443

RTECS Number: VV3270000

UN/NA & ERG Number: UN2435/156

EC Number: 214-407-8

Regulatory Authority and Advisory Information

Hazard Alert: Combustible, Corrosive, Strong reducing agent, Violently reactive with water.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: C; risk phrases: R29; R34; R36/37/38; safety phrases: S23; S24/25; S26; S36/37/39; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Ethyl phenyl dichlorosilane is a colorless liquid. Fumes in humid air. Molecular weight = 205.17; boiling point = 149°C; flash point104°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 2 ₩. Reacts with water, rapidly releasing corrosive hydrogen chloride gas and heat.

Potential Exposure: Used in the manufacture of silicone polymers.

Incompatibilities: A strong reducing agent. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides. Chlorosilanes react vigorously with bases and both organic and inorganic acids generating toxic and/or flammable gases. Chlorosilanes react with water, moist air, or steam to produce heat and toxic, corrosive fumes of hydrogen chloride. They may also produce flammable gaseous hydrogen. Attacks human tissue and metals in the presence of moisture.

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short-Term Exposure: Exposure can irritate the eyes, nose and throat. It is a corrosive chemical and contact can cause severe skin and eye burns leading to permanent eye damage. High levels can irritate the lungs, causing coughing and/or shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: Very irritating substances may affect the lungs.

Points of Attack: Lungs.

Medical Surveillance: For those with frequent or potentially high exposure, the following are recommended before beginning work and at regular times after that. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and do not induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to ethyl phenyl dichlorosilane exists, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe) -approved SCBA with a full facepiece operate in pressure-demand or other positive-pressure mode.

Storage: Color code-White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location; keep acids away from bases and red, yellow, and blue-coded chemicals. Ethyl phenyl dichlorosilane must be stored to avoid contact with water, steam, oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates), and combustible materials (such as wood, paper and oil), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from water, steam and moisture because toxic and corrosive chloride gases, including hydrogen chloride, can be produced. Sources of ignition, such as smoking and open flames are prohibited where ethyl phenyl dichlorosilane is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2435 Ethylphenyldichlorosilane, Hazard class: 8; Labels: 8-Corrosive material.

Spill Handling:

Initial Isolation and Protective Action Distances as Chlorosilanes, Corrosive, n.o.s.

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24 h response line).

Small Spills (from a small package or a small leak from a large package)

When Spilled in Water

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.1/0.2

Large Spills (from a large package or from many small packages)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 0.7/1.2

Stay upwind and uphill. Isolate the area of release or fire and deny entry. Remove all ignition sources. Stop the release if it can be done safely from a distance. All equipment used to handle this material must be grounded. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. *Small spill*: Cover with *dry* earth, *dry* sand, or other noncombustible material followed with plastic sheet to minimize spreading or contact with water or rain. Use clean nonsparking tools to collect material and place material into loosely covered plastic containers for later disposal. Prevent material and runoff from entering sewers and waterways if it can be done safely well ahead of the release. Use vapor suppressing foam to disperse vapors—contain runoff. Water spray may reduce vapor, but may not prevent ignition in enclosed spaces. Ventilate confined area if it can be done without placing personnel at risk. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include phosphine gas, hydrogen chloride and oxides of metal and carbon. *For chlorosilanes do not use water. Use AFFF alcohol-resistant, medium expansion foam. Small fire*: Use *dry* chemical, CO_2, *dry* sand, or alcohol-resistant foam. May react with foams releasing corrosive/toxic gases. *Large fire*: Use water spray or alcohol-resistant foam if it is available in sufficient amounts. Under favorable conditions, experienced crews can use coordinated fog streams to sweep the flames off the surface of the burning liquid. Combustible material: may burn but does not ignite readily. Most vapors are heavier than air. They will spread along ground and collect in low or confined areas (sewers, basements, and tanks). Vapors may travel to source of ignition and flash back. Containers may explode when heated or if contaminated with water. Keep exposures cool long after fire is out to protect against reignition. Do not direct straight streams into the liquid. Cool exposed containers with large quantities of water from unattended equipment or remove intact containers if it can be done safely.

Do not get water on spilled substance or inside containers. If cooling streams are ineffective (*venting sound increases in volume and pitch, tank discolors or shows signs of deforming*), withdraw immediately to a secure location. Always stay away from ends of tanks, especially when engulfed in flames. If material or contaminated runoff from fire control enters waterways, notify downstream users of potentially contaminated water. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Ethyl Phenyl Dichlorosilane*, Trenton, NJ (November 2000)

2-Ethyl-3-propyl acrolein E:0810

Formula: $C_8H_{14}O$
Synonyms: 2-Ethyl-2-hexenal; 2-Ethylhexenal; α-Ethyl-β-*n*-propylacrolein; 2-Ethyl-3-propyl acrolein
CAS Registry Number: 645-62-5
HSDB Number: 1120
RTECS Number: MP6300000
UN/NA & ERG Number: UN1988/131
EC Number: 211-448-3
Regulatory Authority and Advisory Information.
WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: 2-Ethyl-3-propyl acrolein is a colorless or yellowish liquid with a sharp, powerful, irritating odor. Molecular weight = 126.22; boiling point = 175°C; freezing/melting point = 100°C; flash point = 68°C (oc). Hazard identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 1. Slightly soluble in water.

Potential Exposure: Those workers involved in organic synthesis operations and use of this flammable and toxic aldehyde warning agent.

Incompatibilities: Aldehydes are frequently involved in self-condensation or polymerization reactions. These reactions are exothermic; they are often catalyzed by acid. Aldehydes are readily oxidized to give carboxylic acids. Flammable and/or toxic gases are generated by the combination of aldehydes with azo, diazo compounds, dithiocarbamates, nitrides, and strong reducing agents. Aldehydes can react with air to give first peroxo acids, and ultimately carboxylic acids. These autoxidation reactions are activated by light, catalyzed by salts of transition metals, and are autocatalytic (catalyzed by the products of the reaction). The addition of stabilizers (antioxidants) to shipments of aldehydes retards autoxidation[101]. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, caustics, ammonia, and amines.

Permissible Exposure Limits in Air
Russia[43] set a MAC in work-place air of 3 milligram per cubic meter.

Harmful Effects and Symptoms
Short-Term Exposure: This chemical is an irritant, a moderate inhalative and ingestive toxin; and is slightly toxic (LD_{50} = (oral-rat) 3000 mg/kg). It irritates eyes, skin and mucous membranes. Causes smarting of the skin and first degree burns on short exposure. May cause second degree burns on long exposure.

Long-Term Exposure: Very irritating substances may cause lung irritation and bronchitis may develop.

Points of Attack: Lungs.

Medical Surveillance. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Consider chest X-ray following acute overexposure.

First Aid: *Skin Contact:*[52] Flood all areas of body that have contacted the substance with water. Don't wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others. *Eye Contact:* Remove any contact lenses at once. Flush eyes well with copious quantities of water or normal saline for at least 20−30 minutes. Seek medical attention. *Inhalation:* Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion:* If convulsions are not present, give a glass or two of water or milk to dilute the substance. Assure that the person's airway is unobstructed and contact a hospital or poison center immediately for advice on whether or not to induce vomiting.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in cool, dry place and protect from air.

Shipping: UN1988 Aldehydes, flammable, toxic, n.o.s., Hazard Class: 3; Labels: 3-Flammable liquid, 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam (recommended) extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration, or dissolve in flammable solvent and spray into incinerator containing afterburner.

References

(31); (173); (101); (138). (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 8, 72−73 (1981) and 3, No. 2, 48−50 (1983)

Ethyl silicate E:0820

Formula: $C_8H_{20}O_4Si$; $(C_2H_5O)_4Si$

Synonyms: Ethyl orthosilicate; Ethyl silicate, condensed; Ethyl silicate 40; Extrema; Silibone; Silicate d'ethyle (French); Silicic acid tetraethyl ester; TEOS; Tetraethoxysilane; Tetraethyl orthosilicate; Tetraethyl silicate

CAS Registry Number: 78-10-4

HSDB Number: 534

RTECS Number: VV9450000

UN/NA & ERG Number: UN1292/129

EC Number: 201-083-8 [*Annex I Index No.:* 014-005-00-0]

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Flammable, Primary irritant (w/o allergic reaction).

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xn; risk phrases: R10; R20; R36/37; safety phrases: S2; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Ethyl silicate is a colorless, flammable liquid with a sharp odor detectable @ 85 ppm. Molecular weight = 208.37; boiling point = 168.9°C; specific gravity (H_2O:1) = 0.93 @ 25°C; freezing/melting point = −82.8°C; vapor pressure = 1 mmHg @ 20°C; flash point = 54°C (cc). Explosive limits: LEL = 1.3%; UEL: 23%. Hazard identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 0. Slowly hydrolyzes in water.

Potential Exposure: Ethyl silicate is used as a binder in production of cases and molds for investment casting of metals. The next largest application is in corrosion-resistant coatings; primarily as a binder for zinc dust paints. Miscellaneous uses include the protection of white-light bulbs; the preparation of soluble silicas; catalyst preparation and regeneration; and as a crosslinker and intermediate in the production of silicones.

Incompatibilities: May form explosive mixture with air. Strong oxidizers; strong acids; water.

Permissible Exposure Limits in Air

NIOSH IDLH = 700 ppm

OSHA PEL: 100 ppm/850 milligram per cubic meter TWA

NIOSH REL: 10 ppm/85 milligram per cubic meter TWA

ACGIH TLV[1]: 10 ppm/85 milligram per cubic meter TWA

DFG MAK: 10 ppm/86 milligram per cubic meter TWA; Peak Limitation Category I(1); Pregnancy Risk Group D

Australia: TWA 10 ppm (85 milligram per cubic meter), 1993; Austria: MAK 20 ppm (170 milligram per cubic meter), 1999; Belgium: TWA 10 ppm (85 milligram per cubic meter), 1993; Denmark: TWA 10 ppm (85 milligram per cubic meter), 1999; Finland: TWA 10 ppm (85 milligram per cubic meter); STEL 20 ppm (170 milligram per cubic meter), 1999; France: VME 10 ppm (85 milligram per cubic meter), 1999; Japan: 10 ppm (85 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 85 milligram per cubic meter, 2003; Norway: TWA 10 ppm (85 milligram per cubic meter), 1999; the Philippines: TWA 100 ppm (850 milligram per cubic meter), 1993; Poland: MAC (TWA) 80 milligram per cubic meter, MAC (STEL) 250 milligram per cubic meter, 1999; Russia: STEL 20 milligram per cubic meter, 1993; Switzerland: MAK-W 10 ppm (85 milligram per cubic meter), 1999; Turkey: TWA 100 ppm (850 milligram per cubic meter), 1993; United Kingdom: TWA 10 ppm (87 milligram per cubic meter); STEL 30 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: TWA 10 ppm.

Determination in Air: XAD-2 (tube); adsorption on resin, workup with CS2, analysis by gas chromatography/flame ionization. NIOSH II,[3] Method S-264.

Routes of Entry: Inhalation of vapor, ingestion, and skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Skin or eye contact can cause severe irritation or burns. The vapor can irritate the nose, eyes, throat, and bronchial tubes causing cough and difficulty breathing. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: Repeated skin contact can cause drying and cracking. Exposure can affect the nervous system causing tremors, weakness, dizziness, and unconsciousness. High or repeated exposure may damage the liver, kidneys, lungs, and red blood cells.

Points of Attack: Eyes, respiratory system, liver, kidneys, blood, and skin

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that. Lung function tests. Kidney and liver function test. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Liver function tests and CBC.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Remove clothing immediately if wet or contaminated to avoid flammability hazard. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: 100 ppm: Sa (APF = 10) (any supplied-air respirator). 250 ppm: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). 500 ppm: SCBAF (APF = 50) (any SCBA with full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). 700 ppm: SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-, mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code-Red: Flammability Hazard: Store in a flammable (liquid or solid materials) storage area or approved cabinet away from sources if ignition. Ethyl silicate (a silane) must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine), since violent reactions occur. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from water. Sources of ignition, such as smoking and open flames, are prohibited where ethyl silicate is handled, used, or stored. Metal containers involving the transfer of five gallons or more of ethyl silicate should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of ethyl silicate.

Shipping: UN1292 Tetraethyl acetate, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep ethyl silicate out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition includes oxides silicon and carbon. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration in admixture with a more flammable solvent.

References

(31); (173); (101); (138). (100).

National institute for Occupational Safety and Health (NIOSH), *Information Profiles on Potential Occupational Hazards-Single Chemicals: Ethyl Silicate*, pp. 98–105, Report No. RT79-607, Rockville, MD (December 1979)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Ethyl Silicate*, Trenton, NJ (January 1999)

Ethyl thiocyanate E:0830

Formula: C_3H_5NS; C_2H_5SCN

Synonyms: Aethylrhodanid (German); Ethyl rhodanate; Ethyl sulfocyanate; Thiocyanatoethane; Thiocyanic acid, ethyl ester

CAS Registry Number: 542-90-5

HSDB Number: 6394

RTECS Number: XK9900000

UN/NA & ERG Number: UN2929/131

EC Number: 208-833-3

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Flammable liquid, Poison, Agricultural chemical. Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 10,000 lb (4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10,000 lb (4540 kg).

California EPA AB2588-Air Toxics "Hot Spots" Chemicals (CAL)

CAL Air Resources Board/AB 1807 Toxic Air Contaminants

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xn; risk phrases: R11; R20/21/22; R36/37/38; R50/53; safety phrases: S16; S21, S24/25; S26; S36/37; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Ethyl thiocyanate is a liquid. Onion odor. Molecular weight = 87.15; boiling point = 146°C; freezing/melting point = −86°C; flash point 42°C (cc). Hazard identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 0. Insoluble in water.

Potential Exposure: This thiocyanate material is used as an agricultural insecticide.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides. Esters are generally incompatible with nitrates. Moisture may cause hydrolysis or other forms of decomposition. Caution should be exercised in treating a thiocyanate with an oxidizing agent such as a peroxide or chlorate as such mixtures have been known to explode[101].

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 20 milligram per cubic meter

PAC-2: 100 milligram per cubic meter

PAC-3: 170 milligram per cubic meter

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 200 μg[CN]/L; State Drinking Water Standards: California 150 μg[CN]/L; State Drinking Water Guidelines: Arizona 220 μg[CN]/L; Maine. 140 μg[CN]/L; Minnesota 100 μg[CN]/L. United States Army field drinking-water standards for cyanide: 2 mg[CN]/L assuming a water consumption of 15 L/day and 6 mg [CN]/L assuming a water consumption of 5 L/day. United States Army field drinking-water standards for cyanide, long-term consumption 0.5 mg[CN]/L; short-term consumption; raw water constituents (maximum) 20 mg[CN]/L.

Routes of Entry: Inhalation and dermal contact.

Harmful Effects and Symptoms

Short-Term Exposure: The ingestion of a concentrated solution may lead to vomiting. The principal systemic reaction is probably one of central nervous depression, interrupted by periods of restlessness; abnormally fast and deep respiratory movements and convulsions. Death is usually due to respiratory arrest from paralysis of the medullary centers. In nonfatal cases injures to the liver and kidneys may appear. LD_{50} = (oral-rat) 200 mg/kg.

Long-Term Exposure: Prolonged absorption may produce various skin eruptions, runny nose; and occasionally dizziness, cramps, nausea, vomiting and mild or severe disturbances of the nervous system.

Points of Attack: Nervous system, liver, and kidneys.

Medical Surveillance: Liver function tests. Kidney function tests. Examination of the nervous system.

First Aid: Treatment is as for aliphatic thiocyanates. Because cyanide is probably largely responsible for poisonings; antidotal measures against cyanide should be instituted promptly, for including moving the victim to fresh air. Call emergency medical care. If not breathing, give artificial respiration. IF breathing is difficult, give oxygen. In case of contact with material, immediately flush skin or eyes with running water for at least 15 minutes. Speed in removing material from skin is of extreme importance. Remove and isolate contaminated clothing and shoes at the site. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Personal Protective Methods: Wear butyl rubber gloves; protective clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. For emergency situations, wear a positive pressure, pressure-demand, full facepiece SCBA (SCBA) or pressure-demand supplied air respirator with escape SCBA and a fully encapsulating, chemical resistant suit.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: (1) Color code-Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. (2) Color code-Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area away from oxidizers, chlorates, nitrates, nitric acid. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: UN2929 Toxic liquids, flammable, organic, n.o.s., Hazard class: 6.1; Labels: 6.1-Poison Inhalation Hazard, 3-Flammable liquid, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. For *large spills*, dike far ahead of spill for later disposal. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include nitrogen, sulfur and carbon. *Small fires:* dry chemical, carbon dioxide; water spray; or foam. *Large fires:* water spray, fog, or foam. Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Wear positive pressure breathing apparatus and special protective clothing. Move container from fire area if you can do it without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR 165 recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138). (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: *Ethylthiocyanate*, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

Ethyl trichlorosilane E:0840

Formula: $C_2H_5C_{13}Si$
Synonyms: Ethyl silicon trichloride; Ethyl trichloroethylsilane; Ethyl trichlorosilane; Ethyltrichlorosilane; Silane, trichloroethyl-; Silicane, trichloroethyl-; Trichloroethylsilicane
CAS Registry Number: 115-21-9
HSDB Number: 884
RTECS Number: VV4200000
UN/NA & ERG Number: UN1196/155
EC Number: 204-072-6
Regulatory Authority and Advisory Information
Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade).
Hazard Alert: Highly flammable, Violently reactive with water, Organometallic, Strong reducing agent, Primary irritant (w/o allergic reaction).
Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500 lb (227 kg)
EPCRA Section 304 RQ: 500 lb (227 kg).
Hazard symbols, risk, & safety statements: Hazard symbol: T+, F, Xn; risk phrases: R11; R14; R22; R26; R34; safety phrases: S1; S16; S21, S26; S28; S36/37/39; S41; S45 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.
Description: Ethyl trichlorosilane is a colorless liquid with an irritating odor. Molecular weight = 163.51; specific gravity (H_2O:1) = 1.24 @ 25°C; boiling point = 98°C; freezing/melting point = −106°C; vapor pressure = 47 mmHg @ 25°C; flash point = 22°C (oc). Hazard identification (based on NFPA-704 M Rating System): Health 3, Flammability 3, Reactivity 2 ₩. Water reactive, rapidly releasing corrosive hydrogen chloride gas.
Potential Exposure: Used in the manufacture of silicone polymers.
Incompatibilities: A strong reducing agent. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides. Chlorosilanes react vigorously with bases and both organic and inorganic acids generating toxic and/or flammable gases. Chlorosilanes react with water, moist air, or steam to produce heat and toxic, corrosive fumes of hydrogen chloride. They may also produce flammable gaseous hydrogen. Attacks metals in the presence of moisture.
Permissible Exposure Limits in Air
PAC* Ver. 29[138]
PAC-1: $\mathbf{0.60}_{\mathbf{A}}$ ppm
PAC-2: $\mathbf{7.3}_{\mathbf{A}}$ ppm
PAC-3: $\mathbf{33}_{\mathbf{A}}$ ppm
*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.
Routes of Entry: Inhalation, ingestion, and skin and/or eye contact.
Harmful Effects and Symptoms
Short-Term Exposure: Irritates the eyes, skin, and respiratory tract. Contact with the eyes causes irritation, pain, swelling; corneal erosion and blindness may result. Contact with the skin causes dermatitis (red, inflamed skin), severe burns, pain, and shock generally follow dermal exposure. Acute inhalation exposure may result in sneezing, choking, laryngitis, dyspnea (shortness of breath), respiratory tract irritation, and chest pain. Bleeding of nose and gums, ulceration of the nasal and oral mucosa; pulmonary edema; chronic bronchitis; and pneumonia may also occur. If ingested, symptoms include increased salivation; intense thirst; difficulty in swallowing; chills; pain, and shock. Oral, esophageal, and stomach burns are common. Vomitus generally has a coffee-ground appearance. The potential for circulatory collapse is high following ingestion.
Long-Term Exposure: May cause kidney damage. Highly irritating substances can cause lung irritation and bronchitis.
Points of Attack: Lungs and kidneys.
Medical Surveillance: Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. For those with frequent or potentially high exposure, the following are recommended before beginning work and at regular times after that. Lung function tests. Kidney function tests. If symptom develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary

edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposure to ethyl trichlorosilane, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: (1) Color code-Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. (2) Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Color code-Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Ethyl trichlorosilane must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates and nitrates), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from water, steam and moisture; because toxic and corrosive chloride gases; including hydrogen chloride; can be produced. Sources of ignition, such as smoking and open flames, are prohibited where ethyl trichlorosilane is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN1196 Ethyltrichlorosilane, Hazard Class: 3; Labels: 3-Flammable liquid, 8-Corrosive material.

Spill Handling:

Initial Isolation and Protective Action Distances: Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24 h response line).

When Spilled in Water

Small Spills (from a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.2/0.3

Large Spills (from a large package or from many small packages)

First: Isolate in all directions (ft/m) 1000/300
Then: Protect persons downwind (mi/km)
Day 0.5/0.8
Night 1.7/2.7

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Stay upwind; keep out of low areas. If water pollution occurs, notify appropriate authorities. Shut off ignition sources; no flares, smoking or flames in hazard area. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors do not get water inside container. *Small spills:* Flush area with flooding amounts of water. *Large spills:* Dike far ahead of spill for later disposal. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include phosgene. Use dry chemical, CO_2 or foam extinguishers. *Do not use water.* Vapor explosion hazard indoors, outdoors, or in sewers. Runoff to sewer may create fire or explosion hazard. Move container from fire area if you can do it without risk. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. Do not get water inside container. Cool containers that are exposed to flames with water from the side until well after fire is out. Stay away from ends of tanks. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Ethyl Trichlorosilane*, Trenton, NJ (March 1999)

Etridiazole E:0848

Formula: $C_5H_5C_{13}N_2OS$

Synonyms: 4-Way; 5-Ethoxy-3-(trichloromethyl)-1,2,4-thiadiazole; Aaterra; Banrot (with thiophanate-methyl); Dwell; Ethazole; Ethazole; ETMT; Etridiazole; Koban; Mf-344; Olin mathieson 2424; OM 2424; Pansoil; Terrachlor-Super X (with Pentachloronitrobenzene); Terraclor Super X (with Pentachloronitrobenzene); Terracoat; Terraflo; Terramaster; Terrazole; 1,2,4-Thiadiazole, 5-ethoxy-3-(trichloromethyl)-; 3-(Trichloromethyl)-5-ethoxy-1,2,4-thiadiazole; Truban

CAS Number: 2593-15-9; 153233-91-1

HSDB Number: 1709

RTECS Number: XI3875000

UN/NA & ERG Number: UN2810 (toxic liquid, organic, n.o.s.)/153

EC Number: 219-991-8 [*Annex I Index No.*: 613-133-00-X]

Regulatory Authority and Advisory Information

Carcinogenicity[83]: EPA Group B2, probable human carcinogen; EU GHS Category 2: Suspected human carcinogen California Proposition 65 Chemical[102]: Carcinogen (10/1/1994)

Hazard Alert: Poison, Suspected reprotoxic hazard, Endocrine Disruptor Potential Ground water Pollutant [California FAC Section 13145(d)/12811, active] as terrazole Hazard symbols, risk, & safety statements: Hazard symbol: T, Xn, N; risk phrases: R21; R22; R23; R40; R50/53; safety phrases: S1/2; S36/37; S38; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Pale-yellow liquid when pure or reddish-brown liquid or semisolid as a technical product. Mild odor. Molecular weight = 247.53; specific gravity (H_2O:1) = 1.503; freezing/melting point = 20.1°C; boiling point = 95°C @1 mmHg; vapor pressure = 1.3×10^{-4} mmHg @ 20°C; 9.75×10^{-5} mmHg @ 25°C; flash point = 155°C. Moderately soluble in water; solubility = 50−110 mg/L @ 25°C.

Potential Exposure: Aromatic hydrocarbon; Thiazole fungicide Etridiazole is a fungicide used in some countries as a seed treatment on barley, beans, corn, cotton, peanuts, peas, sorghum, soybeans, safflower, and wheat. It is also used on cotton for in-furrow application at planting, on ornamental plants and shrubs by horticultural nurseries, on nonbearing citrus and nonbearing coffee, and for golf course fairways, tees and greens. Some states hold Special Local Need registrations for use on tobacco transplants.

Incompatibilities: Diazo compounds can detonate. This applies in particular to organic azides that have been sensitized by the addition of metal salts or strong acids. Toxic gases are formed by mixing materials of this class with acids, aldehydes, amides, carbamates, cyanides, inorganic fluorides, halogenated organics, isocyanates, ketones, metals, nitrides, peroxides, phenols, epoxides, acyl halides, and strong oxidizing or reducing agents. Flammable gases are formed by mixing materials in this group with alkali metals. Explosive combination can occur with strong oxidizing agents, metal salts, peroxides, and sulfides. This chemical is sensitive to prolonged exposure to heat. This chemical is incompatible with strong oxidizing agents[101].

Permissible Exposure Limits in Air:

OEL (Russia): 1 milligram per cubic meter STEL (1/1993)[9]

Permissible Concentration in Water: State Drinking Water Guidelines: Florida 175 μg/L.

Determination in Water: Octanol-water coefficient: Log $K_{ow} = > 3.0$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood. Fish toxicity (threshold)[101]: Low−369.29192 ppb, MATC (Maximum Acceptable Toxicant Concentration)

Harmful Effects and Symptoms

Short-Term Exposure: Contact with eyes or skin may cause irritation or injury. May be harmful if swallowed. Skin sensitizer. LD_{50} (oral, rat) = > 1000 mg/kg; LD_{50} (dermal, rabbit) = > 1700 mg/kg.

Long-Term Exposure: Skin sensitizer. Possible liver toxin. A neurotoxin. Endocrine system disruptor. Reproductive effects. Human toxicity (long term)[101]: Intermediate—10.51051 ppb, CHCL (Chronic Human Carcinogen Level)

Points of Attack: Skin, liver, brain, and endocrine system.

Medical Surveillance: This chemical is a suspected or known human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and advice for medical monitoring. If symptoms develop or overexposure is suspected, the following may be useful: liver function tests; routine blood analysis. Evaluation by a qualified allergist, including exposure history and testing, may help diagnose allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Do not induce vomiting when formulations containing petroleum solvents are ingested

Personal Protective Methods: Because of its low vapor pressure and low order of toxicity, it does not usually present a major problem in industry. Protective creams, gloves, and masks with organic vapor canisters for use in areas of elevated vapor concentrations should suffice. Elevated temperature may increase the requirement for protective methods or ventilation. Wear appropriate clothing to prevent repeated or prolonged dermal and/or eye contact. Wear eye protection to prevent any possibility of eye contact with molten biphenyl. Employees should wash promptly when skin is contaminated. Work clothing should be changed daily as it may be contaminated. Remove nonimpervious clothing immediately if wet or contaminated.

Respirator Selection: Up to 10 milligram per cubic meter*:* CcrOv95 (APF = 10) [any air-purifying half-mask respirator with organic vapor cartridge(s) in combination with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). Up to 25 milligram per cubic meter*:* Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOvHie* (APF = 25) (any powered air-purifying respirator with an organic vapor cartridge in combination with a high-efficiency particulate filter). Up to 50 milligram per cubic meter*:* CcrFOv100 (APF = 50) [any air-purifying full facepiece respirator equipped with organic vapor cartridge (s) in combination with an N100, R100, or P100 filter]; or GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or PaprTOvHie* (APF = 50) [any powered, air-purifying respirator with a tight-fitting facepiece and organic vapor cartridge(s) in combination with a high-efficiency particulate filter]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) Any supplied-air respirator with a full facepiece. Up to 100 milligram per cubic meter*:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: PD,PP (any SCBA that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code-Blue: Health Hazard: Store in a secure poison location. Before entering confined space where biphenyl may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. If this material contains a flammable carrier, sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN2810 Toxic liquids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling:

UN2810 Toxic liquids, organic, n.o.s.

Initial Isolation and Protective Action Distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24 h response line).

Small Spills (from a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 0.7/1.2

Large Spills (from a large package or from many small packages)

First: Isolate in all directions (ft/m) 1000/300
Then: Protect persons downwind (mi/km)

Day 1.1/1.8
Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Establish ventilation to keep levels below explosive limit. Don't wash it away. Instead, sprinkle the spill with sawdust, vermiculite, or kitty litter. Sweep it into a plastic garbage bag, and dispose of it as directed on the pesticide product label. Wash all contaminated surfaces with a soap and water solution. Do not re-enter the contaminated area until and expert verifies that the area has been properly cleaned. Ventilate area of spill or leak following clean-up. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen and sulfur, chlorides, hydrogen chloride gas, carbon monoxide, and acrid smoke. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration would be an effective disposal procedure where permitted. If an efficient incinerator is not available, the product should be mixed with large amounts of combustible material and contact with the smoke should be avoided. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers.

References

(102); (31); (173); (101); (138); (100).

United States Environmental Protection Agency, "*Reregistration Eligibility Decision (RED), Etridiazole*," Office of Prevention, Pesticides and Toxic Substances, Washington, DC (September 2000). http://www.epa.gov/REDs/0009red.pdf

United States Environmental Protection Agency, Office of Pesticide Programs, Pesticide Residue Limits, "*Etridiazole*," 40 CFR 180.370, http://www.epa.gov/pesticides/food/viewtols.htm.

F

Fenbutatin Oxide F:0085

Formula: $C_{60}H_{78}OSn_2$
Synonyms: AI3-27738; BENDEX; Bis(trineophyltin) oxide; Bis[tris(β,β-dimethylphenethyl)tin]oxide; Bis[tris(2-methyl-2-phenylpropyl)tin]oxide; Caswell No. 481DD; Distannoxane, hexakis(2-methyl-2-phenylpropyl)-; Distannoxane, hexakis(β,β-dimethylphenethyl)-; Di[tri(2,2-dimethyl-2-phenylethyl)tin]oxide; ENT 27738; Fenbutatin-oxyde; Hexakis; Hexakis(β,β-dimethylphenethyl)distannoxane; Hexakis(2-methyl-2-phenylpropyl)distannoxane; 2-(Methyl-2-phenylpropyl)distannoxane; Neostanox; Osdaran; SD-14114; Shell SD-14114; Torque; Vendex
CAS Number: 13356-08-6
HSDB Number: 6632; 7001 for tin compounds
RTECS Number: JN8770000
UN/NA & ERG Number: UN2786/154; UN2811 (toxic solid, organic, n.o.s.)/154
EC Number: 236-407-7 [*Annex I Index No.:* 050-017-00-2]
Regulatory Authority and Advisory Information
Carcinogenicity[83]: EPA Group E, Evidence of noncarcinogenicity for humans
Hazard Alert: Poison, Developmental toxin (TRI), Environmental hazard.
EPCRA Section 313 Form R de minimus concentration reporting level: 1.0%
United States DOT Regulated United States DOT Regulated marine pollutant (49CFR172.101, Appendix B), severe pollutant, as organotin pesticide compounds
Hazard symbols, risk, & safety statements: Hazard symbol: T+, Xn, N; risk phrases: R26; R36/38; R50/R53; safety phrases: S1/2; S28; S36/37; S45; S60; S61; S41 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to waters
Description: White crystalline solid or powder. Mild odor. Molecular weight = 1052.66; specific gravity (H_2O:1) = 1.312; boiling point = (decomposes) 238°C @ 0.05 mm; freezing/melting point = 138°C; 148°C; vapor pressure = 1.8×10^{-11} mmHg @ 20°C. Practically insoluble in water; solubility = 0.005 mg/L @ 23°C.
Potential Exposure: Organotin/phenyltin insecticide and selective miticide for deciduous pome and stone fruits, citrus fruits, grapes, vegetables, berry fruit, nut crops (selected), ornamentals, and greenhouse crops. A United States Environmental Protection Agency Restricted Use Pesticide (RUP).
Incompatibilities: May form explosive mixture with air. Decomposes above 230C. Contact with water causes slow decomposition. Orgotin oxides can be strongly basic and will react, possibly dangerously, with acidic compounds and mixtures.
Permissible Exposure Limits in Air:
NIOSH IDLH = 25 mg[Sn]/m^3
OSHA PEL: 0.1 mg[Sn]/m^3 TWA [*Note*: The PEL applies to all organic tin compounds.]
NIOSH REL: 0.1 mg[Sn]/m^3 TWA [skin] [*Note:* The REL applies to all organic tin compounds, except cyhexatin.]
ACGIH TLV[1]: 0.1 mg[Sn]/m^3 TWA; 0.2 mg[Sn]/m^3 STEL [skin], A4, not classified as a human carcinogen
DFG MAK: 0.1 mg[Sn]/m^3; inhalable fraction TWA; Peak Limitation Category II(2); [skin]; Pregnancy Risk Group D
Phenyltin compounds
DFG MAK: 0.002 mg[Sn]/m^3; inhalable fraction TWA; Peak Limitation Category II(2); Pregnancy Risk Group C
Determination in Air: Filter/XAD-2 (tube); CH_3COOH/CH_3CN; High-pressure liquid chromatography/Graphite furnace atomic absorption spectrometry; NIOSH IV Method #5504, as organotin compounds[18].
Permissible Concentration in Water: State Drinking Water Guidelines: Minnesota 4000 μg[Sn]/L.
Determination in Water: Octanol–water coefficient: Log K_{ow} = > 4.0. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.
Routes of Entry: Inhalation, skin, and/or eye contact. Absorbed through the skin
Harmful Effects and Symptoms
Short-Term Exposure: Highly toxic. Irritates the eyes, skin, and respiratory tract. Contact may cause skin burns. Inhalation can cause coughing, wheezing, and/or shortness of breath. Toxic hazard rating is high for oral, intravenous, intraperitoneal administration. This material causes swelling of the brain and spinal cord. Exposure may result in muscular weakness and paralysis, leading to respiratory failure; convulsive movements; closure of eyelids and sensitivity to light; headaches, and EEG changes, headache, dizziness, psychological and neurological disturbances, vertigo (an illusion of movement), sore throat, cough, abdominal pain, nausea, vomiting, diarrhea; urine retention; paresis, focal anesthesia; pruritus. Higher levels can cause unconsciousness, collapse, and death. LD_{50} (oral, rat) = > 2.5 g/kg; LD_{50} (dermal, rat) = 1000 mg/kg.
Long-Term Exposure*:* Repeated or prolonged contact can cause dermatitis; dry and cracked skin. May cause brain damage, hepatic necrosis; kidney damage. Some organotin compounds, such as dibutyltins and tributyltins, have been shown to affect the immune system in animals, but this has not been examined in people. Studies in animals and people also have shown that some organotins, such as dibutyltins, tributyltins, and triphenyltins, can affect the reproductive system. Reproductive effects.
Points of Attack: Skin, brain, kidneys.
Medical Surveillance: Kidney function tests. Psychological testing. Examination of the nervous system. EEG.

Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens.
DOI: http://dx.doi.org/10.1016/B978-0-323-38968-6.00006-5

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of dermal and/or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA *[Tin, organic compounds as (Sn)]*: *Up to 1 milligram per cubic meter:* CcrOv95 (APF = 10) [any air-purifying half-mask respirator with organic vapor cartridge(s) in combination with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *Up to 2.5 milligram per cubic meter:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOvHie (APF = 25) (any air-purifying full facepiece respirator equipped with an organic vapor cartridge in combination with a high-efficiency particulate filter). *Up to 5 milligram per cubic meter:* CcrFOv100 (APF = 50) [any air-purifying full facepiece respirator equipped with organic vapor cartridge(s) in combination with an N100, R100, or P100 filter]; or GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or PaprTOvHie (APF = 50) [any powered, air-purifying respirator with a tight-fitting facepiece and organic vapor cartridge(s) in combination with a high-efficiency particulate filter]; or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or SCBAF (APF = 50) (any self-contained breathing apparatus (SCBA) with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 25 milligram per cubic meter*133: SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full-faceplate and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [Any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison. Store in a secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, dark, well-ventilated area away from oxidizers. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft (NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. Keep ethylene glycol diethyl ether out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include inorganic tin, tin oxides, and phenyltin compounds. This material is a severe marine pollutant. *Fire involving storage or vehicular tanks:* Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. *Small fire:* Dry chemical, carbon dioxide, or water spray. *Large fire:* Dry chemical, carbon dioxide, alcohol-resistant foam, or water spray. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal; do not scatter the material. *Fire involving tanks or car/trailer loads:* Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Do not get water inside containers. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. Always stay away from tanks engulfed in fire. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Organic tin compounds may be disposed of in sealed containers in secured sanitary landfill. *Chemical Treatability of tin; Concentration Process*: Chemical precipitation; Chemical Classification: Metals; Scale of Study: Pilot scale; Type of Wastewater Used: Synthetic wastewater; Results of Study: At 600 ppm, 95.3% reduction with alum. At 500 ppm, 98% reduction with ferric chloride, 92% reduction with lime (three coagulants used: 200 mg of alum at pH = 6.4, 40 ppm of ferric chloride @ pH = 6.2, 41 ppm of lime @ pH = 11.5 Chemical coagulation was followed by dual media filtration)[83]. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Incineration with effluent gas scrubbing is recommended. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (100); (173); (101); (138).

United States Environmental Protection Agency, Office of Pesticide Programs, Pesticide Residue Limits, "Fenbutatin Oxide," 40 CFR 180.362, http://www.epa.gov/pesticides/food/viewtols.htm.

International Programme on Chemical Safety (IPCS), "Health and Safety Guide, Fenbutatin Oxide," Geneva, Switzerland (1977), (2016).

Mackison, F. W., R. S. Stricoff, and L. J. Partridge, Jr. (eds.). NIOSH/OSHA, *Occupational Health Guidelines for Chemical Hazards*. DHHS(NIOSH) Publication No. 81-123, Washington, DC (January 1981).

Fenitrothion F:0100

Formula: $C_9H_{12}NO_5PS$; $(CH_3O)_2PSO\text{-}C_6H_3(NO_2)(CH_3)$

Synonyms: 8057HC; Accothion; Aceothion; Agria 1050; Agriya 1050; Agrothion; American Cyanamid CL-47,300; Arbogal; BAY 41831; Bayer 41831; Bayer S 5660; Cekutrothion; CL 47300; CP47114; Cyfen; Cytel; Cyten; Dicathion; *O*,*O*-Dimethyl-*O*-(3-methyl-4-nitrophenyl)-monothiophosphat (German); *O*,*O*-Dimethyl *O*-(3-methyl-4-nitrophenyl) phosphorothioate; *O*,*O*-Dimethyl *O*-(3-methyl-4-nitrophenyl) thiophosphate; *O*,*O*-Dimethyl *O*-(4-nitro-3-methylphenyl) phosphorothioate; *O*,*O*-Dimethyl *O*-(4-nitro-3-methylphenyl) thiophosphate; *O*,*O*-Dimethyl-*O*-4-nitro-*m*-toyl phosphorothioate; Dybar; EI 47300; ENT 25,715; Falithion; Fenitex; Fenitox; Fenitrothion; Folethion; Folithion; H-35-F 87 (BVM); Keen Superkill Ant and Roach Exterminator; Killgerm tetracide insecticidal spray; Kotion; MEP (Pesticide); Metathion; Metathione; Metation; Methylnitrophos; Micromite; Monsanto CP 47114; Nitrophos; Novathion; Nuvand; Nuvanol; Oleosumifene; OMS 43; Ovadofos; Pennwalt C-4852; Phenitrothion; Phosphorothioic acid, *O*,*O*-dimethyl *O*-(3-methyl-4-nitrophenyl) ester; Phosphorothioic acid, *O*,*O*-dimethyl *O*-(4-nitro-*m*-tolyl) ester; S 112A; S 5660; SMT; Sumithion; Thiophosphate de *O*,*O*-dimethyle et de *O*-(3-methyl-4-nitrophenyle) (French); Turbair grain storage insecticide; Verthion

CAS Registry Number: 122-14-5

HSDB Number: 1590

RTECS Number: TG0350000

UN/NA & ERG Number: (PIH) UN3017 (organophosphorus pesticides, liquid, toxic, flammable)/131; UN2810 (toxic liquid, organic, n.o.s.)/153

EC Number: 204-524-2 [*Annex I Index No.*: 015-054-00-0]

Regulatory Authority and Advisory Information

United States Environmental Protection Agency Gene-Tox Program, Negative: Rodent dominant lethal; Host-mediated assay; Inconclusive: *D. melanogaster* sex-linked lethal.

Hazard Alert: Poison inhalation hazard, Neurotoxin (cumulative), Combustible, Suspected of causing genetic defects, Suspected reprotoxic hazard.

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500 lb (227 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 1 lb (0.454 kg)

United States DOT 49CFR172.101, Inhalation Hazard Chemical as organophosphates.

Hazard symbols, risk, & safety statements: Hazard symbol: Xn, N; risk phrases: R22; R33; R50/53; R62; R63; safety phrases: S2; S41; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Fenitrothion is a volatile brownish-yellow oil. Molecular weight = 277.25; boiling point = (decomposes) @ 140°C; freezing/melting point = 0.28°C; vapor pressure = 5.3×10^{-5} mbar @ 20°C; flash point = 157°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 1, reactivity 0. Insoluble in water.

Potential Exposure: A potential danger to those involved in the manufacture, formulation, and application of this insecticide. It is a selective acaricide; and a contact and stomach insecticide. Used to control chewing and sucking insects on rice, orchard fruit; vegetables, cereals, cotton, and in forests. Also protects against flies, mosquitoes, and cockroaches.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Strong oxidizers may cause release of toxic phosphorus oxides. Organophosphates, in the presence of strong reducing agents such as hydrides, may form highly toxic and flammable phosphine gas. Keep away from alkaline materials.

Permissible Exposure Limits in Air

No standards or Protective Action Criteria (PAC) available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Japan: 1 milligram per cubic meter [skin] 1999; Poland: MAC (TWA) 0.02 milligram per cubic meter, MAC (STEL) 0.1 milligram per cubic meter, 1999; Russia: STEL 0.1 milligram per cubic meter [skin] 1993. Russia[43] set a MAC in ambient air in residential areas of 0.008 milligram per cubic meter on a momentary basis and 0.001 milligram per cubic meter on a daily average basis.

Determination in Air: OSHA versatile sampler-2; Toluene/Acetone; Gas chromatography/Flame photometric detection for sulfur, nitrogen, or phosphorus; NIOSH Analytical Method (IV) Method #5600, Organophosphorus Pesticides.

Permissible Concentration in Water: Russia[43] set a MAC in water bodies for domestic purposes of 0.25 mg/L; in water bodies used for fishery purposes of zero.

Determination in Water: Fish Tox = 63.62386000 ppb (INTERMEDIATE). Octanol−water coefficient: Log K_{ow} = > 3.2. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, through the skin, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes and skin. Nausea is often the first symptom, followed by vomiting; abdominal cramps; diarrhea, excessive salivation; headache, giddiness, dizziness, weakness, tightness in the chest; loss of muscle coordination; slurring of speech; muscle twitching (particularly the tongue and eyelid); respiratory difficulty; blurring or dimness of vision; pinpoint pupils; profound weakness; mental confusion; disorientation, and drowsiness. This compound is an organophosphate insecticide. It is a highly toxic cholinesterase inhibitor that acts on the nervous system. Does not cause delayed neurotoxicity and contact produces little irritation. The effects may be delayed. Keep exposed victim under medical observation. Human Tox = 9.10000 ppb (HIGH)

Long-Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, central nervous system; cardiovascular system, skin, eyes, plasma, and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of “normal.” Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates. Also consider complete blood count. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Effects may be delayed. Keep victim under medical observation.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: UN3017 Organophosphorus pesticides, liquid, toxic, flammable, flash point not <23°C, Hazard class: 6.1; Labels: 6.1-Poisonous materials, 3-Flammable liquid. UN2810 Toxic liquids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required

Spill Handling:

Initial isolation and protective action distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.3/0.4
Night 0.8/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 600/200
Then: Protect persons downwind (mi/km)
Day 1.4/2.3
Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Do not touch spilled material. Do not breathe vapors. Stay upwind; keep out of low areas. Remove all ignition sources. Ventilate area of spill or leak. This material is a combustible liquid. For a spill or leak of a combustible liquid, shut off ignition sources; no flares, smoking, or flames in hazard area. Stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: Absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: Dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of phosphorus, sulfur, nitrogen, and carbon. *Small fires:* Dry chemical, carbon dioxide; water spray; or foam. *Large fires:* Water spray, fog, or foam. Move containers from fire area if you can do so without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Wear positive pressure breathing apparatus and special protective clothing. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration (for large amounts); alkaline hydrolysis and landfill (for small amounts)[22]. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (80); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 2, No. 4, 88–92 (1982).

United States Environmental Protection Agency, Chemical Hazard Information Profile: *Fenitrothion*, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

Fenoxaprop-ethyl F:0105

Formula: $C_{18}H_{16}ClNO_5$

Synonyms: Acclaim; Caswell No. 431C; 2-[4-((6-Chloro-2-benzoxazolyl)oxy)phenoxy]propionic acid, ethyl ester, (±)-; Depon; (±)-Ethyl 2-[4-((6-chloro-2-benzoxazolyl) oxy)phenoxy] propanoate; Ethyl-2-[(4-(6-chloro-2-benzo xazolyloxy))-phenoxy]propionate; Ethyl-2-[4-((6-chlorobenzoxazol-2-yl)oxy)phenoxy]propionate; Ethyl (D+)-2-[4-(6-chlor-2-benzoxazolyloxy)phenoxy]propanoate; (±)Ethyl-2-[-((6-chloro-2-benzoxazolyl)oxy)phenoxy]ropionate; Propionic acid, 2-[4-((6-chloro-2-benzoxazolyl)oxy)phenoxy] ethylester, (±)-; Excel; Fenoxyprop; Furore; Hoe 033171; Hoe-A 25-01; Option Fenoxaprop-ethyl; Puma; Whip

CAS Number: 66441-23-4; 71283-80-2 (P-ethyl)

HSDB Number: 6848 (66441-23-4)

RTECS Number: UA2454000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 266-362-9 [*Annex I Index No.:* 604-039-00-X]

Regulatory Authority and Advisory Information

California Proposition 65 Chemical[102]: Developmental/ Reproductive toxin (3/26/1999)

Hazard Alert: Suspected reprotoxic hazard, Environmental hazard, Ground water contaminant (PAN), Sensitization hazard (skin), Reproductive toxin. (P-ethyl) Listed for Tier 1 screening as an endocrine disruptor[88].

California EPAAB2588-Air Toxics "Hot Spots" Chemicals (CAL) as chlorophenoxy pesticides

EPCRA Section 313 Form R de minimis concentration reporting level: 1.0%

Marine Pollutant: IMDG

Hazardous to aquatic life or environment, with possible long-lasting effects[192]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: Xi, N; risk phrases: R43; R50/53; safety phrases: S2; S24; S29/35; S37, S60; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Colorless or white solid. Liquid form is dark brown with an aromatic hydrocarbon odor. Molecular weight = 361.78; specific gravity (H_2O:1) = 1.33; boiling point = 199.6°C; freezing/melting point = 84−86°C; vapor pressure = 3.2×10^{-8} mmHg @ 20°C. Practically insoluble in water.

Potential Exposure: A chlorophenoxy/aryloxyphenoxypropionate herbicide used to control annual and perennial grassy weeds in potatoes, soy beans, beans, beets, vegetables, flax, ground nuts, rape, and cotton.

Incompatibilities: Decomposed by acids and alkalis. May react with strong oxidizers such as chlorates, peroxides, nitrates, etc.

Determination in Water: Octanol−water coefficient: Log K_{ow} = > 4.0. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood. Fish toxicity (threshold)[101]: Intermediate—34.71346 ppb, MATC (Maximum Acceptable Toxicant Concentration)

Routes of Entry: Inhalation, ingestion, absorbed through the skin

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the skin, eyes, and respiratory tract. Eye contact may cause irritation, burning sensation, and damage. Harmful if ingested, inhaled or absorbed through the skin. May be harmful if swallowed. LD_{50} (oral, rat) = > 2 g/kg; LD_{50} (dermal, rat) = > 2 g/kg.

Long-Term Exposure: May cause skin sensitization. May cause reproductive and fetal effects. Human toxicity (long term)[101]: Intermediate—17.50 ppb, Health advisory

Points of Attack: Skin. Reproductive system.

Medical Surveillance: Preliminary medical exam to detect chronic diseases of central nervous system, liver, heart, kidneys, lung, and skin, as well as endocrinological or immunological disturbances, should protect susceptible individuals. Periodical medical exams of internal organs, skin, and eyes are important to avoid chronic occupational intoxications. They should include lab and patch tests when necessary[83]. Comprehensive physical examination with emphasis on the genito-urinary tract analysis to include sperm count, motility, and morphology. Other tests, such as serum testosterone, serum follicle stimulating hormone (FSH), and serum lutenizing hormone (LH), may be carried out if, in the opinion of a physician, they are indicated. Consult a physician if poisoning is suspected or if redness, itching, or burning of the eyes or skin develop. Evaluation by a qualified allergist, including exposure history and testing, may help diagnose allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Do not induce vomiting when formulations containing petroleum solvents are ingested.

Respirator Selection: Wherever and whenever workplace conditions warrant respirator use, a respiratory protection program must be followed that meets one or more of the following government standards: OSHA's 29 CFR 1910.134, ANSI Z88.2, or European Standard EN 149.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of dermal and/or eye contact. Safety equipment suppliers/ manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison. Store in a secure poison location. Prior to working with 2,4-DP all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers and bases. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically transfer material from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. If this material contains a flammable carrier, sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: *Solid material:* First remove all sources of ignition. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. *Liquid formulations containing organic solvents*: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include hydrogen chloride and oxides of nitrogen and carbon. As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 m/150 ft for liquids and at least 25 m/75 ft for solids. *Fire involving storage or vehicular tanks:* Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/ 0.5 mi in all directions. *On a small fire:* Use dry chemical, CO_2, water spray, or regular *foam. On a large fire:* Use water spray, fog, or regular foam. Do not scatter spilled material with high pressure streams of water. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal. *Fire involving tanks:* From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. Always stay away from tanks engulfed in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. *Solid material:* A combustible solid. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. *Liquid formulations containing organic solvents:* A combustible liquid. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(102); (31); (173); (101); (138); (100).

United States Environmental Protection Agency, Office of Pesticide Programs, *Pesticide Residue Limits, Fenoxa prop-Ethyl,* 40 CFR 180.430, http://pmep.cce.cornell.edu/profiles/herb-growthreg/fatty-alcohol-monuron/fenoxaprop-ethyl/Fenoxaprop-ethyl_tol_498.html.

Fensulfotion F:0110

Formula: $C_{11}H_{17}O_4PS_2$
Synonyms: BAY 25141; Bayer 25141; Bayer S767; Chemagro 25141; Dasanit; *O*,*O*-Diaethyl-*O*-4-methylsulfinyl-phenyl-monothiophosphat (German); *O*,*O*-Diethyl *O*-[*p*-(methylsulfinyl)phenyl] phosphorothioate; *O*,*O*-Diethyl *O*-[*p*-(methylsulfinyl)phenyl] thiophosphate; DMSP; ENT 24,945; Entphosphorothioate; Ester; Fensulfotiona (Spanish); Phosphorothioic acid, *O*,*O*-diethyl *O*-[*p*-(methylsulfinyl)phenyl]; S 767; Terracur P
CAS Registry Number: 115-90-2
HSDB Number: 1580
RTECS Number: TF3850000
UN/NA & ERG Number: (PIH) UN3018 (organophosphorus pesticide, liquid, toxic)/152; UN2810 (toxic liquid, organic, n.o.s.)/153
EC Number: 204-114-3 [*Annex I Index No.:* 015-090-00-7]
Regulatory Authority and Advisory Information
United States Environmental Protection Agency Gene-Tox Program, Negative: Histidine reversion-Ames test EPA; Negative: *D. melanogaster* sex-linked lethal EPA; Negative: In vitro UDS-human fibroblast; TRP reversion EPA; Negative: *S. cerevisiae-homozygosis* EPA; Inconclusive: *B. subtilis* rec assay; *E. coli polA* without S9.
Hazard Alert: Poison inhalation hazard: Exposure can be lethal, Neurotoxin (cumulative), Combustible, Environmental hazard, Suspected reprotoxic hazard, Environmental hazard.
Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500 lb (227 kg)
Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 500 lb (227 kg)
United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)
United States DOT 49CFR172.101, Inhalation Hazard Chemical as organophosphates.
Hazardous to aquatic life or environment, with possible long-lasting effects [291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.
Hazard symbols, risk, & safety statements: Hazard symbol: T+, N; risk phrases: R26/27/28; R33; R50/53; safety phrases: S1/2; S23; S28; S29; S36/37; S41; S45; S60; S61 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Fensulfothion is a yellow oil. Molecular weight = 308.37; boiling point = 138−141°C at 0.01 mmHg; vapor pressure = 0.0001 mmHg. Hazard identification (based on NFPA-704 M Rating System): Health 4, flammability 1, reactivity 0. Slightly soluble in water.
Potential Exposure: A potential danger to those involved in the manufacture, formulation, or application of this insecticide used to control parasitic, sedentary, and free-living nematodes.
Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Strong oxidizers may cause release of toxic phosphorus oxides. Organophosphates, in the presence of strong reducing agents such as hydrides, may form highly toxic and flammable phosphine gas. Keep away from alkaline materials.
Permissible Exposure Limits in Air
OSHA PEL: None
NIOSH REL: 0.1 milligram per cubic meter TWA
ACGIH TLV[1]: 0.01 milligram per cubic meter TWA inhalable fraction and vapor [skin]; not classifiable as a human carcinogen; BEI_A issued for Acetylcholinesterase inhibiting pesticides
PAC Ver. 29[138]
PAC-1: 0.18 milligram per cubic meter
PAC-2: 2 milligram per cubic meter
PAC-3: 3.1 milligram per cubic meter
Australia: TWA 0.1 milligram per cubic meter, 1993; Belgium: TWA 0.1 milligram per cubic meter, 1993; France: VME 0.1 milligram per cubic meter, 1999; Switzerland: MAK-W 0.1 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 0.1 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Not classifiable as a human carcinogen. Several states have set guidelines or standards for fensulfothion in ambient air[60] ranging from 1.0 μ/m^3 (North Dakota) to 1.6 μ/m^3 (Virginia) to 2.0 μ/m^3 (Connecticut and Nevada).
Determination in Air: OSHA versatile sampler-2; Toluene/Acetone; Gas chromatography/Flame photometric detection for sulfur, nitrogen, or phosphorus; NIOSH Analytical Method (IV) Method #5600, Organophosphorus Pesticides.
Determination in Water: Fish Tox = 6.96732000 pbb (INTERMEDIATE)
Routes of Entry: Inhalation, through the skin, ingestion. eyes.
Harmful Effects and Symptoms
Short-Term Exposure: Contact can irritate the skin and eyes. Exposure can cause rapid, fatal organophosphate poisoning. The acute oral LD_{50} value for rats is 5−10 mg/kg which is highly to extremely toxic. It is a cholinesterase inhibitor. This material may cause nausea, vomiting, abdominal cramps; diarrhea, headache, giddiness, vertigo, weakness, lack of muscle control; tearing, slurring of

speech; difficult breathing; convulsions, excessive salivation; tightness in chest; and death from respiratory arrest. Death results primarily from respiratory arrest stemming from failure of the respiratory center; paralysis of respiratory muscles and intensive bronchoconstriction. Human Tox = 1.75000 ppb (HIGH)

Long-Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, central nervous system; cardiovascular system, skin, eyes, plasma, and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures over *0.1 milligram per cubic meter*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong bases; strong oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: UN3018 Organophosphorus pesticides, liquid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN2810 Toxic liquids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling:

Initial isolation and protective action distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.3/0.4
Night 0.8/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m)600/200
Then: Protect persons downwind (mi/km)
Day 1.4/2.3
Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Do not touch spilled material. Do not breathe vapors. Stay upwind; keep out of low areas. Remove all ignition sources. Ventilate area of spill or leak. This material is a combustible liquid. For a spill or leak of a combustible liquid, shut off ignition sources; no flares, smoking or flames in hazard area. Stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: Absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: Dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of phosphorus, sulfur, nitrogen, and carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Alkaline hydrolysis[22]. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (80); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: *Fensulfothion*, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Fensulfothion*, Trenton, NJ (June 2005).

Fenthion F:0120

Formula: $C_{10}H_{15}O_3PS_2$

Synonyms: AI3-25540; BAY 29493; Baycid; Bayer 29493; Bayer 9007; Bayer S-1752; Baytex; Caswell No.456F; *m*-Cresol, 4-(methylthio)-, *O*-ester with *O*,*O*-dimethyl phosphorothioate; DALF; *O*,*O*-Dimethyl *O*-4-(methylmercapto)-3-methylphenyl phosphorothioate; *O*,*O*-Dimethyl *O*-4-(methylmercapto)-3-methylphenyl thiophosphate; *O*,*O*-Dimethyl *O*-(3-methyl-4-methylmercaptophenyl) phosphorothioate; *O*,*O*-Dimethyl *O*-[3-methyl-4-(methylthio) phenyl] ester, phosphorothioic acid; *O*,*O*-Dimethyl *O*-[3-methyl-4-(methylthio)phenyl] phosphorothioate; *O*,*O*-Dimethyl *O*-(4-methylthio-3-methylphenyl) phosphorothioate; *O*,*O*-Dimethyl *O*-(4-methylthio-3-methylphenyl) thiophosphate; *O*,*O*-Dimethyl *O*-[4-(methylthio)-*m*-tolyl] phosphorothioate; DMTP; ENT 25,540; Entex; EPA pesticide chemical code 053301; Fenthion 4E; Fenthionon; Fentiona (Spanish); Lebaycid; Mercaptophos; 4-Methylmercapto-3-methylphenyldimethyl-thiophosphate; MPP; MPP (in Japan); NCI-C08651; OMS 2; Phenthion; Phosphorothioic acid, *O*,*O*-dimethyl *O*-[3-methyl-4-(methylthio)phenyl] ester; Phosphorothioic acid, *O*,*O*-dimethyl *O*-[4-(methylthio)-*m*-tolyl] ester; Queletox; S 1752; Spotton; Thiophosphate de *O*,*O*-dimethyle et de *O*-(3-methyl-4-methylthiophenyle) (French); Tiguvon; Tolodex

CAS Registry Number: 55-38-9

HSDB Number: 1403

RTECS Number: TF9625000

UN/NA & ERG Number: UN3018 (organophosphorus pesticide, solid toxic)/152; UN2810 (toxic liquid, organic, n.o.s.)/153

EC Number: 200-231-9 [*Annex I Index No.*: 015-048-00-8]

Regulatory Authority and Advisory Information

Carcinogenicity: NCI: Carcinogenesis Bioassay (feed); clear evidence: mouse; no evidence: rat. United States Environmental Protection Agency Gene-Tox Program, Negative: In vitro UDS-human fibroblast; TRP reversion; Negative: *S. cerevisiae-homozygosis*; Inconclusive: *B. subtilis* rec assay; *E. coli polA* without S9; Inconclusive: Histidine reversion-Ames test; Inconclusive: *D. melanogaster* sex-linked lethal.

Hazard Alert: Poison, Neurotoxin (cumulative), Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Environmental hazard.

EPCRA Section 313 Form R de minimis concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), severe pollutant.

Regulations: Hazard symbol: T, N; risk phrases: R21/22; R23; R33; R48/25; R68; R50/53; R62; R63; safety phrases: S1/2; S36/37; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Fenthion is a colorless liquid (when pure) with a weak, garlic-like odor. The technical grade is a yellow-to-brown oil. Molecular weight = 278.34; boiling point = (decomposes below the BP @ 210°C; freezing/melting point = 6.1°C; vapor pressure = 0.0003 mmHg. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 0. Very slightly soluble in water; solubility = 0.006%.

Potential Exposure: A potential danger to those involved in the manufacture, formulation, or application of this agricultural chemical and pesticide; insecticide.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, alkaline insecticides. Organothiophosphates are susceptible to formation of highly toxic and flammable phosphine gas in the presence of strong reducing agents such as hydrideds and active metals. Partial oxidation by oxidizing agents may result in the release of toxic phosphorus oxides[101].

Permissible Exposure Limits in Air

OSHA PEL: None

NIOSH REL: None. Appendix D (NIOSH Pocket Guide)

ACGIH TLV[1]: 0.05 milligram per cubic meter inhalable fraction and vapor [skin]; not classifiable as a human carcinogen; BEI_A issued for Acetylcholinesterase inhibiting pesticides.

PAC Ver. 29[138] PAC-1: 0.15 milligram per cubic meter

PAC-2: 5.9 milligram per cubic meter

PAC-3: 35 milligram per cubic meter

DFG MAK: 0.2 milligram per cubic meter, inhalable fraction TWA; Peak Limitation Category II(2) [skin]

Australia: TWA 0.2 milligram per cubic meter [skin], 1993; Austria: MAK 0.2 milligram per cubic meter [skin], 1999; Belgium: TWA 0.2 milligram per cubic meter [skin], 1993; Denmark: TWA 0.1 milligram per cubic meter [skin], 1999; Japan: 0.2 milligram per cubic meter [skin], 1999; Poland: MAC (TWA) 0.2 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 0.1 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Not classifiable as a human carcinogen. Several states have set guidelines or standards for fenthion in ambient air[60] ranging from 2.0 μ/m^3 (North Dakota) to 3.2 μ/m^3 (Virginia) to 4.0 μ/m^3 (Connecticut) to 5.0 μ/m^3 (Nevada).

Determination in Air: OSHA versatile sampler-2; Toluene/Acetone; Gas chromatography/Flame photometric detection for sulfur, nitrogen, or phosphorus; NIOSH Analytical Method (IV) Method #5600, Organophosphorus Pesticides.

Permissible Concentration in Water: Mexico[35] set a MAC in coastal waters of 0.03 μg/L and 0.0003 mg/L (0.3 μg/L) in estuaries. Russia[35] set a MAC in water bodies used for domestic purposes of 1.0 μg/L and in water used for fishery purposes of zero.

Determination in Water: Fish Tox = 10.60669000 ppb (INTERMEDIATE)

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Fenthion can affect you when breathed in and quickly enters the body by passing through the skin. Fatal poisoning can occur from skin contact. It is highly toxic. It may damage the developing fetus. Exposure can cause rapid fatal organophosphate poisoning with headaches, sweating, nausea and vomiting, muscle twitching; coma and death. Sometimes, effects are delayed for 1–2 days. Poisoning can happen from skin contact, even if no irritation is felt. Human Tox = 4.90000 ppb (HIGH).

Long-Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. Fenthion may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, central nervous system; cardiovascular system, skin, eyes, plasma, and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: Plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1–2 weeks while red blood cell levels may be reduced for 1–3 months. When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If exposure and/or symptoms have occurred, the person should be under medical observation for several days, as some symptoms may be delayed.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working

with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures over *0.2 milligram per cubic meter*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, alkalies, and alkaline pesticides. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN3018 Organophosphorus pesticides, liquid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN2810 Toxic liquids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling:

Initial isolation and protective action distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.3/0.4
Night 0.8/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 600/200
Then: Protect persons downwind (mi/km)
Day 1.4/2.3
Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Do not touch spilled material. Do not breathe vapors. Stay upwind; keep out of low areas. Remove all ignition sources. Ventilate area of spill or leak. This material is a combustible liquid. For a spill or leak of a combustible liquid, shut off ignition sources; no flares, smoking or flames in hazard area. Stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: Absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: Dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Fenthion itself does not burn readily. Thermal decomposition products may include oxides of phosphorus, sulfur, nitrogen, and carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Hydrolysis and landfill for small quantities; incineration with flue gas scrubbing for large amounts[22]. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (80); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 3, No. 1, 56–61 (1983) New York, Van Nostrand Reinhold Co. (1983).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Fenthion, Trenton, NJ (April 1999).

Fenvalerate F:0128

Formula: $C_{25}H_{22}ClNO_3$
Synonyms: A13-29235; Belmark; Benzeneacetic acid, 4-chloro-α-(1-methylethyl)-, cyano(3-phenoxyphenyl)methyl ester; Caswell No. 077A; (IRS)-α-Cyano-3-phenoxybenzyl (RS)-2-(4-chlorophenyl)-3-methybutyrate; α-Cyano-3-phenoxybenzyl 2-(4-chlorophenyl)isovalerate; α-Cyano-3-phenoxybenzyl-2-(4-chlorophenyl)-3-methybutyrate; Cyano(3-phenoxyphenyl)methyl 4-chloro-α-(1-methylethyl)benzeneacetate; Cyano-(3-phenoxybenzyl)methyl 2-(4-chlorophenyl)-3-methylbutyrate; Cyano-(3-phenoxyphenyl)methyl 4-chloro-α-(1-methylethyl)benzeneacetate; Cyano(3-phenoxyphenyl)methyl ester of 4-chloro-α-(1-methylethyl) benzeneacetic acid; α-Cyano-*m*-phenoxybenzyl 2-(*p*-chlorophenyl)-3-methylbutyrate; 4-Chloro-α-(1-methylethyl)benzeneacetic acid, cyano(3-phenoxyphenyl)methyl ester; 4-Chloro-α-(1-methylethyl)benzeneacetic acid cyano(3-phenoxyphenyl)methyl ester; Ectin; Evercide; Fenkill; Fenvaleriato (Spanish); Koranda; Phenvalerate; Pydrin; S 5602; Sanmarton; SD 43775; Sumicide; Sumicidine; Sumicidin; Sumifleece; Sumifly; Sumipower; Sumitick; Tirade; W 1 43775
CAS Number: 51630-58-1
HSDB Number: 6640
RTECS Number: CY1576300
UN/NA & ERG Number: UN3352 (liquid)/151; UN3349 (pyrethroid pesticide, solid, toxic)/151
EC Number: 257-326-3
Regulatory Authority and Advisory Information
Carcinogenicity[83]: EPA Group E, Evidence of noncarcinogenicity for humans; IARC, Group 3 not classifiable as to its carcinogenicity in humans.
Hazard Alert: Poison, Suspected reprotoxic hazard, Possible endocrine disruptor, Environmental hazard.
Permissible Exposure Limits for Chemical Contaminants (CAL/OSHA) as pyrethrum
Clean water act: Section 311 Hazardous Substances/RQ (same as CERCLA) as pyrethrins
United States DOT Regulated marine pollutant (49CFR172.101, Appendix B), severe pollutant.
WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.
Description: Yellowish to brown viscous liquid. Also available as an emulsifiable concentrate, which is corrosive. Technical grade is a brown viscous liquid. Faint chemical odor. Boiling point = decomposes. Molecular weight 419.93; specific gravity (H_2O:1) = 1.17 @ 23°C; vapor pressure = 1.1×10^{-8} mmHg @ 25°C; 3.7×10^{-7} mmHg @ 25°C. Practically insoluble in water; solubility = 0.085 ppm @ 20°C. Physical and toxicological properties may be affected by carrier solvents in commercial formulations.
Potential Exposure: Fenvalerate is one of the most versatile synthetic pyrethroid insecticides. It is mostly used in agriculture and on cattle, but also in homes and gardens. It acts as a stomach poison against a wide variety of leaf and fruit eating such as bollworm fruit and shoot borers and aphids. Crops on which it is used include cotton, cauliflower, okra, vines and fruits. It is also used in public health and animal husbandry. It is effective against pests whose strains are resistant to organochlorine, organophosphorus, and carbamate insecticides. Not used in EU countries.
Incompatibilities: Incompatible with oxidizers, chlorates nitrates, peroxides, sulfuric acid, caustics, ammonia, aliphatic amines, alkanolamines, isocyanates, alkylene oxides, epichlorohydrin. Moisture may cause hydrolysis or other forms of decomposition. Emulsifiable concentrate is corrosive.
Permissible Exposure Limits in Air:
NIOSH[2] IDLH = 5000 ppm
OSHA PEL: 5 milligram per cubic meter TWA
NIOSH REL: 5 milligram per cubic meter TWA
ACGIH TLV[1]: 5 milligram per cubic meter TWA
STEL set by HSE[33] = 10 milligram per cubic meter.
Determination in Air: Collection by impinger or fritted bubbler, analysis by gas liquid chromatography/ultraviolet. See NIOSH IV, Method #5008[18], pyrethrum.
Permissible Concentration in Water: State Drinking Water Guidelines: Arizona 180 μg/L. Runoff from spills or fire control may cause water pollution. Acceptable Daily Intake (ADI) = 0.02 mg/kg as pyrethroid.
Determination in Water: Collection by impinger or fritted bubbler, analysis by gas liquid chromatography/ultraviolet. See NIOSH IV, Method #5008[18], pyrethrum. Octanol−water coefficient: Log K_{ow} = > 4.0. Values above 3.0 are likely to bioaccumulate in marine organisms. Fish toxicity (threshold)[101]: Extra high—0.01433 ppb, MATC.
Routes of Entry: Inhalation, absorbed through the skin
Harmful Effects and Symptoms
Short-Term Exposure: Pyrethrins can affect you when breathed in and by passing through your skin. Irritates the eyes and respiratory tract. High exposure can affect the nervous system causing headache, nausea, vomiting, fatigue, and restlessness, rhinorrhea (discharge of thin nasal mucous). Emulsifiable concentrate is corrosive to skin, eyes, and respiratory tract. LD_{50} (oral, rat) = < 100 mg/kg; LD_{50} (dermal, rabbit) = > 2.5 g/kg.
Long-Term Exposure: May cause tumors. High or repeated exposure can cause lung allergy (with cough, wheezing and/or shortness of breath) or hay fever symptoms (sneezing, runny or stuffy nose). Allergic "pneumonia" can also occur with cough, chest pain, breathing difficulty and abnormal chest X-ray. Repeated attacks may lead to permanent scarring. Skin allergy may also develop with rash and itching, even with lower exposures. Dermal contact can cause rash with redness, blisters and intense itching. A severe generalized allergy can occur with weakness and collapse. Endocrine disruptor. Human toxicity (long term)[101]: Very low—175.00 ppb, Health Advisory.

Points of Attack: Respiratory system, skin, central nervous system

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended: Employees should be screened for history of certain medical conditions which might place the employee at increased risk from pyrethroid exposure. Chronic respiratory disease: In persons with chronic respiratory disease, especially asthma, the inhalation of pyrethroids might cause exacerbation of symptoms due to its sensitizing properties. Lung function tests. These may be normal if the person is not having an attack at the time of the test. Consider chest X-ray if lung symptoms are present. Skin disease: Pyrethroids can cause dermatitis which may be allergic in nature. Persons with preexisting skin disorders may be more susceptible to the effects of this agent. Evaluation by a qualified allergist, including exposure history and testing, may help diagnose allergy. Any employee developing the above-listed conditions should be referred for further medical examination[9].

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. *Do not induce vomiting when formulations containing petroleum solvents are ingested*. Otherwise, give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Applicators and other handlers must wear: Coveralls worn over long-sleeved shirt and long pants; Chemical-resistant gloves such as DuPont Tychem suit fabrics, barrier laminate, or Viton; Chemical-resistant footwear plus socks; Protective eye wear; Chemical-resistant headgear for overhead exposure; Chemical-resistant apron when cleaning equipment, mixing, or loading[83]. Agricultural Use/Engineering Controls: When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the Worker Protection Standard (WPS) for agricultural pesticides, 40 CFR 170.240(d)(4-6), the handler PPE requirements may be reduced or modified as specified in the WPS. Firefighters should wear NIOSH approved SCBA and full protective clothing.

Respirator Selection: NIOSH/OSHA *for pyrethrum*: *50 milligram per cubic meter:* CcrOv95 (APF = 10) [any air-purifying half-mask respirator equipped with an organic vapor cartridge(s) in combination with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *125 milligram per cubic meter:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOvHie (APF = 25) (any air-purifying full facepiece respirator equipped with an organic vapor cartridge in combination with a high-efficiency particulate filter). *250 milligram per cubic meter:* CcrFOv100 (APF = 50) [any air-purifying full facepiece respirator equipped with organic vapor cartridge(s) in combination with an N100, R100, or P100 filter]; or PaprTOvHie (APF = 50) [any powered, air-purifying respirator with a tight-fitting facepiece and organic vapor cartridge(s) in combination with a high-efficiency particulate filter]; or SCBAF (APF = 50) (any SCBA with full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece).*5000 milligram per cubic meter:* SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—Blue: Health Hazard/Poison. Store in a secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN3349 Pyrethroid pesticide, solid toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous material. UN3352 Pyrethroid pesticide, liquid toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: First remove all sources of ignition. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Ventilate area of spill or leak. Use water spray to reduce vapor. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include hydrogen chloride and oxides of nitrogen and carbon. *On a small fire:* use dry chemical, CO_2 or water spray. On a large fire: use water spray, fog or regular foam. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal; do not scatter the material. Use water spray or fog; do not use straight streams. *Fire involving storage or vehicular tanks:* Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Do not get water inside containers. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. ALWAYS stay away from tanks engulfed in fire. For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies.

Disposal Method Suggested: Incineration would be an effective disposal procedure where permitted. If an efficient incinerator is not available, the product should be mixed with large amounts of combustible material and contact with the smoke should be avoided. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Office of Pesticide Programs, Pesticide Residue Limits, “Fenvalerate,” 40 CFR 180.533, http://www.epa.gov/pesticides/food/viewtols.htm.

International Programme on Chemical Safety (IPCS), “Health and Safety Guide, Fenvalerate,” Geneva, Switzerland (1990). http://www.inchem.org/documents/ehc/ehc/ehc95.htm.

Ferbam F:0130

Formula: $C_9H_{18}FeN_3S6$; $Fe[(CH_3)_2NCS_2]_3Fe$

Synonyms: Aafertis; AI3-14689; Bercema Fertam 50; Carbamic acid, dimethyldithio-, iron salt; Caswell No.458; Dimethylcarbamo dithioic acid, iron complex; Dimethylcarbamodithioic acid, iron(3+) salt; Dimethyldithiocarbamic acid, iron salt; Dimethyldithiocarbamic acid, iron(3+) salt; Eisendimethyldithiocarbamat (German); Eisen(III)-tris(*N,N*-dimethyldithiocarbamat) (German); ENT 14,689; EPA pesticide chemical code 034801; Ferbam 50; Ferbam, iron salt; Ferbeck; Fermate ferbam fungicide; Fermocide; Ferradour; Ferradow; Ferric dimethyl dithiocarbamate; Fuklasin ultra; Hexaferb; Hokmate; Iron dimethyldithiocarbamate; Iron(III) dimethyldithiocarbamate; Iron, tris(dimethylcarbamodithioato-*S,S′*-)-; Iron, tris(dimethylcarbamodithioato-*S,S′*)-, (OC-6—11)-; Iron tris(dimethyldithiocarbamate); Iron, tris(dimethyldithiocarbamato)-; Karbam black; Karbam carbamate; Knockmate; Niacide; Stauffer ferbam; Sup’r-Flo Ferbam flowable; Trifungol; (OC-6—11)-Tris(dimethylcarbamodithioato-*S,S′*)iron; Tris (dimethylcarbamodithioato-*S,S′*)iron; Tris(*N,N*-dimethyldithiocarbamato)iron(III); Tris(dimethyldithiocarbamato) iron; Vancide FE95

CAS Registry Number: 14484-64-1; *(alt.)* 301-05-3; *(alt.)* 13494-27-4; *(alt.)* 64070-92-4

HSDB Number: 1645

RTECS Number: NO8750000

UN/NA & ERG Number: UN2771/151; UN3077 (environmentally hazardous substances, solid, n.o.s.)/171;

EC Number: 238-484-2 [*Annex I Index No.*: 006-051-00-5]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human No Adequate Data; Animal Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1987. United States Environmental Protection Agency Gene-Tox Program, Inconclusive: *B. subtilis* rec assay.

Hazard Alert: Poison, Possible thyroid effects. Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard.

United States Environmental Protection Agency, FIFRA 1998 Status of Pesticides: Supported

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U396

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

EPCRA Section 313 Form R de minimis concentration reporting level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: Xi, N; risk phrases: R36/37/38; R50/53; R61; R62; R63; safety phrases: S2; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)]

Description: Ferbam is a combustible, odorless dark brown to black powder or granular solid. Molecular weight = 416.51; freezing/melting point = > 180°C (decomposes). Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 1, reactivity 0. Practically insoluble in water; solubility = 0.01%.

Potential Exposure: A dithiocarbamate. A potential danger to those involved in the production, formulation and application of this dithiocarbamate; used as a fungicide, rubber accelerator, and plastics prodegradant. Some dithiocarbamates have been used as rubber components.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine,

bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Heat alkalies (lime); moisture can cause decomposition. Decomposes on prolonged storage. Dithiocarbamate esters are combustible. They react violently with powerful oxidizers such as calcium hypochlorite. Poisonous gases are generated by the thermal decomposition of Dithiocarbamate compounds, including carbon disulfide, oxides of sulfur, oxides of nitrogen, hydrogen sulfide, ammonia, and methylamine. Thio and dithiocarbamates slowly decompose in aqueous solution to form carbon disulfide and methylamine or other amines. Such decompositions are accelerated by acids. Flammable gases are generated by the combination of dithiocarbamate with aldehydes, nitrides, and hydrides. Dithiocarbamate are incompatible with acids, peroxides, and acid halides.

Permissible Exposure Limits in Air

NIOSH IDLH = 800 milligram per cubic meter

OSHA PEL: 15 milligram per cubic meter (total dust) TWA

NIOSH REL: 10 milligram per cubic meter TWA

ACGIH TLV[1]: 5 milligram per cubic meter, inhalable fraction, TWA; not classifiable as a human carcinogen

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

DFG MAK: Danger of skin sensitization (dithiocarbamates used as rubber components).

Australia: TWA 10 milligram per cubic meter, 1993; Austria: MAK 10 milligram per cubic meter, 1999; Belgium: TWA 10 milligram per cubic meter, 1993; Denmark: TWA 5 milligram per cubic meter, 1999; France: VME 10 milligram per cubic meter, 1999; Norway: TWA 1 mg[Fe]/m^3, 1999; the Netherlands: MAC-TGG 10 milligram per cubic meter, 2003; Switzerland: MAK-W 10 milligram per cubic meter, 1999; Turkey: TWA 15 milligram per cubic meter, 1993; United Kingdom: TWA 10 milligram per cubic meter; STEL 20 milligram per cubic meter, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Several states have set guidelines or standards for ferbam in ambient air[60] ranging from 100 μ/m^3 (North Dakota) to 200 μ/m^3 (Connecticut) to 238 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #0500, Particulates NOR, total dust.

Permissible Concentration in Water: Federal Drinking Water Guidelines: MCGL = 300 μg[Fe]/L. State Drinking Water Standards: Illinois: 1000 μg[Fe]/L; North Carolina: 300 μg[Fe]/L. Degradation produces ethylene thiourea.

Determination in Water: EPA EMSLC Method 630. The Determination of Dithiocarbamate Pesticides in Municipal and Industrial Wastewater by UV−VIS Spectrophotometry.

Routes of Entry: Poisoning can occur by inhalation, ingestion and absorption through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Ferbam can affect you when breathed in. Breathing ferbam can irritate the nose and throat. Ferbam can cause skin and eye irritation. High exposure to ferbam may affect the nervous system and thyroid; dizziness, confusion, loss of coordination; seizures, paralysis, and coma.

Long-Term Exposure: Thyroid effects. Repeated or prolonged contact with skin may cause allergy with skin rash and itching. Exposure to ferbam may damage the kidneys and liver. Ferbam may damage the developing fetus.

Points of Attack: Thyroid function. Thyroid function (may cause goiter). Eyes, skin, respiratory system; gastrointestinal tract.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: Kidney function tests. Liver function tests. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Thyroid function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *up to 50 milligram per cubic meter*: Q_m (APF = 25) (any quarter-mask respirator). *Up to 100 milligram per cubic meter:* 95XQ* (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa* (APF = 10) (any supplied-air respirator). *Up to 250 milligram per cubic meter:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie* (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *Up to 500 milligram per cubic meter:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100); or SaT: Cf

* (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTiE* (any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter); * or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 800 milligram per cubic meter:* Sa:Pd,Pp (APF = 1000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry in unknown concentration or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA). *Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Ferbam is incompatible with strong oxidizers (such as chlorine, bromine and fluorine). Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, strong bases; heat and moisture. Ferbam can decompose upon long-term storage.

Shipping: UN2771 Dithiocarbamate and Thiocarbamate pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Ferbam may burn, but does not readily ignite. Use dry chemical, CO_2, water spray; or foam extinguishers. Thermal decomposition products may include oxides of nitrogen and sulfur. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Ferbam is hydrolyzed by alkali and is unstable to moisture, lime and heat. Ferbam can be incinerated[22]. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (173); (101); (138); (2); (80); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Ferbam, Trenton, NJ (April 1999).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 6, 56−58 (1981) and 8, No. 6, 57−63 (1988).

Ferric Ammonium Citrate F:0140

Formula: $C_{12}H_{18}FeN_2O_{14}$; $FeC_6H_5O_7 \cdot (NH_4)_2C_6H_5O_7$

Synonyms: Ammonium ferric citrate; Ammonium iron(III) citrate; Citrato ferrico amonico (Spanish); FAC; Ferric ammonium citrate, brown; Ferric ammonium citrate, green; Iron(III) ammonium citrate; Soluble ferric citrate

CAS Registry Number: 1185-57-5

HSDB Number: 446

RTECS Number: GE7540000

DOT ID and ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 214-686-6

Regulatory Authority and Advisory Information

Hazard Alert: Combustible.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

United States National Primary Drinking Water Regulations: SMCL = 0.3 mg[Fe]/L as Iron

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1000 lb (454 kg).

Hazard symbols, risk, & safety statements: Hazard symbol: Xi; risk phrases: R36/37/38; safety phrases: S16; S26; S36/37/39; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Ferric ammonium citrate forms reddish brown flakes or grains, or a brownish-yellow powder. It has a slight ammonia odor. There is also a green form that is odorless. Molecular weight = 709.44; specific gravity (H_2O:1) = 1.8 @ 20°C; boiling point = decomposes. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 1, reactivity 0. Highly soluble in water.

Potential Exposure: Ferric ammonium citrate is used in blueprinting, photography, medical treatment; and as an animal food additive[101].

Incompatibilities: Compounds of the carboxyl group react with all bases, both inorganic and organic (i.e., amines) releasing substantial heat, water and a salt that may be harmful. Incompatible with arsenic compounds (releases hydrogen cyanide gas), diazo compounds, dithiocarbamates, isocyanates, mercaptans, nitrides, and sulfides (releasing heat, toxic and possibly flammable gases), thiosulfates and dithionites (releasing hydrogen sulfate and oxides of sulfur).

Permissible Exposure Limits in Air

OSHA PEL: None

NIOSH REL: 1 mg[Fe]/m^3 TWA

ACGIH TLV[1]: 1 mg[Fe]/m^3 TWA

PAC Ver. 28, no value in Ver. 29[138]

PAC-1: 5.4 milligram per cubic meter

PAC-2: 59 milligram per cubic meter

PAC-3: 360 milligram per cubic meter

Finland: TWA 1 mg[Fe]/m^3, 1999; Norway: TWA 1 mg [Fe]/m^3, 1999; Switzerland: MAK-W 1 mg[Fe]/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 1 mg [Fe]/m^3

Determination in Air: See NIOSH Analytical Method (IV)s #7300, Elements, #7301, #7303, #9102 or OSHA Analytical Method ID-121, IDI-125G[58].

Permissible Concentration in Water: Federal Drinking Water Guidelines: MCGL = 300 μg[Fe]/L; State Drinking Water Standards: Illinois: 1000 μg[Fe]/L; North Carolina: 300 μg [Fe]/L.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Ferric ammonium citrate can affect you when breathed in. Irritates the eyes, skin and respiratory tract. Ingestion can cause abdominal pain; diarrhea and vomiting. Inhaling iron oxide fumes may cause pneumoconiosis in the lungs. Iron oxide fumes can cause "metal fume fever."

Long-Term Exposure: Prolonged or repeated high exposure may cause liver damage. Prolonged eye contact can cause a brownish discoloration of the eye.

Points of Attack: Eyes, skin, respiratory system; liver, gastrointestinal tract.

Medical Surveillance: Liver function tests. For those exposed to this chemical, taking dietary supplements or vitamins containing iron is not recommended without medical advice.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. The symptoms of metal fume fever may be delayed for 4−12 hours following exposure: it may last less than 36 hours.

Note to Physician: In case of fume inhalation, treat pneumonitis. Give prednisone or other corticosteroid orally to reduce tissue response to fume. Positive pressure ventilation may be necessary. Treat metal fume fever with bed rest, analgesics and antipyretics.

Note to physician: For severe poisoning *do not* use BAL (British Anti-Lewisite), dimercaprol, dithiopropanol ($C_3H_8OS_2$) as it is contraindicated or ineffective in poisoning from iron.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures *over 1 milligram per cubic meter*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Green: General storage may be used. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from light. Sources of ignition, such as smoking and open flames, are prohibited where ferric ammonium citrate is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Absorb liquids containing ferric ammonium citrate in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Ferric ammonium citrate may burn, but does not readily ignite. Thermal decomposition products may include ammonia and oxides of nitrogen, metal and carbon. Use dry chemical, CO_2, water spray; or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Ferric Ammonium Citrate, Trenton, NJ (September 2001).

Ferric Ammonium Oxalate F:0150

Formula: $C_6H_{18}FeN_3O_{15}$; $Fe(NH_4)_3(C_2O_4)_3 \cdot 3H_2O$

Synonyms: Ammonium ferric oxalate trihydrate; Ammonium ferrioxalate; Ammonium trioxalatoferrate(3+); Ammonium trioxalatoferrate(III); Ethanedioic acid, ammonium iron(3+) salt; Ethanedioic acid, ammonium iron(III) salt; Oxalato ferrico amonico (Spanish); Oxalic acid, ammonium iron(3+) salt (3:3:1); Oxalic acid, ammonium iron(III) salt (3:3:1); Triammonium tris-(ethanedioato(2−)-*o,o′*)ferrate(3-1)

CAS Registry Number: 14221-47-7; 2944-67-4; 55488-87-4; 13268-42-3 (trihydrate)

HSDB Number: 947

RTECS Number: LI8932000

DOT ID and ERG Number: UN3288/155 (trihydrate)

EC Number: 238-090-0 (triammonium trioxalatoferrate); 220-952-2 (triammonium iron(3+) trioxalate); 607-007-00-3 (trihydrate)

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Primary irritant (w/o allergic reaction), Corrosive, Reducing agent.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below) United States National Primary Drinking Water Regulations: SMCL = 0.3 mg[Fe]/L as Iron

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1000 lb (454 kg)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: (trihydrate) Hazard symbol: C, Xn; risk phrases: R21/22; R34; R36/37/38; safety phrases: S24; S25; S26; S27; S36/37/39; S45 (see Appendix 4)

Description: Ferric ammonium oxalate is a green crystalline, solid with a granular or salt-like appearance. Color depends on level of iron present. Molecular weight = 374.06; 428.06. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 0, reactivity 0. Soluble in water.

Potential Exposure: Ferric ammonium oxalate is used in photography and making blueprints.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

OSHA PEL: None

NIOSH REL: 1 mg[Fe]/m^3 TWA

ACGIH TLV[1]: 1 mg[Fe]/m^3 TWA

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Finland: TWA 1 mg[Fe]/m^3, 1999; Norway: TWA 1 mg [Fe]/m^3, 1999; Switzerland: MAK-W 1 mg[Fe]/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 1 mg [Fe]/m^3

Determination in Air: See NIOSH Analytical Method (IV)s #7300, Elements, #7301, #7303, #9102 or OSHA Analytical Method ID-121, IDI-125G[58].

Permissible Concentration in Water: Federal Drinking Water Guidelines: MCGL = 300 μg[Fe]/L; State Drinking

Water Standards: Illinois: 1000 μg[Fe]/L; North Carolina: 300 μg[Fe]/L.

Routes of Entry: Inhalation of dust, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Ferric ammonium oxalate can affect you when breathed in. Irritates the eyes, skin and respiratory tract. Ingestion can cause abdominal pain; diarrhea and vomiting. Inhaling iron oxide fumes may cause pneumoconiosis in the lungs. Iron oxide fumes can cause "metal fume fever;" irritation of eyes, skin, mucous membranes; abdominal pain; diarrhea, vomiting.

Long-Term Exposure: Prolonged or repeated high exposure may cause liver damage. Prolonged eye contact can cause a brownish discoloration of the eye. May cause fibrosis of the lungs. Repeated overexposure may cause kidney stones.

Points of Attack: Eyes, skin, respiratory system; liver, kidneys, lungs, gastrointestinal tract.

Medical Surveillance: Liver function tests. Kidney function tests. Lung function tests. For those exposed to this chemical, taking dietary supplements or vitamins containing iron is not recommended without medical advice.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. The symptoms of metal fume fever may be delayed for 4−12 hours following exposure: it may last less than 36 hours.

Note to physician: For severe poisoning *do not* use BAL, dimercaprol, dithiopropanol ($C_3H_8OS_2$) as it is contraindicated or ineffective in poisoning from iron.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures *over 1 milligram per cubic meter*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Green: General storage may be used. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from light.

Shipping: UN3288 Toxic solids, inorganic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Ferric ammonium oxalate may burn, but does not readily ignite. Thermal decomposition products may include ammonia and oxides of nitrogen and carbon. Use dry chemical, CO_2, water spray; or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Ferric Ammonium Oxalate, Trenton, NJ (October 2001).

Ferric Chloride F:0160

Formula: Cl_3Fe; $FeCl_3$
Synonyms: Anhydrous ferric chloride; Chlorure perrique (French); Cloruro ferrico anhidro (Spanish); Flores martis; Iron chloride; Iron(3+) chloride; Iron(III) chloride; Iron sesquichloride; Iron trichloride; Perchlorure de fer (French); PF etchant
CAS Registry Number: 7705-08-0
HSDB Number: 449
RTECS Number: LJ9100000
UN/NA & ERG Number: UN1773 (anhydrous)/157; UN2582 (solution)/154
EC Number: 231-729-4
Regulatory Authority and Advisory Information
Hazard Alert: Corrosive, Sensitization hazard; Suspected reprotoxic hazard, Suspected of causing genetic defects; FDA-over the counter drug; Known catalytic activity.
United States National Primary Drinking Water Regulations: SMCL = 0.3 mg[Fe]/L as Iron; SMCL = 0.3 mg[Fe]/L as Iron; SMCL = 250 mg[Cl^-]/L as Chloride
Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).
Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1000 lb (454 kg)
Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. as Iron, water-soluble salts, n.o.s.
Hazard symbols, risk, & safety statements: Hazard symbol: C, Xn, Xi; risk phrases: R22; R34; R36/37/38; R41; R43; R62; R63; safety phrases: S26; S36/37/39; S41; S45(see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.
Description: Ferric Chloride is a black-brown, dark-green, or black crystalline solid. Molecular weight = 162.20; specific gravity (H_2O:1) = 2.9 @ 20°C; boiling point = decomposes @ 315°C; freezing/melting point = (decomposes) 316°C; vapor pressure = 1 mmHg @ 194°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 1. Soluble in water; solubility = 63%.
Potential Exposure: Iron chloride is used to treat sewage and industrial waste. It is also used as an etchant for photoengraving and rotogravure; in textiles; photography; as a disinfectant; as a feed additive.
Incompatibilities: Aqueous solutions are a strong acid. Violent reaction with bases, allyl chloride; sulfuric acid; water. Shock- and friction-sensitive explosive material forms with potassium, sodium and other active metals. Attacks metals when wet.
Permissible Exposure Limits in Air
OSHA PEL: None
NIOSH REL: 1 mg[Fe]/m^3 TWA
ACGIH TLV[1]: 1 mg[Fe]/m^3 TWA
PAC Ver. 29[138]
PAC-1: 8.7 milligram per cubic meter
PAC-2: 30 milligram per cubic meter
PAC-3: 180 milligram per cubic meter
Finland: TWA 1 mg[Fe]/m^3, 1999; Norway: TWA 1 mg [Fe]/m^3, 1999; Switzerland: MAK-W 1 mg[Fe]/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 1 mg[Fe]/m^3
Determination in Air: See NIOSH Analytical Method (IV)s #7300, Elements, #7301, #7303, #9102 or OSHA Analytical Method ID-121, IDI-125G[58].
Permissible Concentration in Water: Federal Drinking Water Guidelines: MCGL = 300 μg[Fe]/L; State Drinking Water Standards: Illinois: 1000 μg[Fe]/L; North Carolina: 300 μg[Fe]/L.
Routes of Entry: Inhalation of dust, ingestion; skin and/or eye contact.
Harmful Effects and Symptoms
Short-Term Exposure: Ferric chloride is corrosive to the eyes, skin and respiratory tract. Eye contact may cause permanent damage. Inhaling iron oxide fumes may cause pneumoconiosis in the lungs. Iron oxide fumes can cause "metal fume fever;" irritation of eyes, skin, mucous membranes; abdominal pain; diarrhea, vomiting; Ingestion may cause severe irritation to mouth and throat, weak and rapid pulse; low blood-pressure; nausea, bloody vomiting; violent diarrhea; shock, dark purple skin discoloration, and coma. Animal studies suggest that death may result from 2.5 oz for a 150 lb person.
Long-Term Exposure: Prolonged or repeated high exposure may cause liver damage. Prolonged eye contact can cause a brownish discoloration of the eye. Repeated overexposure may cause kidney stones. Excessive intake of iron compounds may result in increased accumulation of iron in body, especially the liver, spleen and lymphatic system. Inhalation of iron dusts may cause mottling of the lung. Iron chloride may reduce the fertility of both males and females.
Points of Attack: Eyes, skin, respiratory system; liver, kidneys, lungs, gastrointestinal tract.
Medical Surveillance: Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Liver function tests. Kidney function tests. Lung function tests. For those exposed to this chemical, taking dietary supplements or vitamins containing iron is not recommended without medical advice.
First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim*

ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves.

Note to Physician: Gastric lavage should be performed followed by saline catharsis and anodyne. Administer deferoxamine, I.V. Watch for late stricture. Serum, plasma, or urinary iron levels may be employed to estimate amount ingested.

Note to physician: For severe poisoning *do not* use BAL, dimercaprol, dithiopropanol ($C_3H_8OS_2$) as it is contraindicated or ineffective in poisoning from iron.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Neoprene and PVC are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof goggles and face shield when working with powders or dust, unless full facepiece respiratory protection is worn. Wear splash-proof chemical goggles and face shield when working with liquid, unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures *over 1 milligram per cubic meter*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece respirator with a high efficiency particulate filter. Greater protection is provided by a powdered-air purifying respirator. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplier-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: (1) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. (2) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Iron chloride must be stored in tightly closed containers to avoid contact with sulfuric acid, sodium, potassium, allyl chloride and water, since violent reactions occur and toxic vapors may be produced.

Shipping: UN1773 Ferric chloride, anhydrous, Hazard class: 8; Labels: 8-Corrosive material. UN2582 Ferric chloride, solution, Hazard class: 8; Labels: 8-Corrosive material.

Spill Handling: *Solution:* Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Powder (anhydrous): Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Use any extinguishing agents suitable for surrounding fire. Thermal decomposition products may include hydrogen chloride and oxides of metal. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Neutralize with lime or soda ash and bury in an approved landfill[22].

References

(31); (173); (101); (138); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 3, No. 4, 42−45 (1983).

New York State Department of Health, *Chemical Fact Sheet:* Iron (III) Chloride, Bureau of Toxic Substance Assessment, Albany, NY (February 1986).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Iron Chloride, Trenton, NJ (August 2004).

Ferric Nitrate F:0170

Formula: C_3FeO_9; $Fe(CO_3)_3$

Synonyms: Ferric(3+) nitrate; Ferric(III) nitrate; Ferric nitrate, Nonhydrate; Iron nitrate; Iron(3+) nitrate, anhydrous; Iron(III) nitrate, anhydrous; Iron trinitrate; Nitrato ferrico (Spanish); Nitric acid, iron(3+) salt; Nitric acid, iron(III) salt

CAS Registry Number: 10421-48-4

HSDB Number: 451

RTECS Number: QU8915000

UN/NA & ERG Number: UN1466/140

EC Number: 233-899-5

Regulatory Authority and Advisory Information

Hazard Alert: Combustible, Oxidizer, Corrosive, Primary irritant (w/o allergic reaction), Environmental hazard.

United States National Primary Drinking Water Regulations: SMCL = 0.3 mg[Fe]/L as Iron; MCLG = 10 mg[N]/L; MCL = 10 mg/L as Nitrates

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1000 lb (454 kg)

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. as Iron, water-soluble salts, n.o.s.

Hazard symbols, risk, & safety statements: Hazard symbol: C, O, Xi; risk phrases: R8; R20; R34; R36/37/38; R41; safety phrases: S16; S17; S25; S26; S36/37/39; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Ferric nitrate is a pale violet, green, or grayish-white, odorless solid in lumpy crystals (like salt). Molecular weight = 241.86; specific gravity (H_2O:1) = 168 @ 21°C; boiling point = decomposes; freezing/melting point = 35°C; 47°C (nonhydrate). Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 1, reactivity 3, Oxidizer, ₩. Highly soluble in water, releases gaseous hydrogen chloride.

Potential Exposure: Ferric nitrate is used in textile dyeing, tanning, and weighting silk.

Incompatibilities: An oxidizer. Keep away from reducing agents, oxidizable materials and combustibles including metal powders, sulfur, and organic materials, combustibles, and easily oxidizable materials. Light sensitive. Aqueous solution is corrosive to metals.

Permissible Exposure Limits in Air

OSHA PEL: None

NIOSH REL: 1 mg[Fe]/m^3 TWA

ACGIH TLV[1]: 1 mg[Fe]/m^3 TWA

PAC Ver. 29[138]

PAC-1: 13 milligram per cubic meter

PAC-2: 140 milligram per cubic meter

PAC-3: 850 milligram per cubic meter

Finland: TWA 1 mg[Fe]/m^3, 1999; Norway: TWA 1 mg [Fe]/m^3, 1999; Switzerland: MAK-W 1 mg[Fe]/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 1 mg[Fe]/m^3

Determination in Air: See NIOSH Analytical Method (IV) s #7300, Elements, #7301, #7303, #9102 or OSHA Analytical Method ID-121, IDI-125G[58].

Permissible Concentration in Water: Federal Drinking Water Guidelines: MCGL = 300 μg[Fe]/L; State Drinking Water Standards: Illinois: 1000 μg[Fe]/L; North Carolina: 300 μg[Fe]/L.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Ferric nitrate can affect you when breathed in. Exposure can irritate the eyes, nose, throat, and skin. Large amounts of iron in the body can cause nausea, stomach pain; constipation, and black bowel movements. Ingestion can cause abdominal pain; diarrhea and vomiting. Inhaling iron oxide fumes may cause pneumoconiosis in the lungs. Iron oxide fumes can cause "metal fume fever," irritation of eyes, skin, mucous membranes; abdominal pain; diarrhea, vomiting.

Long-Term Exposure: Prolonged or repeated high exposure may cause liver damage. Prolonged eye contact can cause a brownish discoloration of the eye. May cause lung fibrosis. Repeated overexposure may cause kidney stones.

Points of Attack: Eyes, skin, respiratory system; liver, lungs, gastrointestinal tract.

Medical Surveillance: If illness occurs or overexposure is suspected, medical attention is recommended. Blood test for serum iron can detect excess body iron. If increased, consider liver function tests. Examination of the eyes. Lung function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get

medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. The symptoms of metal fume fever may be delayed for 4−12 hours following exposure: it may last less than 36 hours.

Note to physician: For severe poisoning *do not* use BAL, dimercaprol, dithiopropanol ($C_3H_8OS_2$) as it is contraindicated or ineffective in poisoning from iron.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures *over 1 milligram per cubic meter*, use an NIOSH/MSHA or European Standard EN 149-approved respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. *Where there is potential for high exposures exists*, use an NIOSH/MSHA or European Standard EN 149-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use an NIOSH/MSHA or European Standard EN 149-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Check oxygen content prior to entering storage area. Color code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially organic materials, flammables and combustibles, and other incompatible materials. Oxidizers, including oxidizing gases, should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from organic materials and other combustible materials or aluminum powder. Store in a cool, well-ventilated area away from incompatible materials listed above. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage.

Shipping: UN1466 Ferric nitrate, Hazard Class: 5.1; Labels: 5.1-Oxidizer.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient manner and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Use extinguishers suitable for surrounding fire. Thermal decomposition products may include nitric acid and oxides of metal and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Ferric Nitrate, Trenton, NJ (March 1999).

Ferric Sulfate F:0180

Formula: $Fe_2O_{12}S_3$; $Fe_2(SO_4)_3$

Synonyms: Diiron trisulfate; Greenmaster autumn; Iron persulfate; Iron sesquisulfate; Iron sulfate (2:3); Iron(3+) sulfate; Iron(III) sulfate; Iron tersulfate; Maxicrop Moss Killer; Sulfato ferrico (Spanish); Sulfuric acid, iron(3+) salt (3:2); Sulfuric acid, iron(III) salt (3:2); Vitax micro gran; Vitax Turf tonic

CAS Registry Number: 10028-22-5

HSDB Number: 6311

RTECS Number: NO8505000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 233-072-9

Regulatory Authority and Advisory Information

Hazard Alert: Suspected of causing genetic defects

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)

United States National Primary Drinking Water Regulations: SMCL = 0.3 mg[Fe]/L as Iron; SMCL = 250 mg[SO_4^{-2}]/L as Sulfate

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1000 lb (454 kg)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. as Iron, water-soluble salts, n.o.s.; 0.1%. as persulfate compounds.

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xn; risk phrases: R22; R23/24/25; R36/37; R41; R62; safety phrases: S26; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Ferric Sulfate is a grayish-white powder or yellow lumpy crystals. Molecular weight = 399.88; specific gravity (H_2O:1) = 3.1 @ 20°C; boiling point = (decomposes); freezing/melting point = (decomposes) 480°C. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 0, reactivity 0. Slightly soluble in water.

Potential Exposure: This material is used in pigments, textile dyeing, water treatment; and metal pickling.

Incompatibilities: Hydrolyzed slowly in aqueous solution. Incompatible with magnesium, aluminum. Corrosive to copper and its alloys, mild and galvanized steel. Light sensitive.

Permissible Exposure Limits in Air

OSHA PEL: None

NIOSH REL: 1 mg[Fe]/m^3 TWA

ACGIH TLV[1]: 1 mg[Fe]/m^3 TWA; 0.1 milligram per cubic meter TWA *as persulfates*

PAC Ver. 29[138]

PAC-1: 11 milligram per cubic meter

PAC-2: 120 milligram per cubic meter

PAC-3: 710 milligram per cubic meter

Finland: TWA 1 mg[Fe]/m^3, 1999; Norway: TWA 1 mg [Fe]/m^3, 1999; Switzerland: MAK-W 1 mg[Fe]/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 1 mg[Fe]/m^3

Determination in Air: See NIOSH Analytical Method (IV) s #7300, Elements, #7301, #7303, #9102 or OSHA Analytical Method ID-121, IDI-125G[58].

Permissible Concentration in Water: Federal Drinking Water Guidelines: MCGL = 300 μg[Fe]/L; State Drinking Water Standards: Illinois: 1000 μg[Fe]/L; North Carolina: 300 μg[Fe]/L.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: *Inhalation:* May cause irritation of nose and throat, coughing and difficulty in breathing. 0.075 milligram per cubic meter for 2 hours did not cause any change in breathing functions. Inhaling iron oxide fumes may cause pneumoconiosis in the lungs. Iron oxide fumes can cause "metal fume fever," irritation of eyes, skin, mucous membranes; abdominal pain; diarrhea, vomiting. *Skin:* Contact causes irritation. Remove promptly. *Eyes:* Contact causes irritation. *Ingestion:* May cause irritation of mouth and stomach, nausea, vomiting, diarrhea, drowsiness, liver damage; coma and death. The estimated lethal dose is 30 kg (1 oz).

Long-Term Exposure: Excessive intake of iron compounds may result in increased accumulations of iron in the body, especially the liver, spleen and lymphatic system. May cause nausea, vomiting, stomach pain; constipation, and black bowel movements. Inhalation of iron dusts may cause mottling of the lungs. Prolonged or repeated high exposure may cause liver damage. Prolonged eye contact can cause a brownish discoloration of the eye. Repeated overexposure may cause kidney stones.

Points of Attack: Eyes, skin, respiratory system; liver, lungs, gastrointestinal tract.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: blood test for iron level (serum iron). Liver function tests. Lung function tests. For those exposed to this chemical, taking dietary supplements or vitamins containing iron is not recommended without medical advice.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. The symptoms of metal fume fever may be delayed for 4—12 hours following exposure: it may last less than 36 hours.

Note to physician: For severe poisoning *do not* use BAL, dimercaprol, dithiopropanol ($C_3H_8OS_2$) as it is contraindicated or ineffective in poisoning from iron.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures *over 1 milligram per cubic meter* of iron, use an

NIOSH/MSHA or European Standard EN 149-approved respirator equipped with particulate (dust/fume/mist) filters. *Where there is potential for high exposures exists*, use an NIOSH/MSHA or European Standard EN 149-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use an NIOSH/MSHA or European Standard EN 149-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Green: General storage may be used. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from light, moisture, aluminum, magnesium, copper and its alloys, zinc; galvanized and mild steels.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids containing ferric sulfate in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient manner and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Use extinguishers suitable for surrounding fire. Thermal decomposition products may include oxides of sulfur and metal. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Treat with soda ash or dilute NaOH. Separate any precipitate and landfill. Flush solution to sewer[22].

References

(31); (173); (101); (138); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 3, No. 4, 45−47 (1983) and 7, No. 2, 75−79 (1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Ferric Sulfate, Trenton, NJ (March 1999).

New York State Department of Health, *Chemical Fact Sheet:* Iron (III) Sulfate, Bureau of Toxic Substance Assessment, Albany, NY (March 1986).

Ferrocene F:0190

Formula: $C_{10}H_{10}Fe$

Synonyms: Biscyclopentadienyl iron; Di-2,4-cyclopentadien-1-yl iron; Dicyclopentadienyl iron; Iron bis(cyclopentadiene); Iron dicyclopentadienyl

CAS Registry Number: 102-54-5

HSDB Number: 2878

RTECS Number: LK0700000

UN/NA & ERG Number: UN1325 (flammable solid, organic)/133

EC Number: 203-039-3

Regulatory Authority and Advisory Information

Hazard Alert: Flammable solid, Possible risk of forming tumors, Suspected reprotoxic hazard, Organometallic.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%; category D1B, B4; On DSL List.

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xn, N; risk phrases: R10; R22; R51/53; R63; safety phrases: S22; S41; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Ferrocene, a metallocene, is a bright orange salt-like crystals from alcohol. Camphor odor. Molecular weight = 186.05; boiling point = 249°C (sublimes); freezing/melting point = 173°C. Decomposes at 465°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 2, reactivity 1. Insoluble in water.

Potential Exposure: Used as additive in fuel oil; antiknock agent in gasoline fuel; used in making rubber, silicone resins, high-temperature polymers and lubricants; intermediate for high-temperature polymers; as a smoke suppressant and catalyst

Incompatibilities: Violent reaction with ammonium perchlorate, tetranitromethane, mercury(II) nitrate. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Peroxomonosulfuric acid. Decomposes @ ≥465°C.

Permissible Exposure Limits in Air

OSHA PEL: 15 milligram per cubic meter TWA (total dust); 5 milligram per cubic meter TWA, respirable fraction

NIOSH REL: 10 milligram per cubic meter TWA (total dust); 5 milligram per cubic meter TWA, respirable fraction

ACGIH TLV[1]: 10 milligram per cubic meter TWA

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Australia: TWA 10 milligram per cubic meter, 1993; Belgium: TWA 10 milligram per cubic meter, 1993; Finland: TWA 10 milligram per cubic meter; STEL 20 milligram per cubic meter [skin], 1999; France: VME 10 milligram per cubic meter, 1999; Switzerland: MAK-W 10 milligram per cubic meter, 1999; United Kingdom: TWA 10 milligram per cubic meter; STEL 20 milligram per cubic meter, 2000; the Netherlands: MAC-TGG 10 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 10 milligram per cubic meter

Determination in Air: Use OSHA Analytical Method IDI-125G[58]. (Ferrocene is approximately 30% iron). See also NIOSH Analytical Method (IV)s #7300, Elements, #7301, #7303, #9102.

Permissible Concentration in Water: Federal Drinking Water Guidelines: MCGL = 300 μg[Fe]/L; State Drinking Water Standards: Illinois: 1000 μg[Fe]/L; North Carolina: 300 μg[Fe]/L. EPA[32] has suggested a permissible ambient goal of 530 μg/L based on health effects.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin, and respiratory system. Eye contact can cause irritation. Dust may irritate the air passages, with possible cough, phlegm and tightness in the chest. Dicyclopentadienyl iron is classified as a slightly toxic material, but the toxicological properties have not been extensively investigated. LD_{50} (oral-rat) = 1320 mg/kg (slightly toxic).

Long-Term Exposure: There is limited evidence that this chemical may damage the testes. Repeated exposure to iron containing compounds can damage the liver and other body organs. Heavy or repeated exposure may cause mood changes; such as irritability. Repeated exposure may cause lung damage.

Repeated high exposures may cause mood changes; such as irritability. Dicyclopentadienyl iron may cause mutations. Exposure may affect liver and lung functions.

Points of Attack: Lungs. In animals: liver, red blood cell, testicular changes. (NIOSH)

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: Liver function tests. Lung function tests. Complete blood count (CBC). Serum iron level.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures over *10 milligram per cubic meter*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. If while wearing a filter, cartridge or canister respirator, you can smell, taste, or otherwise detect Dicyclopentadienyl iron, or in the case of a full facepiece respirator you experience eye irritation, leave the area immediately. Check to make sure the respirator-to-face seal is still good. If it is, replace the filter, cartridge, or canister. If the seal is no longer good, you may need a new respirator. Be sure to consider all potential exposures in your work-place. You may need a combination of filters, profilers, cartridges, or canisters to protect against different forms of a chemical (such as vapor and mist) or against a mixture of chemicals. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Red Stripe: Flammability Hazard: Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Store flammable solids up to maximum allowable quantity per control area in an approved flammable storage area. Do not store in a basement. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, ammonium perchlorate, tetranitromethane, mercury(II) nitrate, and heat. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN1325 Flammable solids, organic, n.o.s., Hazard Class: 4.1; Labels: 4.1-Flammable solid.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Dicyclopentadienyl iron is a flammable solid. Thermal decomposition products may include oxides of carbon and metal. Extinguish fire using an agent suitable for type of surrounding fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

Sax N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 4, 67−68 (1981) (as Ferrocene).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Dicyclopentadienyl Iron*, Trenton, NJ (October 1998).

Ferrous Ammonium Sulfate F:0200

Formula: $Fe_2H_8N_2O_4S$; $Fe_2(NH_4)_2SO_4$; $Fe(NH_4)_2(SO_4)_2 \cdot 6H_2O$; $O_8S_2 \cdot H_8N_2 \cdot Fe$

Synonyms: Ammonium iron sulfate; Ammonium iron sulphate; Iron ammonium sulfate; Iron ammonium sulphate; Mohr's salt; Sulfato ferroso amonico (Spanish); Sulfuric acid, ammonium iron(2+), salt (2:2:1); Sulphate ammonium sulfate hexahydrate; Sulphate ammonium sulphate; Sulphate ammonium sulphate hexahydrate

CAS Registry Number: 10045-89-3 (anhydrous); 7783-85-9 (hexahydrate)

HSDB Number: 456

RTECS Number: WS5850000

EC Number: 233-151-8

Regulatory Authority and Advisory Information

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)

United States National Primary Drinking Water Regulations: SMCL = 0.3 mg[Fe]/L as Iron; SMCL = 250 mg $[SO_4^{-2}]$/L as Sulfate

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1000 lb (454 kg)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. as Iron, water-soluble salts, n.o.s.

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water. (anhydrous)

Description: Ferrous ammonium sulfate is a pale green or blue-green solid (powder or lumpy crystals). Molecular weight = 284.07; specific gravity (H_2O:1) = 1.87 @ 20°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 1. Soluble in water.

Potential Exposure: This substance is used in photography, analytical chemistry and in dosimeters.

Permissible Exposure Limits in Air

OSHA PEL: None

NIOSH REL: 1 milligram per cubic meter TWA

ACGIH TLV[1]: 1 milligram per cubic meter TWA

10045-89-3, PAC Ver. 29[138]

PAC-1: 50 milligram per cubic meter

PAC-2: 170.4 milligram per cubic meter

PAC-3: 1000 milligram per cubic meter

Finland: TWA 1 mg[Fe]/m^3, 1999; Norway: TWA 1 mg [Fe]/m^3, 1999; Switzerland: MAK-W 1 mg[Fe]/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 1 mg [Fe]/m^3

Determination in Air: See NIOSH Analytical Method (IV)s #7300, Elements, #7301, #7303, #9102 or OSHA Analytical Method ID-121, IDI-125G[58].

Permissible Concentration in Water: Drinking water limits = 0.3 ppm [Fe]. Russia[43] set a MAC for iron in water bodies used for domestic purposes of 0.5 mg/L and a MAC in sea water bodies used for fishery purposes of 0.05 mg/L.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Ferrous ammonium sulfate can affect you when breathed in. Exposure can irritate the eyes, nose and throat. Large amounts of iron in the body can cause nausea and stomach pain; constipation, and black bowel movements. This is more common with swallowed iron. Repeated high exposures may damage the liver. Exposure may irritate the lungs.

Long-Term Exposure: Prolonged or repeated high exposure may cause liver damage. Prolonged eye contact can cause a brownish discoloration of the eye. Repeated overexposure may cause kidney stones.

Points of Attack: Eyes, skin, respiratory system; liver, gastrointestinal tract.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or grater), the following are recommended before beginning work and at regular times after that. Lung function tests. If symptoms develop or overexposure has occurred, the following may be useful: blood tests for iron level (serum iron). Liver function tests. For those exposed to this chemical, taking dietary supplements or vitamins containing iron is not recommended without medical advice.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: For severe poisoning *do not* use BAL, dimercaprol, dithiopropanol ($C_3H_8OS_2$) as it is contraindicated or ineffective in poisoning from iron.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures *over 1 milligram per cubic meter*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from light.

Shipping: Not regulated.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids containing ferrous ammonium sulfate in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient manner and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Use extinguishers suitable for surrounding fire. Thermal decomposition products may include ammonia and oxides of nitrogen, sulfur, carbon and metal. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Ferrous Ammonium Sulfate, Trenton, NJ (October 2001).

Ferrous Chloride F:0210

Formula: Cl_2Fe; $FeCl_2$

Synonyms: Iron(II) chloride (1:2); Iron dichloride; Iron protochloride; Lawrencite; Sulphate chloride tetrahydrate

CAS Registry Number: 7758-94-3

HSDB Number: 459

RTECS Number: NO5400000

UN/NA & ERG Number: UN1759 (solid)/154; UN1760 (solution)/154

EC Number: 231-843-4

Regulatory Authority and Advisory Information
United States National Primary Drinking Water Regulations: SMCL = 0.3 mg[Fe]/L as Iron; SMCL = 250 mg [Cl^-]/L as Chloride
Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)
Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)
Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. as Iron, water-soluble salts, n.o.s.
WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Ferrous chloride is a pale greenish salt-like crystal or power. Molecular weight = 126.75; specific gravity (H_2O:1) = 3.16 @ 20°C; boiling point = 1012°C; freezing/melting point = 675.8°C; vapor pressure = 10 mmHg @ 700°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 1. Soluble in water.

Potential Exposure: It is used in textile dyeing, metallurgy, the pharmaceutical industry and sewage treatment.

Incompatibilities: Solution attacks metals. Contact with ethylene oxide may initiate polymerization. Contact with potassium or sodium forms an impact-sensitive material.

Permissible Exposure Limits in Air
OSHA PEL: None
NIOSH REL: 1 milligram per cubic meter TWA
ACGIH TLV[1]: 1 milligram per cubic meter TWA
PAC Ver. 29[138]
PAC-1: 6.8 milligram per cubic meter
PAC-2: 76 milligram per cubic meter
PAC-3: 460 milligram per cubic meter
Finland: TWA 1 mg[Fe]/m^3, 1999; Norway: TWA 1 mg [Fe]/m^3, 1999; Switzerland: MAK-W 1 mg[Fe]/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 1 mg[Fe]/m^3

Determination in Air: See NIOSH Analytical Method (IV)s #7300, Elements, #7301, #7303, #9102 or OSHA Analytical Method ID-121, IDI-125G[58].

Permissible Concentration in Water: Drinking water limits = 0.3 ppm [Fe]. Russia[43] set a MAC for iron in water bodies used for domestic purposes of 0.5 mg/L and a MAC in sea water bodies used for fishery purposes of 0.05 mg/L.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Ferrous chloride can affect you when breathed in. Repeated or high level exposures may lead to too much iron in the body and possible liver damage. Exposure can irritate the nose and throat. Ferrous chloride is a corrosive chemical and contact can irritate and may burn the eyes and skin.

Long-Term Exposure: Prolonged or repeated high exposure may cause liver damage. Prolonged eye contact can cause a brownish discoloration of the eye. Repeated overexposure may cause kidney stones.

Points of Attack: Eyes, skin, respiratory system; liver, gastrointestinal tract.

Medical Surveillance: Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. If symptoms develop or overexposure is suspected, the following may be useful: serum iron test. Liver function test. For those exposed to this chemical, taking dietary supplements or vitamins containing iron is not recommended without medical advice.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves.

Note to physician: For severe poisoning *do not* use BAL, dimercaprol, dithiopropanol ($C_3H_8OS_2$) as it is contraindicated or ineffective in poisoning from iron.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures *over 1 milligram per cubic meter*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from potassium, sodium metals, or ethylene oxide.

Shipping: UN1759 Ferrous chloride, solid, Hazard class: 8; Labels: 8-Corrosive material. UN1760 Ferrous chloride, solution, Hazard class: 8; Labels: 8-Corrosive material.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Use extinguishers suitable for surrounding fire. Thermal decomposition products may include hydrogen chloride and chlorine. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Ferrous Chloride, Trenton, NJ (March 2004).

Fipronil F:0243

Formula: $C_{12}H_4Cl_2F_6N_4OS$

Synonyms: 5-Amino-1-(2,6-dichloro-4-(trifluoromethyl) phenyl)-4-(1,*R,S*)-(trifluoromethyl)sulfinyl-; (±)-5-Amino-1-(2,6-dichloro-α,α,α-trifluoro-*p*-tolyl)-4-trifluoromethylsulfinylpyrazole-3-carbonitrile; BES 602; Ceasefire; Chipco; Combat; Frontline; Mb-46030; H&G; Icon; Maxforce ant station; Maxforce roach station; 1*H*-Pyrazole-3-carbonitrile, 5-amino-1-(2,6-dichloro-4-(trifluoromethyl) phenyl)-4-[(trifluoromethyl)sulfinyl]-; Regency sofion; Regent; Regent 500-FS; Termidor L VI-NIL

CAS Number: 120068-37-3

HSDB Number: 7051

RTECS Number: UQ4430250

UN/NA & ERG Number: UN2588 (Pesticide, solid, poisonous, n.o.s.)/151; UN2902 (Pesticide, liquid, poisonous, n.o.s.)/151

EC Number: [*Annex I Index No.:* 608-055-00-8]

Regulatory Authority and Advisory Information

Carcinogenicity[83]: EPA Group C, possible human carcinogen

Hazard Alert: Poison, Possible endocrine disruptor.

EPA ADI: EPA Oral reference dose (RfD) = 2.0 × 10 mg/kg/day based on the NOAEL for chronic toxicity (0.500 ppm or 0.019 mg/kg/day).

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R23/24/25; R48/25; R50/53; safety phrases: S1/2; S24; S28; S36/37; S38; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: White crystalline solid. Molecular weight = 437.16; specific gravity (H_2O:1) = 1.5−1.7; boiling point = (decomposes); freezing/melting point = 201°C; vapor pressure = 3×10^{-8} mmHg @ 25°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 0. Low solubility in water; solubility = 1.9 ppm.

Potential Exposure: Pyrazole/phenylpyrazole/organofluorine insecticide; veterinary medicine. Fipronil was introduced into the United States in 1996 for use in animal health and indoor pest control. It is the constituent of many products for controlling a wide spectrum of domestic animal and residential pests. Banned for use in EU.

Determination in Water: Octanol−water coefficient: Log K_{ow} = > 3.5. Values above 3.0 are likely to bioaccumulate in marine organisms. Fish toxicity (threshold)[101]: Extra high—0.31368 ppb, MATC.

Routes of Entry: Inhalation, dermal and eye contact, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Highly toxic. Contact with eyes or skin may cause irritation or injury. Harmful if swallowed. LD_{50} (oral, rat) = 100 mg/kg; LD_{50} (dermal, rabbit) = 354 mg/kg. Fipronil-desulfinyl (breakdown product): LD_{50} (oral, rat) = 15 (female) − 18 (male) mg/kg.

Long-Term Exposure: Fluorides may cause bone disease (pain and tenderness of the bones); mottled teeth in children. Kidney, liver and thyroid toxin. Neurotoxin. Animal tests indicated that this chemical may cause reproductive and fetal effects. Bioconcentrates in tissues. Human toxicity (long term)[101]: Extra high—0.14 ppb, Health Advisory.

Points of Attack: Thyroid, bones, kidney, liver, testicular. Central nervous system.

Medical Surveillance: This chemical is a suspected or known human carcinogen. Exposed persons should contact a physician for advice regarding the possible long term health effects and advice for medical monitoring. Examination of the nervous system. Liver and kidney function tests. More than light alcohol consumption may exacerbate liver damage. In addition to comprehensive initial medical and work histories emphasizing reproductive experience and menstrual history, patient should have physical examination and testing of genito-urinary tract, sperm count, motility and morphology. If required, other tests, such as serum testosterone, serum FSH, and serum LH, may be indicated.

First Aid: Give artificial respiration if victim is not breathing. *Do not* use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves.

Personal Protective Methods: Applicators and other handlers must wear: Coveralls worn over long-sleeved shirt and long pants; Chemical-resistant gloves such as DuPont Tychem suit fabrics, barrier laminate, or Viton; Chemical-resistant footwear plus socks; Protective eye wear; Chemical-resistant headgear for overhead exposure; Chemical-resistant apron when cleaning equipment, mixing, or loading[83]. Agricultural Use/Engineering Controls: When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the WPS for agricultural pesticides, 40 CFR 170.240(d)(4-6), the handler PPE requirements may be reduced or modified as specified in the WPS. Firefighters should wear NIOSH approved SCBA and full protective clothing.

Respirator Selection: *At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000): (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus). *Escape*: GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison. Store in a secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN2588 Pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN2902 Pesticide, liquid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: First remove all sources of ignition. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Ventilate area of spill or leak. Use water spray to reduce vapor. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen and carbon, hydrogen chloride, and hydrogen fluoride. *On a small fire:* use dry chemical, CO_2 or water spray. On a large fire: use water spray, fog or regular foam. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal; do not scatter the material. Use water spray or fog; do not use straight streams. *Fire involving storage or vehicular tanks:* Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Do not get water inside containers. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. ALWAYS stay away from tanks engulfed in fire. For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies.

Disposal Method Suggested: It is the responsibility of chemical waste generators to determine the toxicity and physical properties and of a discarded chemical and to properly identify its classification and certification as a hazardous waste and to determine the disposal method. United States Environmental Protection Agency guidelines for the classification determination are listed in 40 CFR Parts 261.3. Additionally, waste generators must consult and follow all regional, national, state and local hazardous waste laws to ensure complete and accurate classification and disposal methods.

References

(31); (173); (101); (138); (80); (100).

40 CFR 180.517, http://www.epa.gov/pesticides/food/viewtols.htm.

Jackson, D.; Cornell, C. B.; Luukinen, B.; Buhl, K.; Stone, D., *Fipronil Technical Fact Sheet*; National Pesticide Information Center, Oregon State University Extension Services, Corvallis, OR (2009).

Fluazifop-butyl F:0244

Formula: $C_{19}H_{20}F_3NO_4$

Synonyms: Butyl(*RS*)-2-[4-((5-(trifluoromethyl)-2-pyridinyl)oxy)phenoxy]propanoate; (±)-Butyl-2-[4-(((5-trifluoromethyl)-2-pyridinyl)oxy)phenoxy]propanoate; Butyl 2-[4-((5-(trifluoromethyl)-2-pyridyl)oxy)phenoxy]propionate]; Caswell No. 460C; Fusilade; Fusilade max (*p*-butyl); Fusion; Grass-b-Gone; Greencrop; Hache uno super; Horizon; ICI-A0009; Oneside; Oneside EC; Ornamec; PP 009; Propanoic acid, 2-[4-((5-(trifluoromethyl)-2-pyridinyl) oxy)phenoxy]-,butyl ester; Propionic acid, 2-[*p*-((5-(trifluoromethyl)-2-pyridyl)oxy)phenoxy]-, butylester; (*RS*)-2-[4-(5-Trifluoromethyl-2-pyridyloxy)]-phenoxy]propanoic acid, butyl ester; 2-[4-((5-(Trifluoromethyl)-2-pyridinyl) oxy)-phenoxy]propanoic acid, butyl ester; SL-236; TF 1169; TS-7236; Tornado

CAS Number: 69806-50-4; 79241-46-6 (*p*-butyl isomer)

HSDB Number: 6644; 5815 (Fluazifop-*p*-butyl)

RTECS Number: UA3000000

UN/NA & ERG Number: UN3082 (environmentally hazardous substances, liquid, n.o.s.)/171

EC Number: 274-125-6607-304-00-8

Regulatory Authority and Advisory Information

California Prop.65: Listed; Developmental toxin

Hazard Alert: Poison, Suspected reprotoxic hazard, Possible sensitization hazard (skin), Developmental toxin (TRI), Environmental hazard.

California EPAAB2588-Air Toxics "Hot Spots" Chemicals (CAL) as chlorophenoxy pesticides

EPCRA Section 313 Form R de minimus concentration reporting level: 1.0% as Fluazifop-butyl

Hazardous to aquatic life or environment, with possible long-lasting effects [291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Codes: T, N, Xi; Risk phrases: R43; R50/53; R61; R63; Safety phrases: S29; S53; S45; S60; S61 (see Appendix 4); *P-isomer*: Hazard Codes: T, N, Xi; Risk phrases: R43; R63; Safety phrases: S2; S29/35; S36/37; S46; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Pale yellow liquid. Odorless. Molecular weight = 383.37; specific gravity (H_2O:1) = 1.214; boiling point = 164.5°C; (*p*-isomer decomposes before boiling); freezing/melting point = 4.8°C; 13°C; (P-isomer is <1°C); vapor pressure = 4.1×10^{-7} mmHg @ 20°C; 0.055 mmHg @ 20°C; flash point = 37°C. Slightly soluble in water (both isomers); solubility = <1 mg/L @ 25°C.

Potential Exposure: Fluazifop-butyl is a selective post-emergence aryloxyphenoxypropionate/organofluorine herbicide. Its principal uses In California is on rights-of-way, landscapes, almonds, cotton, and outdoor container nurseries.

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guidelines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg [F]/L. Safe Drinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg[F]/L; SMCL = 2 mg/F/L, as Fluoride.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = > 4.5$. Values above 3.0 are likely to bioaccumulate in marine organisms. According to Fluoride Action Network Pesticide Project, "the potential for bioconcentration in aquatic organisms is very high. Highly toxic to zooplankton." Fish toxicity (threshold)[101]: Intermediate—62.61862 ppb, MATC.

Routes of Entry: Inhalation, ingestion, absorbed through the skin

Harmful Effects and Symptoms

Short-Term Exposure: Poisonous; may be fatal if inhaled, swallowed, or absorbed through skin. Severely irritates eyes, skin and respiratory tract, with burning sensation, pain, redness and swelling. Metabolic stimulant. If inhaled, causes coughing, dilated pupils, headache, profuse perspiration, intense thirst, extreme fatigue, rapid pulse, high fever, clammy, flushed skin, rapid breathing, nausea, vomiting, cyanosis (bluish tint to skin and lips), anxiety and confusion, convulsions, risk of lung edema. If swallowed, face and lips turn bluish. Liver injury with associated jaundice, kidney failure, and cardiac arrhythmias are commonly noted. Nerve damage, which may be delayed, may include swelling of legs and feet, muscle twitch and stupor. Severe exposure can cause death from heart failure. Dust or liquid left in contact with the skin for several hours may be absorbed. This may result in severe delayed symptoms as listed above. These symptoms may last for months or years.

LD_{50} (oral, rat) = 2000−4000 + mg/kg; LD_{50} (dermal, rabbit) = > 2 g/kg. Both isomers have low toxicity; the P-isomer is slightly less toxic.

Long-Term Exposure: Fluorides may cause bone disease (pain and tenderness of the bones); mottled teeth in children. May cause reproductive and fetal effects. May cause skin sensitization. Human toxicity (long term)[101]: Low—70.00 ppb, Health Advisory

Points of Attack: Eyes, skin, respiratory system, central nervous system, cardiovascular system, liver, kidney, reproductive system, bones. *P-isomer:* Sensitization hazard (skin), Kidney, spleen and liver toxin, May cause eye cataracts.

Medical Surveillance: Preliminary medical exam to detect chronic diseases of central nervous system, liver, heart, kidneys, lung and skin, as well as endocrinological or immunological disturbances, should protect susceptible individuals. Periodical medical exams of internal organs, skin and eyes are important to avoid chronic occupational intoxications. They should include lab and patch tests when necessary[83]. If symptoms develop or overexposure is suspected, the following may be useful: Liver and kidney function tests. Exam of the nervous system. Evaluation by a qualified allergist, including exposure history and testing, may help diagnose allergy. In addition to comprehensive initial medical and work histories emphasizing reproductive experience and menstrual history, patient should have physical examination and testing of genito-urinary tract, sperm count, motility and morphology. If required, other tests, such as serum testosterone, serum FSH, and serum LH, may be indicated. Evaluation by a qualified allergist, including exposure history and testing, may help diagnose allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. *Do not induce vomiting when formulations containing petroleum solvents are ingested*. Otherwise, give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Applicators and other handlers must wear: Coveralls worn over long-sleeved shirt and long pants; Chemical-resistant gloves such as DuPont Tychem suit fabrics, barrier laminate, or Viton; Chemical-resistant footwear plus socks; Protective eye wear; Chemical-resistant headgear for overhead exposure; Chemical-resistant apron when cleaning equipment, mixing, or loading[83]. Agricultural Use/Engineering Controls: When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the WPS for agricultural pesticides, 40 CFR 170.240(d)(4-6), the handler PPE requirements may be reduced or modified as specified in the WPS. Firefighters should wear NIOSH approved SCBA and full protective clothing.

Respirator Selection: Wherever and whenever workplace conditions warrant respirator use, a respiratory protection program must be followed that meets one or more of the following government standards: OSHA's 29 CFR 1910.134, ANSI Z88.2, or European Standard EN 149.

Spill Handling: First remove all sources of ignition. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Stay upwind; keep out of low areas. Ventilate area of spill or leak. Remove and isolate contaminated clothing at the site. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills:* absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills:* dike far ahead of spill for later disposal. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Fire Extinguishing: Thermal decomposition products may include fluorine and oxides of nitrogen and carbon. As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 m/150 ft for liquids and at least 25 m/75 ft for solids. *Fire involving storage or vehicular tanks:* Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. *On a small fire:* use dry chemical, CO_2, water spray or regular *foam. On a large fire:* use water spray, fog or regular foam. Do not scatter spilled material with high pressure streams of water. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal. *Fire involving tanks:* From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. Always stay away from tanks engulfed in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Fire Extinguishing: Thermal decomposition products may include fluorine and nitrogen oxides. Use dry chemical, carbon dioxide; or alcohol-resistant foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (122); (100).

United States Environmental Protection Agency, Office of Pesticide Programs, *Pesticide Residue Limits, Fluazifop Butyl, 40 CFR 180.411*, http://www.ehso.com/ehso.php.

EXTOXNET, Extension Toxicology Network, *Pesticide Information Profile, Fluazifop-p-butyl*, Oregon State University, Corvallis, OR (June 1996). http://extoxnet.orst.edu/pips/fluazifo.htm.

Ferrous Sulfate F:0220

Formula: FeO_4S; $FeSO_4$

Synonyms: Copperas; Duretter; Duroferon; Exsiccated sulphate sulfate; Exsiccated sulphate; Feosol; Feospan; Fer-In-Sol; Ferralyn; Ferro-gradumet; Ferrosulfat (German); Ferrosulfate; Ferrosulphate; Ferro-Theron; Fersolate; Green vitriol iron monosulfate; Iron protosulfate; Iron sulfate (1:1); Iron(2+) sulfate; Iron(2+) sulfate (1:1); Iron(II) sulfate; Iron vitriol; Irospan; Irosul; Slow-Fe; Sulfato ferroso (Spanish); Sulfuric acid iron salt (1:1); Sulfuric acid, iron (2+) salt (1:1); Sulfuric acid, iron(II) salt (1:1); Sulphate sulphate (1:1); Sulsulphate

CAS Registry Number: 7720-78-7 (anhydrous); 7782-63-0 (heptahydrate)

HSDB Number: 465

RTECS Number: NO8500000

UN/NA & ERG Number: Not regulated.

EC Number: 231-753-5 [*Annex I Index No.:* 026-003-00-7]; [*Annex I Index No.:* 026-003-01-4] (heptahydrate)

Regulatory Authority and Advisory Information

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)

United States National Primary Drinking Water Regulations: SMCL = 0.3 mg[Fe]/L as Iron; SMCL = 250 mg[SO_4^{-2}]/L as Sulfate

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1000 lb (454 kg)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

European/International Regulations (*includes heptahydrate*): Hazard symbol: Xn; risk phrases: R22; R36/38; safety phrases: S2; S41; S46 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Ferrous sulfate is a greenish or yellowish solid in fine or lumpy crystals. Molecular weight = 151.91; freezing/melting point = 65°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 0, reactivity 1. Slowly soluble in water.

Potential Exposure: It is used as a fertilizer, food or feed additive; and in herbicides; process engraving; dyeing, and water treatment. A byproduct of various chemical and metal treating operations.

Incompatibilities: Aqueous solution is acidic. Contact with alkalies form iron. Keep away from alkalies, soluble carbonates; gold and silver salts; lead acetate; lime water, potassium iodide; potassium and sodium tartrate; sodium borate; tannin.

Permissible Exposure Limits in Air

OSHA PEL: None

NIOSH REL: 1 milligram per cubic meter TWA

ACGIH TLV[1]: 1 milligram per cubic meter TWA

PAC Ver. 29[138]

7720-78-7, anhydrous

PAC-1: 8.2 milligram per cubic meter

PAC-2: 41 milligram per cubic meter

PAC-3: 250 milligram per cubic meter

7782-63-0, heptahydrate

PAC-1: 15 milligram per cubic meter

PAC-2: 170 milligram per cubic meter

PAC-3: 990 milligram per cubic meter

Finland: TWA 1 mg[Fe]/m^3, 1999; Norway: TWA 1 mg [Fe]/m^3, 1999; Switzerland: MAK-W 1 mg[Fe]/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 1 mg [Fe]/m^3

Determination in Air: See NIOSH Analytical Method (IV)s #7300, Elements, #7301, #7303, #9102 or OSHA Analytical Method ID-121, IDI-125G[58].

Permissible Concentration in Water: Federal Drinking Water Guidelines: MCGL = 300 μg[Fe]/L; State Drinking Water Standards: Illinois: 1000 μg[Fe]/L; North Carolina: 300 μg[Fe]/L.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Ferrous sulfate can affect you when breathed in. Irritates the eyes, skin and respiratory tract. Ingestion: Less than 5 g (1/6 oz) can cause drowsiness, irritability, weakness, abdominal pain; nausea, vomiting and black, bloody stools. Delayed symptoms include fluid in the lungs, liver abnormalities; shock, coma; intestinal blockage and breakdown of the stomach and intestinal lining. Death has resulted from ingestion of less than an ounce.

Long-Term Exposure: Excessive intake of iron compounds may result in increased accumulation of iron in body, especially the liver, spleen and lymphatic system. Inhalation of iron dusts may cause mottling of the lungs. Prolonged eye contact can cause a brownish discoloration of the eye. Repeated overexposure may cause kidney stones.

Points of Attack: Eyes, skin, respiratory system; liver, gastrointestinal tract.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: serum iron test. Liver function test. Kidney function tests. For those exposed to this chemical, taking dietary supplements or vitamins containing iron is not recommended without medical advice.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to Physician: Gastric lavage with large amounts of 5% sodium phosphate or water. Follow this with a large amount of 1% sodium bicarbonate over a 3-hour period.

Note to physician: For severe poisoning *do not* use BAL, dimercaprol, dithiopropanol ($C_3H_8OS_2$) as it is contraindicated or ineffective in poisoning from iron.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures *over 1 milligram per cubic meter*, use an NIOSH/MSHA or European Standard EN 149-approved respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. *Where there is potential for high exposures exists*, use an NIOSH/MSHA or European Standard EN 149-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use an NIOSH/MSHA or European Standard EN 149-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Green: General storage may be used. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from alkalis.

Agricultural chemical

Shipping: Not regulated.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Use extinguishers suitable for surrounding fire. Thermal decomposition products may include sulfur oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 3, No. 4, 45−47 (1983) and 7, No. 1, 55−60 (1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Ferrous Sulfate, Trenton, NJ (February 1999).

Ferrovanadium Dust F:0230

Formula: FeV

Synonyms: Ferro "V"

CAS Registry Number: 12604-58-9

HSDB Number: 6911 as vanadium compounds

RTECS Number: LK2900000

Regulatory Authority and Advisory Information

An OSHA specifically regulated substance.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

WGK[100] (German Aquatic Hazard Class): (Vanadium and compounds) 3-Severe hazard to water, unless water solubility is <4 μg[V]/L.

Description: Ferrovanadium, a noncombustible solid; the dust may be an explosion hazard. It consists of dark, odorless solid particles (*particulate*): dispersed in air. An alloy having the composition of 50%−80% vanadium with iron, carbon, and trace silicon, manganese, chromium, nickel, etc. Molecular weight = 106.8; freezing/melting point = 1482−1521°C; minimum explosive concentration = 1.3 g/m^3[77]. Insoluble in water.

Potential Exposure: Ferrovanadium is added to steel to produce fineness of grain, toughness, torsion properties; and resistance to high temperatures.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

NIOSH IDLH = 500 milligram per cubic meter

OSHA PEL: 1 mg[V]/m^3 TWA

NIOSH REL: 1 mg[V]/m^3 TWA; 3 mg[V]/m^3 STEL [REL applies to ferrovanadium, vanadium metal, and vanadium carbide.]

ACGIH TLV[1]: 1 mg[V]/m^3 TWA; 3 milligram per cubic meter STEL

7439-89-6 as Iron for reference

NIOSH IDLH = 2500 mg[Fe]/m^3

OSHA PEL: 10 mg[Fe]/m^3 TWA (dust and fume)

ACGIH TLV[1]: 5 mg[Fe]/m^3 (vapor, dust) TWA; not classifiable as a human carcinogen

DFG MAK: 1.5 mg[Fe]/m^3 respirable fraction

No PAC available for ferrovanadium.

DFG MAK: 1 mg[V]/m^3, inhalable fraction; Carcinogen Category: 2; Germ cell mutagen group: 2 (DFG 2005).

Australia: TWA 1 milligram per cubic meter; STEL 3 milligram per cubic meter (*dust*), 1993; Austria: MAK 1 milligram per cubic meter, 1999; Belgium: TWA 1 milligram per cubic meter; STEL 3 milligram per cubic meter (*dust*), 1993; Denmark: TWA 1 milligram per cubic meter (*dust*), 1999; Finland: TWA 0.5 milligram per cubic meter (*dust*), 1999; France: VM 0.05 mg[V_2O_5]/m^3, 1999; Japan: 1 milligram per cubic meter (*dust*), 1999; Norway: TWA 1 milligram per cubic meter, 1999; the Philippines: TWA 1 milligram per cubic meter (*dust*), 1993; Russia: STEL 1 milligram per cubic meter (*dust*), 1993; Switzerland: MAK-W 1 milligram per cubic meter (*dust*), 1999; Turkey: TWA 1 milligram per cubic meter (*dust*), 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 3 milligram per cubic meter. Several states have set guidelines or standards for ferrovanadium dust in ambient air[60] ranging from 10.0−30.0 μ/m^3 (North Dakota) to 16.0 μ/m^3 (Virginia) 20.0 μ/m^3 (Connecticut) to 238.0 μ/m^3 (Nevada).

Determination in Air: Use OSHA Analytical Methods #ID-121, #ID-125G.

Permissible Concentration in Water: *Iron*: Federal Drinking Water Guidelines: MCGL = 300 μg[Fe]/L; State Drinking Water Standards: Illinois: 1000 μg[Fe]/L; North Carolina: 300 μg[Fe]/L. *Vanadium*: State Drinking Water Guidelines: California: 50 μg[V]/L Arizona 7 μg[V]/L; Florida: 49 μg[V]/L; Minnesota: 50 μg[V]/L; Wisconsin: 30 μg[V]/L. Runoff from spills or fire control may cause water.

Routes of Entry: Inhalation, skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritation of eyes and respiratory system. Inhalation can cause irritation with coughing and wheezing.

Long-Term Exposure: Repeated exposure can cause bronchitis, pneumonitis, with cough, phlegm and/or shortness of breath.

Points of Attack: Respiratory system, eyes.

Medical Surveillance: Chest X-ray; pulmonary function tests. An OSHA regulated substance. Medical tests: Chest X-ray; pulmonary function tests. See NIOSH Publication No. 2005-110, December 2004.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: For severe poisoning *do not* use BAL, dimercaprol, dithiopropanol ($C_3H_8OS_2$) as it is contraindicated or ineffective in poisoning from iron.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *up to 5 milligram per cubic meter*: Q_m (APF = 25) (any quarter-mask respirator). *Up to 10 milligram per cubic meter:* Any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100. *Up to 25 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); * or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter).* *up to 50 milligram per cubic meter*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); * or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter); * or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 500 milligram per cubic meter*: SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry in unknown concentration or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA). *Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Dust is an explosion hazard. Prior to working with this material, all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Noncombustible solid, but dust may be an explosion hazard. Use extinguishers suitable for metal fires. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Disposal in a sanitary landfill.

References

(31); (173); (101); (138); (100).

National institute for Occupational Safety and Health (NIOSH), "Criteria for a Recommended Standard: Occupational Exposure to Vanadium, NIOSH Document Number 77-222," Cincinnati, OH (1977).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Ferrovanadium, Trenton, NJ (April 1999).

Fibrous Glass F:0240

Synonyms: Fiber Glass; Fiberglass; Glass fibers; Glass wool; Manmade mineral fibers; Mineral wool fiber; Synthetic vitreous fibers; Slag wool

CAS Registry Number: 65997-17-3; *(alt.)* 94551-77-6

RTECS Number: LK3651000

EC Number: 266-046-0

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen: [certain glass wool fibers (inhalable)]; IARC (special purpose glass fibers): Animal Sufficient Evidence; Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B (*glass filament; glass wool fibers; rock wool fibers*) Human No Adequate Data; Animal Inadequate Evidence*, not classifiable as carcinogenic to humans*, Group 3

California Proposition 65 Chemical (glasswool fibers, airborne particles of respirable size): Cancer 7/1/1990.

Hazard Alert: Possible risk of forming tumors, Suspected reprotoxic hazard.

Hazard symbols, risk, & safety statements: Hazard symbol: Xi, T; risk phrases: R36/37/38; R49; safety phrases: S22; S24/25; S26; S36; S45; S53; S41 (see Appendix 4)

Description: Fibrous glass is the name for a manufactured fiber in which the fiber-forming substance is glass. Glasses are a class of materials made from silicon dioxide with oxides of various metals and other elements, which solidify from the molten state without crystallization. Typically, glass filaments $>3\,\mu m$ in diameter or glass "wool" with diameters down to $0.05\,\mu m$ & length $>1\,\mu m$. A fiber is considered to be a particle with a length-to-diameter ratio of 3:1 or greater. The volume of small diameter fiber production has not been determined. Fibers with diameters less than $1\,\mu m$ are estimated to comprise less than 1% of the fibrous glass market. Specific gravity (H_2O:1) = 2.5. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 0, reactivity 0. Insoluble in water.

Potential Exposure: The major uses of fibrous glass are in thermal, electrical, and acoustical insulation; weatherproofing, plastic reinforcement; filtration media; and in structural and textile materials.

Permissible Exposure Limits in Air

OSHA PEL: 15 milligram per cubic meter (total dust) TWA; 5 milligram per cubic meter TWA, respirable fraction

NIOSH REL: 5 milligram per cubic meter total fibrous glass or 3 fibers/cc TWA (fibers with diameter $\leq 3.5\,\mu m$ diameter; $\geq 10\,\mu m$. In length).

ACGIH TLV[1] (*synthetic vitreous fibers, continuous filament glass fibers; synthetic vitreous fibers, glass wool fibers; synthetic vitreous fibers, special purpose glass fibers)*: 1 f/cc, respirable fibers. confirmed animal carcinogen with unknown relevance to humans.

continuous filament glass fibers or *special purpose glass fibers*: 1 f/cc, respirable fibers 1 f/cc, respirable fibers length $>5\,\mu m$; aspect ratio $\geq 3{:}1$, as determined by the membrane filter method @ 400−450 × magnification (4-mm objective), using phase-contrast illumination; not classifiable as a human carcinogen

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

North Dakota[60] has set a guideline for fibrous glass dust in ambient air of 0.10 milligram per cubic meter.

Determination in Air: Use NIOSH Analytical Method (IV) #7400, asbestos and Other Fibers.

Routes of Entry: Inhalation, skin and/or eye contact.

Harmful Effects and Symptoms

Different dimensions of fibrous glass will produce different biologic effects. Large diameter (greater than $3.5\,\mu m$) glass fibers have been found to cause skin, eye, and upper respiratory tract irritation; a relatively low frequency of fibrotic changes; and a very slight indication of fan excess mortality due to nonmalignant respiratory disease. Smaller diameter (less than $3.5\,\mu m$) fibrous glass has not been conclusively related to health effects in humans but glass fibers of this dimension have only been regularly produced since the 1960s. Smaller diameter fibers have the ability to penetrate to the alveoli. This potential is cause for concern and the primary reason that fibers $3.5\,\mu m$ or smaller are subject to special controls. Experimental studies in animals have demonstrated carcinogenic effects with the long (greater than $10\,\mu m$) and thin fibers (usually less than $1\,\mu m$ in diameter). However, these studies were performed by implanting fibrous glass in the pleural or peritoneal cavities. The data from studies with these routes of exposure cannot be directly extrapolated to conditions of human exposure. On the basis of available information, NIOSH does not consider fibrous glass to be a substance that produces cancer as a result of occupational exposure. The data on which to base this conclusion are limited. Fibrous glass does not appear to possess the same potential as asbestos or for causing, health hazard. Glass fibers are not usually of the fine submicron diameters as are asbestos fibers, and the concentrations of glass fibers in work-place air are generally orders of magnitude less than for asbestos. In one study, glass fibers were found to be cleared from the lungs more readily than asbestos.

Short-Term Exposure: Irritates eyes, skin, nose, throat. Inhalation can cause dyspnea (breathing difficulty)

Long-Term Exposure: A suspected carcinogen, but there is no consistent evidence of chronic health effects in exposed workers.

Points of Attack: Eyes, skin, respiratory system

Medical Surveillance: NIOSH recommends that workers subject to fibrous glass exposure have comprehensive preplacement medical examinations with emphasis on skin susceptibility and prior exposure in dusty trades. Subsequent annual examinations should give attention to the skin and respiratory system with attention to pulmonary function.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. If this chemical has been inhaled, remove from exposure, and move to fresh air.

Personal Protective Methods: Protective clothing shall be worn to prevent fibrous glass contact with skin especially hands, arms, neck, and underarms. Safety goggles or face shields and goggles shall be worn during tear-out or blowing operations; or when applying fibrous glass materials overhead. They should be used in all areas where there is a likelihood that airborne glass fibers may contact the eyes. Engineering controls should be used wherever feasible to maintain fibrous glass concentrations at or below the prescribed limits. Respirators should only be used when engineering controls are not feasible; for example, in certain nonstationary operations where permanent controls are not feasible.

Respirator Selection: NIOSH: *up to* $5 \times REL$: Q_m (APF = 25) (any quarter-mask respirator). *Up to* $10 \times REL$: 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100); or Sa (APF = 10) (any supplied-air respirator). *Up to 25 × REL:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *Up to 50 × REL*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 1000 × REL:* SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000): SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Green: General storage may be used. *Dust only*: Color code—Red: Flammability Hazard: Store in a flammable materials storage area. Prior to working with this chemical, personnel should be trained on its proper handling and storage.

Shipping: Not a regulated substance.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Collect material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete.

Fire Extinguishing: Noncombustible fibers. Use extinguisher suitable for surrounding fire. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Fibrous glass waste and scrap should be collected and disposed of in a manner which will minimize its dispersal into the atmosphere. Emphasis should be placed on covering waste containers; proper storage of materials; and collection of fibrous glass dust. Clean-up of fibrous glass dust should be performed using vacuum cleaners or wet cleaning methods. Dry sweeping should not be performed.

References

(109); (31).

National institute for Occupational Safety and Health (NIOSH), "Occupational Exposure to Fibrous Glass: A Symposium". NIOSH Document Number 76-151 (1976).

National institute for Occupational Safety and Health (NIOSH), "Criteria for a Recommended Standard: Occupational Exposure to Fibrous Glass", NIOSH Document Number 77-152, Cincinnati, OH (1977).

National institute for Occupational Safety and Health (NIOSH), "Criteria for a Recommended Standard: Occupational Exposure to Crystalline Silica", NIOSH Document Number 75-120, Cincinnati, OH (1975).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Fibrous Glass, Trenton, NJ (November 1985).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Glass Wool, Trenton, NJ (July 2001).

Fluenetil F:0250

Formula: $C_{16}H_{15}FO_2$

Synonyms: (1,1′-Biphenyl)-4-acetic acid, 2-fluoroethyl ester; 4-Biphenylacetic acid, 2-fluoroethyl ester; Fluenyl; β-Fluorethyl 4-biphenylacetate; Lambrol

CAS Registry Number: 4301-50-2

HSDB Number: 6437

RTECS Number: DV8335000

UN/NA & ERG Number: UN2588 (Pesticides, solid, toxic, n.o.s.)/151; UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: [*Annex I Index No.:* 607-078-00-0]

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Combustible, Highly toxic (all routes)

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg).

Hazard symbols, risk, & safety statements: Hazard symbol: T+; risk phrases: R23/24/25; R27/28; R50; safety phrases: S1/2; S28; S36/37; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Fluenetil is a crystalline solid. Molecular weight = 258.31. Boiling point = ~178°C; freezing/melting point = 61°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 1, reactivity 0.

Potential Exposure: This material has been used as an acaricide and insecticide. Its main use was as a dormant spray for orchard fruit. It is no longer made or registered as a pesticide in the U.S.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Moisture may cause material to hydrolyze. Compounds of the carboxyl group react with all bases, both inorganic and organic (i.e., amines) releasing substantial heat, water and a salt that may be harmful. Incompatible with arsenic compounds (releases hydrogen cyanide gas), diazo compounds, dithiocarbamates, isocyanates, mercaptans, nitrides, and sulfides (releasing heat, toxic and possibly flammable gases), thiosulfates and dithionites (releasing hydrogen sulfate and oxides of sulfur).

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 0.55 milligram per cubic meter

PAC-2: 6 milligram per cubic meter

PAC-3: 9.1 milligram per cubic meter

Routes of Entry: Ingestion, dermal contact.

Harmful Effects and Symptoms

Short-Term Exposure: Fluenetil is highly toxic. Fatal if ingested or via skin contact. Inhalation may cause pulmonary edema, a medical emergency that can be fatal. LD_{50} = (oral-rat) < 10 mg/kg.

Medical Surveillance: Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from nitrates and moisture.

Shipping: UN2588 Pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft (NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: absorb with sand or other non-combustible absorbent material and place into containers for later disposal. *Small dry spills*: with clean shovel place material into clean, dry container and cover; move containers from spill area. *Large spills*: dike far ahead of spill for later disposal. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material is a combustible solid. Thermal decomposition products may include fluorine. *Small fires:* dry chemical, carbon dioxide; water spray; or foam. *Large fires:* water spray, fog, or foam. Move container from fire area if you can do so without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR 165 recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138).

Hazardous Substance Data Bank (HSDB, Toxicology Data Network, Bethesda MD, (2016); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Fluenetil, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

Flumetsulam F:0255

Formula: $C_{12}H_9F_2N_5O_2S$

Synonyms: (1,2,4)Triazolo(1,5-α)pyrimidine-2-sulfonamide, *N*-(2,6-difluorophenyl)-5-methyl-; *N*-(2,6-Difluorophenyl)-5-methyl-(1,2,4)triazolo-(1,5-α)pyrimidine-2-sulfonamide; accent; broadstrike (flumetsulam plus metolachlor); DE-498; Frontrow, (cloransulam-methyl + flumetsulam); Hornet, (flumetsulam + clopyralid); NAF-9 (flumetsulam + metolachlor); NAF-2 (flumetsulam + metolachlor); Python; Scorpion; XRD-498; XRM-5313 (flumetsulam plus trifluralin); XRM-5019 herbicide

CAS Number: 98967-40-9

RTECS Number: RZ61275000

UN/NA & ERG Number: UN3082 (environmentally hazardous substances, liquid, n.o.s.)/171

EC Number: Not assigned

Regulatory Authority and Advisory Information

Carcinogenicity: EPA Group E, Evidence of noncarcinogenicity for humans

Hazard Alert: Poison (EPA Toxicity Class III, Caution, Slightly toxic). Listed for Tier 1 screening as an endocrine disruptor[88].

Hazard symbols, risk, & safety statements: Hazard symbol: Xi, Xn; risk phrases: R20; R36/37/38; R57; safety phrases: S41; S61 (see Appendix 4)

Description: Flumetsulam is a colorless liquid which does not exist as a free, pure substance. Used as an aqueous solution. Molecular weight = 325.3; specific gravity (H_2O:1) = 1.768 @ 25°C; boiling point = 130°C (decomposes); freezing/melting point = 251−253°C; flash point = > 95°C. Hazard identification (based on NFPA-704M Rating System): Health 3, flammability 0, reactivity 0. Soluble in water; solubility = 50 mg/L.

Potential Exposure: Ttriazolopyrimidine/sulfonanilide herbicide

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guidelines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg [F]/L. Safe Drinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg[F]/L; SMCL = 2 mg/F/L, as Fluoride.

Determination in Water: Octanol−water coefficient: Log K_{ow} = < 1.0. Unlikely to bioaccumulate in marine organisms.

Harmful Effects and Symptoms

Short-Term Exposure: Contact with eyes or skin may cause irritation or injury. Inhalation should be avoided. May be harmful if swallowed. LD_{50} (oral, rat) = > 5000 mg/kg; LD_{50} (dermal, rabbit) = > 2000 mg/kg.

Medical Surveillance: Preliminary medical exam to detect chronic diseases of CNS, liver, heart, kidneys, lung and skin, as well as endocrinological or immunological disturbances, should protect susceptible individuals. Periodical medical exams of internal organs, skin and eyes are important to avoid chronic occupational intoxications. They should include lab and patch tests if necessary[30].

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Do not induce vomiting when formulations containing petroleum solvents are ingested

Respirator Selection: Where the neat test chemical is weighed and diluted, wear a NIOSH-approved half face respirator equipped with a combination filter cartridge, i.e. organic vapor/acid gas/HEPA (specific for organic vapors, HCl, acid gas, SO_2 and a high efficiency particulate filter)[193]

Storage: Color code—Blue: Health Hazard/Poison. Store in a tightly closed container in a dry, well-ventilated and secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Where possible, automatically transfer material from other storage containers to process containers.

Shipping: UN3082 Environmentally hazardous substances, liquid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak

until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is partially combustible; it may burn but does not easily ignite; may support combustion at high temperatures. Thermal decomposition products may include hydrogen fluoride and oxides of nitrogen, carbon, sulfur. Use dry chemical powder extinguishers, foam, carbon dioxide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office. If this material cannot be disposed of according to label instructions, it may be dissolved or mixed with a combustible solvent and burned in a chemical incinerator equipped with an afterburner and scrubber. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Noncombustible containers should be crushed and buried under more than 40 cm of soil[30].

References

(31); (122).

United States Environmental Protection Agency, Office of Pesticide Programs, Pesticide Residue Limits, "Flumetsulam," 40 CFR 180.468, http://www.epa.gov/pesticides/food/viewtols.htm.

Fluoboric Acid F:0260

Formula: HBF_4

Synonyms: Acide fluoroborique (French); Acido fluoborico (Spanish); Borate(1−), tetrafluoro-, hydrogen; Borofluoric acid; Fluboric acid; Fluoro-boric acid; Fluoroborsaeure (German); Hydrofluoboric acid; Hydrogen tetrafluoroborate; Kester 5569 Solder-NU; Prepared bath 2137; Starter 2000; Starter 2137; Tetrofluoroboric acid; Tetrofluoro hydrogen borate

CAS Registry Number: 16872-11-0

HSDB Number: 2083

RTECS Number: ED2685000

UN/NA & ERG Number: UN1775/154

EC Number: 240-898-3 [*Annex I Index No.:* 009-010-00-X]

Regulatory Authority and Advisory Information

United States National Primary Drinking Water Regulations: MCLG = 4 mg[F]/L; MCL = 4 mg[F]/L; SMCL = 2 mg[F]/L, as fluorides.

Hazard symbols, risk, & safety statements: Hazard symbol: C; risk phrases: R34; safety phrases: S1/2; S26; S27; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Fluoboric acid is a colorless liquid which does not exist as a free, pure substance. Used as an aqueous solution. Molecular weight = 87.82; boiling point = 130°C (decomposes). Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 0. Soluble in water.

Potential Exposure: Used as a catalyst for acetal synthesis and cellulose esters; a metal surface cleaning agent; an aluminum electrolytic finishing agent; a stripping solution for the removal of solder and plated metals; and an intermediate in making fluoroborate salt.

Incompatibilities: A strong acid. Reacts violently with chemically active metals; strong bases, releasing flammable hydrogen gas.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 8.7 milligram per cubic meter

PAC-2: 97 milligram per cubic meter

PAC-3: 580 milligram per cubic meter

as inorganic fluoride

NIOSH IDLH = 250 mg[F]/m^3

OSHA PEL: 3 ppm/2.5 mg[F]/m^3 TWA

NIOSH REL: 3 ppm/2.5 mg[F]/m^3 TWA; 6 ppm/5 mg [F]/m^3, 15 min. Ceiling Concentration

ACGIH TLV[1]: 2.5 mg[F]/m^3 TWA; not classifiable as a human carcinogen; BEI: 3 mg[F]/g creatinine in urine *prior* to end-of-shift; 10 mg[F]/g creatinine in urine end-of-shift

DFG MAK: 1 mg[F]/m^3, inhalable fraction [skin]; Peak Limitation Category II(4); Pregnancy Risk Group C; BAT: 7.0 mg[F]/g creatinine in urine at end-of-shift; 4.0 mg[F]/g creatinine in urine at the beginning of the next shift

Several states have set guidelines or standards for fluorine in ambient air[60] ranging from 0 (North Carolina) to 4.0 μ/m^3 (Connecticut) to 6.7 μ/m^3 (New York) to 20.0 μ/m^3 (Florida) to 30.0 μ/m^3 (Virginia) to 20.0−40.0 μ/m^3 (North Dakota) to 48.0 μ/m^3 (Nevada).

Determination in Air: No tests available.

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking

Water Guidelines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg [F]/L. Safe Drinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg[F]/L; SMCL = 2 mg/F/L, as Fluoride.

Routes of Entry: Inhalation, eye and/or skin contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Highly corrosive. Contact can cause severe skin burns and eye irritation and burns with possible eye damage. Inhalation can irritate the lungs, causing coughing and shortness of breath. High exposure can cause headache, weakness, convulsions, collapse and death. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: Repeated exposure can cause nausea, vomiting, diarrhea, loss of appetite and weight; hair loss; skin rash; and bone and teeth changes (fluorosis). May cause kidney damage, anemia; and lung irritation with the possible development of bronchitis with cough, phlegm, and/or shortness of breath.

Points of Attack: Eyes, skin, respiratory system; kidneys, blood.

Medical Surveillance: NIOSH lists the following tests: chest X-ray, electrocardiogram, pulmonary function tests: forced vital capacity, forced expiratory volume (1 second); pelvic X-ray; sputum cytology; urine (chemical/metabolite); urine (chemical/metabolite) pre- and postshift; urinalysis (routine); complete blood count/differential. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA *12.5 milligram per cubic meter:* Q_m (APF = 25) (any quarter-mask respirator). *25 milligram per cubic meter:* 95XQ (APF = 10) *[any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or SA* (any supplied-air respirator). *62.5 milligram per cubic meter:* Sa:Cf (APF = 25) $^{*+}$ (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25)* *if not present as a fume* (any powered, air-purifying respirator with a high-efficiency particulate filter). *125 milligram per cubic meter:* 100F (APF = 50)$^{+}$ [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *250 milligram per cubic meter:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50)$^{+}$ [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or SCBAE (any appropriate escape-type, SCBA). *Substance reported to cause eye irritation or damage; may require eye protection. $^{+}$May need acid gas sorbent.

Storage: Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from chemically active metals; and strong bases. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: UN1775 Fluoroboric acid, Hazard class: 8; Labels: 8-Corrosive material.
Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.
Fire Extinguishing: This chemical may burn but does not easily ignite. Use dry chemical powder extinguishers. Thermal decomposition products may include hydrogen fluoride, fluorine, and boron oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.
References
(31); (173); (101); (138); (122); (100).
New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Fluoboric acid, Trenton, NJ (April 1999).

Fluometuron F:0270

Formula: $C_{10}H_{11}F_3N_2O$; $C_6H_4(CF_3)NHCON(CH_3)_2$
Synonyms: C 2059; CIBA 2059; Cotoran; Cotoran Multi 50WP; Cottonex; *N*,*N*-Dimethyl-*N*′-[3-(trifluoromethyl) phenyl]urea; 1,1-Dimethyl-3-(3-trifluoromethylphenyl)urea; Fluometuron; Herbicide C-2059; Lanex; Meturone; NCI-C08695; Pakhtaran; 3-(5-Trifluormethylphenyl)-, dimethylharnstoff (German)*;* *n*-(*m*-Trifluoromethylphenyl)-*N*′,*N*′-dimethylurea*;* *n*-(3-Trifluoromethylphenyl)-*N*′,*N*′-dimethylurea; 3-(*m*-Trifluoromethylphenyl)-1,1-dimethylurea; 3-(3-Trifluoromethylphenyl)-1,1-dimethylurea; Urea, *N*,*N*-Dimethyl-*N*′-[3-(trifluoromethyl)phenyl]-; Urea, 1,1-dimethyl-3-(α,α,α-trifluoro-*m*-tolyl)-
CAS Registry Number: 2164-17-2
HSDB Number: 1721
RTECS Number: YT1575000
UN/NA & ERG Number: UN2767 (Phenyl urea pesticides, solid, toxic)/151
EC Number: 218-500-4
Regulatory Authority and Advisory Information
Carcinogenicity: IARC: Human No Adequate Data; Animal Inadequate Evidence*, not classifiable as carcinogenic to humans*, Group 3
Hazard Alert: Poison, Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Environmental hazard, Agricultural chemical.
EPCRA Section 313 Form R de minimis concentration reporting level: 1.0%.
Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.
Hazard symbols, risk, & safety statements: Hazard symbol: N, Xn; risk phrases: R22; R33; R40; R51/53; R62; R64; safety phrases: S29; S36/37; S41; S60; S61 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.
Description: Fluometuron is a white crystalline solid often used in liquid solution that may be flammable. Molecular weight = 232.23; freezing/melting point = 163−165°C; vapor pressure = 9.4×10^{-7} mmHg @ 20°C. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 1, reactivity 0. Slightly soluble in water.
Potential Exposure: This material is used as a herbicide.
Incompatibilities: Liquid solutions are incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.
Permissible Exposure Limits in Air
No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.
Permissible Concentration in Water: A no-observed-adverse-effect-level (NOAEL) of 0.0125 mg/kg/day has been calculated by EPA. On this basis a long-term health advisory of 5.3 mg/L and a lifetime health advisory of 0.09 mg/L have been calculated. *Fluoride ion*: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guidelines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg[F]/L. Safe Drinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg[F]/L; SMCL = 2 mg/F/L, as Fluoride.
Determination in Water: Fish Tox = 77.05449000 ppb (INTERMEDIATE). Octanol−water coefficient: Log K_{ow} = 2.3. Unlikely to bioaccumulate in marine organisms.
Routes of Entry: Inhalation, dermal contact.
Harmful Effects and Symptoms
Short-Term Exposure: Contact can cause eye and skin irritation. Inhalation can irritate the respiratory tract.

Symptoms of exposure include increased leukocyte content in circulation of blood. The material is a mild cholinesterase inhibitor. LD_{50} (oral-rat) = 6400 mg/kg (insignificantly toxic). Human Tox = 7.00000 ppb (HIGH)

Long-Term Exposure: May cause skin allergy. Mild cholinesterase inhibitor; cumulative effect is possible. Repeated exposure may cause changes in the red blood cell count. May cause liver damage.

Points of Attack: Respiratory system, lungs, central nervous system; skin, eyes, plasma and red blood cell cholinesterase.

Medical Surveillance: Liver function tests. CBC. Evaluation by a qualified allergist.

First Aid: *Skin Contact*[52]*:* Flood all areas of body that have contacted the substance with water. Don't wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others. *Eye Contact:* Remove any contact lenses at once. Flush eyes well with copious quantities of water or normal saline for at least 20−30 minutes. Seek medical attention. *Inhalation:* Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion:* Consult a physician, hospital or poison center at once. If the victim is unconscious or convulsing, do not induce vomiting or give anything by mouth. Assure that the airway is open, lay on side and keep head lower than body and transport immediately to medical facility. If conscious and not convulsing, give a glass of water to dilute the substance. Do not induce vomiting without a physician's advice.

Personal Protective Methods: Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area separated from strong oxidants, strong bases; strong acids. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2767 Phenyl urea pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: *Dry material:* Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Dampen spilled material with 60%−70% acetone and avoid airborne dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Liquid: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Oil-skimming equipment may be used to remove slicks from water. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include hydrogen fluoride and oxides of nitrogen and carbon. *Dry material:* Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include hydrogen fluoride and nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Combustible solution: Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (122); (100).

United States Environmental Protection Agency, “Alert: Fluometuron” Washington, DC, Office of Drinking Water (August 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Fluometuron, Trenton, NJ (March 1999).

Fluoranthene F:0280

Formula: $C_{16}H_{10}$

Synonyms: 1,2-Benzacenaphthene; Benzo(jk)Fluorene; Fluoranteno (Spanish); Idryl; 1,2-(1,8-Naphthalenediyl) Benzene; 1,2-(1,8-Naphthylene)Benzene

CAS Registry Number: 206-44-0

HSDB Number: 5486

RTECS Number: LL4025000

UN/NA & ERG Number: UN1325 (flammable solids, organic, n.o.s.)/133; UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 205-912-4

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human No Adequate Data, animal No Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1987; EPA: Not Classifiable as to human carcinogenicity. Fluoranthene has not been identified as a carcinogen. Handle with caution as several related polynuclear aromatic hydrocarbons (PAHs) are known carcinogens. NIOSH has recommended that coal tar pitch volatiles, including polycyclic aromatic hydrocarbons (PAHs) be treated as potential human carcinogen.

Hazard Alert: Combustible solid[DOT], Environmental hazard.

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR 1910.1002) as coal tar pitch volatiles

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants; 40CFR423, Appendix A, Priority Pollutants

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U120

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.068; Nonwastewater (mg/kg), 3.4

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8100 (200); 8270 (10)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N, Xn; risk statements: R20; R22; R23/24/25; R36/37/38; R38; R39/23/24/25; R40; R41; R50/53; R51/53; R65; R67; safety statements: S7; S16; S23; S24/25; S26; S29/35; S36/37; S37/39; S45; S50/53; S60; S61; S62 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Fluoranthene is a polycyclic hydrocarbon and a colorless crystalline solid. Molecular weight = 202.25; boiling point = 384°C; freezing/melting point = 110°C; vapor pressure = 1.25 mmHg @ 0°C. Flash point = 195°C. Hazard identification (based on NFPA-704 M Rating System): Health 0, flammability 1, reactivity 0. Virtually insoluble in water.

Potential Exposure: Fluoranthene, a PAH, is produced from the pyrolytic processing of organic raw materials, such as coal and petroleum at high temperatures. It is also known to occur naturally as a product of plant biosynthesis. Fluoranthene is ubiquitous in the environment and has been detected in United States air; in foreign and domestic drinking waters and in food-stuffs. It is also contained in cigarette smoke. Individuals living in areas which are heavily industrialized; and in which large amounts of fossil fuels are burned, would be expected to have greatest exposure from ambient sources of fluoranthene. In addition, certain occupations e.g., coke oven workers, steelworkers, roofers, automobile mechanics) would also be expected to have elevated levels of exposure relative to the general population. Exposure to fluoranthene will be considerably increased among tobacco smokers or those who are exposed to smokers in closed environments (i.e., indoors).

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Compound can react exothermically with bases and with diazo compounds. Substitution at the benzene nucleus occurs by halogenation (acid catalyst), nitration, sulfonation, and the Friedel−Crafts reaction[101].

Permissible Exposure Limits in Air

NIOSH IDLH = 80 milligram per cubic meter as coal tar pitch volatiles

OSHA PEL: 0.2 milligram per cubic meter TWA [1910.1002] (benzene-soluble fraction). OSHA defines "coal tar pitch volatiles" in 29 CFR 1910.1002 as the fused polycyclic hydrocarbons that volatilize from the distillation residues of coal, petroleum (excluding asphalt), wood, and other organic matter.

NIOSH REL: 0.1 milligram per cubic meter (cyclohexane-extractable fraction). NIOSH considers coal tar products (i.e., coal tar, coal tar pitch, or creosote) to be potential occupational carcinogens

ACGIH TLV[1]: 0.2 milligram per cubic meter TWA (as benzene soluble aerosol); Confirmed Human Carcinogen

PAC Ver. 29[138]

PAC-1: 8.2 milligram per cubic meter

PAC-2: 90 milligram per cubic meter

PAC-3: 400 milligram per cubic meter

DFG MAK: Category 1, human carcinogen

Determination in Air: Use NIOSH Analytical Method #5506 PAHs by HPLC; NIOSH Analytical Method #5515, Polycyclic aromatic hydrocarbons by GC; OSHA Analytical Method ID-58.

Permissible Concentration in Water: State Drinking Water Guidelines: Florida 280 μg/L; Minnesota 300 μg/L; Wisconsin 400 μg/L.

Determination in Water: Methylene chloride extraction followed by high pressure liquid chromatography with fluorescence as UV detection; or gas chromatography (EPA Method 610), or gas chromatography plus mass spectrometry (EPA Method 625).

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Long-Term Exposure: There is concern about the toxicity of fluoranthene because it is widespread in the human environment and belongs to a class of compounds (PAHs) that contain numerous potent carcinogens. Experimentally, fluoranthene does not exhibit properties of a mutagen or primary carcinogen but it is a potent cocarciongen. In the laboratory, fluoranthene has also demonstrated toxicity to various freshwater and marine organisms. This finding, coupled with the cocarcinogenic properties of the compound, points out the need to protect humans and aquatic organisms from the potential hazards associated with fluoranthene in water.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Storage: Color code—Red Stripe: Flammability Hazard: Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Store flammable solids up to maximum allowable quantity per control area in an approved flammable storage area. Do not store in a basement. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, ammonium perchlorate, tetranitromethane, mercury(II) nitrate, and heat. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN1325 Flammable solids, organic, n.o.s., Hazard Class: 4.1; Labels: 4.1-Flammable solid.UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. Contain and isolate spill to limit spread. Construct clay/bentonite swale to divert uncontaminated portion of watershed. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed[22]. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (173); (101); (138); (2); (100).

United States Environmental Protection Agency, Fluoranthene: Ambient Water Quality Criteria, Washington, DC (1980).

United States Environmental Protection Agency, Fluoranthene, Health and Environmental Effects Profile No. 103, Office of Solid Waste, Washington, DC (April 30, 1980).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 7, No. 2, 80−84 (1987).

Fluorene F:0290

Formula: $C_{13}H_{10}$

Synonyms: *o*-Biphenylenemethane; *o*-Biphenylmethane; α-Diphenylenemethane; Diphenylenemethane; 9*H*-Fluorene; Fluorene, 9*H*; Fluoreno (Spanish); 2,2′-Methylenebiphenyl

CAS Registry Number: 86-73-7

HSDB Number: 2165

RTECS Number: LL5670000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171.

EC Number: 201-695-5

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human No Adequate Data, animal No Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1987; United States Environmental Protection Agency, Classification: D; not classifiable as to human carcinogenicity. Basis for classification: based on no human data and inadequate data from animal bioassays. Human carcinogenicity data: none. Animal carcinogenicity data: inadequate. *Note*: Handle with caution as several related polynuclear aromatic hydrocarbons (PAHs) are known carcinogens. *NIOSH has recommended that coal tar pitch volatiles, including PAHs be treated as potential human carcinogen.*

Hazard Alert: Combustible, Environmental hazard.

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR 1910.1002) as coal tar pitch volatiles.

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; Section 307(a)(1) Toxic pollutant designated, pursuant to of the and is subject to effluent limitations as PAHs

United States National Primary Drinking Water Regulations: MCLG = 0 mg/L; MCL = 0.0002 mg/L as PAHs.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.059; Nonwastewater (mg/kg), 3.4

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8100 (200); 8270 (10)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 5000 lb (2270 kg).

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, F, N, Xi, Xn; risk phrases: R40; R11; R20; R23/24/25; R36/37/38/39; R39/23/24/25; R41; R50/53; R59; R65; R67; safety phrases: S7; S16; S22; S24/25; S26; S27; S29; S33; S36/37/39; S45; S60; S61; S62; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Fluorene, when pure, is found as dazzling-white flakes or small, crystalline plates. It is fluorescent when impure. Polycyclic aromatic hydrocarbons (PAHs) are compounds containing multiple benzene rings and are also called polynuclear aromatic hydrocarbons. Molecular weight = 166.22; specific gravity (H_2O:1) = 1.2 @ 0°C; boiling point = 295°C (decomposes); freezing/melting point = 115°C; vapor pressure = 7.5 mmHg @ 137.4°C; flash point = 151°C. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 1, reactivity 0. Insoluble in water.

Potential Exposure: Fluorene is used in resins, dyes, and is a chemical intermediate.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine,

bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Compound can react exothermically with bases and with diazo compounds. Substitution at the benzene nucleus occurs by halogenation (acid catalyst), nitration, sulfonation, and the Friedel−Crafts reaction[101].

Permissible Exposure Limits in Air

NIOSH IDLH = 80 milligram per cubic meter as coal tar pitch volatiles

OSHA PEL: 0.2 milligram per cubic meter TWA [1910.1002] (benzene-soluble fraction). OSHA defines "coal tar pitch volatiles" in 29 CFR 1910.1002 as the fused polycyclic hydrocarbons that volatilize from the distillation residues of coal, petroleum (excluding asphalt), wood, and other organic matter.

ACGIH TLV[1]: 0.2 milligram per cubic meter TWA (as benzene soluble aerosol); Confirmed Human Carcinogen

NIOSH REL: 0.1 milligram per cubic meter (cyclohexane-extractable fraction). NIOSH considers coal tar products (i.e., coal tar, coal tar pitch, or creosote) to be potential occupational carcinogens

PAC Ver. 29[138]

PAC-1: 6.6 milligram per cubic meter

PAC-2: 72 milligram per cubic meter

PAC-3: 430 milligram per cubic meter

Determination in Air: Use NIOSH Analytical Method #5506 PAHs by HPLC; NIOSH Analytical Method #5515, Polycyclic aromatic hydrocarbons by GC; OSHA Analytical Method ID-58.

Permissible Concentration in Water: For the maximum protection of human health from the potential carcinogenic effects due to exposure of polynuclear aromatic hydrocarbons through ingestion of contaminated water and contaminated aquatic organisms, therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 1×10^{-5}, 1×10^{-6}, and 1×10^{-7}. The corresponding criteria are 28.0, 2.8, and 0.28 ng/l, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 311.0, 31.1, and 3.11 ng/l respectively. State Drinking Water Guidelines: Florida 500 μg/L Minnesota 300 μg/L Wisconsin 400 μg/L.

Routes of Entry: Inhalation, skin and/or eyes.

Harmful Effects and Symptoms

Short-Term Exposure: Fluorene can irritate and burn the eyes and skin.

Long-Term Exposure: Handle with caution as several related polynuclear aromatic hydrocarbons (PAHs) are known carcinogens. NIOSH has recommended that coal tar pitch volatiles, including PAHs be treated as potential human carcinogen.

Medical Surveillance: This chemical is a suspected human carcinogen[77]. Exposed persons should contact a physician for advice regarding the possible long term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Based on potential carcinogenicity the following is recommended by NIOSH: *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved SCBA that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-face-piece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: As a NIOSH potential carcinogen, store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area separated from strong oxidants, strong bases; strong acids. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Use vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical may burn but does not easily ignite. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; water spray; alcohol foam, or polymer foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Persons in charge of vessels or facilities are required to notify the National Response Center (NRC) immediately when there is a release of this designated hazardous substance, in an amount equal to or greater than its RQ listed above. The toll free number of the NRC is (800) 424-8802; In the Washington D.C. metropolitan area call (202) 426-2675. The rule for determining when notification is required is stated in 40 CFR 302.4 (Section IV. D.3.b).

References

(31); (173); (101); (138); (2); (18); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Fluorene, Trenton, NJ (May 1999).

Fluorides F:0300

Formula: F^-; F_yM_x;

Synonyms: Fluoride(1−); Fluoride ion; Fluoride ion(1−); Fluoride standard; Perfluoride

CAS Registry Number: 16984-48-8 (fluoride). See specific chemicals. This covers selective inorganic fluorides, excluding hydrofluoric acid/hydrogen fluoride. See H:0450

RTECS Number: LM6290000

Regulatory Authority and Advisory Information

Hazard Alert: Oxidizing gas, Corrosive (skin, eyes)

United States National Primary Drinking Water Regulations: MCLG = 4 mg[F]/L; MCL = 4 mg[F]/L; SMCL = 2.0 mg [F]/L, as Fluoride.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. as fluoride compounds Note: Several specific fluoride compounds are regulated by United States Environmental Protection Agency, OSHA and International regulatory bodies.

WGK[100] (German Aquatic Hazard Class): No value found for the general category of "fluorides".

Description: Of the general formula F_yM_x or M_xF_y, appearance, odor and properties vary with specific compounds. Molecular weight = 19.

Potential Exposure: Fluorides are used as an electrolyte in aluminum manufacture; a flux in smelting nickel, copper, gold, and silver; as a catalyst for organic reactions, a wood preservative; fluoridation agent for drinking water; a bleaching agent for cane seats; in pesticides, rodenticides, and as a fermentation inhibitor. They are utilized in the manufacture of steel, iron, glass, ceramics, pottery, enamels, in the coagulation of latex; in coatings for welding rods; and in cleaning graphite, metals, windows, and glassware. Exposure to fluorides may also occur during preparation of fertilizer from phosphate rock by addition of sulfuric acid. Air pollution by fluoride dusts and gases has done substantial damage to vegetation and to animals in the vicinity of industrial fluoride sources. However, the contribution of ambient air to human fluoride intake is only a few hundredths of a milligram per day, an amount that is insignificant in comparison with other sources of fluoride. Operations that introduce fluoride dusts and gases into the atmosphere include: Grinding, drying, and calcining of fluoride-containing minerals; acidulation of the minerals; smelting; electrochemical reduction of metals with fluoride fluxes or melts, as in the aluminum and steel industry; kiln firing of brick and other clay products and the combustion of coal.

Incompatibilities: Fluorides form explosive gases on contact with strong acids or acid fumes.

Permissible Exposure Limits in Air

NIOSH IDLH = 250 mg[F]/m^3

OSHA PEL: 3 ppm/2.5 mg[F]/m^3 TWA

NIOSH REL: 3 ppm/2.5 mg[F]/m^3 TWA; 6 ppm/5 mg [F]/m^3, 15 minutes Ceiling Concentration

ACGIH TLV[1]: 2.5 mg[F]/m^3 TWA; not classifiable as a human carcinogen; BEI: 3 mg[F]/g creatinine in urine *prior* to end-of-shift; 10 mg[F]/g creatinine in urine end-of-shift

DFG MAK: 1 mg[F]/m^3, inhalable fraction [skin]; Peak Limitation Category II(4); Pregnancy Risk Group C; BAT: 7.0 mg[F]/g creatinine in urine at end-of-shift; 4.0 mg [F]/g creatinine in urine at the beginning of the next shift

Australia: TWA 2.5 mg[F]/m^3, 1993; Austria: MAK 2.5 mg [F]/m^3, 1999; Belgium: TWA 2.5 mg[F]/m^3, 1993; Finland: TWA 2.5 mg[F]/m^3, 1999; France: VME 2.5 mg[F]/m^3, 1999; Hungary: TWA 1 mg[F]/m^3; STEL 2 mg[F]/m^3, 1993; Norway: TWA 0.6 mg[F]/m^3, 1999; the Philippines: TWA 2.5 mg[F]/m^3, 1993; Poland: MAC (TWA) 1 mg [HF]/m^3, MAC (STEL) 3 mg[HF]/m^3, 1999; Russia: STEL 0.5 ppm (2.5 milligram per cubic meter), 1993; Sweden: NGV 2 mg[F]/m^3, 1999; Switzerland: MAK-W 1.8 ppm (1.5 mg[F]/m^3), KZG-W 3.6 ppm (3.0 mg[F]/m^3), 1999; Thailand: TWA 2.5 mg[F]/m^3, 1993; United Kingdom: TWA 2.5 mg[F]/m^3, 2000; LTEL 2.5 mg[F]/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen

Several states have set guidelines or standards for fluorides in ambient air[60] ranging from 2.85 μ/m^3 (Iowa) to 25.0 μ/m^3 (North Dakota) to 34.0 μ/m^3 (Massachusetts) to 40.0 μ/m^3 (Virginia).

Determination in Air: Gaseous fluorides collected by impinger using caustic; particulates by filter. Analysis is by ion-specific electrode per NIOSH Analytical Method 7902[18].

Permissible Concentration in Water: Safe Drinking Water Act (47FR 9352): MCLG = 4 mg[F]/L; MCL = 4 mg[F]/L; SMCL = 2.0 mg[F]/L, as Fluoride. Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guidelines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg [Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg[F]/L. Safe Drinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg[F]/L; SMCL = 2 mg/F/L, as Fluoride.

Harmful Effects and Symptoms

Short-Term Exposure: Fluorides can affect you when breathed in. Fluorides can irritate and may damage the eyes. Skin contact can cause irritation, rash or burning sensation. High repeated exposure can cause nausea, vomiting; loss of appetite; and bone and teeth changes. Extremely high levels could be fatal. Breathing can irritate the nose and throat, and cause nausea, headaches, and nosebleeds. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Very high exposure can cause fluoride poisoning with stomach pain; weakness, convulsions, collapse and death. These effects do not occur at the level of fluorides used in water for preventing cavities in teeth.

Long-Term Exposure: Bone disease (pain and tenderness of the bones); children may get mottled teeth. Repeated high exposures may affect kidneys. Repeated high exposures can cause deposits of fluorides in the bones (fluorosis) that may cause pain, disability and mottling of the teeth. Repeated exposure can cause nausea, vomiting, loss of appetite; diarrhea or constipation. Nosebleeds and sinus problems can also occur.

Points of Attack: Eyes, respiratory system; central nervous system; skeleton, kidneys, skin.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that. Lung function tests. Fluoride level in urine (use NIOSH #8308). Levels higher than 4 mg/L may indicate overexposure. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with large amounts of soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: In areas with excessive gas or dust levels for any type of fluorine, worker protection should be provided. Respiratory protection by dust masks or gas masks with an appropriate canister or supplied air respirator should be provided. Goggles or full-face masks should be used. In areas where there is a likelihood of splash or spill, acid resistant clothing including gloves, gauntlets, aprons, boots, goggles, or face shield should be provided to the worker. Personal hygiene should be encouraged, with showering following each shift and before changing to street clothes. Work clothes should be changed following each shift, especially in dusty areas. Attention should be given promptly to any burns from fluorine compounds due to absorption of the fluorine at the burn site, and the possibility of developing systemic symptoms from absorption from burn sites.

Respirator Selection: NIOSH/OSHA *12.5 milligram per cubic meter:* Q_m (APF = 25) (any quarter-mask respirator). *25 milligram per cubic meter:* 95XQ (APF = 10)*[any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or SA* (any supplied-air respirator). *62.5 milligram per cubic meter:* Sa:Cf (APF = 25)$^{*+}$ (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25)* *if not* *present as a fume* (any powered, air-purifying respirator with a high-efficiency particulate filter). *125 milligram per cubic meter:* 100F (APF = 50)$^{+}$ [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *250 milligram per cubic meter:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50)$^{+}$ [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or SCBAE (any appropriate escape-type, SCBA). *Substance reported to cause eye irritation or damage; may require eye protection. *May need acid gas sorbent.

Storage: Storage color will depend on compound. Prior to working with fluorides all handlers should be trained on its proper handling and storage. Fluorides must be stored to avoid contact with strong acids (i.e., hydrochloric, sulfuric, and nitric) since violent reactions can occur. Fluorides form explosive gases on contact with nitric acid. Store in tightly closed containers in a cool, well-ventilated area away from water.

Spill Handling: *Liquid:* Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Solid material: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: *Do not use water.* Thermal decomposition products may include hydrogen fluoride. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Reaction of aqueous waste with an excess of lime, followed by lagooning; and either recovery or land disposal of the separated calcium fluoride.

References

(31); (122); (100).

National Institute for Occupational Safety and Health (NIOSH), Criteria for a Recommended Standard: Occupational Exposure to Inorganic Fluorides, NIOSH Document Number 76-103, Cincinnati, OH (1976).

National Academy of Sciences, *Medical and Biologic Effect of Environmental Pollutants: Fluoride*, Washington, DC (1971).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Fluoride*, Trenton, NJ (January 1986).

Fluorine F:0310

Formula: F_2

Synonyms: Fluor (French, German, Spanish); Fluorine-19; Fluorures acide (French); Saeure fluoride (German)

CAS Registry Number: 7782-41-4

HSDB Number: 541

RTECS Number: LM6475000

UN/NA & ERG Number: UN1045 (compressed)/124

EC Number: 231-954-8 [*Annex I Index No.:* 009-001-00-0]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 1000 (≥1.00% concentration); *Theft hazard* 15 (≥6.17% concentration).

Hazard Alert: Extremely toxic gas, Extremely powerful oxidizing gas, Dangerously water reactive (explosive), Corrosive (resp.), Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated, Primary irritant (w/o allergic reaction).

Clean Air Act: Accidental Release Prevention/Flammable Substances (Section 112[r], Table 3), TQ = 1000 lb (454 kg)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P056

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

EPCRA Section 313 Form R de minimis concentration reporting level: 1.0%.

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500 lb (227 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg) Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: O, T+, C; risk phrases: R5; R7; R21; R26; R35; safety phrases: S1/2; S9; S26; S33; S36/37/39; S38; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Fluorine is a yellow compressed, gas. Commonly shipped as a cryogenic gas. It has a characteristic pungent odor; the odor threshold is 0.035 ppm[41]. Molecular weight = 38.0; specific gravity (H_2O:1) = 1.6 @ 20°C; boiling point = −188.1°C; freezing/melting point = −219.4°C; Relative vapor density (air = 1): 1.31; vapor pressure = 750 mmHg @ −188.3°C. Hazard identification (based on NFPA-704 M Rating System): Health 4, flammability 0, reactivity 4 ₩. Violent reaction with water; forms hydrofluoric acid and oxygen. Explosive.

Potential Exposure: Elemental fluorine is used in the conversion of uranium tetrafluoride to uranium hexafluoride; in the synthesis of organic and inorganic fluorine compounds; and as an oxidizer in rocket fuel.

Incompatibilities: Fluorine is an extremely powerful oxidizing gas. Keep away from heat, water, nitric acid, oxidizers, organic compounds. Containers may explode if heated. Reacts violently with reducing agents; ammonia, all combustible materials, metals (except the metal containers in which it is shipped). Reacts violently with H_2O to form hydrofluoric acid, oxygen and ozone. The most potent oxidizer.

Permissible Exposure Limits in Air

NIOSH IDLH = 25 ppm

Odor threshold = 0.035 ppm[41].

Conversion factor: 1 ppm = 1.55 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 0.1 ppm/0.2 milligram per cubic meter TWA

NIOSH REL: 0.1 ppm/0.2 milligram per cubic meter TWA

ACGIH TLV[1]: 1 ppm/1.6 milligram per cubic meter TWA; 2 ppm/3.1 milligram per cubic meter

PAC* Ver. 29[138]

PAC-1: $\mathbf{1.7}_{\mathbf{A}}$ ppm

PAC-2: $\mathbf{5}_{\mathbf{A}}$ ppm

PAC-3: $\mathbf{13}_{\mathbf{A}}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60-minute values.

DFG MAK: No numerical value established. Data may be available.

Arab Republic of Egypt: TWA 0.1 ppm (0.2 milligram per cubic meter), 1993; Australia: TWA 1 ppm (2 milligram per cubic meter); STEL 2 ppm, 1993; Austria: MAK 0.1 ppm (0.2 milligram per cubic meter), 1999; Belgium: TWA 1 ppm (1.6 milligram per cubic meter); STEL 2 ppm, 1993; Denmark: TWA 0.1 ppm (0.2 milligram per cubic meter), 1999; Finland: STEL 0.1 ppm (0.26 milligram per cubic meter), 1999; France: VLE 1 ppm (2 milligram per cubic meter), 1999; Hungary: TWA 0.2 milligram per cubic meter; STEL 0.4 milligram per cubic meter, 1993; Norway: TWA 0.1 ppm (0.2 milligram per cubic meter), 1999; the Philippines: TWA 0.1 ppm (0.2 milligram per cubic meter), 1993; Poland: MAC (TWA) 0.05 milligram per cubic meter, MAC (STEL) 0.4 milligram per cubic meter, 1999; Sweden: NGV 0.1 ppm (0.2 milligram per cubic meter), KTV 0.3 ppm (0.5 milligram per cubic meter), 1999; Switzerland: MAK-W 0.1 ppm (0.15 milligram per cubic meter), KZG-W 0.2 ppm (0.3 milligram per cubic meter), 1999; Thailand: TWA 0.1 ppm (0.2 milligram per cubic meter), 1993; Turkey: TWA 0.1 ppm (0.2 milligram per cubic meter), 1993; United Kingdom: STEL 1 ppm (1.6 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 2 ppm. Several states have set guidelines or standards for fluorine in ambient air[60] ranging from 0 (North Carolina) to 4.0 μ/m^3 (Connecticut) to 6.7 μ/m^3 (New York) to 20.0 μ/m^3 (Florida) to 30.0 μ/m^3 (Virginia) to 20.0−40.0 μ/m^3 (North Dakota) to 48.0 μ/m^3 (Nevada).

Determination in Air: No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guidelines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg [F]/L. Safe Drinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg[F]/L; SMCL = 2 mg/F/L, as Fluoride.

Routes of Entry: Inhalation, eye and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: *Small amounts of gas in air can have a strong caustic effect on the cornea, eyelids, nose.* *Inhalation:* Corrosive. Inhalation of fluorine causes coughing, choking, and chills. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. A symptomatic period of 1−2 days followed by fever, cough, tightness in chest; and cyanosis indicate pulmonary edema. Inhalation of extremely high levels may cause suffocation. It is also reported that volunteers exposed to levels of

10 ppm for up to 15 minutes reported no irritation. Levels of 25−75 ppm caused increasing irritation. Exposure to levels of 100 ppm for 1 minute caused strong respiratory irritation. *Skin:* Corrosive to the skin. It is also reported that exposure to levels between 90 and 240 ppm produced slight irritation of the skin and a "sticky" feeling of face. Contact with liquid fluorine may cause chemical burns and frostbite. *Eyes:* Corrosive to the eyes; can lead to permanent eye damage. Contact with the liquid may cause frostbite. It is also reported that mild irritation was reported at exposure to levels of 25 ppm for 5 minutes. Levels of 100 ppm for 1 minute produced marked irritation. *Ingestion:* No reported exposures by this route. LD_{50} (rat, inhalation) = < 200 ppm.

Long-Term Exposure: Prolonged exposure can cause fluorine to concentrate in the bones, causing osteosclerosis which may be disabling. The teeth can become mottled. Repeated exposure can cause nosebleeds, nausea, vomiting, loss of appetite; diarrhea and kidney damage. These effects do not occur when fluorine is used to treat drinking water to prevent cavities. It is also reported that levels of 0.1 ppm intermittently, over a prolonged period produced no ill effects.

Points of Attack: Eyes, skin, respiratory system; liver, kidneys.

Medical Surveillance: Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. NIOSH lists the following tests: chest X-ray, electrocardiogram, pulmonary function tests: forced vital capacity, forced expiratory volume (1 second); pelvic X-ray; sputum cytology; urine (chemical/metabolite); urine (chemical/metabolite) pre- and postshift; urinalysis (routine); complete blood count/differential. Liver and kidney function tests. DEXA bone density scan (dual energy X-ray absorptiometry).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Prevent skin contact (liquid). **8 hours:** Barricade coated suits; Responder suits. Also, safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear nonvented, impact resistant goggles when working with fumes, gases, or vapors. When working with liquids, wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated.

Eyewash fountains should be provided (when chemical is in liquid form) in areas where there is any possibility that workers could be exposed to the substance; this is irrespective of the recommendation involving the wearing of eye protection. Facilities for quickly drenching the body should be provided (when chemical is in liquid form) within the immediate work area for emergency use where there is a possibility of exposure. [Note: It is intended that these facilities provide a sufficient quantity or flow of water to quickly remove the substance from anybody areas likely to be exposed. The actual determination of what constitutes an adequate quick drench facility depends on the specific circumstances. In certain instances, a deluge shower should be readily available, whereas in others, the availability of water from a sink or hose could be considered adequate][77]

Respirator Selection: *Up to 1 ppm:* CcrS (APF = 10) [any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern]; *Up to 2.5 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); *Up to 5 ppm:* CcrFS (APF = 50) [any chemical cartridge respirator with a full facepiece and cartridge(s) providing protection against the compound of concern]; *Up to 250 ppm:* SaF:Pd,Pp (APF = 2000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode. *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd, Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:*

GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-, mounted canister providing protection against the compound of concern]; or SCBAE (any appropriate escape-type, SCBA).

Danger: Do NOT use a gas mask with activated carbon filters containing activated carbon filters in atmospheres of high concentrations of fluorine gas. The activated carbon may spontaneously ignite.

Storage: Check oxygen content prior to entering storage area. Poison gas. (1) Color code—Blue: Health Hazard/ Poison: Store in a secure poison location. This gas is highly toxic. Even slight exposure to these gasses can cause death. Store outdoors in a secure, restricted area that containing warning signs. This area must be roofed and shaded with the cylinders stored off the ground and separated from all other products assigned to other hazard categories and radiant heat sources on nonwooden floors. If indoors, store in a well-ventilated areas in temperatures not to exceed 50°C. (2) Color code—Yellow Stripe: Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Oxidizers, including oxidizing gases, should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Fluorine must be stored to avoid contact with most oxidizable materials because it frequently causes them to start on fire. It will frequently ignite bromine, iodine, sulfur; alkaline metals (such as sodium and potassium) and a number of organic chemicals (such as benzene and ethyl alcohol). It should not contact nitric acid, because an explosive gas will be produced. Contact with hydrogen or amorphous silicon dioxide will cause an explosion. Store in containers, such as cylinders, in a cool, well-ventilated area away from heat, water and steam. Heat can cause cylinders to burst. Contact with water or steam can produce heat and corrosive and poisonous gases. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169 with the recommendations of the Compressed Gas Association.

Shipping: UN1045 Fluorine, compressed, Hazard Class: 2.3; Labels: 2.3-Poisonous gas, 5.1-Oxidizer, 8-Corrosive material, Inhalation Hazard Zone A. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling:

Fluorine and fluorine, compressed

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 300/90
Then: Protect persons downwind (mi/km)
Day 0.3/0.5
Night 1.4/2.3

Restrict persons not wearing protective equipment from area of leak until clean-up is complete. Ventilate area of leak to disperse the gas. Stop flow of gas. If source of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. If liquid fluorine is spilled, clear the area and allow it to evaporate. Vapors are heavier than air and will collect in low areas. *Do not use water* or wet method. It may be necessary to contain and dispose of this chemical as a hazardous waste. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Nonflammable, but reacts chemically with any material capable of burning. A few whiffs of the gas or vapor could cause death. Gas, vapor or liquid could be fatal on penetrating the firefighters' normal full protective clothing. Only special protective clothing designed to protect against fluorine should be used; the normal full protective clothing available to the average fire department will not provide adequate protection. Do not direct water onto fluorine leaks as the fire may be intensified. *For small fire*, use dry chemical or carbon dioxide. *For large fire*, use water spray, fog, or foam. *For massive fire in cargo area*, use unmanned hose holder or monitor nozzles[88,136]. This gas is under pressure; containers may rupture and explode when heated. Fluorine can ignite combustible materials and can increase the severity and intensity of an ongoing fire. Use extinguisher appropriate to the burning material. Do not spray water directly on leaking fluorine as poisonous gases are produced. Keep sealed fire-exposed cylinder cool by spraying with water. For small fire, used dry chemical or carbon dioxide. For large fire, use water spray, fog, or foam. For massive fire in cargo area, use unmanned hose holder or monitor nozzles. A few whiffs of the gas or vapor could cause death. Gas, vapor of liquid could be fatal on penetrating the firefighters' normal full protective clothing.

Only special protective clothing designed to protect against fluorine should be used; the normal full protective clothing available to the average fire department will not provide adequate protection. Do not direct water onto fluorine leaks as the fire may be intensified. Do *NOT* spray water on leaking cylinder (to prevent corrosion of cylinder). Turn leaking cylinder with the leak up to prevent escape of gas in liquid state.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Fluorine may be combusted by means of a fluorine-hydrocarbon air burner followed by a caustic scrubber and stack. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (173); (101); (138); (122); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 4, 68−70 (1981) and 3, No. 4, 50−53 (1983).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Fluorine, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

New York State Department of Health, *Chemical Fact Sheet:* Fluorine, Bureau of Toxic Substance Assessment, Albany, NY (May 1986).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Fluorine, Trenton, NJ (March 1999).

Fluoroacetamide F:0320

Formula: C_2H_4FNO; CH_2FCONH_2

Synonyms: AFL 1081; Compound 1081; FAA; Fluorakil 100; 2-Fluoroacetamide; Fluoroacetic acid amide; Fussol; Megatox; Monofluoroacetamide; Navron; Rodex; Yanock

CAS Registry Number: 640-19-7

HSDB Number: 2880

RTECS Number: AC1225000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 211-363-1 [*Annex I Index No.:* 616-002-00-5]

Regulatory Authority and Advisory Information

Hazard Alert: Exposure can be lethal, Combustible, Suspected of causing genetic defects, Suspected reprotoxic hazard, Alert: Combustible.

Banned or Severely Restricted (in agriculture) (several countries) (UN)[13]

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P057

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)

Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)]

Hazard symbols, risk, & safety statements: Hazard symbol: T+; Risk phrases R24; R28; R62; R63; safety phrases: S1/2; S36/37; S41; S45 (see Appendix 4).

Description: Fluoroacetamide is a colorless, crystalline solid. Molecular weight = 77.07; freezing/melting point = 107−109°C. Hazard identification (based on NFPA-704 M Rating System): Health 4, flammability 1, reactivity 0. Soluble in water.

Potential Exposure: This material is an organofluorine rodenticide; insecticide proposed mainly for use on fruits to combat scale insects, aphids, and mites. Use is largely restricted to licensed pest control operators.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

No OSHA, NIOSH, or ACGIH standards set for organic fluorides.

PAC Ver. 29[138]

PAC-1: 0.53 milligram per cubic meter

PAC-2: 5.8 milligram per cubic meter

PAC-3: 19 milligram per cubic meter

DFG MAK: 1 mg[F]/m^3, inhalable fraction [skin]; Peak Limitation Category II(4); Pregnancy Risk Group C; BAT: 7.0 mg[F]/g creatinine in urine at end-of-shift; 4.0 mg[F]/g creatinine in urine at the beginning of the next shift.

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guidelines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg [F]/L. Safe Drinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg[F]/L; SMCL = 2 mg/F/L, as Fluoride.

Routes of Entry: Inhalation, skin and/or eyes.

Harmful Effects and Symptoms

Short-Term Exposure: Signs and symptoms may be extremely severe and range from nausea, vomiting, and diarrhea to convulsions, coma, and heart failure. Other symptoms include hyperactivity, respiratory depression or arrest; cyanosis (blue tint to the skin and mucous membranes); and ventricular fibrillation. This material is super toxic; probable oral lethal dose in humans is less than 5 mg/kg, or a taste (less than 7 drops) for a 150-lb person. Chemically inhibits oxygen metabolism by cells with critical damage occurring to the heart, brain, and lungs, resulting in heart failure; respiratory arrest; convulsions, and death. *Warning:* Effects usually appear within 30 minutes of exposure but may be delayed as long as 20 hours. Caution is advised. Vital signs should be monitored closely.

Points of Attack: Heart, brain, and kidneys.

Medical Surveillance: For those with frequent or potentially high exposure (half the fluoride TLV or greater), the following are recommended before beginning work and at regular times after that. Lung function tests. Fluoride level in urine (use NIOSH #8308). Levels higher than 4 mg/L may indicate overexposure. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Kidney function tests.

First Aid: Acute exposure to fluoroacetamide may require decontamination and life support for the victim. *Inhalation:* Move victim to fresh air. Call 911 or emergency medical service. Evaluate vital signs. If no pulse is detected, provide CPR. If possible, rush victim to a healthcare facility. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. *Eye Exposure:* Remove any contact lenses at once and flush eyes with lukewarm water for 15 minutes. *Skin Exposure:* Follow steps under inhalation above. Wash exposed skin areas three times with soap and water. Rush to healthcare facility. *Ingestion:* Evaluate vital signs, including pulse and respiratory rate, and note any trauma. If no pulse is detected, provide CPR. Obtain authorization and/or further instructions from the local hospital for performance of other invasive procedures. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Emergency personnel should wear protective clothing appropriate to the type and degree of contamination. Air-purifying or supplied-air respiratory equipment should also be worn, as necessary. Rescue vehicles should carry supplies, such as plastic sheeting and disposable plastic bags to assist in preventing spread of contamination. For emergency situations, wear a positive pressure, pressure-demand, full facepiece SCBA or pressure-demand supplied air respirator with escape SCBA and a fully encapsulating, chemical resistant suit. Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA *12.5 milligram per cubic meter:* Q_m (APF = 25) (any quarter-mask respirator). *25 milligram per cubic meter:* 95XQ (APF = 10) *[any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or SA* (any supplied-air respirator). *62.5 milligram per cubic meter:* Sa:Cf (APF = 25)*+ (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25)* *if not present as a fume* (any powered, air-purifying respirator with a high-efficiency particulate filter). *125 milligram per cubic meter:* 100F (APF = 50)$^{+}$ [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *250 milligram per cubic meter:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50)$^{+}$ [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or SCBAE (any appropriate escape-type, SCBA). *Substance reported to cause eye irritation or damage; may require eye protection. *May need acid gas sorbent.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft (NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Do not touch spilled material; stop leak if you can do so without risk. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: dike spill for later disposal. Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include fluorine and nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (173); (101); (138); (80); (122).

United States Environmental Protection Agency, Chemical Hazard Information Profile: *Fluoroacetamide,* Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

Fluoroacetic Acid F:0330

Formula: $C_2H_3FO_2$: FCH_2COOH

Synonyms: Acide monofluoracetique (French); Acido fluoroacetico (Spanish); Cymonic acid; FAA; Fluoroacetate; 2-Fluoroacetic acid; Fluoroethanoic acid; Gifblaar poison; HFA; MFA; Monofluoressigsaeure (German); Monofluoroacetate; Monofluoroacetic acid

CAS Registry Number: 144-49-0

HSDB Number: 2082

RTECS Number: AH5950000

UN/NA & ERG Number: UN2642/154

EC Number: 205-631-7 [*Annex I Index No.:* 607-081-00-7]

Regulatory Authority and Advisory Information

Carcingenicity: ACGIH A4, not classifiable as a human carcinogen.

Hazard Alert: Poison, Drug.

Very Toxic Substance (World Bank)[13]

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 10/10,000 lb (4.54/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg).

Hazard symbols, risk, & safety statements: Hazard symbol: T+, N; risk phrases: R28; R50; safety phrases: S1/2; S20: S22: S26: S41; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Fluoroacetic acid is a colorless crystalline solid. Molecular weight = 78.05; boiling point = 165°C; freezing/melting point = 35°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 0. Soluble in water.

Potential Exposure: This material is used as a rodenticide and a drug.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Reacts with reducing agents releasing flammable gas.

Permissible Exposure Limits in Air

*as fluoride*s

NIOSH IDLH = 30[F] ppm

Odor threshold = 0.03 milligram per cubic meter.

OSHA PEL: 3 ppm/2.5 mg[F]/m^3 TWA

NIOSH REL: 3 ppm/2.5 mg[F]/m^3 TWA; 6 ppm/5 mg [F]/m^3 [15-minute] Ceiling Concentration

ACGIH TLV[1]: 5 ppm/0.41 mg[F]/m^3 TWA; 2 ppm/1.64 mg[F]/m^3 Ceiling Concentration; [skin]; not classifiable as a human carcinogen; BEI: 3 mg[F]/g creatinine in urine *prior* to end-of-shift; 10 mg[F]/g creatinine in urine end-of-shift

PAC Ver. 29[138]

PAC-1: 0.043 milligram per cubic meter

PAC-2: 0.47 milligram per cubic meter

PAC-3: 0.93 milligram per cubic meter

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guidelines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg [F]/L. Safe Drinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg[F]/L; SMCL = 2 mg/F/L, as Fluoride.

Harmful Effects and Symptoms

Short-Term Exposure: Corrosive to the eyes, skin, and respiratory tract. The major symptoms of fluoroacetic acid poisoning include severe epileptiform convulsions alternating with coma and depression; death may result from asphyxiation during convulsion or from respiratory failure.

Cardiac irregularities, such as ventricular fibrillation and sudden cardiac arrest; nausea, vomiting, excessive salivation; numbness, tingling sensations; epigastric pain; mental apprehension; muscular twitching; low blood pressure; and blurred vision may also occur. This material is very toxic; LD_{50} (oral-rat) = 4.7 mg/kg (extremely toxic), and may affect the cardiovascular system; central nervous system; and kidneys, and may cause cardiac and renal failure. This may cause death.

Long-Term Exposure: See information for "Short-Term Exposure."

Points of Attack: Central nervous system; heart, kidneys, lungs.

Medical Surveillance: Kidney function tests. EKG. Lung function tests. Examination of the nervous system. Consider chest X-ray following acute exposure.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy. Eyes: Remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. Skin: Remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. *Inhaled*: Remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. *Swallowed:* Get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. The symptoms of central nervous system; cardiac, and renal failure do not become manifest until a few hours have passed. Specific treatment is necessary in case of poisoning with this substance; the appropriate means with instructions must be available.

Personal Protective Methods: For emergency situations, wear a positive pressure, pressure-demand, full facepiece SCBA or pressure-demand supplied air respirator with escape SCBA and a fully encapsulating, chemical resistant suit. Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers.

Shipping: UN2642 Fluoroacetic acid, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Do not touch spilled material. Stop leak if you can do so without risk. Stay upwind; keep out of low areas. Use water spray to reduce vapors. For *small spills*, take up with sand or other noncombustible absorbent material and place into containers for later disposal. For *large spills*, dike spill for later disposal. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include hydrogen fluoride and oxides of carbon. *Small fires:* use dry chemical, carbon dioxide; water spray; or foam. *Large fires:* Use water spray, fog, or foam. Stay upwind; keep out of low areas. Wear self-contained, positive pressure breathing apparatus and full protective clothing. Move container from fire area. Cool containers that are exposed to flames with water from the side until well after fire is out. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Use a licensed professional waste disposal service to dispose of this material. Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed[24].

References

(31); (173); (101); (138); (122); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Fluoroacetic Acid, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Trifluoroacetic acid, #1911, Trenton, NJ, (October 2001).

Fluoroacetyl Chloride F:0340

Formula: C_2H_2ClFO; FCH_2COCl

Synonyms: Acetyl chloride, fluoro-; TL 670

CAS Registry Number: 359-06-8

HSDB Number: 6327

RTECS Number: AO6825000

UN/NA & ERG Number: UN2922 (Corrosive liquid, toxic, n.o.s.)/154; UN2810 (Toxic liquids, organic, n.o.s.)/153

EC Number: 206-623-6

Regulatory Authority and Advisory Information

Carcinogenicity: At the time of this review, no studies were found on the possible carcinogenic activity of fluoroacetyl chloride in humans, experimental animals; or in the *Salmonella* mutagenicity test.[NLM]

Hazard Alert: Exposure can be lethal, Combustible, Water and air reactive.

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 10 lb (4.54 kg).

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg).

United States National Primary Drinking Water Regulations: MCLG = 4 mg[F]/L; MCL = 4 mg[F]/L; SMCL = 2.0 mg[F]/L, as Fluorides.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, C; risk phrases: R14; R22; R26; R34; R35; R36/37/38; R50/53; safety phrases: S3/7; S9; S26; S27; S36/37/39; S38; S45; S53; S41 (see Appendix 4)

Description: Fluoroacetyl chloride is a liquid. Molecular weight = 96.49; boiling point = 73°C; vapor pressure = 80 *mm*Hg @ 25°C. Hazard identification (based on NFPA-704 M Rating System): Health 4, flammability 1, reactivity 2. ₩Reacts with water forming corrosive hydrochloric acid.

Potential Exposure: May be used in organic synthesis.

Incompatibilities: Compounds of the carboxyl group react with all bases, both inorganic and organic (i.e., amines) releasing substantial heat, water and a salt that may be harmful. Incompatible with arsenic compounds (releases hydrogen cyanide gas), diazo compounds, dithiocarbamates, isocyanates, mercaptans, nitrides, and sulfides (releasing heat, toxic and possibly flammable gases), thiosulfates and dithionites (releasing hydrogen sulfate and oxides of sulfur). Chlorides or fluorides may ignite combustibles (i.e., wood, paper, oil, etc.) or react violently with water forming hydrochloric acid.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 0.91 milligram per cubic meter

PAC-2: 10 milligram per cubic meter

PAC-3: 60 milligram per cubic meter

Routes of Entry: Inhalation, ingestion, dermal contact possible.

Harmful Effects and Symptoms

Short-Term Exposure: Highly toxic by inhalation. Irritating and corrosive to skin, eyes and respiratory tract. Effects may include severe pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Clinical effects are usually seen within 1/2 hour of exposure. Symptoms of nausea, vomiting, excessive salivation, abdominal pain, numbness, a tingling sensation, and apprehension are seen initially, and may last for up to 6 hours. Muscular twitching, blurred vision, and hypotension may develop. Severe effects such as coma, convulsions, and cardiac arrhythmias may be delayed in onset as long as 20 hours[88].

Long-Term Exposure: May cause respiratory problems. Lung damage.

Medical Surveillance: Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. Lung function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Effects may be delayed; keep victim under observation.

Personal Protective Methods: For emergency situations, wear a positive pressure, pressure-demand, full facepiece SCBA or pressure-demand supplied air respirator with escape SCBA and a fully encapsulating, chemical resistant suit. Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: UN2810 Toxic liquids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN2922 Corrosive liquids, toxic, n.o.s., Hazard class: 8; Labels: 8-Corrosive material, 6.1-Poisonous materials.

Spill Handling: UN2810 Toxic liquids, organic, n.o.s.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 0.7/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 1000/300
Then: Protect persons downwind (mi/km)
Day 1.1/1.8
Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Stay upwind; keep out of low areas. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors (may react violently with water). *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: dike far ahead of spill for later disposal. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include hydrogen fluorine, hydrogen chloride and oxides of carbon. This material is a combustible solid and highly water reactive; forms corrosive hydrochloric acid. Extinguish with dry chemical, carbon dioxide. Spray cooling water on unopened containers that are exposed to flames until well after fire is out. Move container from fire area if you can do so without risk. Do not get water in container, as material may react violently with water. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Bromine, Trenton, NJ (July 1998).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Fluoroacetyl Chloride, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

Fluorobenzene F:0350

Formula: C_6H_5F

Synonyms: Benzene fluoride; Benzene, fluoro-; MFB; Monofluorobenzene; Phenyl fluoride

CAS Registry Number: 462-06-6
RTECS Number: DA0800000
UN/NA & ERG Number: UN2387/130
EC Number: 207-321-7

Regulatory Authority and Advisory Information

Hazard Alert: Environmental hazard.

Hazardous to aquatic life or environment, with possible long-lasting effects[194]. Harmful to aquatic life with long-lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: F+, Xi, T, N; risk phrases: R12; R25; R36/37/38; R39; 23/24/25; R51/53; safety phrases: S7/9; S16; S26; S29; S33; S36/37; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Fluorobenzene is a colorless liquid. Molecular weight = 96.11; boiling point = 85°C; flash point = −15°C. Explosive limits: LEL: 1.3%; UEL: 9%. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 4, reactivity 0. Insoluble in water.

Potential Exposure: Fluorobenzene is used as an insecticide and as a reagent for plastic or resin polymers.

Incompatibilities: Vapor may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

PAC Ver. 29[138]
PAC-1: 30 milligram per cubic meter
PAC-2: 330 milligram per cubic meter
PAC-3: 1200 milligram per cubic meter

Determination in Water: Octanol−water coefficient: Log $K_{ow} = < 2.5$. Values above 3.0 are likely to bioaccumulate in aquatic organisms. Hazardous to the aquatic environment. May be hazardous to the aquatic environment. Do not allow release to the environment unless proper permits are obtained from the federal government.

Routes of Entry: Inhalation, passing through the unbroken skin.

Harmful Effects and Symptoms

Short-Term Exposure: Fluorobenzene can irritate the eyes, nose, throat and lungs. Eye irritation may be serious. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. A closely related chemical, chlorobenzene, can damage the liver and kidneys with high or repeated exposure. It is unknown if fluorobenzene causes these effects. Overexposure could cause headache, nausea and make you dizzy.

Long-Term Exposure: May cause liver and kidney damage. Repeated exposure may damage the lungs and affect the nervous system.

Points of Attack: Lungs, liver, kidney, nervous system.

Medical Surveillance: Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: periodic lung function tests. If symptoms develop or overexposure is suspected, the following may also be useful: tests for kidney and liver function. Examination of the nervous system. Consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Where there is potential for exposures to fluorobenzene exists, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Fluorobenzene must be stored to avoid contact with oxidizers, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where fluorobenzene is handled, used, or stored. Metal containers involving the transfer of 5 gal or more of fluorobenzene should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of fluorobenzene.

Shipping: UN2387 Fluorobenzene, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a highly flammable liquid. Thermal decomposition products may include toxic hydrogen fluoride and oxides of carbon. Use dry chemical, carbon dioxide; or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Fluorobenzene, Trenton, NJ (March 1999).

Fluorotrichloromethane F:0360

Formula: CCl_3F

Synonyms: Algofrene type 1; Arctron 9; CFC-11; Electro-CF 11; Eskimon 11; F 11; FC 11; Fluorocarbon 11; Fluorochloroform; Freon 11; Freon HE; Freon MF; Frigen 11; Genetron 11; Halocarbon 11; Isceon 131; Isotron 11; Ledon 11; Methane, fluorotrichloro; Methane, trichlorofluoro-; Monoflurotrichloromethane; NCI-C04637; Propellant 11; R 11; Refrigerant 11; Trichlorofluoromethane; Trichloromonofluoromethane; Ucon fluorocarbon 11; Ucon refrigerant 11

CAS Registry Number: 75-69-4; *(alt.)* 83589-40-6

RTECS Number: PB6125000

DOT ID and ERG Number: UN1956/126[101]

EC Number: 200-892-3

Regulatory Authority and Advisory Information

Carcinogenicity: NCI: Carcinogenesis Bioassay (gavage); no evidence: mouse; inadequate studies: rat.

Hazard Alert: Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated, Possible risk of forming tumors, Environmental hazard (ozone depletion).

Clean Air Act: Stratospheric ozone protection (Title VI, Subpart A, Appendix A), Class I, Ozone Depletion Potential = 1.0.

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U121.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.020; Nonwastewater (mg/kg), 30

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8010 (10); 8240 (5)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 5000 lb (2270 kg)

EPCRA Section 313 Form R de minimis concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Harms public health and the environment by destroying ozone in the upper atmosphere, category 1.

Hazard symbols, risk, & safety statements: Hazard symbol: N, Xn, Xi; risk phrases: R5; R20/21/22; R23/24/25; R36/37/38; R39/23/24/25; R51; R58/59; safety phrases: S7; S9; S16; S23; S24/25; S26; S33; S36/37/39; S38; S41; S45; S57; S59; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Fluorotrichloromethane is a colorless liquid or gas. Chlorinated solvent odor. The Odor Threshold is 5.0 *ppm*. Molecular weight = 137.37; specific gravity (H_2O:1) = 1.47 (Liquid @ 23.9°C); boiling point = 24°C; freezing/melting point = −110°C; Relative vapor density (air = 1) = 4.74; vapor pressure = 750 mmHg @ 23.3°C.

Explosive limits: LEL = 25,000 ppm; UEL: unknown. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 0, reactivity 1. Soluble in water; solubility = 0.1% @ 23.9°C.

Potential Exposure: This material is used as a refrigerant; aerosol propellant; and foaming agent; as blowing agent in production of polyurethane foams.

Incompatibilities: Chemically active and powdered metals: aluminum, barium, sodium, potassium, calcium, powdered aluminum; zinc, magnesium.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 5.62 milligram per cubic meter @ 25°C & 1atm

OSHA PEL: 1000 ppm/5600 milligram per cubic meter TWA

NIOSH REL: 1000 ppm/5600 milligram per cubic meter Ceiling Concentration

ACGIH TLV[1]: 1000 ppm/5620 milligram per cubic meter Ceiling Concentration, Not Classifiable as a Human carcinogen*, as trichloromonofluoromethane*

NIOSH IDLH = 2000 ppm

PAC Ver. 29[138]

PAC-1: 91 ppm

PAC-2: 1000 ppm

PAC-3: 10.000 ppm [= > 10% LEL, lower explosive limit but <50% LEL]

DFG MAK: 1000 ppm/5700 milligram per cubic meter TWA; Peak Limitation Category II(2); Pregnancy Risk Group C, *as trichloromonofluoromethane*

Australia: TWA 1000 ppm (5600 milligram per cubic meter), 1993; Austria: MAK 1000 ppm (5600 milligram per cubic meter), 1999; Belgium: STEL 1000 ppm (5620 milligram per cubic meter), 1993; Denmark: TWA 500 ppm (2810 milligram per cubic meter), 1999; Finland: TWA 1000 ppm (5600 milligram per cubic meter; STEL 1250 ppm (7000 milligram per cubic meter), 1993; Hungary: STEL 40 milligram per cubic meter, 1993; Japan: 1000 ppm (5600 milligram per cubic meter), 1999; Norway: TWA 500 ppm (2800 milligram per cubic meter), 1999; the Philippines: TWA 1000 ppm (5600 milligram per cubic meter), 1993; Poland: MAC (TWA) 500 milligram per cubic meter, MAC 5600 milligram per cubic meter, 1999; Russia: STEL 1000 ppm (1000 milligram per cubic meter), 1993; Sweden: NGV 500 ppm (3000 milligram per cubic meter), KTV 750 ppm (4500 milligram per cubic meter), 1999; Switzerland: MAK-W 1000 ppm (5600 milligram per cubic meter), 1999; Turkey: TWA 1000 ppm (5600 milligram per cubic meter), 1993; United Kingdom: TWA 1000 ppm (5710 milligram per cubic meter); STEL 1250 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Ceiling Concentration 1000 ppm. Russia set a MAC in ambient air in residential areas of 100 milligram per cubic meter on a once-daily basis and 10 milligram per cubic meter on a daily average basis. Several states have set guidelines or standards for F-11 in ambient air[60] ranging from 13.0 milligram per cubic meter (Virginia) to 56.0 milligram per cubic meter (North Dakota) to 112.0 milligram per cubic meter (Connecticut) to 133.33 milligram per cubic meter (Nevada) to 560 milligram per cubic meter (North Carolina). Beyond this, general concern about destruction of the ozone layer above the earth has prompted restrictions on chlorofluorocarbon use and venting to the atmosphere. Substitute materials are being developed to reduce emissions drastically.

Determination in Air: Charcoal adsorption, workup with CS2, analysis by gas chromatography/flame ionization. See NIOSH Analytical Method (IV) #1006[18].

Permissible Concentration in Water: For the protection of human health: preferably zero. An additional lifetime cancer risk of 1 in 100,000 results at a level of 1.9 μg/L. In January 1981 EPA (46FR2266) removed F-11 from the priority toxic pollutant list. Several states have developed guidelines for F-11 in drinking water[61] ranging from 1.0 μg/L (Arizona) to 2300 μg/L (Maine) to 3400 μg/L (California) to 3500 μg/L (Wisconsin) to 8000 μg/L (Kansas) to 8750 μg/L (Maryland).

Determination in Water: Inert gas purge followed by gas chromatography with halide specific detection (EPA Method 601) or gas chromatography plus mass spectrometry (EPA Method 624). Octanol−water coefficient: Log $K_{ow} = 2.5$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the skin and eyes. Overexposure can cause lightheadedness, dizziness, incoherence, tremors, cardiac arrythmia; asphyxiation; cardiac arrest. This can occur without other warning symptoms. The liquid may cause frostbite.

Long-Term Exposure: Repeated or prolonged contact with skin may cause dryness and cracking. Can irritate the lungs, causing coughing and/or shortness of breath.

Points of Attack: Skin, cardiovascular system.

Medical Surveillance: NIOSH lists the following tests: urine (chemical/metabolite). For those with frequent or potentially high exposure (half the TLV or grater), the following are recommended before beginning work and at regular times after that. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider Holter monitor (a special 24 hour EKG to look for irregular heart beat).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large

quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear eye protection and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *2000 ppm:* Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd, Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-, mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Green: General storage may be used. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Trichlorofluoromethane must be stored to avoid contact with chemically active metals, such as aluminum or lithium, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from sources of heat.

Shipping: Hazard Class: 2.2; Labels: 2.2-Nonflammable compressed gas, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible liquid. Thermal decomposition products may include hydrogen fluoride, hydrogen chloride and phosgene. Use extinguishing agents suitable for surrounding fire. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (101); (138); (80); (100).

United States Environmental Protection Agency, *Halomethanes: Ambient Water Quality Criteria*, Washington, DC (1980).

United States Environmental Protection Agency, *Trichlorofluoromethane and Dichlorodifluoromethane*, Health and Environmental Effects Profile No. 167, Office of Solid Waste, Washington, DC (April 30, 1980).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 5, No. 6, 92−95 (1985).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Trichlorofluoromethane, Trenton, NJ (May 2006).

Fluorouracil F:0370

Formula: $C_4H_3FN_2O_2$

Synonyms: Adrucil; AI3-25297; Arumel; 2,4-Dioxo-5-fluoropyrimidine; Effluderm (free base); Efudex; Efudix; Efurix; Fluoroblastin; Fluoroplex; 5-Fluoro-2,4(1*H*,3*H*)-pyrimidinedione; 5-Fluoropyrimidine-2,4-dione; 5-Fluoro-2,4-pyriminedione; 5-Fluorouracil; Fluorouracile; Fluorouracilo; Fluorouracilum; 5-Fluoruracil (German); Fluracilum; Fluri; Fluril; Fluro Uracil; FT-207; 5-FU; FU; Kecimeton; NSC 19893; 2,4(1*H*,3*H*)-Pyrimidinedione, 5-fluoro-; Queroplex; RO 2-9757; Timazin; U-8953; Ulup; Uracil, 5-fluoro-

CAS Registry Number: 51-21-8

HSDB Number: 3228

RTECS Number: YR0350000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 200-085-6

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human Inadequate Evidence, animal Inadequate Evidence*, not classifiable as carcinogenic to humans*, Group 3, 1987.

California Proposition 65 Developmental/Reproductive toxin 1/1/1989.

Hazard Alert: Poison, Combustible, Possible sensitization hazard, Reproductive toxin: Suspected of causing genetic defects; Suspected reprotoxic hazard, Agricultural chemical, Drug.

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 500 lb (227 kg)

EPCRA Section 313 Form R de minimis concentration reporting level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, C, Xn, Xi; risk phrases: R25; R20/21/22; R52; R62; R63; safety phrases: S22; S36; S36/37/39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Fluorouracil is a white crystalline solid. Practically odorless. Molecular weight = 130.08; boiling point = 361°C; freezing/melting point = 282−283°C (decomposes); vapor pressure = 1×10^{-5} mmHg @ 25°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 1. Soluble in water.

Potential Exposure: This material is used as an antineoplastic drug for cancer treatment and as a chemosterilant for insects.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, methotrexrate sodium, sources of heat.

Permissible Exposure Limits in Air

PACVer. 29[138]

PAC-1: 1.7 milligram per cubic meter

PAC-2: 19 milligram per cubic meter

PAC-3: 46 milligram per cubic meter

Determination in Water: Octanol−water coefficient: $\log K_{ow} = < 1$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Ingestion, dermal contact.

Harmful Effects and Symptoms

Short-Term Exposure: Contact can irritate and burn the eyes and skin. Can cause headache, fatigue, dizziness, and mental confusion; nausea, vomiting, diarrhea, and abdominal pain. Minimum toxic dose in humans is approximately 450 mg/kg (total dose) over 30 days for the ingested drug. Intravenous minimum toxic dose in humans is a total dose of 6 mg/kg over 3 days. Depression of white blood cells occurred after intravenous administration of a total dose of 480 mg/kg over 32 days. Occasional neuropathy and cardiac toxicity have been reported. Do not use during pregnancy. Patients with impaired hepatic or renal function, with a history of high-dose pelvic irradiation or previous use of alkylating agents should be treated with extreme caution. Patients with nutritional deficiencies and protein depletion have a reduced tolerance to fluorouracil.

Long-Term Exposure: May decrease fertility in males and females. May cause skin allergy. Very high exposure may affect the heart. Loss of appetite and nausea are earliest symptoms, with other symptoms of diarrhea, inflammation or sores in the mouth; gastric burning; and intestinal discomfort. More serious symptoms are due to the suppression of bone marrow, with decrease of white cell count and blood platelets, and anemia. Hair loss, nail changes; dermatitis, pigmentation and atrophy of skin also occur. Sunlight can exacerbate these effects.

Points of Attack: Blood, heart, skin.

Medical Surveillance: Pregnant women should avoid contact. Employees should be notified by a physician that this chemical may affect the reproductive system. In addition to comprehensive initial medical and work histories emphasizing reproductive experience and menstrual history, patient should have physical examination and testing of genitourinary tract, sperm count, motility and morphology. If required, other tests, such as serum testosterone, serum FSH, and serum LH, may be indicated.

CBC, EKG, evaluation by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature.

Personal Protective Methods: For emergency situations, wear a positive pressure, pressure-demand, full facepiece SCBA or pressure-demand supplied air respirator with escape SCBA and a fully encapsulating, chemical resistant suit. Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool place, possibly a refrigerator. Store @ 59−86°F/15−30°C. Keep away from oxidizers, strong bases; and heat.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft (NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Stay upwind; keep out of low areas. If water pollution occurs, notify appropriate authorities. Spill or leak; shut off ignition sources; no flares, smoking or flames in hazard area. Keep combustibles (wood, paper, oil etc.) away from spilled material. Do not touch spilled material. *Small spills*: Collect powdered material in the most convenient and safe manner and deposit in sealed containers. *Large spills*: dike far ahead of spill for later disposal. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include hydrogen fluoride and oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; or alcohol; or polymer foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 8, No. 6, 64−73 (1988).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Fluorouracil, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* 5-Fluorouracil, Trenton, NJ (June 1999).

Fluosilicic Acid F:0380

Formula: F_6H_2Si; H_2SiF_6

Synonyms: Dihyrogen hydrofluorosilicate; Hexafluorosilicate (2−) dihydrogen; Hexafluorosilicic acid; Hexafluosilicic acid; Hydrofluosilicic acid; Hydrogen hexafluorosilicate; Hydrosilicofluoric acid; Sand acid; Silicofluoric acid

CAS Registry Number: 16961-83-4; *(alt.)* 1309-45-1

HSDB Number: 2018

RTECS Number: VV8225000

UN/NA & ERG Number: UN1778/154

EC Number: 241-034-8 [*Annex I Index No.:* 009-011-00-5]

Regulatory Authority and Advisory Information

United States National Primary Drinking Water Regulations: MCLG = 4 mg[F]/L; MCL = 4 mg[F]/L; SMCL = 2 mg[F]/L, as fluorides.

Hazard symbols, risk, & safety statements: Hazard symbol: C; risk phrases: R34; safety phrases: S1/2; S26; S27; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Fluorosilicic acid is a transparent, colorless fuming liquid. Molecular weight = 144.09; specific gravity (H_2O:1) = 1.04 @ 17.5°C; boiling point = about 100°C (decomposes); freezing/melting point ≤ -20°C. It is not flammable. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 0. Soluble in water.

Potential Exposure: A solution of fluorosilicic acid is used for sterilization in the brewing and bottling industry, electrolytic refining of lead; electroplating, hardening cement; removing mold, and others.

Incompatibilities: The aqueous solution is a strong acid. Reacts with water or steam to produce toxic and corrosive fumes of hydrogen fluoride. Incompatible, and may react violently with: bases, aliphatic amines; alkanolamines, alkylene oxides; aromatic amines; amides, ammonia, ammonium hydroxide; calcium oxide; epichlorohydrin, isocyanates, oleum, organic anhydrides; sulfuric acid; strong oxidizers; vinyl acetate; water. Attacks glass, concrete, and ceramics. The anhydrous form dissociates almost instantly into silicon tetrafluoride and hydrogen fluoride.

Permissible Exposure Limits in Air

NIOSH IDLH = 250 mg[F]/m^3

OSHA PEL: 3 ppm/2.5 mg[F]/m^3 TWA

NIOSH REL: 3 ppm/2.5 mg[F]/m^3 TWA; 6 ppm/5 mg [F]/m^3, 15 min. Ceiling Concentration

ACGIH TLV[1]: 2.5 mg[F]/m^3 TWA; not classifiable as a human carcinogen; BEI: 3 mg[F]/g creatinine in urine *prior* to end-of-shift; 10 mg[F]/g creatinine in urine end-of-shift

PAC Ver. 29[138]

PAC-1: 9.5 milligram per cubic meter

PAC-2: 110 milligram per cubic meter

PAC-3: 630 milligram per cubic meter

DFG MAK: 1 mg[F]/m^3, inhalable fraction [skin]; Peak Limitation Category II(4); Pregnancy Risk Group C; BAT: 7.0 mg[F]/g creatinine in urine at end-of-shift; 4.0 mg[F]/g creatinine in urine at the beginning of the next shift

Russia[43] has set MAC values for ambient air in residential areas as 0.03 milligram per cubic meter on a momentary basis and 0.01 milligram per cubic meter on a daily average basis[43].

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guidelines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg [F]/L. Safe Drinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg[F]/L; SMCL = 2 mg/F/L, as Fluoride.

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Corrosive to the eyes, skin, and respiratory tract. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Medical observation is recommended. *Inhalation:* May cause difficult breathing and burning of the mouth, throat and nose, which may result in bleeding. These may be felt @ 7.5 milligram per cubic meter. Nausea, vomiting, profuse sweating and excess thirst may occur at higher levels. *Ingestion:* Corrosive. Most reported instances of fluoride toxicity are due to accidental ingestion and it is difficult to associate symptoms with dose. 5−40 mg may cause nausea, diarrhea, and vomiting. More severe symptoms of burning and painful abdomen; sores in mouth; throat and digestive tract; tremors, convulsions and shock will occur around a dose of 1 gram. Death may result in ingestion of 2−5 g.

Long-Term Exposure: Fluoride may increase bone density, stimulate new bone growth or cause calcium deposits in ligaments. This may become a problem at levels of 20−50 milligram per cubic meter or higher. May cause mottling of the bones or teeth at this level, resulting in fluorosis. May cause lung damage.

Points of Attack: Bones, lungs.

Medical Surveillance: Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. NIOSH lists the following tests: chest X-ray, electrocardiogram, pulmonary function tests: forced vital capacity, forced expiratory volume (1 second); pelvic X-ray; sputum cytology; urine (chemical/metabolite); urine (chemical/metabolite) pre- and postshift; urinalysis (routine); complete blood count/differential. DEXA bone densitometry scan.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. *Note to Physician:* Inject intravenously 10 mL of 10% calcium gluconate solution. Gastric lavage with lime water of 1% calcium chloride.

Personal Protective Methods: Use only with an effective and properly maintained exhaust ventilation or with a fully enclosed process. Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Remove any clothing that you think may have become chemically soiled and wash before reuse. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA *12.5 milligram per cubic meter:* Q_m (APF = 25) (any quarter-mask respirator).

25 milligram per cubic meter: 95XQ (APF = 10) *[any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or SA* (any supplied-air respirator). *62.5 milligram per cubic meter:* Sa: Cf (APF = 25) $^{*+}$ (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25)* *if not present as a fume* (any powered, air-purifying respirator with a high-efficiency particulate filter). *125 milligram per cubic meter:* 100F (APF = 50)$^{+}$ [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *250 milligram per cubic meter:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50)$^{+}$ [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or SCBAE (any appropriate escape-type, SCBA). *Substance reported to cause eye irritation or damage; may require eye protection. *May need acid gas sorbent.

Storage: (1) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. (2) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in a cool, dry area that is well-ventilated. Protect from damage. Avoid acids. Concentrated solution can be stored in glass, but lead is preferred.

Shipping: UN1778 Fluorosilicic acid, Hazard class: 8; Labels: 8-Corrosive material.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Enter only with protective clothing and devices. Treat with soda ash or slaked lime. Dilute with water. Use an industrial vacuum cleaner to remove the spill. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Material itself is not flammable. *Do not use water*. Use CO_2 or dry chemicals on surrounding fire. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers.

If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire-fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Add slowly to a large amount of soda ash in solution[22]. Discharge to sewer with large volumes of water.

References

(31); (173); (101); (138); (122); (100).

New York State Department of Health, *Chemical Fact Sheet:* Fluosilicic Acid, Bureau of Toxic Substance Assessment, Albany, NY (March 1986).

Flurazepam F:0390

Formula: $C_{21}H_{23}ClFN_3O$

Synonyms: 7-Chloro-1-[2-(diethylamino)ethyl]-5-(2-fluorophenyl)-1*H*-1,4-benzodiazepin-2(3*H*)-one; Dalmane; Felmane; Noctosom; Ro-5-6901/3; Stauroderm

CAS Registry Number: 17617-23-1

HSDB Number: 3085

RTECS Number: DF2368050; DF0875000

UN/NA & ERG Number: UN3249 (Medicines, toxic, solid, n.o.s.)/151

EC Number: 241-591-7

Regulatory Authority and Advisory Information

United States Department of Justice controlled substance [CFR 21 Part 1308.4 (Depressants)].

Hazard symbols, risk, & safety statements: Hazard symbol: T, F, Xn; risk phrases: R11; R22; R23/24/25; R33; R39/23/24/25; R51/53; safety phrases: S1/2; S7; S16; S22; S26; S36/37; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Flurazepam is a pale yellow crystalline solid. Molecular weight = 387.88; freezing/melting point = 79.5°C. Solubility in water; solubility = 500 mg/L.

Potential Exposure: A Drug. Flurazepam is used as a sedative in capsules or liquid form.

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Flurazepam can affect you when breathed in. Flurazepam is used as a medical depressant drug. When taken in that way, it can cause drowsiness and difficulty with coordination, concentration and balance. It can also cause irritability, anxiety, weakness, headache, upset stomach and joint pains. Effects may last for 1−3 days. It is not known for certain if these effects occur from occupational exposure. Drinking alcohol after exposure may worsen the symptoms caused by flurazepam. Person taking lithium (a medication), could have a serious reaction with flurazepam exposure.

Long-Term Exposure: Exposure to flurazepam may cause jaundice, skin rash, and a low white blood cell count. Similar compounds are known teratogens. Suddenly discontinuing exposure after high exposure for @ 3 months may cause shakiness, irritability, and convulsions.

Points of Attack: Blood, liver, skin.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: blood flurazepam level. CBC. Liver function tests. Evaluation by a qualified allergist.

First Aid: *Eye Contact:* Immediately remove any contact lenses and flush with large amounts of water for at least 15 minutes, occasionally lifting upper and lower lids.

Skin Contact: Remove contaminated clothing. Wash contaminated skin with water.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Store in tightly closed containers in a cool, well-ventilated area away from sources of heat. If you are required to work in a "sterile" environment you require special training.

Shipping: UN3249 Medicine, solid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use extinguishing agents suitable for surrounding fire. Thermal decomposition products may include chlorine and fluorine chemicals and nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: It is inappropriate and possibly dangerous to the environment to dispose of expired or waste drugs and pharmaceuticals by flushing them down the toilet or discarding them to the trash. Household quantities of expired or waste pharmaceuticals may be mixed with wet cat litter or coffee grounds, double-bagged in plastic, discard in trash. Larger quantities shall carefully take into consideration applicable DEA, EPA, and FDA regulations. If possible return the pharmaceutical to the manufacturer for proper disposal being careful to properly label and securely package the material. Alternatively, the waste pharmaceutical shall be labeled, securely packaged and transported by a state licensed medical waste contractor to dispose by burial in a licensed hazardous or toxic waste landfill or incinerator.

References
(31); (173); (101); (138); (100).
New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Flurazepam, Trenton, NJ (January 1986).

Fluridone F:03193

Formula: $C_{19}H_{14}F_3NO$

Synonyms: Avast; EL 171; Fluridon; 1-Methyl-3-phenyl-5-[3-(trifluoromethyl)phenyl]-4(1*H*)-pyridinone; Pride; 4(1*H*)-Pyridinone, 1-methyl-3-phenyl-5-[3-(trifluoromethyl) phenyl]-; Sonar; Sonar AS

CAS Number: 59756-60-4

HSDB Number: 6653

RTECS Number: UU77865000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 261-916-6

Regulatory Authority and Advisory Information

Carcinogenicity[83]: EPA Group E, Evidence of noncarcinogenicity for humans.

Hazard symbols, risk, & safety statements: Hazard symbol: N, Xn; risk phrases: R21; R22; R36/37/38; R51/53; safety phrases: S16; S26; S36/37; S45; S60; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [2-Hazard to water. (est.)]

Description: White to tan crystalline solid. Some commercial formulations are a light tan viscous liquid, possibly in a propylene glycol carrier. Slight odor. Molecular weight = 329.33; specific gravity (H_2O:1) = 1.15 @ 25°C; boiling point = 100°C; freezing/melting point = 154°C; vapor pressure = 1×10^{-7} mmHg @ 20°C; Flash point (liquid) = > 93.3°C; Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 0, reactivity 0. Low solubility in water. Physical and toxicological properties may be affected by carrier solvents in commercial formulations.

Potential Exposure: Organic fluoride herbicide used is horticulture, ornamental, aquatic and greenhouse environments. It is used as and auatic herbicide to treat large areas of water (lakes, ponds, reservoirs, etc.) for invasive Eurasian watermilfoil. Not used on food crops.

Incompatibilities: Decomposes in temperature >200°C. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Concentration in Water: Federal Drinking Water Standards (minimum reporting level) : EPA 0.90 μg/L[83]. State Drinking Water Guidelines: Florida 560 μg/L. *Fluoride ion*: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guidelines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg[F]/L. Safe Drinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg[F]/L; SMCL = 2 mg/F/L, as Fluoride.

Determination in Water: Octanol–water coefficient: $\text{Log } K_{ow} = < 2.0$. Unlikely to bioaccumulate in marine organisms. Fish toxicity (threshold)[101]: Very low—678.82839 ppb, MATC.

Harmful Effects and Symptoms

Short-Term Exposure: Contact with eyes or skin may cause irritation or injury. Inhalation should be avoided; use NIOSH- or CEN (UK)-approved air purifying respirators for pesticides. May be harmful if swallowed. LD_{50} (oral, rat) ≥ 5000 mg/kg; >10,000 mg/kg. Low toxicity.

Long-Term Exposure: Fluorides may cause bone disease (pain and tenderness of the bones); mottled teeth in children. Human toxicity (long term)[101]: Very low—560.00 ppb, Health Advisory.

Points of Attack: Bones.

Medical Surveillance: Preliminary medical exam to detect chronic diseases of central nervous system, liver, heart, kidneys, lung and skin, as well as end ocrinological or immunological disturbances, should protect susceptible individuals. Periodical medical exams of internal organs, skin and eyes are important to avoid chronic occupational intoxications. They should include lab and patch tests when necessary[83].

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Applicators and other handlers must wear: Coveralls worn over long-sleeved shirt and long pants; Chemical-resistant gloves such as Butyl rubber (0.4–0.7 mm thickness/ >480 minutes; DuPont Tychem suit fabrics, barrier laminate, or Viton; Chemical-resistant footwear plus socks; Protective eye wear; Chemical-resistant headgear for overhead exposure; Chemical-resistant apron when cleaning equipment, mixing, or loading[83]. Agricultural Use/Engineering Controls: When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the WPS for agricultural pesticides, 40 CFR 170.240(d) (4–6), the handler PPE requirements may be reduced or modified as specified in the

WPS. Firefighters should wear NIOSH approved SCBA and full protective clothing.

Respirator Selection: Specific respirator(s) have not been recommended by NIOSH. However, based on potential carcinogenicity, and where the potential exists for exposure, the following might be considered: *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any MSHA/NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100 F (APF = 50) (any air-purifying, full facepiece respirator with an N100, R100, or P100 filter) or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison. Store in a secure poison location. Store in a refrigerator and protect from exposure to oxidizers or moisture[52]. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Dampen spilled material with alcohol to avoid dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Decomposes >200°C. Thermal decomposition products may include hydrogen fluoride, carbon, and sulfur oxides. As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 m/150 ft for liquids and at least 25 m/75 ft for solids. *Fire involving storage or vehicular tanks:* Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. *On a small fire:* use dry chemical, CO_2, water spray or regular *foam. On a large fire:* use water spray, fog or regular foam. Do not scatter spilled material with high pressure streams of water. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal. *Fire involving tanks:* From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. Always stay away from tanks engulfed in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Safe Disposal of Pesticides. An empty pesticide container can be as hazardous as a full one because of residues left inside. Never reuse such a container. When empty, a pesticide container should be rinsed carefully three times and rinse the water thoroughly drained back onto the sprayer or the container previously used to mix the pesticide. Use the rinse water as a pesticide, following label directions. Replace the cap or closure securely. Dispose of the container according to label instructions. Do not puncture or burn a pressurized container like an aerosol—it could explode. Do cut or puncture other empty pesticide containers made of metal or plastic to prevent someone from reusing them. Wrap the empty container and put it in the trash after you have rinsed it[83]. Do not discharge into drains or sewers. Dispose of waste material as hazardous waste using a licensed disposal contractor to an approved landfill. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (122); (100).

United States National Library of Medicine, *ChemIDplus Advanced*, Bethesda MD, http://chem.sis.nlm.nih.gov/chemidplus/rn/59756-60-4.

Fluroxypyr F:0395

Formula: $C_7H_5Cl_2FN_2O_3$

Synonyms: Acetic acid [(4-amino-3,5-dichloro-6-fluoro-2-pyridinyl)oxy]-,1-methylheptyl ester; [(4-Amino-3,5-dichloro-6-fluoro-2-pyridinyl)oxy]acetic acid, 1-methylheptyl ester; 1-Methylheptyl [(4-amino-3,5-dichloro-6-fluoro-2-pyridinyl)oxy]acetate.

Methyl ester: Agrostar; Bofix FFC; Cabadex; Cascade; Dowco 433 mhe; Forefront; Galaxy gl184; Paradigm;

Pasturegard; Starane; Tomahawk; Vista; Widematch (fluroxypyr + clopyralid); XRM-5084

CAS Number: 69377-81-7; 81406-37-3 (1-methyheptyl ester)

HSDB Number: 6655

RTECS Number: AF2503000

UN/NA&ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: *[Annex I Index No.:* 607-255-00-2]; 279-752-9 *[Annex I Index No.:* 607-272-00-5] (-methy ester).

Regulatory Authority and Advisory Information

Carcinogenicity[83]: EPA, Not likely to be carcinogenic to humans.

European/International Regulations [69377-81-7; 81406-37-3 (1-methyheptyl ester)]: Hazard symbol: N; risk phrases: R52/R53; safety phrases: S2; S60; S61 (see Appendix 4)

Description: White crystalline solid. Molecular weight = 255.03; 367.23 (-methyl ester); specific gravity (H_2O:1) = 1.1 @ 25°C; boiling point = (decomposes); freezing/melting point = 232°C; vapor pressure = 4×10^{-6} mmHg @ 25°C. Highly soluble in water.

Potential Exposure: Those who manufacture, distribute or use this pyridinecarboxylic acid/pyridine herbicide.

Incompatibilities: May not be compatible with nitrates. Moisture may cause hydrolysis or other forms of decomposition; forming a strong acid. Temperatures above 250°C can cause decomposition. *Methyl ester*: Esters react with acids to liberate heat along with alcohols and acids. Strong oxidizing acids may cause a vigorous reaction that is sufficiently exothermic to ignite the reaction products. Heat is also generated by the interaction of esters with caustic solutions. Flammable hydrogen is generated by mixing esters with alkali metals and hydrides.

Determination in Water: Octanol−water coefficient: $\text{Log } K_{ow} = < 2.0$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, dermal and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Contact with eyes or skin may cause irritation or injury. Inhalation should be avoided; use NIOSH- or CEN (UK)-approved air purifying respirators for pesticides. May be harmful if swallowed. LD_{50} (oral, rat) = 2405−3650 mg/kg; LD_{50} (dermal, rat) = > 2 g/kg.

Long-Term Exposure: Possible kidney damage.

Points of Attack: Kidney, adrenal and testicular glands

Medical Surveillance: Preliminary medical exam to detect chronic diseases of central nervous system, liver, heart, kidneys, lung and skin, as well as endocrinological or immunological disturbances, should protect susceptible individuals. Periodical medical exams of internal organs, skin and eyes are important to avoid chronic occupational intoxications. They should include lab and patch tests when necessary[83].

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of dermal and/or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Wherever and whenever workplace conditions warrant respirator use, a respiratory protection program must be followed that meets one or more of the following government standards: OSHA's 29 CFR 1910.134, ANSI Z88.2, or European Standard EN 149.

Storage: Color code—Blue: Health Hazard/Poison. Store in a tightly closed container in a dry, well-ventilated and secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Where possible, automatically transfer material from other storage containers to process containers. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: If a spill occurs, clean it up promptly. Don't wash it away. Instead, sprinkle the liquid spill with sawdust, vermiculite, or kitty litter. Sweep it into a plastic garbage bag, and dispose of it as directed on the pesticide product label. Wash all contaminated surfaces with a soap and water solution.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen and carbon, hydrogen chloride and chlorine gases. As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 m/150 ft for liquids and at least 25 m/75 ft for solids. *Fire involving storage or vehicular tanks:* Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. *On a small* *fire:* use dry chemical, CO_2, water spray or regular *foam. On a large fire:* use water spray, fog or regular foam. Do not scatter spilled material with high pressure streams of water. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal. *Fire involving tanks:* From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. Always stay away from tanks engulfed in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office. Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers.

References

(31); (173); (101); (138).

United States Environmental Protection Agency, Office of Pesticide Programs, Pesticide Residue Limits, "Fluroxypyr 1-methylheptyl Ester", 40 CFR 180.535, http://www.epa.gov/pesticides/food/viewtols.htm.

Flurprimidol F:0396

Formula: $C_{15}H_{15}F_3N_2O_2$

Synonyms: Compound-72500; Cutless 50W; EL-500; α-Isopropyl-α-[*p*-(trifluoromethoxy)phenyl]-5-pyrimidine-methanol; α-(1-Methylethyl)-α-[4-(trifluoromethoxy)phenyl]-5-pyrimidinemethanol; α-(1-Methylethyl)-α-[4-(trifluoromethoxy)phenyl]-; 5-Pyrimidinemethanol, Topflor

CAS Number: 56425-91-3

RTECS Number: UV9283500

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: Not assigned

Regulatory Authority and Advisory Information

EPA Toxicity Class III, Caution, Slightly toxic

SARA Title III Acute Health Hazard

Hazard symbols, risk, & safety statements: Hazard symbol: Xn, N; risk phrases: R20/21/22; R62; R63; R51/53; safety phrases: S24/25; S36/37/39; S41; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [2-Hazard to waters (est.)]

Description: White to pale yellow or buff crystalline solid. Slight aromatic odor. Molecular weight = 312.29; specific gravity (H_2O:1) = 1.35 @ 25°C; boiling point = (decomposes); freezing/melting point = 94−96°C; flash point = 185°C; Autoignition temperature = < 300°C; UEL = 0.13 oz/ft.^{3}[SePRO MSDS] Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 0, reactivity 0. Moderately soluble in water.

Potential Exposure: Pyrimidine plant growth regulator Used on turf and ornamental trees which reduces internode and leaf elongation in cool and warm seasons. A turf grass growth deterrent.

Incompatibilities: Decomposes in temperatures above 200°C. May react with strong oxidizers such as chlorates, peroxides, nitrates, etc.

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 4000 µg[F]/L; Federal Drinking Water Guidelines: EPA 2000 µg[F]/L; State Drinking Water Standards: California 2000 µg[F]/L; Delaware 2000 µg[Fl]/L; Pennsylvania 2000 µg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 µg[F]/L; Maine 1680 µg [F]/L. Safe Drinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg[F]/L; SMCL = 2 mg/F/L, as Fluoride.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 3.3$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Harmful Effects and Symptoms

Short-Term Exposure: Contact with eyes or skin may cause irritation or injury. Inhalation should be avoided; use NIOSH- or CEN (UK)-approved air purifying respirators for pesticides. May be harmful if swallowed. LD_{50} (oral, rat) = 709−1250 mg/kg; LD_{50} (dermal, rabbit) = > 2000 mg/kg.

Long-Term Exposure: May be a liver and kidney toxicant.

Points of Attack: May affect liver, kidneys, adrenal and ovary glands

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Do not induce vomiting when formulations containing petroleum solvents are ingested

Personal Protective Methods: Applicators and other handlers must wear: Coveralls worn over long-sleeved shirt and long pants; Chemical-resistant gloves such as DuPont Tychem suit fabrics, barrier laminate, or Viton; Chemical-resistant footwear plus socks; Protective eye wear; Chemical-resistant headgear for overhead exposure; Chemical-resistant apron when cleaning equipment, mixing, or loading[72]. Agricultural Use/Engineering Controls: When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the WPS for agricultural pesticides, 40 CFR 170.240(d)(4−6), the handler PPE requirements may be reduced or modified as specified in the WPS. Firefighters should wear NIOSH approved SCBA and full protective clothing.

Respirator Selection: Where the neat test chemical is weighed and diluted, wear a NIOSH-approved half face respirator equipped with a combination filter cartridge, i.e., organic vapor/acid gas/HEPA (specific for organic vapors, HCl, acid gas, SO2 and a high efficiency particulate filter)[193]

Storage: Color code—Blue: Health Hazard/Poison. Store in a tightly closed container in a dry, well-ventilated and secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Where possible, automatically transfer material from other storage containers to process containers.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is partially combustible; it may burn but does not easily ignite; may support combustion at high temperatures. Use dry chemical powder extinguishers, foam, carbon dioxide. Thermal decomposition products may include oxides of nitrogen, carbon, hydrogen fluoride. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office. If this material cannot be disposed of according to label instructions, it may be dissolved or mixed with a combustible solvent and burned in a chemical incinerator equipped with an afterburner and scrubber. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Noncombustible containers should be crushed and buried under more than 40 cm of soil[30].

References

(31); (204); (122); (100).

Pesticide Management Education Program, *Flurprimidol (Cutless) EPA Pesticide Fact Sheet 2/89,* Cornell University, Ithaca, NY (February 1989). http://pmep.cce.cornell.edu/profiles/herb-growthreg/fatty-alcohol-monuron/flurprimidol/herb-prof-flurprimidol.html.

Fluvalinate F:0398

Formula: $C_{26}H_{22}ClF_3N_2O_3$

Synonyms: AI3-29426; Apistan; Caswell No. 934; *N*-2-Chloro-α,α,α-(trifluoro-*p*-tolyl)-*dl*-valinealpha-cyano-phenoxy benzyl ester; *N*-(2-Chloro-4-(trifluoromethyl)phenyl-*dl*-valine-cyano(3-phenoxylphenyl)methyl ester; *N*-[2-chloro-4-(trifluoromethyl)phenyl]-*dl*-valine(±)-cyano(3-phenoxylphenyl)methyl ester; (RS)-α-(Cyano-3-phenoxybenzyl *n*-(2-chloro-α,α,α-trifluoro-*p*-tolyl)-D-valinate; (RS)-α-Cyano-3-phenoxybenzyl (R)-2-[2-chloro-4-(trifluoromethyl)anilino]-3-methylbutanoate; Cyano(3-phenoxyphenyl)methyl *N*-[((2-chloro-4-trifluoromethyl)phenyl)]-D-valinate; Kartan; Klartan; Mavrik; Mavrik aquaflow; Spur; Taufluvalinate; DL-Valine,*n*-[2-chloro-4-(trifluoromethyl)phenyl]-cyano(3-phenoxylphenyl)methyl ester; D-Valine, *N*-(2-chloro-4-(trifluoromethyl)phenyl)-, cyano(3-phenoxyphenyl)methyl ester; Yarder; Zeocon; ZR 3210

CAS Number: 69409-94-5; 102851-06-9 (*tau*-T)

HSDB Number: 6659

RTECS Number: YV9397100

UN/NA & ERG Number: UN2902 (Pesticides, liquid, toxic, n.o.s)/151; UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

Regulatory Authority and Advisory Information

California Proposition 65 Chemical[102]: Developmental/Reproductive toxin (11/6/1998)

Hazard Alert: Poison, Suspected reprotoxic hazard, Possible sensitization hazard (skin), Possible endocrine disruptor, Reproductive toxin, Primary irritant (w/o allergic reaction), Environmental hazard.

Permissible Exposure Limits for Chemical Contaminants (CAL/OSHA) as pyrethrum

Clean water act: Section 311 Hazardous Substances/RQ (same as CERCLA) as pyrethrins.

EPA ADI: EPA Oral reference dose (RfD) = 0.01 mg/kg

EPCRA Section 313 Form R de minimis concentration reporting level: 1.0%

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292].

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xn, Xi: risk phrases: R36/37/38; R43; R50/53; R63; safety phrases: S7; S23; S26; S29/35; S35; S36; S39; S41; S45; S61(see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Yellow to yellow-amber, viscous oil. Sweet, weak odor. Molecular weight = 502.92; specific gravity (H_2O:1) = 1.30 @25°C; specific gravity (H_2O:1) = 1.29 @ 25°C; freezing/melting point = 25°C; vapor pressure = 1×10^{-7} mmHg @ 25°C. Henry's Law constant = 1.5×10^{-8} atm m^3/mol @ 25°C (est)[83]. Practically insoluble in water; solubility = 0.005 ppm @ 20−25°C.

Potential Exposure: Pyrethroid insecticide used as a broad spectrum insecticide to control moths, beetles and other pests on cereals, potatoes, fruit trees, vegetables, fleas, cotton, turf and ornamentals. It is also used to control varroa mites in honey bees. Some applications may be classified as a United States Environmental Protection Agency Restricted Use Pesticide (RUP). Formerly used as an insecticide. Production discontinued by Sandoz Agro, Inc[101].

Incompatibilities: Corrosive to some metals. Keep away from strong oxidizers and alkaline materials. Decomposes in temperatures above 350°C releasing toxic vapors of hydrogen chloride, nitrogen oxides, and hydrogen fluoride.

Permissible Exposure Limits in Air:

NIOSH[2] IDLH = 5000 ppm

OSHA PEL: 5 milligram per cubic meter TWA

NIOSH REL: 5 milligram per cubic meter TWA

ACGIH TLV[1]: 5 milligram per cubic meter TWA

STEL set by HSE[33] = 10 milligram per cubic meter.

Determination in Air: Collection by impinger or fritted bubbler, analysis by gas liquid chromatography/ultraviolet. See NIOSH IV, Method #5008[18], pyrethrum.

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guidelines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg [F]/L. Safe Drinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg[F]/L; SMCL = 2 mg/F/L, as Fluoride.

Permissible Concentration in Water: ADI = 0.02 mg/kg as pyrethroid

Determination in Water: Collection by impinger or fritted bubbler, analysis by gas liquid chromatography/ultraviolet. See NIOSH IV, Method #5008[18], pyrethrum. Octanol−water coefficient: Log $K_{ow} = > 3.5$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood. Fish toxicity (threshold)[101]: Extra high—0.09863 ppb, MATC.

Routes of Entry: Inhalation, absorbed through the skin

Harmful Effects and Symptoms

Short-Term Exposure: Pyrethrins can affect you when breathed in and by passing through your skin. Irritates the eyes and respiratory tract. High exposure can affect the nervous system causing headache, nausea, vomiting, fatigue, and restlessness, rhinorrhea (discharge of thin nasal mucous). LD_{50} (oral, rat) = < 300 mg/kg; LD_{50} (dermal, rat) = > 2 g/kg.

Long-Term Exposure: Fluorides may cause bone disease (pain and tenderness of the bones); mottled teeth in children. High or repeated exposure can cause lung allergy (with cough, wheezing and/or shortness of breath) or hay fever symptoms (sneezing, runny or stuffy nose). Allergic "pneumonia" can also occur with cough, chest pain, breathing difficulty and abnormal chest X-ray. Repeated attacks may lead to permanent scarring. Skin allergy may also develop with rash and itching, even with lower exposures. Dermal contact can cause rash with redness, blisters and intense itching. A severe generalized allergy can occur with weakness and collapse. May be a liver and kidney toxin. Human toxicity (long term)[101]: Low—70.00 ppb, Health Advisory

Points of Attack: Respiratory system, skin, central nervous system, kidneys, liver, bones.

Medical Surveillance: Comprehensive physical examination with emphasis on the genito-urinary tract analysis to include sperm count, motility and morphology. Other tests, such as serum testosterone, serum FSH, and serum LH, may be carried out if, in the opinion of a physician, they are indicated. Before beginning employment and at regular times after that, the following are recommended: Employees should be screened for history of certain medical conditions which might place the employee at increased risk from pyrethroid exposure. Chronic respiratory disease: In persons with chronic respiratory disease, especially asthma, the inhalation of pyrethroids might cause exacerbation of symptoms due to its sensitizing properties. Lung function tests. These may be normal if the person is not having an attack at the time of the test. Consider chest X-ray if lung symptoms are present. Skin disease: Pyrethroids can cause dermatitis which may be allergic in nature. Persons with preexisting skin disorders may be more susceptible to the effects of this agent. Evaluation by a qualified allergist, including exposure history and testing, may help diagnose allergy. Any employee developing the above-listed conditions should be referred for further medical examination[9].

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately.

If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. *Do not induce vomiting when formulations containing petroleum solvents are ingested*. Otherwise, give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Applicators and other handlers must wear: Coveralls worn over long-sleeved shirt and long pants; Chemical-resistant gloves such as DuPont Tychem suit fabrics, barrier laminate, or Viton; Chemical-resistant footwear plus socks; Protective eye wear; Chemical-resistant headgear for overhead exposure; Chemical-resistant apron when cleaning equipment, mixing, or loading[83]. Agricultural Use/Engineering Controls: When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the WPS for agricultural pesticides, 40 CFR 170.240(d)(4–6), the handler PPE requirements may be reduced or modified as specified in the WPS. Firefighters should wear NIOSH approved SCBA and full protective clothing.

Respirator Selection: NIOSH/OSHA *for pyrethrum*: *50 milligram per cubic meter:* CcrOv95 (APF = 10) [any air-purifying half-mask respirator equipped with an organic vapor cartridge(s) in combination with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator).*125 milligram per cubic meter:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOvHie (APF = 25) (any air-purifying full facepiece respirator equipped with an organic vapor cartridge in combination with a high-efficiency particulate filter).*250 milligram per cubic meter:* CcrFOv100 (APF = 50) [any air-purifying full facepiece respirator equipped with organic vapor cartridge(s) in combination with an N100, R100, or P100 filter]; or PaprTOvHie (APF = 50) [any powered, air-purifying respirator with a tight-fitting facepiece and organic vapor cartridge(s) in combination with a high-efficiency particulate filter]; or SCBAF (APF = 50) (any SCBA with full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece).*5000 milligram per cubic meter:* SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—Blue: Health Hazard/Poison. Store in a secure poison location at temperature <35°C and away from alkaline materials. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN2902 Pesticides, liquid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: First remove all sources of ignition. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Ventilate area of spill or leak. Use water spray to reduce vapor. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include hydrogen chloride, hydrogen fluoride gas and oxides of nitrogen and carbon. *On a small fire:* use dry chemical, CO_2 or water spray. On a large fire: use water spray, fog or regular foam. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal; do not scatter the material. Use water spray or fog; do not use straight streams. *Fire involving storage or vehicular tanks:* Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Do not get water inside containers. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. ALWAYS stay away from tanks engulfed in fire. For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies.

Disposal Method Suggested: Incineration would be an effective disposal procedure where permitted. If an efficient incinerator is not available, the product should be mixed with large amounts of combustible material and contact with the smoke should be avoided. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers.

References

(173); (101); (138); (102); (31); (122); (100).

EXTOXNET, Extension Toxicology Network, "Pesticide Information Profile, Fluvalinate," Oregon State University, Corvallis, OR (June 1996). http://extoxnet.orst.edu/pips/fluvalin.htm.

United States Environmental Protection Agency, Office of Pesticide Programs, Pesticide Residue Limits, "Fluvalinate," 40 CFR 180.427, http://www.epa.gov/pesticides/food/viewtols.htm.

Fomesafen F:0399

Formula: $C_{15}H_{10}ClF_3N_2O_6S$

Synonyms: BAS 53004; Benzamide, 5-[2-chloro-4-(trifluoromethyl)phenoxy]-*N*-(methylsulfonyl)-2-nitro-; 5-[2-Chloro-4-(trifluoromethyl)phenoxy] -*N*-methylsulfonyl)-2-nitrobenzamide; 5-(2-Chloro-α,αα-trifluoro-*p*-tolyloxy)-*N*-methylsulfonyl-2-nitrobenzamide; 5-[2-Chloro-4-(trifluoromethyl) phenoxy]-*N*-(methylsulphonyl)-2-nitrobenzamide; Faster; Flex; Flexstar; Fomesafen sodium; PP 021; Reflex; Reflex 2lC herbicide (sodium salt); Tornado; Twiste; Typhoon

CAS Number: 72178-02-0; 108731-70-0 (sodium salt)

HSDB Number: 6660

RTECS Number: CV2475000

UN/NA & ERG Number: UN2588 (Pesticides, solid, toxic, n.o.s.)/151

EC Number: 276-439-9 [*Annex I Index No.:* 604-040-00-5]

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Poison inhalation hazard (in fire), Agricultural chemical. Listed for Tier 1 screening as an endocrine disruptor[88].

California EPA AB2588-Air Toxics "Hot Spots" Chemicals (CAL) as chlorophenoxy pesticides

Safe Drinking Water Act (47FR 9352): Priority List (55 FR 1470)

EPCRA Section 313 Form R de minimis concentration reporting level: 1.0%

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xn; risk phrases: R22; safety phrases: S2; S41 (see Appendix 4)

Description: White crystalline solid or powder. Molecular weight = 438.76; specific gravity (H_2O:1) = 1.29 @ 20°C; freezing/melting point = 220°C; Disassociation constant = p*K*a 2.827; vapor pressure = 3.5×10^{-5} mmHg @ 25°C; Henry's Law constant = 7.53×10^{-13} atm m^3/mol @ 25°C (est)[83]. Moderately soluble in water; solubility = 60 mg/L @ 25°C.

Potential Exposure: Chlorophenoxy herbicide. After July 25, 2003, flumesafen was not permitted in many countries to be used as an active ingredient on crops except to control weeds in soybean crops, and white, kidney and snap beans. Limited use allowed in some European countries.

Incompatibilities: Slowly hydrolyzes in water, releasing ammonia and forming acetate salts.

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guidelines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg [F]/L. Safe Drinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg[F]/L; SMCL = 2 ***mg/F/L, as Fluoride***.

Determination in Water: EPA Method D3086. GC method with ECD for the determination of organochlorine pesticides in water and wastewater. Octanol−water coefficient: Log K_{ow} = negative. Unlikely to bioaccumulate in marine organisms. Fish toxicity (threshold)[101]: (sodium salt) Very low—69325.01943 ppb, MATC.

Routes of Entry: Inhalation, ingestion, absorbed through the skin

Harmful Effects and Symptoms

Short-Term Exposure: Poisonous; may be fatal if inhaled, swallowed, or absorbed through skin. Severely irritates eyes, skin and respiratory tract, with burning sensation, pain, redness and swelling. Metabolic stimulant. If inhaled, causes coughing, dilated pupils, headache, profuse perspiration, intense thirst, extreme fatigue, rapid pulse, high fever, clammy, flushed skin, rapid breathing, nausea, vomiting, cyanosis (bluish tint to skin and lips), anxiety and confusion, convulsions, risk of lung edema. If swallowed, face and lips turn bluish. Liver injury with associated jaundice, kidney failure, and cardiac arrhythmias are commonly noted. Nerve damage, which may be delayed, may include swelling of legs and feet, muscle twitch and stupor. Severe exposure can cause death from heart failure. Dust or liquid left in contact with the skin for several hours may be absorbed. This may result in severe delayed symptoms as listed above. These symptoms may last for months or years. LD_{50} (oral, rat) = 1−2 g/kg; LD_{50} (dermal, rat) = 1 g/kg.

Long-Term Exposure: Fluorides may cause bone disease (pain and tenderness of the bones); mottled teeth in children. Workers exposed to chlorophenoxy compounds over a five to ten-year period at levels above 10 milligram per cubic meter complained of weakness, rapid fatigue, headache and vertigo. Liver damage, low blood pressure and slowed heartbeat were also found. Based on animal tests, may affects human reproduction. Human toxicity (long term)[101]: (sodium salt) High—1.75 ppb, Health Advisory.

Points of Attack: Eyes, skin, respiratory system, central nervous system, cardiovascular system, liver, kidney, bones.

Medical Surveillance: Preliminary medical exam to detect chronic diseases of central nervous system, liver, heart, kidneys, lung and skin, as well as endocrinological or immunological disturbances, should protect susceptible individuals. Periodical medical exams of internal organs, skin and eyes are important to avoid chronic occupational intoxications. They should include lab and patch tests when necessary[83]. The following may be useful: Liver and renal/kidney function tests. Exam of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. *Do not induce vomiting when formulations containing petroleum solvents are ingested*. Otherwise, give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of dermal and/or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. DuPont Tychem suit fabrics[88] All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where the neat (undiluted) test chemical is weighed and diluted, wear a NIOSH-approved half face respirator equipped with an organic vapor/acid gas cartridge (specific for organic vapors: Hydrogen chloride, acid gas and SO_2) with a dust/mist filter. Wherever and whenever workplace conditions warrant respirator use, a respiratory protection program must be followed that meets one or more of the following government standards: OSHA's 29 CFR 1910.134, ANSI Z88.2, or European Standard EN 149.

Storage: Color code—Blue: Health Hazard/Poison. Store in a secure poison location. Prior to working with fomesafen all handlers should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers and heat. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN2588 Pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: For leaks or spills, use water spray to disperse vapor and to flush spills. Liquid containing this material should be absorbed in vermiculite, dry sand; earth. Do not touch spilled material; stop leak if you can do it without risk. Establish forced ventilation to keep levels below explosive limit. *Small dry spills*: collect powdered material in the most convenient and safe manner and deposit in sealed containers; move containers from spill area. *Large spills*: dike far ahead of spill for later disposal. Keep unnecessary people away; isolate hazard area and deny entry. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include hydrogen chloride, hydrogen fluoride and oxides of nitrogen and carbon. As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 m/150 ft for liquids and at least 25 m/75 ft for solids. *Fire involving storage or vehicular tanks:* Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m (1/2 mile) in all directions. *On a small fire:* use dry chemical, CO_2, water spray or regular *foam. On a large fire:* use water spray, fog or regular foam. Do not scatter spilled material with high pressure streams of water. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal. *Fire involving tanks:* From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. Always stay away from tanks engulfed in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Do not discharge into drains or sewers. Dispose of waste material as a hazardous waste in a landfill approved and licensed for the disposal of pesticides. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Incineration with effluent gas scrubbing is recommended. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (122).

United States Environmental Protection Agency, Office of Pesticide Programs, Pesticide Residue Limits, “Fomesafen sodium salt”, 40 CFR 180.433, http://www.epa.gov/pesticides/food/viewtols.htm.

Fonofos F:0400

Formula: $C_{10}H_{15}OPS_2$; $C_6H_5SPS(OC_2H_5)C_2H_5$

Synonyms: *O*-Aethyl-*S*-phenyl-aethyl-dithiophosphonat (German); Capfos; Cudgel; Difonate; Double down; Dyfonate; Dyphonate; ENT 25,796; *O*-Ethyl *S*-phenyl ethyldithiophosphonate; *O*-Ethyl *S*-phenyl (RS)-ethylphosphonodithioate; *O*-Ethyl *S*-phenyl ethylphosphonodithioate; Fonophos; N-2790; Phosphonodithioic acid, ethyl-*O*-ethyl, *S*-phenyl ester

CAS Registry Number: 944-22-9

HSDB Number: 1717

RTECS Number: TA5950000

UN/NA & ERG Number: (PIH) UN2783 (organophosphorus pesticides, solid, toxic)/152

EC Number: 213-408-0 [*Annex I Index No.:* 015-091-00-2]

Regulatory Authority and Advisory Information

United States Environmental Protection Agency Gene-Tox Program, Negative: Histidine reversion-Ames test; Negative: In vitro UDS-human fibroblast; TRP reversion; Negative: *S. cerevisiae-homozygosis*; Inconclusive: *B. subtilis* rec assay; *E. coli polA* without S9.

Hazard Alert: Poison inhalation hazard: exposure can be lethal, Neurotoxin (cumulative), Flammable, Suspected reprotoxic hazard, Environmental hazard.

United States Environmental Protection Agency, FIFRA 1998 Status of Pesticides: Unsupported

Banned or Severely Restricted (in agriculture) (Malaysia, E. Germany) (UN)[13]

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500 lb (227 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 500 lb (227 kg)

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

United States DOT 49CFR172.101, Inhalation Hazard Chemical as organophosphates.

Note: Classified for restricted use for direct supervision of a certified applicator.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, F, N; risk phrases: R10; R27/28; R33; R50/53; safety phrases: S1/2; S28; S36/37; S41; S45; S50; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)]

Description: Fonofos is a pale yellow liquid with a pungent, mercaptan-like odor. Molecular weight = 246.34; boiling point = 130°C @ 0.1 mm; freezing/melting point = 30°C; vapor pressure = 0.0003 mmHg @ 20°C; flash point = 93.9°C (cc). Hazard identification (based on NFPA-704 M Rating System): Health 4, flammability 2, reactivity 0. Insoluble in water.

Potential Exposure: A potential danger to those involved in the manufacture, formulation and application of this soil insecticide which is used for control of corn rootworms, wireworms, cutworms, symphylins, and other soil pests.

Incompatibilities: Strong acids, alkalies.

Permissible Exposure Limits in Air

OSHA PEL: None. However, the vacated 1989 OSHA PEL 0.1 milligram per cubic meter TWA [skin] is currently enforced in some states. NIOSH REL: 0.1 milligram per cubic meter TWA [skin]

ACGIH TLV[1]: 0.01 milligram per cubic meter TWA inhalable fraction and vapor [skin]; not classifiable as a human carcinogen; BEI_A issued for Acetylcholinesterase inhibiting pesticides

PAC Ver. 29[138]

PAC-1: 0.3 milligram per cubic meter

PAC-2: 1.3 milligram per cubic meter

PAC-3: 53 milligram per cubic meter

Australia: TWA 0.1 milligram per cubic meter [skin], 1993; Belgium: TWA 0.1 milligram per cubic meter [skin], 1993; Denmark: TWA 0.1 milligram per cubic meter [skin], 1999; France: VME 0.1 milligram per cubic meter [skin], 1999; Switzerland: MAK-W 0.1 milligram per cubic meter [skin], 1999; the Netherlands: MAC-TGG 0.1 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Several states have developed guidelines or standards for fonofos in ambient air[60] ranging from 1.0 μ/m^3 (North Dakota) to 2.0 μ/m^3 (Connecticut, Nevada and Virginia).

Determination in Air: OSHA versatile sampler-2; Toluene/Acetone; Gas chromatography/Flame photometric detection for sulfur, nitrogen, or phosphorus; NIOSH Analytical Method (IV) #5600, Organophosphorus Pesticides.

Permissible Concentration in Water: The EPA has developed health advisories for fonofos as follows: long term health advisory is 70 μg/L and lifetime health advisory is 14 μg/L (See “References” Below).

(31); Determination in Water: Fish Tox = 3.50002000 ppb (HIGH)(100).

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Symptoms include nausea, vomiting, abdominal cramps; diarrhea, excessive salivation; headache, giddiness, vertigo, sensation of tightness in chest; blurring of vision; ocular pain; loss of muscle coordination; slurring of speech; muscle twitching; drowsiness, excessive secretion of respiratory tract mucous; and convulsions. This material is a cholinesterase inhibitor. It can cause severe symptoms and death from respiratory arrest. LD_{50} (oral-rat) = 3 mg/kg (extremely toxic). Exposure above the airborne exposure limit may result in death. The effects may be delayed. Medical observation is recommended. Human Tox (ppb): 10.00000 (INTERMEDIATE).

Long-Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. Fonofos may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system; central nervous system; cardiovascular system, blood cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures over *0.1 milligram per cubic meter*, use an NIOSH/MSHA or European Standard EN 149-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use an NIOSH/MSHA or European Standard EN 149-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool area.

Shipping: UN2783 Organophosphorus pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling:

Initial isolation and protective action distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30

Then: Protect persons downwind (mi/km)

Day 0.3/0.4

Night 0.8/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 600/200

Then: Protect persons downwind (mi/km)

Day 1.4/2.3

Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Do not touch spilled material. Do not breathe vapors. Stay upwind; keep out of low areas. Remove all ignition sources. Ventilate area of spill or leak. This material is a combustible liquid. For a spill or leak of a combustible liquid, shut off ignition sources; no flares, smoking or flames in hazard area. Stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of phosphorus, sulfur, nitrogen and carbon. Use dry chemical, carbon dioxide; water spray, fog, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: This phosphono compound is reported to be satisfactorily decomposed by hypochlorite. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (80).

United States Environmental Protection Agency, Chemical Hazard Information Profile: *Fonofos*, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

United States Environmental Protection Agency, *Alert: Fonofos*, Washington, DC, Office of Drinking Water (August 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Fonofos,* Trenton, NJ (April 1999).

Forchlorfenuron F:0405

Formula: $C_{12}H_{10}ClN_3O$

Synonyms: *N*-(2-Chloro-4-pyridinyl)-*N*′-phenylurea; 1-(2-Chloro-4-pyridyl)-3-phenylurea; CN-11-3183 CPPU; KT-30; *N*-Phenyl-*N*′-(2-chloro-4-pyridyl)urea; SKW 20010; Urea, *N*-(2-chloro-4-pyridinyl)-*N*’-phenyl-

CAS Number: 68157-60-8

HSDB Number: 7983

RTECS Number: YS7182500

UN/NA & ERG Number: UN2767 (Phenyl urea pesticides, solid, toxic)/151

EC Number: [*Annex I Index No.:* 613-254-00-8]

Regulatory Authority and Advisory Information

Carcinogenicity: GHS H351, Category 2, Suspected human carcinogen.

Hazard Alert: Agricultural chemical, Environmental hazard.

EPA Acute reference dose (ARfD) = 0.1 mg/kg/day

Hazardous to aquatic life or environment, with possible long-lasting effects[293]. Toxic to aquatic life with long-lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: Xn, N; risk phrases: R40; R20/21/22; R51/R53; safety phrases: S2; S29/35; S36/37; S46; S61; S41; S46; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to waters

Description: White to faint yellow crystalline powder. Molecular weight = 247.69; specific gravity (H_2O:1) = 1.415 @ 25°C; freezing/melting point = 170−172°C; vapor pressure = very low, 4×10^{-10} mmHg @ 25°C; flash point = > 200°C (cc); low solubility in water.

Potential Exposure: Phenylurea/substituted urea plant growth regulator widely used in agriculture on fruits to increase their size, to promote cell division, and to improve the quality and the yield of fruits, especially table grapes, grape raisins, and kiwi fruit. In some parts of California, forchlorfenuron is reputed to double the size of Thompson seedless grapes and delay crop maturity up to several weeks.

Incompatibilities: May react with strong oxidizers such as chlorates, peroxides, nitrates, etc. Dust may form explosive mixture with air.

Determination in Water: Octanol−water coefficient: Log K_{ow} = > 3.0. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, dermal contact, ingestion

Harmful Effects and Symptoms

Short-Term Exposure: Contact with eyes or skin may cause irritation or injury. Inhalation can cause irritation of the lungs and respiratory tract; May be harmful if swallowed. Dermal contact may cause severe irritation or burns. LD_{50} (oral, rat) = 4904 mg/kg[83]; LD_{50} (dermal, rat) = > 2 g/kg.

Long-Term Exposure: Fluorides may cause bone disease (pain and tenderness of the bones); mottled teeth in children. May cause emphysema, weight loss.

Points of Attack: Respiratory system, bones.

Medical Surveillance: This chemical is a suspected or known human carcinogen. Exposed persons should contact a physician for advice regarding the possible long term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Lung function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water. Do not induce vomiting when formulations containing petroleum solvents are ingested. Do not make an unconscious person vomit.

Personal Protective Methods: Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000): (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus). *Escape*: GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison. Store in a secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Store in a refrigerator or a cool, dry place and protect from exposure to ultraviolet light. Keep liquid away from oxidizers. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN2767 Phenyl urea pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: *Dry material:* First remove all sources of ignition. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Dampen spilled material with 60–70% acetone and avoid airborne dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Liquid: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Oil-skimming equipment may be used to remove slicks from water. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include hydrogen fluoride and nitrogen oxides. As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 m/150 ft for liquids and at least 25 m/75 ft for solids. *Fire involving storage or vehicular tanks:* Isolate for 800 m/0.5 mile in all directions; also, consider initial evacuation for 800 m/0.5 mile in all directions. *On a small fire:* use dry chemical, CO_2, water spray or regular *foam. On a large fire:* use water spray, fog or regular foam. Do not scatter spilled material with high pressure streams of water. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal. *Fire involving tanks:* From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. Always stay away from tanks engulfed in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters.

Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office. If this material cannot be disposed of according to label instructions, it may be dissolved or mixed with a combustible solvent and burned in a chemical incinerator equipped with an afterburner and scrubber. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Office of Pesticide Programs, Pesticide Residue Limits, "Forchlorfenuron", 40 CFR 180.569, http://www.epa.gov/pesticides/food/viewtols.htm.

Formaldehyde F:0410

Formula: CH_2O; HCHO

Synonyms: Aldehyde formique (French); BFV; Dynoform; FA; Fannoform; Formaldehido (Spanish); Formalin; Formalin 40; Formalina (Spanish); Formaline (German); Formalin-loesungen (German); Formalith; Formic aldehyde; Formol; Fyde; Hercules 37M6-8; Hoch; Ivalon; Karsan; Low dye-fast dry ink; Lysoform; Magnifloc 156C flocculant; Meethanal; Methyl aldehyde; Methylene glycol; Methylene oxide; Morbicid; NCI-C02799; Oxomethane; Oxymethylene; Polyoxymethylene glycols; Steriform; Superlysoform; Tetraoxymethylene; Trioxane

CAS Registry Number: 50-00-0; *(alt.)* 8005-38-7; *(alt.)* 8006-07-3; *(alt.)* 8013-13-6; *(alt.)* 112068-71-0

HSDB Number: 164

RTECS Number: LP8925000

UN/NA & ERG Number: UN2209 (solutions, with not <25% formaldehyde)/132; UN1198 (flammable solutions)/132; UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 200-001-8 [*Annex I Index No.:* 605-001-00-5]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 15,000 (≥1.00% concentration).

Carcinogenicity: NTP (*gas*): NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Human Limited Evidence, animal Sufficient Evidence, *probably carcinogenic to humans*, Group 2A, 1995; EPA: Limited evidence of carcinogenicity based on epidemiologic studies; NIOSH: Potential occupational carcinogen; OSHA: potential workplace carcinogen. United States Environmental Protection Agency Gene-Tox Program, Positive: Carcinogenicity-mouse/rat; Positive: *D. melanogaster*-reciprocal translocation; Positive: *N. crassa*-reversion; *E. coli polA* without S9; Positive: *D. melanogaster* sex-linked lethal; Positive: *S. cerevisiae* gene conversion; *S. cerevisiae*-reversion; Inconclusive: In vitro UDS-human fibroblast; Inconclusive: CHO gene mutation.

California Proposition 65 Chemical[102]: Cancer 1/1/1988.

Hazard Alert: Poison, Flammable, Highly toxic gas, Highly flammable gas, Corrosive solution, Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated, Possible risk of forming tumors, Reproductive toxin: possible risk of gene damage/impaired fertility; Suspected reprotoxic hazard, Sensitization hazard, Primary irritant (w/o allergic reaction), Polymerization hazard.

Banned or Severely Restricted (several countries) (UN)[13]

United States Environmental Protection Agency, FIFRA 1998 Status of Pesticides: Supported

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR 1910.1048)

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); Accidental Release Prevention/Flammable Substances (Section 112[r], Table 3), TQ = 15,000 lb (6810 kg)

OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 1000 lb (450 kg)

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U122

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500 lb (227 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)

EPCRA Section 313 Form R de minimis concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazardous to aquatic life or environment, with possible long-lasting effects.[291] Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, F+, Xi; risk phrases: R45; R5; R12; R19; R21; R23/24/25; R34; R40; R43; R61; R62; R63; safety phrases: S1/2; S9; S26; S33; S36/37/39; S38; S45; S51; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Formaldehyde is a colorless, pungent gas or aqueous solution. The Odor Threshold is 0.8 ppm[41]. Also, formalin is an aqueous solution that is 37% formaldehyde by weight; inhibited solutions (added to prevent polymerization) usually contain 6−12% methyl alcohol. Molecular weight = 30.30; specific gravity (H_2O:1) = 0.78; (formalin) 1.08 @ 25°C; Boiling point (gas) = −19.5°C. The 37% commercial solution BP = 101°C; Freezing/Melting point = −92.2°C; Relative vapor density (air = 1) = 1.04; vapor pressure = > 1 atm; flash point = Flammable gas; (formalin) 85°C; (commercial 37% solution, 15% methanol) 50°C; Autoignition temperature = 430°C. Explosive limits (gas): LEL = 7.0%; UEL: 73.0%. NFPA 704 M Hazard identification (gas): Health 3, flammability 4, reactivity 0; (37% solution, 15% methanol): Health 3, flammability 2, reactivity 2. Good solubility in water.

Potential Exposure: Formaldehyde has found wide industrial usage as a fungicide, germicide; and in disinfectants and embalming fluids. It is also used in the manufacture of artificial silk and textiles, latex, phenol, urea, thiourea and melamine resins; dyes, and inks; cellulose esters and other organic molecules; mirrors, and explosives. It is also used in the paper, photographic, and furniture industries. It is an intermediate in drug manufacture and is a pesticide intermediate.

Incompatibilities: Pure formaldehyde may polymerize unless properly inhibited (usually with methanol). May form explosive mixture with air. Incompatible with strong acids; amines, strong oxidizers; alkaline materials; nitrogen dioxide; performic acid; phenols, urea. Reaction with hydrochloric acid forms bis-chloromethyl ether, a carcinogen. Formalin is incompatible with strong oxidizers, alkalis, acids, phenols, urea, oxides, isocyanates, caustics, anhydrides.

Permissible Exposure Limits in Air

NIOSH IDLH = 20 ppm

Conversion factor: 1 ppm = 1.23 milligram per cubic meter.

OSHA PEL: 0.75 ppm TWA; 2 ppm STEL, suspected carcinogen, see 29CFR1910.1048(c).

NIOSH REL: 0.016 ppm TWA; 0.1 ppm Ceiling Concentration [15 min.]; potential carcinogen. Limit exposure to lowest feasible level, See *NIOSH Pocket Guide*, Appendix A

ACGIH TLV[1] 0.3 ppm/0.37 milligram per cubic meter; sensitizer; Ceiling Concentration, Suspected Human Carcinogen

PAC* Ver. 29[138]

PAC-1: $\mathbf{0.90_A}$ ppm

PAC-2: $\mathbf{14_A}$ ppm

PAC-3: $\mathbf{56_A}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60-minute values.

DFG MAK: 0.3 ppm/0.37 milligram per cubic meter TWA; Peak Limitation Category I(2) a momentary value of 1 ppm/1.2 milligram per cubic meter should not be exceeded; [skin: danger of sensitization]; Carcinogen Category 4; Pregnancy Risk Group C

Arab Republic of Egypt: TWA 2 ppm (3 milligram per cubic meter), 1993; Australia: TWA 1 ppm (1.5 milligram per cubic meter); STEL 2 ppm, carcinogen, 1993; Austria: MAK 0.5 ppm (0.6 milligram per cubic meter), Suspected: carcinogen, 1999; Belgium: TWA 1 ppm (1.2 milligram per cubic meter); STEL 2 ppm, carcinogen, 1993; Denmark: TWA 0.3 ppm (0.4 milligram per cubic meter), 1999; France: VME 0.5 ppm, VLE 1 ppm, carcinogen, 1999; Hungary: STEL 0.6 milligram per cubic meter, carcinogen, 1993; the Netherlands: MAC-TGG 1.5 milligram per cubic meter, 2003; Norway: TWA 0.5 ppm (0.6 milligram per cubic meter), 1999; the Philippines: TWA 5 ppm (6 milligram per cubic meter), 1993; Poland: MAC (TWA) 0.5 milligram per cubic meter, MAC (STEL) 1 milligram per cubic meter, 1999; Russia: TWA 0.5 ppm; STEL 0.5 milligram per cubic meter [skin], 1993; Sweden: NGV 0.5 ppm (0.6 milligram per cubic meter), TGV 1 ppm (1.2 milligram per cubic meter) [skin], 1999; Switzerland: MAK-(W) 0.5 ppm (0.6 milligram per cubic meter), KZG-(W) 1 ppm (1.2 milligram per cubic meter), 1999; Thailand: TWA 3 ppm; STEL 5 ppm, 1993; Turkey: TWA 5 ppm (6 milligram per cubic meter), 1993; United Kingdom: TWA 2 ppm (2.5 milligram per cubic meter), carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Ceiling Concentration 0.3 ppm (sensitizer).Russia has also set MAC values for ambient air in residential areas of 0.035 milligram per cubic meter on a momentary basis and 0.012 milligram per cubic meter on a daily average basis,[43] also cited as 0.003 milligram per cubic meter[35]. Several states have set guidelines or standards for formaldehyde in ambient air[60] ranging from 0 (North Carolina and North Dakota) to 0.77 μ/m^3 (Massachusetts) to 5.0 μ/m^3 (New York) to 7.2 μ/m^3 (Pennsylvania) to 7.5 μ/m^3 (South Carolina) to 12.0 μ/m^3 (Connecticut, South Dakota and Virginia) to 18.0 μ/m^3 (Indiana) to 71.0 μ/m^3 (Nevada) to 75.0 μ/m^3 (Washington).

Determination in Air: Use NIOSH (IV), Method #2016, #2541, #3500, #3800. OSHA Analytical Method ID-205, ID-52.

Permissible Concentration in Water: EPA[32] has suggested a permissible ambient goal of 41.4 μg/L based on health effects. Russia set a MAC in water bodies used for domestic purposes of 0.01 mg/L[43] also quoted as 0.05 mg/L[35]. Further, they have set a MAC in water bodies used for fishery purposes of 0.25 mg/L. Several states have set guidelines for formaldehyde in drinking water[61] ranging from 0.7 μg/L (New Jersey)[59] to 10.0 μg/L (Maryland) to 30.0 μg/L (California and Maine).

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Corrosive to the eyes, skin, and respiratory tract. Acute exposure to formaldehyde may result in burns to the skin, eyes, and mucous membranes; lacrimation (tearing), nausea, vomiting (may be bloody); abdominal pain; and diarrhea. Difficulty in breathing; cough, pneumonia, and pulmonary edema may occur. Sensitized people may experience asthmatic reactions, even when exposed briefly. Hypotension (low blood pressure) and hypothermia (reduced body temperature) may precede cardiovascular collapse. Lethargy, dizziness, convulsions, and coma may be noted. Nephritis (inflammation of the kidneys), hematuria (bloody urine), and liver toxicity have been reported. Exposure at concentrations well above the PEL may cause death. The effects may be delayed. *Note:* There is considerable individual variation in sensitivity to formaldehyde.

Inhalation: Irritation of the nose and throat can occur after an exposure of 0.25−0.45 ppm. Levels between 0.4 ppm and 0.8 ppm can give rise to coughing and wheezing, tightness of the chest and shortness of breath. Sudden exposures to concentrations of 4 ppm may lead to irritation of lung and throat severe enough to give rise to bronchitis and laryngitis. Breathing may be impaired at levels above 100 ppm and serious lung damage may occur @ 50 ppm. *Skin:* Direct contact with the liquid can lead to irritation, itching, burning and drying. It is also possible to develop an allergic reaction to the compound following exposure by any route. *Eyes:* Exposure to airborne levels of formaldehyde of 0.4 ppm have brought on tearing and irritation. Small amounts of liquid splashed in the eye can cause damage to the cornea. Eye irritation was reported at levels between 0.05 and 2.0 ppm. *Ingestion:* As little as 1 liquid ounce has resulted in death to humans. Smaller amounts can damage the throat, stomach and intestine resulting in nausea, vomiting, abdominal pain and diarrhea. Accidental exposure may also cause loss of consciousness; lowered blood pressure; kidney damage and, if the person is pregnant, the possibility of the fetus being aborted. LD_{50} (rat, inhalation) = < 1 ppm.

Long-Term Exposure: Inhalation can result in respiratory congestion with associated coughing and shortness of breath. Repeated skin contact can lead to drying and scaling. Some individuals may experience allergic reactions after initial contact with the chemical. Subsequent contact may cause skin rashes and asthma; and reactions may become more severe if exposure persists. Long term inhalation of high levels of formaldehyde vapor (14 ppm) in rats resulted in an elevated incidence of cancer of the nose. Genetic damage from exposure has been shown in bacteria and some insects. Whether it causes effects in humans is uncertain. May be carcinogenic to humans.

Points of Attack: Eyes, respiratory system. *Cancer site:* nasal cancer.

Medical Surveillance: OSHA Mandated Medical Tests: pulmonary function tests: forced vital capacity, forced expiratory volume (1 second), forced expiratory flow rate. Niosh lists the following tests: pulmonary function tests: forced vital capacity, forced expiratory volume (1 second), forced expiratory flow rate; whole blood (chemical/metabolite); chest X-ray; pulmonary function tests: pre- and postshift photopatch testing; urine (chemical/metabolite); urine (chemical/metabolite) pre- and postshift. If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered.

Personal Protective Methods: Prevention of intoxication may be easily accomplished by supplying adequate ventilation and protective clothing. Barrier creams may also be helpful. Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Formalin (as formaldehyde): Prevent skin contact. **8 hours:** butyl rubber (gloves, suits, boots), nitrile rubber (gloves, suits, boots), Viton (gloves, suits), Saranex coated suits, Barricade coated suits; CPF3 suits; **4 hours:** Teflon (gloves, suits, boots), 4*H* and Silver Shield gloves, Responder suits. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Formaldehyde (1910.1048): < or = 7.5 ppm (parts per million) (10 × PEL): Full-facepiece respirator with cartridges or canisters specifically approved for protection against formaldehyde*. < or = 75 ppm (100 × PEL) (1) Full-face mask respirator with chin style or chest- or back-mounted type with industrial size canister specifically approved for protection against formaldehyde; or (2) Type C supplied-air respirator, demand type or continuous flow type, with full facepiece, hood, or helmet. >75 ppm (100 × PEL) or unknown concentrations (emergencies) (1) SCBA with positive-pressure full-facepiece; or (2) Combination supplied-air, full-facepiece positive-pressure respirator with auxiliary self-contained air supply.

Firefighting: SCBA with positive-pressure in full facepiece. *Escape*: (1) SCBA in demand or pressure-demand mode or (2) Full-face mask respirator with chin-style or front- or back-mounted type industrial size canister specifically approved for protection against formaldehyde.

*A half-mask respirator with cartridges specifically approved for protection against formaldehyde can be substituted for the full-facepiece respirator providing that effective gas-proof goggles are provided and used in combination with the half-mask respirator.

***Firefighting**:* SCBA with positive-pressure in full facepiece. *Escape* (1) SCBA in demand or pressure-demand mode; or (2) Full-face mask respirator with chin-style or front- or back-mounted type industrial size canister specifically approved for protection against formaldehyde.

Storage: Check oxygen content prior to entering storage area. Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. UN2209 Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location; keep acids away from bases and red, yellow, and blue-coded chemicals. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Formaldehyde must be stored to avoid contact with oxidizers (such as permanganates, nitrates, peroxides, chlorates and perchlorates), and alkaline materials, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat, sparks or flames. Sources of ignition, such as smoking and open flames, are prohibited where formaldehyde is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Where possible, automatically pump liquid from drums or other storage containers to process containers. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN1198 Formaldehyde solutions, flammable, Hazard Class: 3; Labels: 3-Flammable liquid, 8-Corrosive material. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner. UN2209 Formaldehyde solutions, with not <25% formaldehyde, Hazard class: 8; Labels: 8-Corrosive material. UN3077 For solids containing varying amounts of formaldehyde [possibly y as paraformaldehyde (polymers of formula $HO(CH_2O)xH$ where x averages ~30)]: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Shut off ignition sources; no flares, smoking or flames in hazard area. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors; do not get water inside container. *Small spills:* absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills:* dike far ahead of spill for later disposal. Use fluorocarbon water spray, cellosize, and hycar to diminish vapors. Use sodium carbonate, ammonium hydroxide or sodium sulfite to neutralize spill. Use universal gel, fly ash, universal sorbent material, or cement powder to absorb the spill. Keep formaldehyde out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable gas or a combustible liquid. Thermal decomposition products may include oxides of carbon. *Small fires:* dry chemical, carbon dioxide; water spray or foam. *Large fires:* water spray, fog or foam. Move container from fire area if you can do so without risk. Do not get water inside container. Spray cooling water on containers exposed to flames until well after fire is out. Withdraw immediately in case of rising sound from venting safety device or any discoloration of tank due to fire. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Incineration in solution of combustible solvent[22]. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(109); (102); (31); (173); (101); (138); (80); (100).

Environmental Protection Agency, *Investigation of Selected Potential Environmental Contaminants-Formaldehyde, Final Report,* Office of Toxic Substances, Environmental Protection Agency (August, 1976).

National institute for Occupational Safety and Health (NIOSH), *Criteria for a Recommended Standard: Occupational Exposure to Formaldehyde*, NIOSH Document Number 77-126, Cincinnati, OH (1977).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Formaldehyde Washington, DC (1979).

United States Environmental Protection Agency, Formaldehyde, Health and Environmental Effects Profile No. 104, Office of Solid Waste, Washington, DC (April 30, 1980).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 4, 70−72 (1981) and 3, No. 3, 71−76 (1983).

National institute for Occupational Safety and Health (NIOSH), *Formaldehyde: Evidence of Carcinogenicity, Current Intelligence Bulletin No. 34*, DHHS (NIOSH), Publication No. 81-111, Cincinnati, Ohio (April 15, 1981).

Clary, J. J., Gibson, J. E. and Waritz, R. S., *Formaldehyde Toxicology, Epidemiology, Mechanisms*, New York, Marcel Dekker, Inc. (1983).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Formaldehyde, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

New York State Department of Health, *Chemical Fact Sheet: Formaldehyde*, Bureau of Toxic Substance Assessment, Albany, NY (March 1986).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Formaldehyde, Trenton, NJ (January 2000).

Formaldehyde Cyanohydrin F:0420

Formula: C_2H_3NO; $HOCH_2CN$

Synonyms: Cyanomethanol; Formaldehido cianhidrina (Spanish); Glycolonitrile; Glycolonitrile glyconitrile; Gyycolic nitrile; α-Hydroxyacetonitrile; 2-Hydroxyacetonitrile; Hydroxyacetonitrile; α-Hydroxymethylcyanide; Hydroxymethylinitrile; Methylene cyanohydrine

CAS Registry Number: 107-16-4

HSDB Number: 2123as glycolonitrile

RTECS Number: AM0350000

UN/NA & ERG Number: UN3276 (Nitrile, liquid)/151 (P); UN2810 (Toxic liquid, organic, n.o.s.)/153

EC Number: 203-469-1

Regulatory Authority and Advisory Information

Hazard Alert: Extremely toxic, Combustible, Polymerization hazard (nonstabilized), Spontaneous decomposition hazard (explosive, esp. anhydrous), Primary irritant (w/o allergic reaction).

United States Environmental Protection Agency TSCA Section 8(e) Risk Notification, 8EHQ-0892-9040

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1000 lb (454 kg).

Hazard symbols, risk, & safety statements: Hazard symbol: T+, E, Xi; risk phrases: R1; R10; R19; R26/27/28; R36/37/38; R50/53; safety phrases: S13; S28; S36/37/39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Formaldehyde cyanohydrin is a colorless, odorless, oily liquid. Sweet taste (very highly toxic; do not test). Molecular weight = 57.06; boiling point = 186°C (slight decomposition); freezing/melting point ≤ −72°C; Flash point ≥93°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 2, reactivity 0. Soluble in water.

Potential Exposure: Formaldehyde cyanohydrin is used in the manufacture of intermediates in pharmaceutical production and as a component of synthetic resins as a chemical intermediate for organic compounds, and as a solvent.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, and exposure to heat. Unless stabilized with a weak acid solution, traces of alkalis may cause violent polymerization.

Permissible Exposure Limits in Air

NIOSH REL: (nitriles) 2 ppm/5 milligram per cubic meter Ceiling Concentration, not to be exceeded in any 15-minute work period. PAC* Ver. 29[138]

PAC-1: 0.24 ppm

PAC-2: 2.6 ppm

PAC-3: 11 ppm

Sweden: NGV 1 ppm (5 milligram per cubic meter), KTV 2 ppm (10 milligram per cubic meter) [skin], 1993; Turkey: TWA 1 ppm (5 milligram per cubic meter); STEL 2 ppm [skin], 1993

Determination in Air: See NIOSH Criteria Document 78-212 *NITRILES*[18]

Routes of Entry: Inhalation, skin absorption, ingestion, eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Formaldehyde cyanohydrin is extremely toxic. It can be fatal if inhaled, ingested, or absorbed through the unbroken skin. The symptoms are similar to cyanide poisoning. Odor of bitter almonds on patient's breath may or may not be present. Irritates eyes, skin, respiratory system. Headache, dizziness, weakness, giddiness, confusion, convulsions, vertigo, dyspnea (breathing difficulty), abdominal pain; nausea, and vomiting may follow exposure. Respiration may initially be rapid, then slow and labored; followed by coma and convulsions. Exposure by any route should be avoided; may have fatal consequences; death from asphyxiation may occur similar to that resulting from hydrogen cyanide.

Long-Term Exposure: Repeated exposure may cause personality changes of depression, anxiety, or irritability. Prolonged or repeated exposure may damage the nervous system; affect respiratory system; cardiovascular system. See NIOSH Criteria Document 212 *Nitriles*.

Points of Attack: Eyes, skin, respiratory system; central nervous system; cardiovascular system.

Medical Surveillance: Blood test for cyanide. Examination of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. *Speed in removing material from skin is of extreme importance*. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation. Use amyl nitrate capsules if symptoms develop. All area employees should be trained regularly in emergency measures for cyanide poisoning and in CPR. A cyanide antidote kit should be kept in the immediate work area and must be rapidly available. Kit ingredients should be replaced every 1−2 years to ensure freshness. Persons trained in the use of this kit; oxygen use, and CPR must be quickly available.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See NIOSH Criteria Document 212 *Nitriles*.

Respirator Selection: NIOSH: *up to 20 ppm:* Sa (APF = 10) (any supplied-air respirator). *Up to 50 ppm:* Sa: Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *Up to 100 ppm:* SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 250 ppm:* SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in a refrigerator[52] under an inert atmosphere and away from all alkaline materials. Where possible, automatically pump liquid from storage containers to process containers.

Shipping: UN3276 Nitriles, liquid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required, Potential Inhalation Hazard (Special Provision 5). UN2810 Toxic liquids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling:

UN2810 Toxic liquids, organic, n.o.s.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 0.7/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 1000/300
Then: Protect persons downwind (mi/km)
Day 1.1/1.8
Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Build dikes to contain flow as necessary. Use water spray to disperse vapors and dilute standing pools of liquid. Avoid breathing vapors. Keep upwind. Avoid bodily contact with the material. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include hydrogen cyanides and oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; or halon extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Formaldehyde Cyanohydrin, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Glycolonitrile, Trenton, NJ (April 1999).

Formamide F:0430

Formula: CH_3NO; $HCONH_2$

Synonyms: Carbamaldehyde; Formic acid amide; Methanamide

CAS Registry Number: 75-12-7

HSDB Number: 88

RTECS Number: LQ0525000

UN/NA & ERG Number: UN2810/152

EC Number: 200-842-0 [*Annex I Index No.:* 616-052-00-8]

Regulatory Authority and Advisory Information

Carcinogenicity: Not listed. Carcinogenesis studies; test completed (peer review), October 2000. United States Environmental Protection Agency Gene-Tox Program, Negative: Cell transformation-RLV F344 rat embryo

Hazard Alert: Poison, Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction).

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazard symbols, risk, & safety statements: Hazard symbol: T; risk phrases: R36/37/38; R61; R62; R63; safety phrases: S41; S45; S53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Formamide is a colorless, viscous liquid. Faint ammonia-like odor. Molecular weight = 45.05; specific gravity (H_2O:1) = 1.13; boiling point = (decomposes) 210.5°C; freezing/melting point = 2.5°C; vapor pressure = 0.1 mmHg @ 30°C; 29.7 mmHg @ 129°C; flash point = 154°C[17]. Autoignition temperature ≥500°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 1, reactivity 0. Good solubility in water; hygroscopic.

Potential Exposure: Formamide is a powerful solvent. It is also used as an intermediate in pharmaceutical manufacture.

Incompatibilities: Forms hydrocyanic acid with water solutions. Hygroscopic (absorbs moisture from air). Incompatible with nonoxidizing mineral acids; strong acids; ammonia, cresols, iodine, isocyanates, oleum, phenols, pyridine, sulfur trioxide; oxidizers, iodine, pyridine. Formamide decomposes on heating @ 180°C forming ammonia, water, carbon monoxide and hydrogen cyanide. Attacks metals, such as aluminum, iron, copper, brass, lead, and natural rubber. Thermal decomposition may release deadly hydrogen cyanide. Compounds of the carboxyl group react with all bases, both inorganic and organic (i.e., amines) releasing substantial heat, water and a salt that may be harmful. Incompatible with arsenic compounds (releases hydrogen cyanide gas), diazo compounds, dithiocarbamates, isocyanates, mercaptans, nitrides, and sulfides (releasing heat, toxic and possibly flammable gases), thiosulfates and dithionites (releasing hydrogen sulfate and oxides of sulfur).

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 1.85 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: None

NIOSH REL: 10 ppm/15 milligram per cubic meter TWA [skin]

ACGIH TLV[1]: 10 ppm/18 milligram per cubic meter TWA [skin]

PAC Ver. 29[138]
PAC-1: 30 ppm
PAC-2: 110 ppm
PAC-3: 650 ppm
DFG MAK: [skin]; No numerical value established.
Australia: TWA 10 ppm (15 milligram per cubic meter) [skin], 1993; Belgium: TWA 10 ppm (18 milligram per cubic meter) [skin], 1993; Finland: TWA 20 ppm (37 milligram per cubic meter); STEL 30 ppm (55 milligram per cubic meter) [skin], 1999; France: VME 20 ppm (30 milligram per cubic meter), 1999; Norway: TWA 10 ppm (18 milligram per cubic meter), 1999; Russia: STEL 3 milligram per cubic meter, 1993; Switzerland: MAK-W 10 ppm (18 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 16 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 10 ppm [skin]. Several states have set guidelines or standards for formamide in ambient air[60] ranging from 100 μ/m^3 (New York) to 300 μ/m^3 (Florida) to 300−450 μ/m^3 (North Dakota) to 480 μ/m^3 (Virginia) to 600 μ/m^3 (Connecticut) to 714 μ/m^3 (Nevada) to 750 μ/m^3 (South Carolina).

Determination in Air: No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Permissible Concentration in Water: No criteria set, but EPA[32] has suggested a permissible ambient goal of 414 μg/L based on health effects.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Formamide irritates the skin, eyes, and mucous membranes. Contact may cause eye burns. Exposure can cause skin irritation and a rash. May affect the central nervous system.

Long-Term Exposure: Formamide may also damage the testes (male reproductive glands). There is limited evidence that formamide is a teratogen in animals and may have toxic effects upon human reproduction.

Points of Attack: Blood, eyes, skin, respiratory system; cardiovascular system, central nervous system; reproductive system.

Medical Surveillance: If illness or overexposure is suspected, medical attention is recommended. Blood and cardiovascular tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures *over 20 ppm*; Use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Green: General storage may be used. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from moisture and other incompatible materials listed above.

Shipping: UN2810 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2810: *Isolation Distance, Spill*: 25 m/75 ft (NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep formamide out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include hydrogen cyanide and oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; water spray; or alcohol-resistant foam extinguishers. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve in a combustible solvent and dispose by burning in a furnace equipped with an alkali scrubber for the exit gases[22].

References

(31); (173); (101); (138); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 1, 44–45 (1980).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Formamide, Trenton, NJ (June 2003).

Formetanate Hydrochloride F:0440

Formula: $C_{11}H_{15}N_3O_2 \cdot HCl$

Synonyms: Carzol; Carzol SP; Dicarzol; *m*-([(Di-methylamino)methylene]amino)phenylcarbamate, hydrochloride; 3-Dimethylaminomethyleneaminophenyl-*N*-methylcarbamate, hydrochloride; *N*,*N*-Dimethyl-*N*′-([(methylamino) carbonyl]oxy)phenylmethanimidamide monohydrochloride; ENT 27,566; EP-332; Formetanate hydrochloride; Morton EP332; NOR-AM EP 332; Schering 36056; SN 36056

CAS Registry Number: 23422-53-9

HSDB Number: 2619

RTECS Number: FC2514000

UN/NA & ERG Number: UN2757(carbamate pesticides, solid, toxic)/151; UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 245-656-0 [*Annex I Index No.:* 006-052-00-0]

Regulatory Authority and Advisory Information

Hazard Alert: Poison (extremely poisonous to humans), Possible neurotoxic effects (methyl carbamate), Combustible, Sensitization hazard (skin), Environmental hazard, Agricultural chemical.

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P198

Superfund/EPCRA [40CFR 302 and 355, F R: 8/16/06, Vol 71, No. 158] RQ: 100 lb (45.4 kg)

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.056; Nonwastewater (mg/kg), 1.4

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), severe pollutant as formetanate.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, N, Xi; risk phrases: R26; R28; R43; R50/53; safety phrases: S1/2; S24; S28; S29/35; S37/39; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Formetanate hydrochloride is a white or yellowish, crystalline solid or powder with a faint odor. Molecular weight = 257.75; freezing/melting point = (decomposes) 200–202°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 1, reactivity 0. Highly soluble in water.

Potential Exposure: A potential danger to those involved in the manufacture, formulation, and application of this plant insecticide, acaricide and miticide.

Incompatibilities: Carbamates are incompatible with strong acids and bases, and especially incompatible with strong reducing agents such as hydrideds and active metals. Contact with active metals or nitrides form flammable gaseous hydrogen. Incompatible with strongly oxidizing acids, peroxides, and hydroperoxides.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 0.12 milligram per cubic meter

PAC-2: 1.3 milligram per cubic meter

PAC-3: 7.9 milligram per cubic meter

Determination in Air: Organonitrogen pesticides. OSHA versatile sampler-2; Reagent; High-pressure liquid chromatography/Ultraviolet detection; NIOSH Analytical Method (IV) #5601.

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: May be fatal if inhaled or swallowed. Diarrhea, nausea, vomiting, excessive salivation; headache, pinpoint pupils and uncoordinated muscle movements are all common symptoms. Extremely toxic to humans. Not absorbed through contact with skin. Inhalation or ingestion may cause poisoning. Inhibits cholinesterase activity so effects are in relation to action on nervous system and can result in death. LD_{50} = 20 mg/kg[77]

Long-Term Exposure: May cause skin allergy.

Medical Surveillance: Evaluation by a dermatologist. Evaluation by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately

with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/ manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: UN2757 Carbamate pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: *Isolation Distance, Spill*: 25 m/ 75 ft (NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Stay upwind and keep out of low areas. Do not touch spilled material or breathe the dust, vapors, or fumes from burning materials. Do not handle broken packages without protective equipment. Wash away any material that may have contacted the body with soap and water. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include hydrogen chloride and oxides of nitrogen and carbon. Extinguish fire using agent suitable for type of surrounding fire, as the material itself does not burn or burns with difficulty. Use water in flooding quantities as a fog. Use alcohol foam, carbon dioxide; or dry chemical. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR 165 recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Formetanate HCl, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

NIOSH Manual of Analytical Methods, 4th Edition, Issue 1, *Organonitrogen pesticides*, page 7of 21, Cincinnati, OH, 1/ 15/1998.

Formic Acid F:0450

Formula: CH_2O_2: HCOOH

Synonyms: Acide formique (French); Acido formico (Spanish); ADD-F; AI3-24237; Amasil; Ameisensaeure (German); Aminic acid; Bilorin; Collo-Bueglatt; Collo-Didax; Formisoton; Formylic acid; Hydrogen carboxylic acid; Methanoic acid; Myrmicyl

CAS Registry Number: 64-18-6

HSDB Number: 1646

RTECS Number: LQ4900000

UN/NA & ERG Number: UN1779/153

EC Number: 200-579-1 [*Annex I Index No.:* 607-001-00-0]

Regulatory Authority and Advisory Information

Hazard Alert: Flammable, Corrosive (skin, resp.), Possible risk of forming tumors, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 5000 lb (2270 kg)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U123

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

EPCRA Section 313 Form R de minimis concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: C, Xi; risk phrases: R10; R35; R36/37/38; R43; R62; safety phrases: S1/2; S23; S26; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Formic acid is a colorless, flammable, fuming liquid. Pungent odor. Molecular weight = 46.03; specific gravity (H_2O:1) = 1.22 (90% solution); boiling point = 106.7°C (90% solution); vapor pressure = 35 mmHg @ 20°C; flash point = 69°C; (90% solution) 50°C; Autoignition temperature = 434°C. Explosive limits: LEL = 18%; UEL: 57%. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 2, reactivity 0. Soluble in water.

Potential Exposure: Formic acid is a strong reducing agent and is used as a decalcifier. It is used in pharmaceuticals; in dyeing textiles and finishing color-fast wool; electroplating, coagulating latex rubber; regeneration old rubber, and dehairing, plumping, and tanning leather. It is also used in the manufacture of acetic acid, airplane dope; allyl alcohol; cellulose formate; phenolic resins; and oxalate; and it is used in the laundry, textile, insecticide, refrigeration, and paper industries; as well as in drug manufacture.

Incompatibilities: Vapors may form explosive mixture with air. A medium strong acid and a strong reducing agent. Violent reaction with oxidizers, furfuryl alcohol; hydrogen peroxide; nitromethane. Incompatible with strong acids; bases, ammonia, aliphatic amines; alkanolamines, isocyanates, alkylene oxides; epichlorohydrin. Decomposes on heating and on contact with strong acids forming carbon monoxide. Carbamates are incompatible with strong acids and bases, and especially incompatible with strong reducing agents such as hydrideds and active metals. Contact with active metals or nitrides form flammable gaseous hydrogen. Incompatible with strongly oxidizing acids, peroxides, and hydroperoxides. Attacks metals: aluminum, cast iron and steel; many plastics, rubber and coatings.

Permissible Exposure Limits in Air

NIOSH IDLH = 30 ppm

Conversion factor: 1 ppm = 1.88 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 5 ppm/9 milligram per cubic meter TWA

NIOSH REL: 5 ppm/9 milligram per cubic meter TWA

ACGIH TLV[1]: 5 ppm/9.4 milligram per cubic meter TWA; 10 ppm/19 milligram per cubic meter STEL

PAC* Ver. 29[138]

PAC-1: $\mathbf{3_A}$ ppm

PAC-2: $\mathbf{25_A}$ ppm

PAC-3: $\mathbf{250_A}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60-minute values.

DFG MAK: 5 ppm/9.5 milligram per cubic meter TWA; Peak Limitation Category I(2); Pregnancy Risk Group C

Arab Republic of Egypt: TWA 5 ppm (9 milligram per cubic meter), 1993; Australia: TWA 5 ppm (9 milligram per cubic meter), 1993; Austria: MAK 5 ppm (9 milligram per cubic meter), 1999; Belgium: TWA 5 ppm (9.4 milligram per cubic meter), 1993; Denmark: TWA 5 ppm (9 milligram per cubic meter), 1999; France: VLE 5 ppm (9 milligram per cubic meter), 1999; Hungary: TWA 5 milligram per cubic meter; STEL 8 milligram per cubic meter, 1993; the Netherlands: MAC-TGG 9 milligram per cubic meter, 2003; Norway: TWA 5 ppm (9 milligram per cubic meter), 1999; the Philippines: TWA 5 ppm (9 milligram per cubic meter), 1993; Poland: MAC (TWA) 5 milligram per cubic meter, MAC (STEL) 15 milligram per cubic meter, 1999; Russia: TWA 5 ppm; STEL 1 milligram per cubic meter [skin] 1993; Sweden: TWA 3 ppm (5 milligram per cubic meter); STEL 15 ppm (45 milligram per cubic meter) [skin] 1999; Switzerland: MAK-W 5 ppm (9 milligram per cubic meter); STEL 10 ppm (18 milligram per cubic meter), 1999; United Kingdom: TWA 5 ppm (9.6 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 10 ppm. Several states have set guidelines or standards for formic acid in ambient air[60] ranging from 30 μ/m^3 (New York) to 90 μ/m^3 (Florida and North Dakota) to 150 μ/m^3 (Virginia) to 180 μ/m^3 (Connecticut) to 214 μ/m^3 (Nevada) to 225 μ/m^3 (South Carolina).

Determination in Air: Use NIOSH Analytical Method (IV) #2011 or OSHA Analytical Method ID-186 SG.

Permissible Concentration in Water: No criteria set, but EPA[32] has suggested a permissible ambient goal of 124 μg/L based on health effects.

Determination in Water: Octanol−water partition coefficient: Log K_{ow} = 0.41.

Routes of Entry: Inhalation of vapor, percutaneous absorption, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Formic acid is very corrosive to the eyes, skin, and respiratory tract. *Inhalation:* Workers exposed to 15 ppm experience nausea. Other symptoms include irritation of the nose, throat and lungs; coughing, runny nose and tearing eyes. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. *Skin:* Concentrated solutions may cause severe irritation, burning and blistering. Accidental exposure has resulted in death. *Eyes:* May cause irritation and tearing. Concentrated solutions may cause severe chemical burns. *Ingestion:* Corrosive. May affect the energy metabolism, causing acidosis. May cause salivation, vomiting, burning sensation in the mouth; vomiting of blood; diarrhea and pain. In severe cases, a person may go into shock and develop difficulty in breathing. Death may result. Animal data suggest that ingestion of about 3 oz may be fatal to a 150 lb individual.

Long-Term Exposure: Prolonged or repeated exposure to formic acid may cause skin irritation and allergy with rash and itching. May affect the kidneys. May cause genetic changes in living cells.

Points of Attack: Respiratory system, lungs, skin, kidneys, liver, eyes.

Medical Surveillance: Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Consideration should be given to possible irritant effects on the skin, eyes, and lungs in any placement or periodic examinations. Lung function tests. Kidney function tests checking for blood and urine. Consider chest X-ray following acute overexposure. Evaluation by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Prevent skin contact. **8 hours:** butyl rubber (gloves, suits, boots), Neoprene rubber (gloves, suits, boots), Saranex coated suits, Barricade coated suits; Responder suits, Trellchem HPS suits; **4 hours:** polyvinyl chloride (gloves, suits, boots), Teflon (gloves, suits, boots). Also, safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: SCBA: $>\mathbf{2}_{\mathbf{A}}$ ppm **ERPG** (Emergency Response Planning Guideline). NIOSH: *30 ppm:* Sa (APF = 10) (any supplied-air respirator); or; or SCBAF (APF = 50) (any SCBA with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp: ASCBA (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: (1) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. (2) Color code—Red: Flammability Hazard: Store in a flammable (liquid or solid materials) storage area or approved cabinet away from sources if ignition. (3) Color code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Keep in sealed containers in well-ventilated area. Protect from heat or flame and materials listed above under "Incompatibilities." Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: UN1779 Formic acid, with >85% acid by mass, Hazard class: 8; Labels: 8-Corrosive material, 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition includes oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration with added solvent[22]. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (173); (101); (138); (2); (100).

United States Environmental Protection Agency, Formic Acid, Health and Environmental Effects Profile No. 105, Office of Solid Waste, Washington, DC (April 30, 1980).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 2, 39−41 (1980) and 3, No. 4, 53−56 (1983).

New York State Department of Health, *Chemical Fact Sheet:* Formic Acid, Bureau of Toxic Substance Assessment, Albany, NY (March 1986 and Version 2).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Formic acid, Trenton, NJ (June 2002).

Formothion F:0460

Formula: $C_6H_{12}NO_4PS2$; $(CH_3O)_2PSSCH_2CON(CH_3)CHO$

Synonyms: Aflix; Anthio; Antio; Carbamoylmethyl phosphorodithioate; CP 53926; *O,O*-Dimethyldithiophosphory lacetic acid *n*-methyl-*N*-formylamide; *O,O*-Dimethyl *S*-(*N*-formyl-*N*-methylcarbamoylmethyl) phosphorodithioate; *O*, *O*-Dimethyl-*S*-(3-methyl-2,4-dioxo-3-aza-butyl)-dithiophosphat (German); *O,O*-Dimethyl-*S*-(*N*-methyl-*N*-formyl-carbamoylmethyl)-dithiophosphat (German); *O,O*-Dimethyl *S*-(*N*-methyl-*N*-formylcarbamoylmethyl) dithiophosphate; *O*, *O*-Dimethyl *S*-(*N*-methyl-*N*-formylcarbamoylmethyl) phosphorodithioate; *O,O*-Dimethyl phosphorodithioate *n*-formyl-2-mercapto-*N*-methylacetamide *S*-ester; ENT 27,257; Formotion (Spanish); *S*-[2-(Formylmethylamino)-2-oxo ethyl] *O,O*-dimethyl phosphorodithioate*;* *n*-Formyl-*N*-methylcarbamoylmethyl *O,O*-dimethyl phosphorodithioate; *S*-(*N*-Formyl-*N*-methylcarbamoylmethyl) *O,O*-dimethyl phosphorodithioate; *S*-(*N*-Formyl-*N*-methylcarbamoylmethyl) dimethyl phosphorodithiolothionate; S 6900; SAN 244 I; SAN 6913 I; SAN 71071; Spencer S-6900; VEL 4284

CAS Registry Number: 2540-82-1

HSDB Number: 1587

RTECS Number: TE1050000

UN/NA & ERG Number: UN3018 (organophosphorus pesticide, liquid, toxic)/152

EC Number: 219-818-6 [*Annex I Index No.:* 015-057-00-7]

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Neurotoxin (cumulative), Combustible, Suspected reprotoxic hazard.

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg).

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xn; risk phrases: R21/22; R33; R36/37/38; R34; R40; R45; R51; safety phrases: S2; S22; S26; S36/37/39; S41; S45; S53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [2-Hazard to water. (est.)]

Description: Formothion is an odorless, yellowish viscous oil or crystalline mass. Molecular weight = 257.28; freezing/melting point = 25°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 1, reactivity 0. Slightly soluble in water.

Potential Exposure: Formothion is an insecticide and acaricide for use on crops and ornamentals. Formothion is not currently produced commercially in the U.S.

Incompatibilities: Strong oxidizers may cause release of toxic phosphorus oxides. Organophosphates, in the presence of strong reducing agents such as hydrides, may form highly toxic and flammable phosphine gas. Keep away from alkaline materials.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 2.1 milligram per cubic meter

PAC-2: 24 milligram per cubic meter

PAC-3: 140 milligram per cubic meter

Russia[35,43] set a MAC in work-place air of 0.5 milligram per cubic meter and a MAC in ambient air in residential areas of 0.01 milligram per cubic meter on a momentary basis and 0.006 milligram per cubic meter on a daily average basis.

Determination in Air: Use NIOSH Analytical Method (IV) Method #5600, Organophosphorus Pesticides.

Permissible Concentration in Water: Russia[35,43] set a MAC in water bodies used for domestic purposes of 0.004 mg/L (4 μg/L).

Routes of Entry: Inhalation, absorbed by the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Early symptoms of poisoning include: headache, dizziness, weakness, perspiring, nausea, vomiting, and sensation of tightness in chest. Chronic low doses may produce symptoms similar to influenza. Formothion is one of the least toxic systemic organophosphates. Formothion is a compound of low to moderate toxicity. It causes the depression of cholinesterase leading to accumulation of acetylcholine in the nervous system; which is believed to be responsible for the symptoms. Organic phosphorus insecticides are absorbed by the skin, as well as by the respiratory and gastrointestinal tracts. They are cholinesterase inhibitors. Symptoms of exposure include headache, giddiness; blurred vision; nervousness, profound weakness; nausea, cramps, diarrhea, and discomfort in the chest. Signs include sweating, tearing, salivation, vomiting, cyanosis, convulsions, coma, loss of reflexes, and loss of sphincter control.

Long-Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, central nervous system; cardiovascular system, skin, eyes, plasma and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Speed in removing the material form the skin is of extreme importance. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: SCBA: >0.025 milligram per cubic meter Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from. alkaline materials. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: UN3018 Organophosphorus pesticides, liquid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling:

Initial isolation and protective action distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.3/0.4
Night 0.8/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 600/200
Then: Protect persons downwind (mi/km)
Day 1.4/2.3
Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Do not touch spilled material. Do not breathe vapors. Stay upwind; keep out of low areas. Remove all ignition sources. Ventilate area of spill or leak. This material is a combustible liquid. For a spill or leak of a combustible liquid, shut off ignition sources; no flares, smoking or flames in hazard area. Stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of phosphorus, sulfur, nitrogen and carbon. *Small fires:* dry chemical, carbon dioxide; water spray; or foam. *Large fires:* water spray, fog, or foam. Move container from fire area if you can do so without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter material. This compound is an organophosphorus insecticide. Some of these materials may burn but none of them ignite readily. Fire and runoff from fire control water may produce irritating or poisonous gases. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR 165 recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (2); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Formothion, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Formothion, Trenton, NJ (September 2000).

Fosetyl-Al (Fosetyl-aluminum) F:0468

Formula: $C_6H_{18}AlO_9P_3$

Synonyms: 32545 R; Aliette; Aliette 80 WG; Aluminum tris(*O*-ethylphosphonate); Aluminum phosethyl; Aluminium triethyl triphosphonate; Chipco aliette WDG; Efosite-al; Efosite aluminum; Epal; LS-74783; Mikal; Fosetyl aluminum; Phosethyl-Al; Phosethyl aluminum; Phosphonic acid, monoethyl ester, aluminum salt (3:1)

CAS Number: 39148-24-8

HSDB Number: 6856

RTECS Number: SZ9640000

UN/NA & ERG Number: UN2783 (organophosphorus pesticide, solid, n.o.s.)/152; UN3018 (organophosphorus pesticide, liquid, n.o.s.)/152

EC Number: 254-320-2 [*Annex I Index No.:* 006-095-00-5]

Regulatory Authority and Advisory Information

Carcinogenicity[83]: EPA, Not likely a human carcinogen

Hazard Alert: Poison, Neurotoxin (cumulative), Possible sensitization hazard (skin), Organometallic, Primary irritant (w/o allergic reaction), Agricultural chemical. Listed for Tier 1 screening as an endocrine disruptor[88].

Potential Ground water Pollutant [California FAC Section 13145(d)/12811, active]

DOT Inhalation Hazard Chemicals as organophosphates

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xi; risk phrases: R33; R36/37/38; R41; R43; safety phrases: S2; S26; S39; S46 (see Appendix 4)

Description: White, crystalline solid or powder. Odorless. Molecular weight = 354.101; specific gravity (H_2O:1) = 1.55; boiling point = (decomposes); freezing/melting point = 214°C; vapor pressure = 1×10^{-7} mmHg @ 20°C. Henry's Law constant = 3.2×10^{-15} atm m^3/mol @ 25°C (est)[83] Highly soluble in water; solubility = 120 g/L.

Potential Exposure: Organophosphate fungicide used on fruits, vegetables and nut crops; also on ornamentals and greenhouse products.

Incompatibilities: In the presence of strong reducing agents such as hydrides, organophosphates form highly toxic and flammable phosphine gas. Contact with oxidizers can cause the release of toxic oxides of phosphorus. Decomposes in temperatures above 260°C.

Permissible Exposure Limits in Air:

Determination in Air: OSHA versatile sampler-2; Toluene/ Acetone; Gas chromatography/Flame ionization detection; NIOSH IV[18], Method #5600, Organophosphorus Pesticides

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 50−200[Al]μg/L; State Drinking Water Standards: California 1000[Al]μg/L; State Drinking Water Guidelines: Arizona 73 [Al]μg/L; Maine 1430 [Al]μg/L; California 200 [Al]μg/L.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = -3$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation; dermal and eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: A severe eye irritant. Eye pupils are small; blurred vision; eye watering; runny nose; cough; shortness of breath; salivation; dizziness; nausea, stomach cramps, diarrhea, and vomiting; increased blood pressure; profuse sweating; hypermotility, hallucinations; irritability; tingling of the skin; drowsiness; slow heartbeat; convulsions; fluid in lungs; loss of consciousness; incontinence; breathing stops; death. Organophosphates inhibit the action of acetylcholinesterase enzymes, and alter the way in which nervous impulses are transmitted. The effects can last for hours, days, or much longer. The action of the enzymes is reestablished after new enzymes are formed. LD_{50} (oral, rat) = > 5 g/kg[83]; LD_{50} (dermal, rat) = 600 mg/kg.

Long-Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. Organophosphates may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, central nervous system, cardiovascular system, blood cholinesterase

Medical Surveillance: Medical observation is recommended for 24 to 48 hours following breathing overexposure, as pulmonary edema may be delayed. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure.

First Aid: Speed in removing material from eyes and skin is of extreme importance. *Eyes:* Eye contact can cause dangerous amounts of these chemicals to be quickly absorbed through the mucous membrane into the bloodstream. Immediately and gently flush eyes with plenty of warm or cold water (NO hot water) for at least 15 minutes, occasionally lifting the upper and lower eyelids. Get medical aid immediately. *Skin:* Get medical aid. Dermal contact can cause dangerous amounts of these chemicals to be absorbed into the bloodstream. Wearing the appropriate PPE equipment and respirator for organophosphate pesticides, immediately flush skin with plenty of soap and water for at least 15 minutes while removing contaminated clothing and shoes. Shampoo hair promptly if contaminated. *Ingestion:* Call poison control. Loosen all clothing. Never give anything by mouth to an unconscious person. Get medical aid. Do NOT induce vomiting. * If conscious, alert, and able to swallow, rinse mouth and have victim drink 4 to 8 oz of water do NOT induce vomiting but immediately administer slurry of activated charcoal (2 oz in 8 oz of water). If victim is *UNCONSCIOUnited States OR HAVING CONVULSIONS,* do nothing except keep victim warm. **In some cases you may be specifically instructed by poison control to induce vomiting by way of 2 tablespoons of syrup of ipecac (adult) washed down with a cup of water.* Do NOT give activated charcoal before or with ipecac syrup. *Inhalation:* Get medical aid. Do not contaminate yourself. Wearing the appropriate PPE equipment and respirator for organophosphate pesticides, immediately remove the victim from the contaminated area to fresh air. If the victim is not breathing, administer artificial respiration. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. If breathing is difficult, administer oxygen through bag/mask apparatus until medical help arrives. Do not leave victim unattended. *Note to physician or authorized medical personnel.* Administer atropine, 2 mg (1/30 gr) intramuscularly or intravenously as soon as any local or systemic signs or symptoms of an intoxication are noted; repeat the administration of atropine every 3 to 8 minutes until signs of atropinization (mydriasis, dry mouth, rapid pulse, hot and dry skin) occur; initiate treatment in children with 0.05 mg mg/kg of atropine; repeat at 5 to 10-minute intervals. Watch respiration, and remove bronchial secretions if they appear to be obstructing the airway; intubate if necessary. *Notes to physician or authorized medical personnel*: *N*-methylpyridinium-2-aldoxime (2-PAMCI) when used in conjunction with atropine reacts with the phosphorylated cholinesterase, thereby restoring normal activity to by removing the phosphorylating group. The combination of these two chemicals is synergistic and must be administered within minutes to a few hours following exposure (depending on the specific agent) to be effective. Give 2-PAMCI (Pralidoxime; Protopam), 2.5 gm in 100 mL of sterile water or in 5% dextrose and water, intravenously, slowly, in 15−30 minutes; if sufficient fluid is not available, give 1 gm of 2-PAMCI in 3 mL of distilled water by deep intramuscular injection; repeat this every half hour if respiration weakens or if muscle fasciculation or convulsions recur. Also Diazepam, an anticonvulsant, might be considered. As first aid for pulmonary edema, a doctor or authorized paramedic might consider administering a drug or other inhalation therapy.

Respirator Selection: Wherever and whenever workplace conditions warrant respirator use, a respiratory protection program must be followed that meets one or more of the following government standards: OSHA's 29 CFR 1910.134, ANSI Z88.2, or European Standard EN 149.

Storage: Color code—Blue: Health Hazard/Poison. Store in a secure poison location. Prior to working with this chemical, all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong bases. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN2783 Organophosphorus pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN3018 Organophosphorus pesticides, liquid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling:

Initial isolation and protective action distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.3/0.4
Night 0.8/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 600/200
Then: Protect persons downwind (mi/km)
Day 1.4/2.3
Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Do not touch spilled material. Do not breathe vapors. Stay upwind; keep out of low areas. Remove all ignition sources. Ventilate area of spill or leak. This material is a combustible liquid. For a spill or leak of a combustible liquid, shut off ignition sources; no flares, smoking or flames in hazard area. Stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Decomposes in temperatures above 260°C. Thermal decomposition products may include oxides of phosphorus, nitrogen, metal and carbon. May be fatal if inhaled, ingested or absorbed through skin. Inhalation or contact with some of these materials will irritate or burn skin and eyes. Vapors may cause dizziness or suffocation. *Small fires:* dry chemical, carbon dioxide; water spray; or foam. *Large fires:* water spray, fog, or foam. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Firefighting gear (including SCBA) may not provide adequate protection. If exposure occurs, remove and isolate gear immediately and thoroughly decontaminate personnel. Wear positive pressure breathing apparatus and special protective clothing. Remove and isolate contaminated clothing at the site. Move container from fire area if you can do so without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Destruction by alkali hydrolysis or incineration. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138).

United States Environmental Protection Agency, Office of Pesticide Programs, Pesticide Residue Limits, “Fosetyl-al”, 40 CFR 180.415, http://www.epa.gov/pesticides/food/viewtols.htm.

Pesticide Management Education Program, “Fosetyl-al (Aliette) Chemical Fact Sheet: 10/83,” Cornell University, Ithaca, NY (October 1983). http://pmep.cce.cornell.edu/profiles/fung-nemat/febuconazole-sulfur/fosetyl-al/fung-prof-fosetylal.html.

Fosthietan F:0470

Formula: $C_6H_{12}NO_3PS_2$

Synonyms: AC 64475; Acconem; CL64475; (Diethoxyphosphinylimino)-1,3-dithietane; Diethoxyphosphinylimino-2-dithietanne-1,3 (French); 1,3-Dithietan-2-ylidenephosphoramidic acid diethyl ester; Geofos; NEM-A-TAK

CAS Registry Number: 21548-32-3

HSDB Number: 6449

RTECS Number: NJ6490000

UN/NA & ERG Number: UN3018 (organophosphorus pesticide, liquid, toxic)/152

EC Number: 244-437-7 [*Annex I Index No.:* 015-124-00-0]

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Combustible, Poison, Neurotoxin (cumulative), Agricultural chemical.

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500 lb (227 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 500 lb (227 kg).

Hazard symbols, risk, & safety statements: Hazard symbol: T+; risk phrases: R27/28; R33; safety phrases: S1/2; S36/37; S41; S45 (see Appendix 4).

Description: Fosthietan is a pale yellow oil. It has a mercaptan-like odor. Molecular weight = 241.28; specific gravity (water = 1) = 1.3 g/cm^3 @ 25°C; vapor pressure = 6.5×10^{-6} mmHg @ 25°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 1, reactivity 1. Henry's Law constant = 4.11×10^{-11} atm m^3/mol @ 25°C (est)[72] Moderately soluble in water.

Potential Exposure: Fosthietan is used as a nematocide and insecticide. Not currently registered as a pesticide in the U.S.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Strong oxidizers may cause release of toxic phosphorus oxides. Organophosphates, in the presence of strong reducing agents such as hydrides, may form highly toxic and flammable phosphine gas.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 0.43 milligram per cubic meter

PAC-2: 4.7 milligram per cubic meter

PAC-3: 28 milligram per cubic meter

Determination in Air: Use NIOSH Analytical Method (IV) Method #5600, Organophosphorus Pesticides.

Routes of Entry: Inhalation, ingestion, absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Fosthietan is a liquid organophosphorus insecticide. Acutely toxic, possibly fatal, on contact to the skin or if swallowed. Organic phosphorus insecticides are absorbed by the skin, as well as by the respiratory and gastrointestinal tracts. They are cholinesterase inhibitors. Symptoms of exposure include headache, giddiness; blurred vision; nervousness, weakness, nausea, cramps, diarrhea, and discomfort in the chest. Signs include sweating, tearing, salivation, vomiting, cyanosis, convulsions, coma, loss of reflexes and loss of sphincter control. LD_{50} (oral-rat) = < 5 mg/kg.

Long-Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, central nervous system; cardiovascular system, skin, eyes, plasma and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Remove and isolate contaminated clothing and shoes at the site. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from alkaline material. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: UN3018 Organophosphorus pesticides, liquid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling:

Initial isolation and protective action distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.3/0.4
Night 0.8/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 600/200
Then: Protect persons downwind (mi/km)
Day 1.4/2.3
Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Do not touch spilled material. Do not breathe vapors. Stay upwind; keep out of low areas. Remove all ignition sources. Ventilate area of spill or leak. This material is a combustible liquid. For a spill or leak of a combustible liquid, shut off ignition sources; no flares, smoking or flames in hazard area. Stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical may burn but does not ignite readily. Thermal decomposition products may include oxides of phosphorus, sulfur, nitrogen and carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR 165 recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (2).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Fosthietan, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

Fuberidazole F:0480

Formula: $C_{11}H_8N_2O$

Synonyms: Baycor; Bayer 33172; Baytan; Bitertanol, fuberidazole; Fuberidatol; Fuberisazol; Fubridazole; 2-(2-Furanyl)-1*H*-benzimidazole; Furidazol; Furidazole; 2-(2′-Furyl)-benzimidazole; 2-(2-Furyl)benzimidazole; ICI Baytan; Neovoronit; Sibutol; Sibutrol; Voronit; Voronite; W VII/117

CAS Registry Number: 3878-19-1

RTECS Number: DD9010000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154; UN2588 (Pesticides, solid, toxic, n.o.s.)/151

EC Number: 223-404-0 [*Annex I Index No.:* 613-016-00-3]

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Combustible, Poison, Environmental hazard.

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg).

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: Xn, N; risk phrases: R22; R50/53; safety phrases: S2; S22; S29; S41; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)]

Description: Fuberidazole is a crystalline powder. Molecular weight = 184.21; freezing/melting point = 285°C (decomposition). Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 1, reactivity 0. Very slightly soluble in water. Decomposes ~285−290°C.

Incompatibilities: Fuberidazole is incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, acid halides, anhydrides, epoxides, halogenated organics, isocyanates, peroxides, phenols (acidic). Fuberidazole is a benzimidazole and behaves as an amine. Amines are chemical bases. They neutralize acids to form salts plus water. These acid-base reactions are exothermic. The amount of heat that is evolved per mole of amine in a neutralization is largely independent of the strength of the amine as a base. Amines may be incompatible with isocyanates, halogenated organics, peroxides, phenols (acidic), epoxides, anhydrides, and acid halides. Flammable gaseous hydrogen is generated by amines in combination with strong reducing agents, such as hydrides[101].

Potential Exposure: Fuberidazole, a benzimidazole, uses include cereal seed dressing; and fungicidal, nonmercurial seed dressing with special action against fusarium. Not registered as a pesticide in the U.S.A.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 0.3 milligram per cubic meter

PAC-2: 3.3 milligram per cubic meter

PAC-3: 15 milligram per cubic meter

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 2.7$. Values above 3.0 are likely to bioaccumulate in aquatic organisms.

Routes of Entry: Inhalation, ingestion, dermal contact.

Harmful Effects and Symptoms

Short-Term Exposure: Fuberidazole is classified as moderately toxic. Its probable oral lethal dose in humans is 0.5−5 g/kg or between 1 oz and 1 pt for a 70 kg (150 lb) person. LD_{50} (oral-rat) = 1100 mg/kg[9]; LC_{50} (rat) = 0.33 mg/L.

First Aid Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. For emergency situations, wear a positive pressure, pressure-demand, full facepiece SCBA; or pressure-demand supplied air respirator with escape SCBA and a fully encapsulating, chemical resistant suit.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: UN2588 Pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft (NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Do not touch spilled material;

stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills*: with clean shovel place material into clean, dry container and cover; move containers from spill area. *Large spills*: dike far ahead of spill for later disposal. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen and carbon. This material is a combustible solid. Move container from fire area if you can do so without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Wear positive pressure breathing apparatus and special protective clothing. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers.If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR 165 recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Fuberidazole, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

Fumaric Acid F:0490

Formula: $C_4H_4O_4$

Synonyms: Allomaleic acid; Boletic acid; (*E*)-Butenedioic acid; *trans*-Butenedioic acid; 2-Butenedioic acid (*E*); Butenedioic acid, (*E*)-; 1,2-Ethenedicarboxylic acid, *trans*-; *trans*-1,2-Ethylenedicarboxylic acid; 1,2-Ethylenedicarboxylic acid, (*E*); Lichenic acid; NSC-2752; U-1149

CAS Registry Number: 110-17-8

HSDB Number: 710

RTECS Number: LS9625000

UN/NA & ERG Number:

EC Number: 203-743-0 [*Annex I Index No.:* 607-146-00-X]

Regulatory Authority and Advisory Information

Hazard Alert: Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 5000 lb (2270 kg)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xi; risk phrases: R36; R62; safety phrases: S2; S26; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Fumaric acid is a colorless to white, odorless crystalline powder. Fruity-acidic taste. Molecular weight = 116.08; specific gravity (H_2O:1) = 1.64 @ 20°C; boiling point = 290°C; Sublimation temperature = 200°C; freezing/melting point = 287°C; vapor pressure = 1.54×10^{-4} mmHg @ 25°C; flash point = 230°C; Autoignition temperature = 737°C; also listed as >156°F/ >69°C; Autoignition temperature (dust cloud) = 740°C. Hazard Ranking (based on NFPA 704 M Hazard identification): Health 2, flammability 1, reactivity 0. Slightly soluble in water; solubility = < 1%.

Potential Exposure: Fumaric acid is used in production of resins, polyesters, plasticizers, and alkyl surface coatings; as a food additive; as an antioxidant in resins; to make dyes.

Incompatibilities: Dust cloud from powder or granular form mixed with air can explode. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, sulfuric acid, caustics, ammonia, amines, isocyanates, alkylene oxides; epichlorohydrin. Decomposes above 350°C forming toxic fumes of maleic anhydride.

Permissible Exposure Limits in Air

PAC Ver. 27; No value in Ver. 29[138]

PAC-1: 28 milligram per cubic meter

PAC-2: 310 milligram per cubic meter

PAC-3: 1800 milligram per cubic meter

Determination in Air: No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Determination in Water: Octanol–water coefficient: Log K_{ow} =< 1. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation. Absorbed through the skin.
Harmful Effects and Symptoms
Short-Term Exposure: Irritates the eyes, skin, and respiratory tract.
Long-Term Exposure: Repeated exposure may cause liver damage.
Points of Attack: Liver.
Medical Surveillance: Liver function tests.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.
Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.
Storage: Color code—Green: General storage may be used. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from heat and incompatible materials listed above.
Shipping: Not regulated as a hazardous mateial.
Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.
Fire Extinguishing: Thermal decomposition products may include maleic anhydride and oxides of carbon. This chemical is a combustible solid. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.
Disposal Method Suggested: Use a licensed professional waste disposal service to dispose of this material. Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.
References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Fumaric Acid, Trenton, NJ (July 2002).

Furan F:0500

Formula: C_4H_4O
Synonyms: Divinylene oxide; Furano (Spanish); Furfuran; NCI-C56202; Oxacyclopentadiene; Oxole; Tetrole
CAS Registry Number: 110-00-9
HSDB Number: 89
RTECS Number: LT8524000
UN/NA & ERG Number: UN2389/128
EC Number: 203-727-3 [*Annex I Index No.:* 603-105-00-5]
Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 ($\geq$1.00% concentration).

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Animal Sufficient Evidence; Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B, 1997; NCI: Carcinogenesis Studies (gavage); clear evidence: mouse, rat.

California Proposition 65 Chemical[102]: Cancer 10/1/93.

Hazard Alert: Extremely flammable, Suspected of causing genetic defects, Suspected reprotoxic hazard.

Clean Air Act: Accidental Release Prevention/Flammable Substances (Section 112[r], Table 3), TQ = 5000 lb (2270 kg)

OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 500 lb (227 kg)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U124

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500 lb (227 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)

Hazard symbols, risk, & safety statements: Hazard symbol: F+, T, N; risk phrases: R45; R12; R19; R20/22; R38; R48/22; R50/53; R62; R63; R68; safety phrases: S1; S53; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Furan is a colorless liquid; turns brown on standing. Strong ethereal odor. Molecular weight = 68.07; specific gravity (H_2O:1) = 0.95 @ 20°C; boiling point = 32°C; freezing/melting point = −85.61°C; vapor pressure = 750 mmHg @ 31°C; flash point = −36°C. Explosive limits: LEL = 2.3%; UEL: 14.3%[17]. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 4, reactivity 1. Insoluble in water.

Potential Exposure: Furan is used as a chemical intermediate in the production of herbicides and pharmaceuticals; for making tetrahydrofuran; in formation of lacquers; as a solvent for resins in organic synthesis, especially for pyrrole, thiophene.

Incompatibilities: May form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong acids, amines, strong bases, reducing agents. Unless stabilized with an inhibitor, air exposure forms unstable peroxides.

Permissible Exposure Limits in Air

PAC* Ver. 29[138]

PAC-1: 0.62 ppm

PAC-2: $\mathbf{6.8_A}$ ppm

PAC-3: $\mathbf{19_A}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60-minute values.

DFG MAK:[skin] Carcinogen Category 2

Russia: STEL 0.5 milligram per cubic meter [skin] 1993

Permissible Concentration in Water: Russia[43] set a MAC in water bodies used for domestic purposes of 0.2 mg/L.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 1.3. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion, skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Contact can irritate and burn the skin and eyes. Vapors can irritate the respiratory tract and are a central nervous system depressant. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Exposure can cause headache, dizziness, shortness of breath; unconsciousness, and suffocation are among the symptoms. The vapors are narcotic. Acute exposure to furan by inhalation may involve both reversible and irreversible changes. Acute exposure by ingestion or skin absorption, as well as chronic exposure, are associated with high toxicity.

Long-Term Exposure: Furan may be a carcinogen since it has been shown to cause cancer of the liver and white blood cells in animals. May cause skin allergy. May damage the liver and kidneys.

Points of Attack: Skin, liver, kidneys.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Liver and kidney function tests. Consider chest X-ray following acute overexposure. Evaluation by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Polyvinyl alcohol is among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. For emergency situations, wear a positive pressure, pressure-demand, full facepiece SCBA or pressure-demand supplied air respirator with escape SCBA and a fully encapsulating, chemical resistant suit.

Respirator Selection: *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved SCBA that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-face-piece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA)

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in an explosion-proof refrigerator[52]. Keep in a tightly closed container under an inert atmosphere and protect from light for long-term storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2389 Furan, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Avoid breathing vapors. Keep upwind. Do not handle broken packages without protective equipment. Wash away any material which may have contacted the body with copious amounts of water or soap and water. Shut off ignition sources; no flares, smoking, or flames in hazard area. Stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: dike far ahead of spill for later disposal. The exposure concentration limit of 10 ppm together with the low boiling point of furan requires that adequate ventilation be provided in areas handling this chemical. Establish forced ventilation to keep levels below explosive limit. Contact with liquid must be avoided since this chemical can be absorbed through the skin. Keep furan out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. Thorough washing with soap and water followed by prolonged rinsing should be done immediately after accidental contact. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Water may be ineffective. *Small fires:* use dry chemical, carbon dioxide; water spray; or alcohol foam. *Large fires:* water spray, fog, or alcohol foam. Move container from fire area if this can be accomplished without risk. Spray cooling water on containers that are exposed to flames until well after fire is out. For massive fires in cargo area, use unmanned hose holder or monitor nozzles; if this is impossible withdraw from area and let fire burn. Withdraw immediately in case of rising sound from venting safety device or any discoloration of tank due to fire. Isolate for 1/2 mi in all directions if a tank car or truck is involved. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(109); (102); (31); (173); (101); (138); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 7, No. 3, 93–95 (1987).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Furan, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Furan, Trenton, NJ (May 1999).

Furfural F:0510

Formula: $C_5H_4O_2$
Synonyms: Artificial Ant oil; Fural; 2-Furaldehyde; Furale; 2-Furanaldehyde; 2-Furancarbonal; 2-Furancarboxaldehyde; Furfuraldehyde; α-Furole; Furole; 2-Furyl-methanal; NCI-C56177; Oil of ants, artificial; Pyromucic aldehyde
CAS Registry Number: 98-01-1
HSDB Number: 542
RTECS Number: LT7000000
UN/NA & ERG Number: UN1199/132
EC Number: 202-627-7 [*Annex I Index No.:* 605-010-00-4]
Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Limited Evidence; Human Inadequate Evidence, 1995; United States Environmental Protection Agency Gene-Tox Program, Positive: Histidine reversion-Ames test NTP: Carcinogenesis Studies (gavage); some evidence: rat; NCI: Carcinogenesis Studies (gavage); equivocal evidence: rat; clear evidence: mouse.

Hazard Alert: Poison, Flammable, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U125

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 5000 lb (2270 kg)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R10; R21/22; R23; R36/37; R40; R48/20; R61; R62; R63; safety phrases: S1/2; S36/37; S S45; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Furfural is a colorless to yellow aromatic heterocyclic aldehyde with an almond-like odor. Turns amber on exposure to light and air. Molecular weight = 96.09; specific gravity (H_2O:1) = 1.16 @ 20°C; boiling point = 161.7°C; freezing/melting point = −38.1; vapor pressure = mmHg 1.7 @ 16°C; flash point = 60°C; Autoignition temperature = 316°C. Explosive limits: LEL = 2.1%; UEL: 19.3%. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 2, reactivity 0. Soluble in water; solubility = 8%.

Potential Exposure: Furfural is used for lube oil refining and butadiene extraction; as a solvent for wood resin, nitrated cotton, cellulose acetate, and gums; in the production of phenolic plastics, thermosetting resins, refined petroleum oils, dyes, and varnishes; in the manufacture of pyromucic acid, vulcanized rubber, insecticides, fungicides, herbicides, germicides, furan derivatives, polymers, and other organic chemicals.

Incompatibilities: May form explosive mixture with air. Acids and bases can cause polymerization, causing fire or explosion hazard. Reacts violently with oxidants. Incompatible with strong acids; caustics, ammonia, aliphatic amines; alkanolamines, alromatic amines; oxidizers. Attacks many plastics.

Permissible Exposure Limits in Air

NIOSH IDLH = 100 ppm

OSHA PEL: 5 ppm/20 milligram per cubic meter TWA [skin]

NIOSH REL: None, see Appendix D

ACGIH TLV[1]: 2 ppm/7.9 milligram per cubic meter TWA [skin]; confirmed animal carcinogen with unknown relevance to humans; BEI: 200 mg/g creatinine, end-of-shift; Total fuoric acid in urine.

PAC* Ver. 29[138]

PAC-1: $\mathbf{2_E}$ ppm

PAC-2: $\mathbf{10_E}$ ppm

PAC-3: $\mathbf{100_E}$ ppm

*ERPG [Emergency Response Planning Guidelines] are marked with a subscript "**E**."

DFG MAK: [skin] Carcinogen Category 3B

Australia: TWA 2 ppm (8 milligram per cubic meter) [skin], 1993; Austria: MAK 5 ppm (20 milligram per cubic meter), 1999; Belgium: TWA 2 ppm (7.9 milligram per cubic meter) [skin], 1993; Denmark: TWA 2 ppm (7.9 milligram per cubic meter) [skin], 1999; Finland: TWA 2 ppm (8 milligram per cubic meter) [skin], 1999; France: VLE 2 ppm (8 milligram per cubic meter), 1999; Japan: 2.5 ppm (9.8 milligram per cubic meter) [skin], 1999; the Netherlands: MAC-TGG 8 milligram per cubic meter, 2003; Norway: TWA 2 ppm (8 milligram per cubic meter), 1999; the Philippines: TWA 5 ppm (20 milligram per cubic meter) [skin], 1993; Poland: MAC (TWA) 10 milligram per cubic meter, MAC (STEL) 40 milligram per cubic meter, 1999; Russia: TWA 2.5 ppm; STEL 10 milligram per cubic meter [skin], 1993; Sweden: NGV 2 ppm (8 milligram per cubic meter), KTV 5 ppm (20 milligram per cubic meter) [skin], 1999; Switzerland: MAK-W 2 ppm (8 milligram per cubic meter) [skin], 1999; Turkey: TWA 5 ppm (20 milligram per cubic meter) [skin], 1993; United Kingdom: TWA 2 ppm (8 milligram per cubic meter); STEL 5 ppm [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: confirmed animal carcinogen with unknown relevance to humans. The Czech Republic: MAC 2.5 ppm. Russia[35,43] set a MAC in ambient air of residential areas of 0.05 milligram per cubic meter both on a momentary and on a daily average basis. Several states have set guidelines or standards for furfural in ambient air[60] ranging from 26.7 μ/m^3 (New York) to 80.0 μ/m^3 (Florida) to 160.0 μ/m^3 (Connecticut) to 190 μ/m^3 (Nevada) to 200.0 μ/m^3 (South Carolina) to 80.0−400.0 μ/m^3 (North Dakota).

Determination in Air: Use NIOSH Analytical Method (IV) #2529 or OSHA Analytical Method 72.

Permissible Concentration in Water: Russia[35,43] set a MAC in water bodies used for domestic purposes of 1.0 mg/L.

Routes of Entry: Inhalation of vapor; percutaneous absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Contact may cause skin irritation, causing rash and a burning sensation. Liquid and concentrated vapor are irritating to the eyes, skin, upper respiratory tract. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Workers chronically exposed to the vapor have had complaints of headache, fatigue, itching of the throat; lacrimation, loss of the sense of taste; numbness of the tongue; and tremor. Occupational overexposure is relatively rare due to the liquid's low vapor pressure, and symptoms usually disappear rapidly after removal from exposure.

Long-Term Exposure: Eczematous dermatitis as well as skin sensitization, resulting in allergic contact dermatitis and photosensitivity, may develop following repeated exposure. The substance may have effects on the liver. Furan causes mutations. Repeated exposure may cause loss of taste, numbness of the tongue; and may cause headaches, tiredness, tremors, itchy throat; watery eyes. Long term exposure may cause skin to sunburn more easily.

Points of Attack: Eyes, respiratory system; skin.

Medical Surveillance: NIOSH lists the following tests: urine (chemical/metabolite); urine (chemical/metabolite), end-of-shift. For those with frequent or potentially high exposure (half the TLV or greater) the following are recommended before beginning work and at regular times after that. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: liver function tests. Consider chest X-ray after acute overexposure. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Prevent skin contact. **8 hours:** butyl rubber (gloves, suits, boots), 4*H* and Silver Shield gloves; Barricade coated suits; CPF3 suits, Trellchem HPS$^{\text{suits; Trychem 1000}}$ suits; **4 hours:** PVA, Saranex coated suits. Also, safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: OSHA: *50 ppm:* CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)]; or Sa (APF = 10) (any supplied-air respirator). *100 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or CcrFOv (APF = 50) [any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s)]; or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Furfural must be stored to avoid contact with oxidizing materials (such as perchlorates, peroxides, chlorates, nitrates, and permanganates) and strong acids because violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where furfural is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist.

Shipping: UN1199 Furaldehyde, Hazard class: 6.1; Labels: 6.1-Poisonous materials, 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. Keep furfural out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 2, 41−42 (1980), and 7, No. 3, 96−102(100); (1987)(2).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Furfural, Trenton, NJ (January 2000).

Furfuryl Alcohol F:0520

Formula: $C_5H_6O_2$: $C_4H_3OCH_2OH$

Synonyms: Alcohol furfurilico (Spanish); Alcool furfurylique (French); 2-Furancarbinol; 2-Furanmethanol; Furfural alcohol; Furfuralcohol; Furfurylalkohol (German); Furylalcohol; 2-Furylcarbinol; 2-Hydroxymethylfuran; Microposit remover 1112A; NCI-C56224

CAS Registry Number: 98-00-0

HSDB Number: 711

RTECS Number: LU9100000

UN/NA & ERG Number: UN2874/153

EC Number: 202-626-1 [*Annex I Index No.:* 603-018-00-2]

Regulatory Authority and Advisory Information

Carcinogenicity: NTP: Carcinogenesis Studies (inhalation): some evidence: mouse, rat; NCI: Carcinogenesis Studies (inhalation); equivocal evidence: mouse, rat.

Hazard Alert: Poison, Flammable, Possible risk of forming tumors, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction).

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R10; R21/22; R23; R36/37; R40; R48/20; R61; R62; safety phrases: S1/2; S36/37; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Furfural alcohol is a colorless to amber liquid that darkens on exposure to light. It has a faint, burning odor. Molecular weight = 98.1; specific gravity (H_2O:1) = 1.13 @ 20°C; Boiling point: 171°C; freezing/melting point: −15°C; vapor pressure = 0.75 mmHg @ 20°C; flash point = 65°C (cc); 75°C (oc); Autoignition temperature = 491°C. Explosive limits: LEL = 1.8%; UEL: 16.3%. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 2, reactivity 1. Soluble in water.

Potential Exposure: Used as a starting monomer in the production of furan resins and used to produce tetrahydrofurfural alcohol (THFA).

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Contact with acids can cause polymerization. Strong reaction with oxidizers. Incompatible with alkaline earth and alkali metals; strong caustics; aliphatic amines; isocyanates, acetaldehyde, benzoyl peroxide; chromic acid, chromium trioxide; cyanoacetic acid; dialkylzincs, dichlorine oxide; ethylene oxide; hydrogen peroxide; isopropyl chlorocarbonate; lithium tetrahydroaluminate; nitric acid; nitrogen dioxide; pentafluoroguanidine, phosphorus pentasulfide; tangerine oil; triethylaluminum, triisobutylaluminum. Attacks some plastics, coatings and rubber.

Permissible Exposure Limits in Air
NIOSH IDLH = 75 ppm
OSHA PEL: 50 ppm/200 milligram per cubic meter TWA [skin]
NIOSH REL: 10 ppm/40 milligram per cubic meter TWA; 15 ppm/60 milligram per cubic meter STEL [skin]
ACGIH TLV[1]: 10 ppm/40 milligram per cubic meter TWA; 15 ppm/60 milligram per cubic meter STEL [skin
PAC Ver. 29[138]
PAC-1: 15 ppm
PAC-2: 42 ppm
PAC-3: 250 ppm
DFG MAK: 10 ppm/41 milligram per cubic meter TWA; Peak Limitation Category I(1) [skin]
Australia: TWA 10 ppm (40 milligram per cubic meter); STEL 15 ppm [skin], 1993; Austria: MAK 5 ppm (20 milligram per cubic meter), 1999; Belgium: TWA 10 ppm (40 milligram per cubic meter); STEL 15 ppm [skin], 1993; Denmark: TWA 5 ppm (20 milligram per cubic meter) [skin], 1999; Finland: TWA 5 ppm (20 milligram per cubic meter); STEL 10 ppm (40 milligram per cubic meter) [skin], 1999; France: VME 10 ppm (40 milligram per cubic meter) [skin], 1999; Hungary: STEL 8 milligram per cubic meter [skin], 1993; the Netherlands: MAC-TGG 20 milligram per cubic meter [skin], 2003; Norway: TWA 5 ppm (20 milligram per cubic meter), 1999; the Philippines: TWA 50 ppm (200 milligram per cubic meter), 1993; Russia: TWA 5 ppm; STEL 0.5 milligram per cubic meter [skin], 1993; Sweden: NGV 5 ppm (20 milligram per cubic meter), KTV 10 ppm (40 milligram per cubic meter), 1999; Switzerland: MAK-W 10 ppm (40 milligram per cubic meter) [skin], 1999; Turkey: TWA 50 ppm (200 milligram per cubic meter), 1993; United Kingdom: TWA 5 ppm (20 milligram per cubic meter); STEL 15 ppm [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 15 ppm [skin]

Determination in Air: Use NIOSH Analytical Method #2505.

Determination in Water: Octanol—water coefficient: Log $K_{ow} = < 0.3$. Unlikely to bioaccumulate in marine organisms.

Short-Term Exposure: Irritates the eyes, skin, and respiratory tract. Causes tearing of the eyes, dizziness, nausea, diarrhea, diuresis; vomiting, dermatitis. High exposures may cause respiratory and body temperature depression, with a lowering of consciousness.

Long-Term Exposure: Removes the skins natural oils, causing redness and itching. May affect the central nervous system.

Points of Attack: Eyes, skin, respiratory system; central nervous system.

Medical Surveillance: NIOSH lists the following tests: expired air; pulmonary function tests. Consider the points of attack in preplacement and periodic physical examinations. Lung function tests. Nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Prevent skin contact. **8 hours:** 4*H* and Silver Shield gloves. Also, safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *75 ppm:* CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister]; or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]; or Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA). Note: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Metal containers involving the transfer of 5 gal or more of ethyl acetate should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of ethyl acetate. Store in containers that are properly labeled with health hazard information and safe handling procedures. Wherever ethyl acetate is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Furfuryl alcohol must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine) and any acid, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where furfuryl alcohol is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever furfuryl alcohol is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN2874 Furfuryl alcohol, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration in admixture with a more flammable solvent.

References

(31); (173); (101); (138); (2); (100).

National institute for Occupational Safety and Health (NIOSH), Information Profiles on Potential Occupational Hazards: Furfuryl Alcohol, Report PB-276,678, pp. 12−15, Rockville, MD (1977).

National institute for Occupational Safety and Health (NIOSH), "Criteria for a Recommended Standard: Occupational Exposure to Furfuryl Alcohol", NIOSH Document Number 79-133, Cincinnati, OH (1979).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Furfuryl Alcohol, Trenton, NJ (July 2005).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 7, No. 6, 56−60 (1987).

G

Gallium G:0050

Formula: Ga
Synonyms: Elemental gallium
CAS Registry Number: 7440-55-3
HSDB Number: 6956
RTECS Number: LW8600000
UN/NA & ERG Number: UN2803/172
EC Number: 231-163-8

Regulatory Authority and Advisory Information

Hazard Alert: Corrosive, Strong reducing agent, Suspected of causing genetic defects.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: C, T, Xi; risk phrases: R23/24/25; R34; R36/37/38; R62; safety phrases: S26; S27; S28; S36/37/39; S41; S45 (see Appendix 4)

Description: Gallium is a lustrous, silvery liquid, metal, or gray solid. Molecular weight = 69.72; specific gravity (H_2O:1) = 5.9 @ 20°C; boiling point = 2403°C; freezing/melting point = 30°C. Hazard identification (based on NFPA-704 M Rating System): (metal) Health 2, Flammability 0, Reactivity 0. Insoluble in water.

Potential Exposure: A potential danger to those involved in preparing such semiconductor compounds as gallium arsenide. Used in light-emitting diodes, batteries, and microwave equipment.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides such as lyes, halogens, and alloys of aluminum. Contact with hydrogen chloride/hydrochloric acid or hydrogen peroxide may result in explosion. Corrosive on contact with metals. Moisture, oxygen, and air sensitive.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC) Ver. 29[138]
PAC-1: 30 milligram per cubic meter
PAC-2: 330 milligram per cubic meter
PAC-3: 2000 milligram per cubic meter

Routes of Entry: Inhalation, ingestion, and skin and/or eyes.

Harmful Effects and Symptoms

Short-Term Exposure: Gallium can affect you when breathed in. Gallium is a corrosive chemical and exposure can irritate or burn the eyes, nose, and throat. Inhalation can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Repeated or high exposures can cause metallic taste; nausea, vomiting, skin rash, and may damage the kidneys.

Long-Term Exposure: May cause kidney damage. Some gallium compounds affect the nervous system. Highly irritating substances, such as gallium, may affect the lungs.

Points of Attack: Kidneys.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: kidney function tests.

First Aid: *Eye Contact:* Immediately remove any contact lenses and flush with large amounts of water for at least 15 minutes, occasionally lifting upper and lower lids. *Skin Contact:* Remove contaminated clothing. Wash contaminated skin with water. *Breathing:* Remove the person from exposure. Begin (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. If swallowed, do not induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid, unless full facepiece respiratory protection is worn. Wear dust-proof goggles and face shield when working with powders or dust, unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposure to solid gallium, use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece respirator with a high efficiency particulate filter. Greater protection is provided by a powered-air purifying respirator. Where there is potential for exposure to liquid gallium or high exposures exists, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved self-contained breathing apparatus with a full facepiece operated in the pressure-demand or other positive pressure mode.

DOI: http://dx.doi.org/10.1016/B978-0-323-38968-6.00007-7

Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens.

Storage: Color code-White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location; in tightly closed original containers in a cool, well-ventilated area. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Gallium must be stored to avoid contact with acids and halogens, since violent reactions occur.

Shipping: UN2803 Gallium, Hazard class: 8; Labels: 8-Corrosive material.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide; water spray; or foam extinguishers. Poisonous metal oxides are released in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Use a licensed professional waste disposal service to dispose of this material. Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Gallium*, Trenton, NJ (January 2001).

Gallium Trichloride G:0075

Formula: Cl_3Ga; $GaCl_3$

Synonyms: Gallium chloride; Gallium(3+) chloride; Gallium (III) chloride; Tricloruro de galio (Spanish)

CAS Registry Number: 13450-90-3

HSDB Number: 6445

RTECS Number: LW9100000

UN/NA & ERG Number: UN1759 (corrosive solids, n.o.s.)/154; UN3260 (solid)/154

EC Number: 236-610-0

Regulatory Authority and Advisory Information

Hazard Alert: Suspected reprotoxic hazard, Corrosive, Known catalytic activity.

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 500 lb (227 kg).

United States National Primary Drinking Water Regulations: SMCL = 250 mg$[Cl^-]$/L as Chloride

Hazard symbols, risk, & safety statements: Hazard symbol: C, N; risk phrases: R14; R22; R34; R50/53; R63; R65; R67; safety phrases: S16; S26; S27; S28; S29; S33; S36/37/39; S45; S61; S62 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water [Sigma-Aldrich MSDS].

Description: Gallium trichloride is a colorless solid which forms needle-like crystals. Acidic odor. Molecular weight = 176.081; specific gravity (H_2O:1) = 2.5 @ 26°C; boiling point = 201°C; freezing/melting point = 78°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 1 ₩. Extremely soluble in water. Moisture sensitive; reaction with water may be violent.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, active metals, and water. Aqueous solution is acidic.

Potential Exposure: Used as a raw material in the production of metallic gallium; and in the processing of monocrystal, semiconductor compounds.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 2.9 milligram per cubic meter

PAC-2: 32 milligram per cubic meter

PAC-3: 930 milligram per cubic meter

Routes of Entry: Inhalation, skin, and eyes.

Harmful Effects and Symptoms

Short-Term Exposure: May act on skin or mucous membranes. May cause rash and neuritis. Can cause respiratory center paralysis and death in animals.

Points of Attack: Skin, liver, and respiratory organs.

Medical Surveillance: In view of the toxicity of gallium and its compounds, as shown by experiments, all persons involved in work with these substances should undergo periodic medical examinations, during which special attention should be paid to the condition of the liver, respiratory organs, and skin[136].

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.

Storage: Color code-White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area.

Shipping: UN3260 Corrosive solid, acidic, inorganic, n.o.s., Hazard class: 8; Labels: 8-Corrosive material, Technical Name Required. UN1759 Corrosive solids, n.o.s., Hazard class: 8; Labels: 8-Corrosive material, Technical Name required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Poisonous and corrosive fumes of chlorine and hydrogen chloride are released in fire. This chemical is a combustible solid. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: *Gallium Trichloride*, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

Gasoline G:0100

Formula: C_5H_{12} to C_9H_{20}

Synonyms: Benzine; Essance (French); Gasolina (Spanish); Motor fuel; Motor spirits; Natural gasoline; Petrol

CAS Registry Number: 8006-61-9; 86290-81-5 [A complex combination of hydrocarbons consisting primarily of paraffins, cycloparaffins, aromatic and olefinic hydrocarbons having carbon numbers predominantly greater than C3 and boiling in the range of 30 to 260°C/86 to 500°F].

HSDB Number: 6477 (86290-81-5)

RTECS Number: LX3300000

UN/NA & ERG Number: UN1203/128

EC Number: 232-349-1 [*Annex I Index No.:* 649-261-00-8]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Sufficient Evidence; Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B, 1989; NIOSH: Potential occupational carcinogen

California Proposition 65 Chemical[102]: Cancer [Unleaded gasoline (wholly vaporized)] 1/1/1988; [Gasoline engine exhaust (condensates/extracts)] 10/1/1990.

Hazard Alert: Highly flammable, Possible risk of forming tumors, Primary irritant (w/o allergic reaction).

European/International Regulations (*8006-61-9*): Hazard symbol: F, Xi; risk phrases: R11; R36; R657; safety phrases: S2; S7; S16; S21; S24/25; S26; S41; (*86290-81-5*): Hazard symbols, risk, & safety statements: Hazard symbol: T, F+; risk phrases: R12; R45; R46; R65; safety phrases: S21; S53; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water. (CAS: 86290-81-5)

Description: Gasoline is a highly flammable, mobile liquid with a characteristic odor. A complex mixture of volatile hydrocarbons (paraffins, cycloparaffins, and aromatics). Physical property values may vary depending on grade. The Odor Threshold is 0.25 ppm[41]. Molecular weight = 72; specific gravity (H_2O:1) = 0.72−0.76 @ 16°C; boiling point = 38°C; freezing/melting point = −90.5°C; flash point = −45°C to −38 (depending on octane). Explosive limits: LEL = 1.4%; UE = 7.6%. Hazard identification (based on NFPA-704 M Rating System): Health 1, Flammability 3−4, Reactivity 0. Insoluble in water.

Potential Exposure: Gasoline is used as a fuel, diluent, and solvent throughout industry.

Incompatibilities: May form explosive mixture with air. Strong oxidizers may cause fire and explosions. Incompatible with nitric acid. May accumulate static electrical charges, and may cause ignition of its vapors.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 4.5 milligram per cubic meter (approx) @ 25°C & 1 atm

Odor Threshold = 0.25 ppm[41]

Presently, the composition of gasoline is so varied that a single standard for all types of gasoline is not applicable[3]. It is recommended, however, that atmospheric concentrations should be limited by the aromatic hydrocarbon content.

OSHA PEL: None

NIOSH REL: Potential occupational carcinogen; See *NIOSH Pocket Guide*, Appendix A; [15 ppm LOQ (* The analytical limit of quantitation)], DHHS #92-100, 1992

ACGIH TLV[1]: 300 ppm/890 milligram per cubic meter TWA; 500 ppm/1480 milligram per cubic meter STEL; confirmed animal carcinogen with unknown relevance to humans, See *NIOSH Pocket Guide*, Appendix A.

PAC* Ver. 29[138]

86290-81-5

PAC-1: $\mathbf{200_E}$ ppm

PAC-2: $\mathbf{1000_E}$ ppm

PAC-3: $\mathbf{4000_E}$ ppm

*ERPG [Emergency Response Planning Guidelines] are marked with a subscript "**E**."

Japan; 100 ppm (300 milligram per cubic meter), 1999; Sweden: NGV 200 ppm (800 milligram per cubic meter), KTV 300 ppm (1200 milligram per cubic meter), 1993; Switzerland: MAK week 500 ppm (2000 milligram per cubic meter), 1999; Turkey: TWA 500 ppm (2000 milligram per cubic meter), 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: STEL 500 ppm

Several states have set guidelines or standards for gasoline in ambient air[60] ranging from 15.0 milligram per cubic meter (Virginia) to 18.0 milligram per cubic meter (Connecticut) to 21.429 milligram per cubic meter (Nevada).

Determination in Air: Use NIOSH Analytical Method #PV2820.

Permissible Concentration in Water: States which have set guidelines for gasoline in drinking water include Rhode Island (zero concentration) and Maine (100 μg/L).

Routes of Entry: Inhalation, percutaneous absorption.

Harmful Effects and Symptoms

Short-Term Exposure: Contact can cause eye and skin irritation. Inhalation can cause irritation of the respiratory tract. High levels can cause headache, nausea, dizziness, irregular heartbeat; loss of coordination; seizures, coma, and possible death. *Inhalation:* Nose and throat irritation have been reported after exposure to 900 ppm for 1 hour. Drowsiness, dizziness, nausea, and numbness may occur @ 1000 ppm after 15 minutes exposure. In animal studies, death occurred after 30,000 ppm for 5 minutes. *Skin:* May cause itching and burning of the skin and after a longer exposure, redness and blistering. *Eyes:* Moderate irritation of the eye has been reported after 1 hour exposure to 500 ppm. Mild irritation has been reported after an 8 hours exposure to 140 ppm. *Ingestion:* Gasoline causes a burning sensation in the mouth, throat, and stomach. Vomiting, diarrhea, drowsiness, and intoxication may follow. As little as 3−4 ounces may be fatal. Inhalation of liquid gasoline into the lungs following ingestion or vomiting may result in pulmonary edema (an accumulation of fluid in the lungs and a medical emergency that can be delayed for several hours), rapid breathing, or death.

Long-Term Exposure: There is evidence that gasoline can cause kidney cancer in animals. Repeated exposure can cause permanent eye damage. Prolonged contact can cause drying of the skin with cracking and rash. Repeated high exposure may damage the lungs; and/or cause brain damage. May cause kidney damage. Gasolines often contain hexane, benzene, and lead. Hexane, a component of gasoline, can produce disturbed sleep; resulting in tremors, numbness of hands and feet, and loss of muscle control. Benzene, has been linked to blood disorders in humans, including leukemia. Lead additives can produce nausea, cramps, loss of appetite, sleep problems, headaches, and agitation. See also entries for *tetraethyl lead, benzene, hexane, and ethylene dibromide*.

Points of Attack: Kidneys, skin, eyes, nervous system, and brain. Cancer site in animals: liver and kidney.

Medical Surveillance: If symptoms develop or overexposure has occurred, the following may be useful: urinary lead level. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. If swallowed, use gastric lavage (stomach wash) followed by saline catharsis. Get medical attention. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered.

Personal Protective Methods: Barrier creams and impervious gloves. Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin contact: **8 hours**: nitrile rubber gloves, suits, boots; Viton gloves, suits; Barricade coated suits; **4 hours**: polyvinyl alcohol gloves; 4 H and Silver Shield gloves; Responder suits. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash, protective clothing, and masks in heavy exposure to vapors.

Respirator Selection: Where there is potential exists for exposure over 300 ppm; Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator with an organic vapor cartridge/canister. More protection is provided by a powered-air purifying respirator. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.

Storage: Color code-Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Sources of ignition, such as smoking and open flames are prohibited where gasoline is handled, used, or stored. Metal containers involving the transfer of 1 gallons or more of gasoline should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of gasoline. Wherever gasoline is used, handled, manufactured, or stared, use explosion-proof electrical equipment and fittings.

Shipping: UN1203 Gasoline includes gasoline mixed with ethyl alcohol, with not >10% alcohol, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed. Alternatively, gasoline vapors may be recovered from fuel transfer operations by various techniques.

References

(102); (31); (173); (101); (138); (2); (100).

New York State Department of Health, *Chemical Fact Sheet: Gasoline*, Bureau of Toxic Substance Assessment, Albany, NY (Mart 1986)

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 1, No. 8, 75–76 (1981)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Gasoline*, Trenton, NJ (April 2003)

Germanium G:0110

Formula: Ge

Synonyms: Elemental germanium; Germanium element

CAS Registry Number: 7440-56-4

HSDB Number: 2118

RTECS Number: LY5200000 (powder)

UN/NA & ERG Number: UN3089 (metal powder, flammable, n.o.s.)/170; UN1759 (corrosive solid, n.o.s.)/154

EC Number: 231-164-3

Regulatory Authority and Advisory Information

Listed in on the TSCA inventory

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xi; risk phrases: R11; R36/37/38; safety phrases: S2; S16; S26; S36/37/39; S41 (see Appendix 4)

Description: Germanium is a grayish-white, lustrous, and brittle metalloid. The powder is grayish-black and odorless. It is never found free and occurs most commonly in ergyrodite and germanite. It is generally recovered as a by-product in zinc production, coal processing, or other sources. Molecular weight = 72.59; specific gravity (H_2O:1) = 5.4 g/cm^3; boiling point = 2833°C; melting/freezing point = 937°C; vapor pressure = 0 mmHg @ 25°C. Insoluble in water.

Potential Exposure: Because of its semiconductor properties, germanium is widely used in the electronic industry in rectifiers, diodes, and transistors. It is alloyed with aluminum, aluminum–magnesium, antimony, bronze, and tin to increase strength, hardness, or corrosion resistance. In the process of alloying germanium and arsenic, arsine may be released; stibine is released from the alloying of germanium and antimony. Germanium is also used in the manufacture of optical glass for infrared applications; red-fluorescing phosphors; and cathodes for electronic valves; and in electroplating; in the hydrogenation of coal; and as a catalyst, particularly at low temperatures. Certain compounds are used medically. Industrial exposures to the dust and fumes of the metal or oxide generally occur during separation and purification of germanium, welding, multiple-zone melting operations, or cutting and grinding of crystals. Germanium tetrahydride (germanium hydride, germane, and monogermane) and other hydrides are produced by the action of a reducing acid on a germanium alloy.

Incompatibilities: A strong reducing agent and flammable solid. Finely divided metal is incompatible with oxidizing and nonoxidizing acids, ammonia, bromine, oxidizers, aqua regia, sulfuric acid, carbonates, halogens, and nitrates. Explosive reaction or ignition with potassium chlorate, potassium nitrate, chlorine, bromine, oxygen, and potassium hydroxide in the presence of heat. Violent reaction with strong acids: aqua regia, nitric, and sulfuric. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 3.2 milligram per cubic meter

PAC-2: 35 milligram per cubic meter

PAC-3: 170 milligram per cubic meter

Russia[43] set a MAC in work-place air of 2 milligram per cubic meter.

Permissible Concentration in Water: EPA[32] has suggested a permissible ambient goal of 8 μg/L based on health effects.

Determination in Water: Germanium may be determined by atomic absorption spectroscopy, emission spectrography, and spectrophotometry with phenylfluorone.

Routes of Entry: Inhalation of gas, vapor, fume, or dust.

Harmful Effects and Symptoms

Short-Term Exposure: Symptoms of germanium exposure[24] include low temperature, languor, diarrhea, cyanosis, extreme depression of heart and breath, edema, lung hemorrhage, hemorrhage from the small intestinal wall, and peritoneal extravasation. The dust of germanium dioxide is irritating to the eyes. Germanium tetrachloride causes irritation of the skin. Germanium tetrachloride is an upper respiratory irritant and may cause bronchitis and pneumonitis.

Long-Term Exposure: Prolonged exposure to high level concentrations may result in damage to the liver, kidney, and other organs.

Medical Surveillance: Consider respiratory, liver, and kidney disease in any placement or periodic examinations.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way* *valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.

Storage: (1) Color code-Red Stripe: Flammability Hazard: Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1 hour fire wall from flammable or reactive materials. Store flammable solids up to maximum allowable quantity per control area in an approved flammable storage area. Do not store in a basement. (2) Color code-Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well ventilated area separated from strong oxidants, strong bases and strong acids. Metal containers involving the transfer of this chemical should be grounded and bonded. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN3089 Metal powders, flammable, n.o.s., Hazard Class: 4.1; Labels: 4.1-Flammable solid. UN1759 Corrosive solids, n.o.s., Hazard class: 8; Labels: 8-Corrosive material, Technical Name required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include metal oxides. Use special mixtures of dry chemicals appropriate for extinguishing metal fires. *Do not use water.* If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Recovery and return to suppliers for reprocessing is preferable.

References

(31); (173); (101); (138).

United States Environmental Protection Agency, *Toxicology of Metal*, Vol. II: Germanium, pp. 222−223, Report EPA-600/1-77-022, Research Triangle Park, NC (May 1977)

Germanium Tetrahydride (Germane) G:0120

Formula: GeH_4

Synonyms: Germane; Germanium hydride; Germanomethane; Monogerman

CAS Registry Number: 7782-65-2

HSDB Number: 7911
RTECS Number: LY4900000
UN/NA & ERG Number: (PIH) UN2192 (toxic, inhalation hazard, Zone B)/119
EC Number: 231-961-6

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Theft hazard* 45 (≥20.73% concentration)

Hazard Alert: Poison inhalation hazard: exposure can be lethal, Pyrophoric hazard, Highly poisonous gas with inadequate warning properties, Strong reducing agent, Extremely flammable gas, Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated, Hemolytic effects.

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, F+, Xn; risk phrases: R5; R12; R17, R21; R22; R26; R40; R48/20; safety phrases: S1; S9; S16; S24; S26; S33; S36/37/39; S38; S41; S45 (see Appendix 4)

Description: Germane is a colorless, flammable gas. Pungent odor. Molecular weight = 76.63; specific gravity (H_2O:1) = 1.52 @ −142°C; boiling point = −88.3°C; freezing/melting point = −166°C; relative vapor density (air = 1) = 2.65; vapor pressure = > 1 atm @ 25°C; autoignition temperature = < 85°C. Flammable limits in air: pyrophoric. Hazard identification (based on NFPA-704 M Rating System): Health 4, Flammability 4, Reactivity 3. Insoluble in water.

Potential Exposure: This material is used as a doping agent in solid state electronic component manufacture.

Incompatibilities: Pyrophoric; may ignite spontaneously in air. Attacks hydrocarbon and fluorocarbon lubricants. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from oxidizing and nonoxidizing acids, ammonia, aqua regia, sulfuric acid, carbonates, halogens, and nitrates. Explosive reaction or ignition with potassium chlorate, potassium nitrate, chlorine, bromine, oxygen, and potassium hydroxide in the presence of heat.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 3.13 milligram per cubic meter @ 25°C & 1 atm
OSHA PEL: None
NIOSH REL: 0.2 ppm/0.6 milligram per cubic meter TWA
ACGIH TLV[1]: 0.2 ppm
PAC* Ver. 29[138]
PAC-1: 0.015 ppm
PAC-2: **0.17**$_{\mathbf{A}}$ ppm
PAC-3: **0.50**$_{\mathbf{A}}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values. Australia: TWA 0.2 ppm (0.6 milligram per cubic meter), 1993; Belgium: TWA 0.2 ppm (0.63 milligram per cubic meter), 1993; Denmark: TWA 0.2 ppm (0.6 milligram per cubic meter), 1999; Finland: STEL 0.2 ppm (0.6 milligram per cubic meter), 1999; France: VME 0.2 ppm (0.6 milligram per cubic meter), 1999; Norway: TWA 0.2 ppm (0.6 milligram per cubic meter), 1999; Russia: STEL 5 milligram per cubic meter, 1993; the Netherlands: MAC-TGG 0.6 milligram per cubic meter, 2003; United Kingdom: TWA 0.2 ppm (0.64 milligram per cubic meter); STEL 0.6 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: TWA 0.2 ppm. Several states have set guidelines or standards for germane in ambient air[60] ranging from 6.0 μ/m^3 (North Dakota) to 10.0 μ/m^3 (Virginia) to 12.0 μ/m^3 (Connecticut) to 14.0 μ/m^3 (Nevada).

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short-Term Exposure: Inhalation can cause headache, giddiness, fainting, nausea, and vomiting. Data on toxicity are limited but ACGIH reports that it is between ten hydride (stannone) and arcine in toxicity. Germanium tetrahydride is a toxic hemolytic gas capable of production kidney damage. This effect is similar to that of arsine and stibine (antimony hydride). One hour exposure tests on animals yielded the following results: animal rabbit, concentration 100 ppm, effect survived; animal mouse, concentration 150 ppm, effect fatal; animal mouse, concentration 185 ppm, effect fatal; animal guinea pig, concentration 150 ppm, effect sickened; and animal guinea pig, concentration 185 ppm, effect fatal. The TWA value was set on the rather arbitrary basis that germane can be considered half as toxic as stibine[53].

Long-Term Exposure: May cause kidney injury. Hemolytic effects, affecting blood cells.

Points of Attack: Central nervous system kidneys, and blood.

Medical Surveillance: Workers exposed to germane should undergo periodic physical examinations[30]. Kidney function tests. Complete blood count (CBC). Examination of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof chemical goggles and

face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.

Storage: Check oxygen content prior to entering storage area. Poison gas. (1) Color code-Blue: Health Hazard/Poison: Store in a secure poison location. This gas is highly toxic. Even slight exposure to these gasses can cause death. Store outdoors in a secure, restricted area that containing warning signs. This area must be roofed and shaded with the cylinders stored off the ground and separated from all other products assigned to other hazard categories and radiant heat sources on nonwooden floors. If indoors, store in a well-ventilated areas in temperatures not to exceed 50°C. (2) Color code-Red Stripe: Flammability Hazard: Store separately from all other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1 hour fire wall from flammable or reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool (below 50°C), well ventilated area away from bromine. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: UN2192 Germane, Hazard Class: 2.3; Labels: 2.3-Poisonous gas, 2.1-Flammable gas, Inhalation Hazard Zone B. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling:

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small Spills (from a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 500/150

Then: Protect persons downwind (mi/km)

Day 0.5/0.8

Night 2.0/3.2

Large Spills (from a large package or from many small packages)

First: Isolate in all directions (ft/m) 2500/800

Then: Protect persons downwind (mi/km)

Day 2.7/4.4

Night 6.6/10.6

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of leak to disperse the gas. Stop the flow of gas if it can be done safely. If source of leak is a cylinder and the leak cannot be stopped in place, remove leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. Keep this chemical out of confined space, such as a sewer because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable gas. Dangerous gases may be released in fire including flammable hydrogen and oxides of metal. This gas is under pressure; containers may rupture and explode when heated. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Dispose of contents and container to an approved waste disposal plant. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (170).

Glutaraldehyde G:0140

Formula: $C_5H_8O_2$: $HCO(CH_2)_3CHO$

Synonyms: Cidex; Cudex; 1,3-Diformal propane; Glutamic dialdehyde; Glutaral; Glutard dialdehyde; Glutaric acid dialdehyse; Glutaric dialdehyde; NCI-C55425; 1,5-Pentanedial; Pentanedial; 1,5-Pentanedione; Potentiated acid glutaraldehyde; Sonacide

CAS Registry Number: 111-30-8

HSDB Number: 949

RTECS Number: MA2450000

UN/NA & ERG Number: UN2810 (toxic liquid, organic, n.o.s.)/153

EC Number: 203-856-5 [*Annex I Index No.*: 605-022-00-X]

Regulatory Authority and Advisory Information

Carcinogenicity: NCI: Carcinogenesis Studies (inhalation); no evidence: mouse, rat. United States Environmental Protection Agency Gene-Tox Program, Negative: CHO gene mutation.

Hazard Alert: Poison, Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Sensitization hazard (skin, resp.), Primary irritant (w/o allergic reaction), Environmental hazard.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long lasting effects[291]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N, Xi; risk phrases: R23/25; R34; R42/43; R50; R62; R63; safety phrases: S1/2; S26; S29/35; S36/37/39; S45; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Glutaraldehyde is a colorless liquid with a pungent odor, which readily changes to a glossy polymer. The Odor Threshold is 0.04 ppm (NY) and 0.2 ppm (NJ). Molecular weight = 100.13; specific gravity (H_2O:1) = 1.10; boiling point = 100°C; also reported @ 187−189°C (decomposes); freezing/melting point = −13.8°C; vapor pressure = 17 mmHg. Hazard identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Soluble in water.

Potential Exposure: Glutaraldehyde is used in leather tanning; in embalming fluids; as a germicide; as a cross-linking agent for protein and polyhydroxy materials; as a fixative for tissues; and as an intermediate. Buffered solutions are used as antimicrobial agents in hospitals.

Incompatibilities: Water contact forms a polymer solution. A strong reducing agent. Incompatible with strong acids; caustics, ammonia, amines, and strong oxidizers. *Note:* Alkaline solutions of glutaraldehyde (i.e., activated glutaraldehyde) react with alcohol, ketones, amines, hydrazines, and proteins.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 4.09 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: None

NIOSH REL: 0.2 ppm/0.8 milligram per cubic meter Ceiling Concentration. *Note:* NIOSH recommends that careful consideration should be given to reducing exposures to this aldehyde. Further information can be found in the *NIOSH Current Intelligence Bulletin 55: Carcinogenicity of Acetaldehyde and Malonaldehyde, and Mutagenicity of Related Low-Molecular-Weight Aldehydes* [DHHS (NIOSH), Publication No. 91-112]; See *NIOSH Pocket Guide*, Appendix C

ACGIH TLV[1]: 0.05 ppm/0.2 milligram per cubic meter Ceiling Concentration, sensitizer, not classifiable as a human carcinogen.

PAC* Ver. 29[138]

PAC-1: $\mathbf{0.2_A}$ ppm

PAC-2: $\mathbf{1_A}$ ppm

PAC-3: $\mathbf{5_A}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

DFG MAK: 0.05 ppm/0.21 milligram per cubic meter TWA; Peak Limitation Category I(2) a momentary value of 0.2 ml/m^3/0.83 milligram per cubic meter should not be exceeded; danger of skin and airway sensitization; Carcinogen Category 4; Pregnancy Risk Group C

Australia: TWA 0.2 ppm (0.7 milligram per cubic meter), 1993; Austria: MAK 0.2 ppm (0.8 milligram per cubic meter), 1999; Belgium: TWA 0.2 milligram per cubic meter; STEL 0.82 milligram per cubic meter, 1993; Denmark: TWA 0.2 ppm (0.8 milligram per cubic meter), 1999; Finland: ceiling 0.1 ppm, 1999; France: VLE 0.2 ppm (0.8 milligram per cubic meter), 1999; Norway: TWA 0.2 ppm (0.8 milligram per cubic meter), 1999; the Netherlands: MAC 0.25 milligram per cubic meter, 2003; Russia: STEL 5 milligram per cubic meter, 1993; Sweden: STEL 0.2 ppm (0.8 milligram per cubic meter), [skin], 1999; Switzerland: MAK-W 0.2 ppm (0.8 milligram per cubic meter), KZG-W 0.4 ppm (1.6 milligram per cubic meter), 1999; United Kingdom: TWA 0.05 ppm (0.2 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: Ceiling Concentration 0.05 ppm (senitizer). Several states have set guidelines or standards for glutaraldehyde in ambient air[60] ranging from 6.0 μ/m^3 (Virginia) to 7.0 μ/m^3 (North Dakota) to 14.0 μ/m^3 (Connecticut) to 17.0 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #2532 or OSHA Analytical Method 64.

Determination in Water: Octanol-water coefficient: Log $K_{ow} = -0.22$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, skin absorption, ingestion, and skin and/or eye contact. Can be absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin, and respiratory tract. *Inhalation:* 0.3 ppm can cause nose and throat irritation. 0.4 ppm has caused headaches. 0.5 ppm has been described as intolerably irritating. *Skin:* Can cause irritation. Contact with a 5% solution can sensitize the skin and cause an allergic response to subsequent contact of much lower concentrations. *Eyes:* Vapors of a 2% solution (0.4 ppm) have produced irritation. *Ingestion:* Can cause irritation of the mouth and stomach. The LD_{50} oral rat is 134 mg/kg (moderately toxic).

Long-Term Exposure: Repeated or prolonged contact with skin may cause chemical sensitization, skin allergy, and asthma. Exposure may cause liver and nervous system damage. Glutaraldehyde may cause mutations, handle with extreme caution. Testing has not been completed to determine the carcinogenicity of glutaraldehyde. However, the limited studies to date indicate that these substances have chemical reactivity and mutagenicity similar to acetaldehyde and malonaldehyde. Therefore, NIOSH recommends that careful consideration should be given to reducing exposures to this aldehyde. Further information can be found in the *NIOSH Current Intelligence Bulletin 55: Carcinogenicity of Acetaldehyde and Malonaldehyde, and Mutagenicity of Related Low-Molecular-Weight Aldehydes* [DHHS (NIOSH), Publication No. 91-112].

Points of Attack: Eyes, skin, respiratory system, liver, and nervous system.

Medical Surveillance: If symptoms develop or overexposure has occurred, the following may be useful: liver function tests. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin contact: **8 hours**: butyl rubber gloves, suits, and boots; Viton gloves and suits; **4 hours**: natural rubber gloves; Neoprene rubber gloves, suits, and boots; nitrile rubber gloves, suits, and boots; polyvinyl chloride gloves, suits, and boots. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures *over* 0.2 ppm; Use an NIOSH/MSHA or European Standard EN 149-approved respirator with an organic vapor cartridge/canister and a dust/mist/fume prefilter. More protection is provided by a full facepiece respirator than by a half-mask respirator, and even greater protection is provided by a powered-air purifying respirator. *Where there is potential for high exposures exists*, use an NIOSH/MSHA or European Standard EN 149-approved supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use an NIOSH/MSHA or European Standard EN 149-approved self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.

Storage: (1) Color code-Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. (2) Color code-Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. (2) Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area away from strong acids, caustics, ammonia, amines, and oxidizers.

Shipping: UN2810 Toxic liquids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling:

UN2810 Toxic liquids, organic, n.o.s.

Initial Isolation and Protective Action Distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small Spills (from a small package or a small leak from a large package)
First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 0.7/1.2

Large Spills (from a large package or from many small packages)
First: Isolate in all directions (ft/m) 1000/300
Then: Protect persons downwind (mi/km)
Day 1.1/1.8
Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Glutaraldehyde itself does not burn. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References
(31); (173); (101); (138). (2); (100).
New York State Department of Health, *Chemical Fact Sheet: Glutaraldehyde*, Bureau of Toxic Substance Assessment, Albany, NY (April 1986)
New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Glutaraldehyde*, Trenton, NJ (January 2000)

Glycerin G:0150

Formula: $C_3H_8O_3$; $HOCH_2CHOHCH_2OH$

Synonyms: 90 Technical glycerin; Glycerin, anhydrous; Glycerin, synthetic; Glyceritol; Glycerol; Glycyl alcohol; Grocolene; Moon; 1,2,3-Propanetriol; Synthetic glycerin; 1,2,3-Trihydroxypropane; Trihydroxypropane

CAS Registry Number: 56-81-5

HSDB Number: 492

RTECS Number: MA8050000

UN/NA & ERG Number: UN1760 (corrosive liquids, n.o.s.)/154[101]

EC Number: 200-289-5

Regulatory Authority and Advisory Information

Hazard Alert: Combustible, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction).

FDA-over the counter and proprietary drug

Hazard symbols, risk, & safety statements: Hazard symbol: T; risk phrases: R62; R63;?; safety phrases: (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Glycerol is a viscous colorless or pale yellow, odorless, syrupy liquid. Molecular weight = 92.09; specific gravity (H_2O:1) = 1.26 @ 20°C; boiling point = (decomposes) 290°C; freezing/melting point = 18.1°C; vapor pressure = 0.003 mmHg @ 50°C; flash point = 160°C; also listed @ 177°C (oc). autoignition temperature = 370°C. Explosive limits: LEL = 0.9%; UEL: Unknown. Hazard identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 0. Soluble in water.

Potential Exposure: Glycerol is used as a humectant in tobacco; it is used in cosmetics, antifreezes and inks. It is used as a fiber lubricant. It is used as a raw material for alkyd resins and in explosives manufacture.

Incompatibilities: Able to polymerize above 300°F/150°C. Incompatible with acetic anhydrides (especially in the presence of a catalyst), strong acids, caustics, aliphatic amines, and isocyanates. Strong oxidizers, e.g., chromium trioxide, potassium chlorate, and potassium permanganate); can cause fire and explosion hazard. Hygroscopic (i.e., absorbs moisture from the air). Decomposes when heated, producing corrosive gas of acrolein.

Permissible Exposure Limits in Air

OSHA PEL: 15 milligram per cubic meter (total dust); 5 milligram per cubic meter, respirable fraction, TWA

NIOSH REL: None, see Appendix D

ACGIH TLV[1]: 10 milligram per cubic meter TWA

PAC Ver. 29[138]

PAC-1: 45 milligram per cubic meter

PAC-2: 180 milligram per cubic meter

PAC-3: 1100 milligram per cubic meter

DFG MAK: 50 milligram per cubic meter, inhalable faction of the aerosol; Peak Limitation Category I(2); Pregnancy Risk Group C

Australia: TWA 10 milligram per cubic meter, 1993; Belgium: TWA 10 milligram per cubic meter, 1993; Finland: TWA 20 milligram per cubic meter, 1999; France: VME 10 milligram per cubic meter, 1999; United Kingdom: TWA 10 milligram per cubic meter, mist, 2000; the Netherlands: MAC-TGG 10 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: TWA 10 milligram per cubic meter. Several states have set guidelines or standards for glycerol in ambient air[60] ranging from 3.0 μ/m^3 (Virginia) to 200.0 μ/m^3 (Florida and New York) to 238.0 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Methods #0500 for total nuisance dust and #0600 for respirable nuisance dust.

Determination in Water: Octanol-water coefficient: Log $K_{ow} = -1.8$. Unlikely to bioaccumulate in marine organisms.

Harmful Effects and Symptoms

Short-Term Exposure: Glycerin can be irritating to the eyes, skin, and respiratory tract. When swallowed, it can cause insomnia, nausea, vomiting, diarrhea, fever, hemoglobinuria, convulsions, and paralysis. Toxic in high concentrations; it is somewhat dehydrating and irritating to exposed tissues. Symptoms include headache, dizziness, insomnia, nausea, vomiting, diarrhea, fever, elevated blood sugar, and diabetic coma; very large doses may cause irritation and dehydration of tissues, hemolysis, renal failure, hemoglobinuria, convulsions, and paralysis.

Long-Term Exposure: May cause kidney damage.

Points of Attack: Eyes, skin, respiratory system, and kidneys.

Medical Surveillance: Kidney function tests.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin contact: Prevent skin contact. **8 hours**: natural rubber gloves, Neoprene rubber gloves, suits, and boots; nitrile rubber gloves, suits, and boots; **4 hours**: 4 H and Silver Shield gloves. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.

Storage: Color code-White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location; keep acids away from bases and red, yellow, and blue-coded chemicals. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area away from oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: UN1760 Corrosive liquids, n.o.s., Hazard class: 8; Labels: 8-Corrosive material, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide, water fog, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Mixture with a more flammable solvent followed by incineration.

References

(31); (173); (101); (138). (2); (100).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 1, No. 5, 61–63 (1981) and 3, No. 4, 58–60 (1983)

Glycidol G:0160

Formula: $C_3H_6O_2$: $HOCH_2CH(O)CH_2$

Synonyms: Epihydrin alcohol; 2,3-Epoxy-1-propanol; 2,3-Epoxypropanol; Glycide; Glycidyl alcohol; 3-Hydroxy-1,2- epoxypropane; 3-Hydroxypropylene oxide; Methanol, oxiranyl-; NCI-C55549; Oxiranemethanol

CAS Registry Number: 556-52-5

HSDB Number: 1819

RTECS Number: UB4375000

UN/NA & ERG Number: UN2810 (toxic liquid, organic, n.o.s.)/153

EC Number: 209-128-3 [*Annex I Index No.:* 603-063-00-8]

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Human Inadequate Evidence, animal Sufficient Evidence, *probably carcinogenic to humans*, Group 2 A, 2000

California Proposition 65 Chemical[102]: Cancer 7/1/1990

Hazard Alert: Poison, Combustible liquid, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction).

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xi, Xn; risk phrases: R45; R60; R21/22; R23; R36/37/38; R62; R63; R68; safety phrases: S53; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Glycidol is a colorless liquid. Molecular weight = 74.09; specific gravity (H_2O:1) = 1.1 @ 20°C; boiling point = (decomposes) 166°C; freezing/melting point = −45°C; vapor pressure = 0.9 mmHg @ 25°C; flash point = 72°C (cc); autoignition temperature = 415°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Soluble in water.

Potential Exposure: Glycidol is used as an intermediate in the synthesis of glycerol, glycidyl ethers, esters, and amines.

Incompatibilities: May form explosive mixture with air. Violent reaction with strong oxidizers, nitrates. Decomposes on contact (especially in the presence of heat) with strong acids, strong bases, water, metal salts, e.g., aluminum chloride, ferric chloride, and tin chloride), or metals (copper and zinc), causing fire and explosion hazard. Contact with barium, lithium, sodium, magnesium, and titanium may cause polymerization. Attacks some plastics, rubber, and coatings.

Permissible Exposure Limits in Air

NIOSH IDLH = 150 ppm

Conversion factor: 1 ppm = 3.03 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 50 ppm/150 milligram per cubic meter TWA

NIOSH REL: 25 ppm/75 milligram per cubic meter TWA

ACGIH TLV[1]: 2 ppm/6.1 milligram per cubic meter TWA; confirmed animal carcinogen with unknown relevance to humans.

PAC Ver. 29[138]

PAC-1: 6 ppm

PAC-2: 83 ppm

PAC-3: 500 ppm

DFG MAK: [skin] Carcinogen Category 2

Australia: TWA 25 ppm (75 milligram per cubic meter), 1993; Austria: MAK 50 ppm (150 milligram per cubic meter), 1999; Belgium: TWA 25 ppm (76 milligram per cubic meter), 1993; Denmark: TWA 0.2 ppm (1 milligram per cubic meter), 1999; Finland: TWA 50 ppm (150 milligram per cubic meter); STEL 75 ppm (225 milligram per cubic meter) [skin] 1999; France: VME 25 ppm (75 milligram per cubic meter), 1999; Norway: TWA 25 ppm (75 milligram per cubic meter), 1999; the Phillipines: TWA 50 ppm (150 milligram per cubic meter), 1993; Russia:

STEL 5 milligram per cubic meter, 1993; Sweden: NGV 25 ppm (75 milligram per cubic meter), KTV 50 ppm (150 milligram per cubic meter), 1999; Switzerland: MAK-W 25 ppm (75 milligram per cubic meter), KZG-W 50 ppm (150 milligram per cubic meter), 1999; Turkey: TWA 50 ppm (150 milligram per cubic meter), 1993; United Kingdom: carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: confirmed animal carcinogen with unknown relevance to humans. Several states have set guidelines or standards for glycidol in ambient air[6] ranging from 750 to 3000 μ/m^3 (North Dakota) to 1300 μ/m^3 (Virginia) to 1500 μ/m^3 (Connecticut).

Determination in Air: Use NIOSH Analytical Method (IV) #1608[18] or OSHA Analytical Method 7.

Routes of Entry: Inhalation, ingestion and skin and/or eye contact. Passes through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Glycidol affects you when breathed in and by passing through your skin. Irritates the eyes, skin, and respiratory tract. Vapor exposure can damage vision. Exposure can irritate the eyes, nose, throat, and lungs. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. High levels can cause you to feel dizzy, lightheaded, confused, excited, to pass out, and even die. May affect the central nervous system.

Long-Term Exposure: Repeated or prolonged contact may cause skin sensitization. It can irritate the lungs; bronchitis may develop. May cause personality changes, depression, anxiety, or irritability. Possibly carcinogenic to humans. Because this is a potential mutagen, handle it as a possible carcinogen, with extreme caution. May cause sterility in males. Based on animal tests, this substance may have toxic effects on human reproduction.

Points of Attack: Eyes, skin, respiratory system, and central nervous system. Cancer site in animals: stomach, brain, and breast.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended. Lung function tests. Examination of the nervous system. If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Consider chest X-ray after acute overexposure. Exam of the eyes and vision.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: up to 150 ppm: Sa (APF = 10) (any supplied-air respirator); * or SCBAF (APF = 50) (any self-contained breathing apparatus with a full facepiece). Emergency or planned entry into unknown concentrations or IDLH conditions: SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, self-contained breathing apparatus). *Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Glycidol must be stored to avoid contact with strong oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates). Store in tightly closed containers in a cool, well-ventilated area away from heat. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters.

Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN2810 Toxic liquids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling:

UN2810 Toxic liquids, organic, n.o.s.

Initial Isolation and Protective Action Distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small Spills (from a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 0.7/1.2

Large Spills (from a large package or from many small packages)

First: Isolate in all directions (ft/m) 1000/300
Then: Protect persons downwind (mi/km)
Day 1.1/1.8
Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition includes oxides of carbon. Use dry chemical, carbon dioxide, alcohol foam, or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full facepieces and are operated in a pressure-demand or other positive- pressure mode.

Disposal Method Suggested: *Concentrated waste containing no peroxides:* discharge liquid at a controlled rate near a pilot flame. *Concentrated waste containing peroxides:* perforation of a container of the waste from a safe distance followed by open burning.

References

(109); (102); (31); (173); (101); (138); (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: 2,3-Epoxy-1-Propanol*, Trenton, NJ (December 1998)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Glycidol*, Trenton, NJ, (July 2008)

Glycidylaldehyde G:0170

Formula: $C_3H_4O_2$: CH_2-(O)-CH-CHO

Synonyms: Epihydrinaldehyde; Epihydrine aldehyde; 2,3-Epoxy-1-propanal; 2,3-Epoxypropanal; 2,3-Epoxypropionaldehyde; Glycidal; Glycidaldehyde; Oxirane-carboxaldehyde

CAS Registry Number: 765-34-4

HSDB Number: 5100

RTECS Number: MB3150000

UN/NA & ERG Number: UN2622/131 (P)

EC Number: 212-143-8

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Sufficient Evidence; Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies.

California Proposition 65 Chemical[102]: Cancer 1/1/1988

Hazard Alert: Poison, Highly flammable, Poison, Polymerization hazard.

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U126

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xi; risk phrases: R2, R11; R19; R36/37/38; safety phrases: S9; S15; S16; S21; S33; S45 (see Appendix 4)

Description: Glycidyl aldehyde is a colorless liquid. It has a pungent, aldehyde-like odor. Molecular weight = 72.06; specific gravity (H_2O:1) = 1.14 @ 20°C; boiling point = 112.5°C; freezing/melting point = −62°C; flash point = 31°C. Hazard identification[70]: Health 3, Flammability 3, Reactivity 0. Soluble in water.

Potential Exposure: Glycidyldehyde is and epoxide used to synthesize other chemicals. It has been used in the finishing of wool and the tanning of leather and surgical sutures in the U.K. It has been tested as a disinfectant.

Incompatibilities: Glycidaldehyde may undergo violent polymerization when subjected to heat, strong sunlight, or contamination. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides. When heated or in contact with catalysts, epoxides may cause violent polymerization. Epoxides are incompatible with reducing agents and oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides. May react, possibly violently, with water in the presence of acid and other catalysts. Reacts with alcohols, amines, and other active hydrogen compounds. Slowly hydrolyzes in water.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 0.39 ppm

PAC-2: 4.3 ppm

PAC-3: 26 ppm

Permissible Exposure Limits in Air

Several states have set guidelines or standards for glycidylaldehyde in ambient air[60] ranging from zero (Nevada) to 0.03 μ/m^3 (New York) to 75.0 μ/m^3 (South Carolina).

Routes of Entry: Inhalation, ingestion, and skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: May be fatal if inhaled, ingested, or absorbed through the skin. Contact can cause severe skin and eye irritation and burns with possible permanent eye damage. Skin burns can be slow healing, followed by pigmentation. Inhalation can cause respiratory tract irritation. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: May be a carcinogen in humans. May cause skin sensitization and allergy. May cause liver and kidney damage. May affect the nervous system. Can cause lung irritation and bronchitis.

Points of Attack: Eyes, skin, liver, kidneys, nervous system, lungs, and mucous membranes.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure. Liver and kidney function tests. Examination of the nervous system. Evaluation by a qualified allergist. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. *Gloves:* Butyl, PVC, and Silver Shield/4 H, (4 hours breakthrough for aldehydes; *Coveralls:* DuPont Tychem BR, LV, Responder, and TK; Kappler Zytron 500; and Saint-Gobain ONE Suit TEC (>8 hours breakthrough for aliphatic aldehydes). Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA-or European Standard EN 149-approved self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive pressure mode). *Escape:* 100 F (APF = 50) (any air purifying, full-facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: (1) Color code-Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. (2) Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area away from oxidizers, nitrates, heat, and flames. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2622 Glycidaldehyde, Hazard Class: 3; Labels: 3-Flammable liquid, 6.1-Poisonous materials. The addition of antioxidant stabilizers to shipments of aldehydes may retard autoxidation.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Use water spray to reduce vapors. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; water spray, fog, or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full facepieces and are operated in a pressure-demand or other positive- pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(102); (31); (173); (101); (138).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 7, No. 3, 103−105 (1987)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Glycidaldehyde*, Trenton, NJ (July 2008)

Glyphosate G:0180

Formula: $C_3H_8NO_5P$; $HOCOCH_2NHCH_2PO(OH)_2$

Synonyms: Glycine, *N*-(phosphonomethyl)-; MON0573; MON 2139; *N*-(Phosphonomethyl)-glycine; Phosphonomethyliminoacetic acid; Rodeo; Roundup

CAS Registry Number: 1071-83-6

HSDB Number: 3432

RTECS Number: MC1075000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 213-997-4 [*Annex I Index No.:* 607-315-00-8]

Regulatory Authority and Advisory Information

Carcinogenicity: EPA: Classification D, Not Classifiable as to human carcinogenicity. *Note*: The World Health Organization's (WHO) published its latest review of the cancer risks of glyphosate in March 2015. When high doses were administered to laboratory animals, some studies suggest that glyphosate has carcinogenic potential. Studies on cancer rates in people have provided conflicting results on whether the use of glyphosate containing products is associated with cancer. Some studies have associated glyphosate use with non-Hodgkin lymphoma[162].

Hazard Alert: Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Environmental hazard.

Safe Drinking water Act, United States National Primary Drinking Water Regulations: MCLG = 0.7 mg/L; MCL = 0.7 mg/L.

NTP: Toxicity studies, Report #TOX-16, October 2000

DOT Inhalation Hazard Chemicals as organophosphates

Hazardous to aquatic life or environment, with possible long lasting effects[293]. Toxic to aquatic life with long lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: Xi, N; risk phrases: R40; R41; R51/53; R62; R63; safety phrases: S2; S26; S39; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Glyphosate, an organophosphate/carboxylic acid (substituted), is a colorless crystalline powder. Often used as a liquid in a carrier solvent which may change physical and toxicological properties. Molecular weight = 169.09; freezing/melting point = (decomposes) 230°C. Soluble in water; solubility = 1.2% @ 25°C.

Potential Exposure: A potential danger to those involved in the manufacture, formulation, and application of this nonselective and nonresidual pre-emergence organophosphate herbicide. Has wide residential use in the United States for the control of weeds.

Incompatibilities: Organophosphates are susceptible to formation of highly toxic and flammable phosphine gas in the presence of strong reducing agents such as hydrides. Partial oxidation by oxidizing agents may result in the release of toxic phosphorus oxides[101]. Compounds of the carboxyl group react with all bases, both inorganic and organic (i.e., amines) releasing substantial heat, water, and a salt that may be harmful. Incompatible with arsenic compounds (releases hydrogen cyanide gas), diazo compounds, dithiocarbamates, isocyanates, mercaptans, nitrides, sulfides (releasing heat, toxic, and possibly flammable gases), thiosulfates, and dithionites (releasing hydrogen sulfate and oxides of sulfur). Solutions are corrosive to iron, unlined steel, and galvanized steel, forming a highly combustible or explosive gas mixture. *Do not* store glyphosate in containers made from these materials.

Permissible Exposure Limits in Air: No OELs have been established in the United States for this chemical. Russia has set a ceiling value in work-place air of 1.5 milligram per cubic meter[35],[43].

Permissible Concentration in Water: Safe Drinking Water Act United States National Primary Drinking Water Regulations: MCLG = 0.7 mg/L; MCL = 0.7 mg/L. The United States Environmental Protection Agency has developed data on Glyphosate including a no-observed-adverse-effects-level (NOAEL) of 10 mg/kg/day. This corresponds to a drinking water equivalent level of 3.5 mg/L from which a lifetime health advisory of 0.7 mg/L was derived. California[61] has set a guideline of 0.5 mg/L for drinking water.

Determination in Water: Analysis of glyphosate is by a high-performance liquid chromatographic (HPLC) method. Octanol-water coefficient: Log $K_{ow} = -0.9$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion, and through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin, and respiratory tract. Exposure to high levels can cause nausea, vomiting, diarrhea, decreased blood pressure, and convulsions. High exposures can cause arrhythmia and possible death. LD_{50} (oral, rat) = 5600 mg/kg (insignificantly toxic). Human Tox = 700.00000 ppb (Very Low).

Long-Term Exposure: Glyphosate is reported by United States Environmental Protection Agency to cause kidney problems and reproductive difficulties.

Points of Attack: Respiratory system, lungs, central nervous system; cardiovascular system, skin, eyes, plasma and red blood cell cholinesterase, liver, kidney, and heart.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure. Employees shall be counseled by the physician to ensure that employee is aware that this chemical may affect the reproductive system. In addition to comprehensive initial medical and work histories emphasizing reproductive experience and menstrual history, patient should have physical examination and testing of genitourinary tract, sperm count, motility, and morphology. If required, other tests, such as serum testosterone, serum follicle stimulating hormone (FSH), and serum lutenizing hormone (LH) may be indicated. Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When cholinesterase enzyme levels are reduced by 25% or more below pre-employment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider CBC. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates. Liver and kidney function tests. Special 24-hour EKG (Holter monitor) for irregular heartbeat.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area away from oxidizers.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand, earth, peat, carbon, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers for later disposal. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Solid glyphosate may burn, but does not readily ignite. Use dry chemical, carbon dioxide, water spray, or alcohol foam extinguishers. Thermal decomposition products may include oxides of nitrogen and phosphorus. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, *Alert: Glyphosate*, Washington, DC, Office of Drinking Water (August 1987)

New Jersey Department of Health and Senior Services, *http://water.epa.gov/drink/contaminants/upload/mcl-2.pdf*

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Glyphosate*, Trenton, NJ, (June 1999)

Graphite G:0200

Formula: C

Synonyms: Black lead; Mineral carbon; Plumbago; Silver graphite; Stove black; *synthetic:* Acheson graphite; Artificial graphite

CAS Registry Number: 7782-42-5 (graphite, natural); 7440-44-0 (carbon, graphite, synthetic); 16291-96-6 (synthetic graphite)

HSDB Number: 7713

RTECS Number: MD9659600 (carbon, graphite, natural); FF5250100 (carbon, graphite, synthetic)

UN/NA & ERG Number: UN1362/133 (Graphite, synthetic)

EC Number: 231-955-3 (graphite, natural); 231-153-3 (carbon); 240-383-3 (charcoal or synthetic graphite)

Regulatory Authority and Advisory Information.

WGK[100] (German Aquatic Hazard Class): Non hazard to water.

Description: Graphite is crystallized carbon and usually appears as soft, black scales. There are two types of graphite, natural and artificial (activated). Natural and synthetic graphite may be mixed with each other or contain other additives. Molecular weight = 12.01 (natural and synthetic);

specific gravity (H_2O:1) = 2.0−2.25 (natural); 1.8−3.53 (synthetic); boiling point = 3682°C (synthetic); vapor pressure = 1 mmHg @ 3586°C. Hazard identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 0. Insoluble in water.

Potential Exposure: Natural graphite is used in foundry facings, steel making lubricants, refractories, crucibles, pencil "lead," paints, pigments, and stove polish. Artificial graphite may be substituted for these uses with the exception of clay crucibles; other types of crucibles may be produced from artificial graphite. Additionally, it may be used as a high temperature lubricant or for electrodes. It is utilized in the electrical industry in electrodes, brushes, contacts, and electronic tube rectifier elements; as a constituent in lubricating oils and greases; to treat friction elements, such as brake linings; to prevent molds from sticking together; and in moderators in nuclear reactors. In addition, concerns have been expressed about synthetic graphite in fibrous form. Those exposed are involved in production of graphite fibers from pitch or acrylonitrile fibers and the manufacture and use of composites of plastics, metals, or ceramics reinforced with graphite fibers.

Incompatibilities: Graphite is a strong reducing agent and reacts violently with oxidizers, such as fluorine, chlorine trifluoride, and potassium peroxide. Forms an explosive mixture with air. May be spontaneously combustible in air.

Permissible Exposure Limits in Air

graphite, natural

OSHA PEL: 15 mppcf, respirable fraction (based on impinger samples counted by light field techniques)TWA

NIOSH REL: 2.5 milligram per cubic meter, respirable dust TWA

ACGIH TLV[1]: (all forms except graphic fibers) 2 milligram per cubic meter, respirable fraction TWA

graphite, synthetic

NIOSH IDLH = 1250 milligram per cubic meter

OSHA PEL: 15 ppm total dust/5 milligram per cubic meter, respirable fraction TWA

ACGIH TLV[1]: (all forms except graphic fibers) 2 milligram per cubic meter, respirable fraction TWA

PAC Ver. 29[138]

7782-42-5, natural mineral carbon & 7440-44-0, synthetic

PAC-1: 6 milligram per cubic meter

PAC-2: 330 milligram per cubic meter

PAC-3: 2000 milligram per cubic meter

DFG MAK: 1.5 milligram per cubic meter, respirable fraction; 4 milligram per cubic meter, inhalable fraction; Pregnancy Risk Group C

Australia: TWA 10 milligram per cubic meter, 1993; Australia: TWA 2.5 milligram per cubic meter, 1993; Belgium: TWA 10 milligram per cubic meter, 1993; Belgium: TWA 2.5 milligram per cubic meter, 1993; Finland: TWA 5 milligram per cubic meter, 1999; France: VME 2 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 2 milligram per cubic meter, 2003; Sweden: NGV 5 milligram per cubic meter (*dust*), 1999; Switzerland: MAK-W 2.5 milligram per cubic meter, 1999; United Kingdom: LTEL 5 milligram per cubic meter, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV[1]: TWA 2 milligram per cubic meter, respirable fraction.

Determination in Air: Use NIOSH Analytical Methods #0500 or #0600.

Routes of Entry: Inhalation of dust, eye, and skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Causes upper respiratory irritation.

Long-Term Exposure: Lungs may be affected by repeated or prolonged exposure to dusts, resulting in graphite pneumoconiosis. Exposure to natural graphite may produce a progressive and disabling pneumoconiosis similar to anthracosilicosis. Symptoms include headache, coughing, depression, decreased appetite, dyspnea, and the production of black sputum. Some individuals may be asymptomatic for many years then suddenly become disabled. It has not yet been determined whether the free crystalline silica in graphite is solely responsible for development of the disease. There is evidence that artificial graphite may be capable of producing a pneumoconiosis.

Points of Attack: Respiratory system, lungs, and cardiovascular system.

Medical Surveillance: NIOSH lists the following tests: chest X-ray, expired air, pulmonary function tests: forced vital capacity and forced expiratory volume (1 s).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash

Respirator Selection: NIOSH: (natural) up to 12.5 milligram per cubic meter: Qm (APF = 25) (any quarter-mask respirator). 25 milligram per cubic meter: 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]. 62.5 milligram per cubic meter: PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). 125 milligram per cubic meter: 100 F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter); or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); SCBAF (APF = 50) (any self-contained breathing apparatus with a full facepiece). 1250 milligram per cubic meter: SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100 F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color code-Red Stripe: Flammability Hazard (4.2): Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1 hour fire wall from flammable or reactive materials. Store flammable solids (spontaneously combustible) up to maximum allowable quantity per control area in an approved flammable storage area. Do not store in a basement. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area

Shipping: UN1362 Carbon, activated, Hazard Class: 4.2; Labels: 4.2-Spontaneously combustible material, International.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Do not incinerate. Carbon (graphite) fibers are difficult to dispose of by incineration. Waste fibers should be packaged and disposed of in a landfill authorized for the disposal of special wastes of this nature, or as otherwise may be required by law.

References

(31); (173); (101); (138); (2); (100).

H

Hafnium and Compounds H:0100

Formula: Hf
Synonyms: Celtium; Elemental hafnium; Hafnium metal
CAS Registry Number: 7440-58-6 (metal); 12055-23-1 (oxide)
HSDB Number: 552
RTECS Number: MG4600000
UN/NA & ERG Number: UN2545 (hafnium powder, dry)/135; UN1326 (hafnium powder, wet with not <25% water)/170; UN1346 (Hafnium powder, wetted with not less than 25% water)/170
EC Number: 231-166-4

Regulatory Authority and Advisory Information

Hazard Alert: Flammable solid, Pyrophoric (dry dust/powder), Strong reducing agent.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xn; risk phrases: R11; R17; R20/21/22; safety phrases: S9; S16; S26; S33; S36/37/39; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): Non hazard to water (particles >1 mm).

Description: Hafnium is a refractory metal which occurs in nature in zirconium minerals. Molecular weight = 178.49; specific gravity (H_2O:1) = 13.3; boiling point = 4603°C; freezing/melting point = 2233°C ₩. Practically insoluble in water. Dry powder reacts with moisture forming flammable hydrogen gas and heat that might ignite H_2. *Hafnium oxide*: Molecular weight = 210.49; specific gravity (H_2O:1) = 9.68; boiling point = 5400°C; freezing/melting point = 2812°C. Insoluble in water.

Potential Exposure: Hafnium metal has been used as a control rod material in nuclear reactors. Thus, those engaged in fabrication and machining of such rods may be exposed.

Incompatibilities: Fine powder or dust may form explosive mixture in air. The powder is highly flammable and a strong reducing agent. The powder or dust reacts with moisture forming flammable hydrogen gas; may spontaneously ignite on contact with moist air; and at higher temperatures, with nitrogen, phosphorous, oxygen, halogens, and sulfur; contact with hot nitric acid; heat, shock, friction, strong oxidizers; or ignition sources may cause explosions.

Permissible Exposure Limits in Air

Note: also applies to other hafnium compounds, as [Hf]
NIOSH IDLH = 50 mg [Hf]/m^3
OSHA PEL: 0.5 mg[Hf]/m^3 TWA
NIOSH REL: 0.5 mg[Hf]/m^3 TWA
ACGIH TLV[1]: 0.5 mg[Hf]/m^3 TWA
Protective Action Criteria (PAC) Ver. 29[138]
7440-58-6, metal
PAC-1: 1.5 milligram per cubic meter
PAC-2: 17 milligram per cubic meter
PAC-3: 99 milligram per cubic meter
Australia: TWA 0.5 milligram per cubic meter, 1993; Austria: MAK 0.5 milligram per cubic meter, 1999; Belgium: TWA 0.5 milligram per cubic meter, 1993; Denmark: TWA 0.5 milligram per cubic meter, 1999; Finland: TWA 0.5 milligram per cubic meter, 1999; France: VME 0.5 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 0.5 milligram per cubic meter, 2003; the Philippines: TWA 0.5 milligram per cubic meter, 1993; Poland: MAC (TWA) 0.5 milligram per cubic meter, 1999; Switzerland: MAK-W 0.5 milligram per cubic meter, 1999; United Kingdom: TWA 0.5 milligram per cubic meter; STEL 1.5 milligram per cubic meter, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 0.5 mg[Hf]/m^3. Several states have set guidelines or standards for hafnium in ambient air[60] ranging from 5.0 μ/m^3 (North Dakota) to 8.0 μ/m^3 (Virginia) to 10.0 μ/m^3 (Connecticut) to 12.0 μ/m^3 (Nevada).
PAC Ver. 29[138]
12055-23-1, oxide
PAC-1: 1.8 milligram per cubic meter
PAC-2: 19 milligram per cubic meter
PAC-3: 120 milligram per cubic meter

Determination in Air: Use NIOSH II(5), Method #S-194 or OSHA Analytical Method ID-121.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritation of eyes, skin and mucous membranes.

Long-Term Exposure: Lungs may be affected by repeated or prolonged exposure. May cause liver damage.

Points of Attack: Eyes, skin, lungs, liver, and mucous membranes.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Liver function tests. Lung function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

DOI: http://dx.doi.org/10.1016/B978-0-323-38968-6.00008-9

Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *up to 2.5 milligram per cubic meter*: Q_m (APF = 25) (any quarter-mask respirator). *Up to 5 milligram per cubic meter*: 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *Up to 12.5 milligram per cubic meter*: Sa:Cf (APF = 25) (any powered, air-purifying respirator with a dust and mist filter); or PaprHie* (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *Up to 25 milligram per cubic meter*: 100F (APF = 50) (any air-purifying, full facepiece respirator with an N100, R100, or P100); or SaT:Cf* (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTHie* (APF = 50) (any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any self-contained breathing apparatus (SCBA) with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 50 milligram per cubic meter*: SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SaF:Pd,Pp (APF = 2000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus). *Escape*: 100F (APF = 50) (any air-purifying, full facepiece respirator with an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA). *Substance reported to cause eye irritation or damage; may require eye protection.

Storage: (1) Color code—Red Stripe: Flammability Hazard: Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Store flammable solids up to maximum allowable quantity per control area in an approved flammable storage area. Do not store in a basement. (2) Color code—Yellow Stripe (*dry powder is a strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area separated from strong oxidants, strong bases; strong acids. Metal containers involving the transfer of this chemical should be grounded and bonded. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN1326 Hafnium powder, wetted with not $<25\%$ water (a visible excess of water must be present) (1) mechanically produced, particle size $<53\,\mu m$; (2) chemically produced, particle size $<840\,\mu m$, Hazard Class: 4.1; Labels: 4.1-Flammable solid. UN2545 Hafnium powder, dry, Hazard Class: 4.1; Labels: 4.1-Flammable solid. UN1346 Hafnium powder, wetted with not less than 25% water (a visible excess of water must be present) (1) mechanically produced, particle size less than 53 μm; (2) chemically produced, particle size less than 840 μm, Hazard Class: 4.1; Labels: 4.1-Flammable solid.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency (EPA) for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Thermal decomposition products may include oxides of metal. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Recovery. Consider recycling, otherwise, this chemical must be disposed of in compliance with existing federal and local regulations.

References
(31); (173); (101); (138); (170); (100).

Halothane H:0110

Formula: $C_2HClBrF_3$; $CF_3CHBrCl$
Synonyms: Anestan; 2-Bromo-2-chloro-1,1,1-trifluoro-; 2-Bromo-2-chloro-1,1,1-trifluoroethane; Chalothane; Ethane, 2-bromo-2-chloro-1,1,1-thrifluoro-; Fluotane; Fluothane; Halotan; Halsan; Narcotane; 1,1,1-Trifluoro-2-bromo-2-chloroethane; 1,1,1-Trifluoro-2-chloro-2-bromoethane; 2,2,2-Trifluoro-1-chloro-1-bromoethane
CAS Registry Number: 151-67-7
HSDB Number: 6753 as 2-bromo-2-chloro-1,1,1-trifluoroethane
RTECS Number: KH6475000
UN/NA & ERG Number: UN3082 (environmentally hazardous substances, liquid, n.o.s.)/171
EC Number: 205-796-5
Regulatory Authority and Advisory Information
Carcinogenicity: IARC: Human Inadequate Evidence, animal Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3
Hazard Alert: Possible reproductive toxin, Asphyxiation hazard, Light sensitive (decomposition unless stabilized).
Hazard symbols, risk, & safety statements: Hazard symbol: T, Xi, N; risk phrases: R10; R20, R37/38; R40, R41; R50; R61, R62; safety phrases: S23; S26; S36/37; S41; S45; S53 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.
Description: Halothane is a highly volatile, nonflammable, colorless liquid. Sweet odor. Molecular weight = 197.39; specific gravity (H_2O:1) = 1.87; boiling point = 50°C; freezing/melting point = −118°C; relative vapor density (air = 1) = 2.9; vapor pressure = 243 mmHg. Practically insoluble in water; solubility = 0.5%.
Potential Exposure: Halothane is used as an inhalation anesthetic. It has been estimated that halothane accounts for two-thirds of all anesthetics.
Incompatibilities: May attack rubber and some plastics; sensitive to light. Light causes decomposition. May be stabilized with 0.01% thymol. Halothane is incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Tarnishes or corrodes most metals, with the exception of copper, chromium, nickel, and titanium[101]. Attacks aluminum, brass and lead in the presence of moisture. Attacks rubber and causes some plastics to deteriorate rapidly.
Permissible Exposure Limits in Air
Odor threshold = 33 ppm. OSHA PEL: None
NIOSH REL: 2 ppm/16.2 milligram per cubic meter [60-minute exposure to wasted anesthetic gas] Ceiling Concentration ACGIH TLV[1]: 50 ppm/404 milligram per cubic meter TWA; not classifiable as a human carcinogen
No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.
DFG MAK: 5 ppm/41 milligram per cubic meter TWA; Peak Limitation Category II(8); Pregnancy Risk Group B
Determination in Air: Use OSHA Analytical Method #29.
Permissible Concentration in Water: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guidelines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg[F]/L. SafeDrinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg[F]/L; SMCL = 2 mg/F/L, as Fluoride.
Determination in Water: Octanol−water coefficient: Log $K_{ow} = 2.30$. Unlikely to bioaccumulate in marine organisms.
Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact Passes through the skin.
Harmful Effects and Symptoms
Short-Term Exposure: Contact can irritate the eyes and skin. Inhalation can irritate the respiratory tract causing coughing and wheezing. May affect the cardiovascular system with low blood pressure and abnormal heartbeat; and central nervous system. High levels of exposure may cause dizziness, lightheadedness, nausea, vomiting, and very high levels can cause unconsciousness. Medical observation is indicated. *Inhalation:* Exposure to 4000 ppm can cause amnesia and impairment of manual dexterity. Exposure to 10,000 ppm can cause anesthesia. Liver impairment has occurred from use as an anesthetic. *Skin:* Repeated or prolonged application can destroy the skin. Halothane gives rise to only a very low incidence of postoperative nausea and is generally safe, which accounts for its wide-spread use.
Long-Term Exposure: May affect the liver and kidneys. Reported to have caused irregular menstrual period, headache, fatigue, and unconsciousness. Halothane has also been shown to cause birth defects in rats. May cause reproductive toxicity in humans. Experiments in laboratory animals have shown that continuous exposures of 15−50 ppm may cause liver damage.
Points of Attack: Liver, kidneys, skin, respiratory system; cardiovascular system; central nervous system. Based on animal tests, this may cause damage to the reproductive system.
Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater) the following are recommended before beginning work and at regular times after that: Liver and kidney function tests. EKG. If symptoms develop or overexposure has occurred, repeat these tests. More than light alcohol consumption may exacerbate liver damage. Pregnant women should avoid contact. Employees should be notified by a physician that this chemical may affect the reproductive system. In addition to comprehensive initial medical and work histories

emphasizing reproductive experience and menstrual history, patient should have physical examination and testing of genito-urinary tract, sperm count, motility and morphology. If required, other tests, such as serum testosterone, serum follicle stimulating hormone (FSH), and serum lutenizing hormone (LH) may be indicated.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Prevent skin contact. **8 hours:** polyvinyl alcohol gloves. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures *over 2 ppm*; Use an NIOSH/MSHA or European Standard EN 149-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use an NIOSH/MSHA or European Standard EN 149-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure location. Prior to working with halothane, you should be trained on its proper handling and storage. Store in tightly closed containers in a dark, cool, well-ventilated area, away from direct sunlight and oxidizers.

Shipping: UN3082 Environmentally hazardous substances, liquid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal EPA for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a nonflammable liquid. Thermal decomposition products may include hydrogen chloride, hydrogen fluoride, hydrogen bromide, halogen acids, carbonyl halises and oxides of carbon. Use dry chemical, carbon dioxide; or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (122). (100).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 1, No. 5, 63 (1981).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Halothane, Trenton, NJ (June 1999).

New York State Department of Health, *Chemical Fact Sheet:* Halothane, Bureau of Toxic Substance Assessment, Albany, NY (May 1986).

Helium H:0120

Formula: He

Synonyms: Helium, elemental

CAS Registry Number: 7440-59-7

HSDB Number: 553

RTECS Number: MH6520000

UN/NA & ERG Number: UN1046 (Helium, compressed)/121; UN1963 [Helium, refrigerated liquid (cryogenic liquid)]/120

EC Number: 231-168-5

Regulatory Authority and Advisory Information

Hazard Alert: Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated.

Hazard symbols, risk, & safety statements: Hazard symbol: Xn; risk phrases: R5; R9; R21; safety phrases: S9; S33; R38; S41 (see Appendix 4)

Description: Helium is a colorless, odorless, and tasteless gas. It is nonflammable. Molecular weight = 4.0; specific gravity (H_2O:1) = 0.15 @ −271°C; boiling point = −269°C; freezing/melting point = −272°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 0, reactivity 0. Soluble in water.

Potential Exposure: It is used in weather balloons and in welding gases. Liquid helium is used as a closed system cooling agent.

Permissible Exposure Limits in Air

ACGIH TLV[1]: simple asphyxiant PAC Ver. 29[138]

PAC-1: 65,000 ppm

PAC-2: 230,000 (2.30E + 05) ppm

PAC-3: 400,000 (4.00E + 05) ppm

No occupational exposure limits have been established for this substance. Large amounts of helium will, however, decrease the amount of available oxygen. Oxygen content should never be below 19%.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short-Term Exposure: Helium can affect you when breathed in. Exposure to high levels can cause you to feel dizzy and lightheaded. Very high levels can cause you to pass out and even die due to suffocation from lack of oxygen. Contact with liquid helium can cause frostbite.

First Aid: If frostbite has occurred, seek medical attention immediately; *do not* rub the affected areas or flush them with water. In order to prevent further tissue damage, *do not* attempt to remove frozen clothing from frostbitten areas. If frostbite has NOT occurred, immediately and thoroughly wash contaminated skin with soap and water. Seek medical attention promptly. *Breathing:* Remove the person from exposure. Begin (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility.

Personal Protective Methods: *Clothing:* Where exposure to cold equipment, vapors, or liquid may occur, employees should be provided with special clothing designed to prevent the freezing of body tissues. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. *Eye Protection:* Wear splash-proof chemical goggles and face shield when working with liquid, unless full facepiece respiratory protection is worn.

Respirator Selection: Exposure to helium gas is dangerous because it can replace oxygen and lead to suffocation. Only NIOSH/MSHA or European Standard EN 149-approved SCBA with a full facepiece operated in the positive-pressure mode should be used in oxygen deficient environments.

Storage: Check oxygen content prior to entering storage area. Liquid helium should be stored and transferred under positive pressure to prevent infiltration of air and other gasses. Protect this material from exposure to light. Keep it away from oxidizing materials and store it under refrigerated temperatures. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: UN1046 Helium, compressed, Hazard Class: 2.2; Labels: 2.2-Nonflammable compressed gas; UN1963 Helium, refrigerated liquid (cryogenic liquid), Hazard Class: 2.2; Labels: 2.2-Nonflammable compressed gas.

Spill Handling: If liquid helium is spilled or leaked, take the following steps: Restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Stop the leak or move container to a safe area and allow the liquid to evaporate. Ventilate area of leak to disperse the gas. Stop flow of gas. If source of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty.

Fire Extinguishing: Helium gas may burn but does not readily ignite. Stop flow of gas. Use extinguisher suitable for surrounding fire. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier.

References

(31); (173); (101); (138).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Helium, Trenton, NJ (August 1998).

Hematite H:0130

Formula: Fe_2O_3

Synonyms: Bloodstone; Hematite; Hematite, red; Iron ore; Iron oxide; Red iron ore

CAS Registry Number: 1317-60-8; 1309-37-1 (ferric oxide, Fe_2O_3)

HSDB Number: 2964

RTECS Number: MH7600000

EC Number: 215-168-2 (diiron trioxide; protohematite; CAS 1309-37-1)

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal No Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1987; (*underground mining with exposure to radon*) Human Sufficient Evidence (underground mining with exposure to radon), *carcinogenic to humans*, Group 1, 1998.

Hazard Alert: Possible risk of forming tumors, as Fe_2O_3.

WGK[100] (German Aquatic Hazard Class): Non hazard to water. (CAS: 1309-37-1)

Description: Hematite is a noncombustible, black to black-red or brick-red mineral (iron ore) composed mainly of ferric oxide, Fe_2O_3. *Ferric oxide:* Molecular weight: 159.69; specific gravity (H_2O:1) = 5.3 @ 20°C; freezing/melting point = 1539°C. See also *Iron oxide*

Potential Exposure: Hematite; as an iron ore composed mainly of ferric oxide, is a major source of iron and is used as a pigment for rubber, paints, paper, linoleum, ceramics, dental restoratives; and as a polishing agent for glass and precious metals. It is also used in electrical resistors, semiconductors, magnets, and as a catalyst. Human exposure to hematite from underground hematite mining is principally through inhalation and/or ingestion of dusts. No estimates are available concerning the number of underground miners exposed.

Incompatibilities: Contact with hydrogen peroxide, ethylene oxide, calcium hypochlorite will cause explosion. Violent reaction with powdered aluminum; hydrazine, hydrogen trisulfide.

Permissible Exposure Limits in Air

NIOSH IDLH = 2500 mg[Fe]/m^3

OSHA PEL: 10 mg[Fe]/m^3 TWA (dust and fume)

ACGIH TLV[1]: 5 mg[Fe]/m^3 (vapor, dust) TWA; not classifiable as a human carcinogen (2005)

DFG MAK: 1.5 mg[Fe]/m^3 respirable fraction

PAC Ver. 29[138]

1309-37-1, ferric oxide

PAC-1: 15 milligram per cubic meter

PAC-2: 360 milligram per cubic meter

PAC-3: 22000 milligram per cubic meter

Arab Republic of Egypt: TWA 3 ppm (5 milligram per cubic meter) (fume), 1993; Australia: TWA 5 milligram per cubic meter (fume), 1993; Austria: MAK 6 milligram per cubic meter (*dust*), 1999; Denmark: TWA 3.5 mg[Fe]/m^3, 1999; Finland: TWA 5 ppm (fume), 1999; France: VME 5 milligram per cubic meter (fume), 1999; the Netherlands: MAC-TGG 5 mg[Fe]/m^3, 2003; the Netherlands: MAC-TGG 10 milligram per cubic meter, 2003; Norway: TWA 3 milligram per cubic meter, 1999; the Philippines: TWA 10 milligram per cubic meter (fume), 1993; Poland: MAC (TWA) (fume) 5 milligram per cubic meter, MAC (STEL) 10 milligram per cubic meter, 1999; Sweden: NGV 3.5 milligram per cubic meter (fume), 1999; Switzerland: MAK-W 6 milligram per cubic meter) (fume), 1999; Thailand: TWA 10 milligram per cubic meter (fume), 1993; Turkey: TWA 10 milligram per cubic meter (fume), 1993; United Kingdom: TWA 5 mg[Fe]/m^3; STEL 10 mg [Fe]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen.

Determination in Air: As iron oxide, use NIOSH Analytical Methods #7300, #7301,#7303, #9102; OSHA Analytical Methods ID-121, ID-125G.

Routes of Entry: Dust inhalation.

Harmful Effects and Symptoms

Long-Term Exposure: There is sufficient evidence for the carcinogenicity in humans of underground hematite mining (with exposure to radon). Underground hematite miners have a high incidence of lung cancer, whereas surface hematite miners do not. It is not known whether this excess risk may be due to hematite; to radon (a known lung carcinogen); to inhalation of ferric oxide or silica; or to a combination of these or other factors. Some studies of metal workers exposed to ferric oxide dusts have shown an increased incidence of lung cancer, while other studies have not. The influence of factors in the work-place, other than ferric oxide, cannot be eliminated.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: For severe poisoning, *do not* use BAL (British Anti-Lewisite), dimercaprol, dithiopropanol ($C_3H_8OS_2$) as it is contraindicated or ineffective in poisoning from iron.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *50 milligram per cubic meter*: 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]. *125 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *250 milligram per cubic meter*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *2,500 milligram per cubic meter*: Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Where possible, automatically transfer material from other storage containers to process containers A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal EPA for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Use extinguishing agents suitable for surrounding fires. Thermal decomposition products may include oxides of metal (fume). If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (2); (100).

n-Heptane H:0160

Formula: C_7H_{16}; $CH_3(CH_2)_5CH_3$

Synonyms: Dipropal methane; Dipropyl methane; Dipropylmethane; *n*-Heptane; Heptyl hydride; Normal heptane; Skelly-Solve C

CAS Registry Number: 142-82-5

HSDB Number: 90

RTECS Number: MI7700000

UN/NA & ERG Number: UN1206/128

EC Number: 205-563-8 [*Annex I Index No.*: 601-008-00-2]

Regulatory Authority and Advisory Information

Carcinogenicity: EPA: Not Classifiable as to human carcinogenicity. Hazard Alert: Highly flammable, Drug; Environmental hazard.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: risk phrases: F, Xn, N; R11; R38; R65; R67; R50/53; safety phrases: S2; S9; S16; S21; S29; S33; S60; S61; S62 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: *n*-Heptane is a clear liquid which is highly flammable and volatile with a mild, gasoline-like odor. The odor threshold is 40−547 ppm; also reported @ 230 ppm. Molecular weight = 100.23; specific gravity (H_2O:1) = 0.68; boiling point = 98.5°C; freezing/melting point = −92°C; vapor pressure = 40 mmHg @ 22.3°C; flash point = −4°C; autoignition temperature = 204°C[17]; 285°C. Explosive limits: LEL = 1.1%; UEL: 6.7%. Hazard Identification (based on NFPA-704 M Rating System): Health 1, flammability 3, reactivity 0. Practically insoluble in water; solubility = 0.0003%.

Potential Exposure: *n*-Heptane is used in graphics, textiles, adhesives, and coatings; as an industrial solvent and in the petroleum refining process; as a standard in testing knock of gasoline engines.

Incompatibilities: May form explosive mixture with air. Strong oxidizers may cause fire and explosions. Attacks some plastics, rubber and coatings. May accumulate static electric charges that can ignite its vapors.

Permissible Exposure Limits in Air

NIOSH IDLH = 750 ppm

Conversion factor: 1 ppm = 4.10 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 500 ppm/2000 milligram per cubic meter TWA

NIOSH REL: 85 ppm/350 milligram per cubic meter TWA; 440 ppm/1800 milligram per cubic meter [15 minutes] Ceiling Concentration

ACGIH TLV[1]: 400 ppm/1640 milligram per cubic meter TWA; 500 ppm/2050 milligram per cubic meter STEL

PAC Ver. 29[138]

PAC-1: 500 ppm
PAC-2: 830 ppm
PAC-3: 5000 ppm
DFG MAK: 500 ppm/2100 milligram per cubic meter TWA; Peak Limitation Category I(1); Pregnancy Risk Group D
Australia: TWA 400 ppm (1600 milligram per cubic meter); STEL 500 ppm, 1993; Austria: MAK 500 ppm (2000 milligram per cubic meter), 1999; Belgium: TWA 400 ppm (1640 milligram per cubic meter); STEL 500 ppm, 1993; Denmark: TWA 200 ppm (820 milligram per cubic meter), 1999; Finland: TWA 300 ppm (1200 milligram per cubic meter); STEL 500 ppm (2000 milligram per cubic meter), 1999; France: VME 400 ppm (1600 milligram per cubic meter), 1999; Japan: 200 ppm (820 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 1200 milligram per cubic meter, 2003; Norway: TWA 200 ppm (800 milligram per cubic meter), 1999; the Philippines: TWA 500 ppm (2000 milligram per cubic meter), 1993; Poland: MAC (TWA) 1200 milligram per cubic meter, MAC (STEL) 2000 milligram per cubic meter, 1999; Russia: TWA 200 ppm, 1993; Sweden: NGV 200 ppm (800 milligram per cubic meter), KTV 300 ppm (1200 milligram per cubic meter), 1999; Switzerland: MAK-W 400 ppm (1600 milligram per cubic meter), KZG-W 800 ppm (3200 milligram per cubic meter), 1999; Turkey: TWA 500 ppm (2000 milligram per cubic meter), 1993; United Kingdom: LTEL 400 ppm (1600 milligram per cubic meter); STEL 500 ppm, 1993: Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 500 ppm. Several states have set guidelines or standards for heptane in ambient air[60] ranging from 7.0 milligram per cubic meter (Connecticut and South Dakota) to 16.0−20.0 milligram per cubic meter (North Dakota) to 24.5 milligram per cubic meter (Virginia) to 32.0 milligram per cubic meter (Florida and New York) to 38.095 milligram per cubic meter (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #1500, for Hydrocarbons, BP 36−126°C; OSHA Analytical Method 7.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = >4.5$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation of the vapor, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: *n*-Heptane irritates the eyes, skin, and respiratory tract. A narcotic at high concentrations. *n*-Heptane can cause dermatitis and mucous membrane irritation. Aspiration of the liquid may result in chemical pneumonitis, pulmonary edema; and hemorrhage. Systemic effects may arise without complaints of mucous membrane irritation. Exposure to high concentrations causes narcosis producing vertigo, a lack of coordination; intoxication characterized by hilarity, slight nausea; loss of appetite; and a persisting gasoline taste in the mouth. These effects may be first noticed on entering a contaminated area. *n*-Heptane may cause low order sensitization of the myocardium to epinephrine. Swallowing the liquid may cause chemical pneumonitis.

Long-Term Exposure: The liquid defats the skin causing dryness and irritation. May affect the central nervous system; liver. Many petroleum solvents similar to heptane can cause brain damage that can affect memory, concentration, mood, sleep patterns.

Points of Attack: Skin, respiratory system; lungs, peripheral nervous system.

Medical Surveillance: Preplacement examinations should evaluate the skin and general health, including respiratory, liver, and kidney function. Interview for brain effects. Consider cerebellar, autonomic and peripheral nervous system evaluation. Refer positive and borderline individuals for neuropsychological testing. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin contact; **8 hours**: nitrile rubber gloves, suits, boots; Viton gloves, suits; 4H and Silver Shield gloves. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *750 ppm:* CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister]; or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]; or Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with heptane all handlers should be trained on its proper handling and storage. Before entering confined space where heptane may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1206 Heptanes, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Stay upwind and use water spray to “knock down” vapor. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal EPA for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (2); (100).

National institute for Occupational Safety and Health (NIOSH), *Criteria for a Recommended Standard: Occupational Exposure to Alkanes*, NIOSH Document Number 77-151, Cincinnati OH (1977).

Sax, N. I., Ed., “*Dangerous Properties of Industrial Materials Report*,” 1. No. 6, 58−59 (1981).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Heptane, Trenton, NJ (April, 2004).

1-Heptanethiol H:0170

Formula: $C_7H_{16}S$

Synonyms: *n*-Heptylmercaptan; Heptyl mercaptan

CAS Registry Number: 1639-09-4

RTECS Number: MJ1400000

UN/NA & ERG Number: UN1228/131

EC Number: 216-678-8

Regulatory Authority and Advisory Information.

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: 1-Heptanethiol is a flammable, colorless liquid with a strong odor. Molecular weight = 132.29; boiling point = 176°C; freezing/melting point = −43°C; flash point = 46°C. Insoluble in water.

Potential Exposure: Used as a chemical intermediate for fuels, dyes, pharmaceuticals; and to make other chemicals.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, alkali metals and reducing agents.

Permissible Exposure Limits in Air

OSHA PEL: None

NIOSH REL: 0.5 ppm/2.7 milligram per cubic meter [15-minutes] Ceiling Concentration

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Determination in Air: No method available.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin and respiratory tract. Exposure can cause headache, dizziness, nausea, and vomiting. High concentrations of mercaptans may cause cold extremities, rapid pulse; increased respiration; drowsiness, cyanosis, and unconsciousness.

Long-Term Exposure: Unknown at this time.

Points of Attack: Eyes, skin, respiratory system; central nervous system; blood.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *up to 5 ppm*: CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)]; or Sa (APF = 10) (any supplied-air respirator). *Up to 12.5 ppm*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]. *Up to 25 ppm:* CcrFOv (APF = 50) [any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s)]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or PaprTOv (APF = 50) [any powered, air-purifying respirator with a tight-fitting facepiece and organic vapor cartridge(s)]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1228 Mercaptans, liquid, flammable, toxic, n.o.s. or Mercaptan mixtures, liquid, flammable, toxic, n.o.s., Hazard Class: 3; Labels: 3-Flammable liquid, 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal EPA for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include sulfur oxides, carbon monoxide, and hydrogen sulfide. Use dry chemical, carbon dioxide; alcohol foam; or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* 1-Heptanethiol, Trenton, NJ (June 1999).

Heptene H:0180

Formula: C_7H_{14}; $C_3H_7CH{=}CHC_2H_5$

Synonyms: 1-Ethyl-2-propyl ethylene; *n*-Heptene; 1-Heptene; 1-Heptylene; Heptylene

CAS Registry Number: 592-76-7

HSDB Number: 1078

RTECS Number: MU8815000

UN/NA & ERG Number: UN2278/128

EC Number: 209-767-8 (see Appendix 4).

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Highly flammable liquid, Environmental hazard.

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xn; risk phrases: R11; R36/37/38; R51; R65; safety phrases: S16; S21; S26; S29; S36/37; S45; S62; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to waters.

Description: Heptene is a colorless liquid. Mild, gasoline-like odor. Molecular weight = 98.21; boiling point = 94°C; vapor pressure = 59 mmHg @ 25°C; flash point = −10°C; autoignition temperature = 260°C. Explosive limits: LEL = 1.0%; UEL-unknown. Hazard Identification (based on NFPA-704 M Rating System): Health 1, flammability 3, reactivity 0. Insoluble in water.

Potential Exposure: A potential danger to those involved in use as a plant growth retardant or in organic synthesis.

Incompatibilities: Vapor may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. May react exothermically with reducing agents releasing flammable hydrogen gas.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 130 ppm

PAC-2: 1400 ppm

PAC-3: 8700 ppm

Routes of Entry: Inhalation, skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin and respiratory tract. Narcotic at higher concentrations; may act as a slight anesthetic. Inhalation can cause coughing, wheezing, and/or shortness of breath. May also act as simple asphyxiant.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149

(Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with heptene all handlers should be trained on its proper handling and storage. Before entering confined space where heptene may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN2278 *n*-Heptene, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. Spills on water may be handled with oil skimming equipment and sorbent (polyurethane) foams. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal EPA for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; alcohol foam; or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138). (100).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 2, No. 2, 29–30 (1982).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Heptene, Trenton, NJ (June 1999).

Hexachlorobenzene H:0190

Formula: C_6Cl_6

Synonyms: Amatin; Anticarie; Benzene, hexachloro-; Bunt-Cure; Bunt-No-More; Ceku C.B.; Co-Op Hexa; Granox NM; HCB; Hexa C.B.; Hexachlorbenzol (German); Hexaclorobenceno (Spanish); Julin's carbon chloride; No Bunt; No Bunt 40; No Bunt 80; No Bunt liquid; Pentachlorophenyl chloride; Perchlorobenzene; Saatbenizfungizid (German); Sanocid; Sanocide; Smut-Go; Snieciotox

CAS Registry Number: 118-74-1

HSDB Number: 1724

RTECS Number: DA2975000

UN/NA & ERG Number: UN2729/152

EC Number: 204-273-9 [*Annex I Index No.*: 602-065-00-6]

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Animal Sufficient Evidence, Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B, 2000; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies. United States EPA Gene-Tox Program, Positive: Carcinogenicity-mouse/rat; Negative: Rodent dominant lethal.

California Proposition 65 Chemical[102]: Cancer 10/1/1987; Developmental/Reproductive toxin 1/1/1989.

Hazard Alert: Poison, Combustible, Endocrine disruptor (high), Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard. Listed for Tier 1 screening as an endocrine disruptor[88].

Persistent Organic Pollutants (UN)

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

United States National Primary Drinking Water Regulations: MCLG = 0 mg/L; MCL = 0.001 mg/L

Clean Water Act: Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

United States EPA Hazardous Waste Number (RCRA No.): U127; D032 RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA Toxicity Characteristic (Section 261.24), Maximum Concentration of Contaminants, regulatory level, 0.13 mg/L

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.055; Nonwastewater (mg/kg), 10

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8120 (0.05); 8270 (10)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 10 lb (4.54 kg)

EPCRA Section 313 Form R de minimis concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List ***Concentration Reporting Level: 1.0%***.

Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)]

List of Stockholm Convention POPs: Annex A (Elimination); Annex C (Unintentional production and release) as HCB

Hazard symbols, risk, & safety statements: Hazard symbol: T+, N; risk phrases: R45; R48/25; R50/53; R62; R63; safety phrases: S53; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Hexachlorobenzene is a solid, crystallizing in needles. Molecular weight = 284.76; boiling point = 323−326°C; freezing/melting point = 231 °C; flash point = 242°C. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 1, reactivity 0. Slightly soluble in water.

Potential Exposure: Hexachlorobenzene was used as a fungicide; an additive for pyrotechnic compositions; and as wood preservative. It was used widely as a pesticide to protect seeds of onions and sorghum, wheat, and other grains against fungus until 1965. This material was used to make fireworks; ammunition for military uses; synthetic rubber; as a porosity controller in the manufacture of electrodes; as an intermediate in dye manufacture; in organic synthesis. It is formed as a by-product of making other chemicals; in the waste streams of chloralkali and wood-preserving plants; and when burning municipal waste. Currently, there are no commercial uses of hexachlorobenzene in the United States.

Incompatibilities: Reacts violently with oxidizers; dimethyl formamide above 65°C.

Permissible Exposure Limits in Air

OSHA PEL: None

NIOSH REL: None

ACGIH TLV[1]: 0.002 TWA [skin]; confirmed animal carcinogen with unknown relevance to humans.

PAC Ver. 29[138]

PAC-1: 0.006 milligram per cubic meter

PAC-2: 14 milligram per cubic meter

PAC-3: 91 milligram per cubic meter

DFG MAK: [skin]; Carcinogen Category 4; Pregnancy Risk Group D

France: carcinogen, 1993; Poland: MAC (TWA) 0.5 milligram per cubic meter, 1999; Russia: STEL 0.9 milligram per cubic meter [skin], 1993; United Kingdom: carcinogen, 2000; the Netherlands: MAC-TGG 0.03 milligram per cubic meter, 2003. Russia set a MAC in ambient air of residential areas of 0.013 milligram per cubic meter. The Czech Republic[35] has set a TWA in work-place air of 1.0 milligram per cubic meter and an STEL of 2.0 milligram per cubic meter. Several states have set guidelines or standards for hexachlorobenzene in ambient air[60] ranging from zero in North Dakota to 0.48 ppb (Pennsylvania) to 0.03 μ/m^3 (New York).

Determination in Air: Use NIOSH Analytical Method (IV) #1003, Halogenated hydrocarbons.

Permissible Concentration in Water: Safe Drinking Water Act (47FR 9352): MCL, 0.001 mg/L; MCLG, zero.

Federal Drinking Water Standards: EPA 1 μg/L; State Drinking Water Guidelines: Arizona 0.02 μg/L; Maine 0.2 μg/L; Minnesota 0.02 μg/L.

Determination in Water: Methylene chloride extraction followed by concentration and gas chromatography with electron capture detection (EPA Method 612) or gas chromatography plus mass spectrometry (EPA Method 625). Fish Tox = 1760.07814000 ppb MATC (VERY LOW).

Routes of Entry: Inhalation, ingestion, eye and skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin, and respiratory tract. *Inhalation:* Coughing, shortness of breath and labored breathing have been reported from large, unmeasured doses or by decomposition to chlorine. *Skin:* Can cause irritation. Exposure to sunlight with (or soon after) exposure can increase effects. Following this reaction, changes in skin pigment and blistering may follow. Red or dark urine may be noticed. High doses may cause redness, pain and serious burns. *Eyes:* May cause irritation. Higher doses may cause redness, pain and blurred vision. *Ingestion:* Headache, dizziness, nausea, vomiting, numbness of hands and arms; apprehension, excitement, tremors, partial paralysis of arms and legs; loss of muscle control; loss of sensory perception; convulsions and coma may result from high doses. Human Tox = 1.00000 ppb (HIGH).

Long-Term Exposure: May cause liver or kidney problems; reproductive difficulties; increased risk of cancer. May cause liver, thyroid, and immune system damage. May affect the lungs, liver, skin, and nervous system. This substance causes cancer in laboratory animals, and may be carcinogenic to humans. May damage the developing fetus.

High, prolonged or repeated exposure may affect the nervous system. Repeated skin exposure can lead to permanent skin changes and increased hair growth. Animal tests show that this substance possibly causes toxic effects upon human reproduction. Ingestion of contaminated grain, estimated at doses of 0.05–0.2 g/day, resulted in *porphyria cutanea* tarda in Turkey, which is characterized by red-colored urine; skin sores; change in skin color; arthritis; and problems of the liver, nervous system; and stomach. The following symptoms were also reported: enlarged livers, *porphyria* in the blood; loss or appetite; weight loss and wasting of skeletal muscles. Severe and long-standing poisoning caused abnormal hair growth, loss of vision; wasting of hands; black discoloration; and skin sores which became ulcerated, healing with pigmented scars. Breast-fed children developed "pink-sore," a condition which was 95% fatal. Toxic effects on blood and active symptoms persisted up to 20 years. Studies in animals show that ingestion of this chemical can damage the liver, thyroid, nervous system; bones, kidneys, blood, immune, and endocrine system.

Points of Attack: Liver, skin, thyroid.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Liver function tests. Thyroid function tests. Evaluation by a qualified allergist and/or dermatologist. Iron as a dietary supplement could increase liver damage. consult a physician before taking supplements. Guard against sunlight exposure to contaminated skin.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. *Note to Physician:* For ingestions of less than 10 mg/kg body weight occurring less than an hour before treatment, induce emesis. For ingestions of more than 10 mg/kg body weight occurring less than an hour before treatment, use gastric lavage. For ingestion occurring more than an hour before treatment, use activated charcoal. There is no specific antidote, and supervision for at least 72 hours is recommended.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *SCBA:* >0.006 milligram per cubic meter. *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, dimethyl formamide and heat. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2729 Hexachlorobenzene, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal EPA for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical may burn but does not easily ignite. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. Thermal decomposition products may include chlorine. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration is most effective @ 1300°C and 0.25 seconds. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform to EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(109); (102); (31); (173); (101); (138); (2); (100).

United States Environmental Protection Agency, Chlorinated Benzenes: Ambient Water Quality Criteria. Washington, DC (1980).

United States Environmental Protection Agency, Status Assessment of Toxic Chemicals: Hexachlorobenzene, Report EPA-600/2-79-210g, Cincinnati, OH (December 1979).

United States Environmental Protection Agency, Hexachlorobenzene, Health and Environmental Effects Profile No. 110, Office of Solid Waste, Washington, DC (April 30, 1980).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 4, No. 1, 88−92 (1984).

New York State Department of Health, *Chemical Fact Sheet:* Hexachlorobenzene (HCB), Bureau of Toxic Substance Assessment, Albany, NY (May 1986).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Hexachlorobenzene, Trenton, NJ (July 2001).

United States Department of Health and Human Services, "ATSDR ToxFAQs, Hexachlorobenzene," Atlanta, GA (September 1997).

Hexachlorobutadiene H:0200

Formula: C_4Cl_6; $CCl_2{=}CCl{-}CCl{=}CCl_2$

Synonyms: 1,3-Butadiene, 1,1,2,3,4,4-hexachloro-; Butadiene, hexachloro-; C46; Dolen-Pur; GP-40-66: 120; HCBD; 1,1,2,3,4,4-Hexachloro-1,3-butadiene; Hexachloro-1,3-butadiene; Hexachlorobutadiene; Hexaclorobutadieno (Spanish); Perchloro-1,3-butadiene; Perchlorobutadiene

CAS Registry Number: 87-68-3

HSDB Number: 2870

RTECS Number: EJ0700000

UN/NA & ERG Number: UN2279/151

EC Number: 201-765-5

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Limited Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1999; EPA: Possible Human Carcinogen; NIOSH: Potential occupational carcinogen.

California Proposition 65 Chemical[102]: Cancer 5/3/2011

Hazard Alert: Poison, combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction).

NTP: Toxicity studies, RPT#TOX-01, October 2000

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Clean Water Act: Section 313 Water Priority Chemicals (57FR41331, 9/9/1992); 40CFR401.15 Section 307 Toxic Pollutants

United States EPA Hazardous Waste Number (RCRA No.): U128; D033 RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA Toxicity Characteristic (Section 261.24), Maximum Concentration of Contaminants, regulatory level, 0.5 mg/L

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.055; Nonwastewater (mg/kg), 5.6

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8120 (5); 8270 (10)

Safe Drinking Water Act (47FR 9352): Priority List (55 FR 1470)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg)

EPCRA Section 313 Form R de minimis concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazard symbols, risk, & safety statements: Hazard symbol: T; risk phrases: R62; R63;?; safety phrases: S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Hexachlorobutadiene is a clear, colorless liquid with a faint, turpentine-like odor. Molecular weight = 260.76; specific gravity (H_2O:1) = 1.56; boiling point = 215 °C; freezing/melting point = −21°C; vapor pressure = 0.2 mmHg @ 20°C; flash point = 90°C; autoignition temperature = 610°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 1, reactivity 1. Insoluble in water.

Potential Exposure: Hexachlorobutadiene is used as a solvent; heat-transfer fluid; transformer fluid; hydraulic fluid; as a solvent for elastomers; as a wash liquor for removing higher hydrocarbons.

Incompatibilities: Strong reaction with oxidizers, aluminum powder. Attacks aluminum; some plastics, rubber and coatings

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 10.66 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: None

NIOSH REL: 0.02 ppm/0.24 milligram per cubic meter TWA [skin]; suspected occupational carcinogen; limit exposures to lowest feasible concentration, See *NIOSH Pocket Guide*, Appendix A

ACGIH TLV[1]: 0.02 ppm/0.21 milligram per cubic meter TWA [skin]; confirmed animal carcinogen with unknown relevance to humans.
PAC* Ver. 29[138]
PAC-1: $\mathbf{1_E}$ ppm
PAC-2: $\mathbf{3_E}$ ppm
PAC-3: $\mathbf{10_E}$ ppm
*ERPG [Emergency Response Planning Guidelines] is marked with a subscript "**E**."
DFG MAK: [skin]; Carcinogen Category 3B
Australia: TWA 0.02 ppm (0.24 milligram per cubic meter) [skin], carcinogen, 1993; Austria [skin], Suspected: carcinogen, 1999; Belgium: TWA 0.02 ppm (0.21 milligram per cubic meter) [skin], carcinogen, 1993; Finland: carcinogen, 1999; Norway: TWA 0.02 ppm (0.24 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 0.24 milligram per cubic meter, 2003; Switzerland: MAK-W 0.02 ppm (0.24 milligram per cubic meter) [skin], 1999; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: confirmed animal carcinogen with unknown relevance to humans. Russia[35,43] has set MAC values for ambient air in residential areas of 0.001 milligram per cubic meter on a momentary basis and 0.0002 mg on a daily average basis. Several states have set guidelines or standards for hexachlorobutadiene in ambient air[60] ranging from zero (North Dakota) to 0.72 μ/m^3 (Pennsylvania) to 0.80 μ/m^3 (New York) to 1.2 μ/m^3 (South Carolina) to 2.4 μ/m^3 (Connecticut, Florida, and Virginia) to 6.0 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #2543.

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 1 μg/L; State Drinking Water Guidelines: Florida 0.05 μg/L; Maine 4 μg/L; Minnesota 1 μg/L; New Hampshire 1 μg/L.

Determination in Water: Methylene chloride extraction followed by concentration, gas chromatography with electron capture detection (EPA Method 612) or gas chromatography plus mass spectrometry (EPA Method 625). Octanol−water coefficient: Log $K_{ow} = \sim 5$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Hexachlorobutadiene can affect you when breathed in and by passing through your skin. The liquid is corrosive; contact can irritate and burn the skin and eyes. Vapors can irritate the eyes, skin, and respiratory tract.

Long-Term Exposure: Hexachlorobutadiene should be handled as a carcinogen-with extreme caution. It may damage the developing fetus. Exposure can cause severe kidney damage. Hexachlorobutadiene may damage the liver. Repeated or prolonged contact may cause skin sensitization and allergy.

Points of Attack: Eyes, skin, respiratory system; kidneys. Cancer site in animals: kidney tumors.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Before beginning employment and at regular times after that, the following are recommended: kidney and liver function tests. Evaluation by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/ manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures *over 0.02 ppm*; Use a MSHA/NIOSH/MSHA or European Standard EN 149-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area separated from strong oxidants, strong bases; strong acids. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. A regulated, marked area should be established where hexachlorobutadiene is handled, used, or stored. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2279 Hexachlorobutadiene, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal EPA for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material is not flammable. Use extinguishing agents suitable for surrounding fire. Thermal decomposition products may include hydrogen chloride and oxides of carbon. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: High temperature incineration with flue gas scrubbing[22]. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform to EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(102); (31); (173); (101); (138) (2); (100).

United States Environmental Protection Agency, *Hexachlorobutadiene: Ambient Water Quality Criteria*, Washington, DC (1980).

United States Environmental Protection Agency. *Sampling and Analysis of Selected Toxic Substances. Task 1B-Hexachlorobutadiene, EPA Rep. No. 560/6-76-015*, Off. Toxic Subst., Washington, DC (1976).

United States Environmental Protection Agency, *Hexachlorobutadiene, Health and Environmental Effects Profile No. 111*, Office of Solid Waste, Washington, DC (April 30, 1980).

Sax, N. I., Ed. *Dangerous Properties of Industrial Materials Report*, 2, No. 5, 71-75 (1982).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Hexachlorobutadiene*, Trenton, NJ (August 2004).

Hexachlorocyclohexanes H:0210

Formula: $C_6H_6Cl_6$

Synonyms: *technical grade containing 68.7% α-BHC, 6.5% β-BHC, 13.5% γ-BHC:* BHC; Compound 666; DBH; ENT 8,601; Gammexane; HCCH; Hexa; Hexachlorocyclohexane; Hexachlorocyclohexane (mixed isomers); Hexachlorocyclohexane isomers; Hexacloran; Hexaclorociclohexano (Spanish); Hexaklon (in Sweden); Hexhexane; Hexylan; Jacutin; Latka-666 HCH

α-Isomer: A13-09232; α-Benzenehexachloride; Benzene hexachloride-α-isomer; Benzene-*trans*-hexachloride; α-BHC; Cyclohexane 1,2,3,4,5,6-hexachloro-; Cyclohexane 1,2,3,4,5, 6-hexachloro-α; Cyclohexane 1,2,3,4,5,6-hexachloro-a isomer; Cyclohexane 1,2,3,4,5,6-hexachloro-(*a*, DL); Cyclohexane 1,2,3,4,5,6-hexachloro-(1a,2a,3b,4a,5b,6b)-; Cyclohexane, α-1, 2,3,4,5,6-hexachloro-; ENT9,232; Forlin; Gamaphex; α-HCH; α-Hexachloran; α-Hexachlorane; Hexachlorcyclohexan (German); α-1,2,3,4,5,6-Hexachlorcyclohexane; Hexachloro cyclohexan (German); α-Hexachlorocyclohexane; 1-a,2a,3b, 4a,5b,6b-Hexachlorocyclohexane; 1,2,3,4,5,6-Hexachlorocyclo hexane; 1a,2a,3b,4a,5b,6b-Hexachlorocyclohexane; Hexachlo rocyclohexane; 1,2,3,4,5,6-Hexaclorociclohexano (Spanish); Isotox; Lindagam; α-Lindane; Silvano

β-Isomer: β-Benzenehexachloride; β-BHC; ENT 9,233; β-HCH; β-1,2,3,4,5,6-Hexachlorocyclohexane; β-Hexa chlorocyclohexane; 1-a,2-b,3-a,4-b,5-a,6-β-Hexachloro-cyclohexane; β-Lindane

γ-Isomer: see Lindane

δ-Isomer: δ-Benzenehexachloride; δ-BHC; ENT9,234; δ-HCH; HCH, δ-; HCH-delta; δ-1,2,3,4,5,6-Hexachloro cyclohexane; δ-Hexachlorocyclohexane; 1-α,2-α,3-α,4-β, 5-α,6-β-Hexachlorocyclohexane; δ-Lindane

CAS Registry Number: 608-73-1 (technical grade, mixture of α- and β-isomers); 319-84-6 (α-isomer); 319-85-7 (β-isomer); 58-89-9 (γ-isomer, see "Lindane"); 319-86-8 (δ-delta isomer); 6108-10-7 (δ epsilon-isomer)

HSDB Number: 6029 (319-84-6); 6183 (319-85-7)

RTECS Number: GV3150000

UN/NA & ERG Number: UN2761 (Organochlorine pesticides, solid toxic)/151

EC Number: 210-168-9 (BHC or HCH); 206-270-8 (α-isomer); 206-271-3 (β-isomer); 200-401-2 [*Annex I Index No.*: 602-043-00-6] (γ-isomer); 206-272-9 (δ-isomer)

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen [hexachlorocyclohexane (technical grade) and other hexachlorocyclohexane isomers]; IARC: Animal sufficient (*technical-grade & α-isomer; limited for the β-& g-isomers*); Human Inadequate Evidence, Group 2B; EPA *(technical grade, mixture of α- and β-isomers*): Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies; EPA (β-isomer): Possible Human Carcinogen; EPA (δ-delta-& δ epsilon-isomers): Not Classifiable as to human carcinogenicity.

California Proposition 65 Chemical[102]: Cancer 10/1/1987, Lindane and other hexachloro cyclohexane isomers.

Hazard Alert: Poison, Combustible (all isomers & (technical grade) Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Environmental hazard, Agricultural chemical. (*alpha*-isomer) Listed for Tier 1 screening as an endocrine disruptor[88].

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; 40CFR401.15 Section 307 Toxic Pollutants as hexachlorocyclohexane

European/International Regulations (*technical grade*): Hazard symbol: T, N; risk phrases: R45; R21; R25; R40; 5R0/53; safety phrases: S1/2; S21; S36/37; S45-S60; S61

All isomers:

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), severe pollutant *technical grade*, mixture of α- and β-isomers*:*

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Animal Sufficient Evidence, 1979

California Proposition 65 Chemical[102]: Cancer 10/1/1987.

Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)] (as HCH mixed isomers). See also lindane.

European/International Regulations (*technical grade*): Hazard symbol: T, N; risk phrases: R21; R25; R40; 5R0/53; R62; R63; safety phrases: S1/2; S21; S36/37; S45-S60; S61; R62; (*lindane*): Hazard symbol: T, N; risk phrases: R20/21; R25; R48/22; R64; R50/53; R62; R63; safety phrases: S1/2; S13; S36/37; S41; S45; S60; S61.

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water. (*γ-isomer*)

α-Isomer:

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Animal Sufficient Evidence, 1979. United States EPA Gene-Tox Program, Negative: *S. cerevisiae*-reversion

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; 40CFR401.15 Section 307 Toxic Pollutants as hexachlorocyclohexane

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.00014; Nonwastewater (mg/kg), 0.066

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8080 (0.05); 8250 (10)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg)

EPCRA Section 313 Form R de minimis concentration reporting level: 1.0

List of Stockholm Convention POPs: Annex A (Elimination)

β-Isomer:

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Animal Sufficient Evidence, 1979

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; 40CFR401.15 Section 307 Toxic Pollutants as hexachlorocyclohexane

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.00014; Nonwastewater (mg/kg), 0.066

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8080 (0.05); 8250 (40)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg) List of Stockholm Convention POPs: Annex A (Elimination)

γ-Isomer: See Lindane, L:0260.

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

δ-Isomer:

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; 40CFR401.15 Section 307 Toxic Pollutants as hexachlorocyclohexane

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.023; Nonwastewater (mg/kg), 0.066

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8080 (0.1); 8250 (30)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg)

Description: BHC is a white-to-brownish crystalline solid with a musty, phosgene-like odor. Molecular weight = 290.82; freezing/melting point = 65°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 1, reactivity 0. BCH consists of eight stereoisomers of which the *gamma* (γ) isomer is most insecticidally active and hence most important. See also "Lindane."

Potential Exposure: The major commercial usage of BHC is based upon its insecticidal properties. α-BCH is used as an Agricultural chemical, pesticide, pharmaceutical, and veterinary drug. The 7-isomer has the highest acute toxicity, but the other isomers are not without activity. It is generally advantageous to purify the 7-isomer from the less active isomers. The γ-isomer acts on the nervous system of insects, principally at the level of the nerve ganglia. As a result, lindane has been used against insects in a wide range of applications including treatment of animals, buildings, humans for ectoparasites, clothes; water for mosquitoes; living plants; seeds and soils. Some applications have been abandoned due to excessive residues, e.g., stored foodstuffs. By voluntary action, the principal domestic producer of technical grade BHC requested cancellation of its BHC registrations on September 1, 1976. As of July 21, 1978, all registrants of pesticide products containing BHC voluntarily canceled their registrations or switched their former BHC products to lindane formulations.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Decomposes on contact with powdered iron, aluminum, zinc, and on contact with strong bases producing trichlorobenzene.

Permissible Exposure Limits in Air

ACGIH TLV[1]: as *gamma*-isomer: 0.5 milligram per cubic meter [skin]

DFG MAK: as gamma-isomer: 0.1 milligram per cubic meter, inhalable fraction TWA; Peak Limitation Category II(8) [skin] Carcinogen Category 4; Pregnancy Risk Group C (2006)

Technical grade, mixture of α-BHC (CAS: 319-84-6) and β-BHC (CAS: 319-85-7): 0.1 milligram per cubic meter, inhalable fraction TWA; Peak Limitation Category II(8) [skin]

PAC Ver. 28, no values found in Ver. 29[138]

608-73-1 technical grade, mixed isomers of (*α-* & *β-isomer*s)

PAC Ver. 29[138]

PAC-1: 9.1 milligram per cubic meter

PAC-2: 100 milligram per cubic meter

PAC-3: 1000 milligram per cubic meter

DFG MAK (concentration α-HCH divided by 5) + concentration β-HCH; 0.5 milligram per cubic meter, inhalable fraction TWA; Peak Limitation Category II(8) [skin]

Australia: TWA 0.5 milligram per cubic meter [skin], 1993; Belgium: TWA 0.5 milligram per cubic meter [skin], 1993; Denmark: TWA 0.5 milligram per cubic meter [skin], 1999; Finland: TWA 0.5 milligram per cubic meter [skin], carcinogen, 1999; France: VME 0.5 milligram per cubic meter [skin], 1993; Hungary: TWA 0.5 milligram per cubic meter; STEL 0.1 milligram per cubic meter [skin], 1993; Poland: MAC (TWA) 0.05 milligram per cubic meter, MAC (STEL) 0.4 milligram per cubic meter, 1999; Russia: STEL 0.05 milligram per cubic meter; 0.1 milligram per cubic meter; momentary and daily average [skin], 1993; Switzerland: MAK-W 0.5 milligram per cubic meter [skin], 1999; United Kingdom: LTEL 0.5 milligram per cubic meter; STEL 1.5 milligram per cubic meter [skin], 1993. Russia[43] set a MAC value for ambient air in residential areas of 0.03 milligram per cubic meter on a momentary and on a daily average basis.

319-84-6, α-isomer, *319-85-7, β-isomer*

PAC Ver. 29[138]

PAC-1: 9.1 milligram per cubic meter

PAC-2: 100 milligram per cubic meter

PAC-3: 1000 milligram per cubic meter

Australia: TWA 0.5 milligram per cubic meter [skin], 1993; Belgium: TWA 0.5 milligram per cubic meter [skin], 1993; Denmark: TWA 0.5 milligram per cubic meter [skin], 1999; Finland: TWA 0.5 milligram per cubic meter [skin], carcinogen, 1999; France: VME 0.5 milligram per cubic meter [skin], 1993; Hungary: TWA 0.5 milligram per cubic meter; STEL 0.1 milligram per cubic meter [skin], 1993; Russia: STEL 0.05 milligram per cubic meter; [skin], 1993; Switzerland: MAK-W 0.5 milligram per cubic meter [skin], 1999; United Kingdom: LTEL 0.5 milligram per cubic meter; STEL 1.5 milligram per cubic meter [skin], 1993

319-85-7, β-isomer

Austria: MAK 0.5 milligram per cubic meter [skin], 1999; Denmark: TWA 0.5 milligram per cubic meter [skin], 1999; Switzerland: MAK-W 0.5 milligram per cubic meter [skin], 1999

Determination in Air: Collection by filter/bubbler; workup with isooctane; analysis by gas chromatography/electrolytic conductivity detection; NIOSH Analytical Method (IV) #5502 (γ-isomer).

Permissible Concentration in Water: The EPA has set a limit in drinking water of 0.2 ppb. There are no criteria for the protection of freshwater or saltwater aquatic life from technical BHC (mixed isomers) due to insufficient data. *To protect human health:* preferably zero for technical product. An additional cancer risk of 1 in 100,000 is imposed by a concentration of 0.123 μg/L[6]. Russia[43] set a MAC in water bodies used for domestic purposes of 0.02 mg/L and zero in water bodies used for fishery purposes.

Determination in Water: Methylene chloride extraction followed by gas chromatography with electron capture or halogen specific detection (EPA Method 608) or gas chromatography plus mass spectrometry (EPA Method 625).

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes and respiratory tract. May affect the central nervous system; causing convulsions, respiratory failure; and collapse. Effects may be delayed. Exposure may result in death. See also below.

Long-Term Exposure: Repeated or prolonged skin contact may cause irritation, redness. The effects of lindane and/or the α-, β-, and δ-isomers of HCH observed in humans are lung irritation, heart disorders; blood disorders; headache, convulsions; and changes in the levels of sex hormones.

These effects have occurred in workers exposed to HCH vapors during pesticide formulation and/or in individuals exposed accidentally or intentionally to large amounts of HCH. Exposure to excessive amounts of HCH can also result in death in humans and animals. Convulsions and kidney disease have been reported in animals fed lindane or β-HCH. Liver disease has been reported in animals fed lindane and α-, β-, or technical grade HCH. Longer exposure to lindane and α-, β-, or technical-grade HCH has been reported to result in liver cancer. Reduced ability to fight infection was reported in animals fed lindane and injury to the ovaries and testes was reported in animals exposed to lindane or β-HCH. In animals, there is evidence that oral exposure to lindane during pregnancy results in an increased incidence of fetuses with extra ribs. HCH is processed by the body into other chemical products, some of which probably are responsible for the harmful effects. The Department of Health and Human Services has determined that HCH may reasonably be anticipated to be carcinogenic. Liver cancer has been seen in laboratory rodents that ate HCH for long periods of time.

Points of Attack: Eyes, skin, respiratory system; central nervous system; blood, liver, kidneys

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. NIOSH lists the following tests for Lindane: whole blood (chemical/metabolite); blood serum; Complete blood count (CBC); urine (chemical/metabolite).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Based on potential carcinogenicity the following is recommended by NIOSH: *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved SCBA that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-face-piece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA). *NIOSH: up to 5 milligram per cubic meter*: CcrOv95 (APF = 10) [any air-purifying half-mask respirator equipped with an organic vapor cartridge(s) in combination with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *Up to 12.5 milligram per cubic meter:* Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode);or PaprOvHie* (APF = 25) (any powered air-purifying respirator with an organic vapor cartridge in combination with a high-efficiency particulate filter). *Up to 25 milligram per cubic meter*: CcrFOv100 (APF = 50) [any air-purifying full face-piece respirator equipped with organic vapor cartridge(s) in combination with an N100, R100, or P100 filter; GmFOv100 (APF = 50) [or any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or PaprTOvHie* (APF = 50) [any powered, air-purifying respirator with a tight-fitting facepiece and organic vapor cartridge(s) in combination with a high-efficiency particulate filter]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 50 milligram per cubic meter:* 100XQ (APF = 10) [any air-purifying respirator with an N100, R100, or P100 filter (including N100, R100, and P100 filtering facepieces) except quarter-mask respirators]. *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode; or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus). *Escape:* GmFOv100 (APF = 50) [Any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA). *Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from alkalis, powdered iron, aluminum, and zinc. Always store pesticides in their original containers, complete with labels that list ingredients, directions for use, and first aid steps in case of accidental poisoning. Never store pesticides in cabinets with or near food, animal feed, or medical supplies. Do not store pesticides in places where flooding is possible or in places where they might spill or leak into wells, drains, ground water, or surface water[72]. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2761 Organochlorine pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal EPA for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical may be dissolved in flammable liquids. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. Thermal decomposition products may include phosgene and hydrogen chloride. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: A process has been developed for the destructive pyrolysis of benzene hexachloride @ 400−500°C with a catalyst mixture which contains 5−10% of either cupric chloride, ferric chloride; zinc chloride; or aluminum chloride on activated carbon.

References

(109); (102); (31); (173); (101); (138); (80); (203); (100).

United States Environmental Protection Agency, *Hexachtorocyclohexane: Ambient Water Quality Criteria*. Washington, DC (1980).

United States Environmental Protection Agency, Hexachlorocyclohexane. Health and Environmental Effects Profile No. 112, Office of Solid Waste, Washington, DC (April 30, 1980).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 7, No. 4, 26−38 (1987) New York, Van Nostrand Reinhold Co. (1983).

United States Department of Health and Human Services, *ATSDR ToxFAQs, Hexachlorocyclohexanes*, Atlanta, GA (June 1999).

Hexachlorocyclopentadiene H:0220

Formula: C_5Cl_6

Synonyms: C-56; 1,3-Cyclopentadiene, 1,2,3,4,5,5-hexachloro-; Graphlox; HCCPD; Hex; 1,2,3,4,5,5-Hexachloro-1,3-cyclopentadiene; Hexachloro-1,3-cyclopentadiene; Hexaclorociclopentadieno (Spanish); HRS1655; NCI-C55607; PCL; Perchlorocyclopentadiene

CAS Registry Number: 77-47-4

HSDB Number: 4011

RTECS Number: GY1225000

UN/NA & ERG Number: (PIH) UN2646/151

EC Number: 201-029-3 [*Annex I Index No.*: 602-078-00-7]

Regulatory Authority and Advisory Information

Carcinogenicity: EPA Group E, Evidence of noncarcinogenicity for humans NCI: Carcinogenesis Studies (inhalation); no evidence: mouse, rat; NTP: Carcinogenesis studies (inhalation); no evidence: rat.

Hazard Alert: Poison inhalation hazard: exposure can be lethal, Possible risk of forming tumors, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction). Listed for Tier 1 screening as an endocrine disruptor[88].

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

United States National Primary Drinking Water Regulations: MCLG = 0.05 mg/L; MCL = 0.05 mg/L

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992); 40CFR401.15 Section 307 Toxic Pollutants

United States EPA Hazardous Waste Number (RCRA No.): U130 RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.057; Nonwastewater (mg/kg), 2.4

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8120 (5); 8270 (10)

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg)

EPCRA Section 313 Form R de minimis concentration reporting level: 1.0%.

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, N; risk phrases: R22; R24; R26; R34; R50/53; R62; safety phrases: S1/2; S25; S39; S45; S53; S41; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Hexachlorocyclopentadiene is a pale-yellow to amber-colored, oily liquid. Pungent, unpleasant odor. The odor threshold is 0.15−0.33 ppm. Molecular weight = 272.77; specific gravity (H_2O:1) = 1.7 @ 20°C; boiling point = 239 °C; freezing/melting point = −9°C; vapor pressure = 0.06 mmHg @ 25°C. Hazard identification (based on NFPA-704 M Rating System): Health 4, flammability 1, reactivity 1. Slightly soluble in water; solubility = 0.0002% @ 25°C (reaction).

Potential Exposure: Hexachlorocyclopentadiene is used to produce the flame retardant chlorendic anhydride, which has applications in polyesters; and to produce chlorendic anhydride and chlorendic acid; which is used as a flame retardant in resins. Hexachlorocyclopentadiene is also used as an intermediate in the production of pesticides, such as aldrin, dieldrin, and endosulfan.

Incompatibilities: Reacts slowly with water to form hydrochloric acid; will corrode iron and most metals in presence of moisture. Explosive hydrogen gas may collect in enclosed spaces in the presence of moisture. Contact with sodium may be explosive.

Permissible Exposure Limits in Air

Odor Threshold = 0.15−0.33 ppm.

OSHA PEL: None

NIOSH REL: 0.01 ppm/0.1 milligram per cubic meter TWA

ACGIH TLV[1]: 0.01 ppm/0.11 milligram per cubic meter TWA; not classifiable as a human carcinogen

PAC Ver. 29[138]

PAC-1: 0.03 ppm

PAC-2: 0.55 ppm

PAC-3: 1 ppm

DFG MAK: [skin] No numerical value established. Data may be available.

Australia: TWA 001 ppm (0.1 milligram per cubic meter), 1993; Belgium: TWA 0.01 ppm (0.11 milligram per cubic meter), 1993; Denmark: TWA 0.01 ppm (0.1 milligram per cubic meter), 1999; Finland: TWA 0.1 ppm (1 milligram per cubic meter); STEL 0.3 ppm (3 milligram per cubic meter) [skin], 1999; France: VME 0.01 ppm (0.1 milligram per cubic meter), 1999; Norway: TWA 0.01 ppm (0.1 milligram per cubic meter), 1999; Russia: STEL 0.01 milligram per cubic meter [skin], 1993; the Netherlands: MAC-TGG 0.11 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Several states have set guidelines or standards for hexachtorocyclopentadiene in ambient air[60] ranging from 0.015 μ/m^3 (Massachusetts) to 0.33 μ/m^3 (New York) to 0.50 μ/m^3 (Indiana and South Carolina) to 0.6−10.0 μ/m^3 (North Carolina) to 1.0 μ/m^3 (Florida and North Dakota) to 2.0 μ/m^3 (Connecticut, Nevada and Virginia).

Determination in Air: Sample collection on Porapak tube[2] desorption with hexane and analysis by gas chromatography with electron capture detection. See NIOSH Analytical Method (IV) #2518[18].

Permissible Concentration in Water: The Safe Drinking Water Act (47FR 9352): MCL, 0.05 mg/L; MCLG, 0.05 mg/L. EPA recommends that exposure in children should not exceed 2 ppm in water for 10-day periods or no more than 0.7 ppm for up to 7 years.

Determination in Water: Methylene chloride extraction followed by concentration, gas chromatography with electron capture detection (EPA Method 612) or gas chromatography plus mass spectrometry (EPA Method 625).

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: This compound is very toxic and may be fatal if inhaled, swallowed, or absorbed through the skin. Eye contact may result in severe irritation. Contact of liquid with the skin may cause blistering and burning. Inhalation of mist is highly irritating to mucous membranes; causing tearing, sneezing, and salivation. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Headaches and throat irritation have also been reported as a result of exposure to this compound. The probable human lethal dose is 50−500 mg/kg, or between 1 teaspoon and 1 ounce for a 150 lb (70 kg) person. Severe exposure induces pulmonary hyperemia and edema, degenerative and necrotic changes in brain, heart and adrenal glands; and necrosis of liver and kidney tubules.

Long-Term Exposure: May cause kidney and stomach problems, nervous system; and heart problems; possible liver damage. Can irritate the lungs. Repeated exposure may cause chronic bronchitis with cough, phlegm and/or shortness of breath.

Points of Attack: Eyes, skin, respiratory system; liver, kidneys, stomach.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended: liver and kidney function tests. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: lung, liver and kidney function tests. Exam of the nervous system. Consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least

15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from the skin is of extreme importance. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. butyl rubber/Neoprene and PVC are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures *over 0.01 ppm*; Use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Poison inhalation chemical (PIH); check oxygen content prior to entering storage area. Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from water. Protect containers from physical damage. In the presence of moisture, hexachlorocyclopentadiene will corrode iron and other metals.

Shipping: UN2646 Hexachlorocyclopentadiene, Hazard Class: 6.1; Labels: 6.1-Poison Inhalation Hazard, Inhalation Hazard Zone B.

Spill Handling:

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424−9300 or seek professional environmental engineering assistance from the United States EPA Environmental Response Team at (908) 548−8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 0.3/0.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. *Do not use water* or wet method. Ventilate area of spill or leak after clean-up is complete. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal EPA for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Hexachlorocyclopentadiene itself does not burn. Thermal decomposition products may include chlorine, hydrogen chloride, phosgene, and carbon monoxide. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform to EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (173); (101); (138). (100).

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New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Hexachlorocyclopentadiene, Trenton, NJ (April, 1999).

New York State Department of Health, *Chemical Fact Sheet:* Hexachlorocyclopentadiene, Bureau of Toxic Substance Assessment, Albany, NY (April 1999).

United States Department of Health and Human Services, "ATSDR ToxFAQs, Hexachlorocyclopentadiene (HCCPD)" Atlanta, GA (June 1999).

Hexachloroethane H:0230

Formula: C_2Cl_6; CCl_3CCl_3

Synonyms: Avlothane; Carbon hexachloride; Distokal; Distopan; Distopin; Egitol; Ethane hexachloride; Ethane, hexachloro-; Ethylene hexachloride; Falkitol; Fasciolin; HCE; Hexachloraethan (German); Hexachlorethane; 1,1,1,2,2,2-Hexachloroethane; Hexachloroethylene; Hexacloroetano (Spanish); Mottenhexe; NCI-C04604; Perchloroethane; Phenohep

CAS Registry Number: 67-72-1

HSDB Number: 2033

RTECS Number: K14025000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154; UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 200-666-4

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Sufficient Evidence, Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B, 1999; EPA: Possible Human Carcinogen; NCI: Carcinogenesis Studies (gavage); clear evidence: rat; NTP: Carcinogenesis Studies (gavage); clear evidence: rat; NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; NIOSH: Potential occupational carcinogen.

California Proposition 65 Chemical[102]: Cancer 7/1/1990.

Hazard Alert: Poison, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard.

NTP: Toxicity studies, RPT#TOX-45, October 2000

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Clean Water Act: Section 313 Water Priority Chemicals (57FR41331, 9/9/1992); Toxic Pollutant (Section 401.15) as chlorinated ethanes

Clean Water Act: Section 307(a)(1)Toxic Pollutants subject to effluent limitations as chlorinated ethanes United States EPA Hazardous Waste Number (RCRA No.): U131; D034

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA Toxicity Characteristic (Section 261.24), Maximum Concentration of Contaminants, regulatory level, 3.0 mg/L

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.055; Nonwastewater (mg/kg), 30

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8120 (0.5); 8270 (10)

Safe Drinking Water Act (47FR 9352): Priority List (55 FR 1470) SUPERFUND/EPCRA 302, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)

EPCRA Section 313 Form R de minimis concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T; risk phrases: R62; R63;?; safety phrases: (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Hexachloroethane is a white solid with a camphor-like odor. It gradually evaporates when it is exposed to air. Molecular weight = 236.72; boiling point = (sublimes) @ 183−187°C; freezing/melting point = (sublimes) 187°C; vapor pressure = 0.2 mmHg. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 1, reactivity 0. Practically insoluble in water; solubility = 0.005% @ 25°C.

Incompatibilities: Incompatible with strong acids, oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from strong bases.

Potential Exposure: In the US, about half the HCE is used by the military for smoke-producing devices. It is also used to remove air bubbles in melted aluminum. It may be present as an ingredient in some fungicides, insecticides, lubricants, and plastics. It is no longer made in the United States, but it is formed as a by-product in the production of some chemicals. Can be formed by incinerators when materials containing chlorinated hydrocarbons are burned. Some HCE can also be formed when chlorine reacts with carbon compounds in drinking water. As a medicinal, HCE is used as an anthelmintic to treat fascioliasis in sheep and cattle. It is also added to the feed of ruminants, preventing methanogenesis and increasing feed efficiency. HCE is used in metal and alloy production, mainly in refining aluminum alloys. It is also used for removing impurities from molten metals, recovering metals from ores or smelting products and improving the quality of various metals and alloys. HCE is contained in pyrotechnics. It inhibits the explosiveness of methane and the combustion of ammonium perchlorate. Smoke containing HCE is used to extinguish fires. HCE has various applications as a polymer additive. It has flameproofing qualities, increases sensitivity to radiation crosslinking, and is used as a vulcanizing agent. Added to polymer fibers, HCE acts as a swelling agent and increases affinity for dyes.

Incompatibilities: Incompatible with metals, such as aluminum, cadmium, hot iron; mercury, or zinc. Alkalis forms spontaneously explosive chloroacetylene. Attacks some plastics, rubber and coatings.

Permissible Exposure Limits in Air

NIOSH IDLH = 300 ppm, potential occupational carcinogen

Conversion factor: 1 ppm = 9.68 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 1 ppm/10 milligram per cubic meter TWA [skin]

NIOSH REL: NIOSH REL: 1 ppm/10 milligram per cubic meter TWA[skin]; a potential occupational carcinogen. Limit exposure to lowest feasible concentration, See *NIOSH Pocket Guide*, Appendix A & C.

ACGIH TLV[1]: 1 ppm/9.7 milligram per cubic meter TWA [skin]; confirmed animal carcinogen with unknown relevance to humans.

PAC Ver. 29[138]

PAC-1: 3 ppm

PAC-2: 36 ppm

PAC-3: 300ppm

DFG MAK: 1 ppm/9.8 milligram per cubic meter TWA; Peak Limitation Category II(2)

Australia: TWA 10 ppm (100 milligram per cubic meter), 1993; Austria: MAK 1 ppm (10 milligram per cubic meter), 1999; Belgium: TWA 1 ppm (9.7 milligram per cubic meter), 1993; Denmark: TWA 1 ppm (10 milligram per cubic meter) [skin] 1999; Finland: TWA 1 ppm (10 milligram per cubic meter), short term exposure limit 3 ppm (30 milligram per cubic meter) [skin] 1999; France: VME 1 ppm, VLE 10 ppm, 1999; the Netherlands: MAC-TGG 10 milligram per cubic meter, 2003; the Philippines: TWA 1 ppm (10 milligram per cubic meter) [skin] 1993; Poland: MAC (TWA) 10 milligram per cubic meter, MAC (STEL) 30 milligram per cubic meter, 1999; Switzerland: MAK-W 1 ppm (10 milligram per cubic meter) [skin] 1999; United Kingdom: TWA 5 ppm (49 milligram per cubic meter), vapor, 2000; United Kingdom: TWA 10 milligram per cubic meter, total inhalable dust; TWA 4 milligram per cubic meter, respirable dust, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: confirmed animal carcinogen with unknown relevance to humans. Several states have set guidelines or standards for hexachloroethane in ambient air[60] ranging from 0.18 μ/m^3 (Massachusetts) to 50.0 μ/m^3 (Connecticut) to 238.095 μ/m^3 (Kansas) to 1000 (μ/m^3 (North Dakota) to 1600 μ/m^3 (Virginia) to 2381 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method #1003, Hydrocarbons, halogenated; OSHA Analytical Method 7.

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 1 μg/L; State Drinking Water Guidelines: Maine 7 μg/L

Determination in Water: Methylene chloride extraction followed by concentration, gas chromatography with electron capture detection (EPA Method 612) or gas chromatography plus mass spectrometry (EPA Method 625).

Routes of Entry: Inhalation, skin absorption; ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Contact can irritate and burn the eyes and skin. Exposure can irritate the respiratory tract. High levels of exposure can cause dizziness, lightheadedness, and unconsciousness. Irritation occurs when there is an excessive amount of hexachloroethane dust in the air or when it is heated and vapors are formed. Hexachloroethane acts primarily as a central nervous system depressant; and in high concentrations it causes tremors, and narcosis. It should be noted that the low vapor pressure of this compound as well as its solid state minimize its inhalation hazards.

Long-Term Exposure: A potential occupational carcinogen. May cause kidney and liver damage.

Points of Attack: Eyes, skin, respiratory system; kidneys. Cancer site in animals: liver cancer.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater) the following are recommended before beginning work and at regular times after that: Liver and kidney function tests. More than light alcohol consumption can exacerbate liver damage. Sample of blood, urine, or feces can be tested for exposure to HCE. These tests are useful only if exposure occurred 24 to 48 hours prior to testing.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Hexachloroethane must be stored to avoid contact with hot iron, zinc, aluminum, and alkalis, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft (NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal EPA for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Hexachloroethane itself does not burn. Thermal decomposition products may include phosgene and hydrogen chloride. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform to EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(109); (102); (31); (173); (101); (138). (2); (100).

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New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Hexachloroethane, Trenton, NJ (July 2005).

Hexachlorophene H:0240

Formula: $C_{13}H_6Cl_6O_2$: $C_6H(OH)Cl_3CH_2C_6H(OH)Cl_3$
Synonyms: Acigena; AI3-02372; Almederm; AT-17; AT-7; B 32; B&B flea kontroller (for dogs only); Bilevon; Bis (2-hydroxy-3,5, 6-trichlorophenyl)methane; Bis(3,5,6-trichlor *o*-2-hydroxyphenyl)methane; Blockade antibacterial finish; Brevity Blue liquid bacteriostatic scouring cream; Brevity Blue liquid sanitizing scouring cream; Compound G-11; Cotofilm; Dermadex; 2,2′-Dihydroxy-3,3′,5,5′,6,6′-hexachlorodiphenylmethane; 2,2′-Dihydroxy-3,5,6,3′,5′,6′-hexachlorodiphenylmethane; Distodin; Enditch pet shampoo; EN-Viron D concentrated phenolic disinfectant; Esaclorofene; Exofene; Fesia-Sin; Fomac; Fostril; G-11; Gamophen; Gamophene; Germa-Medica; HCP; Hexabalm; 2,2′,3,3′,5,5′-Hexachloro-6,6′-dihydroxydiphenylmethane; Hexachlorophane; Hexachlorophen; Hexachlorophene; Hexaclorofeno (Spanish); Hexafen; Hexaphene-LV; Hexide; Hexophene; Hexosan; Hilo cat flea powder; Hilo flea powder; Hilo flea powder with rotenone and dichlorophrene; Isobac; Isobac 20; Methane, bis(2,3,5-trichloro-6-hydroxyphenyl); 2,2′-Methylenebis(3,4,6-trichlorophenol); 2,2′-Methylenebis (3,5,6-trichlorophenol); Nabac; Nabac 25 EC; NCI-C02653; Neosept V; NSC4911; Pedigree dog shampoo bar; Phenol, 2,2′-methylenebis(3,4,6-trichloro)-; Phenol, 2,2′-methylenebis (3,5,6-trichloro-); Phisodan; Phisohex; Ritosept; Septisol; Septofen; Staphene O; Steral; Steraskin; Surgi-Cen; Surgi-Cin; Surofene; Tersaseptic; Trichlorophene; Turgex
CAS Registry Number: 70-30-4; *(alt.)* 8054-98-6; *(alt.)* 139411-96-4
HSDB Number: 224
RTECS Number: SM0700000
UN/NA & ERG Number: UN2875/151
EC Number: 200-733-8 [*Annex I Index No.*: 604-015-00-9]
Regulatory Authority and Advisory Information
Carcinogenicity: NCI: Carcinogenesis Bioassay (feed); no evidence: rat; IARC: Animal Inadequate Data; Human Inadequate Data, *not classifiable as carcinogenic to humans*, Group 3, 1997.
Hazard Alert: Poison, Flammable, Possible risk of forming tumors, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction); Drug.
Banned or Severely Restricted (in pharmaceuticals) (UN)[13]
FDA-over the counter and proprietary drug
Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)
United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U132
RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10)
EPCRA Section 313 Form R de minimis concentration reporting level: 1.0%.
Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.
Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.
Hazard symbols, risk, & safety statements: Hazard symbol: T, F, N; risk phrases: R10; R23/24/25; R39; R50/53; R62; R63; safety phrases: S1/2; S16; S20; S37/38; S41; S45; S60; S61 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)]
Description: Hexachlorophene is a crystalline solid compound. Molecular weight = 406.89; freezing/melting point = 165°C. Flash point = 11°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 2, reactivity 0. Insoluble in water.
Potential Exposure: HCP has been used as an antibacterial agent in a wide variety of consumer products, including soaps and deodorants; as a disinfectant. It has also been used as an antifungal agent to treat various citrus fruits and vegetables.
Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.
Permissible Exposure Limits in Air
PAC Ver. 28, no value in Ver. 29[138]
PAC-1: 0.17 milligram per cubic meter
PAC-2: 1.8 milligram per cubic meter
PAC-3: 11 milligram per cubic meter
Russia: STEL 0.1 milligram per cubic meter [skin], 1993. Massachusetts[61] has set a guideline for ambient air of zero.
Permissible Concentration in Water: A no-adverse-effect-level in drinking water has been calculated by NAS/NRC as 0.008 mg/L. An ADI was calculated on the basis of the available chronic toxicity data to be 0.0012 mg/kg/day.

Russia set a MAC in water bodies used for domestic purposes of 0.03 mg/L. Maine has set a guideline for drinking water of 2.0 μg/L[61].

Determination in Water: Log $K_{ow} = > 7$. Values above 3.0 are likely to bioaccumulate in aquatic organisms.

Routes of Entry: Inhalation, passing through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Hexachlorophene may irritate the eyes and skin, and cause a skin allergy to develop. May cause permanent eye damage. Inhaling can irritate the respiratory tract. May affect the central nervous system; causing dizziness, weakness, convulsions (fits), coma, or death. Exposure can cause loss of appetite; nausea, vomiting, cramps and diarrhea. LD_{50} (oral-rat) = 56 mg/kg; (oral-mouse) 67 mg/kg.

Long-Term Exposure: There is an association between exposure to pregnant women to hexachlorophene and birth defects. There is limited evidence that hexachlorophene is a teratogen in animals. May cause an asthma-like allergy. May cause liver damage. Repeated exposure may cause brain damage leading to paralysis and blindness.

Points of Attack: Nervous system, skin, liver, reproductive system.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: examination of the nervous system. Eye exam. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. More than light alcohol consumption may exacerbate liver damage.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures to hexachlorophene, use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece respirator with a high efficiency particulate filter. Greater protection is provided by a powered-air purifying respirator. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers.

Shipping: UN2875 Hexachlorophene, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal EPA for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include hydrogen chloride and oxides of carbon. Hexachlorophene itself does not burn. Extinguish fire using an agent suitable for surrounding fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced[22]. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform to EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (173); (101); (138); (80); (100).

United States Environmental Protection Agency, Hexachlorophene, Health and Environmental Effects Profile No. 116, Office of Solid Waste, Washington, DC (April 30, 1980).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 6, No 2, 62−66 (1986).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Hexachlorophene, Trenton, NJ (April 1999).

Hexaflumuron H:0248

Formula: $C_{16}H_{18}Cl_2F_6N_2O_3$

Synonyms: AI3-29832; Benzamide, *N*-[((3,5-dichloro-4-(1,1,2,2-tetrafluoroethoxy)phenyl)amino)carbonyl]-2,6-difluoro-; Conhex; Consult; DE-473; NAF-46; Recruit; Sonet; Trueno; XRD 473

CAS Number: 86479-06-3

HSDB Number: 7049

RTECS Number: CV3800000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 401-400-1

Regulatory Authority and Advisory Information

Carcinogenicity: Rats and mice fed up to 500 mg/kg/day for 104 weeks did not develop cancer[162]. Not expected to increase the risk cancer in humans.

Hazard Alert: Environmental hazard[162].

Hazard symbols, risk, & safety statements: Hazard symbol: N; risk phrases: R50/53; safety phrases: S2; S29/35; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: White solid or powder. The commercial product may be an emulsifiable concentrate. Molecular weight = 461.16; specific gravity (H_2O:1) = 1.675 @ 25°C; boiling point = (decomposes); freezing/melting point = 203°C; vapor pressure = 5×10^{-7} mmHg (very low/negligible). Practically insoluble in water; solubility = <0.1 ppm. Physical and toxicological properties may be affected by carrier solvents in commercial formulations.

Potential Exposure: Hexaflumuron is a benzoyl urea insecticide, termiticide and insect growth regulator (IGR) that inhibits an insect's growth through chitin synthesis, which termites need to form an exoskeleton. It is used to impregnate termite bait. Worldwide, there are more than 20 suppliers/manufacturers[97]; most are in the United States Not currently registered for agricultural use in some EU countries.

Incompatibilities: Decomposes in temperatures above 275°C. Irritating or toxic fumes or gases in a fire

Permissible Concentration in Water: Runoff from spills or fire control may cause water pollution.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = >5.0$. Values above 3.0 are likely to bioaccumulate in marine organisms. Fish toxicity (threshold)[101]: Intermediate—28.07482 ppb, MATC (Maximum Acceptable Toxicant Concentration).

Routes of Entry: Dermal contact, inhalation, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Contact with eyes or skin may cause irritation or injury. Inhalation should be avoided; use NIOSH- or CEN (UK)-approved air purifying respirators for pesticides. May be harmful if swallowed. LD_{50} (oral, rat) = >5 g/kg; LD_{50} (dermal, rat) ≥ 5 g/kg.

Long-Term Exposure: Fluorides may cause bone disease (pain and tenderness of the bones); mottled teeth in children. May effect the blood; formation of methemoglobin. In long-term (chronic) feeding tests, hexaflumuron increased the incidence and severity of a liver cell abnormality[83].

Points of Attack: Blood, eyes, kidney, liver, bones.

Medical Surveillance: For those with frequent or potentially high exposure, the following are recommended before beginning work and at regular times after that: Lung function tests. If overexposure is suspected, also consider: CBC and test for methemoglobin.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Do not induce vomiting when formulations containing petroleum solvents are ingested.

Personal Protective Methods: For emergency situations, wear a positive pressure, pressure-demand, full facepiece SCBA or pressure-demand supplied air respirator with escape SCBA and a fully-encapsulating, chemical-resistant suit[83] such as DuPont Tychem suit fabrics.

Respirator Selection: Wherever and whenever workplace conditions warrant respirator use, a respiratory protection program must be followed that meets one or more of the following government standards: OSHA's 29 CFR 1910.134, ANSI Z88.2, or European Standard EN 149.

Storage: Color code—Blue: Health Hazard/Poison. Store in a tightly closed container in a dry, well-ventilated and secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Where possible, automatically transfer material from other storage containers to process containers. Always store pesticides in their original containers, complete with labels that list ingredients, directions for use, and first aid steps in case of accidental poisoning. Never store pesticides in cabinets with or near food, animal feed, or medical supplies. Do not store pesticides in places where flooding is possible or where they might spill or leak into wells, drains, ground water, or surface water. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Dampen the spilled material with water. Clean up with dampened absorbent paper and transfer material to a suitable trash container. Seal the absorbent paper and your clothing in a vapor-tight plastic bag for eventual disposal. Wash all contaminated surfaces with a soap and water solution. Do not re-enter the contaminated area until and expert verifies that the area has been properly cleaned.

Fire Extinguishing: Thermal decomposition products in fire include toxic nitrogen oxides, hydrogen chloride, and hydrogen fluoride. As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 m/150 ft for liquids and at least 25 m/75 ft for solids. *Fire involving storage or vehicular tanks:* Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. *On a small fire:* use dry chemical, CO_2, water spray or regular *foam. On a large fire:* use water spray, fog or regular foam. Do not scatter spilled material with high pressure streams of water. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal. *Fire involving tanks:* From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. Always stay away from tanks engulfed in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Do not discharge into drains or sewers. Dispose of waste material as hazardous waste using a licensed disposal contractor to an approved landfill. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Incineration with effluent gas scrubbing is recommended. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (100).

National Pesticides Information Center (NPIC), "Fact Sheet: Hexaflumuron," Corvallis, OR http://www. npic.orst.edu/factsheets/hextech.pdf.

United States Environmental Protection Agency, Office of Pesticide Programs, Pesticide Fact Sheet: 541-737-F-94-012: Hexaflumuron. Washington, DC, Mar. 10, 1994.

Hexafluoroacetone H:0250

Formula: C_3F_6O; CF_3COCF_3

Synonyms: 6FK; Acetone, hexafluoro-; 1,1,1,3,3,3-Hexafluoro-2-propanone; HFA; NCI-C56440; 2-Propanone, 1,1,1,2,2,2-hexafluoro-

CAS Registry Number: 684-16-2; 13098-39-0 (sesquihydrate)

HSDB Number: 2896 as 1,1,1,3,3,3-hexafluoro-2-propanone

RTECS Number: UC2450000

UN/NA & ERG Number: (PIH) UN2420/125

EC Number: 211-676-3

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Theft hazard* 45 (≥15.67% concentration)

Sabotage/Contamination Hazard: A placarded amount (commercial grade).

California Proposition 65 Chemical Developmental/Reproductive toxin (male).

Hazard Alert: Poison inhalation hazard, Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated, Reproductive toxin: Suspected of causing genetic defects.

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T+ ; risk phrases: R5; R14; R21; R23/24/25; R27/28; R34; R50/53; R63; safety phrases: S1; S7; S9; S13; S26; S28; S33; S36; S38; S41; S45; S53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Hexafluoroacetone is a colorless, nonflammable poison gas. Musty odor. Shipped as a liquefied compressed gas. Molecular weight = 166.0; boiling point = −27°C; freezing/melting point = −126°C; Relative vapor density (air = 1) = 5.76; vapor pressure = 750 mmHg @ −28°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 0. Reacts with water.

Potential Exposure: Hexafluoroacetone is used as a chemical intermediate. A gas at room temperature, it forms various hydrates with water which are used as solvents for resins and polymers. Other derivatives are used to make water repellent coatings for textiles and also to produce polymers.

Incompatibilities: Reacts with water, oxidizers, strong acids. Hygroscopic (i.e., absorbs moisture from the air); reacts with moisture to form a highly acidic sesquihydrate and considerable heat.

Permissible Exposure Limits in Air

OSHA PEL: None

NIOSH REL: 0.1 ppm/0.7 milligram per cubic meter TWA [skin]

ACGIH TLV[1]: 0.1 ppm/0.68 milligram per cubic meter TWA [skin]

PAC* Ver. 29[138]

684-16-2

PAC-1: 0.018 ppm

PAC-2: **0.2**$_{\mathbf{A}}$ ppm

PAC-3: **80**$_{\mathbf{A}}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minutes values.

Several states have set guidelines or standards for hexafluoroacetone in ambient air[60] ranging from 7.0 μ/m^3 (North Dakota) to 11.0 μ/m^3 (Virginia) to 14.0 μ/m^3 (Connecticut) to 17.0 μ/m^3 (Nevada).

Determination in Air: No method available.

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guidelines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg [F]/L. Safe Drinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg[F]/L; SMCL = 2 mg/F/L, as Fluoride.

Routes of Entry: Inhalation, passing through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Exposure can severely irritate the eyes, nose, throat, and skin. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Exposure can cause headache, nausea, vomiting, dizziness, and lightheadedness. Skin or eye contact with the liquid can cause frostbite.

Long-Term Exposure: There is a limited evidence that this chemical is a teratogen in animals. It may damage the testes (male reproductive glands) and affect sperm production. Hexafluoroacetone can damage the liver, kidneys and lungs. Repeated exposure may cause bronchitis. Prolonged exposure may affect blood cells.

Points of Attack: Eyes, skin, respiratory system; kidneys, reproductive system.

Medical Surveillance: Pregnant women should avoid contact. Employees should be notified by a physician that this chemical may affect the reproductive system. In addition to comprehensive initial medical and work histories emphasizing reproductive experience and menstrual history, patient should have physical examination and testing of genitourinary tract, sperm count, motility and morphology. If required, other tests, such as serum testosterone, serum FSH, and serum LH may be indicated. NIOSH lists the following tests: chest X-ray, electrocardiogram, pulmonary function tests: forced vital capacity, forced expiratory volume (1 seconds); pelvic X-ray; sputum cytology; urine (chemical/metabolite); urine (chemical/metabolite) pre- and postshift; urinalysis (routine); CBC/differential. For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: lung function tests, reproductive history for men. If symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function tests. Consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear solvent resistant gloves and clothing to prevent any reasonable probability of skin or eye contact. Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with the liquid unless full

facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures over 0.1 ppm; Use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Check oxygen content prior to entering storage area. Poison gas. (1) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. This gas is highly toxic. Even slight exposure to these gasses can cause death. Store outdoors in a secure, restricted area that containing warning signs. This area must be roofed and shaded with the cylinders stored off the ground and separated from all other products assigned to other hazard categories and radiant heat sources on nonwooden floors. If indoors, store in a well-ventilated areas in temperatures not to exceed 50°C. (2) Color code—White stripe: Contact Hazard; Store separately; not compatible with materials in solid white category. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from direct sunlight; water, heat, reducing agents; nitrates, and nitric acid. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: UN2420 Hexafluoroacetone, Hazard Class: 2.3; Labels: 2.3-Poisonous gas, 8-Corrosive material, Inhalation Hazard Zone B. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling:

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States EPA Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 200/60

Then: Protect persons downwind (mi/km)

Day 0.2/0.3

Night 0.9/1.5

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 3000/1000

Then: Protect persons downwind (mi/km)

Day 4.77/7.5

Night 7.0+/11.0+*

*+ means distance can be larger in certain atmospheric conditions.

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. If hexafluoroacetone gas is leaked, take the following steps: Restrict persons not wearing protective equipment from area of leak until clean-up is complete. Ventilate area of leak to disperse the gas. Stop flow of gas. If source of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal EPA for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: HFA is nonflammable reactive gas. This gas is under pressure; containers may rupture and explode when heated. Thermal decomposition includes hydrogen fluoride and oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Nonrefillable cylinders should be disposed of in accordance with local, state and federal regulations. Allow remaining gas to vent slowly into atmosphere in an unconfined area or exhaust hood. Refillable-type cylinders should be returned to original supplier with any valve caps and outlet plugs secured and valve protection caps in place.

References

(31); (173); (101); (138); (122). (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Hexafluoroacetone, Washington, DC (1979).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 1, No. 4, 75−76 (1981).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Hexafluoroacetone, Trenton, NJ (March 1999).

Hexafluoroethane H:0260

Formula: C_2F_6

Synonyms: Ethane, hexafluoro-; F116; Freon 116; Perfluoroethane; R-116

CAS Registry Number: 76-16-4

HSDB Number: 7870 as perfluoroethane

RTECS Number: KI4110000

UN/NA & ERG Number: UN2193/126

EC Number: 200-939-8 (see Appendix 4).

Regulatory Authority and Advisory Bodies

Hazard Alert: Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated,

Global Warming Potential (GWP): (AR2) 9200; (AR4) 12,200; Ozone depletion potential = zero

Hazard symbols, risk, & safety statements: Hazard symbol: Xi; risk phrases: R5; R21; safety phrases: S9; S33; S38 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): Non hazard to water.

Description: Hexafluoroethane is a colorless and odorless gas, or liquid under pressure. Molecular weight = 138.02; specific gravity (Air:1) = 4.76 @ 20°C; boiling point = −78°C. Explosive limits: LEL = 20,000 ppm; UEL: unknown. Hazard Identification (based on NFPA-704 M Rating System): Health 1, flammability 0, reactivity 0. Insoluble in water.

Potential Exposure: It is used as a coolant, in dielectric fluids; as a propellant and refrigerant.

Incompatibilities: Active metals. Keep away from heat and sunlight.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 100 ppm

PAC-2: 1100 ppm [> = 10% LEL, lower explosive limit]

PAC-3: 6800 ppm [> = 10% LEL, lower explosive limit but <50% LEL]

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short-Term Exposure: Hexafluoroethane can affect you when breathed in. Contact with the liquefied gas could cause frostbite. High levels in the air can cause you to feel dizzy, lightheaded, and to pass out. Very high levels could cause suffocation from lack of oxygen and death. Overexposure may also cause abnormal heart rhythms and even cause the heart to stop.

Points of Attack: Heart.

Medical Surveillance: Special 24-hour EKG (Holter monitor). Consider chest X-ray following acute overexposure.

NIOSH lists the following tests as (F): chest X-ray, electrocardiogram, pulmonary function tests: forced vital capacity, forced expiratory volume (1 second); pelvic X-ray; sputum cytology; urine (chemical/metabolite); urine (chemical/metabolite) pre- and postshift; urinalysis (routine); CBC/differential.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof goggles, unless full facepiece respiratory protection is worn. Wear splash chemical goggles and face shield when working with the liquid unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Where exposure to cold equipment, vapors, or liquid may occur employees should be provided with special clothing designed to prevent the freezing of body tissues.

Respirator Selection: Where there is potential for exposures to hexafluoroethane exists, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Check oxygen content prior to entering storage area. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from metals, including aluminum, zinc and beryllium; and from open flames or temperatures above 52°C. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: UN2193 Hexafluoroethane or Refrigerant gas R-116, Hazard Class: 2.2; Labels: 2.2-Nonflammable compressed gas.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Ventilate area of leak to disperse the gas. Stop flow of gas. If source of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal EPA for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Hexafluoroethane is a nonflammable liquid and gas. Use extinguishing agents suitable for type of surrounding fire. Thermal decomposition products may include hydrogen fluoride (hydrofluoric acid) and other fluoride gases. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Hexafluoroethane, Trenton, NJ (March, 1999).

1,1,1,3,3,3-Hexafluoro-2-Propanol H:0265

Formula: $C_3H_2F_6O$

Synonyms: Bis(trifluoromethyl)methanol; 1,1,1,3,3,3-Hexafluoro-2-hydroxypropane; 1,1,1,3,3,3- Hexafluoroisopro panol; Hexafluoroisopropanol; Hexafluoroisopropyl alcohol; 1,1,1,3,3,3-Hexafluoroisopropyl alcohol; 2,2,2-Trifluoro-1-(trifluoromethyl)ethanol; HFIP

CAS Registry Number: 920-66-1

RTECS Number: UB6450000

UN/NA & ERG Number: UN1760 (Corrosive liquid, n.o.s.)/154

EC Number: 213-059-4

Regulatory Authority and Advisory Information

Hazard Alert: Corrosive liquid. Listed in the TSCA inventory. SARA 311/312 codes: Immediate.

Canada: WHMIS Classification: D1B, E; Found on DSL list.

Hazard symbols, risk, & safety statements: Hazard symbol: T, C; risk phrases: R20/21; R25; R34; R41; safety phrases: S36; S37/39; S41 (see Appendix 4).

Description: 1,1,1,3,3,3-Hexafluoro-2-propanol (HFIP) is a clear, colorless, oily, combustible liquid. Odor is described as aromatic. Molecular Weight = 168.1; specific gravity (H_2O:1) = 1.46 @ 20°C; freezing/melting point = −4°C; boiling point = 59°C @ 760 mmHg; vapor pressure = 556 mmHg @ 51°C; 1468 mmHg @ 75°C; flash point: >93°C. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 0; reactivity 0. Water soluble; solubility = ≥ 100 mg/mL @20°C.

Potential Exposure: A specialty solvent for some polymers; a lavatory reagent.

Incompatibilities: HFIP is incompatible with acids, acid chlorides, and oxidizing agents.

Permissible Exposure Limits in Air:

PAC Ver. 29[138]

PAC-1: 1.3 ppm
PAC-2: 15 ppm
PAC-3: 87 ppm

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 1.7$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Ingestion, inhalation, or absorbed through the skin. Causes burns by all exposure routes.

Harmful Effects and Symptoms

Short-Term Exposure: Corrosive; causes burns to all internal or external area of contact. Dangerous if inhaled, swallowed, or absorbed through skin. Highly toxic-by-inhalation. Effects may include severe pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Can cause blindness; immediate washing of the eye may not lessen the magnitude of eye damage. Prolonged skin contact may cause large blisters. Depending on the intensity and duration of exposure, this chemical can cause severe destruction of tissues of the mucous membranes and upper respiratory tract. Symptoms of exposure to this compound may include severe skin and eye irritation, irritation of the mucous membranes and upper respiratory tract; burning feeling, laryngitis; coughing and wheezing, shortness of breath, headache, nausea, and vomiting; blurred vision; incoordination. Inhalation of this chemical can be fatal, resulting from inflammation, bronchial pneumonia, edema of the larynx, bronchi, and pulmonary tract. LD_{50} (oral-rat) = 1500 mg/kg.

Long-Term Exposure: The chronic properties of this material have not been fully investigated. May cause permanent skin damage; scarring. Repeated exposure to a highly toxic material such as HFIP may result in general deterioration of health and possible organ damage.

Points of Attack: Respiratory system, eyes, skin.

Medical Surveillance: Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. Consideration should be given to the skin, eyes, and respiratory tract (lung function tests) in any placement or periodic examinations. Evaluation by a qualified allergist, including careful exposure history and special testing may help diagnose skin or respiratory tract allergy.

First Aid Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Maintain eye wash fountain and quick-drench facilities in work area. Unless full facepiece respiratory protection is worn, wear splash-proof protective eyeglasses or chemical safety goggles as described in OSHA regulations 29CFR1910.133 or European Standard EN166. Wear Tyvek-type disposable protective clothing or other impervious protective clothing, gloves, lab coat, apron or coveralls, as appropriate, to prevent skin contact. Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: When working with this chemical, wear a NIOSH-approved full face chemical cartridge respirator equipped with the appropriate organic vapor cartridges. If that is not available, a half face respirator similarly equipped plus airtight goggles can be substituted. However, please note that half face respirators provide a substantially lower level of protection than do full face respirators.

Storage: Color code—White stripe (store separately): Contact Hazard; not compatible with materials in solid white category. Storage precautions: you should store this chemical in a refrigerator and keep it away from oxidizing materials. Store away from sources of ignition. Protective clothing minimum protective clothing: if Tyvek-type disposable protective clothing is not worn during handling of this chemical, wear disposable Tyvek-type sleeves taped to your gloves.

Shipping: UN1760 Corrosive liquids, n.o.s., Hazard class: 8; Labels: 8-Corrosive material.

Spill Handling: First remove all sources of ignition. Then, use absorbent paper to pick up all liquid spill material. Seal the absorbent paper, as well as any of your clothing which may be contaminated, in a vapor-tight plastic bag for eventual disposal. Wash any surfaces you may have contaminated with a soap and water solution. Do not reenter the contaminated.

Fire Extinguishing: Thermal decomposition products include fluorine. On fire involving this compound, use dry chemical, carbon dioxide, or Halon extinguisher. Vapors are heavier than air and will collect in low areas. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: May be incinerated. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform to EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (101); (138).

Hexamethylenediamine H:0270

Formula: $C_6H_{16}N_2$; $H_2N(CH_2)_6NH_2$

Synonyms: 1,6-Diaminohexane; 1,6-Hexamethylene diamine; Hexamethylenediamine; 1,6-Hexanediamine; HMDA; NCI-C61405

CAS Registry Number: 124-09-4

HSDB Number: 189

RTECS Number: MO1180000

UN/NA & ERG Number: UN2280 (solid)/153; UN1783 (solution)/153

EC Number: 204-679-6 [*Annex I Index No.:* 612-104-00-9]

Regulatory Authority and Advisory Information

Hazard Alert: Corrosive, Polymerization hazard, Suspected of causing genetic defects.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: C; risk phrases: R21/22; R34; R36/37; R62; safety phrases: S1/2; S22; S24/25; S26; S36/37/39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: HMDA is a hygroscopic, colorless solid (pellets or flakes). Weak, fishy odor. Molecular weight = 116.13; boiling point = 199°C; freezing/melting point = 39–42°C; flash point = 71°C; 81°C (solution); autoignition temperature = 310°C. Explosive limits: LEL = 0.7%; UEL: 6.3%. Hygroscopic, soluble in water; ₩ vigorous reaction releasing high levels of carbon dioxide; aqueous solution is strongly basic.

Potential Exposure: HMDA is used as a textile intermediate; a raw material for nylon fiber and plastics; in wet strength resins; in the manufacture of oil-modified and moisture-area types of urethane coatings; in the manufacture of polyamides for printing inks, dimer acids, and textiles; and as an oil and lubricant additive (probably as a corrosion inhibitor); as boiler feed water additives; also used in paints and as a curing agent for epoxy resins; making adhesives.

Incompatibilities: May form explosive mixture with air. The aqueous solution is a strong base and a strong reducing agent. Reacts violently with oxidizers, acids, acid chlorides; acid anhydrides; carbon dioxide acids. Reacts on contact with water forming carbon dioxide. Polymermizes in temperatures >195°C. Reacts with ethylene dichloride, organic anhydrides, isocyanates, vinyl acetate, acrylates, substituted allyls, alkylene oxides, epichlorohydrin, ketones, aldehydes, alcohols, glycols, phenols, cresols, caprolactum solution. Attacks aluminum, copper, lead, tin, zinc and alloys. Absorbs carbon dioxide and water from air. Store under Nitrogen.

Permissible Exposure Limits in Air

Odor Threshold = 0.004 milligram per cubic meter

OSHA PEL: None

NIOSH REL: None

ACGIH TLV[1]: 0.5 ppm/2.3 milligram per cubic meter TWA *as 1,6-hexanediamine*

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Hungary: TWA 1 milligram per cubic meter; STEL 2 milligram per cubic meter [skin], 1993; Russia: STEL 0.1 milligram per cubic meter, 1993; the Netherlands: MAC-TGG 2.3 milligram per cubic meter, 2003. Russia set a MAC in the ambient air of residential areas of 0.001 milligram per cubic meter on a momentary and a daily average basis.

Permissible Concentration in Water: Russia[43] set a MAC in water bodies used for domestic purposes of 0.01 mg/L.

Harmful Effects and Symptoms

Short-Term Exposure: A very corrosive substance. Severely irritates and burns the eyes, skin, and respiratory tract. Can cause permanent eye damage. Inhalation can cause nosebleeds, sore throat; hoarseness, cough, phlegm and/or difficult breathing. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. LD_{50} (oral-rat) = 750 mg/kg (slightly toxic).

Long-Term Exposure: Repeated or prolonged exposure can cause dermatitis, eczema, and liver damage, including hepatitis. There is limited evidence that this chemical can damage the developing fetus. Repeated exposure may cause bronchitis.

Points of Attack: Lungs, skin, liver.

Medical Surveillance: lung function tests, liver function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If convulsions are not present, give a glass or two of water or milk to dilute the substance. Do not induce vomiting. Assure that the person's airway is unobstructed and contact a hospital or poison center immediately for advice on whether or not to induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: (1) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. (2) Color code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Store under nitrogen. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in a cool, dry place away from oxidizers, strong acids; acid chlorides; acid anhydrides; carbon dioxide; and metals. Preferably store under an inert atmosphere in a tightly closed container.

Shipping: UN2280 Hexamethylenediamine, solid, Hazard class: 8; Labels: 8-Corrosive material. UN1783 Hexamethylenediamine, solution, Hazard class: 8; Labels: 8-Corrosive material.

Spill Handling: *Solid:* Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Establish forced ventilation to keep levels below explosive limit. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal EPA for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Liquid: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal EPA for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: *Solid:* This chemical as a solid may burn but does not easily ignite. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. Thermal decomposition products may include oxides of nitrogen and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Liquid: This chemical in solution is a combustible liquid. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; or foam extinguishers. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration; incinerator equipped with a scrubber or thermal unit to reduce nitrogen oxides emissions.

References

(31); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: 1,6-Diaminohexane. Washington, DC (June 6, 1978).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 2, No. 1. 30−31 (1982) and 8, No. 1, 46−50 (1988).

Hexamethylene Diisocyanate H:0280

Formula: $C_8H_{12}N_2O_2$: $OCN(CH_2)_6NCO$

Synonyms: AI3-28285; Desmodur H; Desmodur N; Diisocianto de hexametileno (Spanish); 1,6-Diisocyanatohexane; HDI; Hexamethyl 1,6-diisocyanate; 1,6-Hexamethylene diisocyanate; Hexamethylene 1,6-diisocyanate; 1,6-Hexane diisocyanate; Hexane, 1,6-diisocyanato-; 1,6-Hexanediol diisocyanate; 1,6-Hexylene diisocyanate; HMDI; Isocyanic acid, diester with 1,6-hexanediol; Isocyanic acid, hexamethylene ester; Metyleno-bis-fenyloizocyjanian; NSC 11687; TL78

CAS Registry Number: 822-06-0 (1,6-Diisocyanatohexane); (alt.) 66368-96-5; 28182-81-2 (polymer)

HSDB Number: 6134

RTECS Number: MO1740000

UN/NA & ERG Number: UN2281/156 (P)

EC Number: 212-485-8 [*Annex I Index No.:* 615-011-00-1]

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Combustible, Violently water reactive, Polymerization hazard (high temp.), Sensitization hazard, Agricultural Chemical.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg)

EPCRA Section 313 Form R de minimis concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

European/International Regulations (*822-06-0*): Hazard symbol: T, Xi; risk phrases: R14/15; R23; R29; R36/37/38; R42/43; safety phrases: S1/2; S26; S28; S38; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Hexamethylene diisocyanate is a colorless liquid. Sharp, irritating odor. Molecular weight = 168.19; specific gravity (H_2O:1) = 1.05 @ 20°C; boiling point = 212.8°C; freezing/melting point = −67°C; relative vapor density (air = 1): 5.8; vapor pressure = 0.5 mmHg @ 25°C; flash point = 140°C; autoignition temperature = 454°C. Explosive limits: LEL = 0.9%; UEL: 9.5. Hazard Identification (based on NFPA-704 M Rating System): Health 3, flammability 1, reactivity 1₩. Reacts with water, releasing heat and carbon dioxide.

Potential Exposure: Used to make other chemicals, coatings, and polyurethane. It is also used as a hardener in automobile and airplane paints.

Incompatibilities: May form explosive mixture with air. Isocyanates are highly flammable and reactive with many compounds, even with themselves. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Reaction with moist air, water or alcohols may form amines and insoluble polyureas and react exothermically, releasing toxic, corrosive or flammable gases, including carbon dioxide; and, at the same time, may generate a violent release of heat increasing the concentration of fumes in the air. Incompatible with amines, aldehydes, alkali metals, ammonia, carboxylic acids, caprolactum, alkaline materials, glycols, ketones, mercaptans, hydrides, organotin catalysts, phenols, strong acids, strong bases, strong reducing agents such as hydrides, urethanes, ureas. Elevated temperatures or contact with acids, bases, tertiary amines, and acyl-chlorides may cause explosive polymerization. Attacks some plastics, rubber and coatings. Contact with metals may evolve flammable hydrogen gas. May accumulate static electrical charges, and may cause ignition of its vapors. Temperatures above 200°C can cause polymerization. Attacks copper.

Permissible Exposure Limits in Air

822-06-0, 1,6-diisocyanatohexane

OSHA PEL: None

NIOSH REL: 0.005 ppm/0.035 milligram per cubic meter TWA; 0.020 ppm/0.140 milligram per cubic meter [10-minutes] Ceiling Concentration ACGIH TLV[1]: 0.005 ppm/0.034 milligram per cubic meter TWA

PAC Ver. 29[138]

PAC-1: 0.018 ppm

PAC-2: 0.2 ppm

PAC-3: 3 ppm

DFG MAK: 0.005 ppm/0.035 milligram per cubic meter TWA; Peak Limitation Category I(1), a momentary value of 0.01 mL/m^3/0.070 milligram per cubic meter should not be exceeded; Danger of sensitization of the airways and skin; Pregnancy Risk Group D

Belgium: TWA 0.005 ppm (0.034 milligram per cubic meter), 1993; Denmark: TWA 0.005 ppm (0.035 milligram per cubic meter), 1999; France: VME 0.01 ppm (0.075 milligram per cubic meter), VLE 0.02 ppm (0.15 milligram per cubic meter), 1999; Hungary: TWA 0.05 milligram per cubic meter; STEL 0.1 milligram per cubic meter, 1993; Japan; 0.005 ppm (0.034 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 0.04 milligram per cubic meter, 2003; Poland: MAC (TWA) 0.05 milligram per cubic meter; STEL 0.15 milligram per cubic meter, 1999; Russia: STEL 0.05 milligram per cubic meter [skin], 1993; Sweden: NGV 0.005 ppm (0.03 milligram per cubic meter), TGV 0.01 ppm (0.07 milligram per cubic meter), 1999; Switzerland: MAK-W 0.01 ppm (0.07 milligram per cubic meter), KZG-W 0.02 ppm (0.14 milligram per cubic meter), 1999; United Kingdom: TWA 0.02 mg[NCO]/m^3; STEL 0.07 mg[NCO]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 0.005 ppm. The state of Connecticut has set a guideline for hexamethylene diisocyanate in ambient air of 0.7 μ/m^{3}[60].

28182-81-2, polymer

PAC-1: 7.8 ppm

PAC-2: 86 ppm

PAC-3: 510 ppm

Determination in Air: Use NIOSH (IV), Methods, #5521, #5522,#5525; OSHA Analytical Method 42.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 1.1$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Hexamethylene diisocyanate can affect you when breathed in and by passing through your skin. Contact can irritate and may burn the eyes and skin. Skin contact may cause skin blisters. Eye contact may cause corneal damage. Exposure can cause headache, nausea, vomiting and irritability. Just a few breaths of high levels of hydrogen sulfide in air can cause death. High levels can irritate the lungs, causing coughing and/or shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Respiratory sensitization may result from high levels of exposure. LD$_{50}$ (oral, rat) = < 800 mg/kg.

Long-Term Exposure: Repeated or prolonged contact may cause skin sensitization and allergy with itching and skin rash. Repeated or prolonged inhalation exposure may cause a lung allergy (asthma) to develop. Once allergy develops, future exposure can cause cough, wheezing, and shortness of breath.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended. Lung function tests. These may be normal if person is not having an attack at the time of the test. If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *up to 0.05 ppm:* Sa (APF = 10) (any supplied-air respirator).* *up to 0.125 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode).* *up to 0.25 ppm:* SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 1 ppm:* SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA). *Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Hexamethylene diisocyanate should be stored away from moisture or water. This contact will cause it to polymerize and explode its container. Hexamethylene diisocyanate must be stored to avoid contact with amines, carboxylic acids; strong bases and alcohols, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area at temperatures below 93°C/200°F.

Shipping: UN2281 Hexamethylene diisocyanate, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Stay upwind and uphill. Isolate the area of release or fire and deny entry. Remove all ignition sources. Stop the release if it can be done safely from a distance. All equipment used to handle this material must be grounded. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. *Small spill*: Cover with *dry* earth, *dry* sand, or other noncombustible material followed with plastic sheet to minimize spreading or contact with water or rain. Use clean nonsparking tools to collect material and place material into loosely covered plastic containers for later disposal. Prevent material and runoff from entering sewers and waterways if it can be done safely well ahead of the release. Use vapor suppressing foam to disperse vapors—contain runoff. Water spray may reduce vapor, but may not prevent ignition in enclosed spaces. Ventilate confined area if it can be done without placing personnel at risk. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal EPA for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include hydrogen cyanide and oxides of nitrogen and carbon. This chemical is a combustible liquid. *Small fire*: use *dry* chemical, CO_2, *dry* sand, or alcohol-resistant foam. May react with foams releasing corrosive/toxic gases. *Large fire*: use water spray or alcohol-resistant foam if it is available in sufficient amounts. Under favorable conditions, experienced crews can use coordinated fog streams to sweep the flames off the surface of the burning liquid. Combustible material: may burn but does not ignite readily. Most vapors are heavier than air. They will spread along ground and collect in low or confined areas (sewers, basements, tanks). Vapors may travel to source of ignition and flash back. Containers may explode when heated or if contaminated with water. Keep exposures cool long after fire is out to protect against reignition. Do not direct straight streams into the liquid. Cool exposed containers with large quantities of water from unattended equipment or remove intact containers if it can be done safely. *Do not get water on spilled substance or inside containers*. If cooling streams are ineffective (*venting sound increases in volume and pitch, tank discolors or shows signs of deforming*), withdraw immediately to a secure location. Always stay away from ends of tanks, especially when engulfed in flames. If material or contaminated runoff from fire control enters waterways, notify downstream users of potentially contaminated water. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Hexamethylene Diisocyanate, Trenton, NJ (April 1999).

United States Department of Health and Human Services, “ATSDR ToxFAQs, Hexamethylene Diisocyanate,” Atlanta, GA (August 1999).

Hexamethylphosphoric Triamide H:0290

Formula: $C_6H_{18}N_3OP$; $[(CH_3)_2N]_3PO$

Synonyms: Eastman inhibitor HPT; ENT 50,882; Hempa; Hexametapol; Hexamethylorthophosphoric triamide; Hexamethylphosphoramide; Hexamethylphosphoric acid triamide; *N,N,N,N,N,N*-Hexamethylphosphoric triamide; Hexamethylphosphoric triamide; Hexamethylphosphorotriamide; Hexamethylphosphotriamide; HMPA; HMPT; HMPTA; HPT; Memta; Phosphoric acid hexamethyltriamide; Phosphoric hexamethyltriamide; Phosphoric triamide, hexamethyl-; Phosphoric tris(dimethylamide); Phosphoryl hexamethyltriamide; Triamida hexametilfosforica (Spanish); Tris(dimethyamino)phosphorus oxide; Tris(dimethylamino) phosphine oxide

CAS Registry Number: 680-31-9

HSDB Number: 2031

RTECS Number: TD0875000

UN/NA & ERG Number: UN3082 (environmentally hazardous substances, liquid, n.o.s.)/171

EC Number: 015-106-00-2

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Sufficient Evidence, Human No Adequate Data, *possibly carcinogenic to humans*, Group 2B, 1999; NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; NIOSH: Potential occupational carcinogen. United States EPA Gene-Tox Program, Positive: Carcinogenicity-mouse/rat; Positive: D *melanogaster*-reciprocal translocation; Positive: Rodent dominant lethal; Mammalian micronucleus; Positive: Sperm morphology-mouse; Sperm morphology-rabbit; Positive: D *melanogaster* sex-linked lethal.

California Proposition 65 Chemical[102]: Cancer 1/1/1988; male 10/1/1994.

Hazard Alert: Combustible, Possible risk of forming tumors, Reproductive toxin: possible risk of gene damage/ impaired fertility; Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction).

Banned or Severely Restricted (Sweden)[13]

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg)

EPCRA Section 313 Form R de minimis concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazard symbols, risk, & safety statements: Hazard symbol: T; risk phrases: R45; R46; R23/24/25; R36/37/38; R42; R51; R62; R63; safety phrases: S36/37/39; S45; S53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Hexamethylphosphoric triamide is a colorless liquid with a spicy odor. Molecular weight = 179.2; specific gravity (H_2O:1) = 1.03 @ 20°C; boiling point = 232.8°C; freezing/melting point = 7.2°C; relative vapor density (air = 1) = 6.18; vapor pressure = 0.03 mmHg @ 25°C; flash point = 104.4°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 1, reactivity 0. Soluble in water.

Potential Exposure: Hexamethylphosphoric triamide is a material possessing unique properties and is widely used as a solvent in small quantities, in organic and organometallic reactions in laboratories. This is the major source of occupational exposure to HMPA in the United States. It is also used as a processing solvent in the manufacture of aramid fibers. HMPA has been evaluated for use as an ultraviolet light absorber or inhibitor in polyvinylchloride formulations; as an additive for antistatic effects; as a flame retardant; and as a deicing additive for jet fuels. Hexamethylphosphoric triamide has also been extensively investigated as an insect chemosterilant.

Incompatibilities: Incompatible (possibly violent reaction; fire and explosions) with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.). Keep away from alkaline materials, chemically active metals, strong acids, strong bases.

Permissible Exposure Limits in Air

OSHA PEL: none

NIOSH REL: A potential occupational carcinogen. Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A

ACGIH TLV[1]: No numerical value; [skin]; confirmed animal carcinogen with unknown relevance to humans.

PAC Ver. 29[138]

PAC-1: 0.34 ppm

PAC-2: 3.7 ppm

PAC-3: 17 ppm

DFG MAK: [skin]; Pregnancy risk Group C; Carcinogen Category 2

Australia [skin], carcinogen, 1993; Austria: carcinogen, 1999; Belgium: [skin], carcinogen, 1993; Finland: carcinogen, 1999; France: carcinogen, 1993; Sweden: carcinogen, 1999; Switzerland: [skin], carcinogen, 1999; Switzerland: [skin], Carcinogen 1993; United Kingdom: carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: confirmed animal carcinogen with unknown relevance to humans. Several states have set guidelines or standards for HMPA in ambient air[60] ranging from zero (North Dakota) to 0.0024 ppb (Pennsylvania) to 0.03 μ/m^3 (New York) to 3.0 μ/m^3 (Virginia) to 14.5 μ/m^3 (South Carolina).

Determination in Air: No method available.

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact. Through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Hexamethylphosphoramide can affect you when breathed in and by passing through your skin. Exposure may irritate and damage the nose, throat and lungs, causing a nasal discharge and lung changes. Very high levels may cause kidney and lung damage.

Long-Term Exposure: Potential occupational carcinogen. May cause cancer of the nose. Hexamethylphosphoramide may cause mutations. Handle with extreme caution. There is limited evidence that HEMPA may damage the testes of males and affect sperm production. Repeated exposure may severely damage the kidneys and lungs. May damage the nose, causing chronic nasal discharge.

Points of Attack: Eyes, skin, respiratory system; central nervous system; gastrointestinal tract. Cancer site in animals: nasal cavity.

Medical Surveillance: For those with frequent or potentially high exposure (or significant skin contact), the following are recommended before beginning work and at regular times after that: exam of the nose. Lung function tests. Kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek

medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Butyl rubber is among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue *(potential human carcinogen)*: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Hexamethylphosphoramide must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates); strong acids (such as hydrochloric, sulfuric, and nitric); and chemically active metals (such as potassium, sodium, magnesium, and zinc), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from area. Sources of ignition, such as smoking and open flames are prohibited where hexamethyl phosphoramide is handled, used, or stored. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN3082 Environmentally hazardous substances, liquid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal EPA for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Decomposition products may include phosphine and oxides of nitrogen, phosphorus, and carbon. Use dry chemical or carbon dioxide extinguishers. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(109); (102); (31); (173); (101); (138); (100).

National Institute for Occupational Safety and Health (NIOSH), Current Intelligence Bulletin No. 6: Hexamethylphosphoric Triamide (HMPAI), Rockville, Maryland (October 24, 1975).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Hexamethylphosphoramide, Washington, DC (August, 1976).

National Institute for Occupational Safety and Health (NIOSH), Information Profiles on Potential Occupational Hazards-Single Chemicals: Hexamethyl Phosphoramide, pp. 106–113, Rockville, Maryland (December, 1979).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Hexamethyl Phosphoramide, Trenton, NJ (July 2001).

n-Hexane H:0300

Formula: C_6H_{14}; $CH_3(CH_2)_4CH_3$

Synonyms: Exxsol hexane; Genesolv 404 azeotrope; Gettysolve-B; Hexane; *n*-Hexano (Spanish); Hexano (Spanish); Hexyl hydride; NCI-C60571; NSC68472; Skellysolve B

CAS Registry Number: 110-54-3

Some other hexane isomers except n-hexane

107-83-5 (*2-methylpentane*); 96-14-0 (*3-methylpentane*); 75-83-2 (*2,2-dimethylbutane*); 79-29-8 see also 2,3-Dimethylbutane at D:1120; 96-37-7 see also Methyl cyclopentane at M:0830

HSDB Number: 91

RTECS Number: MN9275000

UN/NA & ERG Number: UN1208/128

EC Number: 203-777-6 [*Annex I Index No.:* 601-037-00-0]

Regulatory Authority and Advisory Information

Carcinogenicity: EPA: Inadequate information to assess carcinogenic potential.

Hazard Alert: Highly flammable, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction), Environmental hazard. Listed for Tier 1 screening as an endocrine disruptor[88].

NTP: Toxicity studies, RPT#TOX-02, October 2000

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg)

EPCRA Section 313 Form R de minimis concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects[293]. Toxic to aquatic life with long-lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

European/International Regulations (*n-HEXANE*): Hazard symbol: F, Xn, N; risk phrases: R11; R38; R48/20; R51/53; R62; R63; R65; R67; safety phrases: S2; S9; S16; S21; S29; S33; S36/37; S41; S61; S62 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to waters (CAS: 110-54-3)

Description: *n*-Hexane is a highly flammable, colorless, volatile liquid with a gasoline-like odor. The water/odor threshold is 0.0064 mg/L and the air/odor threshold is 230−875 milligram per cubic meter. Molecular weight = 86.18; specific gravity (H_2O:1) = 0.66; boiling point = 68.7°C; freezing/melting point = −95.4°C; Relative vapor density (air = 1) = 3.0; vapor pressure = 75 mmHg @ 9.8°C; flash point = −21.6°C (cc); autoignition temperature = 225°C. Explosive limits: LEL = 1.1%, 11,000 ppm; UEL: 7.5%. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 3, reactivity 0. Practically insoluble in water; solubility = 0.002%.

Potential Exposure: *n*-Hexane is industrial chemical, emulsifier, in manufacture of plastics, resins; as a solvent, particularly in the extraction of edible fats and oils; as a laboratory reagent; and as the liquid in low temperature thermometers. Technical and commercial grades consist of 45−85% hexane, as well as cyclopentanes, isohexane, and 1% to 6% benzene.

Incompatibilities: May form explosive mixture with air. Contact with strong oxidizers may cause fire and explosions. Contact with dinitrogen tetraoxide may explode @ 28°C. Attacks some plastics, rubber and coatings. May accumulate static electrical charges, and may cause ignition of its vapors.

Permissible Exposure Limits in Air

NIOSH IDLH = 1100 ppm [LEL]

Conversion factor: 1 ppm = 3.53 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 500 ppm/1800 milligram per cubic meter TWA [skin]

NIOSH REL: 50 ppm/180 milligram per cubic meter TWA

ACGIH TLV[1]: 50 ppm/176 milligram per cubic meter TWA [skin]; BEI: 5 mg [2,5-Hexanedione]/g creatinine in urine at end-of-shift; *n*-Hexane in end-exhaled air during shift

PAC* Ver. 29[138]

PAC-1: 260 ppm

PAC-2: **2900**$_{\mathbf{A}}$ ppm [10%−49% LEL]

PAC-3: **8600**$_{\mathbf{A}}$ ppm [50%−99% LEL; LEL = 11,000 ppm]

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript “**A**” and correspond to 60 minute values.

DFG MAK (*n-hexane only*): 50 ppm/180 milligram per cubic meter TWA; Peak Limitation Category II(8) [skin]; Pregnancy Risk Group C; BAT: 5 mg[hexane-2,5-dione + 4,5-dihydroxy-2-hexanone]/L in urine at end-of-shift

Australia: TWA 50 ppm (180 milligram per cubic meter), 1993; Austria: MAK 50 ppm (180 milligram per cubic meter), 1999; Belgium: TWA 50 ppm (176 milligram per cubic meter), 1993; Denmark: TWA 25 ppm (90 milligram per cubic meter), 1999; Finland: TWA 50 ppm (180 milligram per cubic meter); STEL 150 ppm (530 milligram per cubic meter), 1999; France: VME 50 ppm (170 milligram per cubic meter), 1999; Hungary: TWA 100 milligram per cubic meter; STEL 200 milligram per cubic meter [skin], 1993; the Netherlands: MAC-TGG 90 milligram per cubic meter, 2003; Norway: TWA 25 ppm (90 milligram per cubic meter), 1999; the Philippines: TWA 500 ppm (1800 milligram per cubic meter), 1993; Poland: MAC (TWA) 100 milligram per cubic meter, MAC (STEL) 400 mg/me, 1999; Russia: TWA 40 ppm; STEL 300 milligram per cubic meter, 1993; Sweden: NGV 25 ppm (90 milligram per cubic meter), KTV 50 ppm (180 milligram per cubic meter), 1999; Switzerland: MAK-W 50 ppm (180 milligram per cubic meter), KZG-W 100 ppm

(360 milligram per cubic meter), 1999; Turkey: TWA 500 ppm (1800 milligram per cubic meter), 1993; United Kingdom: TWA 20 ppm (72 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 50 ppm [skin]. Russia[35,43] set a MAC in ambient air in residential areas of 60 milligram per cubic meter on a momentary basis.

Hexane, other isomers other than n-hexane

OSHA PEL: None

NIOSH REL: 100 ppm/350 milligram per cubic meter TWA; 510 ppm/1800 milligram per cubic meter [15-minutes] Ceiling Concentration

ACGIH TLV[1]: 500 ppm/1750 milligram per cubic meter TWA; 1000 ppm/3500 milligram per cubic meter STEL

all hexane isomers except n-hexane:

DFG MAK: 500 ppm/1800 milligram per cubic meter TWA; Peak Limitation Category II(2); Pregnancy Risk Group D.

Determination in Air: Use NIOSH Analytical Method: for Hydrocarbons, Boiling point = 36–126°C, #1500, for Hydrocarbons, Boiling point 36–126°C; #3800; OSHA Analytical Method 7. See also NIOSH Analytical Method: Volatile organic compound, #2549

Permissible Concentration in Water: The EPA[48] has set a health advisory for *n*-hexane involving the calculation of a NOAEL of 570 mg/kg/day which results in a long-term health advisory for an adult of 14.3 mg/L. A health-based maximum contaminant level of 33 μg/L has been derived by the state of New Jersey[59] based on neurotoxic effects observed in rats exposed to *n*-hexane by inhalation. Arizona and Maine[61] have set guidelines for *n*-hexane in drinking water of 4000 μg/L.

Determination in Water: Octanol–water coefficient: Log $K_{ow} = \sim 4$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation of vapor, ingestion, eye and skin contact. Passes through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, nose, and respiratory tract. Exposure can cause lightheadedness, giddiness, headaches, and nausea. High levels can lead to unconsciousness and death. *Inhalation:* Exposure to levels above 500 ppm may cause headaches, abdominal cramps; a burning feeling of the face; numbness and weakness of the fingers and toes. Levels above 1300 ppm may cause the above plus nausea and irritation of the nose and throat. Levels above 1500 ppm may cause the above plus blurred vision, loss of appetite and loss of weight. Most symptoms disappear within a few months if exposure ceases. Breathing liquid into the lungs may cause chemical pneumonia. *Skin:* Contact may cause irritation, redness, swelling, blisters and pain. Skin exposure may contribute to symptoms listed under inhalation. *Eyes:* Levels over 880 ppm may cause irritation. *Ingestion:* May contribute to symptoms listed under inhalation. Estimated lethal dose is one ounce to one pint.

Long-Term Exposure: High or repeated exposure can damage the nervous system; causing numbness, tingling, and/or muscle weakness in the hands, feet, arms and legs. Repeated skin contact can cause irritation, dryness and cracking, and can lead to rash. May cause symptoms listed under inhalation. Exposure to levels above 650 ppm for two to four months can result in weakness and numbness of the arms and legs. Symptoms go away within a few months if exposure stops. Use by older children in the United States and Europe who have "sniffed" household chemicals containing *n*-hexane in an attempt to get "high" has caused paralysis of the arms and legs. In laboratory studies, animals exposed to high levels of *n*-hexane had signs of disturbed sleep; lung damage, and damage to the sperm-forming cells.

Points of Attack: Eyes, skin, respiratory system; central nervous system; peripheral nervous system.

Medical Surveillance: NIOSH lists the following tests: whole blood (chemical/metabolite); whole blood (chemical/metabolite), during exposure, expired air, expired air, during exposure; neurologic examination/electromyography; urine (chemical/metabolite); urine (chemical/metabolite), end-of-shift; urine (chemical/metabolite), end of work-week.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Do not induce vomiting.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Polyvinyl alcohol, Viton, polyurethane, Teflon, Viton/chlorobutyl rubber, Silvershield, and chlorinated polyethylene are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *500 ppm:* Sa (APF = 10) (any supplied-air respirator). *1100 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. *n*-Hexane must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine), because violent reactions occur. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames are prohibited where *n*-hexane is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers used in the transfer of 5 gal or more of n-hexane should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of *n*-hexane.

Shipping: UN1208 Hexanes, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit.

Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal EPA for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (2); (100).

United States Environmental Protection Agency, Clinical Hazard Information Profile: *n*-Hexane, Washington, DC (May 13, 1977).

National Institute for Occupational Safety and Health (NIOSH), "Criteria for a Recommended Standard: Occupational Exposure to Alkanes", NIOSH Document Number 77-151, Cincinnati, OH (1977).

New York State Department of Health, "Chemical Fact Sheet: Hexane, Bureau of Toxic Substance Assessment", Albany, NY (April 1986).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 1, No. 6, 59−61 (1981).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: n*-Hexane, Trenton, NJ (April, 2004).

Hexanol H:0310

Formula: $C_6H_{14}O$; $CH_3(CH_2)_4CH_2OH$

Synonyms: Alcohol C-6; *n*-Amyl carbinol; Amylcarbinol; Caproyl alcohol; Epal-6; *n*-Hexanol; *n*-Hexyl alcohol; Hexyl alcohol; 1-Hydroxyhexane; Pentyl carbinol

CAS Registry Number: 111-27-3

HSDB Number: 565

RTECS Number: MQ4025000

UN/NA & ERG Number: UN2282/129

EC Number: 203-852-3 [*Annex I Index No.:* 603-059-00-6]

Regulatory Authority and Advisory Information

Hazard Alert: Flammable, Primary irritant (w/o allergic reaction).

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xn; risk phrases: R10; R22; safety phrases: S2; S24/25 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Hexanol is a flammable, colorless liquid. Molecular weight = 102.2; specific gravity (H_2O:1) = 0.82 @ 20°C; boiling point = 157°C; freezing/melting point = −47°C; vapor pressure = 1 mmHg @ 24°C; flash point = 63°C. Explosive limits: LEL = 1.2%; 12,000 ppm; UEL: 7.7%[41]. Hazard Identification (based on NFPA-704 M Rating System): Health 3, flammability 2, reactivity 0. Slightly soluble in water.

Potential Exposure: Those using hexanol as a solvent or in the synthesis of pharmaceuticals and textile chemicals. Also used as a plasticizer intermediate, specialty; ethoxylate intermediate; and a defoamer

Incompatibilities: May form explosive mixture with air. Incompatible with strong acids; caustics, aliphatic amines; isocyanates, strong oxidizers.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 10 ppm

PAC-2: 110 ppm

PAC-3: 580 ppm [LEL = 11,000 ppm]

DFG MAK: No numerical value established. Data may be available.

Russia has set a TLV of 2.4 ppm (10 milligram per cubic meter)[43].

Determination in Air: Charcoal tube; CS2; Gas chromatography/Flame ionization detection; IV (#1500, Hydrocarbons)

Permissible Concentration in Water: A value of 0.03 mg/L is the maximum allowed in drinking water[11].

Routes of Entry: Skin contact, inhalation, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Vapor irritates the eyes, skin and respiratory tract. Contact causes smarting of the skin and first-degree burns on short exposure; may cause second-degree burns on long exposure. Believed to be moderately toxic upon ingestion. Exposure can cause headache, dizziness, confusion; muscle weakness; nausea, vomiting, and diarrhea.

Long-Term Exposure: Repeated exposure may damage the nervous system.

Points of Attack: Skin, eyes, nervous system.

Medical Surveillance: Examination of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with hexanol all handlers should be trained on its proper handling and storage. Before entering confined space where hexanol may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, strong acids. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN2282 Hexanol, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak

until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal EPA for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition includes oxides of carbon. Use dry chemical, carbon dioxide; or foam extinguishers. Water may be ineffective. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (80); (100).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 2, No. 2, 32–33 (1982) and 7, No. 6, 65–67 (1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: n*-Hexanol, Trenton, NJ (May, 1999).

Hexazinone H:0320

Formula: $C_{11}H_{20}O_2N_3$

Synonyms: Brushkiller; 3-Cyclohexyl-6-dimethylamino-1-methyl-1,2,3,4-tetrahydro-1,3,5-triazine-2-,4-dione; 3-Cyclohexyl-6-(dimethylamino)-1-methyl-*s*-triazine-2,4(1*H*,3*H*)-dione; 3-Cyclohexyl-6-(dimethylamino)-1-methyl-1,3,5-triazine-2,4(1*H*,3*H*)-dione; 3-Cyclohexyl-1-methyl-6-(dimethylamino)-*s*-trazine-2,4(1*H*,3*H*)-dione; DPX 3674; *s*-Triazine-2,4(1*H*,3*H*)-dione, 3-cyclohexyl-6-(dimethylamino)-1-methyl-; 1,3,5-Triazine-2,4(1*H*,3*H*)-dione, 3-cyclohexyl-6-(dimethylamino)-1-methyl-; Velpar; Velpar weed killer

CAS Registry Number: 51235-04-2

HSDB Number: 6670

RTECS Number: XY7850000

UN/NA & ERG Number: UN2763 (triazine pesticide, solid, toxic)/151; UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 257-074-4 [*Annex I Index No*.: 613-132-00-4]

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Combustible, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction), Environmental hazard, Agricultural chemical.

EPCRA Section 313 Form R de minimis concentration reporting level: 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: Xn, N; risk phrases: R22; R36/37/38; R50/53; safety phrases: S2; S29/35; S41; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)]

Description: Hexazinone is a white crystalline solid that is practically odorless. Molecular weight = 252.36; boiling point = decomposes; freezing/melting point = 115–117°C; vapor pressure = 3.0×10^{-7} mmHg. Soluble in water.

Potential Exposure: A potential danger to those involved in the manufacture, formulation and application of this contact and residual herbicide. It is a broad spectrum triazine herbicide is used in industrial and government right-of-way weed control for pipelines, drainage ditches, etc.[23]

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Permissible Concentration in Water: The EPA has analyzed data on hexazinone and developed a no observed adverse-effect-level (NOAEL) of 25 mg/kg/day based on studies of dogs which resulted in a long-term health advisory of 8.75 mg/L. A NOAEL of 10 mg/kg/day was developed based on studies of rats which yielded a lifetime health advisory of 0.21 mg/L.

Determination in Water: Solvent extraction with methylene chloride followed by analysis by gas chromatography with a thermionic bead detector. Fish Tox = 24566.31408000 bbp MATC (VERY LOW). Octanol–water coefficient: $\text{Log}\,K_{\text{ow}} = -4.4$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Skin, inhalation, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Corrosive eye irritant. May skin irritation. In experience with humans, only one report was available on hexazinone. It involved a 26 year-old woman who inhaled hexazinone dust; vomiting occurred within 24 hours. LD_{50} = (oral, rat) 1690 mg/kg (slightly toxic). Human Tox = 400.00000 ppb (VERY LOW).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area above 32°C.

Shipping: UN2763 Triazine pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal EPA for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, “Alert: Poison, Hexazinone”, Washington, DC, Office of Drinking Water (August 1987).

Hexythiazox H:0355

Formula: $C_{17}H_{21}ClN_2O_2S$

Synonyms: Acarflor; Acariflor; Cesar; *trans*-5-(4-Chlorophenyl)-*N*-cyclohexyl-4-methyl-2-*oxo*-3-thiazolidine-carboxamide; DPX-Y5893; Hexygon DF; HTZ; *trans*-4-Methyl-5-(4-chlorophenyl)-3-cyclohexylcarbamoyl-2-thiazolidone; NA 73; Nissorun; Onager; Savey; 3-Thiazolidinecarboxamide, 5-(4-chlorophenyl)-*N*-cyclohexyl-4-methyl-2-*oxo*-, *trans*-; Trevi; Zeldox

CAS Number: 78587-05-0

HSDB Number: 6671

RTECS Number: XJ5396000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: [*Annex I Index No.:* 613-125-00-6].

Regulatory Authority and Advisory Information

Carcinogenicity[83]: EPA Group C, possible human carcinogen

Hazard Alert: Combustible, Environmental hazard. Listed for Tier 1 screening as an endocrine disruptor[88].

List of priority pollutants (United States Environmental Protection Agency)

Clean Water Act: Toxic Pollutant (Section 401.15) other than those listed elsewhere; includes trichlorophenols

RCRA Section 261 Hazardous Constituents, waste number not listed

EPCRA Section 313 (as chlorophenols) Form R de minimis concentration reporting level: 1.0%

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: N; risk phrases: R45; R50/53; safety phrases: S2; S29; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: White to pale yellow crystalline solid, tan granules or powder. Odorless. Molecular weight = 352.89; boiling point = 221.5°C; freezing/melting point = 105−108°; vapor pressure = 2.3×10^{-8} mmHg. Hazard identification (based on NFPA-704 M Rating System): Health 0, flammability 1, reactivity 0. Very slightly soluble in water; solubility = < 1 ppm.

Potential Exposure: Carboxamide acaricide, IGR, and ovacide for tetranychid mite eggs. Used on a various crops, including citrus, grapes, pome fruit, hops, strawberries, and dates.

Incompatibilities: Dust forms an explosive mixture with air. Slowly hydrolyzes in water, releasing ammonia and forming acetate salts. Decomposes in temperatures >290°C. Compounds of the carboxyl group react with all bases, both inorganic and organic (i.e., amines) releasing substantial heat, water and a salt that may be harmful. Incompatible with arsenic compounds (releases hydrogen cyanide gas), diazo compounds, dithiocarbamates, isocyanates, mercaptans, nitrides, and sulfides (releasing heat, toxic and possibly flammable gases), thiosulfates and dithionites (releasing hydrogen sulfate and oxides of sulfur).

Determination in Water: Octanol−water coefficient: $\text{Log } K_{ow} = 5.57$ (est)[83]. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood. Fish toxicity (threshold)(101): Intermediate−62.61862 ppb, MATC (Maximum Acceptable Toxicant Concentration).

Routes of Entry: Ingestion, absorbed through the unbroken skin.

Short-Term Exposure: Inhalation can cause severe irritation, burns to the nose and throat, headache, dizziness, vomiting, lung damage, muscle twitchings, spasms, tremors, weakness, staggering and collapse. Dermal contact may cause severe irritation and burns. Absorbed through the skin to cause or increase the severity of symptoms listed above. Eye contact causes severe irritation. May cause burns. Ingestion can cause irritation, burns to the mouth and throat, low blood pressure, profuse sweating, intense thirst, nausea, abdominal pain, stupor, vomiting, red blood cell damage and accumulation of fluid in the lungs followed by pneumonia. May also cause restlessness and increased breathing rate followed by rapidly developing muscle weakness. The substance irritates the eyes, the skin and the respiratory tract. LD_{50} (oral, dermal, rat) = > 5 g/kg; LD_{50} (dermal, rat) = > 5 g/kg.

Long-Term Exposure: Skin sensitivity may develop. A possible liver toxin. May have effects on the blood, heart, liver, lung, kidney. The state of New Jersey lists the 2-chloro-isomer as a probable carcinogen, and that it causes leukemia and soft tissue cancers in humans. Human toxicity (long term)[101]: Intermediate—17.50 ppb, Health Advisory.

Points of Attack: Central nervous system, blood, bladder, liver

Medical Surveillance: This chemical is a suspected or known human carcinogen. Exposed persons should contact a physician for advice regarding the possible long term health effects and advice for medical monitoring. If symptoms develop or overexposure is suspected, the following may be useful: Liver function tests. Kidney function tests. Examination by a qualified allergist. EKG

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Do not induce vomiting when formulations containing petroleum solvents are ingested

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of dermal and/or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls, and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit. *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European

Standard EN 149-approved SCBA that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-face-piece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison. Store in a secure poison location. Prior to working with carboxin all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: First remove all sources of ignition. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal EPA for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include hydrogen chloride and oxides of nitrogen, sulfur and carbon. As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 m/150 ft for liquids and at least 25 m/75 ft for solids. *Fire involving storage or vehicular tanks:* Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. *On a small fire:* use dry chemical, CO_2, water spray or regular *foam. On a large fire:* use water spray, fog or regular foam. Do not scatter spilled material with high pressure streams of water. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal. *Fire involving tanks:* From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. Always stay away from tanks engulfed in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Do not discharge into drains or sewers. Dispose of waste material as hazardous waste using a licensed disposal contractor to an approved landfill. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. If allowed, Incineration with effluent gas scrubbing is recommended. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (100).

Pesticide Management Education Program, "Hexythiazox, (Savey) Chemical Profile 4/89" Cornell University, Ithaca, NY (April 1989). http://pmep.cce.cornell.edu/profiles/insect-mite/fenitrothion-methylpara/hexythiazox/insect-prof-hexythiazox.html.

United States Environmental Protection Agency, Office of Pesticide Programs, Pesticide Residue Limits, "Hexythiazox," 40 CFR 180.448, http://www.epa.gov/pesticides/food/viewtols.htm.

1-Hexene H:0330

Formula: C_6H_{12}; $CH_3(CH_2)_3CH{=}CH_2$

Synonyms: Butyl ethylene; Butylethylene; 1-*n*-Hexene; 1-Hexene; Hexylene

CAS Registry Number: 592-41-6

HSDB Number: 1079

RTECS Number: MP6601000

UN/NA & ERG Number: UN2370/128

EC Number: 209-753-1

Regulatory Authority and Advisory Information

Hazard Alert: Highly flammable liquid, Environmental hazard.

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xn; risk phrases: R11; R51/53; R65; R67; safety phrases: S9; S16; S21; S23; S29; S33; S45; S57; S62; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Hexene is a colorless liquid. Molecular weight = 84.16; specific gravity (H_2O:1) = 0.67 @ 20°C; boiling point = 65°C; freezing/melting point = −140°C; vapor pressure = 310 mmHg @ 38°C; flash point = −7°C;

autoignition temperature = 253°C. Explosive Limits: LEL = 1.2%, 12,000 ppm; UEL: 6.9%. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 3, reactivity 0. Insoluble in water.

Potential Exposure: A potential danger to those involved in its use in organic synthesis. Used in fuels, and to make flavors, perfumes, dyes, and plastic resins.

Incompatibilities: Vapor may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. May react exothermically with reducing agents, releasing flammable hydrogen gas.

Permissible Exposure Limits in Air

OSHA PEL: None

NIOSH REL: None

ACGIH TLV[1]: 50 ppm/172 milligram per cubic meter TWA

PAC* Ver. 29[138]

PAC-1: 150 ppm

PAC-2: $\mathbf{500_E}$ ppm

PAC-3: $\mathbf{5000_E}$ ppm (Warning: LEL = 12,000 ppm)

*ERPG [Emergency Response Planning Guidelines] are marked with a subscript "**E**."

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short-Term Exposure: Irritating to skin, eyes and respiratory tract causing coughing and wheezing. Death may occur. Ingestion may cause chemical pneumonitis. Exposure may affect the central nervous system. Exposure can cause headache, nausea, dizziness, and unconsciousness.

Long-Term Exposure: Removes the skin's natural oils, causing dryness and cracking.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Use organic vapor respirator or airline Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. mask. Wear protective goggles or face shield.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with hexene all handlers should be trained on its proper handling and storage. Before entering confined space where hexene may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers and strong acids. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN23701-Hexene, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Avoid contact with liquid or vapor. Stay upwind and use water spray to "knock down" vapor. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Oil skimming equipment and sorbent (urethane) foams may be used for spills on water. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal EPA for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of

carbon. Water may be ineffective. Use alcohol or polymer foam, dry chemical, or carbon dioxide. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (100).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*. 1, No. 8, 78–79 (1981) and 3, No. 2, 50–51 (1983).

sec-Hexyl acetate H:0340

Formula: $C_8H_{16}O_2$: $CH_3COOCH(CH_3)CH_2CH(CH_3)CH_3$

Synonyms: Acetic acid-1,3-dimethylbutyl ester; 1,3-Dimethylbutyl acetate; Hexyl acetate; MAAC; Methylamyl acetate; Methylisoamyl acetate; Methylisobutylcarbinol acetate; Methylisobutylcarbinyl acetate; 4-Methyl-2-pentanol, acetate; 4-Methyl-2-pentyl acetate

CAS Registry Number: 108-84-9

HSDB Number: 1154 as 4-methyl-2-pentyl acetate

RTECS Number: A10875000

UN/NA & ERG Number: UN1233/130

EC Number: 203-621-7

Regulatory Authority and Advisory Information

Hazard Alert: Flammable liquid, Primary irritant (w/o allergic reaction).

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xi; risk phrases: R10; R36/37/38; R51; safety phrases: S16; S26; S36/37/39 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: *sec*-Hexyl acetate is a colorless liquid with a mild, pleasant, fruity odor. Molecular weight = 144.24; specific gravity (H_2O:1) = 0.86; boiling point = 147.2°C; freezing/melting point = −63.8°C; Relative vapor density (air = 1) = 5.0; vapor pressure = 3 mmHg; flash point = 35°C; autoignition temperature = 266°C. Explosive limits: LEL = 0.9%; UEL: 5.7%. Hazard Identification (based on NFPA-704 M Rating System): Health 1, flammability 2, reactivity 0. Insoluble in water.

Potential Exposure: This material is used as a solvent in the spray lacquer industry. It is a good solvent for cellulose esters and other resins.

Incompatibilities: May form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

NIOSH IDLH = 500 ppm

Conversion factor: 1 ppm = 5.90 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 50 ppm/300 milligram per cubic meter TWA

NIOSH REL: 50 ppm/300 milligram per cubic meter TWA

ACGIH TLV[1]: 50 ppm/295 milligram per cubic meter TWA PAC not available.

Australia: TWA 50 ppm (300 milligram per cubic meter), 1993; Austria: MAK 50 ppm (300 milligram per cubic meter), 1999; Belgium: TWA 50 ppm (295 milligram per cubic meter), 1993; Denmark: TWA 50 ppm (300 milligram per cubic meter), 1999; Finland: TWA 50 ppm (300 milligram per cubic meter); STEL 75 ppm (450 milligram per cubic meter), 1999; France: VME 50 ppm (300 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 300 milligram per cubic meter, 2003; the Philippines: TWA 50 ppm (300 milligram per cubic meter), 1993; Switzerland: MAK-W 50 ppm (300 milligram per cubic meter), KZG-W 100 ppm (600 milligram per cubic meter), 1999; Turkey: TWA 50 ppm (300 milligram per cubic meter), 1993; United Kingdom: TWA 50 ppm (299 milligram per cubic meter); STEL 100 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: 50 ppm TWA. Several states have set guidelines and standards for *sec*-hexyl acetate in ambient air[60] ranging from 3.0 milligram per cubic meter (North Dakota) to 6.0 milligram per cubic meter (Connecticut) to 7.143 milligram per cubic meter (Nevada).

Determination in Air: Charcoal adsorption, workup with CS_2, gas chromatography/flame ionization. Use NIOSH Analytical Method 1450 for Esters; OSHA Analytical Method 7[18].

Routes of Entry: Inhalation, ingestion, eye and skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates eyes and respiratory tract. May affect the central nervous system causing headache, dizziness, nausea, narcosis.

Long-Term Exposure: May cause skin drying and cracking.***Points of Attack:*** Eyes, central nervous system.

Medical Surveillance: Consider the points of attack in preplacement and periodic examinations.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Wear eye protection to prevent any reasonable probability of eye contact. Employees should wash promptly when skin is wet or contaminated. Remove nonimpervious clothing promptly if wet or contaminated.

Respirator Selection: *up to 500 ppm:* CcrOv* (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or PaprOv* (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]; or Sa* (APF = 10) (any supplied-air respirator); SCBAF (APF = 50) (any SCBA with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:*
SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).
*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with hexyl acetate all handlers should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1233 Methylamyl acetate, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. Oil skimming equipment may be used to remove slicks from water. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal EPA for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of carbon. Water may be ineffective. Use alcohol foam, CO_2 or dry chemical extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Methyl Amyl Acetate, Trenton, NJ (June 1999).

Hexylene Glycol H:0350

Formula: $C_6H_{14}O_2$: $(CH_3)_2C(OH)CH_2CHOHCH_3$

Synonyms: 2,4-Dihydroxy-2-methylpentane; Diolane; 1,2-Hexanediol; Isol; 2-Methylpentane-2,4-diol; 2-Methyl-2,4-pentanediol; 4-Methyl-2,4-pentanediol; 2,4-Pentanediol, 2-methyl-; Pinakon; α,α,α'-trimethylene glycol

CAS Registry Number: 107-41-5

HSDB Number: 1126

RTECS Number: SA0810000

UN/NA & ERG Number: No citation.

EC Number: 203-489-0 [*Annex I Index No.:* 603-053-00-3]

Regulatory Authority and Advisory Information

Hazard Alert: Combustible, Primary irritant (w/o allergic reaction).

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xi; risk phrases: R10; R36/38; safety phrases: S2; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Hexylene glycol is a colorless liquid with a mild, sweet odor. The odor threshold is 50 ppm. Molecular weight = 118.2; specific gravity (H_2O:1) = 0.92; boiling point = 197 °C; freezing/melting point = −50°C (sets to glass); vapor pressure = 0.05 mmHg @ 20°C; flash point = 93.3°C; autoignition temperature = 260°C; 306°C. Explosive limits: LEL = 1.3%; UEL: 7.4%[41]. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 1, reactivity 0. Soluble in water.

Potential Exposure: Hexylene glycol is used in metal working fluids; the formulation of hydraulic brake fluids; in making printing inks. It is used as a fuel and lubricant additive; as an emulsifying agent; and as a cement additive.

Incompatibilities: Vapor may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Incompatible with caustics, aliphatic amines; isocyanates. Hygroscopic (i.e., absorbs moisture from the air).

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 4.83 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: None

NIOSH REL: 25 ppm/125 milligram per cubic meter Ceiling Concentration

ACGIH TLV[1]: 25 ppm/121 milligram per cubic meter Ceiling Concentration

PAC Ver. 29[138]

PAC-1: 2.3 ppm

PAC-2: 25 ppm

PAC-3: 150 ppm

DFG MAK: 10 ppm/49 milligram per cubic meter TWA; Peak Limitation Category I(2); Pregnancy Risk Group D

Australia: TWA 25 ppm (125 milligram per cubic meter), 1993; Belgium: STEL 25 ppm (121 milligram per cubic meter), 1993; Denmark: TWA 25 ppm (125 milligram per cubic meter), 1999; Finland: TWA 25 ppm (125 milligram per cubic meter); STEL 40 ppm (190 milligram per cubic meter), 1993; France: VLE 25 ppm (125 milligram per cubic meter), 1999; Norway: TWA 20 ppm (100 milligram per cubic meter), 1999; Switzerland: MAK-W 25 ppm, 1999; the Netherlands: MAC 125 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Ceiling Concentration 25 ppm. States which have set guidelines or standards for hexylene glycol in ambient air[60] include 1.25 milligram per cubic meter (North Dakota) and 2.976 milligram per cubic meter (Nevada).

Determination in Air: Use OSHA Analytical Method PV-2101

Determination in Water: Octanol−water coefficient: Log K_{ow} = 0.6. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion; skin and eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin, and respiratory tract. Contact can irritate and may burn the eyes and skin. Exposure may affect the central nervous system. Eye and throat irritation and respiratory discomfort were slight upon exposure to 100 ppm, but more pronounced @ 1000 ppm. Ingestion produces central nervous system depression. High exposure can cause dizziness, loss of coordination; and unconsciousness. Extremely high exposures can cause coma and kidney damage. Toxicity by Ingestion: Grade 2; LD_{50} = 0.5 to 5 g/kg[136].

Long-Term Exposure: Repeated exposure may cause dry skin, rash, sensitization and allergy. May damage the kidney and liver, and may affect the nervous system. Many similar petroleum-based solvents have been shown to cause brain and nerve damage.

Points of Attack: Eyes, skin, respiratory system; central nervous system.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function tests. Evaluation by a qualified allergist. Evaluate for brain effects and refer positive and borderline individuals for neuropsychological testing.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures *over 25 ppm*; Use an NIOSH/MSHA or European Standard EN 149-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use an NIOSH/MSHA or European Standard EN 149-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containersin a cool, well-ventilated area away from oxidizers (such as peroxides, perchlorates, chlorates, permanganates, and nitrates). Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: Hexylene glycol is not cited in DOT'S Performance-Oriented Packaging Standards[19].

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal EPA for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (85); (173); (101); (138); (80); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Hexylene Glycol, Trenton, NJ (April, 2004).

Hexyl Trichlorosilane H:0360

Formula: $C_6H_{13}Cl_3Si$; $C_6H_{13}SiCl_3$

Synonyms: Silane, trichlorohexyl-; Trichlorohexylsilane

CAS Registry Number: 928-65-4

HSDB Number: 2005
RTECS Number: VV4320000
UN/NA & ERG Number: UN1784/156
EC Number: 213-178-1

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade).

Hazard Alert: Flammable, Poison, Corrosive, Violently water reactive

Hazard symbols, risk, & safety statements: Hazard symbol: T+, Xn; risk phrases: R10; R14; R36/37/38; R34; R40; safety phrases: S1; S22; S26; S36/37/39; S45; S53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Hexyl trichlorosilane is a colorless liquid that fumes in moist air. Molecular weight = 219.63; specific gravity (H_2O:1) = 1.1 @ 20°C; boiling point = 190°C; flash point = 85°C. Explosive limits: LEL = 10,000 ppm; UEL: unknown. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 2, reactivity 2₩. Reacts violently with water, rapidly releasing corrosive hydrogen chloride gas.

Potential Exposure: Used in the manufacture of other silicon chemicals.

Incompatibilities: Vapors may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Chlorosilanes react vigorously with bases and both organic and inorganic acids generating toxic and/or flammable gases. Chlorosilanes react with water, moist air or steam to produce heat and toxic, corrosive fumes of hydrogen chloride. They may also produce flammable gaseous hydrogen. Attacks metals in the presence of moisture.

Permissible Exposure Limits in Air

PAC* Ver. 29[138]
PAC-1: $\mathbf{0.6_A}$ ppm
PAC-2: $\mathbf{7.3_A}$ ppm
PAC-3: $\mathbf{33_A}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short-Term Exposure: Hexyl trichlorosilane can affect you when breathed in. Hexyl trichlorosilane is a corrosive chemical and can cause severe skin and eye burns leading to permanent eye damage. Exposure can severely irritate the respiratory tract causing coughing and/or shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: Highly irritating substances can cause lung irritation and bronchitis with cough, phlegm, and/or shortness of breath.

Points of Attack: Lungs.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to hexyl trichlorosilane exists, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: (1) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location.

(2) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from water and steam. Hexyl trichlorosilane can give off corrosive hydrogen chloride gas on contact with water, steam or moisture. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: UN1784 Hexyl trichlorosilane, Hazard class: 8; Labels: 8-Corrosive material.

Spill Handling:

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States EPA Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

Hexyl trichlorosilane when spilled in water

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.3/0.5
Night 0.9/1.5

Stay upwind and uphill. Isolate the area of release or fire and deny entry. Remove all ignition sources. Stop the release if it can be done safely from a distance. All equipment used to handle this material must be grounded. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. *Small spill*: Cover with *dry* earth, *dry* sand, or other noncombustible material followed with plastic sheet to minimize spreading or contact with water or rain. Use clean nonsparking tools to collect material and place material into loosely covered plastic containers for later disposal. Prevent material and runoff from entering sewers and waterways if it can be done safely well ahead of the release. Use vapor suppressing foam to disperse vapors−contain runoff. Water spray may reduce vapor, but may not prevent ignition in enclosed spaces. Ventilate confined area if it can be done without placing personnel at risk. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal EPA for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include hydrogen chloride and oxides if metal and carbon. *Do not use water, as poisonous and corrosive gases will be released. FOR CHLOROSILANES DO NOT USE WATER. USE AFFF ALCOHOL-RESISTANT, MEDIUM EXPANSION FOAM. Small fire*: use *dry* chemical, CO_2, *dry* sand, or alcohol-resistant foam. May react with foams releasing corrosive/toxic gases. *Large fire*: use water spray or alcohol-resistant foam if it is available in sufficient amounts. Under favorable conditions, experienced crews can use coordinated fog streams to sweep the flames off the surface of the burning liquid. Combustible material: may burn but does not ignite readily. Most vapors are heavier than air. They will spread along ground and collect in low or confined areas (sewers, basements, tanks). Vapors may travel to source of ignition and flash back. Containers may explode when heated or if contaminated with water. Keep exposures cool long after fire is out to protect against reignition. Do not direct straight streams into the liquid. Cool exposed containers with large quantities of water from unattended equipment or remove intact containers if it can be done safely. *Do not get water on spilled substance or inside containers.* If cooling streams are ineffective (*venting sound increases in volume and pitch, tank discolors or shows signs of deforming*), withdraw immediately to a secure location. Always stay away from ends of tanks, especially when engulfed in flames. If material or contaminated runoff from fire control enters waterways, notify downstream users of potentially contaminated water. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Hexyl Trichlorosilane, #1004, Trenton, NJ (April 1999).

Hydramethylnon H:0365

Formula: $C_{25}H_{24}F_6N_4$

Synonyms: AC-217300; AI3-29349; Amdro; Amidinohydrazone; Ant killer granular bait; Caswell No. 839A; Caswell No. 642AB; CL 217,300; Combat; Matox; Maxforce; 1,4-Pentadien-3-one-1,5-bis(α,α,α-trifluoro-*p*-tolyl)-tetrahydro-5,5-dimethyl-2(1*H*)-pyrimidinylidene)hydrazone; Pyrimidinone; 2(1*H*)-Pyrimidinone, tetrahydro-5,5-dimethyl-, [3-(4-(trifluoromethyl)phenyl]-1-[2-(4-(trifluoromethyl)phenyl] ethenyl-2-propenylidene]hydrazone; Roach gel sensible; Siege; Tetrahydro-5,5-dimethyl-2(1*H*)-

pyrimidinone[1,5-bis(α,α,α-trifluoro-*p*-tolyl)-1,4-pentadien-3-one]hydrazone; Tetrahydro-5,5-dimethyl-2(1*H*)-pyrimidinone[3-(4-(trifluoromethyl)phenyl)]-1-[2-(4-(trifluoromethyl) phenyl)ethenyl]-2-propenylidene] hydrazone; Wipeout

CAS Number: 67485-29-4

HSDB Number: 6673

RTECS Number: UW7583000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 405-090-9 [*Annex I Index No.:* 613-181-00-1]

Regulatory Authority and Advisory Information

Carcinogenicity[83]: EPA Group C, possible human carcinogen (2006)

California Proposition 65 Chemical[102]: Developmental/ Reproductive toxin (male) (3/5/1999)

Hazard Alert: Endocrine disruptor, Suspected reprotoxic hazard, Environmental hazard, Agricultural chemical.

EPCRA Section 313 Form R de minimis concentration reporting level: 1.0%

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292].

Hazard symbols, risk, & safety statements: Hazard symbol: T+, N; risk phrases: R40; R22; R29/35; R36; R48/25; R50/53; R62; R63; safety phrases: S1/2; S22; S36/37; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Dark yellow to tan crystalline solid, granules, or powder. Commercial products are available in various forms. Characteristic vegetable oil odor. Molecular weight = 494.475; specific gravity (H_2O:1) = 1.68 @ 25°C; freezing/melting point = 190°C; vapor pressure = 2.3×10^{-8} mmHg; flash point = 94°C (cc); Henry's Law constant = 2.20×10^{-6} atm m^3/mol @ 25°C (est)[83]. Practically insoluble in water; solubility = 0.005 mg/L @ 25°C. Physical and toxicological properties may be affected by carrier solvents in commercial formulations.

Potential Exposure: Hydramethylnon is a slow-acting organofluorine insecticide used primarily to control ants in grasses and on rangelands, as well as on other noncrop lands such as lawns, turf, and nonbearing nursery stock. Hydramethylnon is also registered for the control of household ant species and cockroaches in nonfood use areas in and around domestic dwellings and commercial establishments. Hydramethylnon has established tolerances from use on grasses in pastures and rangeland; however hydramethylnon is almost completely metabolized within the body of ruminants and there are no detectable residues in meat, milk, or meat-by-products. Therefore, tolerances are not required for these commodities even though hydramethylnon is considered a food-use pesticide for the purposes of reregistration and tolerance reassessment.

Determination in Water: Octanol−water coefficient: Log K_{ow} = < 2.5. Unlikely to bioaccumulate in marine organisms. Fish toxicity (threshold)[101]: High—8.90567 ppb, MATC (Maximum Acceptable Toxicant Concentration).

Harmful Effects and Symptoms

Short-Term Exposure: Contact with eyes or skin may cause irritation or injury. Inhalation should be avoided; use NIOSH- or CEN (UK)-approved air purifying respirators for pesticides. Toxic if inhaled, ingested, or absorbed through the skin. LD_{50} (oral, rat) = 1200 mg/kg; LD_{50} (dermal, rabbit) = > 5 g/kg.

Long-Term Exposure: A male reproductive toxin. Fluorides may cause bone disease (pain and tenderness of the bones); mottled teeth in children. Human toxicity (long term)[101]: Extra high—0.21 ppb, Health Advisory.

Points of Attack: Testes, reproductive system, bones.

Medical Surveillance: This chemical is a suspected or known human carcinogen. Exposed persons should contact a physician for advice regarding the possible long term health effects and advice for medical monitoring. Comprehensive physical examination with emphasis on the genito-urinary tract including testicle size and consistency in males. Semen analysis to include sperm count, motility and morphology. Other tests, such as serum testosterone, serum FSH, and serum LH may be carried out if, in the opinion of a physician, they are indicated.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Do not induce vomiting when formulations containing petroleum solvents are ingested.

Personal Protective Methods: Applicators and other handlers must wear: Coveralls worn over long-sleeved shirt and long pants; Chemical-resistant gloves such as DuPont Tychem suit fabrics, barrier laminate, or Viton; Chemical-resistant footwear plus socks; Protective eye wear (minimum EN 166 or equivalent); Chemical-resistant headgear for overhead exposure; Chemical-resistant apron when cleaning equipment, mixing, or loading[83]. Agricultural Use/ Engineering Controls: When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the Worker Protection Standard (WPS) for agricultural pesticides, 40 CFR 170.240(d)(4-6), the handler PPE requirements may be reduced or modified as specified in the Worker Protection Standard. Firefighters should wear NIOSH approved SCBA and full protective clothing.

Respirator Selection: *At concentrations above the NIOSH REL, or where there is no REL, at any detectable* *concentration:* SCBAF:Pd,Pp (APF = 10,000): (any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus). *Escape*: GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison. Store in a secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: First remove all sources of ignition. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Ventilate area of spill or leak. Use water spray to reduce vapor. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal EPA for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include hydrogen fluoride, fluorine and oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; or alcohol-resistant foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: It is the responsibility of chemical waste generators to determine the toxicity and physical properties and of a discarded chemical and to properly identify its classification and certification as a hazardous waste and to determine the disposal method. United States EPA guidelines for the classification determination are listed in 40 CFR Parts 261.3. Additionally, waste generators must consult and follow all regional, national, state and local hazardous waste laws to ensure complete and accurate classification and disposal methods.

References

(102); (31); (173); (101); (138); (100).

United States Environmental Protection Agency, "Reregistration Eligibility Decision (RED), Hydramethylnon," Office of Prevention, Pesticides and Toxic Substances, Washington, DC (December 1998). http://www.epa.gov/REDs/2585red.pdf.

Hydrazine H:0370

Formula: H_4N_2; ($H_2N\text{-}NH_2$); $N_2H_4.H_2O$ (hydrate)

Synonyms: Amerzine; Diamide; Diamine; Diamine, hydrazine base; Hidrazina (Spanish); Hydrazine base; Levoxine; Mannitol mustard; Oxytreat 35; SCAV-OX; SCAV-OX 35%; SCAV-OX II; Ultra Pure

CAS Registry Number: 302-01-2 (anhydrous); 7803-57-8 (hydrate)

HSDB Number: 544

RTECS Number: MU7175000

UN/NA & ERG Number: UN2029 (anhydrous or with>64% hydrazine, by mass)/132; UN3293 (with not >37% hydrazine, by mass)/152; UN2030 (hydrate or with not <37% but not > 64% hydrazine, by mass)/153

EC Number: 206-114-9 [*Annex I Index No.:* 007-008-00-3]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): 10,000

Carcinogenicity: IARC: Animal Sufficient Evidence, Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B 1999; NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies; NIOSH: Potential occupational carcinogen. United States EPA Gene-Tox Program, Positive: Carcinogenicity-mouse/rat; Inconclusive: D *melanogaster* sex-linked lethal.

California Proposition 65 Chemical[102]: Cancer 1/1/1988

Hazard Alert: Exposure can be lethal, Flammable liquid, Pyrophoric [air reactive (anhydrous)], Powerful reducing agent, Corrosive (tissue), Sensitization hazard, Possible risk of forming tumors, Reproductive toxin: possible risk of gene damage/impaired fertility; Suspected reprotoxic hazard, Environmental hazard. Removed from 5/22/2014 list of endocrine dispruptors[88]

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 15,000 lb (6810 kg)

United States EPA Hazardous Waste Number (RCRA No.): U133

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

SUPERFUND/EPCRA 302, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg)

EPCRA Section 313 Form R de minimis concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%. Hazardous to aquatic life or environment, with possible long-lasting effects[291,292].

European/International Regulations (*302-01-2*): Hazard symbol: T+, F+, N, Xi; risk phrases: R45; R12; R23/24/25; R34; R43; R50/53; R61; R62; R63; safety phrases: S1; S29/35; S41; S45; S53; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water. (*hydrazine and hydrate*)

Description: Hydrazine is a colorless, oily liquid. Ammoniacal odor. The hydrate is a 64% solution in water. Molecular weight = 32.05; specific gravity (H_2O:1) = 1.01 @ 20°C; boiling point = 119°C; freezing/melting point = −51.7°C; relative vapor density (air = 1) = 1.1; vapor pressure = 14.4 mmHg @ 25°C; flash point = 38°C (cc); autoignition temperature = from 24°C (on a rusty iron surface) to 270°C (on a glass surfaces). Explosive limits: LEL = 2.9%; UEL: 98%[17]. Hazard Identification (based on NFPA-704 M Rating System) (*anhydrous*): Health 4, flammability 4, reactivity 3. Soluble in water; hygroscopic. *Hydrate:* Molecular weight = 50.08; specific gravity (H_2O:1) = 1.03 @ 20°C; boiling point = 113.6°C; freezing/melting point = 1.5°C.

Potential Exposure: Because of its strong reducing capabilities, hydrazine is used as an intermediate in chemical synthesis, and in photography and metallurgy. It is also used as a rocket fuel; in the preparation of anticorrosives; textile agents; pesticides; and as a scavenging agent for oxygen in boiler water. Hydrazine is widely used in pharmaceutical synthesis.

Incompatibilities: Vapor may form explosive mixture with air. A highly reactive reducing agent and a medium strong base. May ignite *spontaneously* on contact with oxidizers or porous materials, such as earth, rust, wood and cloth. Air or oxygen is not required for decomposition. Oxidizers, hydrogen peroxide; nitric acid; metallic oxides; acids, halogens can cause fire and explosions. Attacks cork, glass, some plastics; rubber and coatings. The aqueous solution is highly alkaline; keep away from acids.

Permissible Exposure Limits in Air

NIOSH IDLH = 50 ppm

Odor Threshold = 3.7 ppm

Conversion factor: 1 ppm = 1.31 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 1 ppm/1.3 milligram per cubic meter TWA [skin]

NIOSH REL: 0.03 ppm/0.04 milligram per cubic meter [120-minutes] Ceiling Concentration; A potential occupational carcinogen. Limit exposure to lowest feasible concentration, See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV[1]: 0.01 ppm/0.013 milligram per cubic meter [skin]; confirmed animal carcinogen with unknown relevance to humans PAC* Ver. 29[138]

302-01-2, anhydrous

PAC-1: 0.10 ppm

PAC-2: $\mathbf{13}_{\mathbf{A}}$ ppm

PAC-3: $\mathbf{35}_{\mathbf{A}}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

7803-57-8, hydrate

PAC-1: 0.16 ppm

PAC-2: 20 ppm

PAC-3: 55 ppm

DFG MAK; [skin] danger of skin sensitization; Carcinogen Category 2; TRK: [skin]; danger of skin sensitization; Sampling time: end of exposure or end-of-shift; 380 μg [creatinine]/L urine hydrazine; 340 μg/L plasma hydrazine.

Australia: TWA 0.1 ppm (0.1 milligram per cubic meter) [skin], carcinogen, 1993; Austria: [skin], carcinogen, 1999; Denmark: TWA 0.1 ppm (0.13 milligram per cubic meter) [skin], 1999; Finland: TWA 0.1 ppm; STEL 0.3 ppm [skin], carcinogen, 1999; Japan: 0.01 ppm (0.013 milligram per cubic meter) [skin], 1999; Norway: TWA 0.1 ppm (0.13 milligram per cubic meter), 1999; the Philippines: TWA 1 ppm (1.3 milligram per cubic meter) [skin], 1993; Poland: MAC (TWA) 0.05 milligram per cubic meter, MAC (STEL) 0.1 milligram per cubic meter, 1999; Russia: STEL 0.1 milligram per cubic meter [skin], 1993; Sweden: NGV 0.1 ppm, KTV 0.3 ppm [skin], carcinogen, 1999; Switzerland: MAK-W 0.1 ppm (0.13 milligram per cubic meter) [skin], carcinogen, 1999; Turkey: TWA 1 ppm (1.3 milligram per cubic meter) [skin], 1993; United Kingdom: TWA 0.03 milligram per cubic meter; STEL 0.13 milligram per cubic meter [skin], carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: confirmed animal carcinogen with unknown relevance to humans. The Czech Republic:[35] MAC 0.05 milligram per cubic meter. Several states have set guidelines or standards for hydrazine in ambient air[60] ranging from zero (North Carolina and North Dakota) to 0.003 μ/m^3 (Rhode Island) to 0.018 milligram per cubic meter (Massachusetts) to 0.24 μ/m^3 (Pennsylvania) to 0.33 μ/m^3 (New York) to 0.5 μ/m^3 (South Carolina) to 1.0 μ/m^3 (Connecticut, Florida and Virginia) to 2.0 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method #3503 for hydrazine[18]; OSHA Analytical Method 20 or 108[58].

Permissible Concentration in Water: EPA[32] has suggested a permissible ambient goal of 18 μg/L based on health effects. Russia[35,43] set a MAC in water bodies used for domestic purposes of 0.01 mg/L (10 μg/L).

Determination in Water: Octanol−water coefficient: $\text{Log}\,K_{\text{ow}} = -3.1$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, skin absorption; ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Hydrazine is corrosive to the eyes, skin, and respiratory tract. Inhalation of the vapors can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. May affect the liver, kidneys, and central nervous system. Exposure may result in death. The effects may be delayed. Signs and symptoms of acute exposure to hydrazine may include severe eye irritation; facial numbness; facial swelling; and increased salivation. Hydrazine vapor may immediately irritate the nose and throat. Headache, twitching, seizures, convulsions, and coma may also occur. Gastrointestinal signs and symptoms include anorexia, nausea, and vomiting. Pulmonary edema and hypotension (low blood pressure) are common. Hydrazine is toxic to the liver, ruptures red blood cells, and may cause kidney damage. Dermal contact may result in irritation or severe burns. Target organs affected include central nervous system; respiratory system; skin and eyes. Chronic exposure in humans may cause pneumonia, liver and kidney damage. Liver damage may be more severe than kidney damage. It is a suspected human carcinogen.

Long-Term Exposure: Repeated or prolonged contact may cause sensitization and skin allergy. Hydrazine may affect the liver, kidneys, and central nervous system. A probable carcinogen in humans. Can irritate the lungs and may cause bronchitis. Can damage the nervous system causing weakness, shaking, and loss of balance and coordination. Exposure can cause blood damage and may cause anemia.

Points of Attack: Eyes, skin, respiratory system; central nervous system; liver, kidneys. Cancer site in animals: tumors of the lungs, liver, blood vessels and intestine.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. NIOSH lists the following tests: chest X-ray; pulmonary function tests: forced vital capacity, forced expiratory volume (1 second). For those with frequent or potentially high exposure (half the TLV or greater, or significant skin contact), the following are recommended before beginning work and at regular times after that: CBC. Liver and kidney function tests. Lung function tests. Exam of the nervous system. If symptoms develop or overexposure is suspected, the following may also be useful: consider chest X-ray after acute overexposure. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Note to Physician: Consider pyridoxine (25 mg/kg), which has been shown to be an effective anticonvulsant for hydrazine poisoning.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. nitrile, Silvershield, PVC, Neoprene, and butyl rubber are among the recommended protective material. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd, Pp:ASCBA (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* SCBAE (any appropriate escape-type, SCBA).

Storage: (1) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location; keep acids away from bases and red, yellow, and blue-coded chemicals. (2) Color code—Red Stripe (*hydrazine and hydrazine hydrate*): Flammability Hazard: Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Flammable liquid: Store in a fireproof location. Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where hydrazine may be present, check to make sure that an explosive concentration does not exist. Hydrazine must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates and nitrates); strong acids (such as hydrochloric, sulfuric and nitric); hydrogen peroxide and metal oxides; since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where hydrazine is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever hydrazine is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2029 Hydrazine, anhydrous or hydrazine aqueous solutions with >64% hydrazine, by mass, Hazard class: 8; Labels: 8-Corrosive material, 3-Flammable liquid, 6.1-Poisonous materia. UN2030 Hydrazine hydrate or hydrazine aqueous solutions, with not <37% but not> 64% hydrazine, by mass, Hazard class: 8; Labels: 8-Corrosive material, 6.1-Poisonous material.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Stay up wind; keep out of low areas. In case of contact with material, immediately flush skin or eyes with running water for at least 15 minutes. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal EPA for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include ammonia fumes and oxides of nitrogen and carbon. *Small fires:* dry chemical, carbon dioxide; water spray or foam. *Large fires:* water spray, fog, or foam. Stay upwind; keep out of low areas. Wear positive pressure breathing apparatus and protective clothing. Isolate for one-half mile in all directions if tank car or truck is involved in fire. Move container from fire area if you can do so without risk. Dike fire control water for later disposal, do not scatter material. Spray cooling water on containers that are exposed to flames until well after fire is out. It is a flammable/combustible material and may be ignited by heat, sparks, or flames. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Controlled incineration with facilities for effluent scrubbing to abate any nitrogen compounds formed in the combustion process[22]. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(109); (102); (31); (173); (101); (138); (170); (100).

National Institute for Occupational Safety and Health (NIOSH), *Criteria for a Recommended. Standard: Occupational Exposure to Hydrazines, NIOSH Document Number 78-172*, Cincinnati, OH (1978).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 1, No. 1, 45−46 (1981) and 3. No. 4, 65−68 (1983).

United States Environmental Protection Agency, Chemical Hazard Information Profile: *Hydrazine*, Washington, DC, Chemical Emergency Preparedness Program (Nov. 30, 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Hydrazine*, Trenton, NJ (May 2001).

Hydrazine Sulphate H:0380

Formula: $H_4N_2 \cdot H_2O_4S$
Synonyms: HS; Hydrazine hydrogen; Hydrazine monosulfate; Hydrazine sulphate; Hydrazinium sulfate; Hydrazonium sulfate; NSC-150014
CAS Registry Number: 10034-93-2; *(alt)* 1184-66-3
HSDB Number: 5086
RTECS Number: MV9625000
UN/NA & ERG Number: UN2923/154; UN3260 (Corrosive solid, acidic, inorganic, n.o.s.)/154
EC Number: 233-110-4

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen California Proposition 65 Chemical[102]: Cancer 1/1/1988.

Hazard Alert: Combustible solid, Poison, Corrosive, Strong reducing agent. Possible risk of forming tumors, Suspected of causing genetic defects, Environmental hazard, Drug.

United States National Primary Drinking Water Regulations: SMCL = 250 mg[SO_4^{-2}]/L as sulphate

EPCRA Section 313 Form R de minimis concentration reporting level: 0.1%.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292].

Hazard symbols, risk, & safety statements: Hazard symbol: T, N, Xi; risk phrases: R45; R23/24/25; R50/53; R61; R62; safety phrases: S29/35; S45; S53; S60; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Hydrazine sulfate is a white or colorless, crystalline powder. Molecular weight = 130.1; specific gravity (H_2O:1) = 1.4 @ 20°C; freezing/melting point = 254°C (decomposition). Hazard Identification (based on NFPA-704 M Rating System): Health 3, flammability 1, reactivity 1. Soluble in water.

Potential Exposure: Used in analysis and refining of minerals, rare metals; determination of arsenic in metals, as a catalyst and antioxidant; and in fungicides, germicides and blood tests. Used as a catalyst for making acetate fibers.

Incompatibilities: Aqueous hydrazine sulfate is acidic. It is a strong reducing agent. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

NIOSH REL: [for hydrazines] 0.03 ppm/0.04 milligram per cubic meter 2-hour Ceiling Concentration

PAC Ver. 29[138]
PAC-1: 0.5 milligram per cubic meter
PAC-2: 25 milligram per cubic meter
PAC-3: 120 milligram per cubic meter

Determination in Air: Use OSHA Analytical Method #20 or NIOSH Analytical Method #3503, Hydrazine.

Routes of Entry: Inhalation, skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Highly corrosive. Irritates and burns the eyes, skin, and respiratory tract. Exposure can affect the brain and nervous system; causing dizziness and lightheadedness at first, followed by trembling and convulsions. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours.

Long-Term Exposure: Hydrazine sulfate has been shown to cause liver and lung cancers in animals. Exposure can damage the liver and kidneys. Repeated exposure can damage blood cells, causing a low blood count (anemia). It can also cause methemoglobinemia with fatigue, shortness of breath; and even a bluish color to the nose, finger tips and lips. May cause skin allergy to develop.

Points of Attack: Liver, kidneys, blood, central nervous system; skin.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Liver and kidney function tests. CBC. Examination of the nervous system. Blood methemoglobin level. Evaluation by a qualified allergist.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy. *Note to Physician:* Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine. Pyridoxine (25 mg/kg) is an effective anticonvulsant for hydrazine poisoning.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable

probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Based on potential carcinogenicity the following is recommended by NIOSH: *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved SCBA that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: (1) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. (2) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, bases.

Shipping: UN3260 Corrosive solid, acidic, inorganic, n.o.s., Hazard class: 8; Labels: 8-Corrosive material, Technical Name Required. UN2923 Corrosive solids, toxic, n.o.s., Hazard class: 8; Labels: 8-Corrosive material, 6.1-Poisonous material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal EPA for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include oxides of nitrogen and sulfur. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(109); (102); (31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Hydrazine Sulfate, Trenton, NJ (May 2001).

Hydrazoic Acid H:0390

Formula: HN_3

Synonyms: Azoimide; Diazoimide; Hydrogen azide; Hydronitric acid; Stickstoffwasserstoffsaeure (German); Triazoic acid

CAS Registry Number: 7782-79-8

HSDB Number: 7858

RTECS Number: MW2800000

UN/NA & ERG Number: UN0473 (Explosive)/112

EC Number: 231-965-8

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Highly toxic gas; Unstable, sensitive explosive when dry. *Note*: Must be handled by an expert.

Canada, WHMIS, Ingredients Disclosure List Concentration 1%.

Hazard symbols, risk, & safety statements: Hazard symbol: E, T+; risk phrases: R1; R2; R26/27/28; R44; safety phrases: S41 (see Appendix 4)

Description: The pure and concentrated material is highly unstable and potentially explosive. This material should be handled only by experts. Hydrazoic acid is a colorless, volatile liquid. Intolerable, pungent odor. Molecular weight = 43.03; boiling point = 37°C; freezing/melting point = −80°C. Highly soluble in water.

Potential Exposure: May be used in organic synthesis. Used in making heavy metal azide detonators for explosives. Requires expert handling.

Incompatibilities: Explosive when concentrated, dry or pure. A highly sensitive explosive hazard when subject to shock/impact, exposed to heat, friction, oxidizers. Very dangerous above the boiling point (37°C/98.6°F). Forms unstable and possibly explosive, heavy metal azide compounds with heavy metals. Forms explosive salts with carbon disulfide. Violent reaction with, cadmium, copper, nickel, nitric acid; fluorine.

Permissible Exposure Limits in Air
No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.
DFG MAK: 0.1 ppm/0.18 milligram per cubic meter TWA; Peak Limitation Category I(2)

Routes of Entry: Inhalation, ingestion, skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritating to skin, eyes and respiratory tract. The odor may cause violent headaches in some people. Continued inhalation causes, cough, headache, dizziness, weakness, fall in blood pressure; chills and fever and collapse. Prolonged exposure to high concentration can cause fatal convulsions and death. Highly toxic. LD_{LO} (rat, inhalation) = 1100 ppm/1H.

Long-Term Exposure: Chronic exposure can affect the central nervous system; hypotension, palpitation, ataxia, and weakness.

Points of Attack: Central nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: *Unstable and unpredictable explosive material.* Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from incompatible materials listed above. Protect from heat and shock.

Shipping: UN0473 Substances, explosive, n.o.s., Hazard Class: 1.1A; Labels: 1.1A-Explosive (with a mass explosion hazard); A-Substances which are expected to mass detonate very soon after fire reaches them, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal EPA for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a dangerously explosive material and highly poisonous. Thermal decomposition products may include oxides of nitrogen. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: May be destroyed by converting hydrazoic acid to sodium azide and the reaction mixture decomposed with nitrous acid (National Research Council, 1983).

References

(31); (173); (101); (138).

United States Government Printing Office, Supt. of Documents, (PHRPA6) Public Health Reports, V.1-1878-Volume(issue)/page: 58,607, Washington, DC 1943.

Hydriodic Acid H:0395

Formula: HI
Synonyms: Hydriodic acid solution; Hydrogen iodide
CAS Registry Number: 10034-85-2
HSDB Number: 2155 as hydrogen iodide
RTECS Number: MW3760000
UN/NA & ERG Number: UN1787 (solution)/154; UN2197 (anhydrous)/125
EC Number: 233-109-9 [*Annex I Index No.:* 053-002-00-9]

Regulatory Authority and Advisory Information

Hazard Alert: Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated.

List 1, DEA chemical code 6695 (Title 21 CFR1310.02)

Hazard symbols, risk, & safety statements: Hazard symbol: C; risk phrases: R5; R21; R35; safety phrases: S1/2; S9; S26; S33; S36/37/39; S38; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Theft hazard* 500 (≥95.33% concentration)

Description: Hydriodic acid is colorless when freshly made but rapidly turns yellowish or brown on exposure to light or air. Aqueous solution of hydrogen iodide, which is a gas (anhydrous) at room temperature. Molecular weight = 127.91; specific gravity (H_2O:1) = 5.7 @ 20°C; boiling point = −35.4°C; freezing/melting point = −51°C; vapor pressure = 5940 mmHg @ 25°C; Relative vapor density (air = 1) = 4.42. Hazard identification (based on NFPA-704 M Rating System) (*50% solution*): Health 3, flammability 0, reactivity 1. Soluble in water.

Potential Exposure: Hydriodic acid is used as a disinfectant, analytical reagent; raw material for pharmaceuticals and to make iodine salts.

Incompatibilities: Contact with water forms toxic and corrosive fumes. A strong reducing agent. Violent actions with strong acids; chemically active metals; magnesium, phosphorus, perchloric acid; strong oxidizers. Explodes on contact with ethyl hydroperoxide. Protect from moisture, heat and shock.

Permissible Exposure Limits in Air

As iodides

ACGIH TLV[1]: 0.01 ppm/0.1 milligram per cubic meter, inhalable fraction and vapor, TWA

PAC* Ver. 29[138]
PAC-1: $\mathbf{1.0}_\mathbf{A}$ ppm
PAC-2: $\mathbf{25}_\mathbf{A}$ ppm
PAC-3: $\mathbf{120}_\mathbf{A}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minutes values.

Routes of Entry: Inhalation, ingestion, skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Corrosive to skin, eyes and mucous membranes. Skin or eye contact can cause severe burns and permanent damage. Inhalation causes, cough, headache, fall in blood pressure, chills and fever and collapse; irritation of the nose and throat and can cause spasms of the windpipe which can be fatal. High concentration can cause fatal convulsions. A Japanese source[24] states that HI is painful at 0.15−0.2 ppm; intolerable at 0.3 ppm.

Long-Term Exposure: Chronic exposure can cause injury to kidneys and spleen; hypotension, palpitation, ataxia and weakness. Very irritating substances may cause lung damage. Prolonged absorption of iodides can cause skin rash, headache, irritation of mucous membranes with running nose.

Points of Attack: Lungs, kidneys.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: lung function tests, chest X-ray following acute overexposure, kidney function tests.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to hydriodic acid exists, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Check oxygen content prior to entering storage area. UN2197 Poisonous gas: (1) Color code—Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. (2) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. UN1787 (2) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. (3) Color code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Hydriodic acid must be stored to avoid contact with strong acids (such as hydrochloric, sulfuric and nitric); chemically active metals (such as potassium, sodium, magnesium and zinc), and strong oxidizers (such as chlorine, bromine and fluorine), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat and moisture. Protect storage containers from physical damage. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: UN1787 Hydriodic acid, Hazard Class: 8; Labels: 8-Corrosive material. UN2197 Hydrogen iodide, anhydrous Hazard Class: 2.3; Labels: 2.3-Poisonous gas, 8-Corrosive material, Inhalation Hazard Zone C. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling:

Initial isolation and protective action distances: UN2197 Hydrogen iodide

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States EPA Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.2/0.3

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 500/150
Then: Protect persons downwind (mi/km)
Day 0.6/0.9
Night 1.7/2.7

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Neutralize with chemically basic substances, such as sodium bicarbonate, soda ash; or slaked lime. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal EPA for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include iodine. Use water on fires in which hydriodic acid is involved. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Add slowly to a large amount of soda ash and slaked lime in solution with stirring. Flush resulting solution to a sewer[24].

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Hydriodic Acid, Trenton, NJ (June 2001).

Hydrogen H:0400

Formula: H_2

Synonyms: Hidrogeno (Spanish); Para Hydrogen; Hydrogen, compressed; Hydrogen, refrigerated liquid; Liquid hydrogen

CAS Registry Number: 1333-74-0
HSDB Number: 5026
RTECS Number: MW8900000
UN/NA & ERG Number: UN1049 (Hydrogen, compressed)/115; UN1966 (Hydrogen, refrigerated liquid)/115
EC Number: 215-605-7 [*Annex I Index No.:* 001-001-00-9]
Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Hazard Alert: Highly Reactive Substance and Explosive, Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated,

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg).

Hazard symbols, risk, & safety statements: Hazard symbol: F+; risk phrases: R5; R12; R21; safety phrases: S1; S9; S16; S33; S38 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): Non hazard to water.

Description: Hydrogen is a highly flammable, colorless liquid or gas. Molecular weight = 2.02; specific gravity (H_2O:1) = 0.07 @ −253°C; boiling point = −253°C; vapor pressure = −259.2 mmHg @ 25°C; vapor pressure = 1.24×10^6 mmHg @ 25°C; Autoignition temperature: 500−571°C. Explosive limits: LEL = 4.0%; UEL: 75%. Hazard identification (based on NFPA-704 M Rating System): Health 0, flammability 4, reactivity 0. Slightly soluble in water.

Potential Exposure: Hydrogen is used as a fuel in weeding, as a raw material for ammonia manufacture and in organic hydrogenation reactions.

Incompatibilities: Vapors may form explosive or combustible mixture with air over a wide range of concentrations. Heating may cause violent reaction, combustion or explosion. Ignites easily with oxygen. Violent reaction with strong oxidizers, halogens, acetylene, bromine, chlorine, fluorine, nitrous oxide and other gases; metal catalysts e.g., platinum and nickel) greatly enhance these reactions. Mild steel and most iron alloys become brittle at liquid hydrogen temperatures.

Permissible Exposure Limits in Air

ACGIH TLV[1]: simple asphyxiant Note: The health effects caused by exposure to hydrogen are much less serious than its fire and explosion risk.

PAC Ver. 29[138]
PAC-1: 65,000 ppm
PAC-2: 230,000 (2.30E + 05) ppm
PAC-3: 400,000 (4.00E + 05) ppm

Hydrogen is classed as a simple asphyxiant. Large amounts of hydrogen will decrease the amount of available oxygen. Oxygen content should be tested to ensure that it is at least 19% by volume in confined spaces.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short-Term Exposure: Exposure to high levels can cause suffocation from lack of oxygen. Contact with liquid hydrogen can cause severe burns and frostbite.

Medical Surveillance: There are not special tests.

First Aid: *Contact With Liquid Hydrogen:* Put affected part into warm water. Seek medical attention. *Breathing:* Remove the person from exposure. Begin (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility.

Personal Protective Methods: *Clothing:* Where exposure to cold equipment, vapors, or liquid may occur, employees should be provided with special clothing designed to prevent the freezing of body tissues. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. *Eye Protection:* Wear splash-proof chemical goggles and face shield when working with liquid, unless full facepiece respiratory protection is worn.

Respirator Selection: Exposure to hydrogen is dangerous because it can replace oxygen and lead to suffocation. Only NIOSH/MSHA or European Standard EN 149-approved SCBA with a full facepiece operated in positive-pressure mode should be used in oxygen deficient environments.

Storage: Check oxygen content prior to entering storage area. Flammable gas. Color code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Hydrogen must be stored to avoid contact with heat, flames, sparks, and oxygen. Sources of ignition, such as smoking and open flames are prohibited where hydrogen is used, handled, or stored. Metal containers involving the transfer of 5 gal or more of hydrogen should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of hydrogen. Wherever hydrogen is used, handled, manufactured or stored, use explosion-proof electrical equipment and fittings. Piping should be electrically bonded and grounded. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: UN1049 Hydrogen, compressed, Hazard Class: 2.1; Labels: 2.1-Flammable gas; UN1966 Hydrogen, refrigerated liquid (cryogenic liquid) Hazard Class: 2.1; Labels: 2.1-Flammable gas. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: If hydrogen gas is leaked, take the following steps: Restrict persons not wearing protective equipment from area of leak until clean-up is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Stop flow of gas. If source of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. If liquid hydrogen is spilled or leaked, take the following steps: Restrict persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Stop the leak or move the container to a safe area and allow the liquid to evaporate. Keep hydrogen out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations.

Fire Extinguishing: If spill has not ignited, use water spray to direct flammable gas-air mixtures away from sources of ignition. If it is desirable to evaporate a spill quickly, water spray may be used to increase the rate of evaporation, if the increased vapor evolution can be controlled. Do not discharge solid streams into liquid. Because of danger of reignition, hydrogen fires normally should not be extinguished until the supply of hydrogen has been shut off. If liquid hydrogen has ignited, use water to keep fire-exposed containers cool and to protect workers stopping the source of a spill. If it is necessary to extinguish small hydrogen fires, use dry chemical, carbon dioxide; or halogenated extinguishing agent. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Combustion.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Hydrogen, Trenton, NJ (August 2002)

Hydrogenated Terphenyls H:0410

Formula: $(C_6H_n)_3$; $C_6H_{11}-C_6H_4-C_6H_5$

Synonyms: Hydrogenated diphenylbenzenes; Hydrogenated phenylbiphenyls; Hydrogenated triphenyls

CAS Registry Number: 61788-32-7

HSDB Number: 2537 as M-terphenyl (92-06-8, $C_{18}H_{14}$)

RTECS Number: WZ6535000

EC Number: 262-967-7

Regulatory Authority and Advisory Information.

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Hydrogenated terphenyls, are a complex mixture of partially hydrogenated terphenyl isomers. They are clear, oily, pale-yellow liquids with a faint odor. Molecular weight = 241.00; 298.00 (40% hydrogenated); specific gravity (H_2O:1) = 1.01; boiling point = 340°C (40% hydrogenated); freezing/melting point = 148°C (40% hydrogenated); vapor pressure = 13 Pa @ 25°C; flash point = 157°C (cc); autoignition temperature = 374°C. Insoluble in water.

Potential Exposure: These materials are used as high temperature heat transfer media and as plasticizers.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. When heated, irritating vapors will be released.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 12.19 milligram per cubic meter (40% hydrogenated) @ 25°C & 1 atm.

OSHA PEL: None

NIOSH REL: 0.5 ppm/5 milligram per cubic meter TWA

ACGIH TLV[1]: 0.5 ppm/4.9 milligram per cubic meter (nonirradiated) TWA PAC Ver. 29[138]

PAC-1: 1.5 ppm

PAC-2: 47 ppm

PAC-3: 280 ppm

Australia: TWA 0.5 ppm (5 milligram per cubic meter), 1993; Belgium: TWA 0.5 ppm (4.9 milligram per cubic meter), 1993; Denmark: TWA 0.4 ppm (4.4 milligram per cubic meter), 1999; France: VME 0.5 ppm (5 milligram per cubic meter), 1999; Russia: STEL 5 milligram per cubic meter, 1993; Switzerland: MAK-W 0.5 ppm (5 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 5 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 0.5 ppm. States which have set guidelines or standards for hydrogenated terphenyls in ambient air include Virginia @ 80.0 μ/m^3, Connecticut @ 100.0 μ/m^3, and Nevada @ 119.0 μ/m^3[60].

Determination in Air: No method available.

Routes of Entry: Dermal contact, inhalation, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates eyes, skin, respiratory system. Potential acute hazards consist of damage to the lungs and damage to the skin and eyes from burns from the hot coolant.

Long-Term Exposure: Potential chronic hazards comprise damage to liver, kidney and blood-forming organs with the possibility of induction of metabolic disorders and cancer[53].

Points of Attack: Eyes, skin, respiratory system; liver, kidneys, hemato system. Slightly toxic.

Medical Surveillance: Liver and kidney function tests. CBC. Lung function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/ manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Green: General storage may be used. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal EPA for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Irritating vapors. Use dry chemical, carbon dioxide; or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

Hydrogen Bromide H:0420

Formula: HBr

Synonyms: Acide bromhydrique (French); Anhydrous hydrobromic acid; Bromwasserstoff (German); HBr; Hydrobromic acid; Hydrobromic acid, anhydrous; Hydrogen bromide, anhydrous

CAS Registry Number: 10035-10-6

HSDB Number: 570

RTECS Number: MW3850000

UN/NA & ERG Number: (PIH) UN1048 (anhydrous)/125; UN1788 (hydrobromic acid solution)/154

EC Number: 233-113-0 [*Annex I Index No.*: 035-002-00-0]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Theft hazard* 500 (≥95.33% concentration).

Hazard Alert: Poison inhalation hazard: exposure can be lethal, Corrosive gas, Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated.

OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 5000 lb (2270 kg)

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, C; risk phrases: R5; R21; R35; R37; safety phrases: S1/2; S7/9; S26; S33; S38; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Hydrogen bromide is a corrosive colorless gas. Sharp, irritating odor. Shipped as a liquefied compressed gas. Often used in an aqueous solution. The odor threshold is 2−6.6 ppm. Molecular weight = 80.92; specific gravity (H_2O:1) = 3.5 @ 20°C; boiling point = −67°C (anhydrous); freezing/melting point = −87°C (anhydrous); relative vapor density (air = 1) = 2.81; vapor pressure = 760 mmHg @ −67°C. Soluble in water; solubility = 49%. A constant boiling dihydrate melts at −11°C and boils @ 126°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, flammability 0, reactivity 2.

Potential Exposure: Hydrogen bromide gas and its aqueous solutions are used in the manufacture of organic and inorganic bromides; as a reducing agent and catalyst in controlled oxidations; in the alkylation of aromatic compounds; and in the isomerization of conjugated diolefins. It is used as an intermediates for pharmaceuticals; dyes, photographic chemicals

Incompatibilities: The aqueous solution is a strong acid. Violent reaction with strong oxidizers, strong caustics; and many organic compounds, causing fire and explosion hazard. Reacts with water, forming toxic hydrobromic acid. Incompatible with aliphatic amines, alkanolamines, alkylene oxides; aromatic amines; amides, ammonia, ammonium hydroxide; calcium oxide; epichlorohydrin, fluorine, isocyanates, oleum, organic anhydrides; sulfuric acid; sodium tetrahydroborate; vinyl acetate. Hydrobromic acid is highly corrosive to most metals forming flammable hydrogen.

Permissible Exposure Limits in Air

NIOSH IDLH = 30 ppm

Conversion factor: 1 ppm = 3.31 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 3 ppm/10 milligram per cubic meter TWA

NIOSH REL: 3 ppm/10 milligram per cubic meter Ceiling Concentration

ACGIH TLV[1]: 2 ppm/6.8 milligram per cubic meter TWA Ceiling Concentration (2001).

PAC* Ver. 29[138]

PAC-1: $\mathbf{1.0_A}$ ppm

PAC-2: $\mathbf{40_A}$ ppm

PAC-3: $\mathbf{120_A}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minutes values.

DFG MAK: 2 ppm/6.7 milligram per cubic meter TWA; Peak Limitation value I(1); Pregnancy Risk Group D Australia: TWA 3 ppm (10 milligram per cubic meter), 1993; Austria: MAK 3 ppm (10 milligram per cubic meter), 1999; Belgium: STEL 3 ppm (9.9 milligram per cubic meter), 1993; Denmark: TWA 3 ppm (10 milligram per cubic meter), 1999; Finland: STEL 3 ppm (10 milligram per cubic meter) [skin] 1999; Norway: TWA 3 ppm (10 milligram per cubic meter), 1999; the Philippines: TWA 3 ppm (10 milligram per cubic meter), 1993; Poland: MAC (TWA) 7 milligram per cubic meter, MAC (STEL) 21 milligram per cubic meter, 1999; Russia: STEL 2 milligram per cubic meter, 1993; Switzerland: MAK-W 3 ppm (10 milligram per cubic meter), KZG-W 6 ppm (20 milligram per cubic meter), 1999; Turkey: TWA 5 ppm (17 milligram per cubic meter), 1993; United Kingdom: STEL 3 ppm (10 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Ceiling Concentration 3 ppm. Several states have set guidelines or standards for hydrogen bromide in ambient air[60] ranging from 80.0 μ/m^3 (Virginia) to 100.0 μ/m^3 (North Dakota) to 200.0 μ/m^3 (Connecticut and New York) to 238.0 μ/m^3 (Nevada).

Determination in Air: Collection using Si gel; workup with $NaHCO_3/Na_2CO_3$; Analysis by ion chromatography; NIOSH (IV), Method #7903, Inorganic Acids; OSHA Analytical Method ID-165SG.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Hydrogen bromide is a corrosive chemical and contact can severely burn the eyes, with permanent damage. It can cause severe burns of the skin. Exposure can irritate the eyes, nose, throat and lungs. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. Contact with liquid can cause frostbite.

Long-Term Exposure: Long-term exposure can irritate the lungs and cause a chronic discharge. Bronchitis may develop with cough, phlegm, and/or shortness of breath. It may damage the sense of smell. Long-term exposure can also cause chronic indigestion and may damage the nervous system. Repeated skin contact can cause an acne-like rash to develop.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Serum bromine level. Exam of the nervous system.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear eye protection to prevent any possibility of eye contact. Wear splash-proof chemical goggles and face shield when working with the liquid unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *30 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprAg (APF = 25) [any powered, air-purifying respirator with acid gas cartridge(s)]; or GmFAg (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFAg (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance causes eye irritation or damage; eye protection needed.

Storage: Check oxygen content prior to entering storage area. Poisonous corrosive gas. (1) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. (2) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. (3) Color code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. This gas is toxic and/or corrosive, nonflammable. Outside or detached storage is preferred in an area that is roofed, shaded with the cylinders stored off the ground on nonwooden floors, and away from radiant heat sources and all possible sources of ignition. If indoors or outdoors, store in a well-ventilated noncombustible location temperatures not to exceed 50°C. Automatic monitoring systems are also preferred. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Hydrogen bromide must be stored to avoid contact with strong oxidizers, caustics, metals and moisture, because violent reactions occur. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169 with the recommendations of the Compressed Gas Association.

Shipping: UN1048 Hydrogen bromide, anhydrous, Hazard Class: 2.3; Labels: 2.3-Poisonous gas, 8-Corrosive material, Inhalation Hazard Zone C. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner. UN1788 Hydrobromic acid, with >49% hydrobromic acid or Hydrobromic acid, with not >49% hydrobromic acid, Hazard class: 8; Labels: 8-Corrosive material.

Spill Handling:

Hydrogen bromide, anhydrous

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States EPA Environmental Response Team at (908) 548-8730 (24-hour response line).

UN1048:

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.2/0.3

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 600/180
Then: Protect persons downwind (mi/km)

Day 0.8/1.2
Night 2.4/3.8

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Ventilate area of leak to disperse the gas. Stop flow of gas. If source of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal EPA for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Hydrogen bromide is noncombustible. Reacts with water to produce toxic hydrobromic acid. Fight surrounding fire with an agent appropriate for surrounding fire. Thermal decomposition products may include bromine and hydrogen bromide. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Soda ash/slaked lime is added to give a neutral bromide solution which is discharged to sewers or streams with water dilution.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Bromine and Bromine Compounds, Washington, DC (November 1, 1976).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Hydrogen Bromide, Trenton, NJ (April 1999).

Hydrogen Chloride H:0430

Formula: HCl

Synonyms: Acide chlorhydrique (French); Anhydrous hydrochloric acid; Aqueous hydrogen chloride; Chlorohydric acid; Chlorwasserstoff (German); HCl; Hydrochloric acid; Hydrochloric acid, anhydrous; Hydrochloride; Hydrogen chloride; Muriatic acid; Spirits of salt

CAS Registry Number: 7647-01-0

HSDB Number: 545

RTECS Number: MW9610000; MW4025000

UN/NA & ERG Number: UN1050 (anhydrous)/125; UN1789 (solution)/157; UN2186 (refrigerated liquid)/125

EC Number: 231-595-7 [*Annex I Index No.:* 017-002-00-2]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 5000 (≥1.00% concentration). (1.00% concentration); *Theft hazard* 500 (commercial grade) (*anhydrous*); *Release hazard* 15,000 (≥37.00% concentration) (h*ydrochloric acid*)

Carcinogenicity: IARC: Animal Inadequate Data; Human Inadequate Data, *not classifiable as carcinogenic to humans*, Group 3, 1992.

Hazard Alert: Poison inhalation hazard (gas or liquid), Corrosive, Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated, Known catalytic activity (gas).

List II, DEA chemical code 6545 (Title 21 CFR1310.02) Hydrochloric acid (including anhydrous hydrogen chloride)

United States National Primary Drinking Water Regulations: SMCL = 250 mg[Cl^-]/L as Chloride

Toxic Substance (World Bank)[13]

OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 5000 lb (2270 kg)

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 5000 lb (2270 kg)

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 5000 lb (2270 kg)

EPCRA Section 313 Form R de minimis concentration reporting level: 1.0%. *Note:* Nonaerosol forms of hydrochloric acid have been deleted from EPCRA/SARA 313 reporting, 7/29/96 (FR vol. 61, No. 146, p. 39356-39357)

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, C; risk phrases: R5; R21; R23; R35; safety phrases: S1/2; S9; S26; S33; S36/37/39; S38; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Hydrogen chloride is a colorless to slightly yellow refrigerated gas or fuming liquid with a pungent, irritating odor. May be shipped and stored as a cryogenic liquid. The aqueous solution is known as hydrochloric acid or muriatic acid and may contain as much as 38% HCl. Shipped as a liquefied compressed gas. The odor threshold is 0.77 ppm. Molecular weight = 36.46; specific gravity (H_2O:1) = 1.49 @ 20°C; boiling point = −85°C; freezing/melting point = −114.2°C; relative vapor density (air = 1) = 1.27; vapor pressure = 750 mmHg @ −85°C.

Hazard Identification (based on NFPA-704 M Rating System) (*40%*): Health 3, flammability 0, reactivity 2; (refrigerated gas) Health 3, flammability 0, reactivity 1. Highly corrosive. Soluble in water; solubility = 67% @ 30°C.

Potential Exposure: Hydrogen chloride itself is used in the manufacture of pharmaceutical hydrochlorides, chlorine, vinyl chloride from acetylene; alkyl chlorides from olefins; arsenic trichloride from arsenic trioxide; in the chlorination of rubber; as a gaseous flux for babbitting operations; and in organic synthesis involving isomerization, polymerization, alkylation, and nitration reactions. The acid is used in the production of fertilizers, dyes, dyestuffs, artificial silk, and paint pigments; in refining edible oils and fats; in electroplating; leather tanning; ore refining; soap refining; petroleum extraction; pickling of metals; and in the photographic, textile, and rubber industries. It has been used as a choking/pulmonary agent.

Incompatibilities: The aqueous solution is a strong acid. Corrosive fumes emitted on contact with air. Reacts violently with bases, oxidizers forming toxic chlorine gas. Reacts, often violently, with acetic anhydride, active metals; aliphatic amines; alkanolamines, alkylene oxides; aromatic amines; amides, 2-aminoethanol, ammonia, ammonium hydroxide; calcium phosphide; chlorosulfonic acid; ethylene diamine; ethyleneimine, epichlorohydrin, isocyanates, metal acetylides, oleum, organic anhydrides; perchloric acid, 3-propiolactone, uranium phosphide; sulfuric acid; vinyl acetate; vinylidene fluoride. Highly corrosive to most metals, forming flammable hydrogen gas. Attacks some plastics, rubber and coatings.

Permissible Exposure Limits in Air

NIOSH IDLH = 50 ppm

Conversion factor: 1 ppm = 1.49 milligram per cubic meter @ 25°C & 1 atm

Odor Threshold = 0.77 ppm.

OSHA PEL: 5 ppm/7 milligram per cubic meter Ceiling Concentration NIOSH REL: 5 ppm/7 milligram per cubic meter Ceiling Concentration

ACGIH TLV[1]: 2 ppm/2.98 milligram per cubic meter Ceiling Concentration; not classifiable as a human carcinogen PAC* Ver. 29[138]

PAC-1: **1.8**$_{\mathbf{A}}$ ppm

PAC-2: **22**$_{\mathbf{A}}$ ppm

PAC-3: **100**$_{\mathbf{A}}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

DFG MAK: 2 ppm/3 milligram per cubic meter; Peak Limitation Category I(2); Pregnancy Risk Group C

Several states have set guidelines or standards for HCl in ambient air[60] ranging from 10 μ/m^3 (Massachusetts) to 70 μ/m^3 (North Dakota) to 120 μ/m^3 (Virginia) to 140 μ/m^3 (New York and South Dakota) to 167 μ/m^3 (Nevada) to 175 μ/m^3 (South Carolina) to 600−2000 μ/m^3 (Rhode Island) to 700 μ/m^3 (North Carolina).

Determination in Air: Use NIOSH (IV), Method #7903, Inorganic Acids; OSHA Analytical Method ID-165SG.

Routes of Entry: Inhalation of gas or mist, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Signs and symptoms of acute ingestion of hydrogen chloride may be severe and include salivation, intense thirst; difficulty in swallowing; chills; pain, and shock. Oral, esophageal, and stomach burns are common. Vomitus generally has a coffee-ground appearance. The potential for circulatory collapse is high following ingestion of hydrogen chloride. Acute inhalation exposure of hydrogen chloride may result in sneezing, hoarseness, choking, laryngitis, and respiratory tract irritation. Bleeding of nose and gums, ulceration of the nasal and oral mucosa; bronchitis, pneumonia, dyspnea (shortness of breath), chest pain; and pulmonary edema may also occur. If the eyes have come in contact with hydrogen chloride, irritation, pain, swelling, corneal erosion; and blindness may result. Dermal exposure may result in dermatitis (red, inflamed skin), severe burns, and pain.

Short-Term Exposure: HCl is corrosive to the eyes, skin, and respiratory tract. Inhalation of high concentrations of vapors can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. May cause inflammation and destruction of the nasal passages, dental erosion; loss of voice; coughing, pneumonia, headaches and rapid throbbing of the heart. May cause death in the range of 1000−2000 ppm. Skin contact can cause irritation or burns of the skin. Eye contact may cause irritation and severe damage to the surface of the eye, severe burns and loss of sight. Contact with the liquid may cause frostbite. Ingestion may cause irritation of mouth, throat and stomach; salivation, nausea, vomiting, chills and fever; holes in the intestinal tract; inflammation of the kidneys; and shock.

Long-Term Exposure: Irritates the lungs, causing chronic bronchitis. May cause irritation and skin rash. Long term exposure to low levels (greater than 5 ppm) of hydrogen chloride can cause some dental erosion. Aside from such dental erosions, no significant abnormalities have been associated with long term low level exposures. There is limited evidence that workers involved in the manufacturing of hydrogen chloride have an increase of respiratory cancers.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: NIOSH lists the following tests: chest X-ray; pulmonary function tests: forced vital capacity, forced expiratory volume (1 second). For those with frequent or potentially high exposure (half the TLV or greater) the following are recommended before beginning work and at regular times after that. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Decontamination: This is very important, and you have to decontaminate as soon as you can. The gas is very soluble in water, forming hydrochloric acid. Since the more concentrated the acid, the more dangerous it is; consequently, the acid must be diluted it as much as possible. Decontamination must be started quickly before it has time to do much damage. Extra minutes before decontamination can make a big difference. Although hydrogen chloride is a gas, the victim can't spread the agent to others. But, if the victim is wet, or the victim's clothes are wet, hydrochloric acid may be spread to others outside the hot and warm zones. So, wash a victim thoroughly so that he can't spread the acid to others. If you don't have the equipment and training, don't enter the hot zone to rescue and decontaminate victims. If the victim can't move, decontaminate without touching and without entering the hot zone. Use clean water from any source; if possible, use a hose (spray or fog to prevent injury to the victim) or other system so that you won't have to touch the victim; don't even wait for soap or for the victim to remove clothing, begin washing immediately. Immediately flush the eyes with water for at least 15 minutes. Wash–strip–wash–evacuate up wind and uphill: The approach is to immediately wash with water, then have the victim (not the first responder) remove all the victim's clothing, then wash again (with soap if available); and subsequently move away from the hot zone in an upwind and uphill direction. *Don't use household bleach or other bleach products* to decontaminate the victim. Wash the victim with warm water and soap. After decontamination, treat the acid burns as you would with burns from a fire. Decontaminate with water or with soap and water. Be sure you've decontaminated the victims as much as you can before they leave the area. If you get any of the acid on yourself, decontaminate immediately. Even if you think you are not contaminated, be sure to thoroughly shower and change clothes as soon as you can following the incident.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear eye protection to prevent any possibility of eye contact. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *50 ppm:* CcrS* (APF = 10) (any NIOSH/MSHA or European Standard EN 149-approved chemical cartridge respirator with cartridge(s) providing protection against the compound of concern); or GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern]; or PaprS* (APF = 25) [any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern]; or Sa* (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFAg (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

*Note**: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Check oxygen content prior to entering storage area. Poisonous corrosive gas. (1) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. (2) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. This gas is toxic and/or corrosive, nonflammable. Outside or detached storage is preferred in an area that is roofed, shaded with the cylinders stored off the ground on nonwooden floors, and away from radiant heat sources and all possible sources of ignition. If indoors or outdoors, store in a well-ventilated noncombustible location temperatures not to exceed 50°C. Automatic monitoring systems are also preferred. Hydrogen chloride must be stored to avoid contact with any alkali or active metals (such as potassium, sodium, and zinc), because violent reactions occur. Store in tightly closed containers in cool, well-ventilated area away from heat. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169 with the recommendations of the Compressed Gas Association.

Shipping: UN1050 Hydrogen chloride, anhydrous Hazard Class: 2.3; Labels: 2.3-Poisonous gas, 8-Corrosive material, Inhalation Hazard Zone C.UN2186; Hydrogen chloride, refrigerated liquid, Hazard Class: 2.3; Labels: 2.3-Poisonous gas, 8-Corrosive material, Inhalation Hazard Zone C. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling:

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States EPA

UN1050 Hydrogen chloride, anhydrous

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30

Then: Protect persons downwind (mi/km)

Day 0.1/0.2

Night 0.2/0.3

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 200/60

Then: Protect persons downwind (mi/km)

Day 0.2/0.3

Night 0.8/1.2

Anhydrous (gas): If hydrogen chloride gas is leaked, take the following steps: Restrict persons not wearing protective equipment from area of leak until clean-up is complete. Ventilate area of leak to disperse the gas. Stop flow of gas. If source of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. If hydrogen chloride solution is spilled or leaked, take the following steps: Restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Collect material in a convenient manner and deposit in sealed containers. If necessary, dilute and/or neutralize the material before collection. It may be necessary to contain and dispose of hydrogen chloride as a hazardous waste. Contact the NJ Department of Environmental Protection (DEP) of the federal EPA for specific recommendations.

***Attention:** If dealing with a large spill from the following containers: See "*ERG* Table 3*: Initial Isolation and Protective Action Distances for Different Quantities of Six Common Toxic-by-Inhalation Gases.*" This specialized chart shows isolation protective distances for the transport containers listed above (numbers 1 through 4) and various wind conditions: Low wind (<6 mph); Moderate wind (6 to 12 mph); High wind (>12 mph). (1) Rail tank car, (2) Highway tank truck or trailer, (3) Multiple ton cylinders or (4) Multiple small cylinders or single ton cylinder.

UN2186 Hydrogen chloride, refrigerated liquid

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30

Then: Protect persons downwind (mi/km)

Day 0.1/0.2

Night 0.2/0.3

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 1000/300

Then: Protect persons downwind (mi/km)

Day 1.3/2.0

Night 4.7/7.5

Refrigerated liquid: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal EPA for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. (The material itself does not burn, but contact with metals evolve flammable hydrogen gas which will increase the chance of explosion.) Thermal decomposition products may include chlorine and hydrogen chloride. Use extinguishers suitable for surrounding fires other than water. Contact with water will produce heat and hydrochloric acid. If water is used, it must be used in flooding quantities. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. Do not apply water to cryogenic liquid containers. If cryogenic liquid containers are exposed to direct flame or elevated temperatures for prolonged periods, with draw to a secure location. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Soda ash-slaked lime is added to form the neutral solution of chloride of sodium and calcium. This solution can be discharged after dilution with water[22]. Alternatively, hydrogen chloride can be recovered from a variety of process waste streams.

References

(31); (173); (101); (138); (85); (80); (100).

National institute for Occupational Safety and Health (NIOSH), Information Profiles on Potential Occupational Hazards: Hydrogen Chloride (Gas), pp 23–28, Report PB-276, 678, Rockville, Maryland (1977).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 1, No. 7, 62–65 (1981).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Hydrogen Chloride, Washington, DC, Chemical Emergency Preparedness Program (Nov. 30, 1987).

New York State Department of Health, Chemical Fact Sheet: Hydrogen Chloride, Bureau of Toxic Substance Assessment, Albany, NY (March 1986).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Hydrogen Chloride, Trenton, NJ (June 2001).

Hydrogen Cyanide (Agent AC) H:0440

Formula: CHN; HCN

Synonyms: AC (military designation); Acide cyanhydrique (French); Aero liquid HCN; Blausaeure (German); Cyanwasserstoff (German); Cyclon; CycloneB; Formonitrile; HCN; Hydrocyanic acid; Prussic acid; Zaclon Discoids

CAS Registry Number: 74-90-8

HSDB Number: 165

RTECS Number: MW6825000

UN/NA & ERG Number: (PIH) UN1051 (anhydrous, stabilized)/117 (P); UN1613 (less than 20% solution)/154; UN1614 (stabilized with <3% water and absorbed in a porous inert material)/152

EC Number: 200-821-6 [*Annex I Index No.:* 006-006-00-X]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Theft hazard* 15 (≥4.67% concentration)

OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 1000 lb (454 kg)

Banned of Severely Restricted (Belgium, E. Germany, Philippines) (UN)[13]

Hazard Alert: Poison inhalation hazard: exposure can be lethal, Systemic agent, High acute toxicity-gas with inadequate warning properties., Extremely flammable, Polymerization hazard (unstablilzed), Environmental hazard.

United States National Primary Drinking Water Regulations: MCLG = 0.2 mg[CN^-]/L; MCL = 0.2 mg [CN^-]/L as cyanide

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 2500 lb (1135 kg)

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P063

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) SUPERFUND/EPCRA 302, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg)

EPCRA Section 313 Form R de minimis concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. Hazardous to aquatic life or environment, with possible long-lasting effects[291,292].

Hazard symbols, risk, & safety statements: Hazard symbol: F+, T+, N; R12; R19; R26; R50/53; safety phrases: S1/2; S7/9; S16; S26; S29/35; S36/37/S38; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Hydrogen cyanide (AC) is a volatile, colorless or pale-blue liquid; or a colorless gas. AC gas has a distinctive bitter almond odor (others describe a musty "old sneakers smell"), but a large proportion of people cannot detect it; the odor does not provide adequate warning of hazardous concentrations. It also has a bitter burning taste and is often used as a solution in water. The odor threshold is 0.58 ppm. Odor is *not* a reliable indicator of toxic amounts of vapor. Often used as a 96% solution in water. It is intensely poisonous, highly flammable, and explosive. Molecular weight = 27.03; specific gravity (H_2O:1) = 0.69 (liquid) @ 20°C; boiling point = 26°C (96%); freezing/melting point = −13.3°C (96%); vapor pressure = 750 mmHg @ 25.4°C; flash point = −17.8°C (cc) (96%); autoignition temperature = 537.8°C (96%). Explosive limits: LEL = 5.6%; UEL: 40.0%[17]. Hazard Identification (based on NFPA-704 M Rating System): Health 4, flammability 4, reactivity 2. Soluble in water.

Potential Exposure: Hydrogen cyanide is used in chemical synthesis of sequestrants, polymers, weed killers, and pharmaceuticals; as a fumagant; in electroplating, mining, chemical synthesis, and the production of synthetic fibers, plastics, dyes, and pesticides; in chemical synthesis of acrylates and nitriles, particularly acrylonitrile. It may be generated in blast furnaces, gas works, and coke ovens. Cyanide salts have a wide variety of uses, including steel hardening; gold and silver extraction from ores. AC is used as a chemical warfare agent (blood agent); systemic agent. It forms cyanide in the body.

Incompatibilities: Unless stabilized and maintained, samples stored more than 90 days are hazardous. Dangerous boiling point range. The gas can form an explosive mixture with air. Material containing more than 2%−5% water are less stable than dry material and can be self-reactive, forming an explosive mixture with air. Heat above 50 to 60°C or contact with heat, water, alkaline material, amines, or strong bases can cause polymerization. The aqueous solution is a weak acid. Violent reaction with oxidizers, acetaldehyde, acids, hydrogen chloride in alcoholic mixtures; sodium carbonate; caustic substances, causing fire and explosion hazard. Incompatible with amines, strong acids; sodium hydroxide; calcium hydroxide; sodium carbonate; ammonia. Attacks some plastics, rubber and coatings.

Permissible Exposure Limits in Air

NIOSH IDLH = 50 ppm

Conversion factor: 1 ppm = 1.10 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 10 ppm/11 milligram per cubic meter TWA [skin]

NIOSH REL: 4.7 ppm/5 milligram per cubic meter STEL [skin]

ACGIH TLV[1]: 4.7 ppm/5 mg[CN]/m^3 Ceiling Concentration [skin]

PAC AC 74-90-8*, Ver. 29[138]

PAC-1: **2**$_{\mathbf{A}}$ ppm

PAC-2: **7.1**$_{\mathbf{A}}$ ppm

PAC-3: **15**$_{\mathbf{A}}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

Emergency Response Planning Guidelines

ERPG-1: inappropriate

ERPG-2: 10 ppm

ERPG-3: 25 ppm

DFG MAK: 1.9 ppm/2.1 milligram per cubic meter TWA; Peak Limitation Category II(2) [skin]; Pregnancy Risk Group C

Arab Republic of Egypt: TWA 10 ppm (10 milligram per cubic meter), 1993; Australia: TWA 10 ppm (10 milligram per cubic meter) [skin], 1993; Austria: MAK 10 ppm (11 milligram per cubic meter) [skin], 1999; Denmark: TWA 5 ppm (5 milligram per cubic meter) [skin], 1999; Finland: STEL 10 ppm (11 milligram per cubic meter) [skin], 1999; France: VME 2 ppm (2 milligram per cubic meter), VLE 10 ppm (10 milligram per cubic meter), 1999; Hungary: TWA 0.3 milligram per cubic meter; STEL 0.6 milligram per cubic meter [skin], 1993; the Netherlands: MAC 11 milligram per cubic meter [skin], 2003; Norway: TWA 5 ppm (5 milligram per cubic meter), 1999; the Philippines: TWA 10 ppm (11 milligram per cubic meter) [skin], 1993; Poland: MAC (TWA) 0.3 milligram per cubic meter, ceiling 10 milligram per cubic meter, 1999; Russia: TWA 10 ppm; STEL 0.3 milligram per cubic meter, 1993; Sweden: ceiling 5 milligram per cubic meter [skin], 1999; Switzerland: MAK-W 10 ppm (11 milligram per cubic meter), KZG-W 20 ppm (22 milligram per cubic meter) [skin], 1999; Thailand: TWA 10 ppm (11 milligram per cubic meter), 1993; Turkey: TWA 10 ppm (11 milligram per cubic meter) [skin], 1993; United Kingdom: STEL 10 ppm (11 milligram per cubic meter) [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Ceiling Concentration 4.7 ppm[CN] [skin]. Several states have set guidelines or standards for hydrogen cyanide in ambient air[60] ranging from 33 μ/m^3 (New York) to 80 μ/m^3 (Virginia) to 100 μ/m^3 (North Dakota) to 220 μ/m^3 (Connecticut) to 238 μ/m^3 (Nevada) to 250 μ/m^3 (South Carolina) to 120−1000 μ/m^3 (North Carolina). The Czech Republic: MAC 0.3 milligram per cubic meter. In ambient air in residential areas, Russia set a MAC of 0.01 mg/m on a daily average basis. In ambient air in residential areas, the Czech Republic[35] has set 0.008 milligram per cubic meter on both a momentary and daily average basis.

Determination in Air: Use NIOSH (IV), Method #6010; #6017. Also use NIOSH Analytical Method #7904 Cyanides (aerosol and gas).

Permissible Concentration in Water: A USPHS drinking water criterion for alternate source selection is 100 μg/L[32].

Determination in Water: Octanol−water coefficient: Log K_{ow} = −0.25. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation of vapor; percutaneous absorption of liquid and concentrated vapor; ingestion and eye and skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Hydrogen cyanide can irritate the and burn the skin and eyes. Inhalation can irritate the respiratory tract. Lacrimation (tearing) and a burning sensation of the mouth and throat are common. Can cause dizziness, headache, weakness, anxiety, confusion, pounding heart; difficult breathing and nausea. These can rapidly lead to convulsions and death unless exposure is immediately stopped and proper first aid applied. High exposure can cause sudden death. Signs and symptoms of acute exposure to hydrocyanic acid may include hypertension (high blood pressure) and tachycardia (rapid heart rate), followed by hypotension (low blood pressure) and bradycardia (slow heart rate). Cherry red mucous membranes and blood may be noted. Cardiac arrhythmias and other cardiac abnormalities are common. Cyanosis (blue tint to the skin and mucous membranes) may be observed. Weakness, headache, vertigo (dizziness), agitation, giddiness, salivation, nausea, and vomiting; may be followed by combative behavior, convulsions, paralysis, protruding eyeballs; dilated and unreactive pupils; and coma. Tachypnea (rapid, shallow respirations) or hyperpnea (rapid, deep respirations) may be followed by respiratory depression. Lung hemorrhage and pulmonary edema may also occur. *Inhalation:* At less than 20 ppm, exposure to hydrogen cyanide may produce headache, dizziness, nausea and vomiting. Concentrations greater than 50 ppm may cause difficulty in breathing; rapid throbbing of the heart; paralysis, unconsciousness, respiratory arrest or death. 30 minutes exposure to 135 ppm may cause death. 270 ppm has caused immediate death. *Skin:* Hydrogen cyanide is readily absorbed through the skin. Symptoms are similar to above. *Eyes:* Hydrogen cyanide is irritating to the eye and rapidly absorbed. *Ingestion:* Symptoms are similar to above. Death has resulted from ingestion of 570 mg/kg of 1.4 oz for a 150 pound person.

Long-Term Exposure: Repeated exposure can interfere with thyroid function and can cause goiter. Itching scarlet rash, red bumps; severe nose itch leading to bleeding; and possibly holes in the nose; may result from long term exposure to hydrogen cyanide. Headache, nausea, vomiting, weakness and enlarged thyroid gland have also been reported at exposures from 4 to 12 ppm. May damage the nervous system.

Points of Attack: Central nervous system; cardiovascular system, thyroid, blood.

Medical Surveillance: NIOSH lists the following tests: whole blood (chemical/metabolite), lactic acid, pH (Hydrogen ion concentration), carboxyhemoglobin; blood plasma, bicarbonate, electrocardiogram, on workers over 40 years; expired air. Preplacement and periodic examinations should include the cardiovascular and central nervous systems, liver and kidney function, blood, history of fainting or dizzy spells. Blood cyanide test. Evaluation of thyroid function. Examination of the nervous system. Urinary thiocyanate levels have been used, but are nonspecific and are elevated in smokers.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation. Use amyl nitrate capsules if symptoms develop. All area employees should be trained regularly in emergency measures for cyanide poisoning and in CPR. A cyanide antidote kit should be kept in the immediate work area and must be rapidly available. Kit ingredients should be replaced every 1–2 years to ensure freshness. Persons trained in the use of this kit; oxygen use, and CPR must be quickly available.

Decontamination: This is very important, and you have to decontaminate as soon as you can. Extra minutes before decontamination might make a big difference. If you don't have the equipment and training, don't enter the hot zone to rescue and decontaminate victims. If the victim can't move, decontaminate without touching and without entering the hot zone. Use clean water from any source; if possible, use a hose (spray or fog to prevent injury to the victim) or other system so that you won't have to touch the victim; don't even wait for soap or for the victim to remove clothing, begin washing immediately. Immediately flush the eyes with water for at least 15 minutes. Wash–strip–wash–evacuate up wind and uphill: The approach is to immediately wash with water, then have the victim (not the first responder) remove all the victim's clothing, then wash again (with soap if available) and then move away from the hot zone in an upwind and uphill direction. Wash the victim with warm water and soap. Decontaminate with diluted household bleach (10%, or one part bleach to nine parts water), but don't let any get in the victim's eyes, open wounds, or mouth. Wash off the diluted bleach solution after 15 minutes. Be sure you've decontaminated the victims as much as you can before they leave the area so that they don't spread the agent. If you get some of the agent on yourself, decontaminate immediately. Even if you think you are not contaminated, be sure to thoroughly shower and change clothes as soon as you can after the incident. Use 5% solution of common bleach (sodium hypochlorite) or calcium hypochlorite solution (48 ounces per 5 gal of water) to decontaminate scissors used in clothing removal, and other items.

Personal Protective Methods:

General information: first responders should use a NIOSH-certified chemical, biological, radiological, nuclear (CBRN) SCBA with a level a protective suit when entering an area with an unknown contaminant or when entering an area where the concentration of the contaminant is unknown. Level a protection should be used until monitoring results confirm the contaminant and the concentration of the contaminant. *Note:* safe use of protective clothing and equipment requires specific skills developed through training and experience.

LEVEL A: (*RED ZONE*): select when the greatest level of skin, respiratory, and eye protection is required. This is the maximum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than the AEGL-2. A NIOSH-certified CBRN full-face-piece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle. A totally-encapsulating chemical protective (TECP) suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, and a hard hat worn under the TECP suit are optional items.

LEVEL B: (RED ZONE): Select when the highest level of respiratory protection is necessary but a lesser level of skin protection is required. This is the minimum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than AEGL-2. It differs from Level A in that it incorporates a nonencapsulating, splash-protective, chemical-resistant splash suit that provides Level A protection against liquids but is not airtight. A NIOSH-certified CBRN full-face-piece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL C: (YELLOW ZONE): Select when the contaminant and concentration of the contaminant are known and the respiratory protection criteria factors for using Air Purifying Respirators (APR) or Powered APR (PAPR) are met. This level is appropriate when decontaminating patient/victims. A NIOSH-certified CBRN tight-fitting APR with a canister-type gas mask or CBRN PAPR for air levels greater than AEGL-2. A NIOSH-certified CBRN PAPR with a loose-fitting face-piece, hood, or helmet and a filter or a combination organic vapor, acid gas, and particulate cartridge/filter combination or a continuous flow respirator for air levels greater than AEGL-1. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Escape mask, face shield, coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL D: (GREEN ZONE): Select when the contaminant and concentration of the contaminant are known and the concentration is below the appropriate occupational exposure limit or less than AEGL-1 for the stated duration times.

Limited to coveralls or other work clothes, boots, and gloves.

Notes: Take all necessary precautions to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear eye protection to prevent any possibility of eye contact. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See NIOSH Criteria Document 212 *Nitriles*.

Respirator Selection: When used as a weapon, use SCBA Respirator Certified By NIOSH For CBRN Environments. *47 ppm:* Sa (APF = 10) (any supplied-air respirator). *50 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern]; or SCBAE (any appropriate escape-type, SCBA).

Storage: (1) Color code—Blue: Health Hazard/Toxics/ Poisons: Store in a secure poison location. (2) Color code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from incompatible materials and conditions (see above). Store outdoors, if possible, or indoors in standard combustible liquid storage room or cabinet, away from sources of ignition. Protect containers against physical damage. Metal containers involving the transfer of this chemical should be grounded and bonded. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: PIH; check oxygen content prior to entering storage area. UN1051 Hydrogen cyanide, stabilized with <3% water, Hazard class: 6.1; Labels: 6.1-Poison Inhalation Hazard, 3-Flammable liquid, Inhalation Hazard Zone A; UN1614 Hydrogen cyanide, stabilized, with <3% water and absorbed in a porous inert material, Hazard class: 6.1; Labels: 6.1-Poisonous materials, Potential Inhalation Hazard (Special Provision 5) Military driver shall be given full and complete information regarding shipment and conditions in case of emergency. AR 50-6 deals specifically with the shipment of chemical agents. Shipments of agent will be escorted in accordance with AR 740-32.

Spill Handling:

Hydrogen cyanide

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States EPA Environmental Response Team at (908) 548-8730 (24-hour response line).

Hydrocyanic acid, aqueous solutions, with >20% Hydrogen cyanide; Hydrogen cyanide, anhydrous, stabilized; Hydrogen cyanide, stabilized

Small spills (From a small package or a small leak from a large package)
First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.4/0.6

Large spills (From a large package or from many small packages)
First: Isolate in all directions (ft/m) 1250/400
Then: Protect persons downwind (mi/km)
Day 0.9/1.5
Night 2.4/3.8

Hydrogen cyanide, stabilized, with <3% water and absorbed in a porous inert material

Small spills (From a small package or a small leak from a large package)
First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.4/0.6

Large spills (From a large package or from many small packages)
First: Isolate in all directions (ft/m) 500/150
Then: Protect persons downwind (mi/km)
Day 0.4/0.6
Night 1.1/1.8

AC, when used as a weapon

Small spills (From a small package or a small leak from a large package)
First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 0.6/1.0

Large spills (From a large package or from many small packages)
First: Isolate in all directions (ft/m) 3000/1000
Then: Protect persons downwind (mi/km)
Day 2.3/3.7
Night 5.3/8.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Stay upwind; keep out of low areas. Ventilate closed spaces before entering. Use water spray to reduce vapors. Do not touch spilled material; stop leak if you can do it without risk. Shut off ignition; no flares, smoking, or flames in hazard area. Isolate area until gas is dispersed. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal EPA for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include cyanide. If material is on fire and conditions permit, do not extinguish; combustion products are less toxic than the material itself. Cool exposures using unattended monitors. *Do not use water* directly on fire as cyanide gas may form. Use water to control vapors only. May react with itself without warning with explosive violence.

Gas: This chemical is a flammable gas. Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Wear positive pressure breathing apparatus and special protective clothing. Evacuate area endangered by gas. See isolation distance above if tank car or truck is involved in fire. Use dry chemicals, alcohol resistant (AFFF) foam, or carbon dioxide. Small fires; let burn unless leak can be stopped immediately. *Large fires:* water spray, fog or foam. Move container from fire area if you can do it without risk. Stay away from ends of tanks. Withdraw immediately in case of rising sound from venting safety device or any discoloration of tank due to fire. Cool container with water using unmanned device until well after fire is out. Isolate area until gas has dispersed. Firefighting should be done from a safe distance. A few whiffs of gas, or liquid penetrating firefighter's protective clothing, could be fatal. Only special protective clothing should be worn.

Liquid: This chemical is a flammable liquid. Use dry chemical, carbon dioxide; or alcohol resistant (AFFF) foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. Under favorable conditions, experienced crews can use coordinated fog streams to sweep the flames of the surface of the burning liquid. Do not direct straight streams into the liquid. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Chemical conversion to ammonia and carbon dioxide using chlorine or hypochlorite in a basic media. Controlled incineration is also adequate to totally destroy cyanide[22]. Alternatively, HCN can be recovered, from ammonoxidation process waste streams for example. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (173); (101); (138); (85). (2); (100).

National institute for Occupational Safety and Health (NIOSH), "Criteria for a Recommended Standard: Occupational Exposure to Hydrogen Cyanide", NIOSH Document Number 77-108, Cincinnati OH (1977).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Hydrocyanic Acid, Washington, DC, Chemical Emergency Preparedness Program (Nov. 30, 1987).

New York State Department of Health, *Chemical Fact Sheet:* Hydrogen Cyanide, Bureau of Toxic Substance Assessment, Albany, NY (Feb. 1986 and Version 3).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 6, 61−64 (1981).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Hydrogen Cyanide, Trenton, NJ (June 2006).

Hydrogen Fluoride H:0450

Formula: HF

Synonyms: Acido fluorhidrico (Spanish); Anhydrous hydrofluoric acid; Antisal 2B; C-P 8 solution; Doped poly etch; Fluorhydric acid; Fluoric acid; Fluoruro de hidrogeno (Spanish); Freckle etch; Hydrofluoric acid; Hydrofluoric acid gas; Hydrogen fluoride, anhydrous; Implanter fumer; KTI buffered oxide etch 50: 1; KTI buffered oxide etch 6: 1; KTI oxide etch 10: 1; KTI oxide etch 5: 1; KTI oxide etch 50: 1; Mae etchants; Mixed acid etch; Poly etch 95%; Rubigine; Silicon etch solution

CAS Registry Number: 7664-39-3

HSDB Number: 546

RTECS Number: MW7875000

UN/NA & ERG Number: UN1052 (anhydrous)/125; UN1790 (solution)/157

EC Number: 231-634-8 [*Annex I Index No.:* 009-002-00-6]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release Hazard* 1000 (≥50.00% concentration).

United States EPA Gene-Tox Program, Positive: D *melanogaster* sex-linked lethal.

Hazard Alert: Poison inhalation hazard (systemic agent). Exposure can be lethal, Corrosive, Dangerously water reactive, Air reactive, Suspected reprotoxic hazard, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction).

OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 1000 lb (454 kg)

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

United States EPA Hazardous Waste Number (RCRA No.): U134

SUPERFUND/EPCRA 302, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)

EPCRA Section 313 Form R de minimis concentration reporting level: 1.0%, *HF (concentration ≥ 50%)*

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); (conc. 50% or greater, or anhydrous) Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 1000 lb (454 kg)

United States National Primary Drinking Water Regulations: MCLG = 4 mg[F]/L; MCL = 4 mg[F]/L; SMCL = 2.0 mg[F]/L, as Fluoride.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

United States EPA Hazardous Waste Number (RCRA No.): U134

SUPERFUND/EPCRA 302, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)

EPCRA Section 313 Form R de minimis concentration reporting level: 1.0%.

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, C; risk phrases: R26/27/28; R34; R35; R62; safety phrases: S1/2; S7/9; S26; S36/37/39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Hydrogen fluoride is a colorless, fuming liquid below 19.4°C, or gas with a strong, irritating odor. Hydrogen fluoride mixes readily with water, forming hydrofluoric acid. Molecular weight = 20.01; specific gravity (H_2O:1) = 0.82 (liquid) @ 20°C; boiling point = 19.5°C; freezing/melting point = −83.4°C; vapor pressure = 750 mmHg @ 19.2°C. Hazard identification (based on NFPA-704 M Rating System): Health 4, flammability 0, reactivity 1₩. Highly soluble in water, forming hydrofluoric acid.

Potential Exposure: Hydrogen fluoride, its aqueous solution hydrofluoric acid, and its salts, are used in special metallurgical process; nuclear engineering; making organic and inorganic fluorine compounds, such as fluorides and plastics; as a catalyst, particularly in paraffin alkylation in the petroleum industry; as an insecticide; and to arrest the fermentation in brewing. It is utilized in the fluorination processes, especially in the aluminum industry; in separating uranium isotopes; in cleaning cast iron, copper, and brass; in removing efflorescence from brick and stone; in removing sand from metallic castings; in frosting and etching glass and enamel; in polishing crystal; in decomposing cellulose; in enameling and galvanizing iron; in working silk; in dye and analytical chemistry, and to increase the porosity of ceramics.

Incompatibilities: A super-strong acid; aqueous solutions are less strong. Reacts violently with bases. Reacts, possibly with violence, with many compounds including acetic anhydride, aliphatic amines; alcohols, alkanolamines, alkylene oxides; aromatic amines; amides, 2-aminoethanol, ammonia, ammonium hydroxide; arsenic trioxide; bismuthic acid; calcium oxide; ethylene diamine; ethyleneimine, epichlorohydrin, isocyanates, metal acetylides; nitrogen trifluoride; oleum, organic anhydrides; oxygen difluoride; phosphorous pentoxide; sulfuric acid; strong oxidizers; vinyl acetate; vinylidene fluoride. Attacks glass, concrete, ceramics, and other silicon-containing compounds. Attacks metals, some plastics, rubber and coatings.

Permissible Exposure Limits in Air

As fluorides

NIOSH IDLH = 30[F]ppm Odor threshold = 0.03 milligram per cubic meter.

OSHA PEL: 3 ppm/2.5 mg[F]/m^3 TWA

NIOSH REL: 3 ppm/2.5 mg[F]/m^3 TWA; 6 ppm/5 mg[F]/m^3 [15-minutes] Ceiling Concentration

ACGIH TLV[1]: 5ppm/0.41 mg[F]/m^3 TWA; 2 ppm/1.64 mg[F]/m^3 Ceiling Concentration; [skin]; not classifiable as a human carcinogen; BEI: 3 mg[F]/g creatinine in urine *prior* to end-of-shift; 10 mg[F]/g creatinine in urine end-of-shift

PAC HF*, Ver. 29[138]

PAC-1: $\mathbf{1.0_A}$ ppm

PAC-2: $\mathbf{24_A}$ ppm

PAC-3: $\mathbf{44_A}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

Emergency Response Planning Guidelines

ERPG-1: 2 ppm

ERPG-2: 20 ppm

ERPG-3: 50 ppm

DFG MAK: 1 ppm/0.83 mg[F]/m^3 [skin]; Peak Limitation Category I(2); Pregnancy Risk Group C; BAT: 7.0 mg[F]/g creatinine in urine at end-of-shift; 4.0 mg[F]/g creatinine in urine at the beginning of the next shift

Arab Republic of Egypt: TWA 2 ppm (2 milligram per cubic meter), 1993; Australia: TWA 3 ppm (2.5 milligram per cubic meter), 1993; Austria: MAK 3 ppm (2.5 milligram per cubic meter, 1999; Belgium: STEL 3 ppm (2.6 milligram per cubic meter), 1993; Denmark: TWA 2 ppm (1.6 milligram per cubic meter), 1999; Finland: ceiling 3 ppm [skin] 1999; France: VLE 3 ppm (2.5 milligram per cubic meter), 1999; Hungary: TWA 0.5 milligram per cubic meter; STEL 1 milligram per cubic meter, 1993; Japan: 3 ppm (2.5 milligram per cubic meter), 1999; Norway: TWA 0.8 ppm (0.6 milligram per cubic meter), 1999; the Philippines: TWA 3 ppm (2 milligram per cubic meter), 1993; Poland: MAC (TWA) 0.5 milligram per cubic meter, MAC (STEL) 4 milligram per cubic meter, 1999; Russia: TWA 3 ppm (0.1 milligram per cubic meter); STEL 0.5 milligram per cubic meter, 1993; Sweden: ceiling 2 ppm (1.7 milligram per cubic meter), 1999; Switzerland: MAK-W 1.8 ppm (1.5 milligram per cubic meter), KZG-W 3.6 ppm (3.0 milligram per cubic meter), 1999; Turkey: TWA 3 ppm (2 milligram per cubic meter), 1993; United Kingdom: STEL 3 ppm (2.5 mg[F]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Ceiling Concentration 3 ppm[F]. Several states have set guidelines or standards for hydrogen fluoride in ambient air[60] ranging from 3.4 μ/m^3 (Massachusetts) to 8.3 μ/m^3 (New York) to 20.0 μ/m^3 (Virginia) to 25.0 μ/m^3 (North Dakota and South Carolina) to 30.0 μ/m^3 (Rhode Island) to 50.0 μ/m^3 (Connecticut and South Dakota) to 60.0 μ/m^3 (Nevada) to 25.0−250.0 μ/m^3 (North Carolina) to 830.0 μ/m^3 (Kentucky).

Determination in Air: Use NIOSH Analytical Method #3800, #7902, #7903, #7906; OSHA Analytical Method ID-110.

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guidelines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg[F]/L. SafeDrinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg [F]/L; SMCL = 2 ***mg/F/L, as Fluoride***.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 0.23$. Unlikely to bioaccumulate in marine organisms.***Routes of Entry:*** Inhalation, skin absorption; ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Hydrogen fluoride is corrosive to the eyes, skin, and the respiratory tract. Eye burns may not be immediately painful. Inhalation of this gas can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. High levels of exposure can cause death. Acute exposure to hydrogen fluoride will result in irritation, burns, ulcerous lesions; and necrosis of the eyes, skin, and mucous membranes. Total destruction of the eyes is possible. Other effects include nausea, vomiting, diarrhea, pneumonitis (inflammation of the lungs), and circulatory collapse. Ingestion of an estimated 1.5 g produced sudden death without gross pathological damage. Repeated ingestion of small amounts resulted in moderately advanced hardening of the bones. Contact of skin with anhydrous liquid produces severe burns. Inhalation of anhydrous hydrogen fluoride or hydrogen fluoride mist or vapors can cause severe respiratory tract irritation that may be fatal. Hydrogen fluoride may induce hypocalcemia, causing cardiac and renal failure.

Long-Term Exposure: The substance may cause fluorosis. Can irritate the lungs and may cause bronchitis. Long-term exposure may damage the liver and kidneys.

Points of Attack: Eyes, skin, respiratory system; bones.

Medical Surveillance: NIOSH lists the following tests: Blood Gas Analysis; chest X-ray, electrocardiogram, pulmonary function tests: forced vital capacity, forced expiratory volume (1 second); pelvic X-ray; sputum cytology; urine (chemical/metabolite); urine (chemical/metabolite) pre- and postshift; urinalysis (routine); CBC/differential.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once (contact lenses *should not be worn* when working with HF) and irrigate immediately for at least 30 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and flush immediately with large amounts of water. Immerse exposed skin area in iced 70% ethyl alcohol. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods:

General information: first responders should use a NIOSH-certified CBRN SCBA with a level a protective suit when entering an area with an unknown contaminant or when entering an area where the concentration of the contaminant is unknown. Level a protection should be used until monitoring results confirm the contaminant and the concentration of the contaminant. *Note:* safe use of protective clothing and equipment requires specific skills developed through training and experience.

LEVEL A: (*RED ZONE*): select when the greatest level of skin, respiratory, and eye protection is required. This is the maximum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than the AEGL-2. A NIOSH-certified CBRN full-face-piece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle. A TECP suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, and a hard hat worn under the TECP suit are optional items.

LEVEL B: (RED ZONE): Select when the highest level of respiratory protection is necessary but a lesser level of skin protection is required. This is the minimum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than AEGL-2. It differs from Level A in that it incorporates a nonencapsulating, splash-protective, chemical-resistant splash suit that provides Level A protection against liquids but is not airtight. A NIOSH-certified CBRN full-face-piece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL C: (YELLOW ZONE): Select when the contaminant and concentration of the contaminant are known and the respiratory protection criteria factors for using APR or PAPR are met. This level is appropriate when decontaminating patient/victims. A NIOSH-certified CBRN tight-fitting APR with a canister-type gas mask or CBRN PAPR for air levels greater than AEGL-2. A NIOSH-certified CBRN PAPR with a loose-fitting face-piece, hood, or helmet and a filter or a combination organic vapor, acid gas, and particulate cartridge/filter combination or a continuous flow respirator for air levels greater than AEGL-1. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Escape mask, face shield, coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL D: (GREEN ZONE): Select when the contaminant and concentration of the contaminant are known and the concentration is below the appropriate occupational exposure limit or less than AEGL-1 for the stated duration times. Limited to coveralls or other work clothes, boots, and gloves.

Notes: Take all necessary precautions to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should *not* be worn when working with this chemical. Wear eye protection to prevent any possibility of eye contact. Employees should wash immediately flush with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *30 ppm:* CcrS (APF = 10)* [any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern]; or PaprS (APF = 25)* [any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern]; or GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern]; or SA* (any supplied-air respirator); or SCBA (any SCBA). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern]; or SCBAE (any appropriate escape-type, SCBA).

Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: PIH; check oxygen content prior to entering storage area. Corrosive, toxic gas. (1) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. (2) Color code—Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. This gas is toxic and/or corrosive, nonflammable. Outside or detached storage is preferred in an area that is roofed, shaded with the cylinders stored off the ground on nonwooden floors, and away from radiant heat sources and all possible sources of ignition. If indoors or outdoors, store in a well-ventilated noncombustible location temperatures not to exceed 50°C. Automatic monitoring systems are also preferred. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Hydrogen fluoride must be stored to avoid contact with metals, concrete, glass and ceramics, because it can severely corrode these materials. See also "Incompatibilities;" listed above. Contact with metals may evolve flammable hydrogen gas. Keep away from heat.

Shipping: UN1052 Hydrogen fluoride, anhydrous, Hazard class: 8; Labels: 8-Corrosive material, 6.1-Poisonous materials, Inhalation Hazard Zone C; UN1790 Hydrofluoric acid, with >60% strength & Hydrofluoric acid, with not >60% Hazard class: 8; Labels: 8-Corrosive material, 6.1-Poisonous materials.

Spill Handling:

Hydrogen fluoride, anhydrous

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States EPA Environmental Response Team at (908) 548-8730 (24-hour response line).

UN1052 Hydrogen fluoride, anhydrous

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.3/0.5

Large spills (From a large package or from many small packages)
First: Isolate in all directions (ft/m) 1000/300
Then: Protect persons downwind (mi/km)
Day 0.9/1.5
Night 2.0/3.2

*Attention:** If dealing with a large spill from the following containers: (1) Rail tank car, (2) Highway tank truck or trailer, (3) Multiple ton cylinders or (4) Multiple small cylinders or single ton cylinder see the following: "ERG Table 3: Initial Isolation and Protective Action Distances for Different Quantities of Six Common Toxic-by-Inhalation Gases." This chart shows isolation protective distances for the transport containers listed above (numbers 1 through 4) and various wind conditions: Low wind (<6 mph); Moderate wind (6 to 12 mph); High wind (>12mph). Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Restrict persons not wearing protective equipment from area of leak until clean-up is complete. Ventilate area of spill or leak. If a gas, stop flow of gas. If source of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. If in liquid form, allow to vaporize and disperse the gas, or cover with sodium carbonate or an equal mixture of soda ash and slaked lime. After mixing, add water if necessary to form a slurry. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal EPA for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Hydrogen fluoride is a noncombustible liquid or gas. Contact with metals may evolve flammable hydrogen gas which can cause explosion. Use chemical extinguishers. Thermal decomposition products may include fluorine. Vapors are slightly lighter than air. Firefighting gear (including SCBA) does not provide adequate protection. If exposure occurs, remove and isolate gear immediately and thoroughly decontaminate personnel. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Do not extinguish the fire unless the flow of the gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Use dry chemicals, foam, carbon dioxide. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Reaction with excess lime followed by lagooning and either recovery or landfill disposal of the separated calcium fluoride. The supernatant liquid from this process is diluted and discharged to the sewer[22]. Alternatively, hydrogen can be recovered and recycled in many cases. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥ 100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (173); (101); (138). (2); (122); (100).

National Institute for Occupational Safety and Health (NIOSH), "Criteria for a Recommended Standard: Occupational Exposure to Hydrogen Fluoride", NIOSH Document Number 76-143, Cincinnati, OH (1976).

United States Environmental Protection Agency, Hydrofluoric Acid, Health and Environmental Effects Profile No. 117, Office of Solid Waste, Washington, DC (April 30, 1980).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 6, 64−66 (1981) and 5, No. 6, 52−56 (1985).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Hydrogen Fluoride, Washington, DC, Chemical Emergency Preparedness Program (Now. 30, 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Hydrogen Fluoride, Trenton, NJ (March 2007).

Hydrogen Peroxide H:0460

Formula: H_2O_2

Synonyms: Albone; Carro's acid; Dihydrogen dioxide; Hydrogen dioxide; Hydroperoxide; Hyoxyl; Inhibine; Lea Ronal NP-A/NP-B solder stripper; Nanostrip; Oxydol; Patclin 948 solder stripper; Perhydrol; Perone; Peroxan;

Peroxide; Peroxido de hidrogeno (Spanish); Peroxyde d'hydrogene (French); Piranha etch; RCA Clean (steps 1 and 2); Superoxol

CAS Registry Number: 7722-84-1

HSDB Number: 547

RTECS Number: MX0900000 (90%); MX0899500 (60%); MX0899000 (30%) MX0887000 (3%)

UN/NA & ERG Number: UN2984 [8−19% solution (stabilized as necessary)]/140; UN2015 (>60%, stabilized)/143; UN2014 [>20% <60%, solution (stabilized as necessary)]/140

EC Number: 231-765-0 [*Annex I Index No.:* 008-003-00-9]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Theft hazard* 400 (≥35.00% concentration).

Carcinogenicity: IARC: Animal Limited Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1999 (90%). United States EPA Gene-Tox Program, Positive: *N. crassa*-reversion; *E. coli polA* without S9; Positive: *In vitro* UDS-human fibroblast; *S. pombe*-reversion EPA; Inconclusive: Histidine reversion-Ames test (30%).

Hazard Alert: Strong oxidizer, Possible risk of forming tumors, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction) (90%); Suspected of causing genetic defects (20%), Environmental hazard.

Conc. >52%:

OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 7500 lb

SUPERFUND/EPCRA 302, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg) (Conc >52%)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1000 lb (454 kg) (Conc >52%)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects[194]. Harmful to aquatic life with long-lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: O, C; risk phrases: R5; R8; R20/22; R34; R62; safety phrases: S1/2; S17; S26; S28; S29; S36/37/39; S45; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Hydrogen peroxide is a colorless liquid with a sharp odor and bitter taste. Molecular weight = 34.02; Specific gravity (H_2O:1) = 1.44; boiling point = 141°C (90%); 125°C (70%); 106°C (30%); freezing/melting point = −43C°; −39°C (70%); −11°C (90%); vapor pressure = 0.75 mmHg @ 13°C. Hazard Identification (based on NFPA-704 M Rating System): (30% solution) Health 3, flammability 0, reactivity 1 (Oxidizer). Hydrogen peroxide is completely miscible with water and is commercially sold in concentrations of 3%, 35%, 50%, 70%, and 90% solutions. It is not flammable.

Potential Exposure: Hydrogen peroxide is used in the manufacture of acetone, antichlor, antiseptics, benzoyl peroxide; buttons, disinfectants, pharmaceuticals, felt hats; plastic foam; rocket fuel; sponge rubber, and pesticides; as a food and feed additive; flavor; as a packaging material; in bleaching bone; feathers, flour, fruit, fur, gelatin, glue, hair, ivory, silk, soap, straw, textiles, wax, and wood pulp; and as an oxygen source in respiratory protective equipment. Other specific occupations with potential exposure include liquor and wine agers; dyers, electroplaters, fat refiners, photographic film developers; wool printers; veterinarians, and water treaters.

Incompatibilities: Contact with combustible material may result in SPONTANEO United States combustion. A powerful oxidizer; attacks many substances. Attacks many organic substances, such as wood, textile, and paper. Contact with most organic, readily oxidizable materials, reducing agents and combustibles cause fire and explosions, particularly in the presence of metals. Contact with iron, copper, brass, bronze, chromium, zinc, lead, manganese, silver and catalytic metals (and their salts), especially in a basic (pH 7 or above) environment, cause rapid decomposition with evolution of oxygen gas, which increases fire hazard. Attacks, and may ignite, some plastics, rubber and coatings. Decomposes slowly at ordinary temperatures and builds up pressure in a closed container. The rate of decomposition doubles for each 50°F/10°C rise (1.5 times 10°C rise) in temperature and becomes self-sustaining @ 285°F/141°C.

Permissible Exposure Limits in Air

NIOSH IDLH = 75 ppm

Conversion factor: 1 ppm = 1.39 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 1 ppm/1.4 milligram per cubic meter TWA

NIOSH REL: 1 ppm/1.4 milligram per cubic meter TWA

ACGIH TLV[1] 1 ppm/1.4 milligram per cubic meter TWA; confirmed animal carcinogen with unknown relevance to humans.

PAC* Ver. 29[138]

PAC-1: $\mathbf{10_E}$ ppm

PAC-2: $\mathbf{50_E}$ ppm

PAC-3: $\mathbf{100_E}$ ppm

*ERPG [Emergency Response Planning Guidelines] are marked with a subscript "**E**."

PAC (30% solution)

PAC-1: 33 ppm

PAC-2: 170 ppm

PAC-3: 330 ppm

DFG MAK: 0.5 ppm/0.71 milligram per cubic meter TWA; Peak Limitation Category I(1); Carcinogen Category 4; Pregnancy Risk Group C

Australia: TWA 1 ppm (1.5 milligram per cubic meter), 1993; Belgium: TWA 1 ppm (1.4 milligram per cubic meter), 1993; Finland: TWA 1 ppm (1.4 milligram per cubic meter); STEL 3 ppm (4.2 milligram per cubic meter), 1999; France: VME 1 ppm (1.5 milligram per cubic meter), 1993; Norway: TWA 1 ppm (1.4 milligram per cubic meter), 1999; the Philippines: TWA 1 ppm (1.4 milligram per cubic meter), 1993; the Netherlands: MAC-TGG 1.4 milligram per cubic meter, 2003; Turkey: TWA 1 ppm (1.4 milligram per cubic meter), 1993; United Kingdom: TWA 1 ppm (1.4 milligram per cubic meter; STEL 2 ppm (2.8 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: confirmed animal carcinogen with unknown relevance to humans. Several states have set guidelines or standards for hydrogen peroxide in ambient air[60] ranging from 15 μ/m^3 (North Dakota) to 25 μ/m^3 (Virginia) to 28 μ/m^3 (Connecticut) to 36 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Method #1019 (January 2016); OSHA Analytical Method #ID126SG.

Routes of Entry: Inhalation of vapor or mist, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Hydrogen peroxide is corrosive to the eyes, skin, and respiratory tract. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Signs and symptoms of acute exposure to hydrogen peroxide may be severe and include irritation or burns to the skin, eyes, respiratory tract; mouth, esophagus, stomach; and intestines. Distension or rupture of the stomach and other hollow viscera may occur; vomiting is common. Corneal ulceration may develop.

Long-Term Exposure: Because this is a potential mutagen, handle it as a possible cancer-causing substance—with extreme caution. Can irritate the lungs. Repeated exposure may cause bronchitis. Repeated skin contact can cause a rash with redness and blisters.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater) the following are recommended before beginning work and at regular times after that. Lung function tests. If symptoms develop or overexposure is suspected: consider chest X-ray if pulmonary edema is suspected.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. For hydrogen peroxide (30%−70%), Neoprene + Natural rubber; and Neoprene/natural rubber are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Where fumes or vapor are excessive, workers should be provided with gas masks with full facepieces and proper canisters or supplied air respirators. Additional health hazards may occur from the decomposition of hydrogen peroxide. Oxygen, possibly at high pressure, may form, which may create an explosion hazard. Hydrogen peroxide is generally handled in a closed system to prevent contamination. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *10 ppm:* Sa (APF = 10) (any supplied-air respirator). *25 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *50 ppm:* SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *75 ppm:* SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:PD,PP (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern]; or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Check oxygen content prior to entering storage area. (1) Color code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Oxidizers, including oxidizing gases, should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. (2) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. *Note:* Store corrosives in this group in chemical-resistant secondary containers and/or in corrosion proof cabinets. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Hydrogen peroxide must be stored to avoid contact with iron, copper, chromium, brass, bronze, lead, silver, manganese, and their salts, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from alcohols, glycerol, organic materials and radiant heat, including sunlight. Containers should be protected from physical and mechanical disturbances.

Sources of ignition, such as smoking and open flames are prohibited where hydrogen peroxide is used, handled, or stored in manner that could create a potential fire or explosion hazard. Wherever hydrogen peroxide is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Store in a cool, well-ventilated area away from incompatible materials listed above. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage.

Shipping: UN2984 Hydrogen peroxide, aqueous solutions with not <8% but <20% hydrogen peroxide, stabilized as necessary, Hazard Class: 5.1; Labels: 5.1-Oxidizer.UN2014 Hydrogen peroxide, aqueous solutions with not <20% but not >40% hydrogen peroxide, stabilized as necessary or hydrogen peroxide *aqueous solutions*, stabilized with >60% hydrogen peroxide or Hydrogen peroxide, *aqueous solutions with >40% but not >60% hydrogen peroxide*, stabilized as necessary Hazard Class: 5.1; Labels: 5.1-Oxidizer, 8-Corrosive material. UN2015 Hydrogen peroxide, stabilized, Hazard Class: 5.1; Labels: 5.1-Oxidizer, 8-Corrosive material.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Use a large quantity of water to wash down spills and reduce the flammable vapors. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal EPA for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Noncombustible, but highly reactive and can increase the intensity of fire. Fires should be fought with water only. Do not use dry chemical, carbon dioxide; or foams. *Large fires:* flood fire area with water. Flammable vapors may accumulate in storage areas and containers. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dilution with water to release the oxygen. After decomposition, the waste stream may be discharged safely[22].

References

(31); (173); (101); (138); (80); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Hydrogen Peroxide (>52%) Washington, DC, Chemical Emergency Preparedness Program (Nov. 30, 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Hydrogen Peroxide, Trenton, NJ (October 1998).

New York State Department of Health, *Chemical Fact Sheet:* Hydrogen Peroxide, Bureau of Toxic Substance Assessment, Albany, NY (March 1986).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 6, 66–68 (1981).

Hydrogen Selenide H:0470

Formula: H_2Se

Synonyms: Anhydrous hydrogen selenide; Electronic E-2; Selane; Selenium dihydride; Selenium hydride; Seleniuro de hidrogeno (Spanish)

CAS Registry Number: 7783-07-5

HSDB Number: 548

RTECS Number: MX1050000

UN/NA & ERG Number: UN2202/117

EC Number: 231-978-9

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (0.07% minimum concentration); Theft hazard (previous in italics) 15.

Hazard Alert: Poison inhalation hazard (highly toxic gas with inadequate warning properties), Exposure can be lethal, Extremely flammable and chemically unstable, Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated, Environmental hazard.

OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 150 lb

United States National Primary Drinking Water Regulations: MCLG = 0.05 mg[Se]/L; MCL = 0.05 mg[Se]/L as selenium CLEAN WATER ACT: Section 307 Toxic Pollutants as selenium and compounds.

RCRA Section 261 Hazardous Constituents., as selenium compounds, n.o.s., waste number not listed.

EPCRA Section 313: Includes any unique chemical substance that contains selenium as part of that chemical's infrastructure. Form R de minimus concentration reporting level: 1.0%. Form R Toxic Chemical Category Code: N725

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 500 lb (227 kg)

SUPERFUND/EPCRA 302, Extremely Hazardous Substances: TPQ = 10 lb (4.54 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg)

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: T+, F+, N; risk phrases: R5; R12; R21; R23/25; R33; R50/53; Safety phrases S1/2; S9; S20/21; S28; S29; S33; S38; S41; S45; S60; S61.

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Hydrogen selenide is a colorless, flammable gas. Very offensive odor, resembling decayed horseradish. The odor threshold is 0.3 ppm (higher than the occupational exposure limits); many people rapidly lose the ability to detect the odor of hydrogen selenide so it is not a reliable warning of exposure. Molecular weight = 80.98; specific gravity (H_2O:1) = 2.1 (liquid); boiling point = −41.4°C; freezing/melting point = −64°C; relative vapor density (air = 1): 2.80; vapor pressure = 7600 mmHg @ 23.4°C; flash point = flammable gas. Explosive limits: LEL = 56,000 ppm; UEL: unknown. Hazard Identification (based on NFPA-704 M Rating System): Health 4, flammability 4, reactivity 0. Soluble in water; solubility = 0.9% @ 22.7°C.

Potential Exposure: Hydrogen selenide is used in semiconductor manufacture. Also, it may be produced by the reaction of acids or water and metal selenides, or hydrogen and soluble selenium compounds.

Incompatibilities: Forms an explosive mixture with air. Contact with air causes the emission of toxic and corrosive fumes of selenium dioxide A strong reducing agent. Reacts violently with oxidizers, causing fire and explosion hazard. Incompatible with strong acids; water, halogenated hydrocarbons. Decomposes above 100°C, forming toxic and flammable products including selenium and hydrogen.

Permissible Exposure Limits in Air

NIOSH IDLH = 1 ppm

Conversion factor: 1 ppm = 3.31 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 0.05 ppm[Se]/0.2 milligram per cubic meter TWA

NIOSH REL: 0.05 ppm/0.2 milligram per cubic meter TWA

ACGIH TLV[1]: 0.05 ppm/0.16 milligram per cubic meter TWA

PAC* Ver. 29[138]

PAC-1: 0.045 ppm

PAC-2: $\mathbf{0.11_A}$ ppm

PAC-3: $\mathbf{0.33_A}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

DFG MAK: 0.015 ppm/0.050 milligram per cubic meter TWA; Peak Limitation Category I(2); Carcinogen Category 3B; Pregnancy Risk Group C

Australia: TWA 0.05 ppm (0.2 milligram per cubic meter), 1993; Austria: MAK 0.05 ppm (0.2 milligram per cubic meter), 1999; Belgium: TWA 0.05 ppm (0.16 milligram per cubic meter), 1993; Denmark: TWA 0.01 ppm (0.05 milligram per cubic meter), 1999; Finland: STEL 0.01 ppm (0.03 milligram per cubic meter), 1999; France: VME 0.02 ppm (0.08 milligram per cubic meter), 1999; Japan: 0.05 ppm (0.17 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 0.1 mg[Se]/m^3, 2003; Norway: TWA 0.01 ppm (0.05 milligram per cubic meter), 1999; the Philippines: TWA 0.05 ppm (0.2 milligram per cubic meter), 1993; Poland: MAC (TWA) 0.1 mg[Se]/m^3, MAC (STEL) 0.3 mg[Se]/m^3, 1999; Russia: TWA 0.05 ppm, 1993; Switzerland: MAK-W 0.05 ppm (0.17 milligram per cubic meter); STEL 0.1 ppm, 1999; Turkey: TWA 0.05 ppm (0.2 milligram per cubic meter), 1993; United Kingdom: TWA 0.05 ppm (0.17 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: 0.05 ppm. Several states have set guidelines or standards for H_2Se in ambient air[60] ranging from 2 g/m^3 (North Dakota) to 3 μ/m^3 (Virginia) to 4 μ/m^3 (Connecticut) to 5 μ/m^3 (Nevada).

Determination in Air: No method available.

Permissible Concentration in Water: Hazardous to the aquatic environment. EPA[32] suggests a permissible ambient goal of 10 μg/L (the same as for selenium) based on health effects.

Routes of Entry: Inhalation, eye and/or skin contact. Can be absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin, and respiratory tract. Exposure can cause dizziness, fatigue, nausea, vomiting and diarrhea. *Inhalation:* The odor of hydrogen selenide in small concentrations e.g., below 1 ppm) disappears rapidly because of olfactory fatigue. The odor and irritating effects are not a reliable warning to gradually increasing concentrations. Low levels have caused coughing, sneezing and difficulty in breathing. Levels of 0.2 ppm may cause nausea, vomiting, a metallic taste in the mouth and garlic breath. Levels of 1.5 ppm may cause intolerable irritation of mouth and nose. Inhalation of the gas may cause pneumonitis. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. *Skin:* May cause irritation and red coloration of nails. Contact can cause a burning sensation on contact and rash. Contact with liquid may cause freezing burns. *Eyes:* Levels of 1.5 ppm are described as "intolerable." LD_{50} (rat, inhalation) = 2 ppm.

Long-Term Exposure: Repeated exposure can cause garlic odor on breath; dizziness, nausea, vomiting, labored breathing; bluing of skin; pulmonary edema; metallic taste; coughing, nasal secretion; pain in the chest; difficulty in breathing; irritation of the eyes; irritation of the respiratory tract resulting in bronchitis and conjunctivitis. It may also cause anemia. Animal studies suggest that liver damage and lung impairment are possible.

Points of Attack: Eyes, respiratory system; liver, blood.

Medical Surveillance: Consider the points of attack in replacement and periodic physical examinations. Liver function tests. CBC. Urine test for selenium (normal is less than 100 micrograms per liter of urine).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy. Do not make an unconscious person vomit. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear eye protection to prevent any possibility of eye contact. Wear splash-proof chemical goggles and face shield when working with the liquid unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *up to 0.5 ppm:* Sa (APF = 10) (any supplied-air respirator). *Up to 1 ppm:* Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd, Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern]; or SCBAE (any appropriate escape-type, SCBA). *Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Check oxygen content prior to entering storage area. Poison gas. (1) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. This gas is highly toxic. Even slight exposure to these gasses can cause death. Store outdoors in a secure, restricted area that containing warning signs. This area must be roofed and shaded with the cylinders stored off the ground and separated from all other products assigned to other hazard categories and radiant heat sources on nonwooden floors. If indoors, store in a well-ventilated areas in temperatures not to exceed 50°C. (2) Color code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8–10 m or a 1-hour fire wall from flammable or reactive materials. Prior to working with hydrogen selenide all handlers should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store at room temperature away from contact with oxidizers, acids, water, and halogenated hydrocarbons. Metal containers involving the transfer of this chemical should be grounded and bonded. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: UN2202 Hydrogen selenide, anhydrous, Hazard Class: 2.3; Labels: 2.3-Poisonous gas, 2.1-Flammable gas, Inhalation Hazard Zone A. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling:

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States EPA Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 600/200
Then: Protect persons downwind (mi/km)
Day 0.7/1.1
Night 3.1/4.9

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 3000/1000
Then: Protect persons downwind (mi/km)
Day 5.3/8.5
Night 7.0 + /11.0*

* + means distance can be larger in certain atmospheric conditions.

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Warn other workers of leak. Evacuate area. Put on proper protective clothing and equipment. Stop flow of gas. Ventilate area. Remove sources of ignition. If leak cannot be stopped, move leaking cylinder to safe place out of doors. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal EPA for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable gas. It decomposes above 100°C. Thermal decomposition products may include products of metal oxides and flammable selenium and hydrogen. This gas is under pressure; prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. Do not extinguish fire unless flow of gas can be stopped. *Small fires:* dry chemical or carbon dioxide. Stay upwind and uphill; keep out of low areas. Wear SCBA and full protective clothing. Use water in flooding quantities as fog. Cool containers that are exposed to flames with water until well after the fire is out. Gas is heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier.

References

(31); (173); (101); (138). (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Hydrogen Selenide, Washington, DC, Chemical Emergency Preparedness Program (Nov. 30, 1987).

New York State Department of Health, *Chemical Fact Sheet:* Hydrogen Selenide, Bureau of Toxic Substance Assessment, Albany, NY (April 1986).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Hydrogen Selenide, Trenton, NJ (May 1999).

Hydrogen Sulphide H:0480

Formula: H_2S

Synonyms: Acide sulhydrique (French); Dihydrogen monosulfide; Dihydrogen sulfide; Hydrogene sulfure (French); Hydrogen sulfuric acid; Hydrogen sulphide; Hydrosulfuric acid; Sewer gas; Shwefelwasserstoff (German); Stink damp; Sulfureted hydrogen; Sulfur hydride; Sulfuro de hidrogeno (Spanish)

CAS Registry Number: 7783-06-4

HSDB Number: 576

RTECS Number: MX1225000

UN/NA & ERG Number: (PIH) UN1053/117

EC Number: 231-977-3 [*Annex I Index No.:* 016-001-00-4]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (23.73% minimum concentration); Theft hazard (in italics): 45.

Carcinogenicity: EPA: Available data are inadequate for an assessment of human carcinogenic potential.

Hazard Alert: Poison inhalation hazard: exposure can be lethal, Highly toxic gas with inadequate warning properties (H_2S rapidly blocks the sense of smell), Extremely flammable, Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated, Suspected of causing genetic defects, Environmental hazard.

OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 1500 lb

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg)

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)

United States EPA Hazardous Waste Number (RCRA No.): U135 RCRA, 40CFR261, Appendix 8 Hazardous Constituents

SUPERFUND/EPCRA 302, Extremely Hazardous Substances: TPQ = 500 lb (227 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)

EPCRA Section 313: Currently under administrative stay and is not currently reportable.

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects[291]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: F+ ,T+ , N; risk phrases: R5; R12; R21; R26; R51; R44; R60; R62; safety phrases: S1/2; S9; S15; S16; S26; S28; S29/35; S33; S36/37/39/; S38; S41; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Hydrogen sulfide is a flammable, colorless gas. Characteristic rotten egg odor. The odor threshold is 0.008 ppm. The sense of smell becomes rapidly fatigued and can NOT be relied upon to warn of the continuous presence of H_2S. Shipped as a liquefied compressed gas. Molecular weight = 34.04; specific gravity (H_2O:1) = 1.4 @ 20°C; boiling point = −60°C; freezing/melting point = −86°C; vapor pressure = 750 mmHg @ −60.5°C; Relative vapor density (air = 1) = 1.19; autoignition temperature = 260°C. Explosive limits: LEL = 4.0%; UEL: 44.0%. Hazard identification (based on NFPA-704 M Rating System): Health 4, flammability 4, reactivity 0. Soluble in water; solubility = 0.45% @ 20°C.

Potential Exposure: Hydrogen sulfide is used in the synthesis of inorganic sulfides; sulfuric acid; and organic sulfur compounds; as an analytical reagent; as a disinfectant in agriculture; and in metallurgy. It is generated in many industrial processes as a by-product and also during the decomposition of sulfur-containing organic matter; so potential for exposure exists in a variety of situations. Hydrogen sulfide is found in natural gas, volcanic gas; and in certain natural spring waters. It may also be encountered in the manufacture of barium carbonate, barium salt; cellophane, depilatories, dyes, pigments, felt, fertilizer, adhesives, viscose rayon; lithopone, synthetic petroleum products; in the processing of sugar beets; in mining, particularly where sulfide ores are present; in sewers and sewage treatment plants; during excavation of swampy or filled ground for tunnels, wells, and caissons; during drilling of oil and gas wells; in purification of hydrochloric acid and phosphates; during the low temperature carbonization of coal; in tanneries, breweries, slaughterhouses; in fat rendering; and in lithography and photo-engraving.

Incompatibilities: A highly flammable and reactive gas; heating may cause violent combustion or explosion. May form explosive mixture with air. Incompatible with acetaldehyde, barium pentafluoride; chlorine monoxide; chlorine trifluoride; chromic anhydride; copper, lead dioxide; nitric acid; nitrogen iodide; nitrogen trichloride; nitrogen trifluoride; oxygen difluoride; oxidizers, phenyl diazonium chloride; sodium, sodium peroxide. Reacts with alkali metals. Attacks some plastics.

Permissible Exposure Limits in Air

NIOSH IDLH = 100 ppm

Conversion factor: 1 ppm = 1.40 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 20 ppm Ceiling Concentration; 50 ppm [10-minute maximum peak; once per 8-hour shift]

NIOSH REL: 10 ppm/15 milligram per cubic meter [10-minute] Ceiling Concentration

ACGIH TLV[1]: 1 ppm/1.4 milligram per cubic meter TWA; 5 ppm/7 milligram per cubic meter STEL

PAC* Ver. 29[138]

PAC-1: $\mathbf{0.51_A}$ ppm

PAC-2: $\mathbf{27_A}$ ppm

PAC-3: $\mathbf{50_A}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

DFG MAK: 5 ppm/7.1 g/m^3 TWA; Peak Limitation Category I(2); Pregnancy Risk Group C

Arab Republic of Egypt: TWA 10 ppm (14 milligram per cubic meter), 1993; Australia: TWA 10 ppm (14 milligram per cubic meter), STEL 15 ppm, 1993; Austria: MAK 10 ppm (15 milligram per cubic meter), 1999; Belgium: TWA 10 ppm (14 milligram per cubic meter); STEL 15 ppm, 1993; Denmark: TWA 10 ppm (15 milligram per cubic meter), 1999; Finland: TWA 10 ppm (15 milligram per cubic meter); STEL 15 ppm (20 milligram per cubic meter) [skin], 1999; France: VME 5 ppm (7 milligram per cubic meter), VLE 10 ppm (14 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 15 milligram per cubic meter, 2003; Japan: 10 ppm (14 milligram per cubic meter), 1999; Norway: TWA 10 ppm (15 milligram per cubic meter), 1999; the Philippines: TWA 10 ppm (15 milligram per cubic meter), 1993; Poland: MAC (TWA) 10 milligram per cubic meter, MAC (STEL) 20 milligram per cubic meter, 1999; Russia: TWA 10 ppm, STEL 10 milligram per cubic meter, 1993; Sweden: NGV 10 ppm (14 milligram per cubic meter), KTV 15 ppm (20 milligram per cubic meter), 1999; Switzerland: MAK-W 10 ppm (15 milligram per cubic meter), KZG-W 20 ppm (30 milligram per cubic meter), 1999; Thailand: STEL 20 ppm, 1993; Turkey: TWA 10 ppm (15 milligram per cubic meter), 1993; United Kingdom: TWA 10 ppm (14 milligram per cubic meter), STEL 15 ppm (21 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 15 ppm. Russia[43] set a MAC in ambient air of residential areas of 0.008 milligram per cubic meter on both a momentary and a daily average basis. Several states have set guidelines or standards for hydrogen sulfide in ambient air[60] ranging from 14.0 μ/m^3 (South Carolina) to 230.0 μ/m^3 (Virginia) to 280.0 μ/m^3 (Connecticut) to 333.0 μ/m^3

Determination in Air: Use NIOSH (IV), Method #6013; OSHA Analytical Method ID-141.

Permissible Concentration in Water: EPA[32] suggests a permissible ambient goal of 207 μg/L based on health effects. EPA has established that hydrogen sulfide is a regulated toxic substance and is a hazardous substance defined under the Federal Water Pollution Control Act.

Routes of Entry: Inhalation of gas, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Signs and symptoms of acute exposure to hydrogen sulfide may include tachycardia (rapid heart rate) or bradycardia (slow heart rate), hypertension (low blood pressure), cyanosis (blue tint to skin and mucous membrane), cardiac palpitations; and cardiac arrhythmias. Dyspnea (shortness of breath), tachypnea (rapid respiratory rate), bronchitis, pulmonary edema; respiratory depression; and respiratory paralysis may occur. Neurological effects include giddiness, irritability, drowsiness, weakness, confusion, delirium, amnesia, headache, sweating, and dizziness. Muscle cramping, tremor, excessive salivation; cough, convulsions, and coma may be noted. Nausea, vomiting, and diarrhea are commonly seen. Exposure to hydrogen sulfide gas may result in skin irritation, lacrimation (tearing), inability to detect odors, photophobia (heightened sensitivity to light), and blurred vision.

Short-Term Exposure: Irritates the eyes, skin, and respiratory tract. May affect the central nervous system. Inhalation can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Levels of 20 ppm may cause headache, loss of appetite and dizziness. 50 ppm may cause muscle fatigue. 300 ppm may cause muscle cramps, low blood pressure; and unconsciousness after 20 minutes. Levels of 500 ppm can cause immediate loss of consciousness; slowed respiration and death in 30−60 minutes. At levels of 700 ppm and above respiratory paralysis and death can occur in seconds. Nonfatal cases may recover fully or may experience abnormal reflexes, dizziness, sleep disturbances and loss of appetite that last for months or years. *Skin:* Readily absorbed. May cause irritation, reddening and swelling. Contact with liquid can cause freezing burns. *Eyes:* Irritation may be felt at levels as low as 0.1 ppm. Levels of 10 ppm and above can cause irritation, pain, tearing; and increased light sensitivity. Liquid may cause freezing burns.

Long-Term Exposure: Long term exposure to low levels can cause pain and redness of the eyes with blurred vision. Repeated exposure can cause fatigue, loss of appetite; headaches, irritability, poor memory; dizziness, troubled sleeping; and nausea. Can cause irritation of the lungs and bronchitis with cough, phlegm, and/or shortness of breath. Animals studies showed that pigs that ate food containing hydrogen sulfide had diarrhea after a few days and weight loss after about 105 days.

Points of Attack: Eyes, lungs.

Medical Surveillance: NIOSH lists the following tests: whole blood (chemical/metabolite), carboxyhemoglobin; blood plasma; chest X-ray; pulmonary function tests: forced vital capacity, forced expiratory volume (1 second). For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: blood sulfide level (normal is less than 0.05 mg/L).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Neoprene and polyvinyl chloride are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Because of poor warning signs, it may cause olfactory paralysis, and some persons are congenitally unable to smell H_2S. Accidental exposure may occur when workers enter sewage tanks and other confined areas in which hydrogen sulfide is formed by decomposition. In a number of cases workers enter unsuspectingly and collapse almost immediately. Workers, therefore, should not enter enclosed spaces without proper precautions. All Federal standard and other safety precautions must be observed when tanks or other confined spaces are to be entered. In areas where the exposure to hydrogen sulfide exceeds the standards, workers should be provided with full-face canister gas masks or preferable supplied air respirators. When liquid H_2S is involved, wear clothing to prevent skin freezing. Wear eye protection to prevent any reasonable probability of eye contact. Remove clothing immediately if wet or contaminated to avoid flammability hazard. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *up to 100 ppm:* PaprS (APF = 25) [any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern]; or GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern]; or Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern]; or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Check oxygen content prior to entering storage area. Poison gas. (1) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. This gas is highly toxic. Even slight exposure to these gasses can cause death. Store outdoors in a secure, restricted area that containing warning signs. This area must be roofed and shaded with the cylinders stored off the ground and separated from all other products assigned to other hazard categories and radiant heat sources on nonwooden floors. If indoors, store in a well-ventilated areas in temperatures not to exceed 50°C. (2) Color code—Red: Flammability Hazard: Store in a flammable (liquid or solid materials) storage area or approved cabinet away from sources if ignition. Prior to working with hydrogen sulfide all handlers should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Hydrogen sulfide must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine) and nitric acid, since violent reactions occur. Outdoor or detached storage is preferred. Indoors, store in a cool, well-ventilated area. Sources of ignitions, such as smoking and open flames, are prohibited where hydrogen sulfide is handled, used, or stored. Use only nonsparking tools and equipment, especially when opening and closing containers of hydrogen sulfide. Wherever hydrogen sulfide is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: UN1053 Hydrogen sulfide, Hazard Class: 2.3; Labels: 2.3-Poisonous gas, 2.1-Flammable gas, Inhalation Hazard Zone B. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling:

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States EPA Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (*From a small package or a small leak from a large package*)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.3/0.5

Large spills (*From a large package or from many small packages*)

First: Isolate in all directions (ft/m) 1000/300
Then: Protect persons downwind (mi/km)
Day 1.0/1.5
Night 3.5/5.6

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. If in a building, evacuate building and confine vapors by closing doors and shutting down HVAC systems. Restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Wear chemical protective suit with SCBA to combat spills. Stay upwind and use water spray to "knock down" vapor; contain run-off. Stop the flow of gas, if it can be done safely from a distance. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place; and repair leak or allow cylinder to empty. Keep this chemical out of confined spaces, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a highly flammable gas. Thermal decomposition products may include sulphur dioxide. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Hydrogen sulfide can be recovered as such or converted to elemental sulfur or sulfuric acid. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (173); (101); (138); (100).

National institute for Occupational Safety and Health (NIOSH), “Criteria for a Recommended Standard: Occupational Exposure to Hydrogen Sulfide”, NIOSH Document Number 77-158, Cincinnati, OH (1977).

United States Environmental Protection Agency, Hydrogen Sulfide, Health and Environmental Effects Profile No. 118, Office of Solid Waste, Washington, DC (April 30, 1980).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 3, No. 4, 68−73 (1983).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Hydrogen Sulfide, Washington, DC, Chemical Emergency Preparedness Program (Nov. 30, 1987).

New York State Department of Health, *Chemical Fact Sheet:* Hydrogen Sulfide, Bureau of Toxic Substance Assessment, Albany, NY (March 1986 and Version 2).

United States Department of Health and Human Services, “ATSDR ToxFAQs, Hydrogen Sulfide,” Atlanta, GA (June 1999).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Hydrogen Sulfide, Trenton, NJ (January 2000).

Hydroquinone H:0490

Formula: $C_6H_6O_2$: $C_6H_4(OH)_2$

Synonyms: Arctuvin; Benzene, *p*-dihydroxy-; *p*-Benzenediol; 1,4-Benzenediol; Benzohydroquinone; Benzoquinol; Black and white bleaching cream; Boydes PTS developer; Cronaflex PDC developer; DIAK5; Dihydroquinone; *p*-Dihydroxybenzene; 1,4-Dihydroxybenzene; Dihydroxybenzene; 1,4-Dihydroxy-benzol (German); *p*-Dioxobenzene; *p*-Dioxybenzene; Eldopaque; Eldoquin; HE5; Hidroquinona (Spanish); Hydroquinol; α-Hydroquinone; *p*-Hydroquinone; *p*-Hydroxyphenol; 4-Hydroxyphenol; Kodagraph liquid develo per; Kodak 55/66 developer; NCI-C55834; PD-86 developer; Phiaquin; Pyrogentisic acid; β-Quinol; Quinol; SR-201; Tecquinol; Tenox HQ; Tequinol

CAS Registry Number: 123-31-9

HSDB Number: 577

RTECS Number: MX3500000

UN/NA & ERG Number: UN2662/153; UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 204-617-8 [*Annex I Index No.:* 604-005-00-4]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Limited Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1999; NTP: Carcinogenesis Studies (gavage); some evidence: mouse, rat; NCI: Carcinogenesis Studies (gavage); equivocal evidence: mouse, rat.

Hazard Alert: Poison, Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction), environmental hazard.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

SUPERFUND/EPCRA 302, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)

EPCRA Section 313 Form R de minimis concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects[291]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: Xn, N, Xi; Risk phrases R40; R20/22; R36/37/38; R41;

R50; R61; R62; R63; safety phrases: S2; S24/25; S36/37/39; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Hydroquinone is a light-tan, light-gray, or colorless crystals. Molecular weight = 110.12; specific gravity (H_2O:1) = 1.4 @ 20°C; boiling point = 285°C; freezing/melting point = 172°C; vapor pressure = 1×10^{-4} mmHg @ 20°C; flash point = 165°C (molten); autoignition temperature = 516°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 1, Reactivity 0. Soluble in water; solubility = 7%; 5.9% @ 15°C.

Potential Exposure: Hydroquinone is a reducing agent and is used as an industrial chemical, chemical intermediate, pharmaceutical, and veterinary drug; as a photographic developer and as an antioxidant or stabilizer for certain materials which polymerize in the presence of oxidizing agents. Many of its derivatives are used as bacteriostatic agents (Ed.), particularly 2,5-bis(ethyleneimino) hydroquinone, have been reported to be a good antibiotic and tumor-inhibiting agent.

Incompatibilities: Hydroquinone is a reducing agent. Dust forms an explosive mixture with air. May explode on contact with oxygen. Incompatible with strong oxidizers, caustics; reacts violently with sodium hydroxide. May be oxidized to quinone at room temperatures in the presence of moisture.

Permissible Exposure Limits in Air

NIOSH IDLH = 50 milligram per cubic meter

OSHA PEL: 2 milligram per cubic meter TWA

NIOSH REL: 2 milligram per cubic meter [15 minutes] Ceiling Concentration

ACGIH TLV[1]: 1 milligram per cubic meter TWA; danger of sensitization; confirmed animal carcinogen with unknown relevance to humans.

PAC Ver. 29[138]

PAC-1: 3 milligram per cubic meter

PAC-2: 20 milligram per cubic meter

PAC-3: 120 milligram per cubic meter

DFG MAK: [skin] danger of skin sensitization; Carcinogen Category 2; Germ Cell Mutagen Category 3A

Australia: TWA 2 milligram per cubic meter, 1993; Austria: MAK 2 milligram per cubic meter, 1999; Belgium: TWA 2 milligram per cubic meter, 1993; Denmark: TWA 2 milligram per cubic meter, 1999; Finland: TWA 2 milligram per cubic meter; STEL 4 milligram per cubic meter [skin] 1999; France: VME 2 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 2 milligram per cubic meter, 2003; the Philippines: TWA 2 milligram per cubic meter, 1993; Poland: MAC (TWA) 2 milligram per cubic meter, MAC (STEL) 4 milligram per cubic meter, 1999; Sweden: NGV 0.5 milligram per cubic meter, KTV 1.5 milligram per cubic meter, 1999; Switzerland: MAK-W 2 milligram per cubic meter, KZG-W 4 milligram per cubic meter, 1999; Turkey: TWA 2 milligram per cubic meter, 1993; United Kingdom: LTEL 2 milligram per cubic meter; STEL 4 milligram per cubic meter, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: confirmed animal carcinogen with unknown relevance to humans. Russia set a MAC in ambient air in residential areas of 0.02 milligram per cubic meter on a once-daily basis[35]. Several states have set guidelines or standards for hydroquinone in ambient air[60] ranging from 6.67 μ/m^3 (New York) to 20.0 μ/m^3 (Florida and South Carolina) to 20.0−40.0 μ/m^3 (North Dakota) to 35.0 μ/m^3 (Virginia) to 40.0 μ/m^3 (Connecticut) to 48.0 μ/m^3 (Nevada).

Determination in Air: NIOSH (IV), Method #5004; OSHA Analytical Method PV-2094.

Permissible Concentration in Water: Russia set a MAC in water bodies used for domestic purposes of 0.5 mg/L.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 0.60$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation of dust, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin, and respiratory tract. Can cause conjunctivitis; keratitis (inflammation of the cornea). Can affect the central nervous system and cause excitement. Signs and symptoms of acute exposure to hydroquinone may be severe and include dyspnea (shortness of breath); a sense of suffocation; increased respiratory rate; and respiratory failure. Pallor (paleness of skin); cyanosis (blue tint to skin and mucous membranes); and cardiovascular collapse may occur. Neurologic effects include headache, tinnitus (ringing in the ears), dizziness, delirium, muscle twitching; tremor; and convulsions. Nausea, vomiting, and the production of green to brown-green urine may also occur. Ingestion may cause respiratory failure. This material is very toxic; the probable oral lethal dose for humans is 50−500 mg/kg, or between 1 teaspoon and 1 ounce for a 150 lb person. Fatal human doses have ranged from 5 to 12 g, but 300−500 mg have been ingested daily for 3−5 months without ill effects. Death is apparently initiated by respiratory failure or anoxia.

Long-Term Exposure: Repeated or prolonged contact may cause skin sensitization. Hydroquinone cause changes in color of the conjunctiva, cornea, and skin. Over the years this can cause clouding of the eyes and permanent vision damage. May cause genetic damage, mutations in humans. Such chemicals have a cancer risk.

Points of Attack: Eyes, skin, respiratory system; central nervous system.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. NIOSH lists the following tests: ophthalmic examination; pulmonary function tests. Careful examination of the eyes, including visual acuity and slit lamp examinations, should be carried out in preplacement and periodic examinations. Also, the skin should be examined. Hydroquinone is excreted in the urine as a sulfate ester, although this has not been helpful in following worker exposure to dust.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Neoprene, natural rubber, and Viton are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Specific engineering controls are recommended for this chemical by NIOSH. See NIOSH Criteria Document #78-155.

Respirator Selection: *up to 50 milligram per cubic meter:* PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter); or 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance causes eye irritation or damage; eye protection needed @ 50 and 100 milligram per cubic meter.

Based on potential carcinogenicity the following is also recommended by NIOSH: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved SCBA that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-face-piece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: (1) Color code—Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. (2) Color code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area separated from strong oxidants, strong bases; strong acids. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2662 Hydroquinone, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Stay upwind; keep out of low areas. Remove all ignition sources. Do not touch spilled material; stop leak if you can do it without risk. *Small spills*: take up with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills*: with clean shovel place material into clean, dry container and cover; move containers from spill area. *Large spills*: dike far ahead of spill for later disposal. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal EPA for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Hydroquinone may burn but does not readily ignite. Thermal decomposition products may include oxides of carbon. For small fires use dry chemical, carbon dioxide; water spray or foam. Move container from fire area if you can do so without risk. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration (982°C, 2.0 seconds minimum), then scrub to remove harmful combustion products[22].

References

(31); (173); (101); (138); (100).

National Institute for Occupational Safety and Health (NIOSH), "Criteria for a Recommended Standard: Occupational Exposure to Hydroquinone", NIOSH Document Number 78-155, Cincinnati, OH (1978).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 2, No. 2, 35−37 (1982) and 8, No. 1, 51−60 (1988).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Hydroquinone, Trenton, NJ (August 2000).

Hydroxylamine (& Salts) H:0500

Formula: H_3NO; $HONH_2$

Synonyms: Oxammonium

CAS Registry Number: 7803-49-8

Salts of hydroxylamine: 5470-11-1 (chloride); 13465-08-2 (nitrate); 10039-54-0 (sulfate)

HSDB Number: 579

RTECS Number: NC2975000

UN/NA & ERG Number: UN3290 (Toxic solid, corrosive, inorganic, n.o.s.)/154

EC Number: 232-259-2 [*Annex I Index No.:* 612-122-00-7]

Regulatory Authority and Advisory Information

United States EPA Gene-Tox Program, Positive: Cell transformation-RLV F344 rat embryo; 1988, Positive: N crassa-forward mutation; *S. pombe*-forward mutation; 1988, Negative: *In vitro* cytogenetics-human lymphocyte; 1988, Negative: D *melanogaster*-whole sex chrom. loss; 1988, Inconclusive: Carcinogenicity-mouse/rat; 1988, Inconclusive: *D. melanogaster*-nondisjunction; 1988, Inconclusive: *D. melanogaster* sex-linked lethal.

Hazard Alert: Poison, Explosive, Combustible, Corrosive, Sensitization hazard, Water reactive, Suspected reprotoxic hazard, Environmental hazard.

OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 2500 lb (1135 kg)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: E, Xn, N, Xi; risk phrases: R2; R21/22; R37/38; R40; R41; R43; R48/22; R62; safety phrases: S2; S26; S29/35; S36/37/39; S41; S61 (see Appendix 4).

Description: Hydroxylamine is a white crystalline substance. Molecular weight = 33.03; specific gravity (H_2O:1) = 1.23; boiling point = (decomposes) 56.5°C @22 mmHg; 70°C @60 mmHg; freezing/melting point = 33.05°C; it is very hygroscopic and unstable; vapor pressure = mmHg @ 10°C; flash point = 129.44°C (explosive); explosive limits: LEL = 18,000 ppm; UEL: unknown. Autoignition temperature = 129.44°C (reported to explode in temperatures >70°C[101]). NFPA-704 M Rating System): Health 2, flammability 0, reactivity 3₩. Soluble in water; reactive releasing heat and producing a corrosive alkaline liquid.

Potential Exposure: A potential danger to those involved in chemical synthesis or use of hydroxylamine. Used as a reducing agent.

Incompatibilities: Self-reactive. Contaminants, temperatures above 129.4°C (see also "Autoignition temperature" above), or open flame can cause explosive decomposition, especially in presence of moisture and carbon dioxide. Incompatible with strong acids; organic anhydrides; isocyanates, aldehydes, sodium, finely divided zinc; some metal oxides. Aqueous solution is a weak base. Contact with strong oxidizers may cause a fire and explosion hazard. Attacks some metals. Contact with calcium or zinc forms a heat-sensitive explosive [bis(hydroxylamide)][128].

Permissible Exposure Limits in Air

7803-49-8

PAC Ver. 29[138]

PAC-1: 0.35 milligram per cubic meter

PAC-2: 3.9 milligram per cubic meter

PAC-3: 23 milligram per cubic meter

DFG MAK: Danger of skin sensitization

Routes of Entry: Inhalation and ingestion of dust.

Harmful Effects and Symptoms

Short-Term Exposure: Corrosive to skin, eyes, and mucous membranes. May cause methemoglobinemia. The effects may be delayed. Exposure can cause headache; vertigo (dizziness); tinnitus (ringing of ear); dyspnea (difficult breathing); nausea and vomiting, cyanosis, proteinuria and hematuria, jaundice, restlessness, and convulsion; yellowish brown deposit on conjunctiva and cornea; astigmatism; reddening of hair and exposed skin.

Long-Term Exposure: Repeated or prolonged contact may cause skin sensitization and eczema. May affect the nervous system. May cause anemia. May cause liver damage.
Points of Attack: Skin, blood, liver, nervous system.
Medical Surveillance: Annual physical exams including renal and hepatic. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. CBC. Examination of the nervous system.
First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy. *Note to Physician:* Treat for methemoglobinemia. Test urine for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.
Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.
Storage: (1) Color code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard (thermally unstable); Store separately in temperatures $<10°C$ in an area isolated from flammables, combustibles, or other yellow coded materials. (2) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Protect against physical damage. Store in cool, noncombustible buildings and separate from oxidizing materials. Open airtight containers occasionally to relieve pressure from decomposition products.
Shipping: UN3290 Toxic solid, corrosive, inorganic, n.o.s., Hazard class: 6.1; Labels: 6.1-Poisonous materials, 8-Corrosive material.
Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Cover spill with sodium bisulfite and sprinkle with water. Collect material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal EPA for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.
Fire Extinguishing: Use extreme caution in approaching a fire. This thermally unstable material may explode when exposed to heat or flame. Thermal decomposition products may include oxides of nitrogen and sulfur. No attempt should be made to fight fires except for remotely activated fire extinguishing equipment. Evacuate the surrounding area. Water or foam may cause frothing. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.
Disposal Method Suggested: Add sodium bisulfite solution and flush to sewer; or incinerate.

References

(31); (173); (101); (138).

Sax, N. I., E., *Dangerous Properties of Industrial Materials Report*, 2, No. 2, 37–39 (1982) and 8, No. 4, 34–39 (1988).

2-Hydroxypropyl Acrylate H:0510

Formula: $C_6H_{10}O_3$; $CH_2{=}CHCOOCH_2CHOHCH_3$
Synonyms: Acrylic acid 2-hydroxypropyl ester; HPA; Hydroxypropyl acrylate; β-Hydroxypropyl acrylate; 1,2-Propanediol 1-acrylate; Propylene glycol monoacrylate
CAS Registry Number: 999-61-1

HSDB Number: 7913
RTECS Number: AT1925000
UN/NA & ERG Number: UN2922 (Corrosive liquid, toxic, n.o.s.)/154; UN1760 (Corrosive liquids, n.o.s.)/154; UN2927/154
EC Number: 213-663-8 [*Annex I Index No.:* 607-108-00-2]
Regulatory Authority and Advisory Information
Hazard Alert: Poison, Flammable, Corrosive, Polymerization hazard (heat-sensitive), Sensitization hazard.
Hazard symbols, risk, & safety statements: Hazard symbol: F, C, T, Xi; risk phrases: R10; R23/24/25; R34; R36/37/38; R39; R40; R43; safety phrases: S16; S26; S36/37/39; S41; S45 (see Appendix 4)

Description: 2-Hydroxypropyl acrylate is a clear to light-yellow liquid with a sweetish, solvent odor. Molecular weight = 130.16; specific gravity (H_2O:1) = 1.05; boiling point = 191°C, also listed @ 195 and 205°C; Relative vapor density (air = 1) = 4.5; flash point = ~80°C; autoignition temperature = >200°C. Explosive limits: LEL = 1.8%; UEL: unknown. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 1, reactivity 0. Soluble in water.

Potential Exposure: 2-Hydroxypropyl acrylate is used as a bifunctional monomer for acrylic resins; it is used as a binder in nonwoven fabrics and may be used in the production of detergent lube oil additives.

Incompatibilities: 2-Hydroxypropyl acrylate can polymerize due to heating, contact with initiators or UV light. It can become unstable at high temperatures and pressures; or, it may react with water with some release of energy. Reacts with oxidizers, strong acids; nitrates. Compounds of the carboxyl group react with all bases, both inorganic and organic (i.e., amines) releasing substantial heat, water and a salt that may be harmful. Incompatible with arsenic compounds (releases hydrogen cyanide gas), diazo compounds, dithiocarbamates, isocyanates, mercaptans, nitrides, and sulfides (releasing heat, toxic and possibly flammable gases), thiosulfates and dithionites (releasing hydrogen sulfate and oxides of sulfur).

Permissible Exposure Limits in Air
Conversion factor: 1 ppm = 5.33 milligram per cubic meter @ 25°C & 1 atm
OSHA PEL: None
NIOSH REL: 0.5 ppm/3 milligram per cubic meter TWA [skin]
ACGIH TLV[1]: 0.5 ppm/2.8 milligram per cubic meter TWA [skin] danger of skin sensitization
PAC not available
DFG MAK: [skin] danger of skin sensitization
Australia: TWA 0.5 ppm (3 milligram per cubic meter) [skin], 1993; Belgium: TWA 0.5 ppm (2.8 milligram per cubic meter) [skin], 1993; Denmark: TWA 0.5 ppm (3 milligram per cubic meter) [skin], 1999; France: VME 0.5 ppm (3 milligram per cubic meter) [skin], 1999; Norway: TWA 0.5 ppm (2.9 milligram per cubic meter), 1999; Russia: STEL 1 milligram per cubic meter [skin], 1993; Switzerland: MAK-W 0.5 ppm (2.7 milligram per cubic meter) [skin], 1999; the Netherlands: MAC-TGG 3 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 0.5 ppm [skin], skin sensitizer. Several states have set guidelines or standards for hydroxypropyl acrylate in ambient air[60] ranging from 30 μ/m^3 (North Dakota) to 50 μ/m^3 (Virginia) to 60 μ/m^3 (Connecticut) to 71 μ/m^3 (Nevada).

Determination in Air: No method available.

Routes of Entry: Inhalation, skin contact.

Harmful Effects and Symptoms
Short-Term Exposure: The substance is corrosive to the eyes, the skin, and the respiratory tract. Eye contact can cause burns and permanent damage. Inhalation of the vapors can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. LD_{50} (oral-rat) = 250 g/kg (moderately toxic).

Long-Term Exposure: Sensitization hazard. Repeated or prolonged contact with skin may cause dermatitis and eczema.

Points of Attack: Skin, lungs.

Medical Surveillance. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Lung function tests. Evaluation by a qualified allergist.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: (1) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. (2) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area separated from strong oxidants, strong bases; strong acids. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2922 Corrosive liquids, toxic, n.o.s., Hazard class: 8; Labels: 8-Corrosive material, 6.1-Poisonous materials. UN1760 Corrosive liquids, n.o.s., Hazard class: 8; Labels: 8-Corrosive material, Technical Name Required. UN2927 Toxic liquids, corrosive, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials., 8-Corrosive material, Technical Name Required.

Spill Handling: UN2927

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States EPA Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 0.6/1.0

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 600/200
Then: Protect persons downwind (mi/km)
Day 1.0/1.50
Night 1.9/3/1

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal EPA for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of carbon. Water may be ineffective. Use dry chemical, alcohol foam or carbon dioxide. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Disposal of unused product must be undertaken by qualified personnel who are knowledgeable in all applicable regulations and follow all pertinent safety precautions including the use of appropriate protective equipment. For proper handling and disposal, always comply with federal, state, and local regulations.

References

(31); (173); (101); (138).

I

Imazalil I:0075

Formula: $C_{14}H_{14}Cl_2N_2O$
Synonyms: Allyl-1-(2,4-dichlorophenyl)-2-imidazol-1-ylethyl ether; (±)1-(β-Allyloxy-2,4-dichlorophenethyl)imidazole; (±)-1-[β-(Allyloxy)-2,4-dichlorophenethyl]imidazole; 1-[2-(Allyloxy)-2-(2,4-dichlorophenyl)ethyl]-1*H*-imidazole; Baytan IM; Bromazil imazalil; Caswell No. 497AB; Cerevax extra; Chloramizol; Clinafarm; Deccozil; 1-(2-(2,4-Dichlorophenyl)-2-(2-propenyloxy)ethyl)-1*H*-imidazole; 1-[2-((2,4-Dichlorophenyl)-2-propenyloxy)-ethyl]-1*H*-imidazole; Enilconazole; Fecundal 100EC; FF4961; FLO-PRO IMZ; Freshgard; Fungaflor; Imaverol; 1*H*-Imidazole, 1-[2-(2,4-dichlorophenyl)-2-(2-propenyloxy)ethyl]-; 1*H*-Imidazole, 1-[2-(2,4-dichlorophenyl)-2-(2-propenyloxy)ethyl]-, (±)-; Magnet; Mist-O-Matic liquid seed treatment; Nuzone; Raxil; RTU-Vitavax extra; R 23979; Vitavax extra
CAS Number: 35554-44-0
HSDB Number: 6672
RTECS Number: NI47760000
UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154
EC Number: 212-615-0 [*Annex I Index No.*: 613-042-00-5]
Regulatory Authority and Advisory Information
United States Environmental Protection Agency Carcinogens: Likely to be carcinogenic to humans.
California Proposition 65 Chemical[102]: Cancer 5/20/2011.
Hazard Alert: Poison, Combustible, Suspected reprotoxic hazard, Possible sensitization hazard (skin), Developmental toxin (TRI), Environmental hazard.
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%
Hazardous to aquatic life or environment, with possible long-lasting effects[291,292].
Hazard symbols, risk, & safety statements: Hazard symbol: T, Xi, Xn, N; risk phrases: R45; R20/22; R41; R43; R50/53; R63; safety phrases: S1/2; S26; S29/35; S39; S60; S61 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]
Description: Yellow to brown wax-like, solidified oil or crystalline solid. Commercial products are in various forms including emulsifiable concentrate. Liquid formulations in organic solvents are combustible. Molecular weight = 297.18; freezing/melting point = 51−52°C; boiling point = (decomposes) 320−350°C (estimated); vapor pressure = 6.8×10^{-8} mmHg. Flash point = 191.5°C. Low to moderate solubility in water. Physical and toxicological properties may be affected by carrier solvents in commercial formulations.
Potential Exposure: Imazalil is an imidazole derivative, systemic fungicide used on fruit, vegetables and ornamentals to control powdery mildew, black spot and other fungi. Also used as a seed dressing and for postharvest applications to bananas, citrus and other fruit. It has been shown that the use of imazalil is less likely to lead to resistant fungi strains than other fungicides.
Incompatibilities: Incompatible with oxidizers and alkaline materials. May react with mineral or clay based absorbents. Decomposes >250°C.
Determination in Air: No standards or Protective Action Criteria (PAC) available.
Determination in Water: Fish toxicity (threshold)[101]: Low—193.77060 ppb, MATC (Maximum Acceptable Toxicant Concentration)
Routes of Entry: Inhalation, skin absorption, ingestion, eye and/or dermal contact
Incompatibilities: Strong oxidizers. Forms toxic fumes of nitrogen oxides and chlorine when heated to decomposition
Determination in Water: Octanol−water coefficient: Log K_{ow} = >3.5. Values above 3.0 are likely to bioaccumulate in marine organisms.
Routes of Entry: Eyes, dermal and/or eye contact.
Harmful Effects and Symptoms
Short-Term Exposure: Causes eye irritation with pain. May cause skin and respiratory tract irritation. May cause nausea if ingested; toxic. Liver and kidney toxin. LD (oral, rat) = 250 mg/kg; LD_{50} (dermal, rat) = >4 g/kg.
Long-Term Exposure: May cause cancer and developmental problems. May cause liver and kidney problems. May cause skin sensitization. Human toxicity (long term)[101]: Intermediate—17.50 ppb, Health Advisory.
Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. If skin sensitization is suspected, consider evaluation by a qualified allergist, including exposure history and testing, may help diagnose allergy. Liver and kidney function tests. Comprehensive physical examination with emphasis on the genito-urinary tract analysis to include sperm count, motility and morphology. Other tests, such as serum testosterone, serum follicle stimulating hormone (FSH), and serum lutenizing hormone (LH) may be carried out if, in the opinion of a physician, they are indicated.
First Aid Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact

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Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens.

with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of dermal and/or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. For emergency situations, wear a positive pressure, pressure-demand, full facepiece self-contained breathing apparatus (SCBA); or pressure-demand supplied air respirator with escape SCBA and a fully-encapsulating, chemical resistant suit.

Respirator Selection: Based on potential carcinogenicity the following is recommended by NIOSH: *At any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA -or European Standard EN 149-approved SCBA that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full-face-piece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA). May react with mineral or clay based absorbents.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft[70]. Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills*: with clean shovel place material into clean, dry container and cover; move containers from spill area. *Large spills*: dike far ahead of spill for later disposal. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition (heated >285°C) products include hydrogen chloride and oxides of nitrogen and carbon. *Fire involving storage or vehicular tanks*: Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. *Small fire*: Dry chemical, carbon dioxide or water spray. *Large fire*: dry chemical, carbon dioxide, alcohol-resistant foam or water spray. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal; do not scatter the material. *Fire involving tanks or car/trailer loads*: Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Do not get water inside containers. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. Always stay away from tanks engulfed in fire. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies.

Disposal Method Suggested: In accordance with 40CFR 165 recommendations for the disposal of pesticides and pesticide containers. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(102); (31); (173); (101); (138); (100).

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International Programme on Chemical Safety (IPCS), "Health and Safety Guide, Pesticide Residues in Food, 2000, Imazalil," Geneva, Switzerland, (2000). http://www.inchem.org/documents/jmpr/jmpmono/v00pr08.htm.

Imazethabenz-methyl I:0078

Formula: $C_{16}H_{20}N_2O_3$

Synonyms: Assert; Benzoic acid, 2-(4,5-dihydro-4-methyl-4-(1-methylethyl)-5-xox-1*H*-imidazol-2-yl)-4 (or 5)-methyl-, methyl ester; Dagger; 2[4,5-Dihydro-4-methyl-4-(1-methylethyl)-5-*oxo*-1*H*-imidazol-2-yl]-4 (or 5)-methylbenzoic acid methyl ester; Imazamethabenz; Methyl 6-(4-isopropyl-4-methyl-5-*oxo*-2-imidazolin-2-yl)-*m*-toluate); (Methyl 6-(4-isopropyl-4-methyl-5-*oxo*-2-imidazolin-2-yl)-*m*-toluate plus Methyl 6-(4-isopropyl-4-methyl-5-*oxo*-2-imidazolin-2-yl)-m-toluate); *m*-(or *p*-)Toluic acid, 6-(4-isopropyl-4-methyl-5-*oxo*-2-imidazolin-2-yl)-, methyl ester; *m*-(or *p*-)Toluic acid, 2-(4,5-dihydro-4-methyl-4-isopropyl-5-*oxo*-1*H*-imidazol-2-yl)-, methyl ester

CAS Number: 81405-85-8

HSDB Number: 6675

RTECS Number: DG8576140

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: Not assigned

Regulatory Authority and Advisory Information

Carcinogenicity[83]: EPA Group D, Not classifiable as a human carcinogen

Description: White or slightly yellow powder. Musty odor. Molecular weight = 288.33; specific gravity (H_2O:1) = 0.33 @ 20°C; freezing/melting point = 133–145°C; vapor pressure = 1.2×10^{-8} mmHg @ 25°C; flash point = 91°C. Soluble in water. Physical and toxicological properties may be affected by carrier solvents in commercial formulations.

Potential Exposure: Imidazolinone herbicide generally used as a herbicide on small grain crops. Actively registered for use in the United States Not registered for use in EU, as imazamethabenz.

Incompatibilities: Incompatible with oxidizers, chlorates nitrates, peroxides; and alkaline materials. Strongly acidic, a corrosive material; may attack some metals, including aluminum and steel, and some coatings, especially in the presence of moisture.

Permissible Concentration in Water: Runoff from spills or fire control may cause water pollution.

Determination in Water: Octanol–water coefficient: Log $K_{ow} = < 2.0$. Unlikely to bioaccumulate in marine organisms. Fish toxicity (threshold)[101]: Very low—515.35916 ppb, MATC

Harmful Effects and Symptoms

Short-Term Exposure: May cause irritation to the eyes, skin, or respiratory tract. High levels may cause permanent eye damage. May be toxic if ingested or absorbed through the skin. LD_{50} (oral, rat) = > 5 g/kg.; LD_{50} (dermal, rat) = > 2 g/kg.

Long-Term Exposure: Human toxicity (long term)[101]: Very low—441.00 ppb, Health Advisory.

Medical Surveillance: Preliminary medical exam to detect chronic diseases of central nervous system, liver, heart, kidneys, lung and skin, as well as endocrinological or immunological disturbances, should protect susceptible individuals. Periodical medical exams of internal organs, skin and eyes are important to avoid chronic occupational intoxications. They should include lab and patch tests when necessary[83].

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Applicators and other handlers must wear: Coveralls worn over long-sleeved shirt and long pants; Chemical-resistant gloves such as DuPont Tychem suit fabrics, barrier laminate, or Viton; Chemical-resistant footwear plus socks; Protective eye wear; Chemical-resistant headgear for overhead exposure; Chemical-resistant apron when cleaning equipment, mixing, or loading[83]. Agricultural Use/Engineering Controls: When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the Worker Protection Standard (WPS) for agricultural pesticides, 40 CFR 170.240(d)(4–6), the handler PPE requirements may be reduced or modified as specified in the WPS. Firefighters should wear NIOSH-approved SCBA and full protective clothing.

Respirator Selection: Wherever and whenever workplace conditions warrant respirator use, a respiratory protection program must be followed that meets one or more of the following government standards: OSHA's 29 CFR 1910.134, ANSI Z88.2, or European Standard EN 149.

Storage: Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen and carbon. As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 m/150 ft for liquids and at least 25 m/75 ft for solids. *Fire involving storage or vehicular tanks*: Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m (1/2 mi) in all directions. *On a small fire*: use dry chemical, CO_2, water spray or regular *foam. On a large fire*: use water spray, fog or regular foam. Do not scatter spilled material with high pressure streams of water. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal. *Fire involving tanks*: From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. Always stay away from tanks engulfed in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: It is the responsibility of chemical waste generators to determine if a discarded chemical is classified as a hazardous waste. See 40 CFR Parts 261.3 for United States Environmental Protection Agency guidelines for the classification determination. Additionally, in order to ensure complete and accurate classification, waste generators must consult state and local hazardous waste regulations.

References

(31); (173); (101); (138).

Imazaquin I:0084

Formula: $C_{17}H_{17}N_3O_3$; $C_{17}H_{20}N_4O_3$(ammonium salt)

Synonyms: 2-[4,5-Dihydro-4-methyl-4-(1-methylethyl)-5-*oxo*-1*H*-imidazol-2-yl]-3-quinolinecarboxylic acid; Quinolinecarboxylic acid, 2-(5-isopropyl-5-methyl-4-*oxo*-2-imidazolin-2-yl)-; 3-Quinolinecarboxylic acid, 2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-*oxo*-1*H*-imidazol-2-yl]-*ammonium salt*: AC 252,214; Ala-Scept; Ammonium imazaquin; Backdraft; CL 252,214; Detail; 2-(4,5-dihydro-4-methyl-4-(1-methylethyl)-5-*oxo*-1*H*-imidazol-2-yl)-3-quinolinecarboxylic acid monoammonium salt; Image herbicide consumer concentrate (ammonium salt); Meteor; Mon-9850; Partner imazaquin; Scepter; Squadron (with pendimethalin); Tri-Scept; Upright

CAS Number: 81335-37-7

HSDB Number: 6677

RTECS Number: VB2009800

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Agricultural chemical.

Hazard symbols, risk, & safety statements: Hazard symbol: Xn, N; risk phrases: R21; safety phrases: S29/35; S36; S41; S41 (see Appendix 4)

Description: A gray crystalline solid. Commercial products available as a concentrated liquid. Pungent odor. Molecular weight = 311.337; 328.27 (ammonium salt); boiling point = (decomposes); freezing/melting point = 220°C; 219−224°C (ammonium salt); vapor pressure = 7×10^{-9} mmHg @ 25°C. Soluble in water; solubility = 100 mg/L. Physical and toxicological properties may be affected by carrier solvents in commercial formulations.

Potential Exposure: Imazaquin is an imidazolinone plant growth regulator selective, preemergence and postemergence herbicide used to control grasses and broadleaf weeds. It is used on corn, wheat, soybeans, turf and ornamentals.

Incompatibilities: May react violently with strong oxidizers, bromine, 90% hydrogen peroxide, phosphorus trichloride, silver powders or dust. Incompatible with silver compounds. Mixture with some silver compounds forms explosive salts of silver oxalate. Decomposes in temperatures $>240°C$.

Permissible Concentration in Water: Runoff from spills or fire control may cause water pollution.

Determination in Water: Octanol−water coefficient: Log K_{ow} = negative. Unlikely to bioaccumulate in marine organisms. Fish toxicity (threshold)[101]: Very low—61926.11430 ppb, MATC.

Harmful Effects and Symptoms

Short-Term Exposure: May cause irritation to the eyes, skin, or respiratory tract. May be toxic if ingested or absorbed through the skin. LD_{50} (oral, rat) = 5 g/kg.; LD_{50} (dermal, rat) = >2 g/kg.

Long-Term Exposure: Human toxicity (long term)[101]: Very low—1750.00 ppb, Health Advisory

Medical Surveillance: Preliminary medical exam to detect chronic diseases of central nervous system, liver, heart, kidneys, lung and skin, as well as endocrinological or immunological disturbances, should protect susceptible individuals. Periodical medical exams of internal organs, skin and eyes are important to avoid chronic occupational intoxications. They should include lab and patch tests when necessary[83].

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Applicators and other handlers must wear: Coveralls worn over long-sleeved shirt and long pants; Chemical-resistant gloves such as DuPont Tychem suit fabrics, barrier laminate, or Viton; Chemical-resistant footwear plus socks; Protective eye wear; Chemical-resistant headgear for overhead exposure; Chemical-resistant apron when cleaning equipment, mixing, or loading[83]. Agricultural Use/Engineering Controls: When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the WPS for agricultural pesticides, 40 CFR 170.240(d)(4−6), the handler PPE requirements may be reduced or modified as specified in the WPS. Firefighters should wear NIOSH-approved SCBA and full protective clothing.

Respirator Selection: Wherever and whenever workplace conditions warrant respirator use, a respiratory protection program must be followed that meets one or more of the following government standards: OSHA's 29 CFR 1910.134, ANSI Z88.2, or European Standard EN 149.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen and carbon. As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 m/150 ft for liquids and at least 25 m/75 ft for solids. Fire involving storage or vehicular tanks: Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. On a small fire: use dry chemical, CO_2, water spray or regular foam. On a large fire: use water spray, fog or regular foam. Do not scatter spilled material with high pressure streams of water. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal. Fire involving tanks: From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. Always stay away from tanks engulfed in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: It is the responsibility of chemical waste generators to determine the toxicity and physical properties and of a discarded chemical and to properly identify its classification and certification as a hazardous waste and to determine the disposal method. United States Environmental Protection Agency guidelines for the classification determination are listed in 40 CFR Parts 261.3. Additionally, waste generators must consult and follow all regional, national, state and local hazardous waste laws to ensure complete and accurate classification and disposal methods.

References

(31); (173); (101); (138).

EXTOXNET, Extension Toxicology Network, "Pesticide Information Profile, Imazaquin," Oregon State University, Corvallis, OR. http://extoxnet.orst.edu/pips/imazaqui.htm.

United States Environmental Protection Agency, Office of Pesticide Programs, Pesticide Residue Limits, "Imazaquin," 40 CFR 180.426, http://www.epa.gov/pesticides/food/viewtols.htm.

United States Environmental Protection Agency, Office of Pesticide Programs, Office of Pesticide Programs, Registration Division, Pesticide Fact Sheet, No. 83. United States Environmental Protection Agency, 3/20/ 1986. Washington, DC.

Imazethapyr I:0090

Formula: $C_{15}H_{19}N_3O_3$; $C_{15}H_{22}N_4O_3$ (ammonium salt)
Synonyms: Ammonium salt of (±)-2-(4,5-dihydro-4-methyl-4-(1-methylethyl)-5-*oxo*-1*H*-imidazol-2-yl)-5-ethyl-3-pyridinecarboxylic acid(±)-2-(4,5-Dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1*H*-; Imidazol-2-yl)-5-ethyl-3-pyridinecarboxylic acid, ammonium salt; AC-263499; Cl-263499; Contour; (±)-2-[4,5-Dihydro-4-methyl-4-(1-methylethyl)-5-*oxo*-1*H*-imadazol-2-yl]-5-ethyl-3-pyridinecarboxylic acid; (±)-5-Ethyl-2-(4-isopropyl-4-methyl-5-*oxo*-2-imidazolin-2-yl)nicotinic acid; (±)-5-Ethyl-2-(4-isopropyl-4-methyl-5-*oxo*-1*H*-imidazolin-2-yl)nicotinic acid (ammonium salt); Extreme; Hammer; Lightning; Odyssey, (imazamox + imazethapyr); Overtop; Patriot, (atrazine + imazethapyr); Passport; Pivot; Pursuit, (ammonium salt of); Pursuit dg herbicide; Resolve; Standout; Valor, (imazethapyr + pendimethalin)
CAS Number: 81335-77-5; 101917-66-2 (ammonium salt)
HSDB Number: 6678
RTECS Number: US5682900
UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171
EC Number: 617-222-4
Regulatory Authority and Advisory Information
Carcinogenicity[83]: EPA, Not likely to be carcinogenic to humans.
Potential Ground water Pollutant [California FAC Section 13145(d)/12811, inactive; ammonium salt is active)
Description: Colorless to slightly yellowish crystalline solid. Pungent odor. Molecular weight = 289.33; specific gravity (H_2O:1) = 1.11; boiling point = (decomposes); freezing/melting point = 173 °C. Highly soluble in water; solubility = 1.42×10^3 mg/L.
Potential Exposure: Imazethapyr is an imidazolinone, general use, selective preemergence herbicide that is used to control grasses and broadleaf weeds on a variety of field and vegetable crops including dry and edible beans, peas, soybeans, peanuts, alfalfa, and corn.
Incompatibilities: May react violently with strong oxidizers, bromine, 90% hydrogen peroxide, phosphorus trichloride, silver powders or dust. Incompatible with silver compounds. Corrosive to zinc, mild steel, brass, copper and aluminum. Mixture with some silver compounds forms explosive salts of silver oxalate
Permissible Concentration in Water: Runoff from spills or fire control may cause water pollution.
Determination in Water: Octanol−water coefficient: Log $K_{ow} = < 2.0$. Unlikely to bioaccumulate in marine organisms. Fish toxicity (threshold)[101]: Very low—52267.57728 ppb, MATC
Harmful Effects and Symptoms
Short-Term Exposure: May cause irritation to the eyes, skin, or respiratory tract. May be toxic if ingested or absorbed through the skin. LD_{50} (oral, rat) = > 5 g/kg; (dermal, rat) = > 2 g/kg; (inhalation, rat) = 3.27 mg/L[83].
Long-Term Exposure: Human toxicity (long term)[101]: Very low—1750.00 ppb, Health Advisory.
Medical Surveillance: Preliminary medical exam to detect chronic diseases of central nervous system, liver, heart, kidneys, lung and skin, as well as endocrinological or immunological disturbances, should protect susceptible individuals. Periodical medical exams of internal organs, skin and eyes are important to avoid chronic occupational intoxications. They should include lab and patch tests when necessary[83].
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.
Personal Protective Methods: Applicators and other handlers must wear: Coveralls worn over long-sleeved shirt and long pants; Chemical-resistant gloves such as DuPont Tychem suit fabrics, barrier laminate, or Viton; Chemical-resistant footwear plus socks; Protective eye wear; Chemical-resistant headgear for overhead exposure; Chemical-resistant apron when cleaning equipment, mixing, or loading[83]. Agricultural Use/Engineering Controls: When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the WPS for agricultural pesticides, 40 CFR 170.240(d)(4−6), the handler PPE requirements may be reduced or modified as specified in the WPS. Firefighters should wear NIOSH-approved SCBA and full protective clothing.
Respirator Selection: Wherever and whenever workplace conditions warrant respirator use, a respiratory protection program must be followed that meets one or more of the following government standards: OSHA's 29 CFR 1910.134, ANSI Z88.2, or European Standard EN 149.
Storage: Color code—Green: General storage may be used. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.
Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.
Spill Handling: If a spill occurs, clean it up promptly. Don't wash it away. Instead, sprinkle the spill with sawdust, vermiculite, or kitty litter. Sweep it into a plastic garbage bag, and dispose of it as directed on the pesticide

product label. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen and carbon. As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 m/150 ft for liquids and at least 25 m/75 ft for solids. *Fire involving storage or vehicular tanks*: Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m (1/2 mi) in all directions. *On a small fire*: use dry chemical, CO_2, water spray or regular *foam. On a large fire*: use water spray, fog or regular foam. Do not scatter spilled material with high pressure streams of water. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal. *Fire involving tanks*: From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. Always stay away from tanks engulfed in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: It is the responsibility of chemical waste generators to determine if a discarded chemical is classified as a hazardous waste. See 40 CFR Parts 261.3 for United States Environmental Protection Agency guidelines for the classification determination. Additionally, in order to ensure complete and accurate classification, waste generators must consult state and local hazardous waste regulations.

References

(31); (173); (101); (138).

EXTOXNET, Extension Toxicology Network, “Pesticide Information Profile, Imazethapyr,” Oregon State University, Corvallis, OR (February 1996). http://extoxnet.orst.edu/pips/imazetha.htm.

United States Environmental Protection Agency, Office of Pesticide Programs, Pesticide Residue Limits, “Imazethapyr,” 40 CFR 180.447. http://www.epa.gov/pesticides/food/viewtols.htm.

Imidacloprid I:0092

Formula: $C_9H_{10}ClN_5O_2$

Synonyms: Admire; 1-[(6-Chloro-3-pyridinyl)methyl]-*N*-nitro-2-imidazolidiniminebenzoate; 1-[(6-Chloro-3-pyridinyl)methyl]-4,5-dihydro-*N*-nitro-1*H*-imidazol-2-amine; 1-(2-Chloro-5-pyridylmethyl)-2-(nitroamino)imidazolidine; Confidor 2.5% granular; Confidor 2% flowable; Encore; Gaucho; Imicide; 1*H*-Imidazol-2-amine, 1-[(6-chloro-3-pyridinyl)methyl]-4,5-dihydro-*N*-nitro-; 2-Imidazolidinimine, 1-[(6-chloro-3-pyridinyl)methyl]-*N*-nitro-benzoate; Leverage; Marathon; Merit ntn 33893; Premier; Premise; Prescribe; Protreat; Provado; Trimax

CAS Number: 138261-41-3; 105827-78-9

HSDB Number: 7373

RTECS Number: NJ0560000

UN/NA & ERG Number: UN2588 (Pesticides, solid, toxic, n.o.s.)/151; UN3082 (environmentally hazardous substances, liquid, n.o.s.)/171

EC Number: 428-040-8 [*Annex I Index No.*: 612-252-00-4]

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Environmental hazard.

Potential Ground water Pollutant [California FAC Section 13145(d)/12811, active]

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292].

Hazard symbols, risk, & safety statements: Hazard symbol: Xi, Xn, N; risk phrases: R22; R50/53; safety phrases: S2; S22; S29/35; S41; S57; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Colorless (when pure) to off-white crystalline solid Slight characteristic odor. The commercial product is often water soluble granules. Molecular weight = 255.7; specific gravity (H_2O:1) = 1.55 @ 25°C; boiling point = (decomposes); freezing/melting point = 145°C; vapor pressure = 5×10^{-12} mmHg @ 25°C. Highly soluble in water; solubility = 600 mg/L. Physical and toxicological properties may be affected by carrier solvents in commercial formulations.

Potential Exposure: Neonicotinoid/chloronicotinyl insecticide. Effective 12/1/2013, A two-year ban and severe restriction the use of neonicotinoids for seed treatment, soil application (granules) and foliar treatment on bee attractive plants and cereals. One of the most heavily used pesticide in the world. A systemic insecticide used to control sucking insects in the soil, seeds and foliar environments. It is one of the most-used pesticides in the world and has a broad variety of both agriculture and nonagricultural uses, including on pets and household environments. Used on rice, cereals, maize, vegetables, fruit, sugar beets, potatoes, cotton, hops, and turf. It is related to nicotine and acts on the nervous system. A United States Environmental Protection Agency Restricted Use Pesticide (RUP).

Incompatibilities: Combustible solid. Dust may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Decomposes in temperatures above 225°C.

Permissible Concentration in Water: Federal Drinking Water Guidelines: 400 ppb[14].

Determination in Water: Octanol−water coefficient: Log $K_{ow} = < 0.6$. Unlikely to bioaccumulate in marine organisms. Fish toxicity (threshold)[101]: Very low—1199.99656 ppb, MATC.

Routes of Entry: Dermal contact, inhalation, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: *Inhalation*: Causes labored breathing. *Ingestion*: May cause convulsions, vomiting, diarrhea. May attack central nervous system causing apathy, incoordination. LD_{50} (oral, rat) = 450−500 mg/kg; (dermal, rat) = > 5 g/kg.

Long-Term Exposure: May affect the central nervous system. Human toxicity (long term)[101]: Very low—399.00 ppb, Health Advisory.

Points of Attack: Central nervous system, lungs, digestive system.

Medical Surveillance: Exposed persons should contact a physician for advice regarding the possible long term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Applicators and other handlers must wear: Coveralls worn over long-sleeved shirt and long pants; Chemical-resistant gloves such as DuPont Tychem suit fabrics, barrier laminate, or Viton; Chemical-resistant footwear plus socks; Protective eye wear; Chemical-resistant headgear for overhead exposure; Chemical-resistant apron when cleaning equipment, mixing, or loading[83]. Agricultural Use/Engineering Controls: When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the WPS for agricultural pesticides, 40 CFR 170.240(d)(4−6), the handler PPE requirements may be reduced or modified as specified in the WPS. Firefighters should wear NIOSH-approved SCBA and full protective clothing.

Respirator Selection: Where the neat (undiluted) test chemical is weighed and diluted, wear a NIOSH-approved half face respirator equipped with a combination filter cartridge, i.e. organic vapor/acid gas/HEPA (specific for organic vapors, HCl, acid gas, SO_2 and a high efficiency particulate filter)[88]

Storage: Color code—Blue: Health Hazard/Poison. Store in a tightly closed container in a dry, well-ventilated and secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Where possible, automatically transfer material from other storage containers to process containers. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN2588 Pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN3082 Environmentally hazardous substances, liquid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen and carbon and hydrogen chloride gas. This chemical is combustible; it may burn but does not easily ignite. As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 m/150 ft for liquids and at least 25 m/75 ft for solids. *Fire involving storage or vehicular tanks*: Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. *On a small fire*: use dry chemical, CO_2, water spray or regular *foam. On a large fire*: use water spray, fog or regular foam. Do not scatter spilled material with high pressure streams of water. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal. *Fire involving tanks*: From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. Always stay away from tanks engulfed in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for

firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office. If this material cannot be disposed of according to label instructions, it may be dissolved or mixed with a combustible solvent and burned in a chemical incinerator equipped with an afterburner and scrubber. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers.

References

(31); (173); (101); (138); (100).

EXTOXNET, Extension Toxicology Network, "Pesticide Information Profile, Imidacloprid," Oregon State University, Corvallis, OR http://extoxnet.orst.edu/pips/imidaclo.htm.

Journal of Pesticide Reform, "Insecticide Factsheet, Imidacloprid," Northwest Coalition for Alternatives to Pesticides, Spring 2001, Vol.21, No. 1. http://www.pesticide.org/imidacloprid.pdf.

United States Environmental Protection Agency, Office of Pesticide Programs, Pesticide Residue Limits, "Imidacloprid", 40 CFR 180.472, http://www.epa.gov/pesticides/food/viewtols.htm.

Fishel, Frederick M., Document PI-80, Pesticide Information Office, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, FL, October 2005; Revised February 2013.

Gervais, J. A.; Luukinen, B.; Buhl, K.; Stone, D., *Imidacloprid Technical Fact Sheet*; National Pesticide Information Center, Oregon State University Extension Services, Corvallis, OR (2010).

Indene I:0100

Formula: $C_9H_2O_8$; $CH = CHCH = CHC = CCH = CHCH_2$

Synonyms: IH-Indene; Indonaphthene

CAS Registry Number: 95-13-6

HSDB Number: 5286

RTECS Number: NK8225000

UN/NA & ERG Number: UN/NA1993 (Combustible/flammable liquid, n.o.s.)/128. Only regulated when shipped in bulk. UN3295

EC Number: 202-393-6

Regulatory Authority and Advisory Information

Hazard Alert: Flammable liquid, Poison, Polymerization hazard.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xn; risk phrases: R10; R19; R65; safety phrases: S23; S24/25; S62; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Indene is a colorless liquid from coal tars. The odor threshold is 0.015 ppm. Molecular weight = 116.16; specific gravity (H_2O:1) = 0.997; boiling point = 182 °C; freezing/melting point = −1.5°C; vapor pressure = 0.75 mmHg@ 12°C; flash point = 50°C; −2.0°C[101]. Hazard Identification (based on NFPA-704 M Rating System): Health 2, flammability 2, reactivity 1. Practically insoluble in water.

Potential Exposure: Indene is used in the preparation of synthetic resins, such as coumarone indene resins. It is also used as an organic intermediate. It is an asphalt and naphtha constituent; from petroleum refining and coke processing.

Incompatibilities: Vapor may form explosive mixture with air. Contact with strong oxidizers; strong acids may cause fire and explosion hazard. Polymerizes and oxidizes on standing. Sunlight can cause polymerization. It has exploded during nitration with sulfuric acid + nitric acid.

Permissible Exposure Limits (PELs) in Air

Conversion factor: 1 ppm = 4.75 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: None

NIOSH REL: 10 ppm/45 milligram per cubic meter TWA

ACGIH TLV[1]: 5 ppm/24 milligram per cubic meter TWA

PAC Ver. 29[138]

PAC-1: 15 ppm

PAC-2: 22 ppm

PAC-3: 130 ppm

Australia: TWA 10 ppm (45 milligram per cubic meter), 1993; Belgium: TWA 10 ppm (48 milligram per cubic meter), 1993; Denmark: TWA 10 ppm (45 milligram per cubic meter), 1999; Finland: TWA 10 ppm (47 milligram per cubic meter); STEL 20 ppm (95 milligram per cubic meter), 1999; France: VME 10 ppm (45 milligram per cubic meter), 1999; Norway: TWA 10 ppm (45 milligram per cubic meter), 1999; Switzerland: MAK-W 10 ppm (45 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 45 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 10 ppm. Several states have set guidelines or standards for indene in ambient air[60] ranging from 450−700 μ/m^3 (North Dakota) to 750 μ/m^3 (Virginia) to 900 μ/m^3 (Connecticut) to 1,071 μ/m^3 (Nevada).

Determination in Air: No method listed. The following are used for coal tar products: OSHA Analytical Method 58. See also NIOSH Analytical Method #5506 by HPLC; #5515 by GC.

Permissible Concentration in Water: No criteria set, but EPA[32] has suggested a permissible ambient goal of 621 μg/L based on health effects.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: May cause eye, skin, and respiratory irritation. Animal studies have shown that liver damage and occasionally, spleen and kidney injury result from exposure to high (800−900 ppm) vapor concentrations. Liquid indene defatted the skin but did not cause dermatitis. Aspiration of liquid into the lung caused pneumonitis, pulmonary edema and hemorrhage in laboratory animals.

Long-Term Exposure: May cause skin sensitization and allergy. Has caused liver, kidney, and spleen injury in laboratory animals.

Points of Attack: Eyes, skin, respiratory system; liver, kidneys, spleen.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function tests. Examination by a qualified allergist to diagnose skin allergy. Medical surveillance shall be made available, as specified below, to all employees occupationally exposed to coal tar products. *Preplacement Medical Examinations*: These examinations shall include: Comprehensive initial medical and work histories, with special emphasis directed toward identifying preexisting disorders of the skin; respiratory tract; liver, and kidneys. A physical examination giving particular attention to the oral cavity, skin, and respiratory system. This shall include posteroanterior and lateral chest X-rays (35 × 42 cm). Pulmonary function tests, including forced vital capacity (FVC) and forced expiratory volume @ 1 second (FEV 1.0); and a sputum cytology examination shall be offered as part of the medical examination of exposed employees. Other tests, such as liver function and urinalysis, should be performed as considered appropriate by the responsible physician. In addition, the mucous membranes of the oral cavity should be examined. A judgment of the employee's ability to use positive pressure respirators. *Periodic Examinations*: These examinations shall be made available at least annually and shall include: Interim medical and work histories. A physical examination as outlined above. *Initial Medical Examinations*: These examinations shall be made available to all workers as soon as practicable after the promulgation of a standard based on these recommendations. *Pertinent Medical Records*: These records shall be maintained for at least 30 years after termination of employment. They shall be made available to medical representatives of the government, the employer or the employee.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures *over 10* ppm; Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator with an organic vapor cartridge/canister. More protection is provided by a full facepiece respirator than by a half-mask respirator, and even greater protection is provided by a powered-air purifying respirator. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: (1) Color code—Red: Flammability Hazard: Store in a flammable (liquid or solid materials) storage area or approved cabinet away from sources if ignition. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area separated from strong oxidants, strong bases; strong acids. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN3295 Hydrocarbons, liquid, n.o.s., Hazard Class: 3; Labels: 3-Flammable liquid. UN1993

Flammable liquids, n.o.s., Hazard Class: 3; Labels: 3-Flammable liquid, Technical Name Required. NA1993 Combustible liquids, n.o.s., Hazard Class: 3; Labels: 3-Flammable liquid, Technical Name Required. (Domestic U.S.). Only regulated when shipped in bulk as a Class 3 combustible liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Indene is a flammable liquid. Thermal decomposition products may include oxides of carbon. Extinguish fire using an agent suitable for type of surrounding fire. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Indene, Trenton, NJ (November 1999).

Indeno(1,2,3-*cd*)pyrene I:0110

Formula: $C_{22}H_{12}$

Synonyms: Indenopyrene; IP; *o*-Phenylenepyrene; 1,10-(*o*-Phenylene)pyrene; 1,10-(1,2-Phenylene)pyrene; 2,3-*o*-Phenylenepyrene; 2,3-Phenylenepyrene

CAS Registry Number: 193-39-5

HSDB Number: 5101

RTECS Number: NK9300000

UN/NA & ERG Number: UN2811 (Toxic solids, organic, n.o.s.)/154; UN3077 (environmentally hazardous substances, solid, n.o.s.)/171 (bulk only)

EC Number: 205-893-2

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Sufficient Evidence, Human No Adequate Data, *possibly carcinogenic to humans*, Group 2B, 1997; NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies. Handle with caution as several related polynuclear aromatic hydrocarbons are known carcinogens. NIOSH has recommended that coal tar pitch volatiles, including polycyclic aromatic hydrocarbons (PAHs) be treated as potential human carcinogen. United States Environmental Protection Agency Gene-Tox Program, Positive: Carcinogenicity-mouse/rat.

California Proposition 65 Chemical[102]: Cancer 1/1/1988.

Hazard Alert: Poison, Combustible, Possible risk of forming tumors, Suspected reprotoxic hazard.

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; Section 307(a)(1) Toxic pollutant designated, pursuant to of the and is subject to effluent limitations as polycyclic aromatic hydrocarbons (PAHs)

United States National Primary Drinking Water Regulations: MCLG = zero mg/L; MCL = 0.0002 mg/L as polycyclic aromatic hydrocarbons (PAHs).

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U139

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.0055; Nonwastewater (mg/kg), 3.4

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8100 (200); 8270 (10)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N, Xn; risk phrases: R45; R38; R39/23/24/29; R40; R60; R61; R62; R65; R67; safety phrases: S7; S16; S36/37; S45; S53; S60; S61; S62 (see Appendix 4)

Description: Indeno(1,2,3-*c*,*d*)pyrene is a yellow crystalline solid. Polycyclic aromatic hydrocarbons (PAHs) are compounds containing multiple benzene rings and are also called polynuclear aromatic hydrocarbons. Molecular weight = 276.34; boiling point = 536 °C; freezing/melting point = 162.5−164°C. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 1, reactivity 0. Insoluble in water.

Potential Exposure: Found in internal combustion engine exhausts; cigarette smoke condensate; soot, coal tar pitch.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

PELs in Air

NIOSH IDLH = 80 milligram per cubic meter as coal tar pitch volatiles

OSHA PEL: 0.2 milligram per cubic meter TWA [1910.1002] (benzene-soluble fraction). OSHA defines "coal tar pitch volatiles" in 29 CFR 1910.1002 as the fused polycyclic hydrocarbons that volatilize from the distillation residues of coal, petroleum (excluding asphalt), wood, and other organic matter.

NIOSH REL: 0.1 milligram per cubic meter (cyclohexane-extractable fraction). NIOSH considers coal tar products (i.e., coal tar, coal tar pitch, or creosote) to be potential occupational carcinogens

ACGIH TLV[1]: 0.2 milligram per cubic meter TWA (as benzene soluble aerosol); Confirmed Human Carcinogen

PAC Ver. 29[138]

PAC-1: 1.2 milligram per cubic meter

PAC-2: 13 milligram per cubic meter

PAC-3: 79 milligram per cubic meter

DFG MAK: [skin] danger of skin sensitization; Carcinogen Category 2 Austria: carcinogen, 1999; France: carcinogen, 1993

Determination in Air: Use NIOSH Analytical Method #5506 polycyclic aromatic hydrocarbons by HPLC; NIOSH Analytical Method #5515, Polycyclic aromatic hydrocarbons by GC; OSHA Analytical Method ID-58.

Permissible Concentration in Water: For the maximum protection of human health from the potential carcinogenic effects due to exposure of polynuclear aromatic hydrocarbons through ingestion of contaminated water and contaminated aquatic organisms, therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 1×10^{-5}, 1×10^{-6}, and 1×10^{-7}. The corresponding criteria are 28.0, 2.8, and 0.28 ng/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 311.0, 31.1, and 3.11 ng/L respectively.

Determination in Water: Methylene chloride extraction followed by high performance liquid chromatography (HPLC); with fluorescence or UV detection; or gas chromatography (EPA Method 610; by gas chromatography plus mass spectrometry (EPA Method 625). Octanol−water coefficient: Log $K_{\text{ow}} = > 6$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Ingestion, inhalation eye and/or skin contact.

Harmful Effects and Symptoms

Long-Term Exposure: May be carcinogenic in humans. Repeated exposure may cause dermatitis, bronchitis. Indeno(1,2,3-*cd*)pyrene is a complete carcinogen and an initiator for skin carcinogenesis in the mouse. Subcutaneous injections in mice produce local sarcomas.

Points of Attack: Respiratory system, skin, bladder, kidneys. Cancer site for coal tar pitch volatiles is lung, kidney and skin cancer.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Medical surveillance shall be made available, as specified below, to all employees occupationally exposed to coal tar products. *Preplacement Medical Examinations*: These examinations shall include: Comprehensive initial medical and work histories, with special emphasis directed toward identifying preexisting disorders of the skin; respiratory tract; liver, and kidneys. A physical examination giving particular attention to the oral cavity, skin, and respiratory system. This shall include posteroanterior and lateral chest X-rays (35 × 42 cm). Pulmonary function tests, including FVC and forced expiratory volume @ 1 second (FEV 1.0); and a sputum cytology examination shall be offered as part of the medical examination of exposed employees. Other tests, such as liver function and urinalysis, should be performed as considered appropriate by the responsible physician. In addition, the mucous membranes of the oral cavity should be examined. A judgment of the employee's ability to use positive pressure respirators. *Periodic Examinations*: These examinations shall be made available at least annually and shall include: Interim medical and work histories. A physical examination as outlined above. *Initial Medical Examinations*: These examinations shall be made available to all workers as soon as practicable after the promulgation of a standard based on these recommendations. *Pertinent Medical Records*: These records shall be maintained for at least 30 years after termination of employment. They shall be made available to medical representatives of the government, the employer or the employee.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable

probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Green: General storage may be used. Prior to working with IP all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft[70]. Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. IP itself burns only with difficulty. Thermal decomposition products may include oxides of carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Indeno(1,2,3-*cd*)pyrene may be destroyed by permanganate oxidation; by high-temperature incineration with scrubbing equipment or by microwave plasma treatment. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(109); (102); (31); (173); (101); (138); (2); (18).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Indeno(1,2,3-*cd*)pyrene, Trenton, NJ (March 2007).

Indium and Compounds I:0120

Formula: In

Synonyms: Elemental indium; Indium metal

CAS Registry Number: 7440-74-6 (elemental); 13464-82-9 (sulfate); 13770-61-1 (nitrate); 1312-43-2 (oxide); 10025-82-8 (trichloride)

HSDB Number: 6972 (7440-74-6)

RTECS Number: NL1050000 (elemental); NL1925000 (sulfate); NL1400000 (trichloride)

UN/NA & ERG Number: UN3089 (powder)/170 (7440-74-6)

EC Number: 231-180-0 (elemental); 236-689-1 (sulfate); 237-393-5 (nitrate); 10025-82-8 (trichloride)

Regulatory Authority and Advisory Information

7440-74-6, elemental and others as noted

Hazard Alert: (chloride), Suspected of causing genetic defects, Suspected reprotoxic hazard.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. (all indium compounds).

Hazard symbols, risk, & safety statements: Hazard symbol: C, F, Xn, Xn; risk phrases: R11; R20/21/22; R25; R26; R34; R36/37/38; S41; R60; R61 R62; R63; safety phrases: S9; S16; S26; S28; S36/37/39; S41; S45 (see Appendix 4)

Description: Indium metal, In, is malleable, ductile, shiny, and softer than lead. May be found as a white or gray powder. Indium sulfate is a grayish-white, hygroscopic powder. Soluble in water. The two most important indium compounds are the oxide and sulfate. Indium, elemental unless otherwise specified: Molecular weight = 114.82 (elemental); 221.17 (trichloride); 277.64 (oxide); 245.64 (oxide vapor); 517.82 (sulfate); specific gravity 7.31 @ 20°C (elemental); 7.18 @ 20°C (oxide); 4 @ 20°C (trichloride); 3.44 (sulfate); boiling point = 2080°C (elemental); 600°C (trichloride); freezing/melting point = 156°C (elemental); 1913 (oxide). Insoluble in water. Explosive limits: LEL = 10,000 ppm; UEL: unknown. (sulfate). Hazard Identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 1. Finely divided indium forms hydroxide on contact with water.

Potential Exposure: Indium and its compounds are used as a dental alloy; used to make high quality solders and braze-bonded connectors; in automotive bearings (Europe only); in low-pressure sodium lamps (Europe). Also used in nuclear reactor control rod alloys; catalysts; indium oxide fuel cells; cryogenic gasket material. Indium oxide is used in coloring glass: a light to dark brown can be obtained, depending on the amount used. Indium sulfate is used in electroplating to prepare sulfate electrolytes. Radioisotopes of indium and indium compounds are also used for medical treatment of cancer and diagnostic organ scanning.

Incompatibilities: Not flammable in bulk; however, dust or powdered form may ignite when dispersed in air. Violent reaction with acetonitrile, dinitrogen tetroxide, mercury(II) bromide (at 350°C), sulfur (mixtures ignite when heated). Oxidizes readily at higher temperatures. Keep away from oxidizers.

PELs in Air

OSHA PEL: None

NIOSH REL: 0.1 milligram per cubic meter TWA; also applies to other indium compounds [as In]

ACGIH TLV[1]: 0.1 milligram per cubic meter TWA

PAC Ver. 29[138]

7440-74-6, elemental

PAC-1: 0.3 milligram per cubic meter

PAC-2: 3.3 milligram per cubic meter

PAC-3: 20 milligram per cubic meter

1312-43-2, oxide(III) & 1312-43-2, oxide (vapor)

PAC-1: 0.36 milligram per cubic meter

PAC-2: 4.8 milligram per cubic meter

PAC-3: 29 milligram per cubic meter

Australia: TWA 0.1 milligram per cubic meter, 1993; Belgium: TWA 0.1 milligram per cubic meter, 1993; Denmark: TWA 0.1 mg[In]/m^3, 1999; Finland: TWA 0.1 milligram per cubic meter, 1999; Norway: TWA 0.1 milligram per cubic meter, 1999; Switzerland: MAK-W 0.1 milligram per cubic meter, 1999; United Kingdom: TWA 0.1 mg[In]/m^3; STEL 0.3 mg[In]/m^3, 2000; the Netherlands: MAC-TGG 0.1 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 0.1 milligram per cubic meter. Several states have set guidelines or standards for indium in ambient air[60] ranging from zero (Connecticut) to 1.0 μ/m^3 (North Dakota) to 1.6 μ/m^3 (Virginia) to 2.0 μ/m^3 (Nevada).

PAC Ver. 29[138]

10025-82-8, trichloride

PAC-1: 0.58 milligram per cubic meter

PAC-2: 6.3 milligram per cubic meter

PAC-3: 38 milligram per cubic meter

Indium chloride:

United Kingdom: TWA 0.1 mg[In]/m^3; STEL 0.3 mg[In]/m^3, 2000; the Netherlands: MAC-TGG 0.1 mg[In]/m^3, 2003

13464-82-9, sulfate

PAC-1: 0.68 milligram per cubic meter

PAC-2: 7.6 milligram per cubic meter

PAC-3: 46 milligram per cubic meter

Determination in Air: NIOSH II(5) Method #7303, P&CAM #173; OSHA Analytical Method ID-121

Determination in Water: Neutron activation has been used to analyze for indium in seawater. The detection limit is 0.006 ng/L. Polarography has also been used to determine indium in water with a detection limit of 1.0 μg/L.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Indium can affect you when breathed in. Contact can irritate the skin and eyes. Exposure to high levels may damage the kidneys and liver. Indium can irritate the lungs and may cause permanent damage. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: Possible liver, kidney, heart, blood effects (NIOSH). Indium may damage the developing fetus. May damage the lungs.

Points of Attack: Irritation of eyes, skin, respiratory system; possible liver, kidney, heart, blood effects.

Medical Surveillance: Pregnant women should avoid contact. Employees should be notified by a physician that this chemical may affect the reproductive system. In addition to comprehensive initial medical and work histories emphasizing reproductive experience and menstrual history, patient should have physical examination and testing of genitourinary tract, sperm count, motility and morphology. If required, other tests, such as serum testosterone, serum FSH, and serum LH may be indicated. For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function tests, complete blood count (CBC). Consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure,

begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for Exposures over *0.1 milligram per cubic meter*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Red Stripe: Flammability Hazard: Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Store flammable solids up to maximum allowable quantity per control area in an approved flammable storage area. Do not store in a basement. Bulk quantities of indium *powder* are pyrophoric and require a Red Code. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where powder or dust may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from mineral acids and sulfur. Where possible, automatically transfer from drums or other storage containers to process containers.

Shipping: UN3089 Metal powders, flammable, n.o.s., Hazard Class: 4.1; Labels: 4.1-Flammable solid.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources and nonsparking tools when cleaning up powder and dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include metal oxides. Use special mixtures of dry chemicals appropriate for extinguishing metal fires. *Do not use water*. Extinguish fire using an agent suitable for type of surrounding fire. Indium itself does not burn, but indium powder and dust is flammable and may ignite when exposed to heat or flame. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Indium and its compounds are rated moderately toxic. Recovered indium has a recycled value, so a minimum quantity is discarded. Closed containers are required for the disposal of indium and its compounds. The environmental hazard from indium appears to result from the use and disposal of radioactive isotopes and not chemical toxicity.

References

(31); (173); (101); (138).

United States Environmental Protection Agency, Preliminary Investigation of Effects on the Environment of Boron, Indium, Nickel, Selenium, Tin, Vanadium and Their Compounds, Vol. II, Indium, Report EPA-460/2-75-005b, Washington, DC, Office of Toxic Substances (August 1975).

United States Environmental Protection Agency, Toxicology of Metals, Vol. II: Indium, Report EPA-600/1-77-022, Research Triangle Park, NC, pp 234−241 (May 1977).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Indium, Trenton, NJ (August 1999).

Iodine I:0140

Formula: I_2
Synonyms: Iodine crystals; Molecular iodine
CAS Registry Number: 7553-56-2
HSDB Number: 34
RTECS Number: NN1575000
UN/NA & ERG Number: UN3495/154; UN1759 (corrosive solids, n.o.s.)/154
EC Number: 231-442-4 [*Annex I Index No.*: 053-001-00-3]

Regulatory Authority and Advisory Information

Hazard Alert: Poison, High acute toxicity, Suspected of causing genetic defects, Environmental hazard.

FDA-over the counter drug

List 1, DEA chemical code 6699 (Title 21 CFR1310.02)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.; Class E.

Hazardous to aquatic life or environment, with possible long-lasting effects[291]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, Xn, N; risk phrases: R20/21; R51; R62; safety phrases: S2; S23; S25; S29/35; S41; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to waters.

Description: Iodine is a blue-black or violet solid with a sharp, characteristic odor. Molecular weight = 253.81; specific gravity (H_2O:1) = 4.93; boiling point = 184.4°C; freezing/melting point = 114°C; vapor pressure = 0.75 mmHg @ 36°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 1. Practically insoluble in water; solubility = 0.01%.

Potential Exposure: Iodine is used as a as a drinking water disinfectant; in the manufacture of organic chemicals, especially pharmaceuticals; as a catalyst in organic reactions. It is used in the manufacture of silver iodide for use in photography.

Incompatibilities: Contact with ammonia forms a shock-sensitive compound which will explode, causing fires. A powerful oxidizer. Violent reaction with reducing agents; combustibles, acetylene, acetaldehyde, antimony, cesium, francium, lithium, potassium, powdered metals; rubidium, phosphorous, sodium, sulfur.

PELs in Air

NIOSH IDLH = 2 ppm

Conversion factor: 1 ppm = 10.38 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 0.1 ppm/1 milligram per cubic meter Ceiling Concentration

NIOSH REL: 0.1 ppm/1 milligram per cubic meter Ceiling Concentration

ACGIH TLV[1]: 0.01 ppm/0.1 milligram per cubic meter, inhalable fraction and vapor, TWA; 0.1 ppm/1 milligram per cubic meter STEL

PAC* Ver. 29[138]

iodine & iodine-125

PAC-1: $\mathbf{0.1}_{\mathbf{E}}$ ppm
PAC-2: $\mathbf{0.5}_{\mathbf{E}}$ ppm
PAC-3: $\mathbf{5}_{\mathbf{E}}$ ppm

*ERPG [Emergency Response Planning Guidelines] are marked with a subscript "**E**."

Arab Republic of Egypt: TWA 0.1 ppm (0.1 milligram per cubic meter), 1993; Australia: TWA 0.1 ppm (1 milligram per cubic meter), 1993; Austria: MAK 0,1 ppm (1 milligram per cubic meter), 1999; Belgium: STEL 0.1 ppm (1 milligram per cubic meter), 1993; Denmark: TWA 0.1 ppm (1 milligram per cubic meter), 1999; Finland: STEL 0.1 ppm (1 milligram per cubic meter) [skin], 1999; France: VLE 0.1 ppm (1 milligram per cubic meter), 1999; the Netherlands: MAC 1 milligram per cubic meter, 2003; Japan: 0.1 ppm (1 milligram per cubic meter), 1999; Norway: TWA 0.1 ppm (1 milligram per cubic meter), 1999; the Philippines: TWA 0.1 ppm (1 milligram per cubic meter), 1993; Poland: MAC (TWA) 1 milligram per cubic meter, 1999; Russia: TWA 0.1 ppm; STEL 1 milligram per cubic meter [skin], 1993; Sweden: ceiling 0.1 ppm (1 milligram per cubic meter), 1999; Switzerland: MAK-W 0.1 ppm (1 milligram per cubic meter), KZG-W 0.2 ppm, 1999; Thailand: TWA 0.1 ppm (1 milligram per cubic meter), 1993; Turkey: TWA 0.1 ppm (1 milligram per cubic meter), 1993; United Kingdom: STEL 0.1 ppm (1.1 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Ceiling Concentration 0.1 ppm. Several states have set guidelines or standards for iodine in ambient air[60] ranging from $8\ \mu/m^3$ (Virginia) to $10\ \mu/m^3$ (North Dakota) to $20\ \mu/m^3$ (New York) to $24\ \mu/m^3$ (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #6005; OSHA Analytical Method ID-212. See also OSHA Analytical Method ID-177.

Permissible Concentration in Water: Maine[61] has set a guideline for iodine in drinking water of 340 μg/L.

Determination in Water: Octanol–water coefficient: Log $K_{ow} = 2.5$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Iodine irritates the eyes, skin, and respiratory tract. *Note*: Individuals with thyroid, lung and kidney disease should consult a physician before working with iodine. *Inhalation*: May cause some irritation at a concentration of 0.1 ppm. However, work is difficult at 0.15–0.2 ppm, and impossible at 0.3 ppm. Concentrations of 1 ppm are highly irritating. Iodine vapor can severely irritate eyes, nose, and throat; action of iodine is similar to that of chlorine, but is more irritating to lungs. Leads to tearing, tightness in the chest; sore throat and headache. Painful cough and difficult breathing may continue for several weeks following severe exposure. High exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. *Skin*: Solid, vapor or iodine solution can stain, irritate, damage and penetrate the skin. May produce symptoms similar to those under inhalation. *Eyes*: A concentration of 0.57 ppm for five minutes was reported to cause eye irritation. Irritation was experienced within 2 minutes @ 1.63 ppm. Contact with saturated vapor for 3−4 minutes caused brown staining and subsequent loss of outer layer of the cornea, followed by complete healing in 2−3 days. *Ingestion*: Small doses of iodine preparations produce salivation, excessive tearing; swelling of eyelids; soreness and swelling of salivary glands; metallic taste; skin rash; fever and enlarged lymph glands. Larger doses cause severe vomiting, diarrhea, abdominal pain; thirst, shock, fever, total suppression of urine; delirium, stupor and death. Ingestion of 1 mL (1/30 fluid ounce) of tincture of iodine or 1 g (1/30 oz) of iodine crystals results in similar symptoms including giddiness, faintness, pallor, rapid and feeble pulse; excitement and convulsions; collapse and unconsciousness. Fatal dose for an adult is about 1/15 oz. Some individuals may be more susceptible than others.

Long-Term Exposure: Prolonged exposure to iodine or compounds leads to iodism and deficiency of thyroid hormone. Since iodine or iodine compounds are potent sensitizers, repeated contact may be followed by rash, swelling of the vocal cords; severe generalized allergic reaction; and joint pain and swelling.

Points of Attack: Eyes, skin, respiratory system; central nervous system; cardiovascular system

Medical Surveillance: NIOSH lists the following tests: chest X-ray; pulmonary function tests: FVC, forced expiratory volume (1 second). If symptoms develop or overexposure is suspected, the following may be useful: thyroid function tests, liver function tests.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: *Solid*: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. **8 hours**: Saranex coated suits. **4 hours**: polyethylene gloves, suits, boots. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. *Liquid*: Avoid skin contact with liquids of >7% content or repeated or prolonged contact with liquids of <7% content. Wear eye protection to prevent any possibility of eye contact with liquids of >7% iodine content. Employees should wash immediately with soap when skin is wet or contaminated with liquids of >7% content. Remove nonimpervious clothing immediately if wet or contaminated with liquids containing >7% and promptly remove if liquid contains <7% iodine. Provide emergency showers and eyewash if liquids containing >7% contaminants are involved.

Respirator Selection: *up to 1 ppm*: Sa* (APF = 10) (any supplied-air respirator). *Up to 2 ppm*: Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFAg100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted acid gas canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA). *Substance reported to cause eye irritation or damage; may require eye protection.

Storage: (1) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location; keep acids away from bases and red, yellow, and blue-coded chemicals. (2) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Iodine must be stored to avoid contact with aqueous ammonia, acetylene, acetaldehyde, powdered aluminum; or chemically active metals (such as potassium, sodium, magnesium, and zinc); since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from incompatible materials listed above.

Shipping: UN3495 Iodine, Hazard class: 8; Labels: 8-Corrosive material, 6.1-Poisonous materials. UN1759 Corrosive solids, n.o.s., Hazard class: 8; Labels: 8-Corrosive material, Technical Name Required.

Spill Handling: *Solid*: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources.

Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. *Liquid*: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Thermal decomposition products may include iodine vapors. Extinguish fire using an agent suitable for type or surrounding fire. Iodine itself does not burn. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: React with large volumes of reducing agent (hypo- or bisulfites or ferrous salts) solution, neutralize and flush to sewer with water. Alternatively, iodine may be recovered from various process waste streams.

References

(31); (173); (101); (138); (2); (80); (100).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 1, No. 5, 65−68 (1981).

New York State Department of Health, *Chemical Fact Sheet*: Iodine, Bureau of Toxic Substance Assessment, Albany, NY (May 1986).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Iodine, Trenton, NJ (May 2001).

Iodine Monochloride I:0150

Formula: ClI; ICl

Synonyms: Iodine chloride; Iodochlorine; Protochlorure diode (French); Wijs' chloride

CAS Registry Number: 7790-99-0

HSDB Number: 601

RTECS Number: NN1650000

UN/NA & ERG Number: UN1792 (solid)/157; UN3498 (liquid)/157

EC Number: 232-236-7

Regulatory Authority and Advisory Information

United States National Primary Drinking Water Regulations: SMCL = 250 mg[Cl$^-$]/L as Chloride Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: C; risk phrases: R8; R21; R22; R34; R35; R36/37/38; safety phrases: S23; S26; S36/37/39; S41; S45 (see Appendix 4)

Description: Iodine monochloride is a black crystalline solid or reddish brown liquid. Molecular weight = 162.38; boiling point = 97.4°C and decomposes @ 100°C; freezing/melting point = 27°C (α-form); 14°C (β-form). Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 3₩. Soluble in water.

Potential Exposure: This material is used as a chemical reagent.

Incompatibilities: A strong oxidizer. Reacts with air, forming iodine pentoxide; heat may cause explosions. Violent reaction with water, steam, and other forms of moisture (forming toxic and corrosive fumes); organic matter; aluminum foil; cadmium sulfide, hydrides, lead sulfide; metal powders, phosphorus, phosphorus trichloride; potassium, reducing agents, rubber, silver sulfide; sodium, zinc sulfide, and other metals. Handle and store under nitrogen.

PELs in Air

PAC not available

No occupational exposure limits have been established for this iodine compound. This does not mean that this substance is not harmful. Safe work practices should always be followed. However, because this chemical can release iodides and iodine gas, the OSHA PEL of 0.1 ppm for iodine should not be exceeded at any time.

Determination in Air: Use NIOSH Analytical Method (IV) #6005.

Harmful Effects and Symptoms

Short-Term Exposure: Iodine monochloride is a corrosive chemical and exposure can severely irritate, and may burn, the eyes, skin, nose, throat and lungs. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: Irritates the lungs. Repeated exposure may cause bronchitis.

Points of Attack: Lungs.

Medical Surveillance: NIOSH lists the following tests for iodine: chest X-ray; pulmonary function tests: FVC, forced expiratory volume (1 second).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid. Wear dust-proof goggles and face shield when working with powders or dust, unless full facepiece respiratory. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA (as iodine): *up to 1 ppm*: Sa (APF = 10) (any supplied-air respirator).* *Up to 2 ppm*: Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFAg100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted acid gas canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA). *Substance reported to cause eye irritation or damage; may require eye protection.

Storage: (1) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. (2) Color code—Yellow Stripe (strong oxidizer): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Should be handled and stored under nitrogen. Iodine monochloride must be stored to avoid contact with aluminum foil, cadmium sulfide; lead sulfide; organic matter; phosphorus, phosphorus trichloride; potassium, rubber, silver sulfide; sodium, zinc sulfide, and other metals, since violent reactions occur. Sources of ignition, such as smoking and open flames are prohibited where iodine monochloride is used, handled, or stored a manner that could create a potential fire or explosion hazard. It also reacts with water or steam, producing toxic and corrosive fumes. If iodine monochloride is heated to decomposition (100°C), it gives off poisonous chlorine and iodine gases, and may explode.

Shipping: UN1792 Iodine monochloride, solid, Hazard class: 8; Labels: 8-Corrosive material. UN3498 Iodine monochloride, liquid, Hazard class: 8; Labels: 8-Corrosive material.

Spill Handling: *Solid*: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. *Liquid*: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Iodine monochloride may burn, but does not readily ignite. *Do not use water* as poisonous gases are produced. Use dry chemical, CO_2, or foam extinguishers. If iodine monochloride is heated to decomposition (100°C), it gives off poisonous chlorine, hydrogen iodide and may explode. Containers may explode in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (2).

New Jersey Department of Health and Senior Services, "Hazardous Substance Fact Sheet: Iodine monochloride, Trenton, NJ (August 1999).

Iodoform I:0180

Formula: CHI_3

Synonyms: Methane, triiodo-; NCI-C04568; Triiodomethane

CAS Registry Number: 75-47-8

HSDB Number: 4099

RTECS Number: PB7000000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154; UN3249 (Medicine, solid, toxic, n.o.s.)/151

EC Number: 200-874-5

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Possible risk of forming tumors, Mutagen.

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Iodoform is a bright yellow or greenish-yellow crystalline solid. Disagreeable, pungent odor. The odor threshold is 0.005−1.1 ppm; 0.4 ppb[193]. Molecular weight = 393.72; specific gravity (H_2O:1) = 4.01; boiling point = (decomposes) 210°C; freezing/melting point = 119°C. It is nonflammable. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 1 ₩. Water reactive; practically insoluble; solubility = 0.1%.

Potential Exposure: Iodoform has been used as a topical antiinfective and in veterinary medicine as an antiseptic and disinfectant for superficial lesions.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from water, alkaline materials, strong acids. Reacts violently with strong oxidizers, strong bases, metal powders, fluorine, lithium, acetone, balsam, metallic salts (e.g., mercuric oxide, silver nitrate), hexamethylenetetramine, calomel, tannin. Violent reaction with steam. Decomposes in heat and light.

PELs in Air

Conversion factor: 1 ppm = 16.10 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: None

NIOSH REL: 0.6 ppm/10 milligram per cubic meter TWA

ACGIH TLV[1]: 0.6 ppm/10 milligram per cubic meter TWA

PAC not available

Australia: TWA 0.6 ppm (10 milligram per cubic meter), 1993; Belgium: TWA 0.6 ppm (10 milligram per cubic meter), 1993; Denmark: TWA 0.2 ppm (3 milligram per cubic meter), 1999; France: VME 0.6 ppm (10 milligram per cubic meter), 1999; Norway: TWA 0.2 ppm (3 milligram per cubic meter), 1999; Switzerland: MAK-W 0.6 ppm (10 milligram per cubic meter), 1999; United Kingdom: TWA 0.6 ppm (9.8 milligram per cubic meter); STEL 1 ppm, 2000; the Netherlands: MAC-TGG 3 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 0.6 ppm. Several states have set guidelines or standards for iodoform in ambient air[60] ranging from $100\ \mu/m^3$ (North Dakota) to $160\ \mu/m^3$ (Virginia) to $200\ \mu/m^3$ (Connecticut) to $238\ \mu/m^3$ (Nevada).

Determination in Air: No method available.

Determination in Water: No method available.

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Iodoform can affect you when breathed in and by passing through your skin. Irritates the eyes. A generalized allergic reaction, with fever and rash, sometimes occurs. Exposure to very high levels may cause nervous system effects, such as confusion, irritability, and/or poor muscle coordination. Iodoform may cause a skin allergy. If allergy develops, very low future exposures can cause itching and a skin rash. High exposures may damage the liver and kidneys.

Long-Term Exposure: Repeated or prolonged contact with skin may cause allergy. May cause liver, kidney, heart damage; visual disturbance.

Points of Attack: Eyes, skin, respiratory system; liver, kidneys, heart.

Medical Surveillance: NIOSH lists the following tests for iodine: chest X-ray; pulmonary function tests: FVC, forced expiratory volume (1 second). If symptoms develop or overexposure is suspected, the following may be useful: skin testing with dilute iodoform may help diagnose allergy, if done by a qualified allergist. Liver and kidney function tests. EKG.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way* *valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures *over 0.6* ppm; Use an NIOSH/MSHA or European Standard EN 149-approved respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. *Where there is potential for high exposures exists*, use an NIOSH/MSHA or European Standard EN 149-approved supplied air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use an NIOSH/MSHA or European Standard EN 149-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Iodoform must be stored to avoid contact with lithium and steam, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from mercuric oxide, calomel, silver nitrate; tannin, balsam, and acetone.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN3249 Medicine, solid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft[70]. Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include iodine. Extinguish fire using an agent suitable for type of surrounding fire. This chemical is a combustible solid. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: It is inappropriate and possibly dangerous to the environment to dispose of expired or waste drugs and pharmaceuticals by flushing them down the toilet or discarding them to the trash. Household quantities of expired or waste pharmaceuticals may be mixed with wet cat litter or coffee grounds, double-bagged in plastic, discard in trash. Larger quantities shall carefully take into consideration applicable DEA, EPA, and FDA regulations. If possible return the pharmaceutical to the manufacturer for proper disposal being careful to properly label and securely package the material. Alternatively, the waste pharmaceutical shall be labeled, securely packaged and transported by a state licensed medical waste contractor to dispose by burial in a licensed hazardous or toxic waste landfill or incinerator.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Iodoform, Trenton, NJ (May 2003).

Iprodione I:0185

Formula: $C_{13}H_{13}Cl_2N_3O_3$

Synonyms: Anfor; Chipco 26019; 3-(3,5-Dichlorophenyl)-*N*-(1-methylethyl)-2,4-dioxo-1-imidazolidinecarboxamide; 3-(3,5-Dichlorophenyl)-*N*-isopropyl-2,4-dioxo-1-imidazolidinecarboximide; Diva; DOP 26019; Glycophen; Glycophene; Iprodine; 1-Isopropyl carbamoyl-3-(3,5-dichlorophenyl)-hydantoin; Kiden; LFA 2043; MRC 910; Promidione; Proturf; Rop 500f; Rovral; RP-26019; Verisan

CAS Number: 36734-19-7

HSDB Number: 6855

RTECS Number: NI8870000
UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171
EC Number: 253-178-9 [*Annex I Index No.*: 616-054-00-9]
Regulatory Authority and Advisory Information
Carcinogenicity[83]: EPA, Likely to be carcinogenic to humans; EU GHS Category 2: Suspected human carcinogen.
California Proposition 65 Chemical[102]: Carcinogen (5/1/1996)
Hazard Alert: Possible endocrine disruptor.
Potential Ground water Pollutant [California FAC Section 13145(d)/12811, active]
Hazard symbols, risk, & safety statements: Hazard symbol: Xn, N; risk phrases: R40; R50/53; safety phrases: S2; S36/37; S60; S61 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]
Description: White crystalline solid. Odorless. Molecular weight = 330.18; specific gravity (H_2O:1) = 1.0; freezing/melting point = 135−136°C. Vapor pressure = 1.2×10^{-7} mmHg; flash point = 150°C. Low solubility in water; solubility = 15 mg/L.
Potential Exposure: Iprodione is a dicarboximide contact and/or locally systemic fungicide used to control a broad range of root and stem rots, molds and mildews on a variety of field, fruit, and vegetable crops including almonds, grapes, peaches, potatoes, rice, berries, onions, peanuts and lettuce. Registration does not permit uses on turf, ornamentals and vegetable and small fruit gardens. End-uses for the formulations have been classified for outdoor use only the application methods have been restricted so to avoid undue human contact. Iprodione can also be used as a postharvest fungicide and seed treatment.
Incompatibilities: Slowly hydrolyzes in water, releasing ammonia and forming acetate salts. Incompatible with oxidizers, chlorates nitrates, peroxides; and alkaline materials. Imides react with azo and diazo compounds to generate toxic gases. Flammable gases are formed by the reaction of organic imides with strong reducing agents such as hydrideds and active metals. Imides are extremely weak bases (weaker than water). React with strong bases to form salts. That is, they can react as acids.
PELs in Air: No standards set.
Determination in Air: Filter; none; Gravimetric; NIOSH IV [Particulates NOR; #0500 (total), #0600 (respirable)][18].
Permissible Concentration in Water: State Drinking Water Guidelines: Florida 280 μg/L. Runoff from spills or fire control may cause water pollution.
Determination in Water: Octanol−water coefficient: Log $K_{\mathrm{ow}} = > 3.0$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood. Fish toxicity (threshold)[101]: Low—378.15513 ppb, MATC.
Harmful Effects and Symptoms
Short-Term Exposure: Contact with eyes or skin may cause irritation or injury. Inhalation should be avoided; use NIOSH- or CEN (UK)-approved air purifying respirators for pesticides. May be harmful if swallowed. LD_{50} (oral, rat) $= > 3$ g/kg; LD_{50} (dermal, rat) $= > 2.5$ g/kg.
Long-Term Exposure: May cause lung, pulmonary problems. May cause cancer. Human toxicity (long term)[101]: High—7.97268 ppb, CHCL (Chronic Human Carcinogen Level).
Points of Attack: Lungs. Endocrine disruptor.
Medical Surveillance: This chemical is a suspected or known human carcinogen. Exposed persons should contact a physician for advice regarding the possible long term health effects and advice for medical monitoring.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Do not induce vomiting when formulations containing petroleum solvents are ingested.
Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of dermal and/or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. DuPont Tychem suit fabrics[88] All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: *At any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).
Storage: Color code—Blue: Health Hazard/Poison. Store in a secure poison location. Prior to working with this

chemical all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from water, heat and incompatible materials. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. If this material contains a flammable carrier, sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: First remove all sources of ignition. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Absorb liquid containing this chemical in vermiculite, dry sand; earth, or similar material. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Captan may burn, but does not ignite readily. May be combustible at temperatures above 150°C. Thermal decomposition products may include toxic oxides of nitrogen, carbon and hydrogen chloride gas. As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 m/150 ft for liquids and at least 25 m/75 ft for solids. *Fire involving storage or vehicular tanks*: Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. *On a small fire*: use dry chemical, CO_2, water spray or regular *foam*. *On a large fire*: use water spray, fog or regular foam. Do not scatter spilled material with high pressure streams of water. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal. *Fire involving tanks*: From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. Always stay away from tanks engulfed in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: It is the responsibility of chemical waste generators to determine the toxicity and physical properties and of a discarded chemical and to properly identify its classification and certification as a hazardous waste and to determine the disposal method. United States Environmental Protection Agency guidelines for the classification determination are listed in 40 CFR Parts 261.3. Additionally, waste generators must consult and follow all regional, national, state and local hazardous waste laws to ensure complete and accurate classification and disposal methods.

References

(102); (31); (173); (101); (138); (100).

United States Environmental Protection Agency, "Reregistration Eligibility Decision (RED), Iprodione" Office of Prevention, Pesticides and Toxic Substances, Washington, DC (November 1998). http://www.epa.gov/REDs/2335.pdf.

EXTOXNET, Extension Toxicology Network, "Pesticide Information Profile, Iprodione," Oregon State University, Corvallis, OR (June 1996). http://extoxnet.orst.edu/pips/iprodion.htm.

Iron I:0190

Formula: Fe

Synonyms: 3ZhP; Ancor EN 80/150; Armco iron; Carbonyl iron; EFV 250/400; Elemental iron; EO 5A; Ferrovac E; GS 6; Iron carbonyl (FCC); Iron, electrolytic; Iron, elemental; Iron, reduced (FCC); Loha; Iron, soluble salts; NC100; PZh2M; PzhO; Remko; SUY-B 2

CAS Registry Number: 7439-89-6

HSDB Number: 604

RTECS Number: NO4565500

UN/NA & ERG Number: UN3089 (Metal powder, flammable, n.o.s.)/170; UN3178/131

EC Number: 231-096-4

Regulatory Authority and Advisory Information

Hazard Alert: Highly flammable solid, Pyrophoric hazard, Strong reducing agent, Water reactive

United States National Primary Drinking Water Regulations: SMCL = 0.3 mg[Fe]/L as Iron

European/International Regulations (powder): Hazard Symbol: F, Xn; risk phrases: R10; R17; R36/38; safety phrases: S16; S26; S33; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): Non hazard to water.

Description: Iron is a malleable, silver-gray metal or a gray powder. Molecular weight = 55.85; specific gravity (H_2O:1) = 7.9 @ 20°C; boiling point = 2861°C; freezing/melting point = 1538°C. Ignition temperature of dust cloud = 420°C; Minimum Explosive concentration = 0.10 oz/ft^3[209]. Hazard identification (based on NFPA-704 M Rating System): (*powder*) Health 1, flammability 3, reactivity 1. Insoluble in water. Relative explosion hazard of dust: Strong.

Potential Exposure: Iron is alloyed with carbon to produce steel. The addition of other elements e.g., manganese, silicon, chromium, vanadium, tungsten, molybdenum, titanium, niobium, phosphorus, zirconium, aluminum, copper, cobalt, and nickel) imparts special characteristics to the steel. Occupational exposures occur during mining, transporting, and preparing of ores; and during the production and refining of the metal and alloys. In addition, certain workers may be exposed while using certain iron-containing materials-welders, grinders, polishers, silver finishers; metal workers and boiler scalers.

Incompatibilities: Dust forms an explosive mixture with air. Ultrafine iron powder is pyrophoric and may be potentially explosive. Violent reaction with strong oxidizers, acetaldehyde, (HEAT plus any of the following: ammonium nitrate; bromine pentafluoride; nitryl fluoride; sodium peroxide). Violent reaction with ammonium peroxodisulfate; chloric acid; chlorine trifluoride; chloroform amidinium nitrate; chlorine, dinitrogen tetraoxide; hydrogen peroxide; liquid fluorine; peroxyformic acid; potassium perchlorate; potassium dichromate; sodium acetylide.

PELs in Air

NIOSH IDLH = 2500 mg[Fe]/m^3

OSHA PEL: 10 mg[Fe]/m^3 TWA (dust and fume)

ACGIH TLV[1]: 5 mg[Fe]/m^3 (vapor, dust) TWA; not classifiable as a human carcinogen

PAC Ver. 29[138]

PAC-1: 3.2 milligram per cubic meter

PAC-2: 35 milligram per cubic meter

PAC-3: 150 milligram per cubic meter

DFG MAK: 1.5 mg[Fe]/m^3 respirable fraction

Arab Republic of Egypt: TWA 3 ppm (5 milligram per cubic meter) (fume), 1993; Australia: TWA 5 milligram per cubic meter (fume), 1993; Austria: MAK 6 milligram per cubic meter (*dust*), 1999; Denmark: TWA 3.5 mg[Fe]/m^3, 1999; Finland: TWA 5 ppm (fume), 1999; France: VME 5 milligram per cubic meter (fume), 1999; the Netherlands: MAC-TGG 5 mg[Fe]/m^3, 2003; the Netherlands: MAC-TGG 10 milligram per cubic meter, 2003; Norway: TWA 3 milligram per cubic meter, 1999; the Philippines: TWA 10 milligram per cubic meter (fume), 1993; Poland: MAC (TWA) (fume) 5 milligram per cubic meter, MAC (STEL) 10 milligram per cubic meter, 1999; Sweden: NGV 3.5 milligram per cubic meter (fume), 1999; Switzerland: MAK-W 6 milligram per cubic meter) (fume), 1999; Thailand: TWA 10 milligram per cubic meter (fume), 1993; Turkey: TWA 10 milligram per cubic meter (fume), 1993; United Kingdom: TWA 5 mg [Fe]/m^3; STEL 10 mg[Fe]/m^3, 2000; United Kingdom: TWA 10 milligram per cubic meter, rouge, total inhalable dust, 2000; United Kingdom: TWA 4 milligram per cubic meter, rouge, respirable dust, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen

As iron, soluble salts [as Fe]

NIOSH REL: 1 [Fe]milligram per cubic meter TWA

ACGIH TLV[1]: 1 [Fe]milligram per cubic meter TWA

Determination in Air: Use NIOSH Analytical Method (IV) #7300, Elements.

Permissible Concentration in Water: Federal Drinking Water Guidelines: MCGL = 300 μg[Fe]/L; State Drinking Water Standards: Illinois: 1000 μg[Fe]/L; North Carolina: 300 μg[Fe]/L.

Routes of Entry: Inhalation, ingestion, eyes.

Harmful Effects and Symptoms

Short-Term Exposure: *Inhalation*: Iron dust and fresh iron oxide fumes may cause respiratory irritation and metal fume fever, characterized by metallic taste; dry irritated throat; coughing, shortness of breath; weakness, fatigue, fever, chills, sweating and pain in the muscles and joints. *Skin*: Hot metal may cause burns and irritation. *Eyes*: Dust may cause irritation and inflammation. *Ingestion*: May cause drowsiness, sluggishness, paleness, increased heart and respiration rates, shock; bloody vomiting, and diarrhea.

Long-Term Exposure: Excessive intake of iron compounds may result in increased accumulation of iron in body, especially the liver, spleen and lymphatic system. Inhalation of dusts may cause mottling of the lung. Benign pneumoconiosis with X-ray shadows indistinguishable from fibrotic pneumoconiosis (siderosis). There is limited evidence of an increase in lung cancer among iron ore miners. Iron oxide's role in this increase is unclear at this time. Prolonged or repeated contact can discolor the eyes, causing permanent iron staining.

Points of Attack: Respiratory system, skin.

Medical Surveillance: NIOSH lists the following tests (iron oxide fume): chest X-ray; pulmonary function tests: FVC, forced expiratory volume (1 second); urine (chemical/ metabolite). Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure,

begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give eggs or milk. The symptoms of metal fume fever may be delayed for 4−12 hours following exposure: it may last less than 36 hours. *Note to Physician*: Gastric lavage is only beneficial if done within one hour of ingestion. Deferoxamine may be beneficial in reducing systemic levels. Serum iron levels may be useful in determining severity of exposure if measured during acute phase of intoxication. In case of fume inhalation, treat pulmonary edema. Give prednisone or other corticosteroid orally to reduce tissue response to fume. Positive pressure ventilation may be necessary. Treat metal fume fever with bed rest, analgesics and antipyretics.

Note to physician: For severe poisoning *do not* use BAL (British Anti-Lewisite), dimercaprol, dithiopropanol ($C_3H_8OS_2$) as it is contraindicated or ineffective in poisoning from iron.

Personal Protective Methods: Wear protective gloves and clothing (leather gauntlets, welding masks, steel-toed shoes as needed) to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: To prevent exposure to dusts, wear a dust mask.

At any detectable concentration: SCBAF:Pd,Pp (APF = 10,000) (any MSHA/NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv100 (APF = 50) [Any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Red Stripe: Flammability Hazard: Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Store flammable solids up to maximum allowable quantity per control area in an approved flammable storage area. Do not store in a basement. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers and other incompatible materials (see above). Where possible, automatically transfer material from other storage containers to process containers.

Shipping: UN3089 Metal powders, flammable, n.o.s., Hazard Class: 4.1; Labels: 4.1-Flammable solid. UN3178 Flammable solids, inorganic, n.o.s., Hazard Class: 4.1; Labels: 4.1-Flammable solid.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Fine iron powder is pyrophoric and potentially explosive. Thermal decomposition products may include metal oxides of iron. Thermal decomposition products may include metal oxides. Use special mixtures of dry chemicals appropriate for extinguishing metal fires. *Do not use water*. For large fires use extinguishing agents suitable for surrounding fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Landfilling. Remove metal with an electromagnet and salvage.

References

(31); (173); (101); (138); (2); (170); (100).

National Institute for Occupational Safety and Health (NIOSH), Information Profiles on Potential Occupational Hazards, Iron and Its Compounds, Report No. PB 276-678, Rockville, MD, pp. 143−156 (October 1977).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 1, No. 6, 73−74 (1981).

New York State Department of Health, *Chemical Fact Sheet*: Iron, Bureau of Toxic Substance Assessment, Albany, NY (March 1986).

Iron-Dextran Complex I:0200

Formula: $[C_6H_{10}O_3]_n[Fe(OH)_3]_n$

Synonyms: B 75; Chinofer; Dextran ion complex; Dextrofer 75; Eisendextran (German); Fe-Dextran; Fenate; Ferdex 100; Ferric dextran; Ferridextran; Ferrodextran; Ferroflukin 75; Ferroglucin; Ferroglukin 75; Imferon; Imposil; Iro-Jex; Iron dextran; Iron dextran injection; Iron hydrogenated dextran; Ironorm injection; Myofer 100; Polyfer; Prolongal; Ursoferran

CAS Registry Number: 9004-66-4; 9061-47-6 (powder)

HSDB Number: 5102

RTECS Number: NI2200000

UN/NA & ERG Number: UN1851 (medicine, liquid, toxic, n.o.s.)/151

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Animal Sufficient Evidence, Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B, 1987

California Proposition 65 Chemical[102]: Cancer 1/1/1988

Hazard Alert: Poison, Combustible, Possible risk of forming tumors, Suspected of causing genetic defects.

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xn; risk phrases: R45; R36/37/38; R34; R40; R50; R62; safety phrases: S3; S22; S26; S36/37/39; S45; S53 (see Appendix 4)

Description: Iron-dextran complex is a sterile, dark-brown colloidal solvent. Iron-dextran is a complex of ferric hydroxide with dextran. Dextrans are polysaccharides produced by bacterial action on sucrose. Compounds in this group are pharmaceuticals containing some form of iron associated with carbohydrates of varying complexity. Soluble in water.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Iron dextran is unstable at a pH of 5 and decomposes at 149–158°F. It may be sensitive to prolonged exposure to air[101]. Avoid excessive heat; store between 15 and 20°C.

Potential Exposure: Iron-dextran complex is a parenteral form of medication used in iron-deficiency anemia in humans and baby pigs. The product for human use is a sterile, dark-brown colloidal solution in saline. The products designed for animal use are more concentrated.

PELs in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Harmful Effects and Symptoms

Long-Term Exposure: Iron dextran is carcinogenic in mice and rats after subcutaneous or intramuscular injection, producing local tumors. There have been case reports of sarcomas associated with injections of iron dextran. The tumors appeared at the probable site of the injections, and the similarity of the local effect in humans and animals was noted. Intramuscular injections of iron dextran can cause severe anaphylactic reactions.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. *Note to physician*: For severe poisoning *do not* use BAL (British Anti-Lewisite), dimercaprol, dithiopropanol ($C_3H_8OS_2$) as it is contraindicated or ineffective in poisoning from iron.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. Avoid excessive heat; store between 15 and 20°C prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Where possible, automatically transfer material from other storage containers to process containers. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Large quantity: UN1851 Medicine, liquid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include oxides of carbon and metal. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: It is inappropriate and possibly dangerous to the environment to dispose of expired or waste drugs and pharmaceuticals by flushing them down the toilet or discarding them to the trash. Household quantities of expired or waste pharmaceuticals may be mixed with wet cat litter or coffee grounds, double-bagged in plastic, discard in trash. Larger quantities shall carefully take into consideration applicable DEA, EPA, and FDA regulations. If possible return the pharmaceutical to the manufacturer for proper disposal being careful to properly label and securely package the material. Alternatively, the waste pharmaceutical shall be labeled, securely packaged and transported by a state licensed medical waste contractor to dispose by burial in a licensed hazardous or toxic waste landfill or incinerator.

References

(109); (102); (31); (173); (101); (138).

Iron Oxide I:0210

Formula: Fe_2O_3

Synonyms: Anchred standard; Anhydrous iron oxide; Armenian bole; Bauxite residue; Black oxide of iron; Blended red oxides of iron; Burnt island red; Burnt sienna; Burnt umber; Calcotone red; Caput mortuum; C.I.77491; C.I. Pigment red 101 Mortuum; Colloidal ferric oxide; Deanox; English red; Ferric oxide; Ferrugo; Indian red; Iron(III) oxide; Iron oxide red; Iron sesquioxide; Jeweler's rouge; Levanox red 130A; Light red; Manufactured iron oxides; Mars brown; Mars red; Natural iron oxides; Natural red oxide; Ochre; Prussian brown; Raddle; Red iron oxide; Rouge; Rubigo; Sienna; Specular iron; Stone red; Supra; Synthetic iron oxide; Venetian red; Vitrol red; Vogel's iron red; Yellow ferric oxide; Yellow oxide of iron

CAS Registry Number: 1345-25-1; 1309-37-1 (*ferric oxide; diiron trioxide*); *(alt.)* 8011-97-0; 1317-61-9 [*iron(II,III) oxide; ferrosoferric oxide*]; 1317-60-8 (*hematite*)

HSDB Number: 464

RTECS Number: NO7400000 (III); NO7525000 (fume)

UN/NA & ERG Number: UN1376 (spent); UN3178 (flammable solid, inorganic, n.o.s.)/133; UN3089/170

EC Number: 215-721-8 (iron oxide); 215-168-2 (diiron trioxide); 215-275-4 (hematite)

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Inadequate Evidence; No Human Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1987 (III, dust)

Hazard Alert (spent): Highly flammable, Pyrophoric.

United States National Primary Drinking Water Regulations: SMCL = 0.3 mg[Fe]/L as Iron

European/International Regulations (spent, pyrophoric): Hazard Symbol: F; risk phrases: R11; R17; safety phrases: S7/9; S16; S21, S33; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): Non hazard to water.

Description: Iron oxide is a reddish-brown powder; Iron(II) oxide is a black solid material. Molecular weight = 159.7 (III and fume); 73.85 (II); specific gravity (H_2O:1) = 5.26; 6.0 (II); freezing/melting point = 1539°C; 1377°C (II). Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 3, reactivity 0. Insoluble in water.

Potential Exposure: Iron oxide fumes are produced when iron containing materials are heated very hot, as in arc welding, and is composed of particles too small to see. Used in metallurgy, paint pigments; coloring rubber; polishing compounds; gas purification; in electronic components: permanent magnets, computer memory cores; magnetic tapes. Used as a mordant, laboratory reagent; as a catalyst, feed additive.

Incompatibilities: Keep away from calcium hypochlorite. Contact with hydrogen peroxide, ethylene oxide; and calcium hypochlorite will cause explosions. Reacts violently with powdered aluminum; hydrazine, and hydrogen trisulfide.

PELs in Air

NIOSH IDLH = 2500 mg[Fe]/m^3

Fe_2O_3

OSHA PEL: 10 mg[Fe]/m^3 TWA (fume); Rouge: TWA; 15 mg[Fe]/m^3, total dust: 5 mg[Fe]/m^3, respirable fraction

ACGIH TLV[1]: 5 mg[Fe]/m^3 respirable fraction TWA; Rouge: same as Fe_2O_2; not classifiable as a human carcinogen

Nuisance particulates; (fume) 10 mg[Fe]/m^3 TWA

PAC Ver. 29[138]

1309-37-1, Fe_2O_3

PAC-1: 15 milligram per cubic meter

PAC-2: 360 milligram per cubic meter

PAC-3: 2200 milligram per cubic meter

DFG MAK (*Fe_2O_3 & FeO*): 1.5 mg[Fe]/m^3, respirable fraction; 4 mg[Fe]/m^3 (fume; inhalable fraction); (dust) Carcinogen category 3B.

Arab Republic of Egypt: TWA 3 ppm (5 milligram per cubic meter) (fume), 1993; Australia: TWA 5 milligram per cubic meter (fume), 1993; Austria: MAK 6 milligram per cubic meter (*dust*), 1999; Denmark: TWA 3.5 mg [Fe]/m^3, 1999; Finland: TWA 5 ppm (fume), 1999; France: VME 5 milligram per cubic meter (fume), 1999; the Netherlands: MAC-TGG 5 mg[Fe]/m^3, 2003; the Netherlands: MAC-TGG 10 milligram per cubic meter, 2003; Norway: TWA 3 milligram per cubic meter, 1999; the Philippines: TWA 10 milligram per cubic meter (fume), 1993; Poland: MAC (TWA) (fume) 5 milligram per cubic meter, MAC (STEL) 10 milligram per cubic meter, 1999; Sweden: NGV 3.5 milligram per cubic meter (fume), 1999; Switzerland: MAK-W 6 milligram per cubic meter) (fume), 1999; Thailand: TWA 10 milligram per cubic meter (fume), 1993; Turkey: TWA 10 milligram per cubic meter (fume), 1993; United Kingdom: TWA 5 mg [Fe]/m^3; STEL 10 mg[Fe]/m^3, 2000; United Kingdom: TWA 10 milligram per cubic meter, rouge, total inhalable dust, 2000; United Kingdom: TWA 4 milligram per cubic meter, rouge, respirable dust, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Several states have set guidelines or standards for iron oxide fume in ambient air[60] ranging from 50 μ/m^3 (North Dakota) to 80 μm g/m^3 (Virginia) to 100 μ/m^3 (Connecticut) to 119 μ/m^3 (Nevada).

PAC Ver. 29[138]

1345-25-1, iron(II) oxide

PAC-1: 4.5 milligram per cubic meter

PAC-2: 500 milligram per cubic meter

PAC-3: 3000 milligram per cubic meter

Determination in Air: Filter; Acid; Inductively coupled plasma (ICP); NIOSH Analytical Method (IV) #7300, Elements. See also OSHA Analytical Methods ID-121 and ID-125G.

Permissible Concentration in Water: Federal Drinking Water Guidelines: MCGL = 300 μg[Fe]/L; State Drinking Water Standards: Illinois: 1000 μg[Fe]/L; North Carolina: 300 μg[Fe]/L.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short-Term Exposure: Iron oxide fume can affect you when breathed in. Exposure can cause metal fume fever. This is a flu-like illness with symptoms of metallic taste; fever and chills; aches, chest tightness and cough.

Long-Term Exposure: Prolonged or repeated contact can cause permanent iron staining of the eyes. Repeated exposure to iron oxide fume can cause changes on the chest X-ray. Benign pneumoconiosis with X-ray shadows indistinguishable from fibrotic pneumoconiosis (siderosis).

Points of Attack: Respiratory system.

Medical Surveillance: NIOSH lists the following tests (iron oxide fume): chest X-ray; pulmonary function tests: FVC, forced expiratory volume (1 second); urine (chemical/metabolite). Sometimes, iron-containing metals also contain metals which scar or damage the lungs, such as cobalt, nickel, cadmium, or chromium. See also NIOSH #8310, Metals in Urine; NIOSH Profile (Welding and Brazing).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. The symptoms of metal fume fever may be delayed for 4–12 hours following exposure: it may last less than 36 hours.

Note to physician: For severe poisoning *do not* use BAL (British Anti-Lewisite), dimercaprol, dithiopropanol ($C_3H_8OS_2$) as it is contraindicated or ineffective in poisoning from iron.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *50 milligram per cubic meter*: 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *125 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *250 milligram per cubic meter*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *2,500 milligram per cubic meter*: Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: (*iron powder and chips*): Color code—Red Stripe: Flammability Hazard (4.2): Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Store flammable solids (spontaneously combustible) up to maximum allowable quantity per control area in an approved flammable storage area. Do not store in a basement. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Iron oxide fume must be stored to avoid contact with calcium hypochlorite, aluminum, ethylene oxide and hydrazine, since violent reactions occur. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN3176 Iron oxide, spent, or iron sponge, spent or obtained from coal gas purification, Hazard Class: 4.2; Labels: 4.2-Spontaneously combustible material. UN3089 Metal powders, flammable, n.o.s., Hazard Class: 4.1; Labels: 4.1-Flammable solid. UN3178 Flammable solid, inorganic, Hazard Class: 4.1; Labels: 4.1-Flammable solid.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include metal oxides. Use special mixtures of dry chemicals appropriate for extinguishing metal fires. *Do not use water*. For large fires use extinguishing agents suitable for surrounding fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (170); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Iron Oxide (Dust and Fume), Trenton, NJ (August 1998).

Iron Pentacarbonyl I:0220

Formula: C_5FeO_5; $Fe(CO)_5$

Synonyms: FER pentacarbonyle (French); Hierro pentacarbonilo (Spanish); Iron carbonyl; Iron carbonyl [$Fe(CO)_5$], (TB-5-11)-; Pentacarbonyliron

CAS Registry Number: 13463-40-6; *(alt.)* 37220-42-1

HSDB Number: 6347

RTECS Number: NO4900000

UN/NA & ERG Number: (PIH) UN1994/131

EC Number: 236-670-8

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Hazard Alert: Poison inhalation hazard, High acute toxicity, Extremely flammable, Pyrophoric hazard, Organometallic, Strong reducing agent.

United States National Primary Drinking Water Regulations: SMCL = 0.3 mg[Fe]/L as Iron

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 2500 lb (1135 kg)

SUPERFUND/EPCRA 302, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 100 lb (45.4 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, F+; N; risk phrases: R12; R17; R24; R26/28; R51/53;

safety phrases: S1; S16; S21; S26; S28; S29; S36/37/39/; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Iron pentacarbonyl is a highly flammable colorless to yellow to dark-red viscous liquid. Molecular weight = 195.9; specific gravity (H_2O:1) = 1.45 @ 25°C; boiling point = 102.8°C @ 749 mmHg; freezing/melting point = −25°C; freezing/melting point = −21°C; vapor pressure = 40 mmHg @ 30°C; flash point = −15°C (cc) ; autoignition temperature = 50°C; Explosive limits: LEL = 3.7%; UEL: 12.5%. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 4, reactivity 1. Insoluble in water.

Potential Exposure: Iron carbonyl is used as a catalyst in organic reactions; to make carbonyl iron, which is used in high frequency coils for the radio and television industry; and as an antiknock agent in motor fuels; to make finely divided iron.

Incompatibilities: Vapor may form explosive mixture with air. Chemically unstable. May explode on heating. Pyrophoric; ignites spontaneously on contact with air. Iron pentacarbonyl is decomposed by heat, light, producing toxic gases, including iron oxides and carbon monoxide. The substance is a strong reducing agent and reacts violently with oxidizers, nitrogen oxide; acetic acid; strong bases; water, amines, halogens, hydrogen, carbon tetrachloride, phosgene, mercaptans, transition metal halides, (zinc + cobalt halides). Organometallics are reactive with many other groups. Incompatible with acids and bases. Organometallics are good reducing agents and therefore incompatible with oxidizing agents. Often reactive with water to generate toxic or flammable gases. A brown pyrophoric powder is produced by the combination of the carbonyl with acetic acid containing greater than 5% of water[101]. Store under nitrogen.

PELs in Air

OSHA PEL: None

NIOSH REL: 0.1 ppm[Fe]/0.23 milligram per cubic meter TWA; 0.2 ppm/0.45 milligram per cubic meter [Fe] STEL

ACGIH TLV[1]: 0.1 ppm/0.23 milligram per cubic meter TWA; 0.2 ppm/0.45 milligram per cubic meter STEL

PAC* Ver. 29[138]

PAC-1: 0.0055 ppm

PAC-2: $\mathbf{0.06_A}$ ppm

PAC-3: $\mathbf{0.18_A}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

DFG MAK: 0.1 ppm/0.81 milligram per cubic meter TWA; Peak Limitation Category II(2); Pregnancy Risk Group D

Australia: TWA 0.1 ppm (0.8 milligram per cubic meter); STEL 0.2 ppm, 1993; Austria: MAK 0.1 ppm (0.8 milligram per cubic meter), 1999; Belgium: TWA 0.1 ppm (0.23 milligram per cubic meter); STEL 0.2 ppm, 1993; Denmark: TWA 0.1 ppm (0.8 milligram per cubic meter), 1999; Finland: STEL 0.01 ppm (0.08 milligram per cubic meter), 1999; France: VME 0.1 ppm (0.8 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 0.08 milligram per cubic meter, 2003; Russia: STEL 0.1 milligram per cubic meter [skin], 1993; Switzerland: MAK-W 0.1 ppm (0.8 milligram per cubic meter), KZG-W 0.2 ppm, 1999; United Kingdom: TWA 0.01 ppm (0.08 mg[Fe]/m^3 [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 0.2 [Fe]ppm. Several states have set guidelines or standards for iron pentacarbonyl in ambient air[60] ranging from 8−16 μ/m^3 (North Dakota) to 13 μ/m^3 (Virginia) to 16 μ/m^3 (Connecticut) to 19 μ/m^3 (Nevada).

Determination in Air: No method available.

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Iron pentacarbonyl can irritate the respiratory tract causing cough and/or shortness of breath. Inhalation may result in dizziness, nausea, and vomiting; if exposure continues, unconsciousness will follow. Twelve-to-twenty-four hours later, fever, cough, and shortness of breath may follow. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Contact can cause irritation of the skin. Toxicity of this compound is high via all routes of entry. Cyanosis (bluish discoloration of skin) and circulatory collapse may occur after exposure. Death may result. Pneumonitis and injury to the kidneys, liver, and central nervous system may also occur.

Long-Term Exposure: Iron pentacarbonyl can cause lung irritation and bronchitis may develop. Repeated exposures can damage the liver, lungs, and brain.

Points of Attack: Eyes, respiratory system; central nervous system; liver, kidneys.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater, or significant skin contact), the following are recommended before beginning work and at regular times after that. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: liver function tests. Consider chest X-ray after acute overexposure. Exam of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature.

Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures over 0.1 ppm; Use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Poison inhalation chemical (PIH); check oxygen content prior to entering storage area. (1) Color code—Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. (2) Color code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where iron pentacarbonyl may be present, check to make sure that an explosive concentration does not exist. Store under nitrogen. Iron pentacarbonyl must be stored to avoid contact with water, since violent reactions occur. Store away from contact with light and air, oxidizers, and other incompatible materials listed above. Iron pentacarbonyl should be handled in an automatic mechanized fashion at all times. Containers should be flushed with nitrogen before opening. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1994 Iron pentacarbonyl, Hazard class: 6.1; Labels: 6.1-Poison Inhalation Hazard, 3-Flammable liquid, Inhalation Hazard Zone A.

Spill Handling:

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (*From a small package or a small leak from a large package*)

First: Isolate in all directions (ft/m) 300/100
Then: Protect persons downwind (mi/km)
Day 0.6/0.9
Night 1.3/2.0

Large spills (*From a large package or from many small packages*)

First: Isolate in all directions (ft/m) 1250/400
Then: Protect persons downwind (mi/km)
Day 3.0/4.8
Night 5.2/8.9

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Do not breathe vapors. Shut off or remove ignition sources in hazard area. Do not touch spilled material. Stop leak if this can be done without risk. Use water spray to reduces vapors. Take up *small spills* with sand or other noncombustible absorbent material and place into containers for later disposal. Dike far ahead of *large spills* for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Pyrophoric; this chemical is a flammable liquid and can ignite in air. Thermal decomposition includes oxides of metal and carbon. This material is incompatible with water. Use dry chemical, carbon dioxide; water spray; or foam for small fires. Specially trained personnel operating from a safe distance can fight large fires using dry chemical or foam. Move material from fire area if this can be done without risk. Dike fire control water for later disposal. Isolate hazard area and deny entry. Stay upwind and keep out of low areas. Isolate area in all directions if tank car or truck is involved in fire. See isolation distances above. Wear positive pressure breathing apparatus and special protective clothing. Cool containers exposed to flames with water until fire is out. This material presents a vapor explosion and poison hazard indoors, outdoors, or in sewers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (170); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Iron, Pentacarbonyl, Washington, DC, Chemical Emergency Preparedness Program (Nov. 30, 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Iron Pentacarbonyl, Trenton, NJ (December 1999).

Isoamyl Acetate I:0230

Formula: $C_7H_{14}O_2$

Synonyms: Acetate d'isoamyle (French); Acetato de isoamilo (Spanish); Acetic acid, isopentyl ester; *iso*-Amyl acetate; *sec*-Amyl acetate; Amyl acetate; Amylacetic ester; Banana oil; 1-Butanol, 3-methyl-, acetate; Isoamyl ethanoate; Isopentyl acetate; 3-Methyl-1-butanol acetate; 3-Methyl-1-butyl acetate; 3-Methylbutyl ester of acetic acid; 3-Methylbutyl ethanoate; Methylbutyl ethanoate; Pear oil

CAS Registry Number: 123-92-2

HSDB Number: 1818

RTECS Number: NS9800000

UN/NA & ERG Number: UN1104/129; UN1993 (flammable liquids, n.o.s.)/128

EC Number: 204-662-3 [*Annex I Index No.*: 607-130-00-2]

Regulatory Authority and Advisory Information

Hazard Alert: Highly flammable liquid.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 5000 lb (2270 kg) TSCA: 40CFR712.(e)10; 40CFR716.120(d)10

Canada, WHMIS, Ingredients Disclosure List Concentration 1%.

Hazard symbols, risk, & safety statements: Hazard symbol: F; risk phrases: R11; R66; safety phrases: S2; S21; S23; S25; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Isoamyl acetate is a clear, colorless liquid with a banana-like odor. Molecular weight = 130.21; specific gravity (H_2O:1) = 0.876 @ 15°C; boiling point = 142.5°C; freezing/melting point = −78.5°C; vapor pressure = 4 mmHg @ 20°C; 5.6 mmHg @ 25°C; flash point = 25°C; autoignition temperature = 360°C; 379C[136]. Flammability limits: LEL = 1.0% @ 100°C; UEL: 7.5%. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 3, reactivity 0₩. Floats on water; poor, slight to negligible, solubility. Reacts with water forming flammable, irritating vapor.

Potential Exposure: Used as a solvent in making lacquers, paints, perfumes, artificial fruit flavorings; smokeless powder; airplane "dopes;" dry cleaning compounds.

Incompatibilities: May form explosive mixture with air. Strong alkalis, strong acids; nitrates, oxidizers. Violent reaction with reducing agents. Attacks asbestos; softens and dissolves many plastics, rubber, and coatings.

PELs in Air

NIOSH IDLH = 1000 ppm

Odor threshold = 0.015−0.22 ppm. *Note*: The range of accepted odor threshold values is quite broad and caution should be used in relying on odor alone as a warning of potentially hazardous exposure.

OSHA PEL: 100 ppm/525 milligram per cubic meter TWA

NIOSH REL: 100 ppm/525 milligram per cubic meter TWA

ACGIH TLV[1]: (*all isomers of amyl acetates*) 50 ppm/266 milligram per cubic meter TWA; 100 ppm/532 milligram per cubic meter STEL

PAC Ver. 29[138]

PAC-1: 100 ppm

PAC-2: 500 ppm

PAC-3: 3000 ppm

DFG MAK: 50ppm/270 milligram per cubic meter TWA; Peak Limitation Category I(1); Pregnancy Risk Group D

Australia: TWA 100 ppm (525 milligram per cubic meter), 1993; Belgium: TWA 100 ppm (532 milligram per cubic meter), 1993; Denmark: TWA 100 ppm (525 milligram per cubic meter), 1999; France: VME 100 ppm (525 milligram per cubic meter), 1999; Japan: 100 ppm (530 milligram per cubic meter), 1999; Norway: TWA 50 ppm (260 milligram per cubic meter), 1999; the Philippines: TWA 100 ppm (525 milligram per cubic meter), 1993; Russia: TWA 100 ppm, 1993; Switzerland: MAK-W 50 ppm (270 milligram per cubic meter) [skin], 1999; United Kingdom: LTEL 100 ppm (525 milligram per cubic meter); STEL 125 ppm, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 100 ppm

Determination in Air: Use NIOSH Analytical Method (IV) #1450, Esters I; OSHA Analytical Method 7.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin, and respiratory tract. Exposure to high concentrations of vapors can cause headache. drowsiness, dizziness, lightheadedness, fatigue, and unconsciousness.

Long-Term Exposure: Prolonged contact can cause skin drying and cracking. Can irritate the lungs with cough, phlegm, and/or shortness of breath.

Points of Attack: Eyes, skin, respiratory system; central nervous system.***Medical Surveillance***. Lung function tests. Examination of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Move to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *1000 ppm*: CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)]; or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:PD,PP (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode. *Escape*: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: UN1104 Amyl acetates, Hazard Class: 3; Labels: 3-Flammable liquid

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (85); (173); (101); (138); (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Isoamyl Acetate, Trenton NJ (July 2005).

Isoamyl Alcohols I:0240

Formula: $C_5H_{12}O$; $(CH_3)_2CHCH_2CH_2OH$
Synonyms: *primary*: Alcool isoamylique (French); Fermentation amyl alcohol; Fusel oil; Isoamyl alcohol (primary); Isoamyol; Isobutyl carbinol; Isopentyl alcohol; 3-Methyl-1-butanol; 3-Methyl-1-butanol; Potato spirit oil; Primary isoamyl alcohol
secondary: Isoamyl alcohol (*sec-*); 2-Methyl-3-butanol; Secondary isoamyl alcohol
CAS Registry Number: 123-51-3 (*primary-*); 6032-29-7 (*secondary-*); 137-32-6 (*active primary-*); 8013-75-0 (mixture of isoamyl alcohols)
HSDB Number: 605 (*primary-*)
RTECS Number: EL5425000
UN/NA & ERG Number: UN1105/129
EC Number: 232-395-2 (CAS: 8013-75-0); 204-633-5 (3-methylbutan-1-ol); 227-907-6 (pentan-2-ol); 205-289-9 [*Annex I Index No.*: 603-006-00-7] (2-methylbutan-1-ol)
Regulatory Authority and Advisory Information
Hazard Alert (*primary isomer*): Highly flammable liquid, Possible risk of forming tumors, Primary irritant (w/o allergic reaction), (*secondary*-and *active primary*-isomers) Primary irritant (w/o allergic reaction).
Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.
Hazard symbols, risk, & safety statements: Hazard symbol: F, Xn; risk phrases: R11, R20/R22; R36/37/38; R50/53; R66; safety phrases: S16; S21; S26; S36/37; S45; S46 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water. (*primary*)
Description: Isoamyl alcohol is a colorless liquid. It has a disagreeable odor which causes coughing. Molecular weight = 88.15 (*primary-and sec-*); specific gravity (H_2O:1) = 0.81 @ 20°C; boiling point = 131 °C (primary); 116.3°C (secondary); freezing/melting point = −117.2°C (*primary-*); −69°C (sec-); vapor pressure = 28 mmHg (*primary-*); 7.5 mmHg @24°C (*sec-*); vapor pressure = 0.75 mmHg @ 13°C (*primary-*); flash point = 43°C (cc); 55°C (oc) (*primary-*); 35°C (*sec-*); autoignition temperature = 350°C. Explosive limits: LEL (*primary-*) = 1.2% @ 100°C; UEL (*primary-*) = 9.0% @100°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 3, reactivity 0. Slightly soluble in water; solubility = 2% @ 13.9°C.
Potential Exposure: Amyl alcohols are used in the manufacture of lacquers, paints, varnishes, paint removers; shoe cements; perfumes, pharmaceuticals, chemicals, rubber, plastics, fruit essences; explosives, hydraulic fluids; ore flotation agents; in the preparation of other amyl derivatives; in the extraction of fats; and in the textile and petroleum refining industries.
Incompatibilities: Isoamyl alcohol forms explosive mixture with air. Violent reaction with strong oxidizers, reducing agents; hydrogen trisulfide, causing explosion hazard. Not compatible with acid anhydrides, acid chlorides. Attacks some plastics, rubber and coatings.
PELs in Air
primary- and secondary-
NIOSH IDLH = 500 ppm (*primary- and secondary-*)
Conversion factor: 1 ppm = 3.61 milligram per cubic meter @ 25°C & 1 atm
OSHA PEL: 100 ppm/360 milligram per cubic meter
NIOSH REL: 100 ppm/360 milligram per cubic meter TWA; 125 ppm/450 milligram per cubic meter STEL
ACGIH TLV[1] (*primary-*): 100 ppm/361 milligram per cubic meter TWA; 125 ppm/452 milligram per cubic meter STEL
PAC Ver. 29[138]
123-51-3, primary-
PAC-1: 125 ppm
PAC-2: 1700 ppm
PAC-3: 10,000 ppm
DFG MAK (primary): 20 ppm/73 milligram per cubic meter TWA; Peak Limitation Category II(4); Pregnancy Risk Group C
Australia: TWA 100 ppm (360 milligram per cubic meter); STEL 125 ppm, 1993; Austria: MAK 100 ppm (360 milligram per cubic meter), 1999; Belgium: TWA 100 ppm (361 milligram per cubic meter); STEL 125 ppm (452 milligram per cubic meter), 1993; Denmark: TWA 100 ppm (360 milligram per cubic meter), 1999; France: VME 100 ppm (360 milligram per cubic meter), 1999; Japan: 100 ppm (360 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 360 milligram per cubic meter, 2003; the Philippines: TWA 100 ppm (360 milligram per cubic meter), 1993; Russia: TWA 100 ppm; STEL 5 milligram per cubic meter, 1993; Switzerland: MAK-W 100 ppm (360 milligram per cubic meter), KZG-W 200 ppm (720 milligram per cubic meter), 1999; Turkey: TWA 100 ppm (360 milligram per cubic meter), 1993; United Kingdom: TWA 100 ppm (366 milligram per cubic meter); STEL 125 ppm (458 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 125 ppm. Several states have set guidelines or standards for isoamyl alcohol in ambient air[60] ranging from 3.6−4.5 milligram per cubic meter (North Dakota) to 7.2 milligram per cubic meter (Connecticut, Florida and New York) to 8.571 milligram per cubic meter (Nevada).
(*secondary-*)
Denmark: TWA 100 ppm (360 milligram per cubic meter), 1999; Norway: TWA 50 ppm (180 milligram per cubic meter), 1999; Poland: MAC (TWA) 100 milligram per cubic meter, MAC (STEL) 450 milligram per cubic meter, 1993
Determination in Air: Use NIOSH Analytical Method (IV)s (*primary-and secondary-*) #1402, for Alcohols III; (*primary-*) #1405 for Alcohols Combined.
Permissible Concentration in Water: No criteria set, but EPA[32] has suggested an ambient level goal for all primary pentanols of 5000 μg/L, based on health effects.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 1.42$ (*primary-*). Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact. Passes through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin, and respiratory tract. If ingested, may affect the central nervous system. Isoamyl alcohol can affect you when breathed in and by passing through your skin. Contact can cause severe burns of the eyes, leading to permanent damage. It can irritate the nose and throat. Higher levels may irritate the lungs, causing coughing and/or shortness of breath. Higher exposure can cause dizziness, lightheadedness, headache, cough, dyspnea (breathing difficulty), nausea, vomiting, diarrhea, narcosis, unconsciousness, and death.

Long-Term Exposure: Repeated or prolonged exposure to isoamyl alcohol can cause drying and cracking of the skin. May cause tumors. May cause liver damage. Isoamyl alcohol can irritate the lungs and may cause bronchitis.

Points of Attack: Eyes, skin, respiratory system; central nervous system.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater) the following are recommended before beginning work and at regular times after that: lung function tests, liver function tests.

First Aid: If isoamyl alcohol gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. **8 hours**: butyl rubber gloves, suits, boots; Neoprene rubber gloves, suits, boots; nitrile rubber gloves, suits, boots; Viton gloves, suits. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *500 ppm*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or CcrFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted acid gas canister]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA). *Note*: Substance causes eye irritation or damage; eye protection needed.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where Isoamyl alcohol may be present, check to make sure that an explosive concentration does not exist. Isoamyl alcohol must be stored to avoid contact with strong oxidizers, such as chlorine, and bromine, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames are prohibited where isoamyl alcohol is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN1105 Pentanols or Amyl alcohols, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is flammable. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; alcohol foam; or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Isoamyl Alcohol, Trenton, NJ (April, 1999).

Isobenzan I:0250

Formula: $C_9H_4Cl_8O$

Synonyms: CP14,957; ENT 25,545; ENT25,545-X; Isobenzano (Spanish); 1,3,4,5,6,7,10,10-Octochloro-4,7endo-methylene-4,7,8,9-tetrahydrophthalan; 1,3,4,5,6,8,8-Octochloro-1,3,3a, 4,7,7a-hexahydro-4,7-methanoisobenzofuran; Octochlorohexahydromethanoisobenzofuran; 1,3,4,5, 6,7,8,8-Octochloro-2-*oxa*-3a,4,7,7a-tetrahydro-4,7-methanoindene; Omtan; R 6700; SD 440; Shell 4402; Shell WL 1650; Telodrin; WL 1650

CAS Registry Number: 297-78-9

HSDB Number: 6388

RTECS Number: PC1225000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154; UN2761/151

EC Number: 206-045-4 [*Annex I Index No.*: 602-053-00-0]

Regulatory Authority and Advisory Information

Hazard Alert: Exposure can be lethal, Possible risk of forming tumors, Environmental hazard, Agricultural chemical.

Banned or Severely Restricted (several countries) (UN)[13]

SUPERFUND/EPCRA 302, Extremely Hazardous Substances: TPQ = 100/10,000 lb (454/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg).

Hazardous to aquatic life or environment, with possible long-lasting effects[291]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, N; risk phrases: R27/28; R50/53; safety phrases: S1/2; S28; S36/37; S41; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water

Description: Isobenzan is a white to light brown crystalline powder. Molecular weight = 411.73; specific gravity (H_2O:1) = 1.87 @ 20°C; freezing/melting point = 121.3°C; vapor pressure = 1×10^{-5} mmHg @ 25°C. Hazard identification (based on NFPA-704 M Rating System): Health 4, flammability 0, reactivity 0. Insoluble in water.

Potential Exposure: Isobenzan is a potential danger to those involved in the manufacture, formulation or application of this insecticide.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Decomposes in temperatures >200°C releasing corrosive and toxic hydrogen chloride and chlorine.

PELs in Air

PAC Ver. 29[138]

PAC-1: 0.01 milligram per cubic meter

PAC-2: 0.11 milligram per cubic meter

PAC-3: 0.66 milligram per cubic meter

Routes of Entry: Ingestion, skin contact, inhalation.

Harmful Effects and Symptoms

Short-Term Exposure: This material is highly toxic. It is absorbed by the skin as well as by the respiratory and gastrointestinal tracts. Symptoms may last for a long time because the material is eliminated slowly; its half-life in human blood is 2.77 years[88,136]. Symptoms of exposure include headache, dizziness, drowsiness, irritability, and numbness of the legs. Convulsions may occur.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Use positive pressure, pressure-demand, full facepiece SCBA or pressure-demand supplied air respirator with escape SCBA and fully-encapsulating, chemical resistant suit.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA (SCBA) with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN2761 Organochlorine pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft[70]. Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Keep upwind. Avoid bodily contact with the material. Keep unnecessary people away; isolate hazard area and deny entry. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills*: with clean shovel place material into clean, dry container and cover; move containers from spill area. *Large spills*: dike far ahead of spill for later disposal. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include hydrogen chloride, chlorine and oxides of carbon. Use agent suitable for type of surrounding fire. Use water in flooding quantities as fog. Use alcohol foam, carbon dioxide; or dry chemical. Avoid breathing dusts and fumes from burning material. Keep upwind. Avoid bodily contact with the material. Wear full protective clothing including boots, protective gloves, goggles; and wear SCBA. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR 165 recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Isobenzan, Washington, DC, Chemical Emergency Preparedness Program (Nov. 30, 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Isobenzan, Trenton, NJ, (August 2000).

Isobutane I:0260

Formula: C_4H10; $(CH_3)_3CH$

Synonyms: 1,1-Dimethylethane; Isobutano (Spanish); LPG; 2-Methylpropane; Propane, 2-methyl; Trimethylmethane

CAS Registry Number: 75-28-5

HSDB Number: 608

RTECS Number: TZ4300000

UN/NA & ERG Number: UN1969/115; UN1075 (Petroleum gases, liquefied or Liquefied petroleum gas)/115

EC Number: 200-857-2 [*Annex I Index No.*: 601-004-00-0]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 ($\geq$1.00% concentration).

Hazard Alert: Poison, Extremely flammable gas, Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated.

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg).

Hazard symbols, risk, & safety statements: Hazard symbol: F+; risk phrases: R5; R12; R21; safety phrases: S1; S2; S9; S16; S33; S38; S45

Description: Isobutane is a colorless gas. It has a gasoline or natural gas odor. Shipped as a liquefied compressed gas. Molecular weight = 58.12; specific gravity (H_2O:1) = 0.56 (liquid); boiling point = −12°C; freezing/melting point = 159.4°C; relative vapor density (air = 1) = 2.06; vapor pressure = 750 mmHg @ −12°C; flash point = −60°C; autoignition temperature = 460°C. Explosive limits: LEL = 1.8%; 10,600 ppm[138]; UEL: 8.4%. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 4, reactivity 0. Practically insoluble in water.

Potential Exposure: It is used as a refrigerant, fuel and aerosol propellant.

Incompatibilities: Forms explosive gas mixture with air. Strong oxidizers e.g., nitrates, perchlorates, chlorine, fluorine), (nickel carbonyl + oxygen) may cause fire and explosions. Reacts with acetylene, halogens, and nitrous oxides. May accumulate static electrical charges, and may cause ignition of its vapors.

PELs in Air

Conversion factor: 1 ppm = 2.38 milligram per cubic meter @ 25°C & 1 atm

Large amounts of isobutane will decrease the amount of available oxygen. Before entering a confined space, oxygen content should be tested to ensure that it is at least 19% by volume.

OSHA PEL: None

NIOSH REL: 800 ppm/1900 milligram per cubic meter TWA

ACGIH TLV[1]: 800 ppm TWA

PAC Ver. 29[138]

PAC-1: 5500 ppm

PAC-2: 17,000 ppm

PAC-3: 53,000 ppm

DFG MAK: 1000 ppm (2400 milligram per cubic meter) (isobutane and butane isomers).

Austria: MAK 800 ppm (1900 milligram per cubic meter), 1999; Switzerland: MAK-W 800 ppm (1900 milligram per cubic meter), 1999; United Kingdom: LTEL 600 ppm (1430 milligram per cubic meter); STEL 750 ppm, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 800 ppm

Determination in Water: Octanol−water coefficient: Log K_{ow} = 2.8. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, skin and/or eye contact (liquid).

Harmful Effects and Symptoms

Short-Term Exposure: Isobutane can affect you when breathed in. Isobutane vapor may irritate and burn the eyes. Contact with the liquid can cause frostbite. Exposure to very high amounts can cause dizziness, lightheadedness, irregular heartbeat; and unconsciousness. With extremely high levels, death can occur from lack of oxygen.

Long-Term Exposure: Repeated or prolonged contact with skin may cause drying and cracking.

Points of Attack: Central nervous system; skin.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Prevent possible skin freezing from direct liquid contact. Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Exposure to isobutane is dangerous because it can replace oxygen and lead to suffocation. Only NIOSH/MSHA or European Standard EN 149-approved SCBA with a full facepiece operated in positive-pressure mode should be used in oxygen deficient environments.

Storage: Check oxygen content prior to entering storage area. Flammable gas. Color code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where isobutane may be present, check to make sure that an explosive concentration does not exist. Isobutane cylinders should be stored in a cool, well-ventilated dry area of noncombustible construction. Protect containers against physical damage. Store away from sources of heat or ignition and from oxygen, chlorine, and other oxidizers. Sources of ignition, such as smoking and open flames, are prohibited where isobutane is handled, used, or stored. Ground and bond all lines and equipment used with isobutane. Wherever isobutane is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: UN1969 Isobutane, Hazard Class: 2.1; Labels: 2.1-Flammable gas; UN1075 Petroleum gases, liquefied or Liquefied petroleum gas, Hazard Class: 2.1; Labels: 2.1-Flammable gas. UN1075 also can be used for Isobutane mixture. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: Restrict persons not wearing protective equipment from area of leak until clean-up is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Stop flow of gas. If source of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. Keep isobutane out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Isobutane is a flammable gas or liquid. Stop the flow of gas if it can be done safely. Use dry chemical or CO_2 extinguishers. Use water to keep fire-exposed containers cool. Thermal decomposition includes oxides of carbon. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Isobutane, Trenton, NJ (March 2008).

Isobutyl Acrylate I:0270

Formula: $C_7H_{12}O_2$: $CH_2{=}CHCOOCH_2CH(CH_3)_2$

Synonyms: Acrylic acid isobutyl ester; Isobutyl 2-propenoate; Isobutyl acrylate; Isobutyl propenoate; 2-Methylpropyl acrylate; 2-Propenoic acid 2-methylpropyl ester

CAS Registry Number: 106-63-8

HSDB Number: 610 as isobutyl acrylate

RTECS Number: AT2100000

UN/NA & ERG Number: UN2527/129 (P)

EC Number: 203-417-8 [*Annex I Index No.*: 607-115-00-0]

Regulatory Authority and Advisory Information

Hazard Alert: Highly flammable liquid, Polymerization hazard (nonstabilized), Sensitization hazard (skin), Suspected of causing genetic defects, Drug.

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xi, Xn; risk phrases: R11; R19; R20/21; R38; R43; safety phrases: S2; S9; S21; S24; S37; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Isobutyl acrylate is a clear, colorless liquid. Molecular weight = 128.19; boiling point = 138°C (61−63°C @ 15 mm); flash point = 30°C; autoignition temperature = 427°C. Explosive limits: LEL = 1.9%; UEL: 8.0%. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 3, reactivity 2. Slightly soluble in water.

Potential Exposure: This material is used as a monomer for making acrylate resins.

Incompatibilities: Vapor may form explosive mixture with air. Heat and contamination may cause polymerization. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, aliphatic amines, alkanolamines.

PELs in Air

No standards or PAC available for isobutyl acrylate. See *n*-butyl acrylate 141-32-2; record # B:0830.

Harmful Effects and Symptoms

Short-Term Exposure: Irritating to skin, eyes, nose, and throat. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Moderately toxic when swallowed. LD_{50} (oral-rat) = 7070 mg/kg. Contact with the eyes causes minor irritation no worse than that produced by hand soap.

Long-Term Exposure: Can irritate the lungs. May cause bronchitis to develop.

Points of Attack: Lungs, skin.

Medical Surveillance. Lung function tests. Consider chest X-ray following acute overexposure. Evaluation by a dermatologist and/or qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Polyvinyl alcohol is among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area separated from strong oxidants, strong bases; strong acids. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2527 Isobutyl acrylate, stabilized, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorbent may be used to consolidate spills on land (such as sorbent polyurethane foams). Oil-skimming equipment may be used for spills on water. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or foam extinguishers. Water may be ineffective. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Spray into incinerator. Flammable solvent may be added.

References

(31); (173); (101); (138); (100).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 2, No. 2, 43−44 (1982) and 7, No. 6, 68−71 (1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Isobutyl Acrylate, Trenton, NJ (May 1999).

Isobutylene I:0280

Formula: C_4H_8

Synonyms: γ-Butylene; 1,1-Dimethylethylene; Isobutene; Isobutylene; Liquefied petroleum gas; 2-Methylpropylene; 2-Metilpropeno (Spanish); 1-Propene, 2-methyl-

CAS Registry Number: 115-11-7

HSDB Number: 613

RTECS Number: UD0890000

UN/NA & ERG Number: UN1055 (Isobutylene)/115 (P); UN1075 (Liquefied petroleum gas)/115

EC Number: 204-066-3 [*Annex I Index No.*: 601-012-00-4]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Carcinogenicity: NCI: Carcinogenesis Studies (inhalation); equivocal evidence: rat; no evidence: mouse.

Hazard Alert: Poison, Extremely flammable gas, Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated, Polymerization hazard.

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): D001.

Hazard symbols, risk, & safety statements: Hazard symbol: F+; risk phrases: R5; R12; R19; R21; safety phrases: S1; S2; S9; S19; S16; S33; S38 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): Non hazard to water.

Description: Isobutylene, an aliphatic hydrocarbon, is a colorless gas, or liquid under pressure. Sweet, gasoline odor. Molecular weight = 56.12; specific gravity (H_2O:1) = 0.588; boiling point = −7°C. Freezing point = −140°C; relative vapor density (air = 1) = 1.94; vapor pressure = 3278 mmHg @ 37.7°C; flash point = −76°C (cc); autoignition temperature = 465°C. Explosive Limits: LEL = 1.8%; UEL: 9.6%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, flammability 4, reactivity 1. Practically insoluble in water.

Potential Exposure: Used in the production of aviation gasoline, butyl rubbers; resins, other intermediates and chemicals; making antioxidants for food, packaging, and plastics.

Incompatibilities: Flammable gas; forms explosive mixture with air. Polymerizes easily. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, hydrogen bromide, nitrogen oxides and numerous other materials. May accumulate static electrical charges, and may cause ignition of its vapors.

PELs in Air

PAC Ver. 29[138]

PAC-1: 750 ppm

PAC-2: 2500 ppm

PAC-3: 11,000 ppm

Russia: STEL 100 milligram per cubic meter, 1993

Determination in Water: Octanol−water coefficient: Log K_{ow} = 2.4. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes and respiratory tract. Contact with the liquid can cause frostbite. Can cause headache, dizziness, lightheadedness, and fatigue. Higher levels can cause coma and death.

Long-Term Exposure: Unknown at this time.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If frostbite has occurred, seek medical attention immediately; *do not* rub the affected areas or flush them with water.

In order to prevent further tissue damage, *do not* attempt to remove frozen clothing from frostbitten areas. If frostbite has *not* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Polyethylene is among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear nonvented, impact resistant goggles when working with gas. Wear splash-proof chemical goggles and face shield when working with liquids unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Check oxygen content prior to entering storage area. Flammable gas. Color code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8—10 m or a 1-hour fire wall from flammable or reactive materials. Prior to working with Isobutylene all handlers should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from incompatible materials listed above. Where possible, automatically pump isobutylene from cylinders or from other storage containers to process containers. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: UN1055 Isobutylene, Hazard Class: 2.1; Labels: 2.1-Flammable gas. UN1075 Petroleum gases, liquefied or Liquefied petroleum gas, Hazard Class: 2.1; Labels: 2.1-Flammable gas. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: If in a building, evacuate building and confine vapors by closing doors and shutting down HVAC systems. Restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit and to disperse the gas. Wear chemical protective suit with SCBA to combat spills. Stay upwind and use water spray to “knock down” vapor; contain runoff. Stop the flow of gas, if it can be done safely from a distance. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place; and repair leak or allow cylinder to empty. Keep this chemical out of confined spaces, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable gas. Thermal decomposition products may include oxides of carbon. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Nonrefillable cylinders should be disposed of in accordance with local, state and federal regulations. Allow remaining gas to vent slowly into atmosphere in an unconfined area or exhaust hood. Refillable-type cylinders should be returned to original supplier with any valve caps and outlet plugs secured and valve protection caps in place.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Isobutylene, Trenton, NJ (May 1999).

Isobutyraldehyde I:0300

Formula: C_4H_8O; $(CH_3)_2CHCHO$

Synonyms: Isobutaldehyde; Isobutanal; Isobutiraldehido (Spanish); Isobutyl aldehyde; Isobutyral; Isobutyric aldehyde; Isobutyryl aldehyde; Isopropyl aldehyde; Isopropyl formaldehyde; 2-Methyl-1-propanal; 2-Methylpropanal; Methylpropanal; α-Methylpropionaldehyde; 2-Methylpropio naldehyde; NCI-C60968; Propanal, 2-methyl-; Valine aldehyde

CAS Registry Number: 78-84-2

HSDB Number: 614

RTECS Number: NQ4025000

UN/NA & ERG Number: UN2045/130 (P)

EC Number: 201-149-6

Regulatory Authority and Advisory Information

Carcinogenicity: NCI: Carcinogenesis Studies (inhalation); no evidence: mouse, rat.

Hazard Alert: Poison, Highly flammable liquid, Polymerization hazard (unstabilized); Possible risk of forming tumors, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, F, Xn, Xi; risk phrases: R11; R19; R22; R36/37/38; R62; safety phrases: S9; S16; S21; S26; S29; S33; S36/37/39 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Isobutyraldehyde is a colorless liquid with a pungent odor. The odor threshold is 0.05 ppm. Molecular weight = 72.11; specific gravity (H_2O:1) = 0.79 @ 20°C; boiling point = 64 °C; freezing/melting point = −65°C; vapor pressure = 173 mmHg @ 25°C; flash point = −18°C; autoignition temperature = 196°C. Explosive limits: LEL = 1.6%; 13,000 ppm[138]; UEL: 10.6%[17]. Hazard Identification (based on NFPA-704 M Rating System): Health 2, flammability 3, reactivity 1. Slightly soluble in water; solubility = 7% @ 20°C.

Potential Exposure: Isobutyraldehyde is used in the organic synthesis of pantothenic acid, valine, leucine and cellulose ester; in making gasoline additives, perfumes, flavors, and plasticizers.

Incompatibilities: Forms explosive gas mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong acids, mineral acids, strong bases, caustics, reducing agents; aliphatic amines; alkanolamines, aromatic amines.; strong oxidizers. Can undergo exothermic self-condensation or polymerization reactions that are often catalyzed by acid. Generates flammable and/or toxic gases in combination with azo, diazo compounds, dithiocarbamates and nitrides,. Reacts slowly when exposed to air with air to give peroxides and other products. These reactions are activated by light, catalyzed by salts of transition metals, and are autocatalytic (catalyzed by their products). The addition of stabilizers (antioxidants) retards autoxidation[101].

PELs in Air

PAC Ver. 29[138]

PAC-1: 75 ppm

PAC-2: 78 ppm

PAC-3: 470 ppm

Poland: MAC (TWA) 100 milligram per cubic meter, 1999; Russia: STEL 5 milligram per cubic meter [skin], 1993

Determination in Air: Use NIOSH Analytical Method #2539, aldehydes, screening.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 1.2. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Skin absorption, inhalation, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Isobutyraldehyde can affect you when breathed in and by passing through your skin. Corrosive to the eyes, skin, and respiratory tract. High levels can irritate the lungs. High levels can cause you to feel dizzy, lightheaded and to pass out. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Corrosive on ingestion. Exposure may result in death.

Long-Term Exposure: Can irritate the lungs and may cause bronchitis to develop. Repeated exposure can cause skin dryness, itching and rash.

Points of Attack: Lungs, skin.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure,

begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Butyl rubber is among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures to isobutyraldehyde exists, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Stable for two weeks when stored under nitrogen at temperatures up to 77°F. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers (such as perchlorates, peroxides, permanganates, chlorates and nitrates), since violent reactions occur. Sources of ignition, such as smoking and open flames, are prohibited where isobutyraldehyde is handled, used, or stored. Metal containers involving the transfer of 5 gal or more of isobutyraldehyde should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of isobutyraldehyde. Wherever isobutyraldehyde is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN2045 Isobutyraldehyde or Isobutyl aldehyde, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition includes oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (2); (100).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 2, No. 2, 46−48 (1982).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Isobutyraldehyde, Trenton, NJ (March 1999).

Isobutyric Acid I:0310

Formula: $C_4H_8O_2$

Synonyms: Acetic acid, dimethyl-; Acido isobutirico (Spanish); Dimethylacetic acid; Isobutanoic acid; Isobutyric acid; Isopropylformic acid; α-Methylpropanoic acid; 2-Methylpropanoic acid; α-Methylpropionic acid; Propane-2-carboxylic acid; Propionic acid, 2-methyl-

CAS Registry Number: 79-31-2
HSDB Number: 5228
RTECS Number: NQ4375000
UN/NA & ERG Number: UN2529/132
EC Number: 201-195-7 [*Annex I Index No.*: 607-063-00-9]

Regulatory Authority and Advisory Information

Hazard Alert: Flammable, Corrosive, Primary irritant (w/o allergic reaction).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below), as isomer of butyric acid

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 5000 lb (2270 kg)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: F, C, Xn; risk phrases: R10; R 21/22; R36/38; R41; safety phrases: S2; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Isobutyric acid is a colorless liquid. Odor of rancid butter fat. Molecular weight = 88.12; specific gravity (H_2O:1) = 0.95 @ 20°C; boiling point = 152°C; freezing/melting point = −47°C; vapor pressure = 1 mmHg @ 14.7°C; flash point = 56°C (oc); autoignition temperature = 481.6°C. Flammability limits: LEL = 2.0%; 12,000 ppm[138]; UEL: 9.2%. Hazard Identification (based on NFPA-704 M Rating System): Health 3, flammability 2, reactivity 0. Soluble in water.

Potential Exposure: Isobutyric acid is used to make solvents, flavors, perfumes, varnishes, disinfectants; and in tanning; in nonalcoholic beverages and processed foods.

Incompatibilities: May form explosive mixture with air. Aqueous solution forms a medium-strong acid. Incompatible with oxidizers, sulfuric acid; caustics, ammonia, amines, isocyanates, alkylene oxides; epichlorohydrin. Attacks aluminum and other metals.

PELs in Air

PAC Ver. 29[138]
PAC-1: 0.23 ppm
PAC-2: 2.6 ppm
PAC-3: 15 ppm

This chemical can be absorbed through the skin, thereby increasing exposure. For butyric acid the former-USSR-UNEP/IRPTC joint project MAC value is 2.5 ppm (10 milligram per cubic meter)[43] for work-place air. They also cite a momentary MAC value of 0.015 milligram per cubic meter and an allowable average daily MAC of 0.01 milligram per cubic meter in ambient air of residential areas.

Determination in Air: No method available.

Permissible Concentration in Water: Designated a hazardous substance and regulated under section 311 of the Federal Water Pollution Control Act and the Clean Water Act Amendments. See RQ above, for discharges of this substance.

Routes of Entry: Inhalation, absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Can cause severe eye and skin irritation and burns leading to permanent damage. Inhalation can cause respiratory tract irritation, coughing, wheezing and/or shortness of breath. Ingestion is poisonous and causes irritation of mouth and stomach; between 1 teaspoonful and 1 oz may be fatal. The LD_{50} is 280 mg/kg (oral, rat).

Long-Term Exposure: May affect the blood. Repeated exposures may cause bronchitis to develop with coughing, phlegm, and/or shortness of breath. May cause kidney damage.

Points of Attack: Kidneys, lungs, blood.

Medical Surveillance: Kidney function tests, CBC, lung function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water, or milk. Do not induce vomiting.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, heat, food, and water. Where possible, automatically pump liquid from drums or other storage containers to process containers. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical.

Shipping: UN2529 Isobutyric acid, Hazard Class: 3; Labels: 3-Flammable liquid, 8-Corrosive material.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Isobutyric Acid, Trenton, NJ (May 1999).

Isobutyronitrile I:0320

Formula: C_4H_7N; $(CH_3)_2CHCN$

Synonyms: 2-Cyanopropane; Dimethylacetonitrile; Iso butironitrilo (Spanish); Isopropyl cyanide; Isopropylkyanid; Isopropylnitrile; α-Methylpropanenitrile; 2-Methylpropa nenitrile; α-Methylpropionitrile; 2-Methylpropionitrile; Propanenitrile, 2-methyl-

CAS Registry Number: 78-82-0

HSDB Number: 5221

RTECS Number: TZ4900000

UN/NA & ERG Number: UN2284/131

EC Number: 201-147-5

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 20,000 ($\geq$1.00% concentration).

Hazard Alert: Poison, Highly flammable, Primary irritant (w/o allergic reaction).

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 20,000 lb (9,080 kg)

SUPERFUND/EPCRA 302, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1000 lb (454 kg).

Hazard symbols, risk, & safety statements: Hazard symbol: F, T, Xi; risk phrases: R12; R23/24/25; R36/37/38; safety phrases: S1; S9; S16; S21; S23; S24/25; S26; S36/37/39; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Isobutyronitrile is a colorless liquid. Molecular weight = 69.11; specific gravity (H_2O:1) = 0.77 @ 20°C; boiling point = 104°C; freezing/melting point = −71.5°C; vapor pressure = 33 mmHg @ 25°C; flash point = 8°C; autoignition temperature = 482°C. Explosive limits: LEL = 1.6%; UEL: 10.6%. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 3, reactivity 0. Slightly soluble in water.

Potential Exposure: Isobutyronitrile, a nitrile, is used in organic synthesis; as an intermediate for insecticides; and as a gasoline additive.

Incompatibilities: Vapor may form explosive mixture with air. Reacts with oxidants, strong reductants and strong bases. Nitriles may polymerize in the presence of metals and some metal compounds. They are incompatible with acids; mixing nitriles with strong oxidizing acids can lead to extremely violent reactions. Nitriles are generally incompatible with other oxidizing agents such as peroxides and epoxides. The combination of bases and nitriles can produce hydrogen cyanide. Nitriles are hydrolyzed in both aqueous acid and base to give carboxylic acids (or salts of carboxylic acids). These reactions generate heat. Peroxides convert nitriles to amides. Nitriles can react vigorously with reducing agents. Acetonitrile and propionitrile are soluble in water, but nitriles higher than propionitrile have low aqueous solubility. They are also insoluble in aqueous acids[101].

PELs in Air

NIOSH REL: 8 ppm/22 milligram per cubic meter TWA; *Nitriles*: 2 ppm, Ceiling Concentration, not to be exceeded in any 15-minute work period.

PAC* Ver. 29[138]

PAC-1: 0.18 ppm

PAC-2: $\mathbf{2_A}$ ppm

PAC-3: $\mathbf{6.1_A}$ ppm

*ERPG [Emergency Response Planning Guidelines] are marked with a subscript "**E**." AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

Harmful Effects and Symptoms

Short-Term Exposure: The substance is corrosive to the eyes, skin, and respiratory tract. Corrosive on ingestion. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Lacrimation (tearing) and burning sensation of the mouth and throat are common. Signs and symptoms of acute exposure to isobutyronitrile may include hypertension (high blood pressure) and tachycardia (rapid heart rate), followed by hypotension (low blood pressure) and bradycardia (slow heart rate). Cherry-red (and potentially bloody) mucous membranes; cardiac arrhythmias, and other cardiac abnormalities are common. Cyanosis (blue tint to skin and mucous membranes) may also be found. Tachypnea (rapid respiratory rate) may be followed by respiratory depression. Lung hemorrhage may occur. Headache, vertigo (dizziness), agitation, giddiness, salivation, nausea, and vomiting may be followed by combative behavior, convulsions, and coma. *Warning*: Heart palpitation may occur within minutes after exposure. High doses can stop breathing. Vital signs should be monitored closely. Caution is advised.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, Remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, immediately begin administering 100% oxygen to all victims. Monitor victims for respiratory distress. remove from exposure. Begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, evaluate vital signs and proceed as earlier in this section. Rush to a healthcare facility. Do not induce vomiting or attempt to neutralize. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. **4 hours**: Teflon gloves, suits, boots. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to this chemical exists, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area separated from strong oxidants, strong bases; strong acids. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2284 Isobutyronitrile, Hazard Class: 3; Labels: 3-Flammable liquid, 6.1-Poisonous materials.

Spill Handling:

Nitriles spill

Initial isolation and protective action distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information

from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).
First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.1/0.2
Large spills (From a large package or from many small packages)
First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.3/0.5
Night 0.5/0.8
Keep sparks, flames, and other sources of ignition away. Establish forced ventilation to keep levels below explosive limit. Build dikes to control flow as necessary. Attempt to stop leak if this can be done without hazard. Use water spray to disperse vapors and dilute standing pools of liquid. Avoid breathing vapors. Keep upwind. Avoid bodily contact with the material. Do not handle broken packages without protective equipment. Wash away any material which may have contacted the body with copious amounts of water or soap and water. Wear positive pressure breathing apparatus and special protective clothing. Shut off ignition sources; no flares, smoking, or flames in hazard area. Do not touch spilled material. Use water spray to reduce vapors. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include hydrogen cyanide and oxides of nitrogen and carbon. Extinguish with dry chemical, carbon dioxide; water spray, foam, or fog. Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Wear positive pressure breathing apparatus and special protective clothing. Isolate for 1/2 mi in all directions if tank car or truck in involved in fire. Move container from fire area if you can do so without risk. Dike fire control water for later disposal; do not scatter the material. It is a flammable/combustible material and may be ignited by heat, sparks, or flames. Vapor explosion and poison hazard indoors, outdoors, or in sewers. Runoff to sewer may create fire or explosion hazard. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Isobutyronitrile, Washington, DC, Chemical Emergency Preparedness Program (Nov. 30, 1987).

(173); (101); (138).

Isodrin I:0340

Formula: $C_{12}H_8Cl_6$

Synonyms: AI3-19244; Compound 711; 1,4: 5,8-Dimethano naphthalene, 1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-, (1a,4a,4a.b,5b,8b,8ab)-; 1,4: 5,8-Dimethano naphthalene, 1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-, endo, endo-; ENT19,244; (1a,4a,4ab,5b,8b, 8a.b)-1,2,3,4,10,10-Hexachloro-1,4,4a,-5,8,8a-hexahydro-1,4: 5,8-dimethanonaphthalene; 1,2,3,4,10,10-Hexachloro-1,4,4a,5, 8,8a-hexahydro-1,4: 5,8-endo, endo-dimethanon aphthalene; 1,2,3,4,10,10-Hexachloro-1,4,4a,5,8,8a-hexahydro-1,4-endo, endo-5,8-dimethanon aphthalene; Isodrina (Spanish)

CAS Registry Number: 465-73-6

HSDB Number: 6049

RTECS Number: IO1925000

UN/NA & ERG Number: UN2761/151

EC Number: 207-366-2 [*Annex I Index No*.: 602-050-00-4]

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Combustible, Environmental hazard, Agricultural chemical.

Banned or Severely Restricted (several countries) (UN)[13]

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P060

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.021; Nonwastewater (mg/kg), 0.066

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10)

SUPERFUND/EPCRA 302, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, N; risk phrases: R26/27/28; R51/53; safety phrases: S1/2; S13; S28; S29; S36/37; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to waters.

Description: Isodrin is a crystalline solid. Molecular weight = 364.90; freezing/melting point = 241°C. Decomposes above 100°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 1, reactivity 0. May be dissolved in flammable liquids.

Potential Exposure: A potential danger to those involved in the manufacture, formulation and application of this pesticide. An isomer of aldrin. See also "Aldrin" entry.

Incompatibilities: Incompatible with concentrated mineral acids; acid catalysts; acid oxidizing agents; phenols, reactive metals.

PELs in Air

PAC Ver. 29[138]

PAC-1: 0.64 milligram per cubic meter

PAC-2: 7 milligram per cubic meter

PAC-3: 42 milligram per cubic meter

Determination in Air: There is no OEL established for Isodrin. However, this chemical is an isomer of aldrin. See Aldrin.

Routes of Entry: Inhalation, ingestion, eyes and/or skin.

Harmful Effects and Symptoms

Short-Term Exposure: Isodrin is classified as extremely toxic. Probable oral lethal dose for humans is 5−50 mg/kg or between 7 drops and 2 teaspoonful for a 70 kg (150 lb) person. It causes renal damage and hyperactivity of sympathetic nervous system. Symptoms experienced are similar to poisoning by dieldrin and aldrin, including overall discomfort, headache, nausea, vomiting, dizziness, tremors, convulsions, rise in blood pressure; fever, disturbances in sleep and behavior; and rapid heartbeat. Death from respiratory arrest may occur in coma.

Long-Term Exposure: May cause dermatitis, skin rash, and acne. May cause liver and/or kidney damage.

Points of Attack: Liver, kidneys, skin.

Medical Surveillance: Liver function tests. Kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Effects may be delayed; keep victim under observation.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: UN2761 Organochlorine pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Remove and isolate contaminated clothing at the site. Do not touch spilled material; stop leak if you can do it without risk. Use water spray to reduce vapors. *Small spills*: take up with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills*: with clean shovel place material into clean, dry containers and cover/move containers from spill area. *Large spills*: dike far ahead of spill for later disposal. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material may burn but may not ignite readily. Thermal decomposition products may include hydrogen chloride and oxides of carbon. Fire and runoff from fire control water may produce Extinguish by using water spray, dry chemical, foam, or carbon dioxide. Use water to keep fire exposed containers cool. Wear full protective clothing including positive pressure breathing apparatus. Move container from fire area if you can do so without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (173); (101); (138); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 7, No. 6, 72−75 (1977).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Isodrin, Washington, DC, Chemical Emergency Preparedness Program (Nov. 30, 1987).

Isofenphos I:0345

Formula: $C_{15}H_{24}NO_4PS$

Synonyms: AI3-27748; Amaze; BAY 92114; BAY-SRA-12869; Benzoic acid, 2-[(ethoxy-((1-methylethyl)amino) phosphinothioyl)oxy]-, 1-methylethyl ester; Benzoic acid, 2-[(ethoxy((1-methylethyl)amino)phosphinothioyl)oxy]-, 1-methyl ester; Caswell No. 447AB; Dipropylene glycol; 2-[(Ethoxyl((1-methylethyl)amino)phosphinothioyl)oxy] benzoic acid 1-methylethyl ester; 2-[(Ethoxy((1-methylethyl)amino) phosphinothioyl)oxy]benzoic acid 1-methylethyl ester; *O*-Ethyl *O*-(2-isopropoxycarbonyl)phenylisopropyl phosphoramidothioate; Isopropyl *O*-[ethoxy(isopropylamino)phosphinothioyl]salicylate; Isopropyl *O*-[ethoxy-*N*-isopropylamino(thiophosphoryl)] salicylate; Isopropyl salicylate *O*-ester with *O*-ethyl isopropylphosphoramidothioate; 1-Methylethyl 2-[(ethoxy((1-methylethyl)amino)phosphinothioyl) oxy]benzoate; Oftanol; Phosphoramidothioic acid, isopropyl-, *O*-ethyl *O*-(2-isopropoxycarbonylphenyl) ester; Phosphoramidothioic acid, isopropyl-, *O*-ethyl ester, *O*-ester with isopropyl salicylate; Propanol, oxybis-; Pryfon 6; Salicylic acid, isopropyl ester, *O*-ester with *O*-ethyl isopropyl phosphoramidothioate; 40SD; SRA 12869; SRA 128691

CAS Number: 25311-71-1

HSDB Number: 6983

RTECS Number: VO43955000

UN/NA & ERG Number: UN3018/1562; UN2810 (toxic liquid, organic, n.o.s.)/153

EC Number: 246-814-1 [*Annex I Index No*.: 015-129-00-8]

Regulatory Authority and Advisory Information

Carcinogenicity: EPA, Cancer Classification: Group E, EPA, Cancer Classification: Group E Evidence of Noncarcinogenicity for Humans Evidence of Noncarcinogenicity for Humans. Note: This chemical has been associated with leukemia, a cancer of the blood cells (HSDB 6983, ref following study: Boros LG, Williams RD; Leuk, Res 25 (10): 883-90 (2001)].

DAlert: Poison, Neurotoxin (cumulative), Combustible liquid, Environmental hazard, Agricultural chemical.

All food tolerances for Isofenphos have been revoked, effective January 1999.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%

United States DOT Regulated marine pollutant (49CFR172.101, Appendix B) DOT Inhalation Hazard Chemicals as organophosphates

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292].

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R40; R24/25; R33; R50/53; safety phrases: S1/2; S29/35; S36/ S37; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to waters

Description: A colorless, oily liquid. Molecular weight = 345.4; specific gravity (H_2O:1) = 1.13 @ 20°C; boiling point = (decomposes) 220°C[Bayer]; freezing/melting point = −12°C; vapor pressure = 1.6×10^{-6} mmHg @ 20°C; flash point = 115°C; Explosive limits: LEL = 2.2%; UEL 18.8%. Low solubility in water; solubility = 23.8 mg/kg @ 20°C.

Potential Exposure: An organophosphate insecticide. Registered products containing isofenphos were voluntarily canceled in the United States in 1999. All food tolerances have been revoked in the United States Isofenphos was marketed under the basic producer's trade name, "Oftanol," and was used in the United States on turf and ornamental trees and shrubs to control white grubs, mole crickets, and other insects (mostly subterranean species). Isofenphos, was first registered in the United States in 1980 by Bayer Corporation for use on corn for control of the corn rootworm and was also used as a preemergence soil treatment in fruit crops and vegetables such as maize and carrots.

Incompatibilities: Sensitive to heat and moisture. Hydrolyzed by alkali solution. May react violently with antimony(V) pentafluoride. Incompatible with lead diacetate, magnesium, silver nitrate. In the presence of strong reducing agents such as hydrides, organophosphates form highly toxic and flammable phosphine gas. Contact with oxidizers can cause the release of toxic oxides of phosphorus. May react violently with aliphatic amines, alkalies, boranes, isocyanates, nitric acid, sulfuric acid.

Determination in Air: OSHA versatile sampler-2; Toluene/Acetone; Gas chromatography/Flame ionization detection; NIOSH IV, Method #5600, Organophosphorus Pesticides[18].

Permissible Concentration in Water: Runoff from spills or fire control may cause water pollution.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = > 4$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood. Fish toxicity (threshold)[101]: Low—116.60189 ppb, MATC.

Routes of Entry: Dermal contact, inhalation, ingestion

Harmful Effects and Symptoms

Short-Term Exposure: Highly toxic in contact with skin or if swallowed. Can be absorbed through the unbroken skin. Eye pupils are small; blurred vision; eye watering; runny nose; cough; shortness of breath; salivation; dizziness; nausea, stomach cramps, diarrhea, and vomiting; increased blood pressure; profuse sweating; hypermotility, hallucinations; irritability; tingling of the skin; drowsiness; slow heartbeat; convulsions; fluid in lungs; loss of consciousness; incontinence; breathing stops; death. Organophosphates inhibit the action of acetylcholinesterase enzymes, and alter the way in which nervous impulses are transmitted. The effects can last for hours, days, or much longer. The action of the enzymes is reestablished after new enzymes are formed. LD_{50} (oral, rat) $= < 50$ mg/kg; LD_{50} (dermal, rat) $= < 200$ mg/kg.

Long-Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. Organophosphates may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage. A neurotoxin. Human toxicity (long term)[101]: High—3.50 ppb, Health Advisory.

Points of Attack: Respiratory system, central nervous system, peripheral nervous system, cardiovascular system, blood cholinesterase. This chemical is associated with human myeloid leukemia[193].

Medical Surveillance: This chemical is suspected of causing leukemia, cancer of the blood cells. Exposed persons should contact a physician for advice regarding the possible long term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Medical observation is recommended for 24 to 48 hours following breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a drug or other inhalation therapy. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure

First Aid: Speed in removing material from eyes and skin is of extreme importance. *Eyes*: Eye contact can cause dangerous amounts of these chemicals to be quickly absorbed through the mucous membrane into the bloodstream. Immediately and gently flush eyes with plenty of warm or cold water (NO hot water) for at least 15 minutes, occasionally lifting the upper and lower eyelids. Get medical aid immediately. *Skin*: Get medical aid. Dermal contact can cause dangerous amounts of these chemicals to be absorbed into the bloodstream. Wearing the appropriate PPE equipment and respirator for organophosphate pesticides, immediately flush skin with plenty of soap and water for at least 15 minutes while removing contaminated clothing and shoes. Shampoo hair promptly if contaminated. *Ingestion*: Call poison control. Loosen all clothing. Never give anything by mouth to an unconscious person. Get medical aid. Do NOT induce vomiting. * If conscious, alert, and able to swallow, rinse mouth and have victim drink 4 to 8 oz of water do NOT induce vomiting but immediately administer slurry of activated charcoal (2 oz in 8 oz of water). If victim is *unconscious or having convulsions*, do nothing except keep victim warm. **In some cases you may be specifically instructed by poison control to induce vomiting by way of 2 tablespoons of syrup of ipecac (adult) washed down with a cup of water*. Do NOT give activated charcoal before or with ipecac syrup. *Inhalation*: Get medical aid. Do not contaminate yourself. Wearing the appropriate PPE equipment and respirator for organophosphate pesticides, immediately remove the victim from the contaminated area to fresh air. If the victim is not breathing, administer artificial respiration. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. If breathing is difficult, administer oxygen through bag/mask apparatus until medical help arrives. Do not leave victim unattended. *Note to physician or authorized medical personnel*. Administer atropine, 2 mg (1/30 g) intramuscularly or intravenously as soon as any local or systemic signs or symptoms of an intoxication are noted;

repeat the administration of atropine every 3 to 8 minutes until signs of atropinization (mydriasis, dry mouth, rapid pulse, hot and dry skin) occur; initiate treatment in children with 0.05 mg mg/kg of atropine; repeat at 5 to 10 minute intervals. Watch respiration, and remove bronchial secretions if they appear to be obstructing the airway; intubate if necessary. *Notes to physician or authorized medical personnel*: *N*-methylpyridinium-2-aldoxime (2-PAMCI) when used in conjunction with atropine reacts with the phosphorylated cholinesterase, thereby restoring normal activity to by removing the phosphorylating group. The combination of these two chemicals is synergistic and must be administered within minutes to a few hours following exposure (depending on the specific agent) to be effective. Give 2-PAMCI (Pralidoxime; Protopam), 2.5 gm in 100 mL of sterile water or in 5% dextrose and water, intravenously, slowly, in 15−30 minutes; if sufficient fluid is not available, give 1 g of 2-PAMCI in 3 mL of distilled water by deep intramuscular injection; repeat this every half hour if respiration weakens or if muscle fasciculation or convulsions recur. Also Diazepam, an anticonvulsant, might be considered

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of dermal and/or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. One recommendation is the use of DuPont Tychem suit fabrics[88] All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls, and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit. *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode).

Storage: Color code—Blue: Health Hazard/Poison. Store in a secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Where possible, automatically transfer material from other storage containers to process containers. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN3018 Organophosphorus pesticides, liquid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN2810 Toxic liquids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling:

Initial isolation and protective action distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.3/0.4
Night 0.8/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 600/200
Then: Protect persons downwind (mi/km)
Day 1.4/2.3
Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Do not touch spilled material. Do not breathe vapors. Stay upwind; keep out of low areas. Remove all ignition sources. Ventilate area of spill or leak. This material is a combustible liquid. For a spill or leak of a combustible liquid, shut off ignition sources; no flares, smoking or flames in hazard area. Stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of phosphorus, sulfur, nitrogen and carbon. May be fatal if inhaled, ingested or absorbed through skin. Inhalation or contact with some of these materials will irritate or burn skin and eyes. Vapors may cause dizziness or suffocation. *Small fires*: dry chemical, carbon dioxide; water spray; or foam. *Large fires*: water spray, fog, or foam. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Firefighting gear (including SCBA) may not provide adequate protection. If exposure occurs, remove and isolate gear immediately and thoroughly decontaminate personnel. Wear positive pressure breathing apparatus and special protective clothing. Remove and isolate contaminated clothing at the site. Move container from fire area if you can do so without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Destruction by alkali hydrolysis or incineration. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (100).

EXTOXNET, Extension Toxicology Network, "Pesticide Information Profile, Isofenphos," Oregon State University, Corvallis, OR (June 1996). http://extoxnet.orst.edu/pips/isofenph.htm.

United States Environmental Protection Agency, "Reregistration Eligibility Decision (RED) Facts, Isofenphos" Office of Prevention, Pesticides and Toxic Substances, Washington, DC (December 1999). http://www.epa.gov/REDs/factsheets/2345fact.pdf.

Food and Agriculture Organization of the United Nations (FAO), "*FAO Plant Production and Protection Paper, Isofenphos*," Geneva, Switzerland, (November 1981). http://www.inchem.org/documents/jmpr/jmpmono/v81pr18.htm.

Isofluorophate I:0350

Formula: $C_6H_{14}FO_3P$

Synonyms: Diflupyl; Diflurophate; Diisopropoxyphosphoryl fluoride; *O,O*-Diisopropyl fluorophosphate; Diisopropyl fluorophosphate; Diisopropyl fluorophosphonate; Diisopropylfluorophosphoric acid ester; Diisopropylfluorphosphorsaeureester (German); Diisopropyl phosphofluoridate; Diisopropyl phosphorofluoridate; *O,O′*-Diisopropyl phosphoryl fluoride; DPF; Dyflos; Floropryl; Fluophosphoric acid, diisopropyl ester; Fluorodiisopropyl phosphate; Fluoropryl; Fluostigmine; Isofluorphate; Isoflurophate; Isopropyl fluophosphate; Isoproyl phosphorofluoridate; Neoglaucit; PF-3; Phosphorofluoridic acid, diisopropyl ester; T-1703; TL-466

CAS Registry Number: 55-91-4

HSDB Number: 2133

RTECS Number: TE5075000

UN/NA & ERG Number: (PIH) UN3018 (organophosphorus pesticide, liquid, toxic)/152

EC Number: 200-247-6

Regulatory Authority and Advisory Information

Hazard Alert: Poison inhalation hazard: exposure can be lethal, Combustible, Neurotoxin (cumulative), Dangerously water reactive, Environmental hazard

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P043

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

SUPERFUND/EPCRA 302, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg)

RQ = 100 lb (45.4 kg)

United States DOT 49CFR172.101, Inhalation Hazard Chemical as organophosphates.

Hazardous to aquatic life or environment, with possible long-lasting effects.[291] Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, N; risk phrases: R27/28; R33; R50/53; safety phrases: S1/2; S28; S29/35; S30; S35; S36/37; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)]

Description: Isoflurophate is an oily, colorless to faintly yellow liquid. Molecular weight = 184.17; boiling point = 62°C @ 9 mmHg; freezing/melting point = −82°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, flammability 1, reactivity 0₩. Slightly soluble in water; dangerous reaction releasing hydrofluoric acid.

Potential Exposure: An insecticide. This organophosphate compound is used as a research tool in neuroscience for its ability to inhibit cholinesterase (by phosphorylation) on an acute/sub-acute basis and to produce a delayed neuropathy. Formerly used as a basis for "nerve gases."

Incompatibilities: Forms hydrofluoric acid in the presence of water. In the presence of moisture attacks metals, rubbers, plastics, coatings and silica-containing materials, such as glass. Organophosphates are susceptible to formation of highly toxic and flammable phosphine gas in the presence of strong reducing agents such as hydrideds and active metals. Partial oxidation by oxidizing agents may result in the release of toxic phosphorus oxides[101].

PELs in Air

PAC Ver. 29[138]

PAC-1: 0.33 milligram per cubic meter

PAC-2: 3.6 milligram per cubic meter

PAC-3: 22 milligram per cubic meter

Determination in Air: OSHA versatile sampler-2; Toluene/Acetone; Gas chromatography/Flame photometric detection for sulfur, nitrogen, or phosphorus; NIOSH Analytical Method (IV) Method #5600, Organophosphorus Pesticides.

Harmful Effects and Symptoms

Short-Term Exposure: Organic phosphorus insecticides are absorbed by the skin, as well as by the respiratory and gastrointestinal tracts. They are cholinesterase inhibitors. Symptoms of exposure include headache, giddiness; blurred vision; nervousness, weakness, nausea, cramps, diarrhea, and discomfort in the chest. Signs include sweating, tearing, salivation, vomiting, cyanosis, convulsions, coma, loss of reflexes and loss of sphincter control. Isoflurophate is extremely toxic: probable oral lethal dose in humans is 5−50 mg/kg, between 7 drops and 1 teaspoonful for 70 kg person. Even traces of the vapor cause pinpoint pupils. High exposures may cause pulmonary edema.

Long-Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, central nervous system; cardiovascular system, skin, eyes, plasma and red blood cell cholinesterase. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider CBC. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Use positive pressure, pressure-demand, full facepiece SCBA or pressure-demand supplied air respirator with escape SCBA and a fully-encapsulating, chemical resistant suit.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA (SCBA) with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from water and steam.

Shipping: UN3018 Organophosphorus pesticides, liquid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling:

Initial isolation and protective action distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30

Then: Protect persons downwind (mi/km)

Day 0.3/0.4

Night 0.8/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 600/200

Then: Protect persons downwind (mi/km)

Day 1.4/2.3

Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Do not touch spilled material. Do not breathe vapors. Stay upwind; keep out of low areas. Remove all ignition sources. Ventilate area of spill or leak. This material is a combustible liquid. For a spill or leak of a combustible liquid, shut off ignition sources; no flares, smoking or flames in hazard area. Stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: May burn but will not ignite readily. Thermal decomposition products may include hydrogen fluoride and oxides of phosphorus, nitrogen and carbon. Container may explode in heat of fire. Fire and runoff from fire control water may produce irritating or poisonous gases of fluorine and phosphorus oxides. Use dry chemical, carbon dioxide. For large fires, water spray, fog, or foam. Fight fire from maximum distance. Dike fire control water for later disposal. Stay upwind; keep out of low areas. Wear positive pressure breathing apparatus and special protective clothing. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Generators of waste (equal to or greater than 100 kg/mo) containing this contaminant, EPA hazardous waste number P043, must conform with USEPA regulations in storage, transportation, treatment and disposal of waste [40 CFR 240-280, 300-306, 702-799]. Potential for fluidized bed incineration with a temperature of 840−1800°C with residence times for liquids and gases: seconds; solids: longer. Potential candidate for rotary kiln incineration with a temperature of 1500−2900°C with residence times for liquids and gases: seconds; solids: hours. Potential candidate for liquid injection with a temperature of 1200−2900°C with a residence time of 0.1−2 seconds[72].

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Isofluorophate, Washington, DC, Chemical Emergency Preparedness Program (Nov. 30, 1987).

United States Environmental Protection Agency (USEPA), *Engineering Handbook for Hazardous Waste Incineration*, EPA 68-03-3025, p. 3−9, Washington, DC (1981).

Isolan I:0360

Formula: $C_{10}H_{17}N_3O_2$

Synonyms: Dimethylcarbamate-d'1-isopropyl-3-methyl-5-pyrazoylle (French); Dimethylcarbamic acid 3-methyl-1-(1-methylethyl)-1*H*-pyrazol-5-yl ester; Dimetilcarbamato de 1-isopropil-3-metil-5-pirazolilo (Spanish); ENT 19,060; Geigy G-23611; Isolane (French); Isopropylmethylpyrazol dimethylcarbamate; (1-Isopropyl-3-methyl-1*H*-pyrazol-5-yl)-*N*,*N*-dimethyl-carbamat (German); (1-Isopropyl-3-methyl-1*H*-pyrazol-5-yl)-*N*,*N*-dimethyl carbamate; 1-Isopropyl-3-methyl-5-pyrazolyl dimethyl carbamate; 1-Isopropyl-3-methyl pyrazolyl-(5) dimethylcarbamate; Isopropylmethylpyrazoyl dimethylcarbamate; 5-Methyl-2-isopropyl-3-pyrazolyl dimethyl carbamate; Primin; Saolan

CAS Registry Number: 119-38-0

HSDB Number: 31

RTECS Number: FA2100000

UN/NA & ERG Number: UN2992 (Carbamate pesticides, liquid, toxic)/151

EC Number: 204-318-2 [*Annex I Index No.*: 006-009-00-6]

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Possible neurotoxic effects (dimethyl carbamate), Suspected reprotoxic hazard, Agricultural chemical.

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P192

Superfund/EPCRA [40CFR 302 and 355, F R: 8/16/06, Vol 71, No. 158] RQ: 100 lb (45.4 kg)

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.056; Nonwastewater (mg/kg), 1.4

SUPERFUND/EPCRA 302, Extremely Hazardous Substances: TPQ = 500 lb (227 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg).

Hazard symbols, risk, & safety statements: Hazard symbol: T+; risk phrases: R27/28; R50; safety phrases: S1/2; S28; S36/37/39; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Isolan is a colorless liquid. Molecular weight = 211.30; boiling point = 103 °C @ 0.7 mm, and 117−118°C @ 2.5 mm.

Potential Exposure: This material is a systemic carbamate pesticide (aphicide). It is not registered as a pesticide in the United States Used in Europe.

Incompatibilities: Carbamates are incompatible with reducing agents, strong acids, oxidizing acids, peroxides, and bases. Contact with active metals or nitrides cause the release of flammable, and potentially explosive, hydrogen gas.

PELs in Air

PAC Ver. 29[138]

PAC-1: 0.51 milligram per cubic meter

PAC-2: 5.6 milligram per cubic meter

PAC-3: 34 milligram per cubic meter

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 1.7$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Ingestion, dermal contact.

Harmful Effects and Symptoms

Short-Term Exposure: Isolan is classified as extremely toxic. Probable oral lethal dose in humans is 5−50 mg/kg or between 7 drops and 1 teaspoonful for a 150 lb person. A cholinesterase inhibitor; although it is not an organic phosphate, it resembles that group in action. Can cause death due to respiratory arrest. Symptoms include cool extremities; trembling, fixed pinpoint pupils; nausea; vomiting, slight bluing of skin, lips and nailbeds; tearing, diarrhea, excessive salivation; sweating, slurring of speech; jerky movements; loss of bladder control; convulsions, coma and death.

Short-Term Exposure: A mutagen and may be carcinogenic.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Use positive pressure, pressure-demand full facepiece SCBA or pressure-demand supplied air respirator with escape SCBA and a fully-encapsulating, chemical resistant suit.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA (SCBA) with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: UN2992 Carbamate pesticides, liquid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Avoid breathing vapors. Treat as a liquid carbamate pesticide. Do not touch spilled material; stop leak if you can do it without risk. Use water spray to reduce vapors. *Small spills*: take up with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use methods for liquid carbamate pesticides. *Small fires*: dry chemical, carbon dioxide; water spray; or foam. *Large fires*: water spray, fog, or foam. Move container from fire area if you can do it without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. As with other liquid carbamate pesticides, keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Wear positive pressure breathing apparatus and special protective clothing. Remove and isolate contaminated clothing at the site. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Isopropylmethylpyrazolyl Dimethylcarbamate, Washington, DC, Chemical Emergency Preparedness Program (Nov. 30, 1987).

Isooctyl Alcohol I:0370

Formula: $C_8H_{18}O$; $C_7H_{15}CH_2OH$

Synonyms: 2-Ethylhexanol; Isodibutol; Isooctanol; Oxooctyl alcohol

CAS Registry Number: 26952-21-6

HSDB Number: 6486

RTECS Number: NS7700000

UN/NA & ERG Number: UN/NA1993/128

EC Number: 248-133-5

Regulatory Authority and Advisory Information

Hazard Alert: Flammable, Primary irritant (w/o allergic reaction).

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xn; risk phrases: R10; R35/36/38; R51; safety phrases: S16; S24/25; S26; S36/37; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Isooctyl alcohol is a clear, combustible liquid. Molecular weight = 130.26; specific gravity (H_2O:1) = 0.83; boiling point = 186°C; freezing/melting point = < -76°C; vapor pressure = 0.4 mmHg @ 20°C; flash point = 82°C (oc); autoignition temperature = 277°C. Explosive limits: LEL = 0.9%; UEL: 5.7%. Hazard Identification (based on NFPA-704 M Rating System): Health 3, flammability 2, reactivity 0. Insoluble in water. Reaction with water.

Potential Exposure: It is used to form phthalate, maleate, adipate and sebacate esters with the corresponding acids for use as plasticizers. It is used as a raw material for surfactants and as an antifoaming agent, emulsifier and solvent.

Incompatibilities: Vapor or liquid forms explosive mixture with air. Contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, nitrates, chlorine, bromine, and fluorine) can cause fire and explosion hazard. Incompatible with strong acids; caustics, amines, isocyanates. Attacks plastics.

PELs in Air

OSHA PEL: None

NIOSH REL: 50 ppm/270 milligram per cubic meter TWA [skin]

ACGIH TLV[1]: 50 ppm/266 milligram per cubic meter TWA [skin]

PAC not available

Australia: TWA 50 ppm (270 milligram per cubic meter) [skin], 1993; Belgium: TWA 50 ppm (266 milligram per cubic meter) [skin], 1993; Denmark: TWA 50 ppm (270 milligram per cubic meter) [skin], 1999; France: VME 50 ppm (270 milligram per cubic meter) [skin], 1999; Norway: TWA 25 ppm (135 milligram per cubic meter), 1999; Russia: STEL 50 milligram per cubic meter, 1993; Switzerland: MAK-W 50 ppm (270 milligram per cubic meter) [skin], 1999; the Netherlands: MAC-TGG 270 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 50 ppm [skin]. Russia[43] set a MAC for ambient air in residential areas of 0.15 milligram per cubic meter both on a momentary and a daily average basis. Several states have set guidelines or standards for *iso*-octyl alcohol in ambient air[60] ranging from 2.7 milligram per cubic meter (North Dakota) to 4.5 milligram per cubic meter (Connecticut) to 6.429 milligram per cubic meter (Nevada).

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Isooctyl alcohol can affect you when breathed in and by passing through your skin. Exposure irritates the eyes, nose and throat, and possibly the lungs. Contact can irritate the skin and prolonged contact may cause skin burns. Contact can irritate and burn the eyes and cause possible permanent damage. Inhalation of the vapor can cause depression of the central nervous system; can cause dizziness, lightheadedness, headache, confusion, and unconsciousness. Exposure can cause nausea, vomiting, diarrhea, and irregular heartbeat.

Long-Term Exposure: Defats the skin, causing redness, drying and rash. May damage the liver and kidneys. Inhalation can cause lung irritation causing coughing and/or shortness of breath.

Points of Attack: Eyes, skin, respiratory system; liver and kidneys.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: lung function tests, liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures *over 50* ppm; Use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece respirator with an organic vapor cartridge/canister. Increased protection is obtained from full facepiece powered-air purifying respirators. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers (such as perchlorates, permanganates, chlorates, nitrates, and peroxides). Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN/NA1993 Flammable liquids, n.o.s., Hazard Class: 3; Labels: 3-Flammable liquid, Technical Name Required. Each reference to a Class 3 material is modified to read "COMBUSTIBLE LIQUID" when that material is reclassified in accordance with §173.150 (e) or (f) of this subchapter or has a flash point above 60.5°C/141°F but below 93°C/200°F. A number with the prefix "NA" is not recognized for international shipments, except between the United States and Canada. It falls in Hazard Class "COMBUSTIBLE LIQUID".

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol resistant foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration, preferably in admixture with a more flammable solvent.

References

(31); (173); (101); (138); (100).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 2, No. 2, 49−50 (1982).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Isooctyl Alcohol, Trenton, NJ (February 1999).

Isopentane I:0390

Formula: C_5H_{12}

Synonyms: Butane, 2-methyl-; Ethyl dimethyl methane; Exxsol isopentane; Isoamyl hydride; Isopentano (Spanish); 2-Methylbutane; Phillips 66 isopentane

CAS Registry Number: 78-78-4; *(alt.)* 68923-44-4; *(alt.)* 92046-46-3

HSDB Number: 618

RTECS Number: EK4430000

UN/NA & ERG Number: UN1265/128

EC Number: 201-142-8 [*Annex I Index No.*: 601-006-00-1; 601-085-00-2]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Hazard Alert: Extremely flammable liquid, Environmental hazard.

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg)

Canada, WHMIS, Ingredients Disclosure List (isopentane not listed) *n*-pentane Concentration 1%.

Hazardous to aquatic life or environment, with possible long-lasting effects[293]. Toxic to aquatic life with long-lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: F+, T, N; risk phrases: R12; R51/53; safety phrases: S1; S2; S9; S16; S29; S33; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Isopentane is a volatile, colorless, watery liquid. It has a gasoline odor. Molecular weight = 72.17; specific gravity (H_2O:1) = 0.6 @ 20°C; boiling point = 20.2°C. Freezing point = −161°C; vapor pressure = 591 mmHg @ 21.1°C; flash point ≤ −51°C (cc); Autoignition temperature = 420°C. Flammability limits: LEL = 1.4%; UEL: 7.6%. Hazard Identification (based on NFPA-704 M Rating System): Health 1, flammability 4, reactivity 0. Insoluble in water.

Potential Exposure: Used as expanding or blowing agent in polystyrene foam beads; as a process solvent, chemical intermediate; in the manufacture of chlorinated derivatives; and as a antiknock additive in gasoline.

Incompatibilities: Highly volatile liquid; Vapor may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Attacks some paints, rubber and coatings. May accumulate static electrical charges, and may cause ignition of its vapors.

PELs in Air

NIOSH IDLH = 1500 ppm [LEL]

OSHA PEL: 1000 ppm/2950 milligram per cubic meter TWA

NIOSH REL: 120 ppm/350 milligram per cubic meter TWA

ACGIH TLV[1]: 600 ppm/1770 TWA

PAC Ver. 29[138]

PAC-1: 3000 ppm

PAC-2: 33,000 ppm

PAC-3: 2.00E + 05 ppm

DFG MAK: 1000 ppm/3000 milligram per cubic meter TWA; Peak Limitation Category II(2); Pregnancy Risk Group C

Austria: MAK 600 ppm (1899 milligram per cubic meter), 1999; Denmark: TWA 500 ppm (1500 milligram per cubic meter), 1999; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 600 ppm. United Kingdom[33] TWA 600 ppm (1800 milligram per cubic meter); STEL of 750 ppm (2250 milligram per cubic meter) (all isomers of pentane).

Determination in Air: Use NIOSH Analytical Method (IV) #1500, for Hydrocarbons.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Can irritate the eyes and respiratory tract. Skin contact can cause a rash or burning sensation on contact. Can cause headache, nausea, weakness, dizziness, sleepiness, loss of coordination and loss of consciousness. Ingestion may cause aspiration into the lungs and chemical pneumonitis. May affect the central nervous systems.

Long-Term Exposure: Repeated or prolonged contact with skin may cause drying and cracking.

Points of Attack: Eyes, skin, respiratory system; central nervous system.

Medical Surveillance: Examination of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH (as pentane): *1,200 ppm*: Sa (APF = 10) (any supplied-air respirator). *1500 ppm*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1265 Pentanes, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; alcohol foam; or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Isopentane. Trenton, NJ (June 1999).

Isophorone I:0400

Formula: $C_9H_{14}O$

Synonyms: 2-Cyclohexen-1-one,3,5,5-trimethyl-; Isoaceto phorone; Isoforon; Isoforona (Spanish); NCI-C55618; 1,1,3-Trimethyl-3-cyclohexene-5-one; 3,5,5-Trimethyl-2-cyclohexene-1-one; 3,5,5-Trimethyl-2-cyclohexen-1-one (German)

CAS Registry Number: 78-59-1

HSDB Number: 619

RTECS Number: GW7700000

UN/NA & ERG Number: UN/NA1993/128

EC Number: 201-126-0 [*Annex I Index No.*: 606-012-00-8]

Regulatory Authority and Advisory Information

Carcinogenicity: EPA: Possible Human Carcinogen; NCI: Carcinogenesis Studies (gavage); equivocal evidence: mouse, rat; NTP: Carcinogenesis Studies (gavage); some evidence: rat.

Hazard Alert: Flammable, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction).

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants; 40CFR423, Appendix A, Priority Pollutants

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8090 (60); 8270 (10)

Safe Drinking Water Act (47FR 9352): Priority List (55 FR 1470)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 5000 lb (2270 kg)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xi; risk phrases: R10; R21/22; R36/37; R40; R61; R62; R63; safety phrases: S2; S13; S23; S36/37/39; S46; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Isophorone, a cyclic ketone, is a colorless or pale liquid with a peppermint-like odor. The odor threshold is 5.4 ppm in water; 0.2 ppm in air. Molecular weight = 138.23; specific gravity (H_2O:1) = 0.93 @ 20°C; boiling point = 215 °C; freezing/melting point = −8°C; vapor pressure = 0.3 mmHg @ 20°C; 0.75 mmHg @ 33°C; flash point = 84°C (cc); autoignition temperature = 460°C. Explosive limits: LEL = 0.8%; UEL: 3.8%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, flammability 2, reactivity 0. Slightly soluble in water; solubility = 1%.

Potential Exposure: Isophorone is an industrial chemical synthesized from acetone and used commercially as a solvent or cosolvent for polyvinyl and nitro-cellulose resins, pesticides, herbicides, fats, oils, and gums. It is used as a solvent and emulsifier; in some printing inks, paints, lacquers, and adhesives. It is also used as a chemical feedstock for the synthesis of 3,5-xylenol, 2,3,5-trimethyl-cyclohexanol, and 3,5-dimethylaniline. Although this is an industrial chemical, it also occurs naturally in cranberries.

Incompatibilities: May form explosive mixture with air. Strong oxidizers may cause fire and explosions. Incompatible with aliphatic amines. Attacks some plastics, resins, and rubber.

PELs in Air

NIOSH IDLH = 200 ppm

Conversion factor: 1 ppm = 5.65 milligram per cubic meter @ 25°C & 1 atm

Odor Threshold = 0.2 ppm

OSHA PEL: 25 ppm/140 milligram per cubic meter TWA

NIOSH REL: 4 ppm/23 milligram per cubic meter TWA

ACGIH TLV[1]: 5 ppm/28 milligram per cubic meter TWA Ceiling Concentration; confirmed animal carcinogen with unknown relevance to humans.

PAC Ver. 29[138]

PAC-1: 12 ppm

PAC-2: 33 ppm

PAC-3: 200 ppm

DFG MAK: 2 ppm/11 milligram per cubic meter TWA; Peak Limitation Category I(2); Carcinogen Category 3B; Pregnancy Risk Group C.

Australia: TWA 5 ppm (25 milligram per cubic meter), 1993; Austria: MAK 5 ppm (28 milligram per cubic meter), 1999; Belgium: STEL 5 ppm (28 milligram per cubic meter), 1993; Denmark: TWA 5 ppm (25 milligram per cubic meter), 1999; Finland: TWA 5 ppm (28 milligram per cubic meter); STEL 10 ppm (56 milligram per cubic meter), 1999; France: VLE 5 ppm (25 milligram per cubic meter), 1999; the Netherlands:

MAC-25 milligram per cubic meter, 2003; the Philippines: TWA 25 ppm (140 milligram per cubic meter), 1993; Poland: MAC (TWA) 5 milligram per cubic meter, MAC 25 milligram per cubic meter, 1999; Russia: STEL 1 milligram per cubic meter, 1993; Sweden: KTV 5 ppm (30 milligram per cubic meter), 1999; Switzerland: MAK-W 5 ppm (28 milligram per cubic meter), 1999; Turkey: TWA 25 ppm (149 milligram per cubic meter), 1993; United Kingdom: STEL 5 ppm (29 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Ceiling Concentration 5 ppm. Several states have set guidelines or standards for isophorone in ambient air[60] ranging from 83.3 μ/m^3 (New York) to 200.0 μ/m^3 (Virginia) to 250.0 μ/m^3 (North Dakota and South Carolina) to 460.0 μ/m^3 (Connecticut) to 595 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method #2508; #2556; OSHA Analytical Method 7.

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 100 μg/L; State Drinking Water Guidelines: Florida 37 μg/L; Maine 370 μg/L; Minnesota 100 μg/L; New Hampshire 100 μg/L.

Determination in Water: Methylene chloride extraction followed by exchange to toluene, gas chromatography with flame ionization detection (EPA Method 609) or gas chromatography plus mass spectrometry (EPA Method 625). Octanol−water coefficient: $\text{Log } K_{\text{ow}} = 1.7$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact. Because of the odor and taste of isophorone, ingestion is not expected unless by accident.

Harmful Effects and Symptoms

Short-Term Exposure: Isophorone can affect you when breathed in and by passing through your skin. Irritates the eyes, skin, and respiratory tract. Exposure may cause headaches, nausea, and a drunken feeling. Higher levels can cause you to pass out. Contact can burn the eyes, causing permanent damage. Exposure can irritate the eyes, nose, and throat. Repeated exposure may cause chronic irritation with eye and nasal discharge. Long-term exposure can cause drying and cracking of the skin.

Long-Term Exposure: Repeated or prolonged contact will cause dry skin, cracking; dermatitis. May cause chronic irritation of the eyes and nose, with discharge. May cause liver and kidney damage. Many solvents and other, similar petroleum-based chemicals have been shown to cause brain or other nerve damage. Some animal studies suggest that isophorone may cause birth defects and slower growth in the offspring of rats and mice that breathed the vapors during pregnancy. These studies found some harmful health effects in adult female animals. High doses fed to male rats caused kidney disease, and tumors of the kidney, liver; and lymph and reproductive glands.

Points of Attack: Eyes, skin, respiratory system; central nervous system; liver, kidneys.

Medical Surveillance: NIOSH lists the following tests: chest X-ray; pulmonary function tests. If symptoms develop or overexposure is suspected, the following may be useful: examination of the eyes and nose for chronic inflammation, kidney function tests. Liver function tests. Interview for brain effects and refer positive and borderline individuals for neuropsychological testing.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. **8 hours**: Responder suits. **4 hours**: polyvinyl alcohol gloves; 4H and Silver Shield gloves. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *up to 40 ppm*: CcrOv* (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)]; or Sa (APF = 10) (any supplied-air respirator).* *up to 100 ppm*: Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)].* *up to 200 ppm*: CcrFOv (APF = 50) [any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s)]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or PaprTOv* (APF = 50) [any powered, air-purifying respirator with a tight-fitting facepiece and organic vapor cartridge(s)]; or SaT:Cf* (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd, Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, SCBA). *Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Isophorone must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine), since violent reactions occur. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN1993 Flammable liquids, n.o.s., Hazard Class: 3; Labels: 3-Flammable liquid, Technical Name Required. Each reference to a Class 3 material is modified to read "COMBUSTIBLE LIQUID" when that material is reclassified in accordance with §173.150 (e) or (f) of this subchapter or has a flash point above 60.5°C/141°F but below 93°C/200°F. A number with the prefix "NA" is not recognized for international shipments, except between the United States and Canada. It falls in Hazard Class "COMBUSTIBLE LIQUID".

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed[22].

References

(31); (173); (100).

National Institute for Occupational Safety and Health (NIOSH), "Criteria for a Recommended Standard: Occupational (2). Exposure to Ketones, DHEW (NIOSH) Publ. No. 78-173, Cincinnati OH (1978).

United States Environmental Protection Agency, Isophorone: Ambient Water Quality Criteria, Washington, DC (1980).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 2, No. 1, 108–110 (1982).

United States Public Health Service, Agency for Toxic Substance and Disease Registry, Toxicological Profile for Isophorone, Atlanta, GA (Dec. 1988).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Isophorone, Trenton, NJ (January 2000).

Isophorone Diisocyanate I:0410

Formula: $C_{12}H_{18}N_2O_2$

Synonyms: Cyclohexane, 5-isocyanato-1-(isocyanatomethyl)-1,3,3-trimethyl-; Diisocianato de isoforona (Spanish); IPDI; 5-Isocyanato-1-(isocyanatomethyl)-1,3,3-trimethylcyclohexane; 3-Isocyanatomethyl-3,5,5-trimethylcyclohexyl isocyanate; Isocyanic acid, methylene(3,5,5-trimethyl-3,1-cyclohexylene) ester; Isophorone diamine diisocyanate; Triisocyanatoisocyanurate of isophoronediisocyanate

CAS Registry Number: 4098-71-9

HSDB Number: 6337

RTECS Number: NQ9370000

UN/NA & ERG Number: (PIH) UN2290/156

EC Number: 223-861-6 [*Annex I Index No.*: 615-008-00-5]

Regulatory Authority and Advisory Information

Hazard Alert: Poison inhalation hazard, Combustible, Sensitization hazard, Suspected of causing genetic defects, Environmental hazard, Electrostatic hazard.

SUPERFUND/EPCRA 302, Extremely Hazardous Substances: TPQ = 500 lb (227 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 500 lb (227 kg)

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazardous to aquatic life or environment, with possible long-lasting effects[293]. Toxic to aquatic life with long-lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; Xi; risk phrases: R23; R36/37/39; R42/43; R51/53; R61; safety phrases: S1/2; S26; S28; S29/35; S38; S41; S45; S61.

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Isophorone diisocyanate is a colorless to yellowish liquid. An unpleasant, pungent odor. Molecular weight = 222.32; specific gravity (H_2O:1) = 1.06 @ 20°C; boiling point = 360 °C; freezing/melting point = −60°C; vapor pressure = 3×10^{-4} mmHg @ 25°C; flash point = 155°C (cc) ; autoignition temperature = 430°C; Explosive limits: LEL = 0.7%; UEL: 4.5%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, flammability 1, reactivity 1. Decomposes in water (soluble).

Potential Exposure: Isophorone diisocyanate is used as a raw material for polyurethane paints, varnishes and elastomers which are exceptionally stable to atmospheric and chemical attack.

Incompatibilities: May form explosive mixture with air. Isocyanates are highly flammable and reactive with many compounds, even with themselves. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Reaction with moist air, water or alcohols may form amines and insoluble polyureas and react exothermically, releasing toxic, corrosive or flammable gases, including carbon dioxide; and, at the same time, may generate a violent release of heat increasing the concentration of fumes in the air. Incompatible with amines, aldehydes, alkali metals, ammonia, carboxylic acids, caprolactum, alkaline materials, glycols, ketones, mercaptans, hydrides, organotin catalysts, phenols, strong acids, strong bases, strong reducing agents such as hydrides, urethanes, ureas. Elevated temperatures or contact with acids, bases, tertiary amines, and acyl-chlorides may cause explosive polymerization. Contact with metals may evolve flammable hydrogen gas. Attacks some plastics, rubber and coatings. Contact with metals may evolve flammable hydrogen gas. May accumulate static electrical charges, and may cause ignition of its vapors.

PELs in Air

Conversion factor: 1 ppm = 9.09 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: None

NIOSH REL: 0.005 ppm/0.045 milligram per cubic meter TWA; 0.02 ppm/0.18 milligram per cubic meter STEL [skin]

ACGIH TLV[1]: 0.005 ppm/0.045 milligram per cubic meter TWA

PAC Ver. 29[138]

PAC-1: 0.02 ppm

PAC-2: 0.14 ppm

PAC-3: 0.6 ppm

DFG MAK: 0.005 ppm/0.046 milligram per cubic meter TWA; Peak Limitation Category I(1), a momentary value of 0.01 mL/m^3/0.092 milligram per cubic meter should not be exceeded; [skin] danger of sentization of the airways and the skin; Pregnancy Risk Group D

Austria: MAK 0.01 ppm (0.09 milligram per cubic meter), 1999; Belgium: TWA 0.005 ppm (0.045 milligram per cubic meter) [skin], 1993; Denmark: TWA 0.005 ppm (0.045 milligram per cubic meter) [skin], 1999; France: VME 0.01 ppm (0.09 milligram per cubic meter), VLE 0.02 ppm (0.18 milligram per cubic meter), 1999; Norway: TWA 0.005 ppm (0.045 milligram per cubic meter), 1999; Switzerland: MAK-W 0.01 ppm (0.09 milligram per cubic meter), KZG-W 0.02 ppm (0.18 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 0.05 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 0.005 ppm. Several states have set guidelines or standards for IPDI in ambient air[60] ranging from 0.09 μ/m^3 (Connecticut) to 1.5 μ/m^3 (Virginia) to 9.0 μ/m^3 (North Dakota).

Determination in Air: Use NIOSH Analytical Method #5525; OSHA Analytical Method PV-2034.

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Contact can irritate and burn the skin and eyes. Permanent eye damage may result. Inhalation can cause coughing, wheezing, shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Isocyanates can cause itching and skin rashes, tearing of the eyes; inflammation of the mucous membrane of the nose; and lung problems. This material is highly toxic by inhalation and moderately toxic through the skin. People with skin or respiratory problems should avoid exposure. LD_{50} (oral, rat) $= < 5$ g/kg.

Long-Term Exposure: Repeated or prolonged contact may cause skin sensitization and allergy with itching and skin rash. Isophorone diisocyanate may cause an asthma-like allergy. Future exposures can cause asthma attacks with shortness of breath; wheezing, cough, and/or chest tightness. Permanent damage to the lungs could also occur. Permanent lung damage may occur, even if no allergic symptoms are noticed.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended. Lung function tests. These may be normal if person is not having an attack at the time of the test. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. **8 hours**: butyl rubber gloves, suits, boots; nitrile rubber gloves, suits, boots; polyvinyl alcohol gloves; Viton gloves, suits; Responder suits. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *up to 0.05 ppm*: Sa (APF = 10) (any supplied-air respirator).* *up to 0.125 ppm*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode).* *up to 0.25 ppm*: SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 1 ppm*: SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp:ASCBA (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, SCBA). *Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from water, alcohol, phenols; amines, urethanes; mercaptans and ureas.

Shipping: UN2290 Isophorone diisocyanate, Hazard Class: 6.1; Labels: 6.1-Poison Inhalation Hazard.

Spill Handling: Avoid inhalation. Stay upwind and uphill. Isolate the area of release or fire and deny entry. Remove all ignition sources. Stop the release if it can be done safely from a distance. All equipment used to handle this material must be grounded. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. *Small spill*: Cover with *dry* earth, *dry* sand, or other noncombustible material followed with plastic sheet to minimize spreading or contact with water or rain. Use clean nonsparking tools to collect material and place material into loosely covered plastic containers for later disposal. Prevent material and runoff from entering sewers and waterways if it can be done safely well ahead of the release. Use vapor suppressing foam to disperse vapors−contain runoff. Water spray may reduce vapor, but may not prevent ignition in enclosed spaces. Ventilate confined area if it can be done without placing personnel at risk. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical may burn, but does not readily ignite. Thermal decomposition products may include oxides of nitrogen and carbon. *Small fire*: use *dry* chemical, CO_2, *dry* sand, or alcohol-resistant foam. May react with foams releasing corrosive/toxic gases. *Large fire*: use water spray or alcohol-resistant foam if it is available in sufficient amounts. Under favorable conditions, experienced crews can use coordinated fog streams to sweep the flames off the surface of the burning liquid. Combustible material: may burn but does not ignite readily. Most vapors are heavier than air. They will spread along ground and collect in low or confined areas (sewers, basements, tanks). Vapors may travel to source of ignition and flash back. Containers may explode when heated or if contaminated with water. Keep exposures cool long after fire is out to protect against reignition. Do not direct straight streams into the liquid. Cool exposed containers with large quantities of water from unattended equipment or remove intact containers if it can be done safely. *Do not get water on spilled substance or inside containers*. If cooling streams are ineffective (*venting sound increases in volume and pitch, tank discolors or shows signs of deforming*), withdraw immediately to a secure location. Always stay away from ends of tanks, especially when engulfed in flames. If material or contaminated runoff from fire control enters waterways, notify downstream users of potentially contaminated water. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (2); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Isophorone Diisocyanate, Washington, DC, Chemical Emergency Preparedness Program (Nov. 30, 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Isophorone Diisocyanate, Trenton, NJ (February 1999).

Isoprene I:0420

Formula: $C_5H_2O_8$; $CH_2{=}C(CH_3)CH{=}CH_2$

Synonyms: 1,3-Butadiene, 2-methyl; Isoprene rubber; Isopreno (Spanish); β-Methylbivinyl; 2-Methyl-1,3-butadiene; 2-Methylbutadiene; (*Z*)-1,4-Polyisoprene rubber; *cis*-1,4-Polyisoprene rubber

CAS Registry Number: 78-79-5; *(alt.)* 78006-92-5

HSDB Number: 620

RTECS Number: NT4037000

UN/NA & ERG Number: UN1218/130 (P)

EC Number: 201-143-3 [*Annex I Index No.*: 601-014-00-5]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Animal Sufficient Evidence, Human No Adequate Data, *possibly carcinogenic to humans*, Group 2B, 1999; NCI: Carcinogenesis Studies (inhalation); clear evidence: rat.

California Proposition 65 Chemical[102]: Cancer 5/1/1996.

Hazard Alert: Extremely hazardous liquid, Polymerization hazard (nonstabilized). Unstable chemical, Possible risk of forming tumors, Suspected reprotoxic hazard, Environmental hazard.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg)

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR423, Appendix A, Priority Pollutants; Toxic Pollutant (Section 401.15)

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8090 (60); 8270 (10)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: F+, T, N; risk phrases: R45; R12; R19; R36/38; R38; R46; R48/20; R50/53; R60; R62; R63; R65; R67; safety phrases: S1; S16; S26; S36/37; S41; S45; S46; S53; S63 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to waters

Description: Isoprene is a colorless liquid with a mild petroleum-like odor. Vapor is heavier than air; will collect in low areas. The odor threshold is 0.005 ppm. Molecular weight = 68.13; specific gravity (H_2O:1) = 0.68 @ 20°C; boiling point = 34 °C; freezing/melting point = −147°C; vapor pressure = 400 mmHg@ 550°C; flash point = −54°C; autoignition temperature = 395°C. Explosive limits: LEL = 1.5%; UEL: 8.9%[17]. Hazard Identification (based on NFPA-704 M Rating System): Health 1, flammability 4, reactivity 2. Insoluble in water.

Potential Exposure: Isoprene is used in the manufacture of synthetic rubber and in elastomer plastics; in the production of *cis*-1,4-polyisoprene rubber, styrene/isoprene/styrene block polymers.

Incompatibilities: Isoprene is a highly flammable and reactive liquid, and a dangerous fire and explosive hazard. Store under inert atmosphere (preferably nitrogen) with at least 50 ppm *tert*-butylcatechol present as an inhibitor. May form explosive mixture with air. Air contact forms explosive peroxides; heat, buildup of peroxides; and contact with many materials may cause violent polymerization, with fire or explosion hazard. Violent reaction with oxidizers, strong acids; reducing agents; strong bases; acid chlorides; alcohols, causing fire and explosion hazard. Attacks some paints, rubber, and coatings. May accumulate static electrical charges and may cause ignition of its vapors.

PELs in Air

PAC* Ver. 29[138]

PAC-1: $\mathbf{5}_{\mathbf{E}}$ ppm

PAC-2: $\mathbf{1000}_{\mathbf{E}}$ ppm

PAC-3: $\mathbf{4000}_{\mathbf{E}}$ ppm

DFG MAK: 3 ppm/8.5 milligram per cubic meter TWA; Peak Limitation Category II(8); Pregnancy Risk Group C; Germ Cell Mutagen Category 5; Carcinogen Category 5

Poland: MAC (TWA) 100 milligram per cubic meter, MAC (STEL) 300 milligram per cubic meter, 1999; Russia: STEL 40 milligram per cubic meter, 1993. Russia has set[35] a MAC in ambient air in residential areas of 0.04 milligram per cubic meter on a once-daily basis.

Permissible Concentration in Water: Russia[35,43] set a MAC in water bodies used for domestic purposes of 0.005 mg/L and surface water used for fishery purposes of 0.01 mg/L.

Routes of Entry: Inhalation, eyes and/or skin.

Harmful Effects and Symptoms

Short-Term Exposure: Exposure can irritate the eyes, skin, and respiratory tract. Contact irritates the eyes and skin. Higher levels can affect the central nervous system and cause dizziness, lightheadedness, confusion, and unconsciousness.

Long-Term Exposure: Lungs may be affected by repeated or prolonged exposure; bronchitis may develop. There is limited evidence that isoprene can cause cancer of the testes in animals, in high concentrations. This substance is possibly carcinogenic to humans. High exposures may affect blood cells.

Points of Attack: Lungs, blood cells.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Lung function tests, CBC, consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Viton and polyvinyl alcohol are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures to isoprene exists, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Isoprene must be stored to avoid contact with strong acids (such as chlorosulfonic, sulfuric and nitric), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat, flame and oxidizers. Sources of ignition, such as smoking and open flames, are prohibited where isoprene is handled, used, or stored. Metal containers involving the transfer of 5 gal or more of isoprene should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment especially when opening and closing containers of isoprene. Wherever isoprene is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN1218 Isoprene, inhibited, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable and reactive liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or polymer foam extinguishers. Water may be ineffective. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed[22].

References

(109); (102); (31); (173); (101); (138); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 6, 74–76 (1981).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Isoprene, Trenton, NJ (February 1999).

Isopropanolamine Dodecylbenzene Sulfonate I:0430

Formula: $C_{18}H_{30}O_3S \cdot C_3H_9NO$

Synonyms: Benzenesulfonic acid, 4-dodecyl-, compound with 1-amino-2-propanol (1:1); Isopropaneolamine salt of dodecylbenzenesulfonate; Isopropanolamine dodecyl benzenesulfonate

CAS Registry Number: 42504-46-1; 54590-52-2

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 255-854-9

Regulatory Authority and Advisory Information

Hazard Alert: Combustible, Environmental hazard

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1000 lb (454 kg).

Description: Isopropanolamine dodecylbenzenesulfonate is a white to light yellow granular solid. Molecular weight = 385.5; 401.61; vapor pressure = 13–15 mmHg @20°C; flash point = > 149°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, flammability 1, reactivity 0. Soluble in water.

Potential Exposure: Isopropanolamine dodecylbenzenesulfonate is used as a surface active ingredient in soaps and detergents; used in the fragrance industry

Incompatibilities: Salts, basic, such as isopropanolamine dodecylbenzene sulfonate, are generally soluble in water. The resulting solutions contain moderate concentrations of hydroxide ions and have pH's greater than 7.0. They react as bases to neutralize acids. These neutralizations generate heat, but less or far less than is generated by neutralization of the bases in reactivity group 10 (Bases) and the neutralization of amines. They usually do not react as either oxidizing agents or reducing agents but such behavior is not impossible[101].

PELs in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Routes of Entry: Inhalation, ingestion

Harmful Effects and Symptoms

Short-Term Exposure: Can irritate and burn the eyes and skin on contact. Inhalation can cause irritation of the nose and throat with coughing and wheezing.

Long-Term Exposure: Unknown at this time.

Medical Surveillance: There is no special test for this chemical. However, if illness occurs or overexposure is suspected, medical attention is recommended.

First Aid: If this chemical gets into the eyes, remove any contact lense at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable

probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to this chemical exists, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Green: General storage may be used. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: The primary hazard is the threat to the environment. Immediate steps should be taken to limit its spread to the environment. Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Do not touch or walk through spilled material. Stop leak if you can do it without risk. Prevent dust cloud. Avoid inhalation of asbestos dust. SMALL DRY SPILL: With clean shovel place material into clean, dry container and cover loosely; move containers from spill area. SMALL SPILL: Take up with sand or other noncombustible absorbent material and place into containers for later disposal. LARGE SPILL: Dike far ahead of liquid spill for later disposal. Cover powder spill with plastic sheet or tarp to minimize spreading. Prevent entry into waterways, sewers, basements or confined areas[117]. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is may burn but does not easily ignite. Thermal decomposition products may include oxides of sulfur and carbon. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (101); (138).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Isopropanolamine Dodecylbenzenesulfonate, Trenton NJ (May 1999).

2-Isopropoxyethanol I:0440

Formula: $C_5H_{12}O_2$

Synonyms: Dowanol Eipat; Ethanol, isopropoxy-; Ethylene glycol isopropyl ether; Ethylene glycol, monoisopropyl ether; β-Hydroxyethyl isopropyl ether; IPE; Isopropoxyethanol; Isopropyl cellosolve; Isopropyl glycol; Isopropyloxitol; 2-(1-Methylethoxy)ethanol; Monoisopropyl ether of ethylene glycol

CAS Registry Number: 109-59-1

HSDB Number: 2831

RTECS Number: KL5075000

UN/NA & ERG Number: UN2929/131; UN3271 (ethers)/127

EC Number: 203-685-6 [*Annex I Index No.*: 603-013-00-5]

Regulatory Authority and Advisory Information

Hazard Alert: Flammable liquid, Possible polymerization hazard (glycol ethers),; Reproductive toxin, Primary irritant (w/o allergic reaction).

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xn; risk phrases: R6; R10; R19; R20/21; R3637/38; safety phrases: S2; S24/25; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

As glycol ethers:

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) includes mono- and di-ethers of ethylene glycol, diethyl glycol, and triethylene glycol R-$(OCH_2CH_2)_n$-OR′; where $n = 1$, 2, or 3; R = alkyl or aryl groups; R′ = R, H, or groups which, when removed, yield glycol ethers with the structure: R-$(OCH_2CH)_n$-OH. Polymers are excluded from the glycol category.

EPCRA Section 313: Certain glycol ethers are covered. R-$(OCH_2CH_2)_n$-OR′; where $n = 1$, 2, or 3; R = alkyl C7 or less; or R = phenyl or alkyl substituted phenyl; R′ + H, or alkyl C7 or less; or consisting of carboxylic ester, sulfate, phosphate, nitrate or sulfonate. Form R *de minimis* concentration reporting level: 1.0%.

Description: Isopropoxyethanol is a clear, colorless liquid with an ethereal odor. Molecular weight = 104.14; specific gravity (H_2O:1) = 0.9; boiling point = 139.4°C. Vapor pressure = 3 mmHg @ 20°C; flash point = 33°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, flammability 2, reactivity 1. Soluble in water.

Potential Exposure: Used in lacquers and other coatings; and as a solvent for resins, dyes, and textiles.

Incompatibilities: Vapor may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. May slowly form reactive peroxides during prolonged storage or on exposure to air and light.

PELs in Air

OSHA PEL: None

NIOSH REL: None established; See *NIOSH Pocket Guide*, Appendix D.

ACGIH TLV[1]: 25 ppm/106 gm/m^3 TWA [skin]

PAC not available

DFG MAK: 5 ppm/22 milligram per cubic meter TWA; Peak Limitation Category II(8) [skin]; Pregnancy Risk Group C

Australia: TWA 25 ppm (105 milligram per cubic meter), 1993; Austria: MAK 5 ppm (22 milligram per cubic meter) [skin], 1999; Belgium: TWA 25 ppm (106 milligram per cubic meter), 1993; Denmark: TWA 25 ppm (105 milligram per cubic meter), 1999; France: VME 25 ppm (105 milligram per cubic meter), 1999; Norway: TWA 20 ppm (80 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 44 milligram per cubic meter, 2003; MAC-TGG 44 milligram per cubic meter [skin], 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 25 ppm [skin]

Determination in Air: No method available.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Contact can irritate and burn the eyes and respiratory tract. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. High exposure through skin contact or inhalation can cause severe damage to the kidneys, blood, and liver. This can cause bloody urine and death.

Long-Term Exposure: Exposure can cause anemia. Prolonged contact can degrease and irritate the skin; may cause drying and cracking. Very irritating substances, such as IPE may affect the lungs.

Points of Attack: Eyes, skin, respiratory system; blood.

Medical Surveillance. Lung function tests. Liver and kidney function tests. CBC. urinalysis. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy. The use of alcoholic beverages may enhance the toxic effect.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN3271 Ethers, n.o.s., Hazard class: 3; Labels: 3-Flammable liquid, Technical Name Required. UN2929 Toxic liquids, flammable, organic, n.o.s., Hazard class: 6.1; Labels: 6.1-Poison Inhalation Hazard, 3-Flammable liquid, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Isopropoxyethanol, Trenton, NJ (February 1999).

Isopropyl Acetate I:0450

Formula: $C_5H_{10}O_2$: $CH_3COOCH(CH_3)_2$

Synonyms: Isopropylacetat (German); Isopropyl (acetate d') (French); Isopropyl ester of acetic acid; 1-Methylethyl acetate; 1-Methylethyl ester of acetic acid; *sec*-Propyl acetate; 2-Propyl acetate

CAS Registry Number: 108-21-4

HSDB Number: 159

RTECS Number: AI4930000

UN/NA & ERG Number: UN1220/129

EC Number: 203-561-1 [*Annex I Index No.*: 607-024-00-6]

Regulatory Authority and Advisory Information

Hazard Alert: Highly flammable, Primary irritant (w/o allergic reaction).

Hazard symbols, risk, & safety statements: Hazard symbol: F; risk phrases: R11; R36; R66; R67; safety phrases: S2; S16; S21; S26; S29; S33; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Isopropyl acetate is a colorless liquid with a fruity odor. Molecular weight = 102.15; specific gravity (H_2O:1) = 0.87; boiling point = 88.4°C; freezing/melting point = −68.8°C; vapor pressure = 40 mmHg @ 17°C; flash point = 2.2°C; autoignition temperature = 460°C. Explosive limits: LEL = 1.8% @ 38°C; 10,000 ppm[138]; UEL: 8.0%[17]. Hazard Identification (based on NFPA-704 M Rating System): Health 1, flammability 3, reactivity 0. Moderately soluble in water; solubility = 3%.

Potential Exposure: This material is used as an organic solvent for nitrocellulose and other resins, fats, oils, waxes and gums. It is used in synthetic perfumes and food flavorings.

Incompatibilities: May form explosive mixture with air. Contact with strong oxidizers may cause fire and explosions. Incompatible with strong acids; caustics, nitrates. Dissolves rubber and many plastic materials. Contact with steel may cause slow decomposition. May accumulate static electrical charges, and may cause ignition of its vapors.

PELs in Air

NIOSH IDLH = 1800 ppm

Conversion factor: 1 ppm = 4.18 milligram per cubic meter @ 25°C & 1 atm

Odor Threshold = 4.1 ppm

OSHA PEL: 250 ppm/950 milligram per cubic meter TWA

NIOSH REL: None established; See Appendix D of the *NIOSH Pocket Guide*

ACGIH TLV[1]: 100 ppm/418 milligram per cubic meter TWA; 200 ppm/950 milligram per cubic meter STEL (2001).

PAC Ver. 29[138]
PAC-1: 200 ppm
PAC-2: 2700 ppm
PAC-3: 16,000 ppm (LEL, lower explosive limit)
DFG MAK: 100 ppm/420 milligram per cubic meter TWA; Peak Limitation Category I(2); Pregnancy Risk Group C.
Australia; TWA 200 ppm (950 milligram per cubic meter); STEL 310 ppm, 1993; Austria: MAK 200 ppm (840 milligram per cubic meter), 1999; Belgium: TWA 250 ppm (1040 milligram per cubic meter); STEL 310 ppm (1290 milligram per cubic meter), 1993; Denmark: TWA 150 ppm (625 milligram per cubic meter), 1999; France: VME 250 ppm (950 milligram per cubic meter), VLE 300 ppm (1140 milligram per cubic meter), 1999; Hungary: TWA 400 milligram per cubic meter; STEL 800 milligram per cubic meter, 1993; Norway: TWA 100 ppm (240 milligram per cubic meter), 1999; the Philippines; TWA 250 ppm (950 milligram per cubic meter), 1993; Switzerland: MAK-W 200 ppm (840 milligram per cubic meter), KZG-W 400 ppm (1680 milligram per cubic meter), 1999; United Kingdom: STEL 200 ppm (849 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 310 ppm. Several states have set guidelines or standards for isopropyl acetate in ambient air[60] ranging from 1.4 milligram per cubic meter (Massachusetts) to 3.3 milligram per cubic meter (New York) to 9.5−11.85 milligram per cubic meter (North Dakota) to 16.0 milligram per cubic meter (Virginia) to 19.0 milligram per cubic meter (Connecticut) to 22.619 milligram per cubic meter (Nevada).

Determination in Air: Use NIOSH (IV), Method #1454, #1460; OSHA Analytical Method 7.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Health effects can occur below the legal exposure limit. Eye contact can cause severe irritation or burns. The vapors can cause eye, nose and throat irritation. Coughing and chest tightness can also occur. Higher levels cause headaches, drowsiness, poor coordination and passing out. Ingestion may cause chemical pneumonitis.

Long-Term Exposure: Repeated exposure can cause dry, cracking skin and may damage the liver. Can irritate the lungs and may cause bronchitis to develop. Although this chemical has not been adequately evaluated, many solvents and similar petroleum-based chemicals have been shown to cause brain or other nerve damage.

Points of Attack: Eyes, skin, respiratory system; central nervous system.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: liver function tests; evaluation for brain effects. Positive and borderline individuals should be referred for neuropsychological testing.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *1800 ppm*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA). *Note*: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from nitrates and strong oxidizers (such as chlorine, bromine, and fluorine) and strong acids (such as hydrochloric, sulfuric, and nitric) and strong alkalis. Sources of ignition, such as smoking and open flames, are prohibited where isopropyl acetate is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gal or more of isopropyl acetate should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of isopropyl acetate.

Shipping: UN1220 Isopropyl acetate, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (100).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 1 No. 3, 68−69 (1981).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Isopropyl Acetate, Trenton, NJ (April 2004).

Isopropyl Alcohol I:0460

Formula: C_3H_8O; $CH_3CHOHCH_3$

Synonyms: Alcohol isopropilico (Spanish); Alcojel; Alcool isopropylique (French); Alcosolve 2; Alcowipe; Avantin; Avantine; Combi-Schutz; Dimethylcarbinol; Hartosol; 2-Hydroxypropane; Imsol A; IPA; I.P.S.; Isohol; Isopropanol; Lutosol; Petrohol; PRO; *i*-Propanol; *n*-Propan-2-ol; 2-Propanol; Propan-2-ol; Propol; *sec*-Propyl alcohol; 2-Propyl alcohol; *i*-Propylalkohol (German); *iso*-Propylalkohol (German); Sasetone; Spectrar; Sterisol hand disinfectant; Takineocol

CAS Registry Number: 67-63-0; *(alt.)* 8013-70-5

HSDB Number: 116 as isopropanol

RTECS Number: NT8050000

UN/NA & ERG Number: UN1219/129

EC Number: 200-661-7 [*Annex I Index No.*: 603-117-00-0]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Inadequate Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1999. United States Environmental Protection Agency Gene-Tox Program, Negative: Cell transformation-SA7/SHE; *N. crassa-aneuploidy*.

Hazard Alert: Highly flammable: Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction).

EPCRA Section 313 (reportable if being manufactured by the strong process only; no supplier notification) Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xi; risk phrases: R11; R36; R62; R63; R67; safety phrases: S2; S7; S16; S21; S24/25; S26. (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Isopropyl alcohol is a flammable liquid with a slight odor resembling that of a mixture of ethanol and acetone. The odor threshold is 22 ppm. Molecular weight = 60.11; specific gravity (H_2O:1) = 0.79; boiling point = 82.3°C; freezing/melting point = −79.5°C; vapor pressure = 33 mmHg @ 20°C; 75 mmHg @ 34°C; flash point = 12°C; autoignition temperature = 399°C. Explosive limits: LEL = 2.0%; 13,000 ppm[138]; UEL: 12.7% @ 93°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, flammability 3, reactivity 0. Soluble in water.

Potential Exposure: Isopropyl alcohol is a chemical widely used as an analytical reagent and to manufacture acetone, glycerol and isopropyl acetate; in liniments, skin lotions, cosmetics, permanent wave preparations; pharmaceuticals, and hair tonics. It is also employed as a solvent in perfumes, in extraction processes; as a preservative; in lacquer formulations; and in many dye solutions. In addition, it has been employed as an ingredient of antifreezes, soaps, and window cleaners. It may also be used as a raw material for the manufacture of various isopropyl derivatives, such as pesticides.

Incompatibilities: May form explosive mixture with air. Incompatible with alkaline earth and alkali metals; crotonaldehyde, phosgene, strong acids; amines, ammonia, caustics, strong oxidizers. Attacks some plastics, rubber and coatings. Reacts with metallic aluminum at high temperatures.

PELs in Air

NIOSH IDLH = 2000 ppm

Conversion factor: 1 ppm = 2.46 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 400 ppm/980 milligram per cubic meter

NIOSH REL: 400 ppm/980 milligram per cubic meter TWA: 500 ppm/1225 milligram per cubic meter STEL

ACGIH TLV[1]: 200 ppm TWA; 400 ppm STEL; not classifiable as a human carcinogen (2001).

PAC Ver. 29[138]

PAC-1: 400 ppm

PAC-2: 2000 ppm

PAC-3: 12,000 ppm [>50% LEL but <100% LEL = 13,000]

DFG MAK: 200 ppm/500 milligram per cubic meter TWA; Peak Limitation Category II(2); Pregnancy Risk Group C; BAT 50 mg[acetone]/L blood/end-of-shift; 50 mg[acetone]/L urine/end-of-shift; Pregnancy Risk Group C

Australia: TWA 400 ppm (980 milligram per cubic meter); STEL 500 ppm, 1993; Austria: MAK 400 ppm (980 milligram per cubic meter), 1999; Belgium: TWA 400 ppm (985 milligram per cubic meter); STEL 500 ppm, 1993; Denmark: TWA 200 ppm (490 milligram per cubic meter), 1999; France: VLE 400 ppm, 1999; Japan: STEL 400 ppm (980 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 650 milligram per cubic meter, 2003; the Philippines: TWA 400 ppm (980 milligram per cubic meter), 1993; Poland; MAC (TWA) 900 milligram per cubic meter, MAC (STEL) 1200 milligram per cubic meter, 1999; Russia: STEL 400 ppm (10 milligram per cubic meter), 1993; Sweden: NGV 150 ppm (350 milligram per cubic meter), KTV 250 ppm (600 milligram per cubic meter), 1999; Switzerland: MAK-W 400 ppm (980 milligram per cubic meter), KZG-W 800 ppm (1960 milligram per cubic meter), 1999; Turkey: TWA 200 ppm (500 milligram per cubic meter), 1993; United Kingdom: TWA 400 ppm (999 milligram per cubic meter); STEL 500 ppm (1250 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 500 ppm. Russia[43] has set MAC values in the ambient air of residential areas of 0.6 milligram per cubic meter both on a momentary and on a daily average basis. Several states have set guidelines or standards for isopropanol in ambient air[60] ranging from 3.267 milligram per cubic meter (New York) to 9.8 milligram per cubic meter (Florida) to 9.8−12.25 milligram per cubic meter milligram per cubic meter (North Dakota) to 16.5 milligram per cubic meter (Virginia) to 19.6 milligram per cubic meter (Connecticut, South Dakota) to 23.333 milligram per cubic meter (Nevada).

Determination in Air: Charcoal adsorption, workup with 2-butanol in CS_2, analysis by gas chromatography/flame ionization. Use NIOSH Analytical Method #1400[18].

Permissible Concentration in Water: EPA[32] has suggested a permissible ambient goal of 13,500 μg/L based on health effects. Russia[43] set a MAC in water bodies used for domestic purposes of 0.25 mg/L. Maryland[61] has set a guideline for isopropanol in drinking water of 3.0 mg/L.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Isopropyl alcohol irritates the eyes, skin, and respiratory tract. *Inhalation*: Irritation of the nose and throat may occur @ 400 ppm and above. *Skin*: 5% solution may cause irritation and dryness. *Eyes*: Vapor levels of 20 ppm or above may result in irritation. Liquid may cause corneal burns and eye damage. *Ingestion*: 22.5 mL (2/3 oz) has caused salivation, reddening of face; stomach pain; depression, dizziness, headache, vomiting and unconsciousness. Ingestion of 100 mL (3 oz) has caused death.

Long-Term Exposure: Repeated or prolonged contact may cause dry, cracking skin. There is an increased incidence of nasal sinus cancer in workers involved in the manufacture of IPA by the strong acid process. Although this chemical has not been adequately evaluated, many solvents and similar petroleum-based chemicals have been shown to cause brain or other nerve damage.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: NIOSH lists the following tests: whole blood (chemical/metabolite), expired air, urine (chemical/metabolite). Also, NIOSH recommends that workers subject to isopropyl alcohol exposure have comprehensive preplacement medical examinations. Periodic medical examinations shall be made available on an annual basis. Particular attention will be given in these medical examinations to the skin sinuses, and respiratory system. Isopropyl alcohol and its metabolite, acetone, may be detected in blood, urine, and body tissues. Evaluation for brain effects. Positive and borderline individuals should be referred for neuropsychological testing.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. **8 hours**: butyl rubber gloves, suits, boots; nitrile rubber gloves, suits, boots; Viton gloves, suits; 4H and Silver Shield gloves, CPF3 suits; Responder suits. **4 hours**: Neoprene rubber gloves, suits, boots; Teflon gloves, suits, boots Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *2000 ppm*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or CcrFOv (APF = 50) [any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s)]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA). *Note*: Substance causes eye irritation or damage; eye protection needed.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Isopropyl alcohol must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where isopropyl alcohol is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gal or more of isopropyl alcohol should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of isopropyl alcohol.

Shipping: UN1219 Isopropanol or Isopropyl alcohol, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Water may be ineffective. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (2); (80); (100).

National institute for Occupational Safety and Health (NIOSH), "Criteria for a Recommended Standard: Occupational Exposure to Isopropyl Alcohol", NIOSH Document Number 76-142, Cincinnati OH (1976).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Isopropyl Alcohol, Washington, DC (December 29, 1977), also revised edition (1979).

New York State Department of Health, *Chemical Fact Sheet*: Isopropyl Alcohol, Bureau of Toxic Substance Assessment, Albany, NY (March 1986).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Isopropyl Alcohol, Trenton, NJ (June 2003).

Isopropylamine I:0470

Formula: C_3H_9N; $(CH_3)_2CHNH_2$
Synonyms: 1-Amino-2-hydroxypropane; 2-Aminopropane; 1-Amino-propanol-2; 2-Amonopropan (German); 2-Hydroxy propylamine; Isopropilamina (Spanish); Isopropyl amine; 1-Methylethylamine; Monoisopropylamine; 2-Propanamine; *sec*-Propylamine
CAS Registry Number: 75-31-0
HSDB Number: 804
RTECS Number: NT8400000
UN/NA & ERG Number: UN1221/132
EC Number: 200-860-9 [*Annex I Index No.*: 612-007-00-1]
Regulatory Authority and Advisory Information
Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).
Hazard Alert: Possible risk of forming tumors, Corrosive, Primary irritant (w/o allergic reaction).
Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg)
Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.
Hazard symbols, risk, & safety statements: Hazard symbol: F+, C, Xi; risk phrases: R12; R34; R36/37/38; safety phrases: S1; S2; S16; S24/25; S26; S27; S29; S41 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.
Description: Isopropylamine is a colorless liquid with a pungent ammonia-like odor. A gas above the boiling point. The odor threshold is 0.21 ppm. Molecular weight = 59.13; specific gravity (H_2O:1) = 0.69; boiling point = 34.4°C; freezing/melting point = −101°C; vapor pressure = 460 mmHg @ 20°C; flash point = −37°C; autoignition temperature = 402°C. Explosive limits: LEL = 2.0%; UEL: 10.4%. Hazard Identification (based on NFPA-704 M Rating System): Health 3, flammability 4, reactivity 0. Soluble in water.
Potential Exposure: Isopropyl amine is used to produce rubber accelerators, oil-soluble emulsifiers; in the synthesis of pharmaceuticals; pesticides, dyes and surface active agents.
Incompatibilities: May form explosive mixture with air. A strong base. Reacts with alkali metals; alkaline earth; acid anhydrides; acid chlorides. Reacts violently with strong oxidizers (fire and explosions), strong acids (explosive spattering); nitroparaffins, halogenated hydrocarbon; aldehydes, ketones, epoxides, and many other substances. Attacks some plastics, rubber and coatings. Attacks copper and its compounds, lead, zinc, tin.
PELs in Air
NIOSH IDLH = 750 ppm
Conversion factor: 1 ppm = 2.42 milligram per cubic meter @ 25°C & 1 atm
OSHA PEL: 5 ppm/12 milligram per cubic meter TWA
NIOSH REL: None established; See Appendix D of the *NIOSH Pocket Guide*
ACGIH TLV[1]: 5 ppm/12 milligram per cubic meter TWA; 10 ppm/24 milligram per cubic meter STEL
PAC Ver. 29[138]
PAC-1: 10 ppm
PAC-2: 670 ppm
PAC-3: 4000 ppm
DFG MAK: 5 ppm/12 milligram per cubic meter TWA; Peak Limitation Category I(2), a momentary value of 10 mL/m^3/25 milligram per cubic meter should not be exceeded; Pregnancy Risk Group C.
Australia: TWA 5 ppm (12 milligram per cubic meter); STEL 10 ppm, 1993; Austria: MAK 5 ppm (12 milligram per cubic meter), 1999; Belgium: TWA 5 ppm (12 milligram per cubic meter); STEL 10 ppm (24 milligram per cubic meter), 1993; Denmark: TWA 5 ppm (12 milligram per cubic meter), 1999; France: VME 5 ppm (12 milligram per cubic meter), 1999; Norway: TWA 5 ppm (12 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 12 milligram per cubic meter, 2003; Poland: MAC (TWA) 12 milligram per cubic meter, MAC (STEL) 24 milligram per cubic meter, 1999; Russia: STEL 1 milligram per cubic meter, 1993; Sweden: TWA 5 ppm (12 milligram per cubic meter); STEL 10 ppm (25 milligram per cubic meter), 1999; Switzerland: MAK-W 5 ppm (12 milligram per cubic meter), KZG-W 10 ppm (24 milligram per cubic meter), 1999; Turkey: TWA 5 ppm (12 milligram per cubic meter), 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 10 ppm. The OSHA PEL is 5 ppm TWA. NIOSH, the DFG MAK[3] and the ACGIH[1] TWA value is 5 ppm (12 milligram per cubic meter) and the STEL is 10 ppm (24 milligram per cubic meter). Russia[43] set a MAC in work-place air of 1.0 milligram per cubic meter and Russia set a MAC value for ambient air in residential areas of0.01 milligram per cubic meter. Several states have set guidelines or standards for monoisopropylamine in ambient air[60] ranging from 40 μ/m^3 (New York) to 120 μ/m^3 (Florida) to 120−240 μ/m^3 (Nevada) to 300 μ/m^3 (South Carolina).
Determination in Air: Use NIOSH II(3), Method #S147.
Permissible Concentration in Water: Russia[35,43] set a MAC in water bodies used for domestic purposes of 2.0 mg/L.
Routes of Entry: Inhalation, ingestion, skin absorption, eye and/or skin contact.
Harmful Effects and Symptoms
Short-Term Exposure: Isopropylamine is corrosive to the eyes, skin, and respiratory tract. Contact with the liquid or vapor can cause severe burns of the eyes and skin; can cause blurred vision or seeing halos around lights, with loss of vision and scarring. Corrosive on ingestion. Swallowing

the liquid may cause chemical pneumonitis. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: Repeated or prolonged contact can cause thickening and cracking of the skin. Repeated exposure can cause loss of vision and scarring. Can irritate the lungs and may cause bronchitis.

Points of Attack: Lungs, eyes.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: lung function tests, exam of the eyes and vision. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. **8 hours**: Tychem 1000 suits. **4 hours**: Teflon gloves, suits, boots. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: OSHA: *125 ppm*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode)$^{£}$; or PaprS (APF = 25) [any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern $^{£}$]. *250 ppm*: CcrFS (APF = 50) [Any air-purifying full facepiece respirator equipped with cartridge(s) providing protection against the compound of concern]; or GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted canister protection against the compound of concern]; or PaprTS (APF = 50) [any powered, air-purifying respirator with a tight-fitting facepiece and cartridge(s) providing protection against the compound of concern]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *750 ppm*: SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode. *Escape*: GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted canister protection against the compound of concern]; or SCBAE (any appropriate escape-type, SCBA). *Note*: Substance causes eye irritation or damage; eye protection needed.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Isopropylamine must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates and nitrates) and strong acids (such as hydrochloric, sulfuric and nitric), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where isopropylamine is handled, used, or stored. Metal containers involving the transfer of 5 gal or more of isopropylamine should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of isopropylamine. Wherever isopropylamine is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Isopropylamine will attack some forms of plastics, rubber and coatings.

Shipping: UN1221 Isopropylamine, Hazard Class: 3; Labels: 3-Flammable liquid, 8-Corrosive material.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include hydrogen cyanide and oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Controlled incineration (incinerator equipped with a scrubber or thermal unit to reduce nitrogen oxides emissions).

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Isopropylamine, Trenton, NJ (May 2003).

N-Isopropyl Aniline I:0480

Formula: $C_9H_{13}N$; $C_6H_5NHCH(CH_3)_2$

Synonyms: Aniline, *o*-isopropyl-; Benzenamine, *N*-(1-methylethyl)-; 2-Isopropyl aniline; Isopropylaniline; *N*-(1-Methylethyl)-benzenamine; *N*-IPA; *N*-Phenylisopropylamine

CAS Registry Number: 768-52-5

HSDB Number: 6133

RTECS Number: BY4200000

UN/NA & ERG Number: UN2810 (toxic liquid, organic, n.o.s.)/153

EC Number: 212-196-7

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Primary irritant (w/o allergic reaction).

Hazard symbols, risk, & safety statements: Hazard symbol: T, F; risk phrases: R10; R16; R22; R23; R36/37/38; R40; safety phrases: S7/9; S16; S26; S36/37; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Isopropyl aniline is a yellowish liquid with a sweet, aromatic odor. Molecular weight = 135.23; specific gravity (H_2O:1) = 0.93 @15.6°C; boiling point = 202.6°C; freezing/melting point = −50°C; vapor pressure = 0.03 mmHg @ 20°C; flash point = 82 to 87.7°C. Insoluble in water.

Potential Exposure: *N*-isopropyl aniline is used in the dyeing of acrylic fibers and as a chemical intermediate.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

PELs in Air

Conversion factor: 1 ppm = 5.53 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: None

NIOSH REL: 2 ppm/10 milligram per cubic meter TWA [skin]

ACGIH TLV[1]: 2 ppm/11 milligram per cubic meter TWA [skin]; BEIM issued for methemoglobin inducers.

PAC not available

Australia: TWA 2 ppm (10 milligram per cubic meter) [skin], 1993; Belgium: TWA 2 ppm (11 milligram per cubic meter) [skin], 1993; Denmark: TWA 2 ppm (10 milligram per cubic meter) [skin], 1999; France: VME 2 ppm (10 milligram per cubic meter) [skin], 1999; Norway: TWA 2 ppm (11 milligram per cubic meter), 1999; Switzerland: MAK-W 2 ppm (11 milligram per cubic meter) [skin], 1999; the Netherlands: MAC-TGG 10 milligram per cubic meter [skin], 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 2 ppm [skin]. North Dakota has set a standard for *N*-Isopropyl aniline in ambient air or 100 μ/m^3[60].

Determination in Air: Use OSHA Analytical Method 78.

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: *N*-Isopropyl aniline reduces the blood's ability to supply oxygen to the body, resulting in formation of methemoglobin. Exposure can cause cyanosis (the lips, ears, and other skin areas turn blue). The effects may be delayed. It can also cause headaches and lightheadedness. High exposures can cause trouble breathing; collapse, and even death. Contact may irritate the eyes and skin.

Long-Term Exposure: Repeated or prolonged contact may cause skin sensitization. Repeated high exposures may cause headaches, dizziness, poor appetite, and anemia.

Points of Attack: Eyes, skin, respiratory system; blood, cardiovascular system, liver, kidneys.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: blood methemoglobin level.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Effects may be delayed. Medical observation recommended.

Note to Physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures *over 2* ppm; Use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers; strong acids. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN2810 Toxic liquids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling:

UN2810 Toxic liquids, organic, n.o.s.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 0.7/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 1000/300
Then: Protect persons downwind (mi/km)
Day 1.1/1.8
Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; or foam extinguishers. *Do not use water.* Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: *N*-Isopropylaniline, Trenton, NJ (October 2006).

Isopropyl Chloroformate I:0490

Formula: $C_4H_7ClO_2$: $(CH_3)_2CHOOCCl$

Synonyms: Carbonochloride acid 1-methyl ester; Carbonochloridic acid, 1-methylethyl ester; Chloroformic acid isopropyl ester; Cloruro de isopropilo (Spanish); Isopropyl chlorocarbonate; Isopropyl chloromethanoate

CAS Registry Number: 108-23-6

HSDB Number: 2848

RTECS Number: LQ6475000

UN/NA & ERG Number: (PIH) UN2407/155

EC Number: 203-563-2

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 15,000 (≥1.00% concentration).

Hazard Alert: Poison inhalation hazard, Highly flammable liquid, Primary irritant (w/o allergic reaction).

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 15,000 lb (6810 kg)

SUPERFUND/EPCRA 302, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1000 lb (454 kg)

United States DOT 49CFR172.101, Inhalation Hazardous Chemical (PIH).

Hazard symbols, risk, & safety statements: Hazard symbol: T + , F, C; risk phrases: R11; R14/15; R20/22; R26; R29; R34; R36/37/38; R41; R48/20/23; R51; R63; R65; R67; safety phrases: S1; S8; S16; S26; S28; 36/37/39; S41; S45; S62; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Isopropyl chloroformate is a highly flammable, clear, colorless liquid. Pungent odor. Molecular weight = 122.56; specific gravity (H_2O:1) = 1.08 @ 20°C; boiling point = 105 °C; freezing/melting point = −80°C; vapor pressure = 72 mmHg @ 21°C; flash point = 28°C (oc); Autoignition temperature ≥ 500°C. Explosive limits: LEL = 4%; UEL: 15%. Insoluble in water; decomposition forming hydrogen chloride.

Potential Exposure: Isopropyl chloroformate is used as an intermediate for free-radical polymerization initiators and in organic synthesis.

Incompatibilities: Vapor may form explosive mixture with air. Decomposes slowly in cold water and above 20°C forming hydrogen chloride. Store under refrigeration. Contact with iron salts may cause explosive thermal decomposition. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, metal salts; amines, alcohols, ethers.

PELs in Air

PAC* Ver. 29[138]

PAC-1: 0.3 ppm

PAC-2: $\mathbf{3.3_A}$ ppm

PAC-3: $\mathbf{10_A}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values. Russia: STEL 0.1 milligram per cubic meter, 1993; United Kingdom TWA1 ppm (5.1 milligram per cubic meter), 2000; Netherlands: MAC-TGG 5 milligram per cubic meter, 2003

Routes of Entry: Inhalation, ingestion, skin absorption.

Harmful Effects and Symptoms

Short-Term Exposure: A phosgene derivative. Inhalation exposures at elevated concentrations cause death by immediate lung damage; lower concentrations cause difficult breathing; collapse, and convulsions. Can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Inhalation of material may cause death or permanent injury. Eye irritations, irritation of upper respiratory tract and surface burns have been observed. Eye irritation may persist after exposure ceases, and skin sensitization may occur. Ingestion can be fatal.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: (1) Color code—Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. (2) Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in refrigeration, below 20°C. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, iron salts; acids, alkalis, amines, alcohols. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: UN2407 Isopropyl chloroformate, Hazard class: 6.1; Labels: 6.1-Poison Inhalation Hazard, 3-Flammable liquid, 8-Corrosive material, Inhalation Hazard Zone B

Spill Handling:

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (*From a small package or a small leak from a large package*)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.2/0.3

Large spills (*From a large package or from many small packages*)

First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.3/0.5
Night 0.6/1.0

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

In case of spills or leaks, shut off ignition sources and keep away flares, smoke or flames. Do not touch spilled material. Use water to reduce vapors but do not get water inside containers. Take up *small spills* with sand or other noncombustible absorbent material and place in containers for later disposal. For *large spills*, dike far ahead of spill for later disposal.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include hydrogen chloride and oxides of carbon. For small fires, use dry chemical, carbon dioxide; water spray or foam. For large fires, use water spray, fog or foam. Stay upwind and keep out of low areas. Wear self-contained (positive pressure if available) breathing apparatus and full protective clothing. Vapor explosion hazard indoors, outdoors or in sewers. Runoff to sewer may create fire or explosion hazard. *See above for isolation distances*. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. Do not get water inside container. Cool containers exposed to flame with water until well after fire is out. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Isopropyl Chloroformate, Washington, DC, Chemical Emergency Preparedness Program (June 2002).

Isopropyl Formate I:0500

Formula: $C_4H_8O_2$: $HCOOCH(CH_3)_2$

Synonyms: Formic acid, isopropyl ester; Isopropyl methanoate

CAS Registry Number: 625-55-8

HSDB Number: 6401

RTECS Number: LQ8750000

UN/NA & ERG Number: UN1281/129

EC Number: 210-901-2 [*Annex I Index No.*: 607-016-00-2]

Regulatory Authority and Advisory Information

Hazard Alert: High acute toxicity, Highly flammable liquid, Primary irritant (w/o allergic reaction).

Hazard symbols, risk, & safety statements: Hazard symbol: T+, F, Xi; risk phrases: R11; R36/37/38; R67; R51; R67; safety phrases: S2; S9; S16; S21; S24; S33; S36; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [2-Hazard to water. (est.)]

Description: Isopropyl formate is a clear liquid with a pleasant odor. Molecular weight = 88.11; boiling point = 67°C; flash point = −6°C (cc) ; autoignition temperature = 485°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, flammability 3, reactivity 1. Slow decomposition in water.

Potential Exposure: Used as a fumigant and in organic synthesis.

Incompatibilities: Vapor may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Compounds of the carboxyl group react with all bases, both inorganic and organic (i.e., amines) releasing substantial heat, water and a salt that may be harmful. Incompatible with arsenic compounds (releases hydrogen cyanide gas), diazo compounds, dithiocarbamates, isocyanates, mercaptans, nitrides, and sulfides (releasing heat, toxic and possibly flammable gases), thiosulfates and dithionites (releasing hydrogen sulfate and oxides of sulfur).

PELs in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Harmful Effects and Symptoms

Short-Term Exposure: Inhalation of vapor can cause irritation of eyes and nose. High concentrations can cause drowsiness leading to unconsciousness in a few minutes; death within a few hours. Contact with liquid formic acid, isopropyl ester can cause irritation of eyes and skin. Eye irritation can be serious. Ingestion can result in irritation of the mouth and stomach, with loss of consciousness and possible death occurring if untreated.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: UN1281 Propyl formates, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Shut off ignition sources; no flares, smoking or flames in hazard area. Stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. *Small fires*: dry chemical, carbon dioxide; water spray; or foam. *Large fires*: water spray, fog, or foam. Move container from fire area if you can do it without risk. For massive fire in cargo area, use unmanned hose holder or monitor nozzles; if this is impossible, withdraw from area and let fire burn. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Isopropyl Formate, Washington, DC, Chemical Emergency Preparedness Program (Nov. 30, 1987).

Isopropyl Glycidyl Ether I:0510

Formula: $C_6H_{12}O_2$: CH_2-(O)-CH-CH_2-O-$CH(CH_3)_2$

Synonyms: 1,2-Epoxy-3-isopropoxypropane; Glycidyl isopropyl ether; IGE; Isopropil glicidil eter (Spanish); Isopropyl epoxypropyl ether; (Isoproxymethyl)oxirane; NCI-C56439; Oxyde de 2,3-epoxypropyle et d'isopropyle (French)

CAS Registry Number: 4016-14-2

HSDB Number: 4302

RTECS Number: TZ3500000

EC Number: 223-672-9

UN/NA & ERG Number: UN3271/127; UN1993 (flammable liquids, n.o.s.)/128

EC Number: 223-672-9

Regulatory Authority and Advisory Information

Carcinogenicity: DFG Carcinogen Category 3 (suspected)

Hazard Alert: Highly Flammable, Reproductive toxin: possible risk of gene damage/impaired fertility; possible polymerization hazard (glycol ethers), Primary irritant (w/o allergic reaction); Sensitization hazard.

CLEAN AIR ACT: Hazardous Air Pollutants (Title I, Part A, Section 112) as glycol ethers.

EPCRA Section 313: Form R *de minimis* concentration reporting level: 1.0% as glycol ethers.

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xi; risk phrases: R11; R19; R36/37/38; R42/43; R62; safety phrases: S2; S16; S26; S36/37/39; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)].

as glycol ethers:

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) includes mono-and di-ethers of ethylene glycol, diethyl glycol; and triethylene glycol R-$(OCH_2CH_2)_n$-OR′ where $n = 1, 2$, or 3; R = alkyl or aryl groups; R′ = R, H, or groups which, when removed, yield glycol ethers with the structure: R-$(OCH_2CH)_n$-OH. Polymers are excluded from the glycol category.

EPCRA Section 313: Certain glycol ethers are covered. R-$(OCH_2CH_2)_n$-OR′; where $n = 1, 2$, or 3; R = alkyl C7 or less; or R = phenyl or alkyl substituted phenyl; R′ + H, or alkyl C7 or less; or OR′ consisting of carboxylic ester, sulfate, phosphate, nitrate or sulfonate. Form R de minimis concentration reporting level: 1.0%.

Description: Isopropyl glycidyl ether is a flammable colorless liquid. Molecular weight = 116.18; specific gravity (H_2O:1) = 0.92 @ 20°C; boiling point = 127.2°C; vapor pressure = 9.4 mmHg @ 25°C; flash point = 33.3°C. Highly soluble in water; solubility = ≥100 mg/L @ 19°C.

Potential Exposure: Making various products including epoxy resins, organic compounds, ethers and esters.

Incompatibilities: Vapor may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Ethers may act as bases; they form salts with strong acids and addition complexes with Lewis acids. When heated or in contact with catalysts, epoxides may cause violent polymerization. Epoxides are incompatible with reducing agents and oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. May react, possibly violently, with water in the presence of acid and other catalysts. Reacts with alcohols, amines and other active hydrogen compounds. Slowly hydrolyzes in water. Ethers can form unstable and explosive peroxides upon standing. Reacts violently with strong oxidizers. Ethers can act as bases. They form salts with strong acids and addition complexes with Lewis acids. The complex between diethyl ether and boron trifluoride is an example. Ethers may react violently with strong oxidizing agents. In other reactions, which typically involve the breaking of the carbon-oxygen bond, ethers are relatively inert[101].

PELs in Air

NIOSH IDLH = 400 ppm

Conversion factor: 1 ppm = 4.75 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 50 ppm/240 milligram per cubic meter TWA

NIOSH REL: 50 ppm/240 milligram per cubic meter [15-min] Ceiling Concentration

ACGIH TLV[1]: 50 ppm/238 milligram per cubic meter TWA; 75 ppm/356 milligram per cubic meter STEL

PAC not available

DFG MAK: Carcinogen Category 3B

Australia: TWA 50 ppm (240 milligram per cubic meter); STEL 75 ppm, 1993; Austria: Suspected: carcinogen, 1999; Belgium: TWA 50 ppm (238 milligram per cubic meter); STEL 75 ppm (356 milligram per cubic meter), 1993; Denmark: TWA 50 ppm (240 milligram per cubic meter), 1999; Finland: STEL 50 ppm (240 milligram per cubic meter), 1999; France: VME 50 ppm (240 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 0.5 milligram per cubic meter, 2003; Switzerland: MAK-W 50 ppm (240 milligram per cubic meter), KZG-W 100 ppm (480 milligram per cubic meter), 1999; Turkey: TWA 30 ppm (240 milligram per cubic meter), 1993; United Kingdom: TWA 50 ppm (241 milligram per cubic meter); STEL 75 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 75 ppm. Several states have set guidelines or standards for IGE in ambient air[60] ranging from 2.4 milligram per cubic meter (Connecticut) to 2.4−3.6 milligram per cubic meter (North Dakota) to 4.0 milligram per cubic meter (Virginia) to 5.714 milligram per cubic meter (Nevada).

Determination in Air: Use NIOSH (IV), Method #1620, Isopropyl glycidyl ether; OSHA Analytical Method 7.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = < 0.5$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion; dermal contact; absorbed through the unbroken skin.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin, and respiratory tract. May affect the central nervous system; causing headache, dizziness, and loss of consciousness.

Long-Term Exposure: Repeated or prolonged contact with skin may cause skin sensitization. Lungs may be affected by inhalation of high concentrations of the vapor, and may cause bronchitis. Possible hematopoietic effects.

Points of Attack: Eyes, skin, respiratory system; blood, reproductive system.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. CBC. Pulmonary function tests. Evaluation by a dermatologist or by a qualified allergist.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *1000 ppm*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or SCBAF (APF = 50) (any SCBA with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA). *Note*: Substance causes eye irritation or damage; eye protection needed.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in an explosion-proof refrigerator. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: UN3271 Ethers, n.o.s., Hazard class: 3; Labels: 3-Flammable liquid, Technical Name Required. UN1993 Flammable liquids, n.o.s., Hazard Class: 3; Labels: 3-Flammable liquid, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Concentrated waste containing no peroxides-discharge liquid at a controlled rate near a pilot flame. Concentrated waste containing peroxides-perforation of a container of the waste from a safe distance followed by open burning.

References

(31); (173); (101); (138); (100).

National institute for Occupational Safety and Health (NIOSH), Information Profiles on Potential Occupational Hazards; Glycidyl Ethers, Report PB-276, 678, Rockville, MD, pp 116–123 (October 1977).

National institute for Occupational Safety and Health (NIOSH), “Criteria for a Recommended Standard: Occupational Exposure to Glycidyl Ethers”, NIOSH Document Number 78-166, Washington, DC (1978).

Isoxaflutole I:0560

Formula: $C_{15}H_{12}F_3NO_4S$

Synonyms: Balance PRO; Balance WDG; 5-Cyclopropylisoxazol-4-yl 2-mesyl-4-trifluoromethylphenyl ketone; 5-Cyclopropyl-4-isoxazolyl)[2-(methylsulfonyl)-4-(trifluoromethyl)phenyl]-methanone; 5-Cyclopropyl-4-(2-methanesulfonyl-4-trifluoromethylbenzoyl)isoxazole; 5-Cyclode minimispropyl-4-(2-methylsulfonyl-4-trifluoromethylbenzoyl) isoxazole; 5-Cyclopropyl-1,2-oxazol-4-yl α,α,α-trifluoro-2-mesyl-*p*-tolyl ketone; Epic (flufenacet + isoxaflutole); 264-EUP-99; **Isoxaflutole**; 4-(2-Methylsulfonyl-4-trifluoromethylbenzoyl)-5-cyclopropylisoxazole; RPA 201772

CAS Number: 141112-29-0

HSDB Number: 7275

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: [*Annex I Index No*.: 606-054-00-7]

Regulatory Authority and Advisory Information

Carcinogenicity[83]: EPA, Likely to be carcinogenic to humans; suspected developmental toxin California Proposition 65 Chemical[102]: Carcinogen (12/22/2000)

Hazard Alert: Poison, Combustible, Suspected of causing genetic defects, Suspected reprotoxic hazard; Environmental hazard.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: Xn, N; risk phrases: R50/53; R63; safety phrases: S2; S29; S36/37; S41; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Yellow to tan/beige granular solid. Slight acetic acid odor for technical grade; the end-use material is odorless. Molecular weight = 359.32; specific gravity (H_2O:1) = 1.10; boiling point = (decomposes); freezing/melting point = 138–140°C; flash point = < 150°C. Low solubility in water; ~5 mg/L @20°C.

Potential Exposure: Cyclopropylisoxazole is a preemergent herbicide used on maize and field cotton. A United States Environmental Protection Agency RUP.

Incompatibilities: Dust may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guidelines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg[F]/L. SafeDrinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg [F]/L; SMCL = 2 mg/F/L, as Fluoride.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = < 2.5$. Unlikely to bioaccumulate in marine organisms.

Harmful Effects and Symptoms

Short-Term Exposure: Contact with eyes or skin may cause irritation or injury. Inhalation should be avoided; use NIOSH-or CEN (UK)-approved air purifying respirators for pesticides. May be harmful if swallowed. LD_{50} (oral, rat) $= > 2$ g/kg; also >5 g/kg.; LD_{50} (dermal, rat) $= > 2$ g/kg.

Long-Term Exposure: Fluorides may cause bone disease (pain and tenderness of the bones); mottled teeth in children. This chemical is a probable carcinogen and it may be a reproduction hazard.

Points of Attack: Reproductive cells. May cause reproductive and fetal effects.

Medical Surveillance: Preliminary medical exam to detect chronic diseases of central nervous system, liver, heart, kidneys, lung and skin, as well as endocrinological or immunological disturbances, should protect susceptible individuals. Periodical medical exams of internal organs, skin and eyes are important to avoid chronic occupational intoxications. They should include lab and patch tests when necessary[83]. This chemical is a suspected or known human carcinogen. Exposed persons should contact a physician for advice regarding the possible long term health effects and advice for medical monitoring. In addition to comprehensive initial medical and work histories emphasizing reproductive experience and menstrual history, patient should have physical examination and testing of genitourinary tract, sperm count, motility and morphology. If required, other tests, such as serum testosterone, serum FSH, and serum LH may be indicated.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Do not induce vomiting when formulations containing petroleum solvents are ingested

Personal Protective Methods: Wear positive pressure SCBA (SCBA). Wear chemical protective clothing that is specifically recommended by the manufacturer. DuPont Tychem Suit Fabrics is recommended by one government source[88]. It may provide little or no thermal protection. Structural firefighters' protective clothing provides limited protection in fire situations ONLY; it is not effective in spill situations where direct contact with the substance is possible.

Respirator Selection: *At any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a tightly closed container in a dry, well-ventilated and secure poison location and refrigerate 2 to 8°C. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Where possible, automatically transfer material from other storage containers to process containers. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Small spills and leakage: should a spill occur while you are handling this chemical, first remove all sources of ignition, then you should dampen the solid spill material with 60−70% ethanol and transfer the dampened material to a suitable container. Use absorbent paper dampened with 60−70% ethanol to pick up any remaining material. Seal the absorbent paper, and any of your clothes, which may be contaminated, in a vapor-tight plastic bag for eventual disposal. Solvent wash all contaminated surfaces with 60−70% ethanol followed by washing with a soap and water solution. Do not reenter the contaminated area until the safety officer (or other responsible person) has verified that the area has been properly cleaned.

Fire Extinguishing: Decomposes in temperatures >200°C. Thermal decomposition products may include hydrogen fluoride and oxides of nitrogen, sulfur, and carbon. As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 m/150 ft for liquids and at least 25 m/75 ft for solids. *Fire involving storage or vehicular tanks*: Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. *On a small fire*: use dry chemical, CO_2, water spray or regular *foam*. *On a large fire*: use water spray, fog or regular foam. Do not scatter spilled material with high pressure streams of water. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal. *Fire involving tanks*: From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. Always stay away from tanks engulfed in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Do not discharge into drains or sewers. Dispose of waste material as hazardous waste using a licensed disposal contractor to an approved landfill. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. If allowed, Incineration with effluent gas scrubbing is recommended. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(173); (101); (102); (138); (31); (173);(122) (100).

United States Environmental Protection Agency, Office of Pesticide Programs, *Pesticide Residue Limits, "Isoxaflutole*, 40 CFR 180.537. http://pmep.cce.cornell.edu/profiles/herb-growthreg/fatty-alcohol-monuron/isoxaflutole/Isoxaflutole_tol_998.html.

United States Environmental Protection Agency, Office of Pesticide Programs, *Pesticide Fact Sheet*: *Isoxaflutole*, (September 15, 1998). http://www.epa.gov/opprd001/factsheets/isoxaflutole.pdf.

K

Kerosene K:0100

Synonyms: AF 100 (pesticide); Avtur; Avtur (pesticide); Bayol 35; Bitumen cutter; Coal oil; Deobase; Escaid 100; Escaid 110; Exxsol D 200/240; Fuel oil No. 1; Fuel oil, No. 5; Fuels, kerosine; Illuminating oil; Ink oil; Jet fuel JP-1; Kaisrosène (French); Keroseno (Spanish); Kerosine; KO 30 (solvent); Lamp oil; Light petroleum; NCI-C54784; Neochiozol; Nysolvin 75a; Odorless solvent 3440; Pegasol 3040; Petroleum fuel; Range oil; Residual oil No. 5; Straight run kerosene; Shell 140; Shellsol 2046; SX 7; SX 12

CAS Registry Number: 8008-20-6; 70892-10-3

HSDB Number: 632

RTECS Number: OA5500000

UN/NA & ERG Number: UN1223/128; UN3082 (environmentally hazardous substances, liquid, n.o.s.)/171

EC Number: 232-366-4 [*Annex I Index No.:* 650-001-02-5]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC (as jet fuel): Animal Limited Evidence, Group 3, 1989.

Hazard Alert: Flammable, Possible risk of forming tumors, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction), (petroleum, hydrotreated), Possible risk of forming tumors, FDA-over the counter drug (8008-20-6).

United States Environmental Protection Agency, FIFRA 1998 Status of Pesticides: Canceled (8008-20-6)

Hazardous to aquatic life or environment, with possible long lasting effects[293]. Toxic to aquatic life with long lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xn; risk phrases: R10; R51; R61; R62; R65; safety phrases: S2; S23; S24; S62; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [2-Hazard to water. (est.)]

Description: Kerosene is a pale yellow or clear, mobile liquid, composed of a mixture of petroleum distillates, having a characteristic odor. The odor threshold is 0.6 milligram per cubic meter. The taste threshold is 0.1 mg/L in water[59]. A refined petroleum solvent (predominantly C9−C16), which typically is 25% normal paraffins, 11% branched paraffins, 30% monocycloparaffins, 12% dicycloparaffins, 1% tricycloparaffins, 16% mononuclear aromatics, and 5% dinuclear aromatics. Molecular weight = 170 (approximately); specific gravity (H_2O:1) = 0.81; boiling point = 175−325°C; freezing/melting point = −23°C; vapor pressure = 5 mmHg @ 37.8°C; flash point = 35−72°C; autoignition temperature = 210−220°C. Explosive limits: LEL = 0.7%; UEL: 5.0%[17]. Hazard Identification (based on NFPA-704 M Rating System): Health 2; flammability 2; reactivity 0. Insoluble in water.

Potential Exposure: Kerosene is used as a fuel for lamps, stoves, jets, and rockets. It is also used for degreasing and cleaning metals and as a vehicle for insecticides. Jet fuels JP-5 and JP-8 are used as aircraft fuels by the military. JP-8 is the primary jet fuel used by the United States Navy and Air Force. Kerosene is the primary component of both JP-5 and JP-8.

Incompatibilities: Kerosene vapors may form explosive mixture in air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong acids, nitric acid, strong bases. May accumulate static electrical charges, and may cause ignition of its vapors.

Permissible Exposure Limits in Air

OSHA PEL: None, but both OSHA and the Air Force Office of Safety and Health have set an exposure limit of 400 milligram per cubic meter of petroleum product for an 8-hour work-day, 40-hour work-week.

NIOSH REL: 100 milligram per cubic meter TWA

ACGIH TLV[1]: 200 milligram per cubic meter TWA [skin] avoid prolonged and repeated skin contact; may be associated with an increase in skin cancer.

70892-10-3, Protective Action Criteria (PAC)* Ver. 29[138]

PAC-1: **290**$_{\mathbf{A}}$ milligram per cubic meter

PAC-2: **1100**$_{\mathbf{A}}$ milligram per cubic meter

PAC-3: 4800 milligram per cubic meter

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

Poland: MAC (TWA) 100 milligram per cubic meter, MAC (STEL) 300 milligram per cubic meter, 1999; Russia[43] set a MAC in work-place air of 300 milligram per cubic meter.

Determination in Air: Use NIOSH Analytical Method (IV) #1550, Naphthas.

Permissible Concentration in Water: MAC concentrations in water bodies used for domestic purposes ranging from 0.10 mg/L have been set by Russia[43]. New Jersey[59] has declined to set a maximum contaminant level for kerosene in water because of its variable composition.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Slightly irritates the skin and respiratory tract. *Inhalation:* Does not evaporate fast enough to cause health effects except when heated or in enclosed spaces. Headache, tiredness, stupor, dizziness, nausea, coma and death, may occur with increasing exposure. *Skin:* If not promptly removed, may cause reddening, blisters, itching and an increased risk of infection. *Eyes:* Irritation may occur. *Ingestion:* Accidental ingestion of unknown amounts has caused irritation of mouth, throat and stomach; nausea, vomiting, rapid breathing; Blue skin coloration; and convulsions. Death may result from as little as 1-fluid ounce. Inhalation into lungs following ingestion may result in bronchitis, chemical pneumonia; accumulation of fluid and blood in lungs, and death. As little as 1/30 oz may be

Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens.
DOI: http://dx.doi.org/10.1016/B978-0-323-38968-6.00010-7

fatal in this way. LD_{50} = (oral-rat) >500 mg/kg. LD_{50} = 5 to 15 g/kg[85].

Long-Term Exposure: Repeated or prolonged skin contact may cause defatting, itching, and rash. Absorption through skin is slow but repeated skin contact over many years has caused muscular weakness, anemia, changes in white blood cells; fever and death. Can irritate the lungs; bronchitis may develop. May cause kidney damage. A study on the use of kerosene stoves found an increase in oral cancer in humans who used kerosene stoves. Skin tumors were seen in mice when their skin was exposed to jet fuel JP-5 for 60 weeks.

Points of Attack: Eyes, skin, respiratory system, central nervous system.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposure, the following are recommended. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure, kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. **8 hours**: nitrile rubber and nitrile latex gloves, suits, boots; polyethylene gloves, suits, boots; Viton gloves, suits. **4 hours**: Neoprene rubber gloves, suits, boots; polyvinyl alcohol gloves; polyvinyl chloride gloves, suits, boots; Barricade coated suits; Responder suits. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Polyvinyl alcohol, nitrile, and nitrile + PVC are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *1000 ppm:* CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)]; or Sa (APF = 10) (any supplied-air respirator). *2500 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]. *5000 ppm:* CcrFOv (APF = 50) [any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s)]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin- style, front-or back-mounted acid gas canister]; or PaprTOv (APF = 50) [any powered, air-purifying respirator with a tight-fitting facepiece and organic vapor cartridge(s)]; or SCBAF (APF = 50) (any self-contained breathing apparatus with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:PD, PP (any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd, Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self- contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1223 Kerosene, Hazard Class: 3; Labels: 3-Flammable liquid. UN3082 Environmentally hazardous substances, liquid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive

limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Oil-skimming equipment may be used to remove slicks from water. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include toxic oxides of carbon and irritating gases. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed. Spray into furnace after mixing with a more flammable solvent.

References

(31); (85); (173); (101); (138); (80); (2); (100).

National Institute for Occupational Safety and Health (NIOSH), *Criteria for a Recommended. Standard: Occupational Exposure to Refined Petroleum*, NIOSH Document Number 77-192, Cincinnati, OH (1977).

New York State Department of Health, Chemical Fact Sheet: *Kerosene*, Bureau of Toxic Substance Assessment, Albany, NY (April 1986).

United States Department of Health and Human Services, *ATSDR ToxFAQs, Jet Fuels JP-5 and JP-8*, Atlanta, GA, August 1999.

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Kerosene*, Trenton, NJ (April 2004).

Ketene K:0110

Formula: C_2H_2O; $H_2C = C = O$

Synonyms: Carbomethene; Ethenone; Keto-ethylene; *Diketene*: Acetyl ketene; 3-Butenoic acid; Diketene, stabilized; 3-Hydroxy-, *beta*-lactone; Ethenone, dimer; Ketene dimer; Vinylaceto, *beta*-lactone

CAS Registry Number: 463-51-4; 674-82-8 Diketene (ketene dimer)

HSDB Number: 633 (463-51-4); 2063 (674-82-8) as acetyl ketene

RTECS Number: OA7700000

UN/NA & ERG Number: UN1955/123 (P)[101] *Note*: Ketene is rarely stored or transported. UN2521(Diketene, stabilized)/131 *Note*: Obtained from the dimerization of ketene and can be stored and transported under refrigeration.

EC Number: 207-336-9

Regulatory Authority and Advisory Information

Hazard Alert: Exposure can be lethal, Extremely flammable gas, Severe lacrimator, Inhalation hazard (can be lethal), Explosive, Chemically unstable, Polymerization hazard (spontaneous, nonstabilized), Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated, Violently water reactive

Hazard symbols, risk, & safety statements: Hazard symbol: T + ; risk phrases: R5; R12; R14; R19; R21; R27/28; R50/53; safety phrases: S9; S13; S28; S33; S38; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Ketene is an extremely flammable, highly reactive colorless gas. Prepared as needed from diketene*. Sharp, disagreeable, penetrating odor. Molecular weight = 42.04; boiling point = −49.8°C; −56.1°C[101]; freezing/melting point = −148−151°C; relative vapor density (air = 1): 1.45; vapor pressure = 750 mmHg @ −50°C. Explosive limits: LEL = 7000 ppm; UEL[138]: unknown. Hazard Identification (based on NFPA-704 M Rating System): Health 4; flammability 2; reactivity 3₩. Reacts violently with water.

*Diketene (CAS: 674-82-8); Formula: ($C_4H_2O_2$) is a colorless liquid. Pungent odor. Depolymerizes at 650°C to give ketene[101]. Molecular weight = 84.08; density = 1.08 g/cm^3. Boiling point = 127°C. Freezing/melting point = −6.5°C; flash point = 33.9°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4; flammability 2; reactivity 2₩. Slightly soluble in water; reacts violently. *Note*: Obtained from the dimerization of ketene and can be stored and transported under refrigeration.

Potential Exposure: Ketene is used to synthesize various organic compounds; as an acetylating agent in cellulose acetate and aspirin manufacture; it is used in the conversion of higher acids to their anhydrides; in the production of spices, acetic anhydride, diethylamino gestrinone; ethyl acetate; ethyl acetoacetate; sorbic acid; vitamin A.

Incompatibilities: Diketene is chemically unstable except at very low temperatures; mixtures with air are explosive above 33°C. Reacts violently with water forming acetic acid. Diketene undergoes a further exothermic polymerization unless stabilized or retarded by storage in the solid state (below −6.5°C). This polymerization becomes violent (with risk of fire or explosion) with warming or on contact with acids or bases[101]. Ketene readily and spontaneously polymerizes. Decomposes in water, alcohol, and ammonia. Contact with hydrogen peroxide forms explosive diacetyl peroxide. Reacts violently with reducing agents; oxidizers, and many organic compounds. Soluble in diethyl ether and acetone. Can dimerize to diketene even at very low temperatures. Ketene is extremely flammable. It readily and spontaneously polymerizes; *it cannot be stored or shipped* and is obtained instead *as needed* from diketene. It is only partially stable at low temperatures (−80°C). It always has to be freshly prepared and processed immediately. Decomposes in water, alcohol, and ammonia. Reacts violently with water to form acetic acid. Contact with hydrogen peroxide forms explosive diacetyl peroxide. Reacts violently with reducing agents; oxidizers, alcohols, ammonia, and many organic compounds. Can dimerize to diketene even at very low temperatures[101].

Permissible Exposure Limits in Air

NIOSH IDLH = 5 ppm

Conversion factor: 1 ppm = 1.72 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 0.5 ppm/0.9 milligram per cubic meter TWA

NIOSH REL: 0.5 ppm/0.9 milligram per cubic meter TWA; 1.5 ppm/3 milligram per cubic meter STEL

ACGIH TLV[1]: 0.5 ppm/0.86 milligram per cubic meter TWA; 1.5 ppm/2.6 milligram per cubic meter STEL

PAC Ver. 29[138]

Ketene

PAC-1: 0.0057 ppm

PAC-2: $\mathbf{0.063_A}$ ppm

PAC-3: $\mathbf{0.19_A}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60-minute values.

Arab Republic of Egypt: TWA 0.5 ppm (0.9 milligram per cubic meter), 1993; Australia: TWA 0.5 ppm (0.9 milligram per cubic meter); STEL 1.5 ppm, 1993; Austria: MAK 0.5 ppm (0.9 milligram per cubic meter), 1999; Belgium: TWA 0.5 ppm (0.89 milligram per cubic meter); STEL 1.5 ppm, 1993; Denmark: TWA 0.5 ppm (0.9 milligram per cubic meter), 1999; Finland: STEL 0.5 ppm (0.9 milligram per cubic meter), 1999; France: VME 0.5 ppm (0.9 milligram per cubic meter), 1999; the Netherlands: MAC−TGG 0.9 milligram per cubic meter, 2003; Norway: TWA 0.5 ppm, 1999; the Philippines: TWA 0.5 ppm (0.9 milligram per cubic meter), 1999; Poland: MAC (TWA) 0.5 milligram per cubic meter, MAC (STEL) 1.5 milligram per cubic meter, 1999; Switzerland: MAK-W 0.5 ppm (0.9 milligram per cubic meter), KZG-W 1 ppm (1.8 milligram per cubic meter), 1999; Turkey: TWA 0.5 ppm (0.9 milligram per cubic meter), 1993; United Kingdom: TWA 0.5 ppm (0.87 milligram per cubic meter); STEL 0.5 ppm (2.6 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 1.5 ppm; Several states have set guidelines or standards for ketene in ambient air[60] ranging from 3.3 μ/m^3 (New York) to 4.5 μ/m^3 (South Carolina) to 9.0 μ/m^3 (Florida) to 9.0−30.0 μ/m^3 (North Dakota) to 18.0 μ/m^3 (Connecticut) to 21.0 μ/m^3 (Nevada) to 25.0 μ/m^3 (Virginia).

674-82-8, Diketene (ketene dimer)

PAC-1: 0.091 ppm

PAC-2: $\mathbf{1.0_A}$ ppm

PAC-3: $\mathbf{3.0_A}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minutes values.

Determination in Air: Use NIOSH (II-2)[2], Method #S92.

Routes of Entry: Inhalation, skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Poison gases. Ketene and Diketene (ketene dimer) can affect you when breathed in. Breathing the vapor can irritate the lungs, causing coughing, chest pain; and/or shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Repeated or high exposure may cause permanent lung damage. Exposure can irritate the eyes, nose, and throat.

Long-Term Exposure: Repeated or prolonged exposure may cause permanent lung damage, resulting in emphysema and fibrosis. Prolonged skin contact may cause skin rash.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: NIOSH lists the following tests: Blood Gas Analysis; chest X-ray, electrocardiogram, pulmonary function tests: forced vital capacity, forced expiratory volume (1 second); sputum cytology; white blood cell count/differential. If symptoms develop or overexposure in suspected, the following may be useful: consider chest X-ray after acute overexposure, or to rule out scarring in persons with a history of suspected repeated overexposures.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/ manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *up to 5 ppm:* Sa* (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any self-contained breathing apparatus with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-, or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, self-contained breathing apparatus). *Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Poison inhalation chemical; check oxygen content prior to entering storage area. Ketene readily polymerizes and cannot be shipped or stored. Is generated and processed instead as needed at the point of use from diketene. Poison gas. (1) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. This gas is highly toxic and chemically unstable. Even slight exposure to these gasses can cause death. Store outdoors in a secure, restricted area that containing warning signs. This area must be roofed and shaded with the cylinders stored off the ground and separated from all other products assigned to other hazard categories and radiant heat sources on nonwooden floors. If indoors, store in well-ventilated areas in temperatures not to exceed 50°C. Ketene cannot be stored. Ketene must be kept away from water and a wide variety of organic compounds, since violent reactions occur. Ketene must be kept in tightly closed containers in a cool, well-ventilated area away from heat. Metal containers involving the transfer of this chemical should be grounded and bonded. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: UN1955 ***Ketene*** *is not shipped as a rule, but is usually generated as needed from diketene at the point of use in a chemical process by acetone pyrolysis. It polymerizes readily and hence immediate use is highly preferred.* Compressed gas, toxic, n.o.s. Inhalation Hazard Zone A, Hazard Class: 2.3; Labels: 2.3-Poisonous gas, Technical Name Required, Inhalation Hazard Zone A. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner. UN2521 **Diketene, stabilized**, Hazard class: 6.1; Labels: 6.1-Poisonous materials, 3-Flammable liquid, Inhalation Hazard Zone B.

Spill Handling:

Initial isolation and protective action distances: ***Ketene***

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 300/90
Then: Protect persons downwind (mi/km)
Day 0.3/0.5
Night 1.4/2.3

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 2000/610
Then: Protect persons downwind (mi/km)
Day 2.2/3.6
Night 5.9/9.5

Initial isolation and protective action distances: ***Diketene, stabilized***

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase

with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).
Small spills (From a small package or a small leak from a large package)
First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.1/0.2
Large spills (From a large package or from many small packages)
First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 0.3/0.5
Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Restrict persons not wearing protective equipment from area of leak until clean-up is complete. Ventilate area of leak to disperse the gas. Stop flow of gas. If source of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. *Do not use water* because it reacts violently with ketene. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.
Fire Extinguishing: *See Initial isolation and protective action distances above*. These chemicals are chemically unstable. Thermal decomposition products may include oxides of carbon. *Highly flammable*: Will be easily ignited by heat, sparks, or flames. Vapors may form explosive mixture with air. Vapors may travel to source of ignition and flashback. Most vapors are heavier than air. They will spread along ground and collect in low or confined areas (sewers, basements, tanks). Vapor explosion and poison hazard indoors, outdoors or in sewers. Those substances designated with a (P) may polymerize explosively when heated or involved in a fire. Runoff to sewer may create fire or explosion hazard. Containers may explode when heated. Many liquids are lighter than water. *Caution*: All these products have a very low flash point: Use of water spray when fighting fire may be inefficient. *Small fire*: Dry chemical, CO_2, water spray, or alcohol-resistant foam. *Large fire*: Water spray, fog, or alcohol-resistant foam. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal; do not scatter the material. Use water spray or fog; do not use straight streams. *Fire involving tanks or car/trailer loads*: Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. *Always* stay away from tanks engulfed in fire. For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn (ERG, 2012). Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.
Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Use a licensed professional waste disposal service to dispose of this material. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (100).
New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Ketene, Trenton, NJ (November 1999).

Kinetin K:0120

Formula: $C_{10}H_9N_5O$
Synonyms: Adenine, *N*-furfuryl-; Adenine, N^6-furfuryl-; Cytokinin; Cytokinin, as kinetin, based on biological activity; Cytokinins (with Cytokinin B, Cytokinin R); Cytokinins (derived from aqueous extract of seaweed); FAP; Foliar trigger; Foli-zyme; N^6-(Furfurylamino)purine; 6-(Furfurylamino) purine; N^6-Furfuryladenine; 2-Furanmethanamine, *N*-1*H*-purin-6-yl-; *N*-(2-Furanylmethyl)-1*H*-purin-6-amine; 6-Furfurylaminopurine; Goldengro; Happygro; Maxon; Megagro; Mepex; Nitrozyme; 1-*H*-Purin-6-amine, *N*-(2-furanylmethyl)-
CAS Number: 525-79-1
HSDB Number: 7429
RTECS Number: AU6270000

UN/NA & ERG Number: UN3462/153

EC Number: 208-382-2

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Suspected reprotoxic hazard

Hazard symbols, risk, & safety statements: Hazard symbol: Xi; risk phrases: R68; R36/37/38; R50/53; R61; safety phrases: S2; S22; S23; S24/25; S26; S27 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to waters.

Description: White crystalline solid. Commercial formulations may be liquid concentrates. Molecular weight = 215.22; freezing/melting point = 265°C; Henry's Law constant = 1.2×10^{-14} atm-m^3/mole @ 25°C (est)[83]; vapor pressure = 1.8×10^{-8} mmHg @ 25°C[83]. Slightly soluble in water; solubility = 358 mg/L @ 25°C[83].

Potential Exposure: Cytokinin is a group of botanical plant growth regulators used to promote cell division, leaf expansion and retard leaf aging. Cytokinin is derived from aqueous extract of seaweed meal. The extracts from these plant species (e.g., the naturally occurring cytokinins) are exempt from the requirements of tolerances when used as plant regulators in or on many raw agricultural commodities (40 CFR 180.1042). Cytokinin is applied to growing crops (field crops, vegetable crops, small fruits, vines, and tree fruit), young trees, ornamental, to increase fruit size, yield, blossoms, branching, healthy appearance, and other desirable growth effects. Also used on golf courses.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Determination in Water: Octanol−water coefficient: $\log K_{ow} = 0.6$ (est)[83]. Unlikely to bioaccumulate in marine organisms.

Harmful Effects and Symptoms

Short-Term Exposure: Contact with eyes or skin may cause irritation or injury. Inhalation should be avoided; use NIOSH- or CEN (UK)-approved air-purifying respirators for pesticides. May be harmful if swallowed.

Long-Term Exposure: May cause reproductive and fetal effects.

Points of Attack: Reproductive cells.

Medical Surveillance: In addition to comprehensive initial medical and work histories emphasizing reproductive experience and menstrual history, patient should have physical examination and testing of genito-urinary tract, sperm count, motility, and morphology. If required, other tests, such as serum testosterone, serum follicle stimulating hormone, and serum lutenizing hormone, may be indicated.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Do not induce vomiting when formulations containing petroleum solvents are ingested.

Respirator Selection: Wherever and whenever workplace conditions warrant respirator use, a respiratory protection program must be followed that meets one or more of the following government standards: OSHA's 29 CFR 1910.134, ANSI Z88.2, or European Standard EN 149.

Storage: Color code—Blue: Health Hazard/Poison. Store in a secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN3462 Toxins, extracted from living sources, solid, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: First remove all sources of ignition. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Ventilate area of spill or leak. Use water spray to reduce vapor. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include toxic oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; or alcohol-resistant foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Do not discharge into drains or sewers. Dispose of waste material as hazardous waste using a licensed disposal contractor to an approved landfill. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. If allowed, Incineration with effluent gas scrubbing is recommended. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, "Reregistration Eligibility Decision (RED), Cytokinin," Office of Prevention, Pesticides and Toxic Substances, Washington, DC (December 1995). http://www.epa.gov/REDs/4107.pdf.

United States Environmental Protection Agency, Office of Pesticide Programs, Pesticide Residue Limits, "Cytokinin (as kinetin)," 40 CFR 180.1157. http://www.epa.gov/pesticides/food/viewtols.htm.

L

Lactofen L:0050

Formula: $C_{19}H_{15}ClF_3NO_7$

Synonyms: Benzoic acid, 5-[2-chloro-4-(trifluoromethyl)phenoxy]-2-nitro-2-ethoxy-1-methyl-2-oxoethyl ester; 1-(Carboethoxy)ethyl-5-[2-chloro-4-(trifluoromethyl)phenoxy]-2-nitrobenzoate; 5-[2-Chloro-4-(trifluoromethyl)phenoxy]-2-nitrobenzoic acid 2-ethoxy-1-methyl-2-oxoethyl ester; Cobra; (±)-2-Ethoxy-1-methyl-2-oxoethyl-5-[2-chloro-4-(trifluoromethyl)phenoxy]-2-nitrobenzoate; Ethyl *O*-[5-(2-chloro-α,α,α-trifluoro-*p*-tolyloxy)-2-nitrobenzoyl]-*dl*-lactate; PPG-844; Steller; V-10086

CAS Registry Number: 77501-63-4; (81362-49-4 obsolete); 62476-59-9 (lactofen-sodium, degradation product)

HSDB Number: 6991; 6551 (lactofen-sodium)

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

RTECS Number: DG5643120

EC Number: Not assigned

Regulatory Authority and Advisory Information

Carcinogenicity[83]: EPA, Likely to be carcinogenic to humans in high doses; unlikely to be a carcinogen at low doses.

California Proposition 65 Chemical[102]: Carcinogen (1/1/1989)

Hazard Alert: Poison, Agricultural chemical. Listed for Tier 1 screening as an endocrine disruptor[88].

EPA acceptable daily intake (ADI) = 0.0015 mg/kg/day; EPA Oral reference dose (RfD) = 0.002 mg/kg/day

Safe Drinking Water Act (47FR 9352): Priority List (55 FR 1470)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%

Hazard symbols, risk, & safety statements: Hazard symbol: N, Xn; risk phrases: R21; R51/53; safety phrases: S29; S36/37; S61; S41 (see Appendix 4)

Description: Tan to dark brown solid. Technical product is a white crystalline solid. Commercial product may also be available as an emulsifiable concentrate. Molecular weight = 461.79; specific gravity (H_2O:1) = 1.39; freezing/melting point = 43.9–45.5°C; vapor pressure = 7.9×10^{-9} mmHg @ 20°C. Practically insoluble in water.

Potential Exposure: Lactofen is a diphenyl ether, broad-spectrum herbicide used both for preemergence and post-emergent weed control on peanuts, snap beans, soybeans, cotton, and fruiting vegetables. Not registered for use in residential settings.

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guidelines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg[F]/L. Safe Drinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg[F]/L; SMCL = 2 mg/F/L, as Fluoride.

Determination in Water: High Performance Liquid Chromatography. Octanol-water coefficient: Log K_{ow} = >4. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood. Fish toxicity (threshold)[101]: High−1.97989 ppb, MATC (Maximum Acceptable Toxicant Concentration).

Routes of Entry: Eyes, dermal contact, ingestion. May be absorbed through unbroken skin.

Harmful Effects and Symptoms

Short-Term Exposure: This material can cause corrosive burns to the skin and eyes. *Ingestion*: Slight irritation. Mildly toxic via all routes of exposure. LD_{50} (oral, rat) = >5 g/kg.; LD_{50} (dermal, rat) = >2 g/kg.

Long-Term Exposure: Fluorides may cause bone disease (pain and tenderness of the bones); mottled teeth in children. May cause permanent eye damage. May be mutagenic. Human toxicity (long term)[101]: High−2.05882 ppb, CHCL (Chronic Human Carcinogen Level).

Points of Attack: Liver and kidneys, eyes and skin.

Medical Surveillance: Preliminary medical exam to detect chronic diseases of central nervous system (CNS), liver, heart, kidneys, lung, and skin, as well as endocrinological or immunological disturbances, should protect susceptible individuals. Periodical medical exams of internal organs, skin and eyes are important to avoid chronic occupational intoxications. They should include lab and patch tests when necessary[83]. This chemical is a suspected or known human carcinogen (in high doses). Exposed persons should contact a physician for advice regarding the possible long term health effects and advice for medical monitoring.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Do not induce vomiting when formulations containing petroleum solvents are ingested

Personal Protective Methods: Diphenyl ether derivatives may react with the following absorbent materials: Expanded Polymeric[88]. Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of dermal and/or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation.

Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens.
DOI: http://dx.doi.org/10.1016/B978-0-323-38968-6.00011-9

DuPont Tychem suit fabrics[88]. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: At any detectable concentration: SCBAF: Pd,Pp (APF = 10,000) (any (NIOSH)/MSHA or European Standard EN 149-approved self-contained breathing apparatus (SCBA) that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). Escape: 100 F (APF = 50) (any air purifying, full facepiece respirator with N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Corrosive and poisonous. Color code-White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Store in tightly closed containers in a cool, well-ventilated area. Color code-Blue: Health Hazard/Poison; Store in a secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from water, heat, and incompatible materials. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. If this material may contain a flammable carrier, sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: First remove all sources of ignition. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Absorb liquid containing this chemical in vermiculite, dry sand, earth, or similar material. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include toxic hydrogen chloride (HCl) and hydrogen fluoride gas and oxides of nitrogen and carbon. As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 m/150 ft for liquids and at least 25 m/75 ft for solids. Fire involving storage or vehicular tanks: Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. On a small fire: use dry chemical, CO_2, water spray or regular foam. On a large fire: use water spray, fog or regular foam. Do not scatter spilled material with high pressure streams of water. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal. Fire involving tanks: From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. Always stay away from tanks engulfed in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: It is the responsibility of chemical waste generators to determine the toxicity and physical properties and of a discarded chemical and to properly identify its classification and certification as a hazardous waste and to determine the disposal method. United States Environmental Protection Agency guidelines for the classification determination are listed in 40 CFR Parts 261.3. Additionally, waste generators must consult and follow all regional, national, state, and local hazardous waste laws to ensure complete and accurate classification and disposal methods.

References

(173); (101); (138); (102); (31); (173); (122).

EXTOXNET, Extension Toxicology Network, “Pesticide Information Profile, Lactofen,” Oregon State University, Corvallis, OR (July 1996). http://extoxnet.orst.edu/pips/lactofen.htm

United States Environmental Protection Agency, Office of Pesticide Programs, Pesticide Residue Limits, “Lactofen,” 40 CFR 180.432. http://www.ehso.com/ehso.php

Lactonitrile L:0055

Formula: C_3H_5NO; $CH_3CHOHCN$

Synonyms: Acetaldehyde cyanohydrin; 2-Hydroxypropionitrile; Lactonitrilo (Spanish); NSC 7764; Propionitrile, 2-hydroxy-

CAS Registry Number: 78-97-7

HSDB Number: 5225

RTECS Number: OD8225000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154; UN3276 (Nitriles, toxic, liquid, n.o.s.)/151

EC Number: 201-163-2

Regulatory Authority and Advisory Information

Hazard Alert: Exposure can be lethal, Extremely toxic, Flammable.

SUPERFUND/EPCRA 302, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 1000 lb (454 kg).

Hazard symbols, risk, & safety statements: Hazard symbol: T, F; risk phrases: R10; R20; R23/24/25; R27; R36/37/38; R42; R50; safety phrases: S13; S22; S23; S26; S36/37/39; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Lactonitrile is a colorless to straw-colored liquid. Molecular weight = 71.09; specific gravity (H_2O:1) = 0.98 @ 20°C; boiling point = 183°C (slight decomposition); 221°C[138]; freezing/melting point = −40°C; vapor pressure = 0.119 mmHg @ 25°C; flash point = 77°C. Hazard identification (based on NFPA-704 M Rating System): Health 4, Flammability 2, Reactivity 0. Soluble in water.

Potential Exposure: This material is used as a solvent and as an intermediate in the production of ethyl lactate and lactic acid.

Incompatibilities: Alkalis form hydrogen cyanide. Vapors may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides. Nitriles may polymerize in the presence of metals and some metal compounds. They are incompatible with acids; mixing nitriles with strong oxidizing acids can lead to extremely violent reactions. Nitriles are generally incompatible with other oxidizing agents such as peroxides and epoxides. The combination of bases and nitriles can produce hydrogen cyanide. Nitriles are hydrolyzed in both aqueous acid and base to give carboxylic acids (or salts of carboxylic acids). These reactions generate heat. Peroxides convert nitriles to amides. Nitriles can react vigorously with reducing agents. Acetonitrile and propionitrile are soluble in water, but nitriles higher than propionitrile have low aqueous solubility. They are also insoluble in aqueous acids[101].

Permissible Exposure Limits in Air

NIOSH REL: Nitriles: 2 ppm, Ceiling Concentration, not to be exceeded in any 15-minute work period.

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 0.24 milligram per cubic meter

PAC-2: 2.6 milligram per cubic meter

PAC-3: 16 milligram per cubic meter

Determination in Air: See NIOSH Criteria Document 78-212 *Nitriles*[18]

Routes of Entry: Inhalation, ingestion, skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Extremely toxic by oral, skin, or eye contact[72]. Signs and symptoms of acute exposure to lactonitrile may include hypertension (high blood pressure) and tachycardia (rapid heart rate), followed by hypotension (low blood pressure) and bradycardia (slow heart rate). Cherry-red mucous membranes and blood, cardiac arrhythmias; and other cardiac abnormalities are common. Cyanosis (blue tint to the skin and mucous membranes) may be present, following exposure to lactonitrile. Salivation, nausea, and vomiting may also occur. Tachypnea (rapid respiratory rate) may be followed by respiratory depression. Lung hemorrhage and pulmonary edema may occur. Headache, vertigo (dizziness), agitation, and giddiness may be followed by combative behavior, convulsions, paralysis, protruding eyeballs; dilated and unreactive pupils, and coma. Lactonitrile is irritating to the skin and mucous membranes. Lacrimation (tearing) and a burning sensation of the mouth and throat are common. Warning: Heart palpitations may occur within minutes after exposure. Caution is advised. Vital signs should be monitored closely. Symptoms may be delayed.

Long-Term Exposure: May cause liver and kidney damage. See NIOSH Criteria Document 212 *Nitriles*.

Points of Attack: Respiratory system; CNS; cardiovascular system, liver, kidneys.

Medical Surveillance: Liver function tests. Kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. The NIOSH REL for nitriles is a Ceiling Concentration of 6 milligram per cubic meter, not to be exceeded in any 15-minute work period.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers and alkalies. Store in a refrigerator under an inert atmosphere and protect from light for prolonged storage.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft (NJ). Isolation Distance, Fire: 800 m/0.5 mi[70].

Nitriles spill

Initial Isolation and Protective Action Distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.1/0.2

Large Spills (from a large package or from many small packages)

First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.3/0.5
Night 0.5/0.8

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial Isolation and Protective Action Distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small Spills (from a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.1/0.2

Large Spills (from a large package or from many small packages)

First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.3/0.5
Night 0.5/0.8

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: *Lactonitrile*, Washington, DC, Chemical Emergency Preparedness Program (Nov. 30, 1987)

Lead & inorganic compounds L:0100

Formula: Pb

Synonyms: C.I. 77575; C.I. Pigment metal 4; Glover; Haro mix CE-701; Haro mix CK-711; Haro mix MH-204; JMI Sloop; KS-4; Lead-S2; Lead element; Lead flake; Litharge; Omaha; PB-S 100; Plomo (Spanish); Plumbum

CAS Registry Number: 7439-92-1 (metallic lead)

HSDB Number: 6923

RTECS Number: OF7520000

UN/NA & ERG Number: None for bulk material. UN3077 (Environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 231-100-4

Regulatory Authority and Advisory Information

Carcinogenicity: Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC (inorganic): Human Inadequate Evidence, animal Sufficient Evidence, *probably carcinogenic to humans*, Group 2A; (organic) Animal Inadequate Evidence, Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies. United States Environmental Protection Agency Gene-Tox Program, Positive: Sperm morphology-human; Negative: In vivo cytogenetics-nonhuman bone marrow; Negative: In vitro cytogenetics-human lymphocyte; Inconclusive: Carcinogenicity-mouse/rat; Inconclusive: In vivo cytogenetics-human lymphocyte.

California Proposition 65 Chemical[102]: Cancer; 10/1/1992; Developmental/Reproductive toxin (male, female) 2/27/1987

OSHA, 29CFR1910 Specifically Regulated Chemicals (See 29 CFR 1910.1025).

Hazard Alert: Poison (cumulative), Possible risk of forming tumors, Reproductive toxin: Suspected of causing genetic defects, Organometallic, Strong reducing agent (powder), Environmental hazard.

Banned or Severely Restricted (Many countries, especially in food) (UN)[35] (Maine, Minnesota)[61]

EPA ADI = (preschool children) less than the 3 mg[Pb]/week recommended provisionally for adults.

Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

WGK[100] (German Aquatic Hazard Class): Nonwater polluting agent. (Particle size ≥ 1 mm)

Lead, metallic:

California Proposition 65 Chemical[102]: Cancer; 10/1/1992; Developmental/Reproductive toxin (male, female) 2/27/1987

United States National Primary Drinking Water Regulations: MCLG = zero mg[Pb]/L; MCL = Action Level = 0.015 mg[Pb]/L. Lead is regulated by a Treatment Technique (TT) that requires systems to control the corrosiveness of their water. If more than 10% of tap water samples exceed the action level of 0.015 mg[Pb]/L, water systems must take additional steps; MCLG = zero mg/L; MCL = 4 millirems/year, as *beta*-proton emitter (Pb_{209})

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/1992); 40CFR401.15 Section 307 Toxic Pollutants as lead and compounds

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): D008

RCRA Toxicity Characteristic (Section 261.24), Maximum Concentration of Contaminants, regulatory level, 5.0 mg/L

RCRA, 40CFR261.24, Appendix 8 Hazardous Constituents, as lead compounds, n.o.s., D008

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.69; Nonwastewater (mg/L), 0.37 TCLP

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 6010 (40); 7420 (1000); 7421 (10)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Lead compounds:

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as lead and compounds

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number D008

EPCRA Section 313: Includes any unique chemical substance that contains lead as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: inorganic compounds 0.1%; organic compounds 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as lead compounds, soluble, n.o.s.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0% as inorganic compounds, n.o.s.

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xi, Xn; risk phrases: R45; R20/22; R33; R36/38; R40; R48/20; R61; R62; Safety phrases: S26; S36/37; S41; S45; S53; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): Nonhazard to water.

Description: Inorganic lead includes lead oxides, metallic lead, lead salts, and organic salts, such as lead soaps; but excludes lead arsenate and organic lead compounds. Lead is a blue-gray metal which is very soft and malleable. Lustrous when freshly cut; tarnishes in moist air. Specific gravity (H_2O:1) = 11.34; molecular weight = 207.19; boiling point = 1750°C; freezing/melting point = 327.5°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Insoluble in water.

Potential Exposure: Metallic lead is used for lining tanks, piping, and other equipment where pliability and corrosion resistance are required, such as in the chemical industry in handling corrosive gases and liquids used in the manufacture of sulfuric acid; in petroleum refining; and in halogenation, sulfonation, extraction, and condensation processes; and in the building industry. It is also used as an ingredient in solder; a body filler in the automobile industry; and a shielding material for X-rays and atomic radiation; in manufacture of tetraethyl lead and organic and inorganic lead compounds; pigments for paints and varnishes; storage batteries; fling glass; vitreous enameling, ceramics as a glaze; litharge rubber, plastics, and electronic devices. Lead is utilized in metallurgy and may be added to bronze, brass, steel, and other alloys to improve their characteristics. It forms alloys with antimony, tin, copper, etc. It is also used in metallizing to provide protective coatings and as a heat treatment bath in wire drawing. Exposures to lead dust may occur during mining, smelting, refining, and to fume, during high temperature ($>$ 500°C) operations, such as welding or spray coating of metals with molten lead. There are numerous applications for lead compounds, some of the more common being in the plates of electric batteries and accumulators; as compounding agents in rubber manufacture; as ingredients in paints, glazes, enamels, glass, pigments; and in the chemical industry. In addition, to these usual levels of exposure from environmental media, there exist miscellaneous sources which are hazardous. The level of exposure resulting from contact is highly variable. Children with pica for paint chips or for soil may experience elevation in blood lead, ranging from marginal to sufficiently great to cause clinical illness. Certain adults may also be exposed to hazardous concentrations of lead in the work-place, notably in lead smelters and storage battery manufacturing plants. Again, the range of exposure is highly variable. Women in the work-place are more likely to experience adverse effects from lead exposure than men due to the fact that their hematopoietic system is more lead-sensitive than men. Because of health concerns, lead from gasoline, paints, and ceramic products; caulking, and pipe solder, has been dramatically reduced in recent years.

Incompatibilities: Lead dust is flammable in air and may explode when exposed to heat or flame. Reacts with sulfuric acid, hot concentrated nitric acid; boiling concentrated hydrochloric acid. Powdered lead can react (possibly violently) with strong oxidizers, ammonium nitrate; chlorine trifluoride; chemically active metals; concentrated hydrogen peroxide; sodium acetylide. Incompatible with sodium azide, disodium acetylide; hydrogen peroxide; active metals-sodium, potassium, zirconium. Lead is attacked by pure water and weak organic acids in the presence of oxygen. Attacked at room temperature by chlorine, fluorine.

Permissible Exposure Limits in Air

NIOSH IDLH = 100 mg [Pb]/m^3

OSHA PEL: The employer shall assure that no employee is exposed to lead at concentrations greater than 50 μg/m^3 of air averaged over an 8-hour period. If an employee is exposed to lead for more than 8 hour. In any work day, the permissible exposure limit, as a TWA for that day, shall be reduced according to the following formula: Maximum permissible limit (in μg/m^3) = 400 divided by the number of hours worked in the day [29 CFR 1910.1025(c)].

NIOSH REL: 0.050 mg[Pb]/m^3 TWA. Suspected carcinogen. Limit exposure to lowest feasible level. [*Note*: The REL also applies to other lead compounds (as Pb)]. *Note*: NIOSH considers "lead" to mean metallic lead, lead oxides; and lead salts (including organic salts, such as lead "soaps" but excluding lead arsenate). Air concentrations should be maintained so that worker blood lead remains less than 0.060 mg[Pb]/100 g of whole blood. See NIOSH Pocket Guide, Appendix C.

ACGIH TLV[1]: 0.05 mg[Pb]/m^3 TWA; BEI: 30 μg[Pb]/100 mL (blood). (*Note*: The TLV also applies to lead, inorganic compounds) *Note*: women of child bearing potential whose blood exceeds 10 μg[Pb]/dL are at risk of delivering a child with a blood [Pb] over the current CDC guideline of 10 μg[Pb]/dL and may cause birth defects; confirmed animal carcinogen with unknown relevance to humans.

PAC Ver. 29[138]

Metallic Lead:

PAC-1: 0.15 milligram per cubic meter

PAC-2: 120 milligram per cubic meter

PAC-3: 700 milligram per cubic meter

National primary and secondary ambient air quality standards for lead and its compounds, 1.5 μ[Pb]/m^3, maximum arithmetic mean averaged over a calendar quarter [40 CFR 50.12, Appendix G].

European OEL: 0.15 mg[Pb]/m^3 TWA (2002)

DFG MAK: BAT: 400 μg[Pb]/L (blood) not fixed; 100 μg [Pb]/L (blood) women age $<$ 45; Carcinogen Category 2; Germ Cell Mutagen Group 3A.

Austria: MAK 0.1 milligram per cubic meter, 1999; Denmark: TWA 0.1 milligram per cubic meter, 1999; Japan 0.1 milligram per cubic meter, 1999; Norway: TWA 0.05 milligram per cubic meter, 1999; Poland: MAC (TWA) 0.05 milligram per cubic meter, 1999; Sweden: TWA 0.05 milligram per cubic meter (resp. dust), 1999; Sweden:

TWA 0.1 milligram per cubic meter (total dust), 1999; the Netherlands: MAC-TGG 0.15 milligram per cubic meter, 2003. The EPA requires lead in air not to exceed 1.5 micrograms per cubic meter (1.5 μ/m^3) averaged over 3 months. The Czech Republic at 0.7 μ/m^3 on a daily average basis and @ 2.0 μ/m^3 on a momentary basis. Several states have set guidelines or standards for lead in ambient air[60] ranging from 0.068 μ/m^3 (Massachusetts) to 0.357−1.5 μ/m^3 (North Dakota and Pennsylvania) to 2.5 μ/m^3 (New York) to 3.0 μ/m^3 (Connecticut) to 4.0 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) s #7082, 7105, 7300, 7301, 7303, 7700, 7701, 7702, 9100, 9102, 9105; OSHA Analytical Methods ID-121, ID-125G, ID-206.

Permissible Concentration in Water: Safe Drinking Water Act (47FR 9352): MCLG = zero mg[Pb]/L; MCL = Action Level = 0.015 mg[Pb]/L. Lead is regulated by a TT that requires systems to control the corrosiveness of their water. If more than 10% of tap water samples exceed the action level of 0.015 mg[Pb]/L, water systems must take additional steps. State Drinking Water Standards: Arizona: 50 μg[Pb]/L; State Drinking Water Guidelines: Arizona: 20 μg[Pb]/L; Maine: 10 μg[Pb]/L.

Determination in Water: Digestion followed by atomic absorption, or by colorimetric (dithizone) analysis, or by inductively coupled plasma (ICP) optical emission spectrometry. That gives total lead; dissolved lead may be determined by 0.45 micron filtration prior to such analysis.

Routes of Entry: Ingestion of dust; inhalation of dust or fume, skin, and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: The effects of exposure to fumes and dusts of inorganic lead may be slow to develop. Extremely high exposures can lead to seizures, coma, and death, but symptoms occur after weeks to months of exposure. The earliest symptoms may include tiredness, decreased physical fitness; fatigue, sleep disturbance; headache, aching bones and muscles; constipation, abdominal pains and decreased appetite; and moodiness (mostly irritability and depression). Skin contact may cause irritation. Eyes contact may cause irritation. Ingestion of large amounts of lead may lead to seizures, coma, and death.

Long-Term Exposure: Lead can accumulate in the body over a period of time. Therefore, long-term exposures to lower levels can result in a buildup of lead in the body and more severe symptoms. These may include high blood pressure, anemia, pale skin, a Blue line at the gum margin; paralysis of forearm, wrist joint, and fingers, causing decreased hand-grip strength; abdominal pain; severe constipation; nausea, vomiting. Prolonged exposure to high enough levels may result in serious, permanent kidney and brain damage. If the nervous system is affected, usually due to very high exposures, the resulting effects include severe headache, mood and personality changes; retarded mental development; convulsions, coma, delirium, and death. In nonfatal cases, recovery is slow and not always complete. Alcohol ingestion and physical exertion may bring on symptoms. Lead is a probable teratogen in humans. Continuous exposure can result in decreased fertility in males and females. Elevated lead exposure of either parent before pregnancy can increase the chances of miscarriage or birth defects. Exposure of the mother during pregnancy can cause birth defects. May cause retarded development of the newborn. *Note*: Lead is a cumulative poison. Increasing amounts can build up in the body, eventually reaching a point where symptoms and disability occur. Lead dust carried home on contaminated clothing can result in exposure and symptoms in other family members. Standards only protect for inhalation exposure. Extra precautions should be taken if skin exposure also occurs. The effects may be delayed. Medical observation is recommended. The biological half-life of lead (Pb) in the bones of humans = 10 years.

Points of Attack: Eyes, gastrointestinal (GI) tract; CNS; kidneys, blood, gingival tissue.

Medical Surveillance: OSHA mandated medical tests: whole blood (chemical/metabolite), blood lead level, hemoglobin, hematocrit, zinc protoporphyrin, blood urea nitrogen, serum creatinine; urinalysis (routine), microscopic examination. Prior to initial exposure, and annually for exposed person having blood lead readings exceeding 40 μg/100 g of whole blood, OSHA also requires a complete medical history, complete blood count (CBC), and kidney function tests in addition to the tests listed above. OSHA defines "exposure" for these tests as air levels which average 30 micrograms of lead or more in a cubic meter of air. OSHA requires your employer to send the doctor a copy of the lead standard and provide one for you. *Note*: Blood-lead level is a good indicator of total lead exposure. Current OSHA regulations require that if an individual has a blood-lead level greater than or equal to 0.050 mg lead per 100 ml blood, he or she must be removed from all exposures to lead and cannot return to the exposure environment until the blood level falls to 0.040 mg lead per 100 ml blood or less. The following tolerance levels for occupational exposures may also be useful: ACGIH BEI = 50 mg/L (blood); 150 mg/g creatinine (urine). DFG BAT = 70 mg/L (blood); 30 mg/L (blood) for women $<$ 45 years old.

NIOSH lists the following tests: whole blood (chemical/metabolite); blood lead level; biologic tissue/biopsy; CBC; nerve conduction studies; neurologic examination/electromyography; red blood cells/count; red blood cells/count: zinc protoporphyrin; urine (chemical/metabolite); urine (chemical/metabolite), end-of-shift; urine (chemical/metabolite), 24-hour collection; Zinc Protoporphyrin; Zinc Protoporphyrin, after 1-month exposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. When this chemical has been swallowed, get medical attention.

Antidotes and Special Procedures: Persons with significant lead poisoning are sometimes treated with Ca EDTA while hospitalized. This “chelating” drug causes a rush of lead from the body organs into the blood and kidneys, and thus has its own hazards, and must be administered only by highly experienced medical personnel under controlled conditions and careful observation. edetate disodium calcium (Ca EDTA) or similar drugs should never be used to prevent poisoning while exposure continues or without strict exposure control as severe kidney damage can result.

Note to Physician: For severe poisoning, British Anti-Lewisite, dimercaprol, dithiopropanol ($C_3H_8OS_2$) (BAL) has been used to treat toxic symptoms of certain heavy metals poisoning. In the case of lead poisoning it may have SOME value. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Prevent skin contact: Any barrier that will prevent contamination from the dust. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Vacuum clothing with HEPA. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See also NIOSH 78-158: *Lead, Inorganic Dusts and Fumes*.

Respirator Selection: Lead (1910.1025 & 1926.62): < or = 0.5 milligram per cubic meter (milligrams per cubic meter) (10 × PEL): Half-mask* air-purifying respirator equipped with high-efficiency filters**. < or = 2.5 milligram per cubic meter (50 × PEL): Full-facepiece air-purifying respirator with high-efficiency filters**. < or = 50 milligram per cubic meter (1000 × PEL): (1) Any powered air-purifying respirator with high-efficiency filters**; or (2) Half-mask* supplied-air respirator operated in positive-pressure mode. < or = 100 milligram per cubic meter (2000 × PEL): Supplied-air respirators with full facepiece, hood, helmet, or suit, operated in positive-pressure mode. > 100 milligram per cubic meter, unknown concentration, or firefighting: Full-facepiece, SCBA operated in positive-pressure mode.

* Full facepiece is required if the lead aerosols cause eye or skin irritation at the use concentrations.

** A high-efficiency filter means a filter that is at least 99.97% efficient against monodispersed particles of 0.3 μm (micrometers) in diameter or higher.

Respirator Requirements of 1926.62 (Construction Lead Standard)

< or = 0.5 milligram per cubic meter: (1) Half-mask* air-purifying respirator with high-efficiency filters**; or (2) Half-mask* supplied-air respirator operated in demand (negative pressure) mode. < or = 1.25 milligram per cubic meter: (1) Loose-fitting hood or helmet powered air-purifying respirator with high-efficiency filters**; or (2) Hood or helmet supplied-air respirator operated in a continuous-flow mode, e.g., Type CE abrasive blasting respirators operated in a continuous-flow mode). < or = 2.5 milligram per cubic meter: (1) Full-facepiece air-purifying respirator with high-efficiency filters**; (2) Tight-fitting powered air-purifying respirator with high-efficiency filters**; (3) Full-facepiece supplied-air respirator operated in demand mode; (4) Half-mask* or full-facepiece supplied-air respirator operated in a continuous-flow mode; or (5) Full-facepiece SCBA operated in demand mode. < or = 50 milligram per cubic meter: Half-mask* supplied-air respirator operated in pressure-demand or other positive-pressure mode. < or = 100 milligram per cubic meter: Full-facepiece supplied-air respirator operated in pressure- demand or other positive-pressure mode, e.g., Type CE abrasive blasting respirators operated in a continuous-flow mode). > 100 milligram per cubic meter, unknown concentration, or firefighting: Full-facepiece SCBA in pressure-demand or other positive-pressure mode.

* Full facepiece is required if the lead aerosols cause eye or skin irritation at the use concentrations.

** A high-efficiency filter means a filter that is at least 99.97% efficient against monodispersed particles of 0.3 μm in diameter and higher.

Storage: (1) Color code-Red Stripe: Flammability Hazard: Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8—10 m or a 1-hour fire wall from flammable or reactive materials. Store flammable solids up to maximum allowable quantity per control area in an approved flammable storage area. Do not store in a basement. (2) Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Lead must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates) and chemically active metals (such as potassium, sodium, magnesium, and zinc), since violent reactions occur. Lead is regulated by OSHA Standard 1910. 1025. All requirements of the standard must be followed.

Shipping: UN3089 Metal powders, flammable, n.o.s., Hazard Class: 4.1; Labels: 4.1-Flammable solid.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Get all workers out of spill area. Put on necessary protective equipment including respirators. If spill is a solution, cover with absorbent and shovel into suitable container. If spill is in powder form, vacuum (HEPA) whenever possible to avoid raising dust by sweeping or blowing. Place in suitable container. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Lead powder is flammable when exposed to heat or flame. Thermal decomposition products may include metal oxides. Do not use water. Use dry chemicals appropriate for extinguishing metal fires. Generally the problem is to fight a fire based on the surrounding combustible material since metallic lead is not combustible. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Recycle wherever possible. May be treated with HNO_3 to give lead nitrate; the lead may be precipitated as the sulfide, which is then sent to a lead recovery plant[22]. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(109); (102); (31); (173); (101); (138). (2); (100).

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United States Environmental Protection Agency, Lead: Ambient Water Quality Criteria, Washington, DC (1980)

United States Environmental Protection Agency, Status Assessment of Toxic Chemicals: Lead, Report EPA-600/2-79-210h, Cincinnati, Ohio (Dec. 1979)

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United States Department of Health and Human Services, "ATSDR ToxFAQs, Lead," Atlanta, Georgia, (June 1999)

New York State Department of Health, *Chemical Fact Sheet*: *Lead (Metallic and Inorganic Compounds*), Bureau of Toxic Substance Assessment, Albany, NY (June 1982 and Version 3)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Lead, Trenton*, NJ (September 2001).

United States Department of Health and Human Services Public Health Service National Toxicology Program, *Final Report on Carcinogens Background Document for Lead and Lead Compounds*, Contract Number N01-ES-85421, Research Triangle Park, NC 27709, May 8, 2003

Lead acetate L:0110

Formula: $C_4H_6O_4Pb$ (diacetate); $C_4H_{12}O_7Pb$ [Lead(II) acetate, trihydrate]; $C_4H_{10}O_8Pb_3$ (subacetate); $Pb(OCOCH_3)_2$

Synonyms: Acetate de plomb (French); Acetato de plomo (Spanish); Acetic acid, lead(2 +) salt; Acetic acid, lead(II) salt; Arseniato de plomo (Spanish); Black marking ink, 105E; Bleiacetat (German); Dibasic lead acetate; Leadac; Lead(2 +) acetate; Lead(II) acetate; Lead acetate trihydrate; Lead acetate(II), trihydrate; Lead diacetate; Multilayer dielectric ink HD; Neutral lead acetate; Normal lead acetate; Plumbous acetate; Salt of saturn; Sugar of lead

CAS Registry Number: 301-04-2, diacetate; 6080-56-4 [Lead(II) acetate, trihydrate]; 1335-32-6, basic, subacetate

HSDB Number: 1404 (301-04-2)

RTECS Number: AI5250000

UN/NA & ERG Number: UN1616/151

EC Number: 206-104-4 [*Annex I Index No.*: 082-007-00-9]; 215-630-3 [*Annex I Index No.*: 082-007-00-9] (basic)

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen (as lead and lead compounds); EPA, classification: B2; probable human carcinogen. IARC (*as organic lead compounds*): Animal Inadequate Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3.

California Proposition 65 Chemical[102]: Cancer: (*lead acetate*) 1/1/1988; (*lead*) Developmental/Reproductive toxin (male, female) 2/27/1987.

Hazard Alert: Poison, Possible risk of forming tumors, Organometallic, Strong reducing agent, Reproductive toxin: possible risk of gene damage/impaired fertility; Suspected reprotoxic hazard, Environmental hazard.

OSHA, 29CFR1910 Specifically Regulated Chemicals (See 29 CFR 1910.1025)

United States National Primary Drinking Water Regulations: MCLG = zero mg[Pb]/L; MCL = Action Level = 0.015 mg [Pb]/L. Lead is regulated by a TT that requires systems to control the corrosiveness of their water. If more than 10% of tap water samples exceed the action level, water systems must take additional steps, as Lead (Pb).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992); 40CFR401.15 Section 307 Toxic Pollutants as lead and compounds

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U144

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

European/International Regulations (*301-04-2*): Hazard Symbol: T, N; Risk phrases: R61; R33; R48/22; R50/53; R62; R63; Safety phrases: S29; S41; S45; S53; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Lead acetate is a white, flaky crystalline substance with a slight odor of acetic acid. Commercial grades may be powdered granules, or brown or gray lumps. *Diacetate*: Powder. Molecular weight = 325.29; specific gravity (H_2O:1) = 2.55 @ 20°C; boiling point = 280°C; freezing/melting point = 75°C (decomposes above 200°C). Hazard identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Soluble in water, but absorbs carbon dioxide upon exposure to air, and may become insoluble in water. *Basic, subacetate*: Solid. Molecular weight = 807.7; freezing/melting point = 280°C; Hazard identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Soluble in water, but absorbs carbon dioxide upon exposure to air, and may become insoluble in water. *Lead(II) acetate, trihydrate*: Molecular weight = 379.4; specific gravity (H_2O:1) = 2.55 @ 20°C; freezing/melting point = 74.5°C.

Potential Exposure: Lead acetate is used as a color additive in hair dyes; as a mordant in cotton dyes, in the lead coating of metals; as a drier in paints; varnishes and pigment inks; and in medicinals, such as astringents.

Incompatibilities: A strong reducing agent. Reacts violently with strong oxidizers, bromates, strong acids; chemically active metals; phosphates, carbonates, phenols. Contact with strong acids forms acetic acid. Incompatible with strong bases: ammonia, amines, cresols, isocyanates, alkylene oxides; epichlorohydrin, sulfites, resorcinol, salicylic acid, and chloral hydrate.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

301-04-2, diacetate

PAC-1: 5 milligram per cubic meter

PAC-2: 55 milligram per cubic meter

PAC-3: 330 milligram per cubic meter

6080-56-4, lead acetate(II), trihydrate

PAC-1: 14 milligram per cubic meter

PAC-2: 150 milligram per cubic meter

PAC-3: 920 milligram per cubic meter

1335-32-6, basic

PAC-1: 5.4 milligram per cubic meter

PAC-2: 59 milligram per cubic meter

PAC-3: 360 milligram per cubic meter

As Organic Lead:

ACGIH TLV[1]: No listing for organic lead compounds.

Determination in Air: Use NIOSH Analytical Method (IV) s #7082, 7105, 7300, 7301, 7303, 7700, 7701, 7702, 9100, 9102, 9105; OSHA Analytical Methods ID-121, ID-125G, ID-206

Permissible Concentration in Water: Federal Drinking Water Standards: MCGL = zero mg/L; State Drinking Water Standards: Arizona: 50 μg[Pb]/L; State Drinking Water Guidelines: Arizona: 20 μg[Pb]/L; Maine: 10 μg[Pb]/L.

Determination in Water: Digestion followed by atomic absorption, or by colorimetric (dithizone) analysis, or by ICP optical emission spectrometry. That gives total lead; dissolved lead may be determined by 0.45 micron filtration prior to such analysis.

Routes of Entry: Inhalation, ingestion. Passes through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: This material is poisonous. It emits toxic fumes of lead when heated to decomposition. Symptoms of exposure include irritation on the eyes, respiratory tract, and alimentary tract; headache, nausea, vomiting, colic, constipation, leg cramps; muscle weakness; paralysis, paresthesias, depression, dizziness, loss of consciousness; coma, and death. High levels of exposure to lead acetate may affect the CNS and blood, causing anemia, nervous disorders; kidney impairment.

Long-Term Exposure: Repeated exposure may cause lead to accumulate in the body and may cause lead poisoning. See above for symptoms. May affect the blood, bone marrow; cardiovascular system; kidneys, nervous system including weakness and poor coordination in the arms and legs; hemolytic anemia; increase of blood pressure; paralysis, brain damage; behavioral effects including irritability, reduced memory; and disturbed sleep. Has been shown to cause kidney cancer in animals; possibly carcinogenic to humans. A probable teratogen. May cause reduced growth of offspring after birth while also decreasing fertility in males.

Points of Attack: Kidneys, brain, nervous system; blood.

Medical Surveillance: OSHA mandated medical tests: whole blood (chemical/metabolite), blood lead level, hemoglobin, hematocrit, zinc protoporphyrin, blood urea nitrogen, serum creatinine; urinalysis (routine), microscopic examination. Prior to initial exposure, and annually for exposed person having blood lead readings exceeding 40 μg/100 g of whole blood, OSHA also requires a complete medical history, CBC and kidney function tests in addition to the tests listed above. OSHA defines "exposure" for these tests as air levels which average 30 micrograms of lead or more in a cubic meter of air. OSHA requires your employer to send the doctor a copy of the lead standard and provide one for you. *Note*: Blood-lead level is a good indicator of total lead exposure. Current OSHA regulations require that if an individual has a blood-lead level greater than or equal to 0.050 mg lead per 100 ml blood, he or she must be removed from all exposures to lead and cannot return to the exposure environment until the blood level falls to 0.040 mg lead per 100 ml blood or less. The following tolerance levels for occupational exposures may also be useful: ACGIH BEI = 50 mg/L (blood); 150 mg/g creatinine (urine). DFG BAT = 70 mg/L (blood); 30 mg/L (blood) for women $<$ 45 years old.

NIOSH lists the following tests: whole blood (chemical/metabolite); Blood Lead Level; biologic tissue/biopsy; CBC; Nerve Conduction Studies; Neurologic Examination/Electromyography; red blood cells/count; red blood cells/count: Zinc Protoporphyrin; urine (chemical/metabolite); urine (chemical/metabolite), end-of-shift; urine (chemical/metabolite), 24-hour collection; Zinc Protoporphyrin; Zinc Protoporphyrin, after 1-month exposure.

First Aid: Skin Contact:[52] Flood all areas of body that have contacted the substance with water. Do not wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others. Eye Contact: Remove any contact lenses at once. Immediately flush eyes well with copious quantities of water or normal saline for at least 20−30 minutes. Seek medical attention. Inhalation: Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. Ingestion: Contact a physician, hospital or poison center at once. If the victim is unconscious or convulsing, do not induce vomiting or give anything by mouth. Assure that the patient's airway is open and lay him on his side with his head lower than his body and transport immediately to a medical facility. If conscious and not convulsing, give a glass of water to dilute the substance. Vomiting should not be induced without a physician's advice.

Antidotes and Special Procedures for Lead: Persons with significant lead poisoning are sometimes treated with Ca EDTA while hospitalized. This "chelating" drug causes a rush of lead from the body organs into the blood and kidneys, and thus has its own hazards, and must be administered only by highly experienced medical personnel under controlled conditions and careful observation. Ca EDTA or similar drugs should never be used to prevent poisoning while exposure continues or without strict exposure control as severe kidney damage can result.

Note to Physician: For severe poisoning, BAL has been used to treat toxic symptoms of certain heavy metals poisoning. In the case of lead poisoning it may have SOME value. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Avoid dust inhalation; wear NIOSH and United States Bureau of Mines approved dust mask. Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Use any barrier that will prevent contamination from the dust. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See also NIOSH 78-158: *Lead, Inorganic Dusts and Fumes*.

Respirator Selection: Lead (1910.1025 & 1926.62): $<$ or = 0.5 milligram per cubic meter (10 × PEL)

Half-mask* air-purifying respirator equipped with high-efficiency filters**. $<$ or = 2.5 milligram per cubic meter (50 × PEL) Full-facepiece air-purifying respirator with high-efficiency filters**. $<$ or = 50 milligram per cubic meter (1000 × PEL) (1) Any powered air-purifying respirator with high-efficiency filters**; or (2) Half-mask* supplied-air respirator operated in positive-pressure mode. $<$ or = 100 milligram per cubic meter (2000 × PEL) Supplied-air respirators with full facepiece, hood, helmet, or suit, operated in positive-pressure mode. $>$ 100 milligram per cubic meter, unknown concentration, or firefighting Full-facepiece, SCBA operated in positive-pressure mode.

* Full facepiece is required if the lead aerosols cause eye or skin irritation at the use concentrations.

** A high-efficiency filter means a filter that is at least 99.97% efficient against monodispersed particles of 0.3 μm in diameter or higher.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in a cool, dry place and keep tightly covered and avoid contact with oxidizers, strong acids; chemically active metals. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN1616 Lead acetate, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Dampen spilled material with water to avoid airborne dust then transfer material to vapor-tight plastic bags for eventual disposal. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Lead acetate may burn but does not easily ignite. Thermal decomposition products may include Acetic acid fumes and oxides of metal and carbon. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAes that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Convert to nitrate using nitric acid; evaporate, then saturate with H_2S; wash and dry the sulfide and ship to the supplier[22]. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(109); (102); (31); (173); (101); (138); (2); (100).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 1, No. 4, 79−82 (1981) and 6, No. 2, 73−79 (1986)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Lead Acetate*, Trenton, NJ (April 2002)

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Lead arsenate L:0120

Formula: $AsHO_4Pb$; As_2O_8Pb3; $PbHAsO_4$; $Pb_3(AsO_4)_2$

Synonyms: *3687-31-8*: Arseniate de plomb (French); Arseniato de plomo (Spanish); Arsenic acid, lead salt; Lead acetate acid; Plumbous arsenate

7784-40-9: Acid lead arsenate; Acid lead arsenite; Acid lead orthoarsenate; Arsenate of lead; Arseniato de plomo (Spanish); Arsenic acid, lead(2 +); Arsenic acid, lead(II); Arsenic acid, lead salt; Arsinette; Dibasic lead arsenate; Gypsine; Lead acid arsenate; Ortho L10 dust; Ortho L40 dust; Plumbous arsenate; Salt arsenate of lead; Schultenite; Security; Soprabel; Standard lead arsenate; Talbot

10102-48-4: Acid lead arsenate; Acid lead orthoarsenate; Arsenate of lead; Arseniato de plomo (Spanish); Arsenic acid, lead(2 +) salt; Arsinette; Dibasic lead arsenate; Gypsine; Ortho L10 dust; Ortho L40 dust; Schultenite; Security; Soprabel; Standard lead arsenate; Talbot

CAS Registry Number: 3687-31-8; 7784-40-9 (dibasic); 7645-25-2 (PbH_3AsO_4)

HSDB Number: 1648 (3687-31-8)

RTECS Number: CG0980000 ($PbHAsO_4$); CG0990000 [$Pb_3(AsO_4)_2$]; CG1000000 ($Pb_xH_3AsO_4$)

UN/NA & ERG Number: UN1617/151

EC Number: 232-064-2 [*Annex I Index No.*: 082-011-00-0] (lead hydrogen arsenate); 222-979-5 (trilead diarsenate)

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Animal Inadequate Evidence, Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2A, 1987; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies.

California Proposition 65 Chemical[102]: (*lead and compounds*) Cancer; 10/1/1992; (*lead and compounds*) Developmental/Reproductive toxin (male, female) 2/27/1987; (*hexavalent chromium*) Cancer 2/27/1987; Developmental/Reproductive toxin (male, female) 12/19/08; (lead and compounds) Cancer 10/1/1992

Hazard Alert: Poison (cumulative), Possible risk of forming tumors, Reproductive toxin, Environmental hazard.

EPA ADI = (preschool children) less than the 3 mg[Pb]/week recommended provisionally for adults.

Banned or Severely Restricted (In Agriculture in India, Japan) (UN)[13]

OSHA, 29CFR1910 Specifically Regulated Chemicals (See 29 CFR 1910.1025 and 1910. 1018)

United States National Primary Drinking Water Regulations: MCLG = zero mg[Pb]/L; MCL = Action Level = 0.015 mg [Pb]/L. Lead is regulated by a TT that requires systems to control the corrosiveness of their water. If more than 10% of tap water samples exceed the action level, water systems must take additional steps, as Lead; MCLG = zero mg[As]/L; MCL = 0.010 mg[As]/L as Arsenic.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992); 40CFR401.15 Section 307 Toxic Pollutants as lead and compounds

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number D008

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R45; R23/25; R50/53; R62; safety phrases: S1/2; S20/21; S28; S29; S41; S45, S60, S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Lead arsenate is an odorless, heavy, white powder, or crystals. Molecular weight = 899.4; specific gravity (H_2O:1) = 5.8 @ 20°C; freezing/melting point = (decomposes) approximately 280°C. Also listed @ 1042°C (decomposes). Hazard identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Insoluble in cold water; soluble in hot water.

Dibasic: Molecular weight = 347; Specific gravity (H_2O:1) = 5.94 @ 20°C.

Potential Exposure: Used as an insecticide, herbicide, and in manufacture of drugs; veterinary tapeworm medicine.

Incompatibilities: Violent reactions occur from contact with oxidizers, chemically active metals; strong acids. Acids and acid mists cause the release of arsine, a deadly gas. Decomposes above 270°C forming toxic fumes including arsenic and lead compounds.

Permissible Exposure Limits in Air

NIOSH IDLH = 5 mg[As]/m^3 See also IDLH for lead [Pb] below.*

As Arsenic:

OSHA PEL: 0.01 mg[As]/m^3 TWA; cancer hazard that can be inhaled, see 29CFR1910.1018

NIOSH REL: 0.002 mg[As]/m^3 [15 min.] Ceiling Concentration. Limit exposure to lowest feasible level. See NIOSH Pocket Guide, Appendix A

ACGIH TLV[1]: TLV[1] withdrawn.

DFG TRK: 0.10 mg[As]/m^3; BAT: 1.30 μg[As]/L in urine/end-of-shift; Carcinogen Category; Germ Cell Mutagen Group 3A.

PAC Ver. 29[138]

3687-31-8

PAC-1: 9.1 milligram per cubic meter

PAC-2: 100 milligram per cubic meter

PAC-3: 600 milligram per cubic meter

7784-40-9, dibasic

PAC-1: 7 milligram per cubic meter

PAC-2: 77 milligram per cubic meter

PAC-3: 460 milligram per cubic meter

Arab Republic of Egypt: TWA 0.2 milligram per cubic meter, 1993; Australia: TWA 0.05 milligram per cubic meter, carcinogen, 1993; Belgium: TWA 0.2 milligram per cubic meter, 1993; Denmark: TWA 0.05 milligram per cubic meter, 1999; Finland: carcinogen, 1993; France: VME 0.2 milligram per cubic meter, 1993; Hungary: STEL 0.5 milligram per cubic meter, carcinogen, 1993; India: TWA 0.2 milligram per cubic meter, 1993; Norway: TWA 0.02 milligram per cubic meter, 1999; the Philippines: TWA 0.5 milligram per cubic meter, 1993; Poland: MAC (TWA) 0.01 milligram per cubic meter, 1999; Sweden: NGV 0.03 milligram per cubic meter, carcinogen, 1999; Switzerland: TWA 0.1 milligram per cubic meter, carcinogen, 1999; Thailand: TWA 0.5 milligram per cubic meter, 1993; Turkey: TWA 0.5 mg(As)/m^3, 1993; Turkey: TWA 0.5 milligram per cubic meter, 1993; United Kingdom: TWA 0.1 milligram per cubic meter, carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH: TLV: Confirmed Human Carcinogen. Russia[43] set a MAC of 0.003 milligram per cubic meter on an average daily basis for residential areas. Several states have set guidelines or standards for arsenic in ambient air:[60] 0.06 milligram per cubic meter (California Prop. 65), 0.0002 μ/m^3 (Rhode Island), 0.00023 μ/m^3 (North Carolina), 0.024 μ/m^3 (Pennsylvania), 0.05 μ/m^3 (Connecticut), 0.07–0.39 μ/m^3 (Montana), 0.67 μ/m^3 (New York), 1.0 μ/m^3 (South Carolina), 2.0 μ/m^3 (North Dakota), 3.3 μ/m^3 (Virginia), 5 μ/m^3 (Nevada).

As Lead:

*NIOSH IDLH = 100 mg [Pb]/m^3

OSHA PEL: The employer shall assure that no employee is exposed to lead at concentrations greater than 50 μg/m^3 of air averaged over an 8-hour period. If an employee is exposed to lead for more than 8 hours in any work day, the permissible exposure limit, as a TWA for that day, shall be reduced according to the following formula: Maximum permissible limit (in μg/m^3) = 400 divided by the number of hours worked in the day [29 CFR 1910.1025(c)].

NIOSH REL: 0.050 mg[Pb]/m^3 TWA. Suspected carcinogen. Limit exposure to lowest feasible level. [*Note*: The REL also applies to other lead compounds (as Pb)]. *Note*: NIOSH considers “lead” to mean metallic lead, lead oxides; and lead salts (including organic salts, such as lead “soaps” but excluding lead arsenate). Air concentrations should be maintained so that worker blood lead remains less than 0.060 mg[Pb]/100 g of whole blood.

ACGIH TLV[1]: 0.05 mg[Pb]/m^3 TWA; BEI: 30 μg[Pb]/100 mL (blood). (*Note*: The TLV also applies to lead, inorganic compounds) *Note*: women of child bearing potential whose blood exceeds 10 μg[Pb]/dL are at risk of delivering a child with a blood [Pb] over the current CDC guideline of 10 μg[Pb]/dL and may cause birth defects; confirmed animal carcinogen with unknown relevance to humans.

DFG MAK: BAT: 400 μg[Pb]/L (blood) not fixed; 100 μg [Pb]/L (blood) women age < 45; Carcinogen Category 2; Germ Cell Mutagen Group 3A.

National primary and secondary ambient air quality standards for lead and its compounds, 1.5 μ[Pb]/m^3, maximum arithmetic mean averaged over a calendar quarter [40 CFR 50.12, Appendix G].

Argentina[35] has set 0.15 milligram per cubic meter as a TWA ambient air[60] ranging from 0.5 μ/m^3 (New York) to 0.75 μ/m^3 (South Carolina) to 0.5 μ/m^3 (Florida and North Dakota) to 2.5 μ/m^3 (Virginia) to 3.0 μ/m^3 (Connecticut) to 4.0 μ/m^3 (Nevada).

Permissible Concentration in Water: Arsenic: Federal Drinking Water Guidelines: EPA 10 μg[As]/L; State Drinking Water Guidelines: Arizona 10 μg[As]/L; Connecticut 10 μg[As]/L. Runoff from spills or fire control may cause water pollution. Lead: Federal Drinking Water Standards: MCGL = zero mg/L; State Drinking Water Standards: Arizona: 50 μg[Pb]/L; State Drinking Water Guidelines: Arizona: 20 μg[Pb]/L; Maine: 10 μg[Pb]/L.

Determination in Water: See OSHA Analytical Method ID-105 for arsenic. The atomic absorption graphite furnace technique is often used for measurement of total arsenic in water. It also has been standardized by EPA. Total arsenic may be determined by digestion followed by silver diethyldithiocarbamate; an alternative is atomic absorption; another is ICP optical emission spectrometry. For lead, digestion followed by atomic absorption, or by colorimetric (dithizone) analysis, or by ICP optical emission spectrometry. That gives total lead; dissolved lead may be determined by 0.45 micron filtration prior to such analysis.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Lead arsenate irritates the eyes, skin, and respiratory tract. Skin contact can cause burning sensation; itching and rash. High exposure can cause poor appetite; nausea, vomiting, and muscle cramps. May affect the heart, with abnormal EKG, GI tract, and nervous system. Arsenic intoxication; nausea, diarrhea, inflammation of skin and mucous membranes; lead intoxication: abdominal pain; appetite loss; constipation; tiredness, weakness, nervousness; paresthesia. A rebuttable presumption against registration for pesticide uses was issued on October 18, 1978 by EPA on the basis of oncogenicity, teratogenicity, and mutagenicity.

Long-Term Exposure: Arsenic can cause skin damage or problems with circulatory systems, and may have increased risk of cancer. Lead can cause the following: Infants and children: Delays in physical or mental development; children could show slight deficits in attention span and learning abilities. Adults: Kidney problems; high blood pressure. Lead arsenate is a carcinogen and has been shown to cause skin, lung, and liver cancer. Lead arsenate may also affect the GI tract; nervous system; kidneys, and blood. Lead and certain lead compounds may be teratogens and cause reproductive damage in humans. See entry on lead for additional information on lead poisoning.

Points of Attack: Kidneys, blood, gingival tissue, lymphatic, skin, GI system; CNS.

Medical Surveillance: Before first exposure and every 6 months thereafter, OSHA (1910.1025) requires your employer to provide: blood lead test, ZPP test (a special test for the effect of lead on blood cells). Examination of the nervous system. Prior to initial exposure, and annually for exposed person having blood lead readings exceeding 40 μg/100 g of whole blood, OSHA also requires a complete medical history, CBC and kidney function tests in addition to the tests listed above. OSHA defines "exposure" for these tests as air levels which average 30 micrograms of lead or more in a cubic meter of air. OSHA requires your employer to send the doctor a copy of the lead standard and provide one for you. Test for urine arsenic. Levels should not be greater than 100 micrograms per gram of creatinine in the urine. Examine the skin for abnormal growths. Liver and kidney function tests. *Note*: Blood-lead level is a good indicator of total lead exposure. Current OSHA regulations require that if an individual has a blood-lead level greater than or equal to 0.050 mg lead per 100 ml blood, he or she must be removed from all exposures to lead and cannot return to the exposure environment until the blood level falls to 0.040 mg lead per 100 ml blood or less. The following tolerance levels for occupational exposures may also be useful: ACGIH BEI = 50 mg/L (blood); 150 mg/g creatinine (urine). DFG BAT = 70 mg/L (blood); 30 mg/L (blood) for women $<$ 45 years old.

Also seek prompt medical evaluation if health effects are noticed. With each visit, careful attention should be given to the inner nose, skin, nails and nervous system. A test for serum arsenic is recommended. NIOSH recommends urine arsenic should not be greater than 50−100 μg/L of urine.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to Physician: For severe poisoning, BAL has been used to treat toxic symptoms of certain heavy metals poisoning—including arsenic and may be of SOME value in the case of lead poisoning. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5). For milder poisoning *penicillamine (not penicillin)* has been used, both with mixed success. Side effects occur with such treatment and it is never a substitute for controlling exposure. It can only be done under strict medical care.

Persons with significant lead poisoning can be treated with Ca EDTA while hospitalized. Since this drug causes a rush of lead from body organs into the blood and kidneys, and thus has its own hazards, it must be done by experienced medical persons under careful observation. It or other "chelating" drugs should never be used to prevent poisoning while exposure continues, as severe kidney damage can result.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Use any barrier that will prevent contamination from the dust. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See also NIOSH Criteria Document #78-158: *Lead, Inorganic Dusts and Fumes*.

Respirator Selection: Where risk assessment shows air-purifying respirators are appropriate, use a full-face respirator type (N100) United States or Type P3 (EN-143) respirators as backup to engineering controls. If the respirator is the sole means of protection, use a full-face supplied respirator. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU). Requirements for Respiratory Protection for Inorganic Arsenicals with Significant Vapor Pressure: < or = 100 μg/m^3 (1) Half-mask* air-purifying respirator equipped with high-efficiency filter** and acid gas cartridge; or (2) Any half-mask* supplied-air respirator. < or = 500 μg/m^3 (1) Front-or back-mounted gas mask equipped with high-efficiency filter** and acid gas canister; (2) Any full-facepiece supplied-air respirator; or (3) Any full-facepiece SCBA. < or = 10,000 μg/m^3 Half-mask* supplied-air respirator operated in positive-pressure mode. < or = 20,000 μg/m^3 Supplied-air respirator with full facepiece, hood, or helmet or suit, operated in positive-pressure mode. > 20,000 μg/m^3, unknown concentrations, or firefighting: Any full-facepiece SCBA operated in positive-pressure mode.

* Half-mask respirators shall not be used for protection against arsenic trichloride, as it is rapidly absorbed through the skin.

** A high-efficiency filter means a filter that is at least 99.97% efficient against monodisperesed particles of 0.3 μm in diameter or higher.

As Lead:

Lead (1910.1025 & 1926.62): < or = 0.5 milligram per cubic meter (10 × PEL)

Half-mask* air-purifying respirator equipped with high-efficiency filters**. < or = 2.5 milligram per cubic meter (50 × PEL) Full-facepiece air-purifying respirator with high-efficiency filters**. < or = 50 milligram per cubic meter (1000 × PEL) (1) Any powered air-purifying respirator with high-efficiency filters**; or (2) Half-mask* supplied-air respirator operated in positive-pressure mode. < or = 100 milligram per cubic meter (2000 × PEL) Supplied-air respirators with full facepiece, hood, helmet, or suit, operated in positive-pressure mode. > 100 milligram per cubic meter, unknown concentration, or firefighting Full-facepiece, SCBA operated in positive-pressure mode.

* Full facepiece is required if the lead aerosols cause eye or skin irritation at the use concentrations.

** A high-efficiency filter means a filter that is at least 99.97% efficient against monodispersed particles of 0.3 μm in diameter or higher.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Lead arsenate must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates) and chemically active metals (such as potassium, sodium, magnesium, and zinc), since violent reactions occur. Avoid the presence of acids since arsine, a very deadly gas, is released in the presence of acid or acid mist. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN1617 Lead arsenates, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Not flammable. Thermal decomposition products may include metal oxides of lead and arsenic. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. Protect against exposure to dust or fumes. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Long- term storage in large, weatherproof, and sift-proof storage bins or silos; may be disposed of by conversion to soluble salt, such as chloride, precipitation as sulfide and return to supplier[22].

References

(109); (102); (31); (173); (101); (138); (80); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Lead Arsenate*, Trenton, NJ (September 2001).

United States Department of Health and Human Services Public Health Service National Toxicology Program, *Final Report on Carcinogens Background Document for Lead and Lead Compounds*, Contract Number N01-ES-85421, Research Triangle Park, NC 27709, May 8, 2003

Lead chloride L:0130

Formula: Cl_2Pb

Synonyms: Cloruro de plomo (Spanish); Lead(2 +) chloride; Lead(II) chloride; Lead dichloride; Plumbous chloride

CAS Registry Number: 7758-95-4

HSDB Number: 6309

RTECS Number: OF9450000

UN/NA & ERG Number: UN2291 (lead compound, soluble, n.o.s.)/151

EC Number: 231-845-5

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Animal Inadequate Evidence, Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2A, 1987; Carcinogenicity: EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies.

California Proposition 65 Chemical[102]: (*lead and compounds*) Cancer; 10/1/1992; (*lead and compounds*) Developmental/Reproductive toxin (male, female) 2/27/1987

Hazard Alert: Poison (cumulative), Environmental hazard, Reproductive toxin, Reducing agent.

EPA ADI = (preschool children) less than the 3 mg[Pb]/week recommended provisionally for adults.

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR 1910.1025)

United States National Primary Drinking Water Regulations: MCLG = zero mg[Pb]/L; MCL = Action Level = 0.015 mg[Pb]/L. Lead is regulated by a TT that requires systems to control the corrosiveness of their water. If more than 10% of tap water samples exceed the action level, water systems must take additional steps, as Lead; SMCL = 250 mg[Cl^-]/L as Chloride.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992); 40CFR401.15 Section 307 Toxic Pollutants as lead and compounds

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number D008

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R45; R20/22; R23/25; R33; R50/53; R61; R62; safety phrases: S20/21; S28; R29; S45; S53; S60; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Lead chloride is a white crystalline powder. Molecular weight = 278.1; specific gravity (H_2O:1) = 5.85 @ 20°C; boiling point = 950°C; freezing/melting point = 501°C; vapor pressure = 1 mmHg @ 547°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. Slightly soluble in cold water; more soluble in hot water.

Potential Exposure: Used to make lead salts; lead chromate pigments; as an analytical reagent for making other chemicals; making printed circuit boards; as a solder and flux.

Incompatibilities: A reducing agent. Violent reaction with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, and chemically active metals. Explosive with calcium + warming.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 0.2 milligram per cubic meter

PAC-2: 160 milligram per cubic meter

PAC-3: 940 milligram per cubic meter

Lead:

OSHA PEL: The employer shall assure that no employee is exposed to lead at concentrations greater than 50 $\mu g/m^3$ of air averaged over an 8-hour period. If an employee is exposed to lead for more than 8 hours in any work day, the permissible exposure limit, as a TWA for that day, shall be reduced according to the following formula: Maximum permissible limit (in $\mu g/m^3$) = 400 divided by the number of hours worked in the day [29 CFR 1910.1025(c)].

NIOSH REL: 0.050 mg[Pb]/m^3 TWA. Suspected carcinogen. Limit exposure to lowest feasible level. [*Note*: The REL also applies to other lead compounds (as Pb)]. *Note*: NIOSH considers “lead” to mean metallic lead, lead oxides; and lead salts (including organic salts, such as lead "soaps" but excluding lead arsenate). Air concentrations should be maintained so that worker blood lead remains less than 0.060 mg[Pb]/100 g of whole blood.

ACGIH TLV[1]: 0.05 mg[Pb]/m^3 TWA; BEI: 30 μg[Pb]/100 mL (blood). (*Note*: The TLV also applies to lead, inorganic compounds) *Note*: women of child bearing potential whose blood exceeds 10 μg[Pb]/dL are at risk of delivering a child with a blood [Pb] over the current CDC guideline of 10 μg[Pb]/dL and may cause birth defects; confirmed animal carcinogen with unknown relevance to humans.

The National primary and secondary ambient air quality standards for lead and its compounds (measured as elemental Pb) = 1 mg[Pb]/m^3, maximum arithmetic mean averaged over a calendar quarter. In addition, Russia[43] set a MAC in the ambient air of residential areas (on a daily average basis) of 0.0017 milligram per cubic meter (about six times the same limits for lead compounds in general).

Determination in Air: Use NIOSH Analytical Method (IV) s #7082, 7105, 7300, 7301, 7303, 7700, 7701, 7702, 9100, 9102, 9105; OSHA Analytical Methods ID-121, ID-125G, ID-206

Permissible Concentration in Water: Federal Drinking Water Standards: MCGL = zero mg/L; State Drinking Water Standards: Arizona: 50 μg[Pb]/L; State Drinking Water Guidelines: Arizona: 20 μg[Pb]/L; Maine: 10 μg[Pb]/L.

Determination in Water: Digestion followed by atomic absorption, or by colorimetric (dithizone) analysis, or by ICP optical emission spectrometry. That gives total lead; dissolved lead may be determined by 0.45 micron filtration prior to such analysis.

Routes of Entry: Inhalation, skin. Can be absorbed through skin at chronically toxic levels.

Harmful Effects and Symptoms

Short-Term Exposure: Lead chloride can irritate the eyes on contact. Inhalation can irritate the nose and throat. Skin contact can cause burning, itching, rash, and pigment changes. Ingestion of large amounts of lead may lead to seizures, coma, and death. The effects of exposure to fumes and dusts of inorganic lead may not develop quickly. Symptoms may include decreased physical fitness, fatigue, sleep disturbance; headache, aching bones and muscles; constipation, abdominal pains, and decreased appetite. These effects are reported to be reversible if exposure ceases. Inhalation of large amounts of lead may lead to seizures, coma, and death. *Note*: Lead is a cumulative poison. Increasing amounts can build up in the body, eventually reaching a point where symptoms and disability occur. Lead dust carried home on contaminated clothing can result in exposure and symptoms in other family members. Standards only protect for inhalation exposure. Extra precautions should be taken if skin exposure also occurs.

Long-Term Exposure: Lead chloride causes mutations. Such chemicals have a cancer risk. May damage the developing fetus. High levels can cause lead poisoning with symptoms of headache, irritability, disturbed sleep; tiredness, reduced memory, and personality changes. Higher levels can cause muscle or joint pains, weakness, and easy fatigue. Exposure can increase the risk of high blood pressure. May cause kidney and brain damage, and anemia. Lead can accumulate in the body over a period of time. Therefore, long-term exposures to lower levels can result in a buildup of lead in the body and more severe symptoms. These may include anemia, pale skin, a Blue line at the gum margin; decreased handgrip strength; abdominal pain; severe constipation; nausea, vomiting, and paralysis of the wrist joint. Prolonged exposure may also result in kidney and brain damage. If the nervous system is affected, usually due to very high exposures, the resulting effects include severe headache, convulsions, coma, delirium and death. In nonfatal cases, recovery is slow and not always complete. Alcohol ingestion and physical exertion may bring on symptoms. Lead exposure increases the risk of high blood pressure. Continuous exposure can result in decreased fertility. Elevated lead exposure of either parent before pregnancy can increase the chances of miscarriage or birth defects. Exposure of the mother during pregnancy can cause birth defects.

Points of Attack: Blood, kidneys, brain, nervous system.

Medical Surveillance: Before first exposure and every 6 months thereafter, OSHA (1910.1025) requires your employer to provide: blood lead test, ZPP test (a special test for the effect of lead on blood cells). Examination of the nervous system. Prior to initial exposure, and annually for exposed person having blood lead readings exceeding 40 μg/100 g of whole blood, OSHA also requires a complete medical history, CBC and kidney function tests in addition to the tests listed above. OSHA defines "exposure" for these tests as air levels which average 30 micrograms of lead or more in a cubic meter of air. OSHA (under 1910.1020) requires your employer to send the doctor a copy of the lead standard and provide one for you. *Note*: Blood-lead level is a good indicator of total lead exposure. Current OSHA regulations require that if an individual has a blood-lead level greater than or equal to 0.050 mg lead per 100 ml blood, he or she must be removed from all exposures to lead and cannot return to the exposure environment until the blood level falls to 0.040 mg lead per 100 ml blood or less. The following tolerance levels for occupational exposures may also be useful: ACGIH BEI = 50 mg/L (blood); 150 mg/g creatinine (urine). DFG BAT = 70 mg/L (blood); 30 mg/L (blood) for women < 45 years old.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical

facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to Physician: Administer saline cathartic and an enema. For relief of colic, administer antispasmodic (calcium gluconate, atropine, and papaverine). Consider morphine sulfate for severe pain. Whole blood lead levels, circulating plasma/erythrocyte lead concentration ratio; urine ALA; and erythrocyte protoporphyrin fluorescent microscopy may all be useful in monitoring or assessing lead exposure. Chelating agents, such as edetate disodium calcium (Ca EDTA) and penicillamine (*not penicillin*) have been found to be generally useful in the therapy of acute lead intoxication.

Antidotes and Special Procedures for Lead: Persons with significant lead poisoning are sometimes treated with Ca EDTA while hospitalized. This "chelating" drug causes a rush of lead from the body organs into the blood and kidneys, and thus has its own hazards, and must be administered only by highly experienced medical personnel under controlled conditions and careful observation. Ca EDTA or similar drugs should never be used to prevent poisoning while exposure continues or without strict exposure control as severe kidney damage can result. Note to Physician: For severe poisoning, BAL has been used to treat toxic symptoms of certain heavy metals poisoning. In the case of lead poisoning it may have SOME value. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Use any barrier that will prevent contamination from the dust. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Work clothing should be HEPA vacuumed before removal. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Lead (1910.1025 & 1926.62): < or = 0.5 milligram per cubic meter (10 × PEL)
Half-mask* air-purifying respirator equipped with high-efficiency filters**. < or = 2.5 milligram per cubic meter (50 × PEL) Full-facepiece air-purifying respirator with high-efficiency filters**. < or = 50 milligram per cubic meter (1000 × PEL) (1) Any powered air-purifying respirator with high-efficiency filters**; or (2) Half-mask* supplied-air respirator operated in positive-pressure mode. < or = 100 milligram per cubic meter (2000 × PEL) Supplied-air respirators with full facepiece, hood, helmet, or suit, operated in positive-pressure mode. > 100 milligram per cubic meter, unknown concentration, or firefighting Full-facepiece, SCBA operated in positive-pressure mode.
* Full facepiece is required if the lead aerosols cause eye or skin irritation at the use concentrations.
** A high-efficiency filter means a filter that is at least 99.97% efficient against monodispersed particles of 0.3 μm in diameter or higher.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, chemically active metals; calcium and heat. Lead is regulated by an OSHA Standard 1910.1025. All requirements of the standard must be followed.

Shipping: UN2291 Lead compounds, soluble n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Use vacuum or a wet method to reduce dust. Do not dry sweep. When vacuuming, a HEPA filter should be used, not a standard shop vac. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical may burn but does not easily ignite. Thermal decomposition products may include poisonous fumes of lead and chlorine. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(109); (102); (31); (173); (101); (138). (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Lead Chloride*, Trenton, NJ (April 2002).

United States Department of Health and Human Services Public Health Service National Toxicology Program, *Final Report on Carcinogens Background Document for Lead and Lead Compounds*, Contract Number N01-ES-85421, Research Triangle Park, NC 27709, May 8, 2003

Lead chromate L:0140

Formula: CrO_4Pb; $PbCrO_4$

Synonyms: Canary chrome yellow 40-2250; Chrome green; Chrome yellow; Chromic acid, lead(2 +) salt (1:1); C.I. 77600; Cologne yellow; Crocoite; King's yellow; Lead chromate(VI); Leipzig yellow; Lemon yellow; Paris yellow; Plumbous chromate

CAS Registry Number: 7758-97-6; *(alt.)* 8049-64-7; *(alt.)* 11119-70-3; 18454-12-1 (lead chromate oxide)

HSDB Number: 1650 (7758-97-6)

RTECS Number: GB2975000

UN/NA & ERG Number: UN3085 (oxidizing solid, corrosive, n.o.s.),/140; UN3288 (Toxic solid, inorganic, n.o.s.)/151

EC Number: 231-846-0 [*Annex I Index No.*: 082-004-00-2]

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen; IARC (inorganic): Human Inadequate Evidence, animal Sufficient Evidence, *probably carcinogenic to humans*, Group 2A; EPA [as Cr (VI)] *(inhalation)* Known human carcinogen; NTP: Known to be a human carcinogen. United States Environmental Protection Agency Gene-Tox Program, Positive: Carcinogenicity-mouse/rat; Cell transformation-SA7/SHE; Positive: *Saccharomyces cerevisiae-homozygosis*.

California Proposition 65 Chemical[102]: (*hexavalent chromium*) Cancer 2/27/1987; (*hexavalent chromium*) Developmental/Reproductive toxin (male, female) 12/19/08; (*lead and compounds*) Cancer; 10/1/1992; (*lead and compounds*) Developmental/Reproductive toxin (male, female) 2/27/1987.

Hazard Alert: Poison (cumulative), Strong oxidizer, Possible risk of forming tumors, Suspected reprotoxic hazard, Environmental hazard.

OSHA, 29CFR1910 Specifically Regulated Chemicals (See 29 CFR 1910.1025)

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as lead and compounds

United States National Primary Drinking Water Regulations: MCLG = zero mg[Pb]/L; MCL = Action Level = 0.015 mg [Pb]/L. Lead is regulated by a TT that requires systems to control the corrosiveness of their water. If more than 10% of tap water samples exceed the action level, water systems must take additional steps, as Lead; MCLG = 0.01 mg[Cr]/L; MCL = 0.1 mg[Cr]/L as Chromium.

EPA ADI = (preschool children) less than the 3 mg[Pb]/week recommended provisionally for adults

EPA ADI: Chromium(VI) = 0.175 mg/day/man. EPA estimated adequate and safe intake (EASI) levels for chromium: **Infants**: age 0.0−0.5 year: 0.01−0.04 mg/day; age 0.5−1.0 year: 0.02−0.06 mg/day. **Children** age 1−3 years: 0.02−0.08 mg/day; age 4−6 years: 0.03−0.12 mg/day; age 7−10 years: 0.05−0.20 mg/day; age > or = to 11 years: 0.05−0.20 mg/day.

Adults: 0.05−0.20 mg/day.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number D008

EPCRA Section 313: Includes any unique chemical substance that contains lead as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: inorganic compounds 0.1%; organic compounds 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as lead compounds, soluble, n.o.s.

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, O, N; risk phrases: R45; R8; R61; R62; R33; R50/53; safety phrases: S53; S45; S60; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to waters.

Description: Lead chromate is an orange or orange-yellow crystalline solid or powder. Molecular weight = 323.19; 546.38 (lead chromate oxide); specific gravity (H_2O:1) = 6.1 @ 20°C; boiling point = (decomposes); freezing/melting point = 844°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Insoluble in water.

Potential Exposure: Lead chromate is used to make paint pigments for wood and metal.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, and active metals; hydrazine, sodium, and potassium; organics at elevated temperature. Reacts with aluminum dinitronaphthalene, iron(III) hexacyanoferrate (IV).

Permissible Exposure Limits in Air

ACGIH TLV[1]: 0.01 mg[Cr]/m^3 TWA, Confirmed Human Carcinogen

ACGIH TLV[1] (*as lead*): 0.05 mg[Pb]/m^3 TWA; BEI: 30 μg[Pb]/100 mL (blood). (*Note*: The TLV also applies to lead, inorganic compounds) *Note*: women of child bearing potential whose blood exceeds 10 μg[Pb]/dL are at risk of delivering a child with a blood [Pb] over the current CDC guideline of 10 μg[Pb]/dL and may cause birth defects; confirmed animal carcinogen with unknown relevance to humans.

DFG MAK (lead chromate & lead chromate oxide): Carcinogen Category 3B

PAC Ver. 29[138]

7758-97-6

PAC-1: 0.036 milligram per cubic meter

PAC-2: 16 milligram per cubic meter

PAC-3: 97 milligram per cubic meter

As Chromium(VI), Inorganic Insoluble Compounds

NIOSH IDLH = 15 mg[Cr(VI)]/m^3

OSHA PEL: 0.005 mg[Cr(VI)]/m^3 TWA Concentration. See 29CFR1910.1026

NIOSH REL: 0.001 mg[Cr]/m^3 TWA, potential carcinogen, limit exposure to lowest feasible level. NIOSH considers all Cr(VI) compounds (including chromic acid, *tert*-butyl chromate, zinc chromate, and chromyl chloride) to be potential occupational carcinogens. See NIOSH Pocket Guide, Appendixes A & C.

ACGIH TLV[1]: 0.01 mg[Cr]/m^3 TWA, Confirmed Human Carcinogen

DFG MAK: Danger of skin sensitization; Carcinogen Category 2; TRK: 0.05 mg[Cr]/m^3; 20 μg/L [Cr] in urine at end-of-shift

As Lead:

NIOSH IDLH = 100 mg [Pb]/m^3

OSHA PEL: The employer shall assure that no employee is exposed to lead at concentrations greater than 50 μg/m^3 of air averaged over an 8-hour period. If an employee is exposed to lead for more than 8 hours in any work day, the permissible exposure limit, as a TWA for that day, shall be reduced according to the following formula: Maximum permissible limit (in μg/m^3) = 400 divided by the number of hours worked in the day [29 CFR 1910.1025(c)].

NIOSH REL: 0.050 mg[Pb]/m^3 TWA. Suspected carcinogen. Limit exposure to lowest feasible level. [*Note*: The REL also applies to other lead compounds (as Pb)]. *Note*: NIOSH considers "lead" to mean metallic lead, lead oxides; and lead salts (including organic salts, such as lead "soaps" but excluding lead arsenate). Air concentrations should be maintained so that worker blood lead remains less than 0.060 mg[Pb]/100 g of whole blood.

ACGIH TLV[1]: 0.05 mg[Pb]/m^3 TWA; BEI: 30 μg[Pb]/100 mL (blood). (*Note*: The TLV also applies to lead, inorganic compounds) *Note*: women of child bearing potential whose blood exceeds 10 μg[Pb]/dL are at risk of delivering a child with a blood [Pb] over the current CDC guideline of 10 μg[Pb]/dL and may cause birth defects; confirmed animal carcinogen with unknown relevance to humans.

DFG MAK: BAT: Carcinogen Category 3B

Australia: TWA 0.05 milligram per cubic meter, carcinogen, 1993; Austria: Suspected: carcinogen, 1999; Belgium: TWA 0.05 milligram per cubic meter, carcinogen, 1993; Denmark: TWA 0.02 mg[Cr]/m^3, 1999; TWA 0.1 mg[Pb]/m^3, 1999; Finland: carcinogen, 1999; France: VME 0.05 mg[Cr]/m^3, VME 0.15 mg[Pb]/m^3, 1999; Japan 0.01 mg[Cr]/m^3, 1999; 0.1 mg[Pb]/m^3, 1999; Norway: TWA 0.1 mg[CrO_3]/m^3, 1999; Norway: TWA 0.05 mg[Pb]/m^3, 1999; Poland: TWA 0.1 milligram per cubic meter; STEL 0.3 milligram per cubic meter, 1999; Poland: MAC (TWA) 0.05 mg[Pb]/m^3, 1999; Sweden: TWA 0.02 mg[Cr]/m^3, carcinogen, 1999; Switzerland: MAK-W 0.05 mg[Cr]/m^3, carcinogen, 1999; United Kingdom: TWA 0.05 mg [Cr]/m^3, carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Suspected Human Carcinogen. Several states have set guidelines or standards for lead chromate in ambient air[60] ranging from 0.5 μ/m^3 (Connecticut and Virginia) to 1.0 μ/m^3 (Nevada).

Determination in Air:***Determination in Air***: For lead use NIOSH Analytical Method (IV)s #7082, 7105, 7300, 7301, 7303, 7700, 7701, 7702, 9100, 9102, 9105; OSHA Analytical Methods ID-121, ID-125G, ID-206; #7024 for chromium, hexavalent.

Permissible Concentration in Water: *Lead:* Federal Drinking Water Standards: MCGL = zero mg/L; State Drinking Water Standards: Arizona: 50 μg[Pb]/L; State Drinking Water Guidelines: Arizona: 20 μg[Pb]/L; Maine: 10 μg[Pb]/L. *Chromium*: State Drinking Water Guidelines: California 10 μg[Cr(VI)]/L; Maine 35 μg[Cr(VI)]/L.

Determination in Water: Digestion followed by atomic absorption, or by colorimetric (dithizone) analysis, or by ICP optical emission spectrometry. That gives total lead; dissolved lead may be determined by 0.45 micron filtration prior to such analysis.

Routes of Entry: Inhalation, ingestion, skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the respiratory tract. Lead chromate is a carcinogen-handle with extreme caution. Lead poisoning symptoms may include poor appetite; colic, upset stomach; headache, irritability, muscle or joint pains; and weakness. Permanent kidney damage can result from long term or high exposure. Breathing lead chromate can cause a hole in the inner nose. Irritation of nose, throat or bronchial tubes can also occur, with cough and/or wheezing. Skin contact with concentrated lead chromate can cause burns, deep ulcers; or an allergic skin rash.

Long-Term Exposure: Chromium may cause allergic dermatitis. Lead chromate has been shown to cause kidney cancer. Repeated or prolonged contact may cause skin sensitization; dermatitis, irritation, chronic ulcers, eczema. Repeated or prolonged inhalation exposure may cause asthma. Lead chromate may affect the kidneys. May cause increased blood pressure. May cause reproductive toxicity and genetic damage in humans. May cause lead poisoning with symptoms of poor appetite; upset stomach; colic, headache, irritability, muscle or joint pains and weakness; constipation, disturbed sleep and reduced memory. See also "Lead" entry.

Points of Attack: Kidneys, skin, lungs.

Medical Surveillance: NIOSH lists the following tests for chromates: Blood gas analysis, CBC; chest X-ray, electrocardiogram, liver function tests; pulmonary function tests; sputum cytology, urine (chemical/metabolite), urinalysis (routine), white blood cell count/differential. Before first exposure and every 6 months thereafter, OSHA (1910. 1025) requires employers to provide: blood lead test, ZPP test (a special test for the effect of lead on blood cells). Examination of the nervous system. Prior to initial exposure, and annually for exposed person having blood lead readings exceeding 40 μg/100 g of whole blood, OSHA also requires a complete medical history, CBC and kidney function tests in addition to the tests listed above. OSHA defines "exposure" for these tests as air levels which average 30 micrograms of lead or more in a cubic meter of air. OSHA requires your employer to send the doctor a copy of the lead standard and provide one for you. *Note*: Blood-lead level is a good indicator of total lead exposure. Current OSHA regulations require that if an individual has a blood-lead level greater than or equal to 0.050 mg lead per 100 ml blood, he or she must be removed from all exposures to lead and cannot return to the exposure environment until the blood level falls to 0.040 mg lead per 100 ml blood or less. The following tolerance levels for occupational exposures may also be useful: ACGIH BEI = 50 mg/L (blood); 150 mg/g creatinine (urine). DFG BAT = 70 mg/L (blood); 30 mg/L (blood) for women < 45 years old.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Antidotes and Special Procedures for Lead: Persons with significant lead poisoning are sometimes treated with Ca EDTA while hospitalized. This "chelating" drug causes a rush of lead from the body organs into the blood and kidneys, and thus has its own hazards, and must be administered only by highly experienced medical personnel under controlled conditions and careful observation. Ca EDTA or similar drugs should never be used to prevent poisoning while exposure continues or without strict exposure control as severe kidney damage can result.

Note to Physician: For severe poisoning, BAL has been used to treat toxic symptoms of certain heavy metals poisoning. In the case of lead poisoning it may have SOME value. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin contact: (*as chromic acid and chromates*) 8 hours (more than 8 hours of resistance to breakthrough >0,1 micron g/cm/min): polyethylene gloves, suits, boots; polyvinyl chloride gloves, suits, boots; Saranex™ coated suits; 4 hours (At least 4 but < 8 hours of resistance to breakthrough >0.1 micron $g/cm^2/min$): butyl rubber gloves, suits, boots; Viton gloves, suits. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Specific engineering controls are recommended in NIOSH Criteria Document #76-129 *Chromium (VI)* and NIOSH 78-158: Lead, Inorganic Dusts and Fumes.

Respirator Selection: *As Lead*: Lead (1910.1025 & 1926.62): < or = 0.5 milligram per cubic meter (10 × PEL) Half-mask* air-purifying respirator equipped with high-efficiency filters**. < or = 2.5 milligram per cubic meter (50 × PEL) Full-facepiece air-purifying respirator with high-efficiency filters**. < or = 50 milligram per cubic meter (1000 × PEL) (1) Any powered air-purifying respirator with high-efficiency filters**; or (2) Half-mask* supplied-air respirator operated in positive-pressure mode. < or = 100 milligram per cubic meter (2000 × PEL) Supplied-air respirators with full facepiece, hood, helmet, or suit, operated in positive-pressure mode. > 100 milligram per cubic meter, unknown concentration, or firefighting Full-facepiece, SCBA operated in positive-pressure mode. * Full facepiece is required if the lead aerosols cause eye or skin irritation at the use concentrations. ** A high-efficiency filter means a filter that is at least 99.97% efficient against monodispersed particles of 0.3 μm in diameter or higher. *as chromates*: NIOSH, as chromates: at any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration: SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). Escape: 100 F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Check oxygen content prior to entering storage area. Color code-Yellow: Reactive Hazard; Store in a location separate from other materials, especially organic materials, flammables and combustibles, and other incompatible materials. Oxidizers, including oxidizing gases, should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. *Note*: Store corrosives in this group in chemical resistant secondary containers and/or in corrosion proof cabinets. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Lead chromate must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates) and chemically active metals (such as potassium, sodium, magnesium, zinc and ferric ferrocyanide), since violent reactions occur. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Store in a cool, well-ventilated area away from incompatible materials listed above. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43A: *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage.

Shipping: UN3085 Oxidizing solid, corrosive, n.o.s, Hazard Class: 5.1; Labels: 5.1-Oxidizer, 8-Corrosive material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Lead chromate may burn but does not easily ignite. Thermal decomposition products may include metal oxides of lead and chromium. NFPA recommends the use of water on fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(109); (102); (31); (173); (101); (138). (2); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 7, 65−66 (1981)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Lead Chromate*, Trenton, NJ (September 2001).

United States Environmental Protection Agency, *Health Assessment Document*: *Chromium*, EPA 600/8-83-014F, Washington, DC (1984)

United States Department of Health and Human Services Public Health Service National Toxicology Program, *Final Report on Carcinogens Background Document for Lead and Lead Compounds*, Contract Number N01-ES-85421, Research Triangle Park, NC 27709, May 8, 2003

Lead dioxide L:0145

Formula: O_2Pb; PbO_2

Synonyms: Lead, brown; Lead(IV) oxide; Lead oxide, brown; Lead peroxide; Lead superoxide; Peroxyde de plomb (French)

CAS Registry Number: 1309-60-0

HSDB Number: 4335

RTECS Number: OG0700000

UN/NA & ERG Number: UN1872/141

EC Number: 215-174-5

Regulatory Authority and Advisory Information

Carcinogenicity: Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Animal Inadequate Evidence, Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2A, 1987; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies.

California Proposition 65 Chemical[102]: (*lead and compounds*) Cancer; 10/1/1992; (*lead and compounds*) Developmental/Reproductive toxin (male, female) 2/27/1987

Hazard Alert: Exposure can be lethal, Cumulative poison, Combustible, Strong oxidizer, Reproductive toxin: Suspected of causing genetic defects, Environmental hazard.

EPA ADI = (preschool children) less than the 3 mg[Pb]/week recommended provisionally for adults.

United States National Primary Drinking Water Regulations: MCLG = zero mg[Pb]/L; MCL = Action Level = 0.015 mg[Pb]/L. Lead is regulated by a TT that requires systems to control the corrosiveness of their water. If more than 10% of tap water samples exceed the action level, water systems must take additional steps, as Lead (Pb).

Banned or Severely Restricted (various countries; in Pharmaceuticals) (UN)[13]

OSHA, 29CFR1910 Specifically Regulated Chemicals (See 29 CFR 1910.1025)

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as lead and compounds

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number D008

EPCRA Section 313: Includes any unique chemical substance that contains lead as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: inorganic compounds 0.1%; organic compounds 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as lead compounds, soluble, n.o.s.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. as lead inorganic compounds, n.o.s.

Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: O, T + , N; risk phrases: R45; R8, R20/22; R23/25; R33; R50/53; R61; R62; safety phrases: S20/21; S28; S29; S45; S53; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Lead dioxide is a dark brown crystalline solid or powder. Molecular weight = 239.19; specific gravity (H_2O:1) = 9.64 @ 20°C; freezing/melting point = (decomposes) 290°C. Hazard identification (based on NFPA-704 M Rating System): Health 4, Flammability 1, Reactivity 3 (Oxidizer). Insoluble in water.

Potential Exposure: This material is used in electrodes for lead-acid batteries; in matches; explosives, and as a curing agent for polysulfide elastomers.

Incompatibilities: Lead dioxide is a powerful oxidizer. Violent reaction with many compounds, including reducing agents; chemically active metals; combustible materials, strong acids, alkaline earth sulfides, aluminum carbides, aluminum, amines, calcium sulfide, carbides, chlorine trifluoride, glycerin, hydrides, hydrochloric acid, hydrogen peroxide, hydrogen sulfide, hydroxylamine, magnesium, metal powders, metal sulfides, molybdenum, phenylhydrazine, phosphorous red/friction, phosphorous trichloride, silicon, sulfides, sulfur, sulfur dioxide, sulfur/friction, sulfuric acid, tungsten, hydrogen trisulfide.

Permissible Exposure Limits in Air

See below NIOSH IDLH value for inorganic lead.*

PAC Ver. 29[138]

PAC-1: 0.17 milligram per cubic meter

PAC-2: 140 milligram per cubic meter

PAC-3: 810 milligram per cubic meter

As Inorganic Lead:

*NIOSH IDLH = 100 mg [Pb]/m^3

OSHA PEL: The employer shall assure that no employee is exposed to lead at concentrations greater than 50 μg/m^3 of air averaged over an 8-hour period. If an employee is exposed to lead for more than 8 hours in any work day, the permissible exposure limit, as a TWA for that day, shall be reduced according to the following formula: Maximum permissible limit (in μg/m^3) = 400 divided by the number of hours worked in the day [29 CFR 1910.1025(c)].

NIOSH REL: 0.050 mg[Pb]/m^3 TWA. Suspected carcinogen. Limit exposure to lowest feasible level. [*Note*: The REL also applies to other lead compounds (as Pb)]. *Note*: NIOSH considers "lead" to mean metallic lead, lead oxides; and lead salts (including organic salts, such as lead "soaps" but excluding lead arsenate). Air concentrations should be maintained so that worker blood lead remains less than 0.060 mg[Pb]/100 g of whole blood. See NIOSH Pocket Guide, Appendix C

ACGIH TLV[1]: 0.05 mg[Pb]/m^3 TWA; BEI: 30 μg[Pb]/100 mL (blood). (*Note*: The TLV also applies to lead, inorganic compounds) *Note*: women of child bearing potential whose blood exceeds 10 μg[Pb]/dL are at risk of delivering a child with a blood [Pb] over the current CDC guideline of 10 μg[Pb]/dL and may cause birth defects; confirmed animal carcinogen with unknown relevance to humans.

European OEL: 0.15 mg[Pb]/m^3 TWA (2002)

DFG MAK: BAT: 400 μg[Pb]/L (blood) not fixed; 100 μg [Pb]/L (blood) women age < 45; Carcinogen Category 2; Germ Cell Mutagen Group 3A.

Determination in Air: Determination in Air: Use NIOSH Analytical Method (IV)s #7082, 7105, 7300, 7301, 7303, 7700, 7701, 7702, 9100, 9102, 9105; OSHA Analytical Methods ID-121, ID-125G, ID-206.

Permissible Concentration in Water: Federal Drinking Water Standards: MCGL = zero mg/L; State Drinking Water Standards: Arizona: 50 μg[Pb]/L; State Drinking Water Guidelines: Arizona: 20 μg[Pb]/L; Maine: 10 μg[Pb]/L.

Determination in Water: Digestion followed by atomic absorption, or by colorimetric (dithizone) analysis, or by ICP optical emission spectrometry. That gives total lead; dissolved lead may be determined by 0.45 micron filtration prior to such analysis.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short-Term Exposure: Lead dioxide can affect you when breathed in. Irritates eyes, skin, and respiratory tract. Lead dioxide should be handled as a teratogen-with extreme caution. Lead poisoning can cause poor appetite; colic, upset stomach; headaches, irritability, muscle or joint pains and weakness. Permanent kidney damage can result from high exposures.

Long-Term Exposure: Repeated, prolonged, or high exposures may cause kidney damage. May cause lead poisoning with symptoms of poor appetite; upset stomach; colic, headache, irritability, muscle or joint pains and weakness, constipation, disturbed sleep and reduced memory. See also "Lead" entry.

Points of Attack: Kidneys

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Before first exposure and every 6 months thereafter, OSHA (1910. 1025) requires your employer to provide: blood lead test, ZPP test (a special test for the effect of lead on blood cells). Examination of the nervous system. Prior to initial exposure, and annually for exposed person having blood lead readings exceeding 40 μg/100 g of whole blood, OSHA also requires a complete medical history, CBC and kidney function tests in addition to the tests listed above. OSHA defines "exposure" for these tests as air levels which average 30 micrograms of lead or more in a cubic meter of air. OSHA requires your employer to send the doctor a copy of the lead standard and provide one for you. *Note*: Blood-lead level is a good indicator of total lead exposure. Current OSHA regulations require that if an individual has a blood-lead level greater than or equal to 0.050 mg lead per 100 ml blood, he or she must be removed from all exposures to lead and cannot return to the exposure environment until the blood level falls to 0.040 mg lead per 100 ml blood or less. The following tolerance levels for occupational exposures may also be useful: ACGIH BEI = 50 mg/L (blood); 150 mg/g creatinine (urine). DFG BAT = 70 mg/L (blood); 30 mg/L (blood) for women < 45 years old.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Antidotes and Special Procedures for Lead: Persons with significant lead poisoning are sometimes treated with Ca EDTA while hospitalized. This "chelating" drug causes a rush of lead from the body organs into the blood and kidneys, and thus has its own hazards, and must be administered only by highly experienced medical personnel under controlled conditions and careful observation. Ca EDTA or similar drugs should never be used to prevent poisoning while exposure continues or without strict exposure control as severe kidney damage can result. Note to Physician: For severe poisoning, BAL has been used to treat toxic symptoms of certain heavy metals poisoning. In the case of lead poisoning it may have SOME value. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Use any barrier that will prevent contamination from the dust. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See also NIOSH Criteria Document #78-158: *Lead, Inorganic Dusts and Fumes*.

Respirator Selection: Lead (1910.1025 & 1926.62): < or = 0.5 milligram per cubic meter (10 × PEL) Half-mask* air-purifying respirator equipped with high-efficiency filters**. < or = 2.5 milligram per cubic meter (50 × PEL) Full- facepiece air-purifying respirator with high-efficiency filters**. < or = 50 milligram per cubic meter (1000 × PEL) (1) Any powered air-purifying respirator with high-efficiency filters**; or (2) Half-mask* supplied-air respirator operated in positive-pressure mode. < or = 100 milligram per cubic meter (2000 × PEL) Supplied-air respirators with full facepiece, hood, helmet, or suit, operated in positive-pressure mode. > 100 milligram per cubic meter, unknown concentration, or firefighting Full-facepiece, SCBA operated in positive-pressure mode. * Full facepiece is required if the lead aerosols cause eye or skin irritation at the use concentrations. ** A high-efficiency filter means a filter that is at least 99.97% efficient against monodispersed particles of 0.3 μm in diameter or higher.

At Any Detectable Concentration: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA-or European Standard EN 149-approved SCBA that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). Escape: 100 F (APF = 50) (any air purifying, full-face-piece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Check oxygen content prior to entering storage area. Color code-Yellow: Reactive Hazard; Store in a location separate from other materials, especially organic materials, flammables and combustibles, and other incompatible materials. Oxidizers, including oxidizing gases, should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Lead dioxide must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates); chemically active metals (such as potassium, sodium, magnesium and zinc), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from combustible materials, such as wood, paper and oil. Lead dioxide is regulated by OSHA Standard 1910.1025. All requirements of the standard must be followed. Store in a cool, well-ventilated area away from incompatible materials listed above. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43A: *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage.

Shipping: UN1872 Lead dioxide, Hazard Class: 5.1; Labels: 5.1-Oxidizer.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. Keep combustibles (wood, paper, and oil) away from spilled material. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Lead dioxide does not burn but it will increase the intensity of a fire. Thermal decomposition products may include metal oxides of lead. Use extinguisher suitable for surrounding fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Conversion to soluble salt, precipitation as sulfide and return to supplier. Do not discharge into drains or sewers. Dispose of waste material as hazardous waste using a licensed disposal contractor to an approved landfill. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(109); (102); (31); (173); (101); (138); (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Lead Dioxide*, Trenton, NJ (September **2001).**

United States Department of Health and Human Services Public Health Service National Toxicology Program, *Final Report on Carcinogens Background Document for Lead and Lead Compounds*, Contract Number N01-ES-85421, Research Triangle Park, NC 27709, May 8, 2003

Lead fluoborate L:0150

Formula: B_2F_8Pb; $Pb(BF_4)_2$

Synonyms: Borate(1-), tetrafluoro-, lead(2 +); Fluoborato de plomo (Spanish); Lead tetrafluoroborate; Tetrafluoro borate; Tetrafluoro borate(1-), lead(2 +)

CAS Registry Number: 13814-96-5

HSDB Number: 1991

RTECS Number: ED2700000

UN/NA & ERG Number: UN2291 (lead compound, soluble, n.o.s.)/151; UN2922 (Corrosive liquid, toxic, n.o.s.)/154

EC Number: 237-486-0

Regulatory Authority and Advisory Information

Carcinogenicity: Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Animal Inadequate Evidence, Human Inadequate Evidence*, possibly carcinogenic to humans*, Group 2A, 1987; Carcinogenicity: EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies.

California Proposition 65 Chemical[102]: (*lead and compounds*) Cancer; 10/1/1992; (*lead and compounds*); Developmental/Reproductive toxin (male, female) 2/27/1987

Hazard Alert: Poison (cumulative), Corrosive, Reproductive toxin, Environmental hazard.

EPA ADI = (preschool children) less than the 3 mg[Pb]/week recommended provisionally for adults.

Air Pollutant Standard set. See below, "Permissible Exposure Limits in Air" section.

OSHA, 29CFR1910 Specifically Regulated Chemicals (See 29 CFR 1910.1025)

Hazardous Substance (EPA) (RQ = 5000/2270)[4]

United States National Primary Drinking Water Regulations: MCLG = zero mg[Pb]/L; MCL = Action Level = 0.015 mg[Pb]/L. Lead is regulated by a TT that requires systems to control the corrosiveness of their water. If more than 10% of tap water samples exceed the action level, water systems must take additional steps, as Lead; MCLG = 4 mg[F]/L; MCL = 4 mg[F]/L; SMCL = 2.0 mg [F]/L, as Fluoride.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992); 40CFR401.15 Section 307 Toxic Pollutants as lead and compounds

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number D008

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. as lead inorganic compounds, n.o.s.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R45; R20/22; R23/25; R33; R50/53; R61; R62; safety phrases: S20/21; S28; S29; S36/37; S45; S53; S60; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Lead fluoborate is a nonflammable colorless liquid or crystalline powder. Faint odor. Molecular weight = 380.81; specific gravity (H_2O:1) = 1.75 @ 20°C. Hazard identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 0. Slightly soluble in water (decomposes).

Potential Exposure: This material is used in material finishing operations.

Incompatibilities: Aqueous solution is acidic. Incompatible with oxidizers, bases, active metals. Decomposes in water or alcohol. Attacks most metals; especially aluminum.

Permissible Exposure Limits in Air

See below NIOSH IDLH value for inorganic lead.*

13814-96-5

PAC Ver. 29[138]

PAC-1: 0.28 milligram per cubic meter

PAC-2: 220 milligram per cubic meter

PAC-3: 1300 milligram per cubic meter

As Inorganic Lead:

*NIOSH IDLH = 100 mg [Pb]/m^3

OSHA PEL: The employer shall assure that no employee is exposed to lead at concentrations greater than 50 μg/m^3 of air averaged over an 8-hour period. If an employee is exposed to lead for more than 8 hours in any work day, the permissible exposure limit, as a TWA for that day, shall be reduced according to the following formula: Maximum permissible limit (in μg/m^3) = 400 divided by the number of hours worked in the day [29 CFR 1910.1025(c)].

NIOSH REL: 0.050 mg[Pb]/m^3 TWA. Suspected carcinogen. Limit exposure to lowest feasible level. [*Note*: The REL also applies to other lead compounds (as Pb)]. *Note*: NIOSH considers "lead" to mean metallic lead, lead oxides; and lead salts (including organic salts, such as lead "soaps" but excluding lead arsenate). Air concentrations should be maintained so that worker blood lead remains less than 0.060 mg[Pb]/100 g of whole blood. See NIOSH Pocket Guide, Appendix C

ACGIH TLV[1]: 0.05 mg[Pb]/m^3 TWA; BEI: 30 μg[Pb]/100 mL (blood). (*Note*: The TLV also applies to lead, inorganic compounds) *Note*: women of child bearing potential whose blood exceeds 10 μg[Pb]/dL are at risk of delivering a child with a blood [Pb] over the current CDC guideline of 10 μg[Pb]/dL and may cause birth defects; confirmed animal carcinogen with unknown relevance to humans.

European OEL: 0.15 mg[Pb]/m^3 TWA (2002)

DFG MAK: BAT: 400 μg[Pb]/L (blood) not fixed; 100 μg [Pb]/L (blood) women age < 45; Carcinogen Category 2; Germ Cell Mutagen Group 3A.

Determination in Air: Use NIOSH Analytical Method (IV) s #7082, 7105, 7300, 7301, 7303, 7700, 7701, 7702, 9100, 9102, 9105; OSHA Analytical Methods ID-121, ID-125G, ID-206

Permissible Concentration in Water: Federal Drinking Water Standards: MCGL = zero mg/L; State Drinking Water Standards: Arizona: 50 μg[Pb]/L; State Drinking Water Guidelines: Arizona: 20 μg[Pb]/L; Maine: 10 μg[Pb]/L.

Determination in Water: Digestion followed by atomic absorption, or by colorimetric (dithizone) analysis, or by ICP optical emission spectrometry. That gives total lead; dissolved lead may be determined by 0.45 micron filtration prior to such analysis.

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Lead fluoborate can affect you when breathed in and if swallowed from food, drinks, or cigarettes. Contact can cause skin and eye irritation and burns. Irritates the respiratory tract. Can cause headache, irritability, mood changes; reduced memory; and disturbed sleep.

Long-Term Exposure: Repeated exposure causes lead fluoborate build-up in the body and lead to lead or fluoride poisoning. Low levels may cause tiredness, mood changes; headaches, stomach problems, and trouble sleeping. Higher levels may cause aching, weakness, and concentration or memory problems. May damage the nervous system causing numbness, "pins and needles" weakness in the hands and feet. Lead fluoborate can also cause serious permanent kidney, brain damage, and damage the blood cells, causing anemia. Lead fluoborate exposure increases risk of high blood pressure. Lead compounds have been determined to be teratogens and may also cause reproductive damage, such as reduced fertility and interference with menstrual cycles. Lead fluoborate should be handled as a teratogen-with extreme caution.

Points of Attack: Kidneys, nervous system; brain, blood.

Medical Surveillance: Before first exposure and every 6 months thereafter, OSHA (1910.1025) requires your employer to provide: blood lead test, ZPP test (a special test for the effect of lead on blood cells). Examination of the nervous system. Prior to initial exposure, and annually for exposed person having blood lead readings exceeding 40 μg/100 g of whole blood, OSHA also requires a complete medical history, CBC and kidney function tests in addition to the tests listed above. OSHA defines "exposure" for these tests as air levels which average 30 micrograms of lead or more in a cubic meter of air. OSHA (under 1910.1020) requires your employer to send the doctor a copy of the lead standard and provide one for you. *Note*:

Blood-lead level is a good indicator of total lead exposure. Current OSHA regulations require that if an individual has a blood-lead level greater than or equal to 0.050 mg lead per 100 ml blood, he or she must be removed from all exposures to lead and cannot return to the exposure environment until the blood level falls to 0.040 mg lead per 100 ml blood or less. The following tolerance levels for occupational exposures may also be useful: ACGIH BEI = 50 mg/L (blood); 150 mg/g creatinine (urine). DFG BAT = 70 mg/L (blood); 30 mg/L (blood) for women $<$ 45 years old.

NIOSH lists the following tests for fluorides: chest X-ray, electrocardiogram, pulmonary function tests: forced vital capacity, forced expiratory volume (1 second); pelvic X-ray; sputum cytology; urine (chemical/metabolite); urine (chemical/metabolite) pre- and postshift; urinalysis (routine); CBC /differential.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Antidotes and Special Procedures for Lead: Persons with significant lead poisoning are sometimes treated with Ca EDTA while hospitalized. This “chelating” drug causes a rush of lead from the body organs into the blood and kidneys, and thus has its own hazards, and must be administered only by highly experienced medical personnel under controlled conditions and careful observation. Ca EDTA or similar drugs should never be used to prevent poisoning while exposure continues or without strict exposure control as severe kidney damage can result.

Note to Physician: For severe poisoning, BAL has been used to treat toxic symptoms of certain heavy metals poisoning. In the case of lead poisoning it may have SOME value. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Use any barrier that will prevent contamination from the dust. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See also NIOSH Criteria Document #78-158: *Lead, Inorganic Dusts and Fumes.*

Respirator Selection: Lead (1910.1025 & 1926.62): $<$ or = 0.5 milligram per cubic meter (10 × PEL)
Half-mask* air-purifying respirator equipped with high-efficiency filters**. $<$ or = 2.5 milligram per cubic meter (50 × PEL) Full-facepiece air-purifying respirator with high-efficiency filters**. $<$ or = 50 milligram per cubic meter (1000 × PEL) (1) Any powered air-purifying respirator with high-efficiency filters**; or (2) Half-mask* supplied-air respirator operated in positive-pressure mode. $<$ or = 100 milligram per cubic meter (2000 × PEL) Supplied-air respirators with full facepiece, hood, helmet, or suit, operated in positive-pressure mode. $>$ 100 milligram per cubic meter, unknown concentration, or firefighting Full-facepiece, SCBA operated in positive-pressure mode.

* Full facepiece is required if the lead aerosols cause eye or skin irritation at the use concentrations.

** A high-efficiency filter means a filter that is at least 99.97% efficient against monodispersed particles of 0.3 μm in diameter or higher.

Storage: (1) Color code-White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. (2) Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Lead fluoborate must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates) and chemically active metals (such as potassium, sodium, magnesium and zinc), since violent reactions occur. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Lead is regulated by an OSHA Standard 1910.1025. All requirements of the standard must be followed.

Shipping: UN2291 Lead compounds, soluble n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN2922 Corrosive liquids, toxic, n.o.s., Hazard class: 8; Labels: 8-Corrosive material, 6.1-Poisonous materials.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate and wash area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental

protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Lead fluoborate itself does not burn. Thermal decomposition products may include hydrogen fluoride and metal oxides of lead and boron. Use any agent suitable for type of surrounding fire. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(109); (102); (31); (173); (101); (138). (2); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 6, 79−80 (1981)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: *Lead Fluoborate*, Trenton, NJ (November 1999)

United States Department of Health and Human Services Public Health Service National Toxicology Program, *Final Report on Carcinogens Background Document for Lead and Lead Compounds*, Contract Number N01-ES-85421, Research Triangle Park, NC 27709, May 8, 2003

Lead fluoride L:0160

Formula: F_2Pb

Synonyms: Fluoruro de plomo (Spanish); Hydrofluoric acid, lead(2 +) salt; Hydrofluoric acid, lead(II) salt; Lead difluoride; Lead(2 +) fluoride; Lead(II) fluoride; Plomb fluorure (French); Plumbous fluoride

CAS Registry Number: 7783-46-2

HSDB Number: 6288

RTECS Number: OG1225000

UN/NA & ERG Number: UN2291 (lead compound, soluble, n.o.s.)/151; UN3288 (Toxic solid, inorganic, n.o.s.)/151

EC Number: 231-998-8

Regulatory Authority and Advisory Information

Carcinogenicity: Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Animal Inadequate Evidence, Human Inadequate Evidence*, possibly carcinogenic to humans*, Group 2A, 1987; Carcinogenicity; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies.

California Proposition 65 Chemical[102]: (*lead and compounds*) Cancer; 10/1/1992; (*lead and compounds*); Developmental/Reproductive toxin (male, female) 2/27/1987

Hazard Alert: Poison (cumulative), Known catalytic activity, Reproductive toxin, Environmental hazard.

United States National Primary Drinking Water Regulations: MCLG = 4 mg[F]/L; MCL = 4 mg[F]/L; SMCL = 2 mg[F]/L, as fluorides.

United States National Primary Drinking Water Regulations: MCLG = zero mg[Pb]/L; MCL = Action Level = 0.015 mg[Pb]/L. Lead is regulated by a TT that requires systems to control the corrosiveness of their water. If more than 10% of tap water samples exceed the action level, water systems must take additional steps, as Lead; MCLG = 4 mg[F]/L; MCL = 4 mg[F]/L; SMCL = 2.0 mg [F]/L, as Fluoride.

EPA ADI = (preschool children) less than the 3 mg[Pb]/week recommended provisionally for adults.

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR 1910.1025)

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992); 40CFR401.15 Section 307 Toxic Pollutants as lead and compounds

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number D008

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Hazardous to aquatic life or environment, with possible long lasting effects[291,292].

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R45; R10; R20/22; R23/25; R33; R50/53; R61; R62; safety phrases: S20/21; S28; S29/35; S36/37; S41; S45; S53; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Lead fluoride is a white to colorless, odorless crystalline (rhombic, orthorhombic) solid. Molecular weight = 245.19; specific gravity (H_2O:1) = 7.75 (cubic) @ 20°C; boiling point = 1290°C; freezing/melting point = 855°C; vapor pressure = 10 mmHg @ 904°C. Hazard identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 0. Slightly soluble in water.

Potential Exposure: Used to make other chemicals, underwater paints; electronic and optical parts (for growing single-crystal, solid-state lasers); in high-temperature dry-film lubricants; and making special grades of glass.

Incompatibilities: Violent reaction with oxidizers, chemically active metals; calcium carbide. May ignite combustibles, such as wood, paper, oil, etc.

Permissible Exposure Limits in Air

See below NIOSH IDLH values for inorganic lead and fluorides*

PAC Ver. 29[138]

7783-46-2

PAC-1: 0.18 milligram per cubic meter

PAC-2: 140 milligram per cubic meter

PAC-3: 830 milligram per cubic meter

As Inorganic Lead:

*NIOSH IDLH = 100 mg [Pb]/m^3

OSHA PEL: The employer shall assure that no employee is exposed to lead at concentrations greater than 50 μg/m^3 of air averaged over an 8-hour period. If an employee is exposed to lead for more than 8 hours in any work day, the permissible exposure limit, as a TWA for that day, shall be reduced according to the following formula: Maximum permissible limit (in μg/m^3) = 400 divided by the number of hours worked in the day [29 CFR 1910.1025(c)].

NIOSH REL: 0.050 mg[Pb]/m^3 TWA. Suspected carcinogen. Limit exposure to lowest feasible level. [*Note*: The REL also applies to other lead compounds (as Pb)]. *Note*: NIOSH considers "lead" to mean metallic lead, lead oxides; and lead salts (including organic salts, such as lead "soaps" but excluding lead arsenate). Air concentrations should be maintained so that worker blood lead remains less than 0.060 mg[Pb]/100 g of whole blood. See NIOSH Pocket Guide, Appendix C

ACGIH TLV[1]: 0.05 mg[Pb]/m^3 TWA; BEI: 30 μg[Pb]/100 mL (blood). (*Note*: The TLV also applies to lead, inorganic compounds) *Note*: women of child bearing potential whose blood exceeds 10 μg[Pb]/dL are at risk of delivering a child with a blood [Pb] over the current CDC guideline of 10 μg[Pb]/dL and may cause birth defects; confirmed animal carcinogen with unknown relevance to humans.

DFG MAK: BAT: 400 μg[Pb]/L (blood) not fixed; 100 μg [Pb]/L (blood) women age $<$ 45; Carcinogen Category 2; Germ Cell Mutagen Group 3A.

Permissible Exposure Limits in Air

As Inorganic Fluorides:

*NIOSH IDLH = 250 mg[F]/m^3

OSHA PEL: 3 ppm/2.5 mg[F]/m^3 TWA

NIOSH REL: 3 ppm/2.5 mg[F]/m^3 TWA; 6 ppm/5 mg[F]/m^3, 15 min Ceiling Concentration

ACGIH TLV[1]: 2.5 mg[F]/m^3 TWA; not classifiable as a human carcinogen; BEI: 3 mg[F]/g creatinine in urine prior to end-of-shift; 10 mg[F]/g creatinine in urine end-of-shift

DFG MAK: 1 mg[F]/m^3, inhalable fraction [skin]; Peak Limitation Category II(4); Pregnancy Risk Group C; BAT: 7.0 mg[F]/g creatinine in urine at end-of-shift; 4.0 mg[F]/g creatinine in urine at the beginning of the next shift

Determination in Air: Use NIOSH Analytical Method (IV) s #7082, 7105, 7300, 7301, 7303, 7700, 7701, 7702, 9100, 9102, 9105; OSHA Analytical Methods ID-121, ID-125G, ID-206.

Permissible Concentration in Water: Fluoride: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guidelines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg [F]/L. Safe Drinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg[F]/L; SMCL = 2 mg[F]/L; *Lead*: Safe Drinking Water Act (47FR 9352) MCLG = zero mg[Pb]/L; MCL = Action Level = 0.015 mg[Pb]/L. Lead is regulated by a TT that requires systems to control the corrosiveness of their water. If more than 10% of tap water samples exceed the action level, water systems must take additional steps. State Drinking Water Standards: Arizona: 50 μg[Pb]/L; State Drinking Water Guidelines: Arizona: 20 μg[Pb]/L; Maine: 10 μg[Pb]/L.

Determination in Water: Digestion followed by atomic absorption, or by colorimetric (dithizone) analysis, or by ICP optical emission spectrometry. That gives total lead; dissolved lead may be determined by 0.45 micron filtration prior to such analysis.

Routes of Entry: Inhalation, skin. Lead can be absorbed through skin at chronically toxic levels.

Harmful Effects and Symptoms

Short-Term Exposure: Contact can cause skin and eye irritation and burns. Inhalation can irritate the nose and throat. Lead fluoride can cause headache, irritability, mood changes; reduced memory; and disturbed sleep. The fluoride ion can cause protoplasmic poisoning at higher concentrations. See also entry on "Fluorides." *Note*: Lead is a cumulative poison. Increasing amounts can build up in the body, eventually reaching a point where symptoms and disability occur. Lead dust carried home on contaminated clothing can result in exposure and symptoms in other family members. Standards only protect for inhalation exposure. Extra precautions should be taken if skin exposure also occurs.

Long-Term Exposure: While lead fluoride has not been identified as a teratogen, or a reproductive hazard, lead and certain lead compounds have been determined to be teratogens and may also cause reproductive damage, such as reduced fertility and interfere with menstrual cycles. Handle with extreme caution. Lead can accumulate in the body over a period of time. Therefore, long-term exposures to lower levels can result in a buildup of lead in the body and more severe symptoms. These may include anemia, pale skin, a Blue line at the gum margin; decreased handgrip strength; abdominal pain; severe constipation; nausea, vomiting, and paralysis of the wrist joint. Prolonged exposure may also result in kidney and brain damage. If the nervous system is affected, usually due to very high exposures, the resulting effects include severe headache, convulsions, coma, delirium and death. In nonfatal cases, recovery is slow and not always complete. Alcohol ingestion and physical exertion may bring on symptoms. Lead exposure increases the risk of high blood pressure.

Points of Attack: Blood, kidneys, brain, nervous system.

Medical Surveillance: Before first exposure and every 6 months thereafter, OSHA (1910.1025) requires your employer to provide: blood lead test, ZPP test (a special test for the effect of lead on blood cells). Examination of the nervous system. Prior to initial exposure, and annually for exposed person having blood lead readings exceeding 40 μg/100 g of whole blood, OSHA also requires a complete medical history, CBC and kidney function tests in addition to the tests listed above. OSHA defines "exposure" for these tests as air levels which average 30 micrograms of lead or more in a cubic meter of air. OSHA (1910.1020) requires your employer to send the doctor a copy of the lead standard and provide one for you. *Note*: Blood-lead level is a good indicator of total lead exposure. Current OSHA regulations require that if an individual has a blood-lead level greater than or equal to 0.050 mg lead per 100 ml blood, he or she must be removed from all exposures to lead and cannot return to the exposure environment until the blood level falls to 0.040 mg lead per 100 ml blood or less. The following tolerance levels for occupational exposures may also be useful: ACGIH BEI = 50 mg/L (blood); 150 mg/g creatinine (urine). DFG BAT = 70 mg/L (blood); 30 mg/L (blood) for women < 45 years old.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to Physician: Administer saline cathartic and an enema. For relief of colic, administer antispasmodic (calcium gluconate, atropine, and papaverine). Consider morphine sulfate for severe pain.

Whole blood lead levels, circulating plasma/erythrocyte lead concentration ratio; urine ALA; and erythrocyte protoporphyrin fluorescent microscopy may all be useful in monitoring or assessing lead exposure. Chelating agents, such as Ca EDTA and penicillamine (*not penicillin*) have been found to be generally useful in the therapy of acute lead intoxication.

Antidotes and Special Procedures for Lead: Persons with significant lead poisoning are sometimes treated with Ca EDTA while hospitalized. This "chelating" drug causes a rush of lead from the body organs into the blood and kidneys, and thus has its own hazards, and must be administered only by highly experienced medical personnel under controlled conditions and careful observation. Ca EDTA or similar drugs should never be used to prevent poisoning while exposure continues or without strict exposure control as severe kidney damage can result.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Use any barrier that will prevent contamination from the dust. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Work clothing should be HEPA vacuumed before removal. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Lead (1910.1025 & 1926.62): < or = 0.5 milligram per cubic meter (10 × PEL)

Half-mask* air-purifying respirator equipped with high-efficiency filters**. < or = 2.5 milligram per cubic meter (50 × PEL) Full-facepiece air-purifying respirator with high-efficiency filters**. < or = 50 milligram per cubic meter (1000 × PEL) (1) Any powered air-purifying respirator with high-efficiency filters**; or (2) Half-mask* supplied-air respirator operated in positive-pressure mode. < or = 100 milligram per cubic meter (2000 × PEL) Supplied-air respirators with full facepiece, hood, helmet, or suit, operated in positive-pressure mode. > 100 milligram per cubic meter, unknown concentration, or firefighting Full-facepiece, SCBA operated in positive-pressure mode.

* Full facepiece is required if the lead aerosols cause eye or skin irritation at the use concentrations.

** A high-efficiency filter means a filter that is at least 99.97% efficient against monodispersed particles of 0.3 μm in diameter or higher.

As fluorides:

NIOSH/OSHA 12.5 milligram per cubic meter: Qm (APF = 25) (any quarter-mask respirator). 25 milligram per cubic meter: 95XQ (APF = 10)*[any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or SA * (any supplied-air respirator). 62.5 milligram per cubic meter: Sa:Cf (APF = 25)* + (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25)* if not present as a fume (any powered, air-purifying respirator with a high-efficiency particulate filter). 125 milligram per cubic meter: 100 F (APF = 50)$^+$ [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, and P100]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). 250 milligram per cubic meter: Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). Emergency or Planned Entry into Unknown Concentrations or IDLH Conditions: SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). Escape: 100 F (APF = 50)$^+$ [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, and P100]; or SCBAE (any appropriate escape-type, SCBA). *Substance reported to cause eye irritation or damage; may require eye protection. *May need acid gas sorbent.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Lead is regulated by an OSHA Standard 1910.1025. All requirements of the standard must be followed.

Shipping: UN3288 Toxic solids, inorganic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN2291 Lead compounds, soluble n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Use vacuum or a wet method to reduce dust. Do not dry sweep. When vacuuming, a HEPA filter should be used, not a standard shop vac. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical does not burn. Thermal decomposition products may include hydrogen fluoride, oxides of metal and lead fumes. Use any extinguishing agent suitable for surrounding fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(109); (102); (31); (173); (101); (138). (2); (122); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: *Lead Fluoride*, Trenton, NJ (November, 1999)

United States Department of Health and Human Services Public Health Service National Toxicology Program, *Final Report on Carcinogens Background Document for Lead and Lead Compounds*, Contract Number N01-ES-85421, Research Triangle Park, NC 27709, May 8, 2003

Lead iodide L:0170

Formula: I_2Pb; PbI_2

Synonyms: Lead(2 +) iodide; Lead(II) iodide; Yoduro de plomo (Spanish)

CAS Registry Number: 10101-63-0

HSDB Number: 636

RTECS Number: OG1515000

UN/NA & ERG Number: UN3288 (Toxic solid, inorganic, n.o.s.)/151; UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 233-256-9

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; Animal Inadequate Evidence, Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2A, 1987; Carcinogenicity: EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies.

California Proposition 65 Chemical[102]: (*lead and compounds*) Cancer; 10/1/1992; (*lead and compounds*) Developmental/Reproductive toxin (male, female) 2/27/1987

Hazard Alert: Poison (cumulative), Reproductive toxin, Environmental hazard.

EPA ADI = (preschool children) less than the 3 mg[Pb]/week recommended provisionally for adults.

OSHA, 29CFR1910 Specifically Regulated Chemicals (See 29 CFR 1910.1025)

Hazardous Substance (EPA) (RQ = 5000/2270)[4]

United States National Primary Drinking Water Regulations: MCLG = zero mg[Pb]/L; MCL = Action Level = 0.015 mg [Pb]/L. Lead is regulated by a TT that requires systems to control the corrosiveness of their water. If more than 10% of tap water samples exceed the action level, water systems must take additional steps, as Lead (Pb).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992); 40CFR401.15 Section 307 Toxic Pollutants as lead and compounds

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number D008

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. as lead, inorganic compounds, n.o.s.

Hazardous to aquatic life or environment, with possible long lasting effects[291,292].

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R45; R20/22; R23/25; R33; R50/53; R61; R62; safety phrases: S20/21; S28; S29/35; S45; S53; S60; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Lead iodide is a heavy, bright-yellow, odorless powder. Molecular weight = 461; specific gravity (H_2O:1) = 6.16 @ 20°C; boiling point = 954°C; freezing/melting point = 402°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. Soluble in water.

Potential Exposure: Lead iodide is used in bronzing, gold pencils; mosaic gold; printing, and photography.

Incompatibilities: Lead iodide has weak oxidizing or reducing powers. Redox reactions can however still occur. The majority of compounds in this class are slightly soluble or insoluble in water. If soluble in water, then the solutions are usually neither strongly acidic nor strongly basic. These compounds are not water-reactive. Light sensitive[101] Contact with oxidizers or active metals may cause violent reaction.

Permissible Exposure Limits in Air

see below NIOSH IDLH value for lead*

10101-63-0

PAC Ver. 29[138]

PAC-1: 0.33 milligram per cubic meter

PAC-2: 270 milligram per cubic meter

PAC-3: 1600 milligram per cubic meter

As Iodides:

ACGIH TLV[1]: 0.01 ppm/0.1 milligram per cubic meter, inhalable fraction and vapor, TWA

As Inorganic Lead:

*NIOSH IDLH = 100 mg [Pb]/m^3

OSHA PEL: The employer shall assure that no employee is exposed to lead at concentrations greater than 50 μg/m^3 of air averaged over an 8-hour period. If an employee is exposed to lead for more than 8 hours in any work day, the permissible exposure limit, as a TWA for that day, shall be reduced according to the following formula: Maximum permissible limit (in μg/m^3) = 400 divided by the number of hours worked in the day [29 CFR 1910.1025(c)].

NIOSH REL: 0.050 mg[Pb]/m^3 TWA. Suspected carcinogen. Limit exposure to lowest feasible level. [*Note*: The REL also applies to other lead compounds (as Pb)]. *Note*: NIOSH considers "lead" to mean metallic lead, lead oxides; and lead salts (including organic salts, such as lead "soaps" but excluding lead arsenate). Air concentrations should be maintained so that worker blood lead remains less than 0.060 mg[Pb]/100 g of whole blood. See NIOSH Pocket Guide, Appendix C

ACGIH TLV[1]: 0.05 mg[Pb]/m^3 TWA; BEI: 30 μg[Pb]/100 mL (blood). (*Note*: The TLV also applies to lead, inorganic compounds) *Note*: women of child bearing potential whose blood exceeds 10 μg[Pb]/dL are at risk of delivering a child with a blood [Pb] over the current CDC guideline of 10 μg[Pb]/dL and may cause birth defects; confirmed animal carcinogen with unknown relevance to humans.

DFG MAK: BAT: 400 μg[Pb]/L (blood) not fixed; 100 μg [Pb]/L (blood) women age $<$ 45; Carcinogen Category 2; Germ Cell Mutagen Group 3A.

Determination in Air: Use NIOSH Analytical Method (IV) s #7082, 7105, 7300, 7301, 7303, 7700, 7701, 7702, 9100, 9102, 9105; OSHA Analytical Methods ID-121, ID-125G, ID-206.

Permissible Concentration in Water: Federal Drinking Water Standards: MCGL = zero mg/L; State Drinking Water Standards: Arizona: 50 μg[Pb]/L; State Drinking Water Guidelines: Arizona: 20 μg[Pb]/L; Maine: 10 μg[Pb]/L.

Determination in Water: Digestion followed by atomic absorption, or by colorimetric (dithizone) analysis, or by ICP optical emission spectrometry. That gives total lead; dissolved lead may be determined by 0.45 micron filtration prior to such analysis.

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Can cause headache, irritability, reduced memory and disturbed sleep. Lead poisoning can cause poor appetite; colic, upset stomach; headaches, irritability, muscle or joint pains and weakness.

Long-Term Exposure: Permanent kidney damage can result from long-term or high exposures. Repeated exposure may cause brain damage, and damage to the blood cells, leading to anemia. Higher levels can cause muscle and joint pains, weakness and fatigue. May cause nerve damage. Lead exposure increases the risk of high blood pressure. Lead iodide should be handled as a teratogen, with extreme caution. Repeated exposure may cause lead poisoning and/or iodism. Symptoms of iodism can include running nose, headache, mucous membrane irritation; and skin rash.

Points of Attack: Kidneys, brain, nervous system; blood.

Medical Surveillance: Before first exposure and every 6 months thereafter, OSHA (1910. 1025) requires your employer to provide: blood lead test, ZPP test (a special test for the effect of lead on blood cells). Examination of the nervous system. Prior to initial exposure, and annually for exposed person having blood lead readings exceeding 40 μg/100 g of whole blood, OSHA also requires a complete medical history, CBC and kidney function tests in addition to the tests listed above. OSHA defines "exposure" for these tests as air levels which average 30 micrograms of lead or more in a cubic meter of air. OSHA (under 1910.1020) requires your employer to send the doctor a copy of the lead standard and provide one for you. *Note*: Blood-lead level is a good indicator of total lead exposure. Current OSHA regulations require that if an individual has a blood-lead level greater than or equal to 0.050 mg lead per 100 ml blood, he or she must be removed from all exposures to lead and cannot return to the exposure environment until the blood level falls to 0.040 mg lead per 100 ml blood or less. The following tolerance levels for occupational exposures may also be useful: ACGIH BEI = 50 mg/L (blood); 150 mg/g creatinine (urine). DFG BAT = 70 mg/L (blood); 30 mg/L (blood) for women < 45 years old.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Antidotes and Special Procedures for Lead: Persons with significant lead poisoning are sometimes treated with Ca EDTA while hospitalized. This "chelating" drug causes a rush of lead from the body organs into the blood and kidneys, and thus has its own hazards, and must be administered only by highly experienced medical personnel under controlled conditions and careful observation. Ca EDTA or similar drugs should never be used to prevent poisoning while exposure continues or without strict exposure control as severe kidney damage can result.

Note to Physician: For severe poisoning, BAL has been used to treat toxic symptoms of certain heavy metals poisoning. In the case of lead poisoning it may have SOME value. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Use any barrier that will prevent contamination from the dust. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See also NIOSH Criteria Document #78-158: *Lead, Inorganic Dusts and Fumes*.

Respirator Selection: Lead (1910.1025 & 1926.62): < or = 0.5 milligram per cubic meter (10 × PEL) Half-mask* air-purifying respirator equipped with high-efficiency filters**. < or = 2.5 milligram per cubic meter (50 × PEL) Full-facepiece air-purifying respirator with high-efficiency filters**. < or = 50 milligram per cubic meter (1000 × PEL) (1) Any powered air-purifying respirator with high-efficiency filters**; or (2) Half-mask* supplied-air respirator operated in positive-pressure mode. < or = 100 milligram per cubic meter (2000 × PEL) Supplied-air respirators with full facepiece, hood, helmet, or suit, operated in positive-pressure mode. > 100 milligram per cubic meter, unknown concentration, or firefighting Full-facepiece, SCBA operated in positive-pressure mode.

* Full facepiece is required if the lead aerosols cause eye or skin irritation at the use concentrations.

** A high-efficiency filter means a filter that is at least 99.97% efficient against monodispersed particles of 0.3 μm in diameter or higher.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Lead iodide must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates and nitrates) and chemically active metals (such as potassium, sodium, magnesium and zinc), since violent reactions occur. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Lead iodide is regulated by an OSHA Standard, 1910.1025. All requirements of the standard must be followed.

Shipping: UN3288 Toxic solids, inorganic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide; water spray; or foam extinguishers. Poisonous fumes of lead and iodine. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(109); (102); (31); (173); (101); (138). (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Lead Iodide*, Trenton, NJ (October 2004)

United States Department of Health and Human Services Public Health Service National Toxicology Program, *Final Report on Carcinogens Background Document for Lead and Lead Compounds*, Contract Number N01-ES-85421, Research Triangle Park, NC 27709, May 8, 2003

Lead phosphate L:0180

Formula: O_8P_2Pb3; $Pb_3(PO_4)_2$

Synonyms: Bleiphosphat (German); C.I. 77622; Fasfato de plomo (Spanish); Lead orthophosphate; Lead phosphate (3:2); Lead(2 +) phosphate; Lead(II) phosphate; Normal lead orthophosphate; Perlex paste; Phosphoric acid, lead salt; Phosphoric acid, lead(2 +) salt (2:3); Plumbous phosphate; Trilead phosphate; Trilead bis(orthophosphate)

CAS Registry Number: 7446-27-7

HSDB Number: 2637

RTECS Number: OG3675000

UN/NA & ERG Number: UN3288 (Toxic solid, inorganic, n.o.s.)/151

EC Number: 231-205-5 [*Annex I Index No.*: 082-006-00-3]

Regulatory Authority and Advisory Information

Carcinogenicity: Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Animal Inadequate Evidence, Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2A, 1987; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies.

California Proposition 65 Chemical[102]: (*lead and compounds*) Cancer; 10/1/1992; (*lead and compounds*) Developmental/Reproductive toxin (male, female) 2/27/1987

Hazard Alert: Poison (cumulative), Highly acute toxicity, Possible risk of forming tumors, Reproductive toxin: Suspected of causing genetic defects, Environmental hazard.

EPA ADI = (preschool children) less than the 3 mg[Pb]/week recommended provisionally for adults.

OSHA, 29CFR1910 Specifically Regulated Chemicals (See 29 CFR 1910.1025)

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as lead and compounds

United States National Primary Drinking Water Regulations: MCLG = zero mg[Pb]/L; MCL = Action Level = 0.015 mg[Pb]/L. Lead is regulated by a TT that requires systems to control the corrosiveness of their water. If more than 10% of tap water samples exceed the action level, water systems must take additional steps, as Lead (Pb).

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U145

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Form R Toxic Chemical Category Code: N420

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazardous to aquatic life or environment, with possible long lasting effects[291,292].

Hazard symbols, risk, & safety statements: Hazard symbol: T + , N; risk phrases: R45; R26/27/28; R61; R33; R48/22; R50/53; safety phrases: S41; S45; S53; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to waters.

Description: Lead phosphate is a white powder or colorless crystals. Molecular weight = 811.51; specific gravity (H_2O:1) = 7 @ 20°C; freezing/melting point = 1014°C. Hazard identification (based on NFPA-704 M Rating System) (estimated): Health 3, Flammability 0, Reactivity 0. Insoluble in water.

Potential Exposure: Lead phosphate is used as a stabilizer in styrene and casein plastics.

Incompatibilities:Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, and active metals.

Permissible Exposure Limits in Air

See below NIOSH IDLH value for inorganic lead.*

PAC Ver. 29[138]

PAC-1: 0.2 milligram per cubic meter

PAC-2: 150 milligram per cubic meter

PAC-3: 910 milligram per cubic meter

As Inorganic Lead:

*NIOSH IDLH = 100 mg [Pb]/m^3

OSHA PEL: The employer shall assure that no employee is exposed to lead at concentrations greater than 50 μg/m^3 of air averaged over an 8-hour period. If an employee is exposed to lead for more than 8 hours in any work day, the permissible exposure limit, as a TWA for that day, shall be reduced according to the following formula: Maximum permissible limit (in μg/m^3) = 400 divided by the number of hours worked in the day [29 CFR 1910.1025(c)].

NIOSH REL: 0.05 mg[Pb]/m^3 TWA. Suspected carcinogen. Limit exposure to lowest feasible level. [*Note*: The REL also applies to other lead compounds (as Pb)]. *Note*: NIOSH considers "lead" to mean metallic lead, lead oxides; and lead salts (including organic salts, such as lead "soaps" but excluding lead arsenate). Air concentrations should be maintained so that worker blood lead remains less than 0.060 mg[Pb]/100 g of whole blood. See NIOSH Pocket Guide, Appendix C.

ACGIH TLV[1]: 0.05 mg[Pb]/m^3 TWA; BEI: 30 μg[Pb]/100 mL (blood). (*Note*: The TLV also applies to lead, inorganic compounds) *Note*: women of child bearing potential whose blood exceeds 10 μg[Pb]/dL are at risk of delivering a child with a blood [Pb] over the current CDC guideline of 10 μg[Pb]/dL and may cause birth defects; confirmed animal carcinogen with unknown relevance to humans.

DFG MAK: BAT: 400 μg[Pb]/L (blood) not fixed; 100 μg [Pb]/L (blood) women age $<$ 45; Carcinogen Category 2; Germ Cell Mutagen Group 3A.

Determination in Air: Use NIOSH Analytical Method (IV) s #7082, 7105, 7300, 7301, 7303, 7700, 7701, 7702, 9100, 9102, 9105; OSHA Analytical Methods ID-121, ID-125G, ID-206.

Permissible Concentration in Water: Federal Drinking Water Standards: MCGL = zero mg/L; State Drinking Water Standards: Arizona: 50 μg[Pb]/L; State Drinking Water Guidelines: Arizona: 20 μg[Pb]/L; Maine: 10 μg[Pb]/L.

Determination in Water: Digestion followed by atomic absorption, or by colorimetric (dithizone) analysis, or by ICP optical emission spectrometry. That gives total lead; dissolved lead may be determined by 0.45 micron filtration prior to such analysis.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short-Term Exposure: Highly toxic, may be fatal if inhaled, swallowed or absorbed through skin. Avoid any skin contact. Effects of contact or inhalation may be delayed[31]. Lead phosphate can cause headache, irritability, reduced memory; and disturbed sleeping patterns. Lead enters the body by breathing and from contaminated food, beverages or cigarettes. Lead poisoning can cause poor appetite; colic, upset stomach; headaches, irritability, muscle or joint cramps and weakness.

Long-Term Exposure: Lead phosphate is a carcinogen, handle with extreme caution. Lead phosphate should be handled as a teratogen, with extreme caution. Permanent kidney damage can result from long-term or high exposures. Lead exposure increases the risk of high blood pressure. High or repeated exposure may damage the nerves resulting in loss of coordination in the arms and legs. Can cause brain damage and anemia.

Points of Attack: Kidneys, blood, nervous system., brain.

Medical Surveillance: Before first exposure and every 6 months thereafter, OSHA (1910. 1025) requires your employer to provide: blood lead test, ZPP test (a special test for the effect of lead on blood cells). Examination of the nervous system. Prior to initial exposure, and annually for exposed person having blood lead readings exceeding 40 μg/100 g of whole blood, OSHA also requires a complete medical history, CBC and kidney function tests in addition to the tests listed above. OSHA defines "exposure" for these tests as air levels which average 30 micrograms of lead or more in a cubic meter of air. OSHA (under 1910.1020) requires your employer to send the doctor a copy of the lead standard and provide one for you. *Note*: Blood-lead level is a good indicator of total lead exposure. Current OSHA regulations require that if an individual has a blood-lead level greater than or equal to 0.050 mg lead per 100 ml blood, he or she must be removed from all exposures to lead and cannot return to the exposure environment until the blood level falls to 0.040 mg lead per 100 ml blood or less. The following tolerance levels for occupational exposures may also be useful: ACGIH BEI = 50 mg/L (blood); 150 mg/g creatinine (urine). DFG BAT = 70 mg/L (blood); 30 mg/L (blood) for women $<$ 45 years old.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Antidotes and Special Procedures for Lead: Persons with significant lead poisoning are sometimes treated with Ca EDTA while hospitalized. This "chelating" drug causes a rush of lead from the body organs into the blood and kidneys, and thus has its own hazards, and must be administered only by highly experienced medical personnel under controlled conditions and careful observation. Ca EDTA or similar drugs should never be used to prevent poisoning while exposure continues or without strict exposure control as severe kidney damage can result.

Note to Physician: For severe poisoning, BAL has been used to treat toxic symptoms of certain heavy metals poisoning. In the case of lead poisoning it may have SOME value. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Use any barrier that will prevent contamination from the dust. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Work clothing should be HEPA vacuumed before removal. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See also NIOSH Criteria Document #78-158: *Lead, Inorganic Dusts and Fumes*.

Respirator Selection: Lead (1910.1025 & 1926.62): < or = 0.5 milligram per cubic meter (10 × PEL) Half-mask* air-purifying respirator equipped with high-efficiency filters**. < or = 2.5 milligram per cubic meter (50 × PEL) Full-facepiece air-purifying respirator with high-efficiency filters**. < or = 50 milligram per cubic meter (1000 × PEL) (1) Any powered air-purifying respirator with high-efficiency filters**; or (2) Half-mask* supplied-air respirator operated in positive-pressure mode. < or = 100 milligram per cubic meter (2000 × PEL) Supplied-air respirators with full facepiece, hood, helmet, or suit, operated in positive-pressure mode. > 100 milligram per cubic meter, unknown concentration, or firefighting Full-facepiece, SCBA operated in positive-pressure mode.

* Full facepiece is required if the lead aerosols cause eye or skin irritation at the use concentrations.

** A high-efficiency filter means a filter that is at least 99.97% efficient against monodispersed particles of 0.3 μm in diameter or higher.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from heat, oxidizers, and strong acids. Lead is regulated by an OSHA Standard 1910.1025. All requirements of the standard must be followed. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN3288 Toxic solids, inorganic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of metal (lead) and phosphorus. Use dry chemical, carbon dioxide; water spray; or extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(109); (102); (31); (173); (101); (138); (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Lead Phosphate*, Trenton, NJ (October 2004)

United States Department of Health and Human Services Public Health Service National Toxicology Program, *Final Report on Carcinogens Background Document for Lead and Lead Compounds*, Contract Number N01-ES-85421, Research Triangle Park, NC 27709, May 8, 2003

Lead stearate L:0190

Formula: $C_{18}H_{36}O_2$ xPb

Synonyms: Bleistearat (German); Estearato de plomo (Spanish); Neutral lead stearate; Octadecanoic acid, Lead salt; Octadecanoic acid, lead(2 +) salt; Octadecanoic acid, lead(II) salt; Stearic acid, lead salt; Stearic acid, lead(2 +) Salt; Stearic acid, lead(II) salt; Steric acid, lead salt

CAS Registry Number: 7428-48-0 (stearic acid, lead salt); 1072-35-1 (lead distearate); 56189-09-4 [dioxobis(stearato) dilead]

HSDB Number: 6923 as lead compound

RTECS Number: WI4300000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 231-068-1 (stearic acid, lead salt); 214-005-2 (lead distearate); 260-043-8 [dioxobis(stearato)dilead]

Regulatory Authority and Advisory Information

Carcinogenicity (*as organic lead compounds*): IARC: Organic lead compounds are not classifiable as to their carcinogenicity to humans, (Group 3, 2004); Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen (as lead and lead compounds).

California Proposition 65 Chemical[102]: Cancer 10/1/1992 as lead compounds.

Hazard Alert: Poison (cumulative), Combustible, Environmental hazard.

EPA ADI = (preschool children) less than the 3 mg[Pb]/week recommended provisionally for adults.

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR 1910.1025)

United States National Primary Drinking Water Regulations: MCLG = zero mg[Pb]/L; MCL = Action Level = 0.015 mg [Pb]/L. Lead is regulated by a TT that requires systems to control the corrosiveness of their water. If more than 10% of tap water samples exceed the action level, water systems must take additional steps, as Lead (Pb).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992); 40CFR401.15 Section 307 Toxic Pollutants as lead and compounds

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number D008

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Canada, WHMIS, organic lead compounds are not included on the Ingredients Disclosure List.

Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R45; R20/22; R23/25; R33; R50/53; R61; R62; safety phrases: S20/21; S28; S45; S53; S60; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Lead stearate is an organic lead compound. It is a white powder with a slight fatty odor. Molecular weight = 1734.87; 774.1466[193]; freezing/melting point = 116°C; flash point = 232°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Insoluble in water.

Potential Exposure: It is used as a stabilizer for plastics and rubber processing; in extreme-pressure lubricants and as a drier in varnishes.

Incompatibilities: Dust may form explosive mixture with air; keep away from high heat and sources of ignition. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides.

Permissible Exposure Limits in Air

As Organic Lead:

ACGIH TLV[1]: No listing for organic lead compounds.

Determination in Air: Use (*for inorganic lead*) NIOSH Analytical Method (IV)s #7082, 7105, 7300, 7301, 7303, 7700, 7701, 7702, 9100, 9102, 9105; OSHA Analytical Methods ID-121, ID-125G, ID-206.

Permissible Concentration in Water: Federal Drinking Water Standards: MCGL = zero mg/L; State Drinking Water Standards: Arizona: 50 μg[Pb]/L; State Drinking Water Guidelines: Arizona: 20 μg[Pb]/L; Maine: 10 μg[Pb]/L.

Determination in Water: Digestion followed by atomic absorption, or by colorimetric (dithizone) analysis, or by ICP optical emission spectrometry. That gives total lead; dissolved lead may be determined by 0.45 micron filtration prior to such analysis.

Routes of Entry: Ingestion, skin contact. Lead can be absorbed through skin at chronically toxic levels.

Harmful Effects and Symptoms

Short-Term Exposure: Ingestion of large amounts of lead may lead to seizures, coma, and death. The effects of exposure to fumes and dusts of inorganic lead may not develop quickly. Symptoms may include decreased physical fitness, fatigue, sleep disturbance; headache, aching bones, and muscles; constipation, abdominal pains and decreased appetite. These effects are reported to be reversible if exposure ceases. Inhalation of large amounts of lead may lead to seizures, coma, and death. Between 1 ounce and 1 pound of lead stearate may be fatal. *Note*: Lead is a cumulative poison. Increasing amounts can build up in the body, eventually reaching a point where symptoms and disability occur. Lead dust carried home on contaminated clothing can result in exposure and symptoms in other family members. Standards only protect for inhalation exposure. Extra precautions should be taken if skin exposure also occurs.

Long-Term Exposure: While lead stearate has not been identified as a teratogen, or a reproductive hazard, lead and certain lead compounds have been determined to be teratogens and may also cause reproductive damage; such as reduced fertility and interfere with menstrual cycles. Handle with extreme caution. Lead can accumulate in the body over a period of time. Therefore, long-term exposures to lower levels can result in a buildup of lead in the body and more severe symptoms. These may include anemia, pale skin; a Blue line at the gum margin; decreased handgrip strength; abdominal pain; severe constipation; nausea, vomiting, and paralysis of the wrist joint. Prolonged exposure may also result in kidney and brain damage. If the nervous system is affected, usually due to very high exposures, the resulting effects include severe headache, convulsions, coma, delirium and death. In nonfatal cases, recovery is slow and not always complete. Alcohol ingestion and physical exertion may bring on symptoms. Lead exposure increases the risk of high blood pressure.

Points of Attack: Blood, kidneys, brain, nervous system.

Medical Surveillance: *For Inorganic Lead*: Before first exposure and every 6 months thereafter, OSHA (1910.1025) requires your employer to provide: blood lead test, ZPP test (a special test for the effect of lead on blood cells). Examination of the nervous system. Prior to initial exposure, and annually for exposed person having blood lead readings exceeding 40 μg/100 g of whole blood, OSHA also requires a complete medical history, CBC and kidney function tests in addition to the tests listed above. OSHA defines "exposure" for these tests as air levels which average 30 micrograms of lead or more in a cubic meter of air. OSHA (under 1910.1020) requires your employer to send the doctor a copy of the lead standard and provide one for you. *Note*: Blood-lead level is a good indicator of total lead exposure. Current OSHA regulations require that if an individual has a blood-lead level greater than or equal to 0.050 mg lead per 100 ml blood, he or she must be removed from all exposures to lead and cannot return to the exposure environment until the blood level falls to 0.040 mg lead per 100 ml blood or less. The following tolerance levels for occupational exposures may also be useful: ACGIH BEI = 50 mg/L (blood); 150 mg/g creatinine (urine). DFG BAT = 70 mg/L (blood); 30 mg/L (blood) for women < 45 years old.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Note to Physician: Administer saline cathartic and an enema. For relief of colic, administer antispasmodic (calcium gluconate, atropine, and papaverine). Consider morphine sulfate for severe pain.

Whole blood lead levels, circulating plasma/erythrocyte lead concentration ratio; urine ALA; and erythrocyte protoporphyrin fluorescent microscopy may all be useful in monitoring or assessing lead exposure. Chelating agents, such as Ca EDTA and penicillamine (*not penicillin*) have been found to be generally useful in the therapy of acute lead intoxication.

Antidotes and Special Procedures for Lead: Persons with significant lead poisoning are sometimes treated with Ca EDTA while hospitalized. This "chelating" drug causes a rush of lead from the body organs into the blood and kidneys, and thus has its own hazards, and must be administered only by highly experienced medical personnel under controlled conditions and careful observation. Ca EDTA or similar drugs should never be used to prevent poisoning while exposure continues or without strict exposure control as severe kidney damage can result.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Use any barrier that will prevent contamination from the dust. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Work clothing should be HEPA vacuumed before removal. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Lead (1910.1025 & 1926.62): < or = 0.5 milligram per cubic meter (10 × PEL)

Half-mask* air-purifying respirator equipped with high-efficiency filters**. < or = 2.5 milligram per cubic meter (50 × PEL) Full-facepiece air-purifying respirator with high-efficiency filters**. < or = 50 milligram per cubic meter (1000 × PEL) (1) Any powered air-purifying respirator with high-efficiency filters**; or (2) Half-mask* supplied-air respirator operated in positive-pressure mode. < or = 100 milligram per cubic meter (2000 × PEL) Supplied-air respirators with full facepiece, hood, helmet, or suit, operated in positive-pressure mode. > 100 milligram per cubic meter, unknown concentration, or firefighting Full-facepiece, SCBA operated in positive-pressure mode.

* Full facepiece is required if the lead aerosols cause eye or skin irritation at the use concentrations.

** A high-efficiency filter means a filter that is at least 99.97% efficient against monodispersed particles of 0.3 μm in diameter or higher.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from heat, oxidizers, and strong acids. Dust may explode at high temperature. Lead is regulated by an OSHA Standard 1910.1025. All requirements of the standard must be followed.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft (NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Use vacuum or a wet method to reduce dust. Do not dry sweep. When vacuuming, a HEPA filter should be used, not a standard shop vac. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Thermal decomposition products may include oxides of metal and carbon. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(109); (102); (31); (173); (101); (138). (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Lead Stearate*, Trenton, NJ (August 1999)

United States Department of Health and Human Services Public Health Service National Toxicology Program, *Final Report on Carcinogens Background Document for Lead and Lead Compounds*, Contract Number N01-ES-85421, Research Triangle Park, NC 27709, May 8, 2003

Lead subacetate L:0200

Formula: $C_4H_{10}O_8Pb_3$

Synonyms: Basic lead acetate; Bis(acetato)tetrahydroxytrilead; Bis(aceto)dihydroxytrilead; BLA; Lead acetate, basic; Lead, bis(acetato-*O*)tetrahydroxytri-; Lead monosubacetate; Monobasic lead acetate; Subacetate lead; Subaceto de plomo (Spanish)

CAS Registry Number: 1335-32-6

HSDB Number: 1651

RTECS Number: OF8750000

UN/NA & ERG Number: UN1616/151

EC Number: 215-630-3 [*Annex I Index No.*: 082-007-00-9]

Regulatory Authority and Advisory Information

Carcinogenicity: Carcinogenicity (*as organic lead compounds*): IARC: Organic lead compounds are not classifiable as to their carcinogenicity to humans, (Group 3, 2004); Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen (as lead and lead compounds).

California Proposition 65 Chemical[102]: (*lead and compounds*) Cancer; 10/1/1992; (*lead and compounds*) Developmental/Reproductive toxin (male, female) 2/27/1987

Hazard Alert: Poison (cumulative), Reproductive toxin, Environmental hazard.

EPA ADI = (preschool children) less than the 3 mg[Pb]/week recommended provisionally for adults.

United States National Primary Drinking Water Regulations: MCLG = zero mg[Pb]/L; MCL = Action Level = 0.015 mg [Pb]/L. Lead is regulated by a TT that requires systems to control the corrosiveness of their water. If more than 10% of tap water samples exceed the action level, water systems must take additional steps, as Lead (Pb).

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as lead and compounds

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U146

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R45; R33; R40; R48/22; R50/53; R61; safety phrases: S29; S45; S53; S41; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to waters.

Description: Lead subacetate is a white, heavy powder or gelatinous solid. Molecular weight = 807.71. Hazard identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Soluble in water.

Permissible Exposure Limits in Air

basic; subacetate:

PAC-1: 5.4 milligram per cubic meter

PAC-2: 59 milligram per cubic meter
PAC-3: 360 milligram per cubic meter
As Organic Lead:
ACGIH TLV[1]: No listing for organic lead compounds.

Potential Exposure: Used as a decolorizing agent in sugar solutions and as an analytical chemical.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides.

Determination in Air: Use (*for inorganic lead*) NIOSH Analytical Method (IV)s #7082, 7105, 7300, 7301, 7303, 7700, 7701, 7702, 9100, 9102, 9105; OSHA Analytical Methods ID-121, ID-125G, ID-206.

Permissible Concentration in Water: Federal Drinking Water Standards: MCGL = zero mg/L; State Drinking Water Standards: Arizona: 50 μg[Pb]/L; State Drinking Water Guidelines: Arizona: 20 μg[Pb]/L; Maine: 10 μg[Pb]/L.

Determination in Water: Digestion followed by atomic absorption, or by colorimetric (dithizone) analysis, or by ICP optical emission spectrometry. That gives total lead; dissolved lead may be determined by 0.45 micron filtration prior to such analysis.

Routes of Entry: Inhalation, skin. Lead can be absorbed through skin at chronically toxic levels.

Harmful Effects and Symptoms

Short-Term Exposure: Lead subacetate can cause headache, irritability, mood changes; reduced memory; and disturbed sleep. *Note*: Lead is a cumulative poison. Increasing amounts can build up in the body, eventually reaching a point where symptoms and disability occur. Lead dust carried home on contaminated clothing can result in exposure and symptoms in other family members. Standards only protect for inhalation exposure. Extra precautions should be taken if skin exposure also occurs.

Long-Term Exposure: Lead subacetate may be a carcinogen in humans since it has been shown to cause kidney, lung, and brain cancer in animals. May be a teratogen in humans. May damage the testes. Repeated exposure may cause lead poisoning with symptoms of headache, irritability, disturbed sleep; tiredness, reduced memory and personality changes. Higher levels can cause muscle or joint pains, weakness, disturbed sleep; and easy fatigue. Exposure can increase the risk of high blood pressure. May cause kidney and brain damage, and anemia. Lead can accumulate in the body over a period of time. Therefore, long-term exposures to lower levels can result in a buildup of lead in the body and more severe symptoms. These may include anemia, pale skin, a Blue line at the gum margin; decreased handgrip strength; abdominal pain; severe constipation; nausea, vomiting, and paralysis of the wrist joint. Prolonged exposure may also result in kidney and brain damage. If the nervous system is affected, usually due to very high exposures, the resulting effects include severe headache, convulsions, coma, delirium and death. In nonfatal cases, recovery is slow and not always complete. Alcohol ingestion and physical exertion may bring on symptoms. Lead exposure increases the risk of high blood pressure. Continuous exposure can result in decreased fertility. Elevated lead exposure of either parent before pregnancy can increase the chances of miscarriage or birth defects. Exposure of the mother during pregnancy can cause birth defects.

Points of Attack: Blood, kidneys, brain, nervous system.

Medical Surveillance: (*for inorganic lead)* Before first exposure and every 6 months thereafter, OSHA (1910.1025) requires your employer to provide: blood lead test, ZPP test (a special test for the effect of lead on blood cells). Examination of the nervous system. Prior to initial exposure, and annually for exposed person having blood lead readings exceeding 40 μg/100 g of whole blood, OSHA also requires a complete medical history, CBC and kidney function tests in addition to the tests listed above. OSHA defines "exposure" for these tests as air levels which average 30 micrograms of lead or more in a cubic meter of air. OSHA (1910.1020) requires your employer to send the doctor a copy of the lead standard and provide one for you. *Note*: Blood-lead level is a good indicator of total lead exposure. Current OSHA regulations require that if an individual has a blood-lead level greater than or equal to 0.050 mg lead per 100 ml blood, he or she must be removed from all exposures to lead and cannot return to the exposure environment until the blood level falls to 0.040 mg lead per 100 ml blood or less. The following tolerance levels for occupational exposures may also be useful: ACGIH BEI = 50 mg/L (blood); 150 mg/g creatinine (urine). DFG BAT = 70 mg/L (blood); 30 mg/L (blood) for women $<$ 45 years old.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to Physician: Administer saline cathartic and an enema. For relief of colic, administer antispasmodic (calcium gluconate, atropine, and papaverine). Consider morphine sulfate for severe pain.

Whole blood lead levels, circulating plasma/erythrocyte lead concentration ratio; urine ALA; and erythrocyte protoporphyrin fluorescent microscopy may all be useful in monitoring or assessing lead exposure. Chelating agents, such as Ca EDTA and penicillamine (*not penicillin*) have been found to be generally useful in the therapy of acute lead intoxication.

Antidotes and Special Procedures for Lead: Persons with significant lead poisoning are sometimes treated with Ca EDTA while hospitalized. This "chelating" drug causes a rush of lead from the body organs into the blood and kidneys, and thus has its own hazards, and must be administered only by highly experienced medical personnel under controlled conditions and careful observation. Ca EDTA or similar drugs should never be used to prevent poisoning while exposure continues or without strict exposure control as severe kidney damage can result.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Use any barrier that will prevent contamination from the dust. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Lead (1910.1025 & 1926.62): < or = 0.5 milligram per cubic meter (10 × PEL)

Half-mask* air-purifying respirator equipped with high-efficiency filters**. < or = 2.5 milligram per cubic meter (50 × PEL) Full-facepiece air-purifying respirator with high-efficiency filters**. < or = 50 milligram per cubic meter (1000 × PEL) (1) Any powered air-purifying respirator with high-efficiency filters**; or (2) Half-mask* supplied-air respirator operated in positive-pressure mode. < or = 100 milligram per cubic meter (2000 × PEL) Supplied-air respirators with full facepiece, hood, helmet, or suit, operated in positive-pressure mode. > 100 milligram per cubic meter, unknown concentration, or firefighting Full-facepiece, SCBA operated in positive-pressure mode.

* Full facepiece is required if the lead aerosols cause eye or skin irritation at the use concentrations.

** A high-efficiency filter means a filter that is at least 99.97% efficient against monodispersed particles of 0.3 μm in diameter or higher.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from heat, oxidizers, and strong acids. Lead is regulated by an OSHA Standard 1910.1025. All requirements of the standard must be followed. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN1616 Lead acetate, Hazard Class: 6.1; Labels: 6.1-Poison Inhalation Hazard.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Use vacuum or a wet method to reduce dust. Do not dry sweep. When vacuuming, a HEPA filter should be used, not a standard shop vac. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Thermal decomposition products may include metal oxides of lead and carbon. Use dry chemical, carbon dioxide; water spray; alcohol foam or polymer foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(109); (102); (31); (173); (101); (138). (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Lead Subacetate*, Trenton, NJ (July 1999)

United States Department of Health and Human Services Public Health Service National Toxicology Program, *Final Report on Carcinogens Background Document for Lead and Lead Compounds*, Contract Number N01-ES-85421, Research Triangle Park, NC 27709, May 8, 2003

Lead sulfate L:0210

Formula: O_4PbS; $PbSO_4$; $Pb_4O_3(SO_4)$ & Pb_4O_7S (tribasic)

Synonyms: Anglisite; Bleisulfat (German); C.I. 77630; C.I. Pigment white 3; Fast white; Freemans white lead; Lanarkite; Lead bottoms; Lead(2 +) sulfate(1:1); Lead(II) sulfate(1:1); Lead sulfate; Lead(2 +) sulfate(1:1); Lead(II) sulfate (1:1); Milk white; Mulhouse white; Sulfate de plomb (French); Sulfato de plomo (Spanish); Sulfuric acid, lead(2 +) salt(1:1); Sulfuric acid, lead(II) salt(1:1); White lead C.I. Pigment white

CAS Registry Number: 7446-14-2; 12202-17-4 (tribasic)

HSDB Number: 6308 (7446-14-2)

RTECS Number: OG4375000

UN/NA & ERG Number: UN1759 (corrosive solids, n.o.s.)/154; UN2291 (lead compound, soluble, n.o.s.)/151; UN1794 (with > 3% free acid)/154; UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 231-198-9

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Animal Inadequate Evidence, Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2A, 1987; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies.

California Proposition 65 Chemical[102]: (*lead and compounds*) Cancer; 10/1/1992; (*lead and compounds*) Developmental/Reproductive toxin (male, female) 2/27/1987

Hazard Alert: Poison (cumulative), Corrosive, Reproductive toxin, Environmental hazard.

EPA ADI = (preschool children) less than the 3 mg[Pb]/week recommended provisionally for adults.

OSHA, 29CFR1910 Specifically Regulated Chemicals (See 29 CFR 1910.1025)

Hazardous Substance (EPA) (RQ = 5000/2270)[4]

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992); 40CFR401.15 Section 307 Toxic Pollutants as lead and compounds

United States National Primary Drinking Water Regulations: MCLG = zero mg[Pb]/L; MCL = Action Level = 0.015 mg[Pb]/L. Lead is regulated by a TT that requires systems to control the corrosiveness of their water. If more than 10% of tap water samples exceed the action level, water systems must take additional steps, as Lead (Pb). SMCL = 250 mg[SO_4^{-2}]/L as Sulfate

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number D008

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R45; R61; R33; R40; R48/22; R50/53; safety phrases: S29; S53; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to waters.

Description: Lead sulfate is a heavy, white crystalline powder. Molecular weight = 303.25; specific gravity (H_2O:1) = 6.2 @ 20°C; freezing/melting point = 1170°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 1. Soluble in water.

Potential Exposure: Lead sulfate is used in storage batteries and paint pigments. Used in the making of alloys, fast-drying oil varnishes; weighting fabrics; in lithography.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Contact with potassium can cause explosion. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides.

Permissible Exposure Limits in Air

See below NIOSH IDLH value for inorganic lead.*

PAC Ver. 29[138]

7446-14-2

PAC-1: 0.22 milligram per cubic meter

PAC-2: 170 milligram per cubic meter

PAC-3: 1000 milligram per cubic meter

As Inorganic Lead:

*NIOSH IDLH = 100 mg [Pb]/m^3

OSHA PEL: The employer shall assure that no employee is exposed to lead at concentrations greater than 50 μg/m^3 of air averaged over an 8-hour period. If an employee is exposed to lead for more than 8 hours in any work day, the permissible exposure limit, as a TWA for that day, shall be reduced according to the following formula: Maximum permissible limit (in μg/m^3) = 400 divided by the number of hours worked in the day [29 CFR 1910.1025(c)].

NIOSH REL: 0.050 mg[Pb]/m^3 TWA. Suspected carcinogen. Limit exposure to lowest feasible level. [*Note*: The REL also applies to other lead compounds (as Pb)]. *Note*: NIOSH considers "lead" to mean metallic lead, lead oxides; and lead salts (including organic salts, such as lead "soaps" but excluding lead arsenate). Air concentrations should be maintained so that worker blood lead remains less than 0.060 mg[Pb]/100 g of whole blood. See NIOSH Pocket Guide, Appendix C.

ACGIH TLV[1]: 0.05 mg[Pb]/m^3 TWA; BEI: 30 μg[Pb]/100 mL (blood). (*Note*: The TLV also applies to lead, inorganic compounds) *Note*: women of child bearing potential whose blood exceeds 10 μg[Pb]/dL are at risk of delivering a child with a blood [Pb] over the current CDC guideline of 10 μg[Pb]/dL and may cause birth defects; confirmed animal carcinogen with unknown relevance to humans.

DFG MAK: BAT: 400 μg[Pb]/L (blood) not fixed; 100 μg [Pb]/L (blood) women age < 45; Carcinogen Category 2; Germ Cell Mutagen Group 3A.

Determination in Air: Use NIOSH Analytical Method (IV)s #7082, 7105, 7300, 7301, 7303, 7700, 7701, 7702, 9100, 9102, 9105; OSHA Analytical Methods ID-121, ID-125G, ID-206.

Permissible Concentration in Water: Federal Drinking Water Standards: MCGL = zero mg/L; State Drinking Water Standards: Arizona: 50 μg[Pb]/L; State Drinking Water Guidelines: Arizona: 20 μg[Pb]/L; Maine: 10 μg[Pb]/L.

Determination in Water: Digestion followed by atomic absorption, or by colorimetric (dithizone) analysis, or by ICP optical emission spectrometry. That gives total lead; dissolved lead may be determined by 0.45 micron filtration prior to such analysis.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short-Term Exposure: This chemical is corrosive. Skin contact can cause severe irritation and burns, itching, rash and pigment changes. Eye contact can cause severe irritation and burns. Inhalation can cause irritation of the respiratory tract. Ingestion of large amounts of lead may lead to seizures, coma, and death. The effects of exposure to fumes and dusts of inorganic lead may not develop quickly. Symptoms may include decreased physical fitness, fatigue, sleep disturbance; headache, aching bones and muscles; constipation, abdominal pain; and decreased appetite. These effects are reported to be reversible if exposure ceases. Inhalation of large amounts of lead may lead to seizures, coma, and death. *Note*: Lead is a cumulative poison. Increasing amounts can build up in the body, eventually reaching a point where symptoms and disability occur. Lead dust carried home on contaminated clothing can result in exposure and symptoms in other family members. Standards only protect for inhalation exposure. Extra precautions should be taken if skin exposure also occurs.

Long-Term Exposure: Highly irritating and corrosive substances can cause lung irritation that may lead to bronchitis. Lead can accumulate in the body over a period of time. Therefore, long-term exposures to lower levels can result in a buildup of lead in the body and more severe symptoms. These may include anemia, pale skin, a Blue line at the gum margin; decreased handgrip strength; abdominal pain; severe constipation; nausea, vomiting, and paralysis of the wrist joint. Prolonged exposure may also result in kidney and brain damage. If the nervous system is affected, usually due to very high exposures, the resulting effects include severe headache, convulsions, coma, delirium and death. In nonfatal cases, recovery is slow and not always complete. Alcohol ingestion and physical exertion may bring on symptoms. Lead exposure increases the risk of high blood pressure. Continuous exposure can result in decreased fertility. Elevated lead exposure of either parent before pregnancy can increase the chances of miscarriage or birth defects. Exposure of the mother during pregnancy can cause birth defects.

Points of Attack: Lungs, blood, kidneys, brain.

Medical Surveillance: Before first exposure and every 6 months thereafter, OSHA (1910. 1025) requires your employer to provide: blood lead test, ZPP test (a special test for the effect of lead on blood cells). Examination of the nervous system. Prior to initial exposure, and annually for exposed person having blood lead readings exceeding 40 μg/100 g of whole blood, OSHA also requires a complete medical history, CBC and kidney function tests in addition to the tests listed above. OSHA defines “exposure” for these tests as air levels which average 30 micrograms of lead or more in a cubic meter of air. OSHA (under 1910.1020) requires your employer to send the doctor a copy of the lead standard and provide one for you. *Note*: Blood-lead level is a good indicator of total lead exposure. Current OSHA regulations require that if an individual has a blood-lead level greater than or equal to 0.050 mg lead per 100 ml blood, he or she must be removed from all exposures to lead and cannot return to the exposure environment until the blood level falls to 0.040 mg lead per 100 ml blood or less. The following tolerance levels for occupational exposures may also be useful: ACGIH BEI = 50 mg/L (blood); 150 mg/g creatinine (urine). DFG BAT = 70 mg/L (blood); 30 mg/L (blood) for women < 45 years old. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy. If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 20 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Do not induce vomiting.

Note to Physician: Whole blood lead levels, circulating plasma/erythrocyte lead concentration ratio; urine ALA; and erythrocyte protoporphyrin fluorescent microscopy may all be useful in monitoring or assessing lead exposure. Chelating agents, such as Ca EDTA and penicillamine (*not penicillin*) have been found to be generally useful in the therapy of acute lead intoxication. For severe poisoning, BAL has been used to treat toxic symptoms of certain heavy metals poisoning. In the case of lead poisoning it may have SOME value. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Use any barrier that will prevent contamination from the dust. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Work clothing should be HEPA vacuumed before removal. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See also NIOSH Criteria Document #78-158: *Lead, Inorganic Dusts and Fumes*.

Respirator Selection: Lead (1910.1025 & 1926.62): $<$ or $=$ 0.5 milligram per cubic meter ($10 \times$ PEL)
Half-mask* air-purifying respirator equipped with high-efficiency filters**. $<$ or $=$ 2.5 milligram per cubic meter ($50 \times$ PEL) Full-facepiece air-purifying respirator with high-efficiency filters**. $<$ or $=$ 50 milligram per cubic meter ($1000 \times$ PEL) (1) Any powered air-purifying respirator with high-efficiency filters**; or (2) Half-mask* supplied-air respirator operated in positive-pressure mode. $<$ or $=$ 100 milligram per cubic meter ($2000 \times$ PEL) Supplied-air respirators with full facepiece, hood, helmet, or suit, operated in positive-pressure mode. $>$ 100 milligram per cubic meter, unknown concentration, or firefighting Full-facepiece, SCBA operated in positive-pressure mode. * Full facepiece is required if the lead aerosols cause eye or skin irritation at the use concentrations. ** A high-efficiency filter means a filter that is at least 99.97% efficient against monodispersed particles of 0.3 μm in diameter or higher.

Storage: (1) Color code-White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. (2) Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Lead sulfate must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates) and chemically active metals (such as potassium, sodium, magnesium, and zinc), since violent reactions occur. Lead is regulated by an OSHA Standard 1910.1025. All requirements of the standard must be followed. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2291 Lead compounds, soluble n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN1794 Lead sulfate with more than 3% free acid, Hazard class: 8; Labels: 8-Corrosive material. UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Lead sulfate is not combustible. Thermal decomposition products may include oxides of sulfur and metal. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(109); (102); (31); (173); (101); (138); (2); (100).

New York State Department of Health, *Chemical Fact Sheet: Lead Sulfate, Bureau of Toxic Substance Assessment*, Albany, NY (March 1986 and Version 2)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Lead Sulphate*, Trenton, NJ (April, 2004)

United States Department of Health and Human Services Public Health Service National Toxicology Program, *Final Report on Carcinogens Background Document for Lead and Lead Compounds*, Contract Number N01-ES-85421, Research Triangle Park, NC 27709, May 8, 2003

Lead sulfide L:0220

Formula: PbS

Synonyms: C.I. 77640; Galena; Lead monosulfide; Natural lead sulfide; Plumbous sulfide; Sulfuro de plomo (Spanish)

CAS Registry Number: 1314-87-0
HSDB Number: 639
RTECS Number: OG4550000
UN/NA & ERG Number: UN3288/165; UN3077 (environmentally hazardous substances, solid, n.o.s.)/171
EC Number: 215-246-6

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Animal Inadequate Evidence, Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2A, 1987; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies.

California Proposition 65 Chemical[102]: (*lead and compounds*) Cancer; 10/1/1992; (*lead and compounds*) Developmental/Reproductive toxin (male, female) 2/27/1987

Hazard Alert: Poison (cumulative), Reproductive toxin, Environmental hazard.

EPA ADI = (preschool children) less than the 3 mg[Pb]/week recommended provisionally for adults.

OSHA, 29CFR1910 Specifically Regulated Chemicals (See 29 CFR 1910.1025)

Hazardous Substance (EPA) (RQ = 5000/2270)[4]

Section 261 Hazardous Constituents, waste number D008

United States National Primary Drinking Water Regulations: MCLG = zero mg[Pb]/L; MCL = Action Level = 0.015 mg [Pb]/L. Lead is regulated by a TT that requires systems to control the corrosiveness of their water. If more than 10% of tap water samples exceed the action level, water systems must take additional steps, as Lead (Pb).

EPCRA Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as lead and compounds

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number D008

RCRA Section 313: Includes any unique chemical substance that contains lead as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: inorganic compounds 0.1%; organic compounds 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as lead compounds, soluble, n.o.s.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R20/22; R23/25; R33; R50/53; R61; R62; safety phrases: S20/21; S28; S29; S45; S53; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Lead sulfide is a silvery to black crystalline powder. Molecular weight = 239.25; specific gravity (H_2O:1) = 7.5 @ 20°C; boiling point = 1281°C (sublimes); freezing/melting point = 1114°C; vapor pressure = 1 mmHg @ 852°C. Hazard identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 0. Practically insoluble in water (0.000086 g/100 cc water @ 13°C).

Potential Exposure: Lead sulfide is used in ceramics, infrared radiation detectors, and semiconductors.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, and iodine monochloride. Sulfides react with acids to produce toxic and flammable vapors of hydrogen sulfide.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

1314-87-0

PAC-1: 0.17 milligram per cubic meter
PAC-2: 140 milligram per cubic meter
PAC-3: 810 milligram per cubic meter

Inorganic Lead:

NIOSH IDLH = 100 mg [Pb]/m^3

OSHA PEL: The employer shall assure that no employee is exposed to lead at concentrations greater than 50 μg/m^3 of air averaged over an 8-hour period. If an employee is exposed to lead for more than 8 hours in any work day, the permissible exposure limit, as a TWA for that day, shall be reduced according to the following formula: Maximum permissible limit (in μg/m^3) = 400 divided by the number of hours worked in the day [29 CFR 1910.1025(c)].

NIOSH REL: 0.050 mg[Pb]/m^3 TWA. Suspected carcinogen. Limit exposure to lowest feasible level. [*Note*: The REL also applies to other lead compounds (as Pb)]. *Note*: NIOSH considers "lead" to mean metallic lead, lead oxides; and lead salts (including organic salts, such as lead "soaps" but excluding lead arsenate). Air concentrations should be maintained so that worker blood lead remains less than 0.060 mg[Pb]/100 g of whole blood. See NIOSH Pocket Guide, Appendix C.

ACGIH TLV[1]: 0.05 mg[Pb]/m^3 TWA; BEI: 30 μg[Pb]/100 mL (blood). (*Note*: The TLV also applies to lead, inorganic compounds) *Note*: women of child bearing potential whose blood exceeds 10 μg[Pb]/dL are at risk of delivering a child with a blood [Pb] over the current CDC guideline of 10 μg[Pb]/dL and may cause birth defects; confirmed animal carcinogen with unknown relevance to humans.

DFG MAK: BAT: 400 μg[Pb]/L (blood) not fixed; 100 μg [Pb]/L (blood) women age $<$ 45; Carcinogen Category 2; Germ Cell Mutagen Group 3A.

In addition, Russia[43] set a MAC in the ambient air of residential areas (on a daily average basis) of 0.0017 milligram per cubic meter (about 6 times the same limits for lead compounds in general).

Determination in Air: Use NIOSH Analytical Method (IV) s #7082, 7105, 7300, 7301, 7303, 7700, 7701, 7702, 9100, 9102, 9105; OSHA Analytical Methods ID-121, ID-125G, ID-206.

Permissible Concentration in Water: Federal Drinking Water Standards: MCGL = zero mg/L; State Drinking Water Standards: Arizona: 50 μg[Pb]/L; State Drinking Water Guidelines: Arizona: 20 μg[Pb]/L; Maine: 10 μg[Pb]/L.

Determination in Water: Digestion followed by atomic absorption, or by colorimetric (dithizone) analysis, or by ICP optical emission spectrometry. That gives total lead; dissolved lead may be determined by 0.45 micron filtration prior to such analysis.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short-Term Exposure: Lead sulfide is very slightly soluble in water and sulfides react with water, forming hydrogen sulfide. Eye contact may cause eye irritation and damage. Ingestion of large amounts of lead may lead to seizures, coma, and death. The effects of exposure to fumes and dusts of inorganic lead may not develop quickly. Symptoms may include decreased physical fitness, fatigue, sleep disturbance; headache, aching bones and muscles; constipation, abdominal pains and decreased appetite. These effects are reported to be reversible if exposure ceases. Inhalation of large amounts of lead may lead to seizures, coma, and death. *Note*: Lead is a cumulative poison. Increasing amounts can build up in the body, eventually reaching a point where symptoms and disability occur. Lead dust carried home on contaminated clothing can result in exposure and symptoms in other family members. Standards only protect for inhalation exposure. Extra precautions should be taken if skin exposure also occurs.

Long-Term Exposure: Lead can accumulate in the body over a period of time. Therefore, long-term exposures to lower levels can result in a buildup of lead in the body and more severe symptoms. These may include anemia, pale skin, a Blue line at the gum margin; decreased handgrip strength; abdominal pain; severe constipation; nausea, vomiting, and paralysis of the wrist joint. Prolonged exposure may also result in kidney and brain damage. If the nervous system is affected, usually due to very high exposures, the resulting effects include severe headache, convulsions, coma, delirium and death. In nonfatal cases, recovery is slow and not always complete. Alcohol ingestion and physical exertion may bring on symptoms. Lead exposure increases the risk of high blood pressure. Continuous exposure can result in decreased fertility. Elevated lead exposure of either parent before pregnancy can increase the chances of miscarriage or birth defects. Exposure of the mother during pregnancy can cause birth defects.

Points of Attack: Lungs, blood, kidneys, brain.

Medical Surveillance: Before first exposure and every 6 months thereafter, OSHA (1910. 1025) requires your employer to provide: blood lead test, ZPP test (a special test for the effect of lead on blood cells). Examination of the nervous system. Prior to initial exposure, and annually for exposed person having blood lead readings exceeding 40 μg/100 g of whole blood, OSHA also requires a complete medical history, CBC and kidney function tests in addition to the tests listed above. OSHA defines "exposure" for these tests as air levels which average 30 micrograms of lead or more in a cubic meter of air. OSHA (under 1910.1020) requires your employer to send the doctor a copy of the lead standard and provide one for you. *Note*: Blood-lead level is a good indicator of total lead exposure. Current OSHA regulations require that if an individual has a blood-lead level greater than or equal to 0.050 mg lead per 100 ml blood, he or she must be removed from all exposures to lead and cannot return to the exposure environment until the blood level falls to 0.040 mg lead per 100 ml blood or less. The following tolerance levels for occupational exposures may also be useful: ACGIH BEI = 50 mg/L (blood); 150 mg/g creatinine (urine). DFG BAT = 70 mg/L (blood); 30 mg/L (blood) for women < 45 years old.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention.

Note to Physician: whole blood lead levels, circulating plasma/erythrocyte lead concentration ratio; urine ALA; and erythrocyte protoporphyrin fluorescent microscopy may all be useful in monitoring or assessing lead exposure. Chelating agents, such as Ca EDTA and penicillamine (*not penicillin*) have been found to be generally useful in the therapy of acute lead intoxication.

Antidotes and Special Procedures for Lead: Persons with significant lead poisoning are sometimes treated with Ca EDTA while hospitalized. This "chelating" drug causes a rush of lead from the body organs into the blood and kidneys, and thus has its own hazards, and must be administered only by highly experienced medical personnel under controlled conditions and careful observation. Ca EDTA or similar drugs should never be used to prevent poisoning while exposure continues or without strict exposure control as severe kidney damage can result.

Note to Physician: For severe poisoning, BAL has been used to treat toxic symptoms of certain heavy metals poisoning. In the case of lead poisoning it may have SOME value. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Use any barrier that will prevent contamination from the dust. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Work clothing should be HEPA vacuumed before removal. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See also NIOSH Criteria Document #78-158: *Lead, Inorganic Dusts and Fumes*.

Respirator Selection: Lead (1910.1025 & 1926.62): < or = 0.5 milligram per cubic meter (10 × PEL)

Half-mask* air-purifying respirator equipped with high-efficiency filters**. < or = 2.5 milligram per cubic meter (50 × PEL) Full-facepiece air-purifying respirator with high-efficiency filters**. < or = 50 milligram per cubic meter (1000 × PEL) (1) Any powered air-purifying respirator with high-efficiency filters**; or (2) Half-mask* supplied-air respirator operated in positive-pressure mode. < or = 100 milligram per cubic meter (2000 × PEL) Supplied-air respirators with full facepiece, hood, helmet, or suit, operated in positive-pressure mode. > 100 milligram per cubic meter, unknown concentration, or firefighting Full-facepiece, SCBA operated in positive-pressure mode.

* Full facepiece is required if the lead aerosols cause eye or skin irritation at the use concentrations.

** A high-efficiency filter means a filter that is at least 99.97% efficient against monodispersed particles of 0.3 μm in diameter or higher.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Lead sulfide must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates and nitrates) and chemically active metals (such as potassium, sodium, magnesium and zinc), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from moisture and acids. Lead is regulated by an OSHA Standard 1910.1025. All requirements of the standard must be followed. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required. UN3288 Toxic solids, inorganic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide; water spray; or foam extinguishers. Thermal decomposition products may include oxides of lead and sulfur. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(109); (102); (31); (173); (101); (138); (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Lead Sulfide*, Trenton, NJ (August 2005)

United States Department of Health and Human Services Public Health Service National Toxicology Program, *Final Report on Carcinogens Background Document for Lead and Lead Compounds*, Contract Number N01-ES-85421, Research Triangle Park, NC 27709, May 8, 2003

Lead thiocyanate L:0230

Formula: C_2N_2PbS2; $Pb(SCN)_2$

Synonyms: Lead dithiocyanate; Lead sulfocyanate; Lead (2 +) thiocyanate; Lead(II) thiocyanate; Thiocyanic acid, lead(2 +) salt; Thiocyanic acid, lead(II) salt

CAS Registry Number: 592-87-0

HSDB Number: 641

RTECS Number: XL1538000

UN/NA & ERG Number: UN2291(Lead compound, soluble, n.o.s.)/151

EC Number: 209-774-6

Regulatory Authority and Advisory Information

Carcinogenicity: IARC (as organic lead compounds): Animal Inadequate Evidence; Human Inadequate Evidence, not classifiable as carcinogenic to humans, Group 3; NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen (as lead and lead compounds).

California Proposition 65 Chemical[102]: (lead and compounds) Cancer; 10/1/1992; (lead and compounds) Developmental/Reproductive toxin (male, female) 2/27/1987

Hazard Alert: Poison (cumulative), Combustible, Reproductive toxin: possible risk of gene damage/impaired fertility; Suspected reprotoxic hazard, Environmental hazard.

EPA ADI = (preschool children) less than the 3 mg[Pb]/week recommended provisionally for adults.

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR 1910.1025)

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) as cyanide compounds

United States National Primary Drinking Water Regulations: MCLG = zero mg[Pb]/L; MCL = Action Level = 0.015 mg [Pb]/L. Lead is regulated by a TT that requires systems to control the corrosiveness of their water. If more than 10% of tap water samples exceed the action level, water systems must take additional steps, as Lead (Pb).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992); 40CFR401.15 Section 307 Toxic Pollutants as lead and compounds

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number D003

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0% as lead compounds, n.o.s.

Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R20/21/22; R23/25; R32; R33; R33; R50/53; R61; R62; R63; safety phrases: S13; S20/21; S28; S29; S45; S53; S60; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Lead thiocyanate is a white or light yellow, odorless, crystalline powder. Odorless. Molecular weight = 323.36; specific gravity (H_2O:1) = 3.82; freezing/melting point = 190°C (decomposes). Hazard identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 1. Slightly soluble in water; solubility = $<$ 0.05%.

Potential Exposure: An explosive, thermally unstable material. Used in making safety matches, primers for small arms cartridges; pyrotechnic devices; and in dyes.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides. Contact with acids or acid fumes caused decomposition with fumes of cyanide. Will decompose in hot water.

Permissible Exposure Limits in Air

NIOSH IDLH = 100 mg [Pb]/m^3

OSHA PEL: The employer shall assure that no employee is exposed to lead at concentrations greater than 50 μg/m^3 of air averaged over an 8-hour period. If an employee is exposed to lead for more than 8 hours in any work day, the permissible exposure limit, as a TWA for that day, shall be reduced according to the following formula: Maximum permissible limit (in μg/m^3) = 400 divided by the number of hours worked in the day [29 CFR 1910.1025(c)].

No PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Determination in Air: Use NIOSH Analytical Method (IV)s #7082, 7105, 7300, 7301, 7303, 7700, 7701, 7702, 9100, 9102, 9105; OSHA Analytical Methods ID-121, ID-125G, ID-206.

Permissible Concentration in Water: Federal Drinking Water Standards: MCGL = zero mg/L; State Drinking Water Standards: Arizona: 50 μg[Pb]/L; State Drinking Water Guidelines: Arizona: 20 μg[Pb]/L; Maine: 10 μg [Pb]/L. Federal Drinking Water Guidelines: EPA 200 μg [CN]/L; State Drinking Water Standards: California 150 μg [CN]/L; State Drinking Water Guidelines: Arizona 220 μg [CN]/L; Maine. 140 μg[CN]/L; Minnesota 100 μg[CN]/L. United States Army field drinking-water standards for cyanide: 2 mg[CN]/L assuming a water consumption of 15 L/day and 6 mg[CN]/L assuming a water consumption of 5 L/day. United States Army field drinking-water standards for cyanide, long term consumption 0.5 mg[CN]/L; Short-term consumption; Raw water constituents (maximum) 20 mg[CN]/L.

Determination in Water: 0.1 mg[Pb]/L in drinking water may cause chronic poisoning. The EPA limits lead in drinking water to 15 μg per liter. Various organizations worldwide have set other standards for lead in drinking water as follows[35] (all in mg/L): Argentina 0.01; the Czech Republic 0.05; Germany 0.04; EEC 0.05; Japan 0.10; Mexico 0.05; the former USSR-UNEP/IRPTC joint project 0.03; WHO 0.10. The states of Maine and Minnesota have set guidelines for lead in drinking water[61] at the level of 20 μg/L.

Routes of Entry: Inhalation, skin. Lead can be absorbed through skin at chronically toxic levels.

Harmful Effects and Symptoms

Short-Term Exposure: Skin and eye contact can cause irritation and burns. Lead thiocyanate can cause headache, irritability, mood changes; reduced memory; and disturbed sleep. *Note*: Lead is a cumulative poison. Increasing amounts can build up in the body, eventually reaching a point where symptoms and disability occur. Lead dust carried home on contaminated clothing can result in exposure and symptoms in other family members. Standards only protect for inhalation exposure. Extra precautions should be taken if skin exposure also occurs.

Long-Term Exposure: Repeated exposure can cause lead poisoning with symptoms of headache, irritability, disturbed sleep; tiredness, reduced memory and personality changes. Higher levels can cause muscle or joint pains, weakness, disturbed sleep; and easy fatigue. Exposure can increase the risk of high blood pressure. May cause kidney and brain damage; and anemia. Lead can accumulate in the body over a period of time. Therefore, long-term exposures to lower levels can result in a buildup of lead in the body and more severe symptoms. These may include anemia, pale skin, a Blue line at the gum margin; decreased handgrip strength; abdominal pain; severe constipation; nausea, vomiting, and paralysis of the wrist joint. Prolonged exposure may also result in kidney and brain damage. If the nervous system is affected, usually due to very high exposures, the resulting effects include severe headache, convulsions, coma, delirium and death. In nonfatal cases, recovery is slow and not always complete. Alcohol ingestion and physical exertion may bring on symptoms. Lead exposure increases the risk of high blood pressure. Continuous exposure can result in decreased fertility. Elevated lead exposure of either parent before pregnancy can increase the chances of miscarriage or birth defects. Exposure of the mother during pregnancy can cause birth defects.

Points of Attack: Blood, kidneys, brain, nervous system.

Medical Surveillance: Before first exposure and every 6 months thereafter, OSHA (1910.1025) requires your employer to provide: blood lead test, ZPP test (a special test for the effect of lead on blood cells). Examination of the nervous system. Prior to initial exposure, and annually for exposed person having blood lead readings exceeding 40 μg/100 g of whole blood, OSHA also requires a complete medical history, CBC and kidney function tests in addition to the tests listed above. OSHA defines "exposure" for these tests as air levels which average 30 micrograms of lead or more in a cubic meter of air. OSHA (1910.1020) requires your employer to send the doctor a copy of the lead standard and provide one for you. *Note*: Blood-lead level is a good indicator of total lead exposure. Current OSHA regulations require that if an individual has a blood-lead level greater than or equal to 0.050 mg lead per 100 ml blood, he or she must be removed from all exposures to lead and cannot return to the exposure environment until the blood level falls to 0.040 mg lead per 100 ml blood or less. The following tolerance levels for occupational exposures may also be useful: ACGIH BEI = 50 mg/L (blood); 150 mg/g creatinine (urine). DFG BAT = 70 mg/L (blood); 30 mg/L (blood) for women < 45 years old.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to Physician: Administer saline cathartic and an enema. For relief of colic, administer antispasmodic (calcium gluconate, atropine, and papaverine). Consider morphine sulfate for severe pain.

Whole blood lead levels, circulating plasma/erythrocyte lead concentration ratio; urine ALA; and erythrocyte protoporphyrin fluorescent microscopy may all be useful in monitoring or assessing lead exposure. Chelating agents, such as Ca EDTA and penicillamine (*not penicillin*) have been found to be generally useful in the therapy of acute lead intoxication.

Antidotes and Special Procedures for Lead: Persons with significant lead poisoning are sometimes treated with Ca EDTA while hospitalized. This "chelating" drug causes a rush of lead from the body organs into the blood and kidneys, and thus has its own hazards, and must be administered only by highly experienced medical personnel under controlled conditions and careful observation. Ca EDTA or similar drugs should never be used to prevent poisoning while exposure continues or without strict exposure control as severe kidney damage can result.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Use any barrier that will prevent contamination from the dust. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Work clothing should be HEPA vacuumed before removal. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Lead (1910.1025 & 1926.62): < or = 0.5 milligram per cubic meter (10 × PEL)

Half-mask* air-purifying respirator equipped with high-efficiency filters**. < or = 2.5 milligram per cubic meter (50 × PEL) Full-facepiece air-purifying respirator with high-efficiency filters**. < or = 50 milligram per cubic meter (1000 × PEL) (1) Any powered air-purifying respirator with high-efficiency filters**; or (2) Half-mask* supplied-air respirator operated in positive-pressure mode. < or = 100 milligram per cubic meter (2000 × PEL) Supplied-air respirators with full facepiece, hood, helmet, or suit, operated in positive-pressure mode. > 100 milligram per cubic meter, unknown concentration, or firefighting Full-facepiece, SCBA operated in positive-pressure mode.

* Full facepiece is required if the lead aerosols cause eye or skin irritation at the use concentrations.

** A high-efficiency filter means a filter that is at least 99.97% efficient against monodispersed particles of 0.3 μm in diameter or higher.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from hot water, heat, oxidizers; acids, acid fumes. Lead is regulated by an OSHA Standard 1910.1025. All requirements of the standard must be followed.

Shipping: UN2291 Lead compounds, soluble n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Neutralize with lime or sodium bicarbonate. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Use vacuum or a wet method to reduce dust. Do not dry sweep. When vacuuming, a HEPA filter should be used, not a standard shop vac. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is slightly flammable when exposed to heat or flame. Thermal decomposition products may include cyanides and oxides of nitrogen, sulfur and metal. Use dry chemical, carbon dioxide; water spray; alcohol foam, or polymer foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire-fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(109); (102); (31); (173); (101); (138); (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Lead Thiocyanate*, Trenton, NJ (June 1999)

United States Department of Health and Human Services Public Health Service National Toxicology Program, *Final Report on Carcinogens Background Document for Lead and Lead Compounds*, Contract Number N01-ES-85421, Research Triangle Park, NC 27709, May 8, 2003

Leptophos L:0240

Formula: $C_{13}H_{10}BrCl_2O_2PS$; $C_6H_5PS(OCH_3)OC_6H_2BrCl_2$

Synonyms: Abar; *O*-(4-Bromo-2,5-dichlorophenyl) *O*-methyl phenylphosphonothioate; *O* -(2,5-Dichloro-4-bromophenyl) *O*-methyl phenylthiophosphonate; Fosvel; K62-105; MBCP; *O*-Methyl *O*-(4-bromo-2,5-dichlorophenyl)phenyl thiophosphonate; NK711; Phenylphosphonothioic acid *O*-(4-bromo-2,5-bromo-2,5-dichlorophenyl) *O*-methyl ester; Phosphonothioic acid, phenyl-, *O*-(4-bromo-2,5-dichlorophenyl) *O*-methyl ester; Phosvel; PSL; V.C.S.; VCS-506; Velsicol 506; Velsicol VCS 506

CAS Registry Number: 21609-90-5

HSDB Number: 2621

RTECS Number: TB1720000

UN/NA & ERG Number: (PIH) UN3464 (organophosphorus compound, solid, toxic, n.o.s)/151; UN2783 (organophosphorus pesticides, solid, toxic)/152

EC Number: 244-472-8 [*Annex I Index No.*: 015-093-00-3]

Regulatory Authority and Advisory Information

Hazard Alert: Poison inhalation hazard, Combustible, Poison, Neurotoxin (cumulative), Environmental hazard.

SUPERFUND/EPCRA 302, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 500 lb (227 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: inorganic compounds 0.1%; organic compounds 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

United States DOT 49CFR172.101, Inhalation Hazard Chemical as organophosphates.

Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R21; R25; R33; R39/25; R33; R50/53; safety phrases: S1/2; S25; S29/35; S36/37/39; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to waters

Description: Leptophos is a tan, waxy solid. Molecular weight = 412.07; freezing/melting point = about 70°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Practically insoluble in water; solubility = 0.028%.

Potential Exposure: A potential danger to those involved in the manufacture, formulation and application of this insecticide. Its use is not currently permitted in the United States of America.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides. Organophosphates are susceptible to formation of highly toxic and flammable phosphine gas in the presence of strong reducing agents such as hydrides and active metals. Partial oxidation by oxidizing agents may result in the release of toxic phosphorus oxides[101].

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 2.7 milligram per cubic meter

PAC-2: 30 milligram per cubic meter

PAC-3: 53 milligram per cubic meter

Determination in Air: OSHA versatile sampler-2; Toluene/Acetone; Gas chromatography/Flame photometric detection for sulfur, nitrogen, or phosphorus; NIOSH Analytical Method (IV) Method #5600, Organophosphorus Pesticides.

Determination in Water: Octanol-water coefficient: Log $K_{ow} = >6$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, ingestion, skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Organic phosphorus insecticides are absorbed by the skin, as well as by the respiratory and GI tracts. They are cholinesterase inhibitors. Symptoms of exposure include headache, giddiness; blurred vision; nervousness, weakness, nausea, cramps, diarrhea, and discomfort in the chest. Death may occur from failure of the respiratory center; paralysis of the respiratory muscles; intense bronchoconstriction; or all three. This material is highly toxic; it is capable of causing death or permanent injury by exposure during normal use. LD_{50} = (oral-rat) 30 mg/kg.

Long-Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, CNS; cardiovascular system, skin, eyes, plasma, and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below pre-employment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider CBC. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Note to Physician: 1,1′-trimethylenebis(4-formylpyridinium bromide)dioxime (a.k.a TMB-4 dibromide and TMV-4) has been used as an antidote for organophosphate poisoning.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: UN2783 Organophosphorus pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN3464 Organophosphorus compound, solid, toxic, n.o.s, Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling*:*Initial Isolation and Protective Action Distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small Spills (from a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30

Then: Protect persons downwind (mi/km)

Day 0.3/0.4

Night 0.8/1.2

Large Spills (from a large package or from many small packages)

First: Isolate in all directions (ft/m) 600/200

Then: Protect persons downwind (mi/km)

Day 1.4/2.3

Night 2.8/4.5

Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material may burn, but does not ignite readily. Thermal decomposition products may include HCl and oxides of phosphorus, sulfur, nitrogen, and carbon. For small fires, use dry chemical, cargo dioxide, water spray; or foam. For large fires: use water spray, fog, or foam. Stay upwind; keep out of low areas. Move container from fire area if you can do it without risk. Fight fire from maximum distance. Dike fire control water for later disposal do not scatter the material. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Small amounts may be treated with alkali then burned in a landfill. Large quantities should be incinerated in a unit with effluent gas scrubbing[22]. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138). (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: *Leptophos*, Washington, DC, Chemical Emergency Preparedness Program (Nov. 30, 1987)

Lewisite (Agents L-1, L-2, L-3, & HL−WMD)

L:0250

Formula: $C_2H_2AsCl_3$; $ClCH = CHAsCl_2$

Synonyms: (2-Chloroethenyl)arsenous dichloride; β-Chlorovinylbichloroarsine; (2-Chlorovinyl)dichloroarsine; 2-Chlorovinyldichloroarsine; Dichloro(2-chlorovinyl) arsine; L-1, L-2, L-3 (military designations); Levista (Spanish); Lewisite (arsenic compound)

Mustard-Lewisite: Agent HL; Sulfur mustard/Lewisite mixture

CAS Registry Number: 541- 25-3 (L-1); 40334-69-8 (L-2); 40334-70-1 (L-3); 1306-02-1; The Mustard-Lewisite mixture (HL) had no established CAS number.

HSDB Number: 6393

RTECS Number: CH2975000

UN/NA & ERG Number: (PIH) UN3280 (organoarsenic compound, liquid, n.o.s.)/151; UN2810 (toxic liquid, organic, n.o.s.)/153; UN3162 (Liquefied gas, poisonous, n. o.s.)/123; UN2927/154

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity: Theft hazard CUM 100 g. (L1, L2, or L3).

Hazard Alert: Poison inhalation hazard: exposure can be lethal, Blister agent/vesicant, Poison, Combustible, Organometallic, Strong reducing agent, Suspected reprotoxic hazard, Possible risk of forming tumors. Primary irritant (w/o allergic reaction), Environmental hazard.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); List of high risk pollutants (Section 63.74), as arsenic compounds

Clean Water Act: Toxic Pollutant (Section 401.15) as arsenic and compounds

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, as arsenic compounds, n.o.s., D004 (arsenic compounds)

SUPERFUND/EPCRA 302, Extremely Hazardous Substances: TPQ = 10 lb (4.54 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0% (as organic arsenic compound) inhalation hazard

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as arsenates

United States DOT 49CFR172.101, Inhalation Hazard Chemical.

Hazardous to aquatic life or environment, with possible long lasting effects[291,292].

WGK[100] (German Aquatic Hazard Class): No value found (all above CAS numbers). [3-Severe hazard to water. (est.)]

Description: Lewisite is a colorless, odorless liquid when pure. Industrially produced lewisite is an amber to dark brown oily liquid with an odor of geraniums. It turns violet to black or green with age. Odor is not a reliable indicator of the presence of toxic amount of vapor. Blister agent, lewisite (L) rapidly decomposes in relative humidity over 70%. Lewisite is a complex mixture of several cis-and trans-isomer compounds. In chemical agent grade lewisite, the L-1 isomer [2-Chlorovinylarsonous dichloride] generally predominates. (L-1) Molecular weight = 207.32; specific gravity (H_2O:1) = 1.888 @ 20°C; volatility = 2500 milligram per cubic meter @20°C; specific gravity (H_2O:1) = 1.89 @ 20; boiling point = 190°C (decomposes); freezing/melting point = -13°C. Explosive limits: LEL = 84,000 ppm; UEL: unknown. Hazard identification (based on NFPA-704M Rating System): Health 4, Flammability 1, Reactivity 1. Sinks in water and is slightly soluble; solubility = 0.5 g/L. (L-2) Molecular weight = 233.35. (L-3) Molecular weight = 2593.394.

The three homologues, L-1, L-2 [Bis(2-chlorovinyl)arsinous chloride], and L-3 [Tris(2-chlorovinyl)arsine] form from the catalyzed reaction of arsenic trichloride and acetylene. L-1 forms initially, but it continues to react with acetylene to form L-2 and L-3. L-1 is the vesicant agent. L-2 and L-3 are also toxic, but considerably less than L-1.

Mustard-lewisite (military designation HL) is a liquid mixture of distilled mustard (HD) and lewisite (L) and has some properties of both. HL is both a blister agent (vesicant) and an alkylating agent (causes damage to the DNA of rapidly dividing cells). The mustard-lewisite mixture requires lower ambient temperatures before it will freeze; this property allows for improved ground dispersal and aerial spraying. Due to its low freezing point, the mixture remains a liquid in cold weather and at high altitudes. The mixture with the lowest freezing point consists of 63% Lewisite and 37% mustard. Mustard-lewisite mixture may have a garlic odor. Odor, however, should not be depended on to detect HL mixture[77]. Exposure to large amounts of HL may be fatal.

Potential Exposure: A potential danger to those involved in the manufacture or use of this organo-arsenic warfare agent which is a vesicant. L-1, L-2, and L-3 have been used as a blister-agent type war gas.

Mustard-lewisite mixture was developed to achieve a lower freezing point for ground dispersal and aerial spraying.

Persistence of Chemical Agent: Agents L or HL: Summer: 1 to 3 days; Winter: May last for weeks.

Incompatibilities: Lewisite reacts with water and sweat; and, as it breaks down in water or sweat, it produces arsenic containing materials which are less dangerous than lewisite but still dangerous. Heating causes lewisite to yield arsenic trichloride, *tris*-(2-chlorovinyl)arsine, and *bis*-(2-chlorovinyl)chloroarsine. Lewisite attacks copper, aluminum and its alloys. Mustard-lewisite mixture is rapidly corrosive to brass at 65°C and will corrode steel at a rate of 0.0001 in. of steel per month at 65°C. It will hydrolyze into hydrochloric acid, thiodiglycol, and nonvesicant arsenic compounds. Lewisite hydrolyzes in acidic medium to form hydrochloric acid and nonvolatile (solid) chlorovinylarsenous oxide, a less potent blister agent than lewisite. See the emergency response cards for hydrochloric acid and chlorovinylarsenous oxide. Lewisite hydrolyzes in basic media, as in decontamination with alcoholic, caustic, or carbonate solution, to form acetylene and trisodium arsenate[77]. Contact with metals may evolve flammable hydrogen gas.

Permissible Exposure Limits in Air The Surgeon General's Working Group (United States Department of Health and Human Services) recommends (for the working place) 0.003 milligram per cubic meter, Ceiling Concentration

PAC Ver. 29[138]

L-1; L-2; L-3

PAC-1: 0.0.23 milligram per cubic meter

PAC-2: $\mathbf{0.25_A}$ milligram per cubic meter

PAC-3: $\mathbf{0.74_A}$ milligram per cubic meter

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

Determination in Water: Lewisite dissolves rapidly in water and breaks down into toxic products that are much less dangerous than lewisite, but still poisonous, containing arsenic products. Warn pollution control authorities and advise shutting water intakes. Octanol-water coefficient: Log K_{ow} (estimated) = 2.56. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion, skin contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Lewisite is a cell irritant, blister agent; and systemic poison that can be absorbed through skin; a few drops can cause death. It produces an immediate searing sensation in the eye, and permanent loss of sight if not decontaminated within 1 minute. It produces an immediate and strong stinging sensation to the skin, followed by reddening within 30 minutes and blistering after about 13 hours. This material causes pulmonary edema, diarrhea, restlessness, weakness, subnormal temperature and low blood pressure. Inhalation of high concentrations may be fatal in as short a time as 10 minutes. Lethal dose in humans is 6 ppm (inhalation), 20 mg/kg (skin). Eye injury below 300 mg-min./m^3. Pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: May cause sensitization and chronic lung impairment. It is a suspected carcinogen.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least

30 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Note to Physician: For severe poisoning, BAL has been used to treat toxic symptoms of certain heavy metals poisoning—including arsenic. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5). For milder poisoning *penicillamine (not penicillin)* has been used, both with mixed success. Side effects occur with such treatment and it is never a substitute for controlling exposure. It can only be done under strict medical care.

Decontamination: This is very important, and you have to decontaminate as soon as you can. Extra minutes before decontamination might make a big difference. If you do not have the equipment and training, do not enter the hot or the warm zone to rescue and decontaminate victims. If the victim cannot move, decontaminate without touching and without entering the hot or the warm zone. Use clean water from any source; if possible, use a hose (spray or fog to prevent injury to the victim) or other system so that you will not have to touch the victim; do not even wait for soap or for the victim to remove clothing, begin washing immediately. Immediately flush the eyes with water for at least 15 minutes. Use caution to avoid hypothermia in children and the elderly. Wash−strip−wash−evacuate up wind and uphill: The approach is to immediately wash with water, then have the victim (not the first responder) remove all the victim's clothing, then wash again (with soap if available) and then move away from the hot zone in an upwind and uphill direction. Wash the victim with warm water and soap. There are differing guidelines for decontamination and more research is needed to identify the optimal decontamination method. The effect of lewisite and mustard-lewisite can be prevented by rapid topical application of 2,3-dimercaptopropanol, known as BAL which reacts with lewisite to form a stable nontoxic cyclic product. Decontaminate with diluted household bleach (0.5%, or one part bleach to 200 parts water), but do not let any get in the victim's eyes, open wounds, or mouth. Wash off the diluted bleach solution after 15 minutes. Be sure you have decontaminated the victims as much as you can before they leave the area so that they do not spread the Lewisite. Use the antidote "Anti-Lewisite." Use 5% solution of common bleach (sodium hypochlorite) or calcium hypochlorite solution (48 ounces per 5 gallons of water) to decontaminate scissors used in clothing removal, clothes and other items. *Note*: Decontamination wash water (effluent) will contain toxic arsenic.

Personal Protective Methods:

General Information: first responders should use a NIOSH-certified chemical, biological, radiological, nuclear (CBRN) SCBA with a level a protective suit when entering an area with an unknown contaminant or when entering an area where the concentration of the contaminant is unknown. Level a protection should be used until monitoring results confirm the contaminant and the concentration of the contaminant. *Note*: safe use of protective clothing and equipment requires specific skills developed through training and experience.

Level A: (*Red Zone*): select when the greatest level of skin, respiratory, and eye protection is required. This is the maximum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than the AEGL-2. A NIOSH-certified CBRN full-face-piece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle. A totally encapsulating chemical protective (TECP) suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, and a hard hat worn under the TECP suit are optional items.

Level B: (Red Zone): Select when the highest level of respiratory protection is necessary but a lesser level of skin protection is required. This is the minimum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than AEGL-2. It differs from Level A in that it incorporates a nonencapsulating, splash-protective, chemical-resistant splash suit that provides Level A protection against liquids but is not airtight. A NIOSH-certified CBRN full-face-piece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

Level C: (Yellow Zone): Select when the contaminant and concentration of the contaminant are known and the respiratory protection criteria factors for using air purifying respirators (APR) or powered-air purifying respirators (PAPR) are met. This level is appropriate when decontaminating patient/victims. A NIOSH-certified CBRN tight-fitting APR with a canister-type gas mask or CBRN PAPR for air levels greater than AEGL-2. A NIOSH-certified CBRN PAPR with a loose-fitting face-piece, hood, or helmet and a filter or a combination organic vapor, acid gas, and particulate cartridge/filter combination or a continuous flow respirator for air levels greater than AEGL-1. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Escape mask, face shield, coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

Level D: (Green Zone): Select when the contaminant and concentration of the contaminant are known and the concentration is below the appropriate occupational exposure limit or less than AEGL-1 for the stated duration times. Limited to coveralls or other work clothes, boots, and gloves.

Notes: Take all necessary precautions to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear full facepiece respiratory protection. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: ***Requirements for Respiratory Protection for Inorganic Arsenicals with Significant Vapor Pressure***

$<$ or $= 100\ \mu g/m^3$ (1) Half-mask* air-purifying respirator equipped with high-efficiency filter** and acid gas cartridge; or (2) Any half-mask* supplied-air respirator. $<$ or $= 500\ \mu g/m^3$ (1) Front-or back-mounted gas mask equipped with high-efficiency filter** and acid gas canister; (2) Any full-facepiece supplied-air respirator; or (3) Any full-facepiece SCBA. $<$ or $= 10{,}000\ \mu g/m^3$ Half-mask* supplied-air respirator operated in positive-pressure mode. $<$ or $= 20{,}000\ \mu g/m^3$ Supplied-air respirator with full facepiece, hood, or helmet or suit, operated in positive-pressure mode. $> 20{,}000\ \mu g/m^3$, unknown concentrations, or firefighting: Any full-facepiece SCBA operated in positive-pressure mode.

* Half-mask respirators shall not be used for protection against arsenic trichloride, as it is rapidly absorbed through the skin.

** A high-efficiency filter means a filter that is at least 99.97% efficient against monodisperesed particles of 0.3 μm in diameter or higher.

Storage: (1) Color code-Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. (2) Color code-Red Stripe (UN3162): Flammability Hazard: Store separately from all other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from alkalies.

Shipping: UN2810 Toxic liquids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required (Lewisite). UN3280 Organoarsenic compound, liquid, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required (Lewisite), Potential Inhalation Hazard (Special Provision 5). UN2927 Toxic liquids, corrosive, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, 8-Corrosive material, Technical Name Required (Lewisite). Military driver shall be given full and complete information regarding shipment and conditions in case of emergency. AR 50-6 deals specifically with the shipment of chemical agents. Shipments of agent will be escorted in accordance with AR 740-32.

Spill Handling:

UN2810 Toxic liquids, organic, n.o.s.

Initial Isolation and Protective Action Distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small Spills (from a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 0.7/1.2

Large Spills (from a large package or from many small packages)

First: Isolate in all directions (ft/m) 1000/300
Then: Protect persons downwind (mi/km)
Day 1.1/1.8
Night 2.8/4.5

Agents L-1, L-2, L-3, & HL when used as a weapon

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.2/0.3

Large Spills (*from a large package or from many small packages*)

First: Isolate in all directions (ft/m) 300/100
Then: Protect persons downwind (mi/km)
Day 0.3/0.5
Night 0.6/1.0

BACK OFF! Isolate a wide area around the release and call for expert help. If in a building, evacuate and confine vapors by closing doors and shutting down heating, ventilation, and air conditioning systems. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Avoid contact with eyes and skin; avoid breathing vapors. Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Remove and isolate contaminated clothing at the site. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors.

Small Spills: Cover with vermiculite, diatomaceous earth, clay, or fine sand and neutralize as soon as possible using large amounts of alcoholic caustic, carbonate, or Decontaminating Solution No. 2 [DS2: (2% NaOH, 70% diethylenetriamine, 28% ethylene glycol monomethyl ether)]. Caution: acetylene given off. Place into containers for later disposal. Large Spills: dike far ahead of spill for later disposal. Can be decontaminated by supertropical bleach, or caustic soda. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include HCl, arsenic, and oxides of carbon. Principles and methods for destruction of chemical weapons: “Destruction of chemical weapons” means a process by which chemicals are converted in an essentially irreversible way to a form unsuitable for production of chemical weapons, and which in an irreversible manner renders munitions and other devices unusable as such. Each nation shall determine how it shall destroy chemical weapons, except that the following processes may not be used: dumping in any body of water, land burial, or open-pit burning. It shall destroy chemical weapons only at specifically designated and appropriately designed and equipped facilities. Each nation shall ensure that its chemical weapons destruction facilities are constructed and operated in a manner to ensure the destruction of the chemical weapons; and that the destruction process can be verified under the provisions of this Convention [Organization for the Prohibition of Chemical Weapons; Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and Their Destruction]. Heating causes lewisite to yield arsenic compounds: arsenic trichloride (A: 1570), *tris*-(2-chlorovinyl)arsine, and *bis*-(2-chlorovinyl)chloroarsine. Firefighting gear (including SCBA) does not provide adequate protection. Use unattended equipment whenever possible. If exposure occurs, remove and isolate gear immediately and thoroughly decontaminate personnel. Specially trained personnel operating from a safe distance can fight fires using foam or dry chemicals, or use fog streams to extinguish burning liquids. Thermal decomposition products may include chlorine and arsenic. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. From a secure, explosion-proof location, use water spray from unattended equipment to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (85); (86); (87); (169); (93); (94); (103); (105); (163); (176); (186); (187); (80); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: *Lewisite*, Washington, DC, Chemical Emergency Preparedness Program (Nov. 30, 1987)

United States Department of Health and Human Services, “ATSDR Medical Management Guidelines for Blister Agents: Lewisite (L) ($C_2H_2AsCl_3$) and Mustard-Lewisite Mixture (HL),” Atlanta, Georgia, (November 2, 2006)

Lindane L:0260

Formula: $C_6H_6Cl_6$

Synonyms: Aalindan; Aficide; Agrisol G-20; Agrocide; Agronexit; Ameisenatod; Ameisenmittel (Merck); Aparasin; Aphtiria; Aplidal; Arbitex; BBH; Ben-Hex; Bentox 10; γ-Benzene hexachloride; Benzene hexachloride; Benzene hexachloride g isomer; Bexol; γ-BHC; BHC; Celanex; Chloresene; Codechine; 2,5-Cyclohexane, 1,2,3,4,5,6-hexachloro-, (1a,2a,3b,4a,5a,6b)-; DBH; Delsanex dairy fly spray; Detmol-extrakt; Detox 25; Devoran; DOL Granule; Drill Tox-Spezial Aglukon; Dual murganic RPB seed treatment; ENT7,796; Entomoxan; Exagama; Forlin; Fumite tecnalin smoke generators; Gallogama; Gamacid; Gamaphex; Gamene; *gamma*-benzene hexachlorocyclohexane (g isomer); *gamma*-BHC; *gamma*-Col; gamma HCH; *gamma*-HCH; Gammahexa; Gammahexane; Gammalex; Gammalin; Gammalin 20; Gammaphex; Gammasan 30; Gammaterr; Gammex; Gammexane; Gammexene; Gammopaz; Gexane; HCCH; γ-HCH; HCH; HCH BHC; Heclotox; Hexa; γ-Hexachloran; Hexachloran; γ-Hexachlorane; Hexachlorane; γ-Hexachlorobenzene; γ-1,2,3,4,5,6-Hexachlorocyclohexane; γ-Hexachlorocyclohexane; 1a,2a,3b,4a,5a,6b-Hexachlorocyclohexane; 1,2,3,4,5,6-Hexachlorocyclohexane, *g* isomer;

Hexachlorocyclohexane (*g* isomer); Hexachlorocyclohexane, 1,2,3,4,5,6-hexachlor-cyclohexane; γ-Hexaclorobenzene; Hexaflow; Hexatox; Hexaverm; Hexicide; Hexyclan; HGI; Hortex; Inexit; Isotox; Jacutin; Kokotine; Kwell; Lendine; Lentox; Lidenal; Lindafor; Lindagam; Lindagrain; Lindagram; Lindagranox; γ-Lindane; Lindane; Lindapoudre; Lindatox; Lindosep; Lintox; Lorexane; Marstan fly spray; Mergamma 30; Milbol 49; Mist-O-Matic Lindex; Mszycol; NCI-C00204; Neo-Scabicidol; Nexen FB; Nexit; Nexit-Stark; Nexol-E; Nicochloran; Novigam; Omnitox; Ovadziak; Owadziak; Pedraczak; Pflanzol; Quellada; Rodesco insect powder; Sang gamma; Silvano; Silvano L; Spritz-Rapidin; Spruehpflanzol; Streunex; TAP85; TRI-6; Viton

CAS Registry Number: 58-89-9; *(alt)* 8007-42-9; *(alt)* 55963-79-6

HSDB Number: 646

RTECS Number: GV4900000

UN/NA & ERG Number: UN2761/151

UN/NA & ERG Number: 200-401-2 [*Annex I Index No.*: 602-043-00-6]

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen [Lindane, Hexachlorocyclohexane (technical grade), and other Hexachlorocyclohexane isomers]; IARC: Animal Sufficient Evidence, Human No Adequate Data, possibly carcinogenic to humans, Group 2B. United States Environmental Protection Agency Gene-Tox Program, Positive: *S. cerevisiae* gene conversion; Positive/limited: Carcinogenicity-mouse/rat; Inconclusive: Host-mediated assay; *Drosophila melanogaster* sex-linked lethal.

California Proposition 65 Chemical[102]: *(Lindane and Other Hexachlorocyclohexane Isomers*) Cancer 1/1/1989.

Hazard Alert: Poison, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Environmental hazard. Listed for Tier 1 screening as an endocrine disruptor[88].

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

United States National Primary Drinking Water Regulations: MCLG = 0.0002 mg/L; MCL = 0.0002 mg/L

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR 423, Appendix A: Priority Pollutants; Section 313

Water Priority Chemicals (57FR41331, 9/9/1992); 40CFR 401.15 Section 307 Toxic Pollutants, as hexachlorocyclohexane

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U129; Tox # D013; Regulated level = 0.4 mg/L

RCRA Toxicity Characteristic (Section 261.24), Maximum

Concentration of Contaminants, regulatory level, 0.4 mg/L

RCRA, 40CFR261, Appendix 8: Hazardous Constituents

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8080 (0.05)

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.0017; Nonwastewater (mg/kg), 0.066

SUPERFUND/EPCRA 302, Extremely Hazardous Substances: TPQ = 1000/10,000 lb (454/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)] (as lindane) See also HCH (mixed isomers) 608-73-1

List of Stockholm Convention POPs: Annex A (Elimination)

Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R20/21; R25; R48/22; R50/53; R62; R63; R64; safety phrases: S1/2; S13; S29; S36/37; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Lindane is a white to yellow, crystalline powder with a slight, musty odor (pure material is odorless). Molecular weight = 390.82; specific gravity (H_2O:1) = 1.85; boiling point = 323.3°C; freezing/melting point = 112.8°C; vapor pressure = 0.00001 mmHg; Hazard identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Insoluble in water. Noncombustible solid, but may be dissolved in flammable liquids.

Potential Exposure: Lindane has been used against insects in a wide range of applications including treatment of animals, buildings, humans for ectoparasites, clothes, water for mosquitoes; living plants; seeds and soils. Some applications have been abandoned due to excessive residues, e.g., stored foodstuffs. Formulators, distributors and users of lindane represent a special risk group. The major use of lindane in recent years has been to pretreat seeds. Thus, those engaged in treatment and planting can be exposed.

Incompatibilities: Lindane decomposes on contact with powdered iron, aluminum, and zinc and with alkalis producing trichlorobenzene. Corrosive to metals

Permissible Exposure Limits in Air

NIOSH IDLH = 50 milligram per cubic meter

OSHA PEL: 0.5 milligram per cubic meter TWA [skin]

NIOSH REL: 0.5 milligram per cubic meter TWA [skin]

ACGIH TLV[1]: 0.5 milligram per cubic meter TWA [skin]; confirmed animal carcinogen with unknown relevance to humans.

PAC Ver. 29[138]

PAC-1: 9.1 milligram per cubic meter

PAC-2: 100 milligram per cubic meter

PAC-3: 1000 milligram per cubic meter
DFG MAK: 0.1 milligram per cubic meter, inhalable fraction; [skin]; Carcinogen Category 4; Pregnancy Risk Group C
Austria: MAK 0.5 milligram per cubic meter, [skin], 1999; Denmark: TWA 0.5 milligram per cubic meter, [skin], 1999; Finland: TWA 0.5 milligram per cubic meter, [skin], 1999; France: VME 0.5 milligram per cubic meter, [skin], 1999; Norway: TWA 0.5 milligram per cubic meter, 1999; the Philippines: TWA 0.5 milligram per cubic meter, [skin], 1993; Switzerland: MAK-W 0.5 milligram per cubic meter, [skin], 1999; the Netherlands: MAC-TGG 4 μg/m^3, [skin], 2003; Turkey: TWA 0.5 milligram per cubic meter, [skin], 1993; United Kingdom: TWA 0.1 milligram per cubic meter, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: confirmed animal carcinogen with unknown relevance to humans. Several states have set guidelines or standards for lindane in ambient air[60] ranging from zero (North Dakota) to 0.068 μ/m^3 (Massachusetts) to 1.19 μ/m^3 (Kansas) to 1.2 μ/m^3 (Pennsylvania) to 1.67 μ/m^3 (New York) to 5.0 μ/m^3 (Connecticut, Florida, South Carolina) to 8.0 μ/m^3 (Virginia) to 12.0 μ/m^3 (Nevada).

Determination in Air: Collection on a filter, workup with isooctane, analysis by gas chromatography/flame ionization. Use NIOSH Analytical Method 5502[18].

Permissible Concentration in Water: Safe Drinking Water Act (47FR 9352): MCL, 0.0002 mg/L; MCLG, 0.0002 mg/L. Federal Drinking Water Standards: EPA 0.2 μg/L; Federal Drinking Water Guidelines: EPA 0.2 μg/L; State Drinking Water Guidelines: Arizona 0.2 μg/L; Maine 0.2 μg/L.

Determination in Water: Methylene chloride extraction followed by gas chromatography with electron capture or halogen specific detection (EPA Method 608) or gas chromatography plus mass spectrometry (EPA Method 625). Octanol-water coefficient: Log $K_{\text{ow}} = > 3.5$. Values above 3.0 are likely to bioaccumulate in aquatic organisms.

Routes of Entry: Inhalation, skin absorption; ingestion, eye and/or skin contact. Fish Tox = 0.11310000 MATC (EXTRA HIGH).

Harmful Effects and Symptoms

Short-Term Exposure: Lindane irritates the eyes and the respiratory tract and may affect the CNS. Symptoms of exposure include vomiting, faintness, tremor, restlessness, muscle spasms; unsteady gait; and convulsions may occur as a result of exposure. Elevated body temperature and pulmonary edema have been reported in children. Coma, respiratory failure and death can result. Exposure to vapors of this compound or its thermal decomposition products may lead to headache, nausea, vomiting, and irritation of the eyes, nose, and throat. Lindane is a stimulant of the nervous system; causing violent convulsions that are rapid in onset and generally followed by death or recovery within 24 hours. The probable human oral lethal dose in 50−500 mg/kg, or between 1 teaspoon and 1 ounce for a 150 lb (70 kg) person. Human Tox = 0.20000 ppb MCL (Extra High).

Long-Term Exposure: Liver and/or kidney problems. Repeated or prolonged contact with skin may cause dermatitis. May damage the liver and kidneys. May damage the nerves in the arms and legs, possibly with weakness and poor coordination. May cause a serious drop in the blood cell count (aplastic anemia) or in the white blood cell count (agranulocytopenia). The Department of Health and Human Services has determined that hexachlorocyclohexanes (HCH) may reasonably be anticipated to be carcinogenic. Liver cancer has been seen in laboratory rodents that ate HCH for long periods of time. In animals, there is evidence that oral exposure to lindane during pregnancy results in an increased incidence of fetuses with extra ribs. However, ATSDR reports that animal studies have not shown birth defects in the babies of animals fed HCH during pregnancy. BCH has been detected in human breast milk.

Points of Attack: Eyes, CNS; blood, liver, kidneys, skin.

Medical Surveillance: NIOSH lists the following tests: whole blood (chemical/metabolite); blood serum; CBC; urine (chemical/metabolite). Blood test for lindane (may not be accurate longer than 1 week following last exposure). Liver and kidney function tests. See "*Occupational Health Guidelines for Chemical Hazards*," NIOSH Pub Nos. 81-123; 88-118, Suppls. I-IV. 1981-1995.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Employees should wash immediately when skin is wet or contaminated. Work clothing should be changed daily if it is possible that clothing is contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers.

Respirator Selection: Up to 5 milligram per cubic meter: Any air-purifying half-mask respirator with organic vapor cartridge(s) in combination with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100; or Sa (APF = 10) (any supplied-air respirator). Up to 12.5 milligram per cubic meter: Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOvHie (APF = 25) (any powered air-purifying respirator with an organic vapor cartridge in combination with a high-efficiency particulate filter).* Up to 25 milligram per cubic meter: CcrFOv100 (APF = 50) [any air-purifying full facepiece respirator equipped with organic vapor cartridge(s) in combination with an N100, R100, or P100 filter]; or GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or PaprTOvHie* (APF = 50) [any powered, air-purifying respirator with a tight-fitting facepiece and organic vapor cartridge(s) in combination with a high-efficiency particulate filter]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). Up to 50 milligram per cubic meter: SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). Emergency or planned entry into unknown concentrations or IDLH conditions: SCBAF: Pd,Pp (APF = 10,000) any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode; or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus). Escape: GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA). *Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly sealed containers in a cool, dry place away from light and incompatible materials. Protect containers against physical damage. Always store pesticides in their original containers, complete with labels that list ingredients, directions for use, and first aid steps in case of accidental poisoning. Never store pesticides in cabinets with or near food, animal feed, or medical supplies. Do not store pesticides in places where flooding is possible or in places where they might spill or leak into wells, drains, ground water, or surface water[72]. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2761 Organochlorine pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include HCl, phosgene and oxides of carbon. Use dry chemical, carbon dioxide; water spray; or foam for small fires. Use water spray, fog, or foam for large fires. Move container from fire area if this can be done without risk. Use water to keep fire-exposed containers cool. Isolate hazard area and deny entry. Stay upwind and keep out of low areas. Ventilate closed spaces before entering. Wear positive breathing apparatus and special protective clothing. Fight fire from maximum distance, dike fire control water for later disposal. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: For the disposal of lindane, a process has been developed involving destructive pyrolysis @ 400–500°C with a catalyst mixture which contains 5%–10% of either cupric chloride, ferric chloride; zinc chloride; or aluminum chloride on activated carbon. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(109); (102); (31); (80); (173); (101); (138); (202); (203); (100).

United States Environmental Protection Agency, *Hexachlorocyclohexane*: *Ambient Water Quality Criteria*, Washington, DC (1980)

United States Environmental Protection Agency, *gamma-Hexachlorocyclohexane, Health and Environmental Effects Profile No. 113*, Washington, DC, Office of Solid Waste (April 30, 1980)

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 3, No. 1, 62−66 (1983)

United States Environmental Protection Agency, Chemical Hazard Information Profile: *Lindane*, Washington, DC, Chemical Emergency Preparedness Program (Nov. 30, 1987)

New York State Department of Health, *Chemical Fact Sheet*: *gamma-BHC*, Bureau of Toxic Substance Assessment, Albany, NY (May 1986)

United States Department of Health and Human Services, *ATSDR ToxFAQs: Hexachlorocyclohexanes*, Atlanta, GA (June 1999)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Lindane*, Trenton, NJ (September 2001).

Linuron L:0265

Formula: $C_9H_{10}Cl_2N_2O_2$

Synonyms: Afalon; Alibi; Alistell; Broadcide 20ec; Bronox; Caswell No. 528; Certol-lin onions; Clovacorn extra; Crop weedstop; 3-(3,4-Dichlorophenyl)-1-metoxy-1-methylurea; *N*′-(3,4-Dichlorophenyl)-*N*-methoxy-*N*-methylurea; 3-(3,4-Dichlorophenyl)-1-methoxymethylurea; 3-(3,4-Dichlorophenyl)-1-methoxy-1-methylurea; *N*-(3,4-Dichlorophenyl)-*N*′-methyl-*N*′-methoxyurea; 3-(4,5-Dichlorphenyl)-1-methoxy-1-methylharnstoff (German); Du Pont 326; FF6135′ herbicide 326; Garnitan; H 326; Gemini; Herbicide 326; Hoe 2810; Janus; Landside; Linnet; Linex; Linorox; Linurex; Lorex; Lorox; Marksman 1; Methoxydiuron; 1-Methoxy-1-methyl-3-(3,4-dichlorophenyl)urea; Neminfest; Onslaught; Preempt; Premalin; Profalon; Rotilin; Sarclex; Scarclex; Sinuron; Stay kleen; Tempo; Trifarmon fl; Trifluron; Trilin; Uranus (trifluralin + linuron); Urea, *N*′-(3,4-dichlorophenyl)-*N*-methoxy-*N*-methyl-; Urea, 3-(3,4-dichlorophenyl)-1-methoxy-1-methyl-; Warrior

CAS Number: 330-55-2

HSDB Number: 1733

RTECS Number: YS9100000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 206-356-5 [*Annex I Index No.*: 006-021-00-1]

Regulatory Authority and Advisory Information

Carcinogenicity[83]: EPA Group C, possible human carcinogen; Carcinogenicity: GHS Category 2: Suspected human carcinogen

California Proposition 65 Chemical[102]: Developmental/Reproductive toxin (3/19/1999)

Hazard Alert: Poison, Endocrine disruptor (high), Suspected reprotoxic hazard, Reproductive and developmental toxin (TRI), Possible endocrine disruptor, Environmental hazard.

Marine Pollutant, IMDG

Potential Ground water Pollutant [California FAC Section 13145(d)/12811, active]

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%

Hazardous to aquatic life or environment, with possible long lasting effects[291]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R45; R22; R48/22; R50/53; R62; R63; safety phrases: S2; S29/35; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: White crystalline solid or powder. Odorless. Commercial product may be available a water soluble or emulsifiable concentrate. Molecular weight = 249.11; specific gravity (H_2O:1) = 1.492 @ 20°C; freezing/melting point = 93−94°C; vapor pressure = 1.43×10^{-6} mmHg @ 25°C[83]. Slightly soluble in water; solubility = 75 mg/L @ 25°C.

Potential Exposure: Inhibits photosynthesis. Linuron is a selective, pre-emergence urea herbicide used to control grasses and broadleaf weeds in carrots, beans, peas, asparagus, maize, potatoes, soybeans, sorghum, wheat, bananas, coffee, cotton, and ornamentals. It is also used for control of annual weeds in storehouses, roadsides, fence rows and other noncrop lands. Linuron is frequently used in formulations with other herbicides, insecticides, and fungicides.

Incompatibilities: Amides are incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides. Similar organic amides react with azo and diazo compounds, releasing toxic gases. Contact with reducing agents can release flammable gases. Amides are very weak bases but they can react as acids, forming salts. Mixing amides with dehydrating agents such as such as phosphorus pentoxide or thionyl chloride generates the corresponding nitrile[101].

Determination in Air: Filter; none; Gravimetric; NIOSH IV [Particulates NOR; #0500 (total), #0600 (respirable)][18].

Permissible Concentration in Water: State Drinking Water Standards: Florida 14 μg/L; Minnesota 1.0 μg/L

Determination in Water: Octanol-water coefficient: Log $K_{ow} = > 3.0$. Values above 3.0 are likely to bioaccumulate in marine organisms. Fish toxicity (threshold)[101]: Intermediate−42.00007 ppb, MATC.

Routes of Entry: Dermal contact, ingestion, inhalation.

Harmful Effects and Symptoms

Short-Term Exposure: Contact with eyes or skin may cause irritation or burns. Inhalation should be avoided; use

NIOSH-or CEN (UK)-approved APRs for pesticides. Ingestion may cause nausea, vomiting, and diarrhea. LD_{50} (oral, rat) = 1146 mg/kg; LD_{50} (dermal, rat) = > 2.5 g/kg.

Long-Term Exposure: Developmental problems. Possible mutagen. Human toxicity (long term)(101): High−5.60 ppb, Health Advisory.

Points of Attack: Skin; reproductive system

Medical Surveillance: Preliminary medical exam to detect chronic diseases of CNS, liver, heart, kidneys, lung, and skin, as well as endocrinological or immunological disturbances, should protect susceptible individuals. Periodical medical exams of internal organs, skin, and eyes are important to avoid chronic occupational intoxications. They should include lab and patch tests when necessary[83]. This chemical is a suspected or known human carcinogen. Exposed persons should contact a physician for advice regarding the possible long term health effects and advice for medical monitoring. Comprehensive physical examination with emphasis on the genitourinary tract analysis to include sperm count, motility, and morphology. Other tests, such as serum testosterone, serum follicle stimulating hormone, and serum luteinizing hormone may be carried out if, in the opinion of a physician, they are indicated.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water. Do not induce vomiting when formulations containing petroleum solvents are ingested. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of dermal and/or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where the neat (undiluted) test chemical is weighed and diluted, wear a NIOSH-approved half face respirator equipped with a combination filter cartridge, i.e., organic vapor/acid gas/HEPA (specific for organic vapors, HCl, acid gas, SO_2, and a high efficiency particulate filter)[88]

Storage: Color code-Blue: Health Hazard/Poison. Store in a tightly closed container in a dry, well-ventilated and secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Where possible, automatically transfer material from other storage containers to process containers. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: First remove all sources of ignition. Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Do not touch spilled material; stop leak if you can do it without risk. Use water spray to reduce vapors. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Large Spills: Dike far ahead of spill for later disposal. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include hydrogen chloride and oxides of nitrogen and carbon. As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 m/150 ft for liquids and at least 25 m/75 ft for solids. Fire involving storage or vehicular tanks: Isolate for 800 m/0.5 mile in all directions; also, consider initial evacuation for 800 m/0.5 mile in all directions. On a small fire: use dry chemical, CO_2, water spray or regular foam. On a large fire: use water spray, fog or regular foam. Do not scatter spilled material with high pressure streams of water. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal. Fire involving tanks: From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. Always stay away from tanks engulfed in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incinerate in a unit operating at 850°C equipped with off-gas scrubbing equipment. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(102); (31); (173); (101); (138); (100).

EXTOXNET, Extension Toxicology Network, "Pesticide Information Profile, Linuron," Oregon State University, Corvallis, OR (June 1996). http://extoxnet.orst.edu/pips/linuron.htm

United States Environmental Protection Agency, Office of Pesticide Programs, Pesticide Residue Limits, "Linuron," 40 CFR 180.184, http://www.epa.gov/pesticides/food/viewtols.htm

Liquefied petroleum gas (LPG)L:0270

Formula: C_3H_8-C_3H_6-C_4H_{10}-C_4 H_8 (mixture)

A mixture of propane (C_3H_8) and butane (C_4H_{10}).

Synonyms: Bottled gas; Compressed petroleum gas; Gas de petroleo licuado (Spanish); Liquefied hydrocarbon gas; L.P.G.; Petroleum gas, liquefied; Propane-butane-(propylene); Pyrofax

CAS Registry Number: 68476-85-7

HSDB Number: 7914

RTECS Number: SE7545000

UN/NA & ERG Number: UN1075/115

EC Number: 270-704-2 [*Annex I Index No.*: 649-202-00-6]

Regulatory Authority and Advisory Information

Hazard Alert: Highly flammable gas, Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated.

Hazard symbols, risk, & safety statements: Hazard symbol: F + , T; risk phrases: R3; R5; R12; R21; R45; R46; safety phrases: S33; S38; S41; S45; S53 (see Appendix 4).

Description: LPG is a colorless, noncorrosive, odorless mixture of gases when pure. A foul-smelling odorant is usually added. Shipped as a liquefied compressed gas (a mixture of propane, butanes, propylene, and butylenes). Molecular weight: 43.9; boiling point ≥ 6°C; 42−44°C (propane); −1°C (butane); flash point = (flammable gas): −104°C (propane); −60°C (butane). Explosive limits: LEL = 2.1%; UEL: 9.5% (propane); LEL = 1.9%; UEL: 8.5% (butane); Autoignition temperature = about 400°C: 466°C (propane); 405°C (butane). Hazard identification (based on NFPA-704 M Rating System): Health 1, Flammability 4, Reactivity 0. Insoluble in water.

Potential Exposure: LPG is used as a fuel propellant; in metal cutting; and in the production of petrochemicals.

Incompatibilities: May form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides. Contact with chlorine dioxide may cause fire and explosions. Attacks some plastics, rubber and coatings.

Permissible Exposure Limits in Air

NIOSH IDLH = 2000 ppm [LEL]

Conversion factor: 1 ppm = 1.72−2.37 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 1000 ppm/1800 milligram per cubic meter TWA

NIOSH REL: 1000 ppm/1800 milligram per cubic meter TWA

ACGIH TLV[1]: 1000 ppm TWA *as aliphatic hydrocarbon gas* (C_1−C_4)

PAC Ver. 29[138]

PAC-1: 65,000 ppm

PAC-2: 2.30E + 05 ppm

PAC-3: 4.00E + 05 ppm

The Philippines: TWA 1000 ppm (1800 milligram per cubic meter), 1993; Switzerland: MAK-W 1000 ppm (1800 milligram per cubic meter), 1999; Turkey: TWA 1000 ppm (1800 milligram per cubic meter), 1993; United Kingdom: TWA 1000 ppm (1750 milligram per cubic meter); STEL 1250 ppm, 2000; the Netherlands: MAC-TGG 1800 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: TWA 1000

Routes of Entry: Inhalation, skin and/or eye contact (liquid).

Harmful Effects and Symptoms

Short-Term Exposure: Liquefied petroleum gas can affect you when breathed in. Exposure to high levels can cause you to feel dizzy and lightheaded. Very high levels could cause suffocation and death from lack of oxygen. Contact with liquid liquefied petroleum gas can cause frostbite.

Points of Attack: Respiratory system; CNS.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations.

First Aid: Skin Contact: Do not rub. Seek medical attention. Breathing: Remove the person from exposure. Begin (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. If frostbite has occurred, seek medical attention immediately; do not rub the affected areas or flush them with water. In order to prevent further tissue damage, do not attempt to remove frozen clothing from frostbitten areas. If frostbite has not occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid d unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash

Respirator Selection: 2000 ppm: Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with a full facepiece). Emergency or planned entry into unknown concentrations or IDLH conditions: SCBAF: Pd, Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode. Escape: SCBAE (any appropriate escape-type, SCBA).

Storage: Check oxygen content prior to entering storage area. Flammable gas. Color code-Red Stripe: Flammability Hazard: Store separately from all other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers (such as chlorine, bromine, and fluorine). Metal containers involving the transfer of 5 gallons or more of liquefied petroleum gas should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Sources of ignition, such as smoking and open flames are prohibited where liquefied petroleum gas is handled, used, or stored. Wherever liquefied petroleum gas is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: UN1075 Petroleum gases, liquefied or Liquefied petroleum gas; Hazard Class: 2.1; Labels: 2.1-Flammable gas. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Ventilate area of leak to disperse the gas. Stop flow of gas. If source of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Liquefied petroleum gas is a flammable gas. The flame may be invisible. Thermal decomposition products may include oxides of carbon. Use dry chemical, CO_2, water spray; or foam extinguishers. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Flaring using smokeless flare designs.

References

(31); (173); (101); (138).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Liquefied Petroleum Gas*, Trenton, NJ (February 2001).

Lithium L:0280

Formula: Li

Synonyms: Li; Lithium, elemental; Lithium metal; Lithium monohydride

CAS Registry Number: 7439-93-2

HSDB Number: 647

RTECS Number: OJ5540000

UN/NA & ERG Number: UN1415 (Dangerous when wet)/138; UN3089 (Metal powder, flammable, n.o.s.)/170

EC Number: 231-102-5 [*Annex I Index No.*: 003-001-00-4]

Regulatory Authority and Advisory Information

Hazard Alert: Combustible, Strong reducing agent, Dangerously water reactive, Suspected of causing genetic defects, Suspected reprotoxic hazard.

Hazard symbols, risk, & safety statements: Hazard symbol: F, C; risk phrases: R10; R14/15; R15/29; R34; R61; R62; R63; safety phrases: S1/2; S8; S43; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Lithium is a silvery to grayish-white metal that turns yellow on exposure to air and/or moisture. Molecular weight = 6.94; specific gravity (H_2O:1) = 5.3 @ 20°C; boiling point = 1342°C; freezing/melting point = 181°C; vapor pressure = 5.92×10^{-13} mmHg @ 127°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 2 ₩. Violent reaction with water forming lithium hydroxide and flammable hydrogen gas.

Potential Exposure: Lithium is used in inorganic syntheses; the manufacture of storage batteries; heat transfer liquids; and metal alloys.

Incompatibilities: Violent reaction with water, forming flammable hydrogen gas and corrosive lithium hydroxide, a strong caustic solution. Heating may cause violent combustion or explosion. Finely divided particles or powdered form may ignite spontaneously in air. Contact with air forms corrosive fumes of lithium hydroxide. Violent reaction with oxidizers, acetonitrile, nitric acid; arsenic, bromobenzene, carbon tetrachloride; hydrocarbons, halogens, halons, sulfur, and many other substances. Forms impact- and friction-sensitive mixtures with bromobenzene, carbon tetrabromide, chloroform (weak explosion), iodoform, halogens, halocarbons, methyl dichloride; methyl diiodide and other substances. Attacks plastics, rubber, ceramic materials; concrete, sand, and metal alloys: cobalt, iron, manganese, nickel.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 3.3 mg[Li]/m^3

PAC-2: 36 mg[Li]/m^3

PAC-3: 220 mg[Li]/m^3

Determination in Air: Use OSHA Analytical Method ID-121; NIOSH Analytical Method #8005, Elements in blood or tissue.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Corrosive. Contact can cause severe skin and eye burns. Inhalation can irritate the respiratory tract causing coughing, and/or shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Exposure to lithium can cause loss of appetite; nausea, tremor, muscle twitches; apathy, convulsions, coma and death.

Long-Term Exposure: Exposure can cause loss of appetite; nausea, vomiting, diarrhea, and abdominal pain; headache; muscle weakness; loss of coordination; confusion, seizures, and coma. May affect the thyroid gland causing goiter. May affect the kidneys and heart function. Exposure may cause an allergy to develop, affecting the skin, blood vessels, and/or possibly the lungs.

Points of Attack: Lungs, thyroid, kidneys, heart, skin.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: EKG, blood test for lithium. Thyroid function tests. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposure to lithium, use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece respirator with a high efficiency particulate filter. Greater protection is provided by a PAPR. Where there is potential for high exposures exists, use a NIOSH/MSHA (US) or EN149 (Europe)-

approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: UN1415 Color code-Red Stripe: Dangerous when wet materials release flammable gases on contact with water: Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8–10 m or a 1-hour fire wall from flammable or reactive materials. Do not store in a basement. UN3089 (1) Color code-Red Stripe: Flammability Hazard: Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8–10 m or a 1-hour fire wall from flammable or reactive materials. Store flammable solids up to maximum allowable quantity per control area in an approved flammable storage area. Do not store in a basement. (2) Color code-Yellow Stripe: Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Reacts with body moisture, forming corrosive lithium hydroxide: (3) Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Protect storage containers from physical damage. Lithium must be stored to avoid contact with water, halogenated compounds, carbon dioxide; oxidizers, strong acids; alcohols, metals chlorinated arsenic compounds; hydrocarbons, sulfur, acetonitrile, nitrogen, and many other materials, since violent reactions occur. Store in tightly closed containers under kerosene or neutral oil in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where lithium is used, handled or stored in a manner that could create a potential fire or explosion hazard. Wherever lithium is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1415 Lithium, Hazard Class: 4.3; Labels: 4.3-Dangerous when wet material. UN3089 Metal powders, flammable, n.o.s., Hazard Class: 4.1; Labels: 4.1-Flammable solid.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. Keep lithium out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Lithium is a highly reactive, combustible solid that is difficult to extinguish. Can be spontaneously flammable in temperatures > 180°C. Thermal decomposition products may include lithium oxide. Do not use water, foam, dry chemical, halogenated hydrocarbons; CO_2 on fire or adjacent fire. Use Class D extinguishers, dry clay; dry graphite; limestone, or appropriate special metal fire extinguishing powder. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Lithium*, Trenton, NJ (November, 1999)

Lithium aluminum hydride L:0285

Formula: AlH_4Li; $LiAlH_4$

Synonyms: Aluminum lithium hydride; Lithium alanate; Lithium aluminohydride; Lithium aluminum tetrahydride; Lithium tetrahydroaluminate

CAS Registry Number: 16853-85-3

HSDB Number: 648

RTECS Number: BD0100000

UN/NA & ERG Number: UN1410 (dry)/138; UN1411 (ether solution)/138

EC Number: 240-877-9 [*Annex I Index No.*: 001-002-00-4]

Regulatory Authority and Advisory Information

Hazard Alert: Highly flammable solid, Dangerously water reactive, Strong reducing agent,

United States National Primary Drinking Water Regulations: SMCL = 0.05 to 0.2 mg[Al]/L as aluminum.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: F, C; risk phrases: R14/15; R35; safety phrases: S1/2; S7/8; S21; S26; S36/37/39; S43; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Lithium aluminum hydride is a white to gray powder. A combustible solid. Molecular weight + 37.96;

decomposes @ 125°C; specific gravity (H_2O:1) = 0.92 @ 20°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, Flammability 3, Reactivity 2 ₩. Reacts with water.

Potential Exposure: This material is used as a catalyst and as a specialty reducing agent in organic synthesis.

Incompatibilities: Combustible solid. Can ignite spontaneously in moist air or heat. Decomposes on heating @ 125°C forming aluminum, lithium hydride and flammable hydrogen gas. A strong reducing agent; violent reaction with oxidizers. Violent reaction with water, alcohols, acids, dimethylether, ethers, tetrahydrofuran, benzoyl peroxide; boron trifluoride etherate. Reduces carbon dioxide or sodium hydrogen carbonate to methane and ethane at elevated temperatures. These flammable or explosive gases can form when CO_2 extinguishers are used to fight hydride fires. Forms explosive complexes with ether, dimethylamine and various tetrazoles. Tetrazoles include, 2-methyl, 2-ethyl, 5-ethyl, 2-methyl-5-vinyl, 5-amino-2-ethyl [United States Pat. 3 396 170, 1968, Cameo].

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 8.4 milligram per cubic meter

PAC-2: 92 milligram per cubic meter

PAC-3: 550 milligram per cubic meter

Permissible Concentration in Water: No criteria set. Reacts violently with water.

Routes of Entry: Inhalation, ingestion, eyes and/or skin.

Harmful Effects and Symptoms

Short-Term Exposure: Lithium aluminum hydride can affect you when breathed in. Contact can cause severe burns of the eyes and skin. Exposure can irritate the eyes, nose, throat and lungs, causing coughing and sneezing. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Exposure can cause loss of appetite; nausea, confusion, tremor, and muscle twitching. High exposure can cause coma and death.

Long-Term Exposure: Can cause loss of appetite; nausea, vomiting, diarrhea, and abdominal pain; headache; muscle weakness; loss of coordination; confusion, seizures, and coma. Can affect the thyroid gland causing goiter. May cause kidney damage.

Points of Attack: Thyroid gland, kidneys.

Medical Surveillance: For those with frequent or potentially high exposure, the following are recommended before beginning work and at regular times after that. Lung function tests. Thyroid function tests. If symptoms develop or overexposure is suspected, the following maybe useful: serum lithium level. Consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/ manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures over 5 milligram per cubic meter, use a NIOSH/ MSHA (US) or EN149 (Europe)-approved full facepiece respirator with a high efficiency particulate filter. More protection is provided by a full facepiece respirator than by a half-mask respirator, and even greater protection is provided by a PAPR. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. Where there is potential for high exposures exists, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: (1) Color code-Red Stripe: Dangerous when wet materials release flammable gases on contact with water. Do not store this material in a room protected by water sprinkler systems. Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Do not store in a basement. (2) Color code-Red Stripe: Flammability Hazard: Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. (3) Color code-Yellow Stripe (strong reducing agent): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Lithium aluminum hydride must be stored to avoid contact with water, air, acids, alcohols, benzoyl peroxide; boron trifluoride etherate; ethers, tetrahydrofuran, and strong oxidizers (such as chlorine, bromine, and fluorine), since violent reactions occur. Sources of ignition, such as smoking and open flames are prohibited where lithium aluminum hydride is handled, used, or stored. Use only nonsparking tools and equipment, especially when opening and closing containers of lithium aluminum hydride. Wherever lithium aluminum hydride is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Open only in inert atmospheres or very low humidity rooms.

Shipping: UN1410 Lithium aluminum hydride (dry), Hazard Class: 4.3; Labels: 4.3-Dangerous when wet material. UN1411 Lithium aluminum hydride, ethereal, Hazard Class: 4.3; Labels: 4.3-Dangerous when wet material, 3-Flammable liquid.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Decomposes at 125°C forming flammable hydrogen gas. The heat generated may cause ignition and/or explosion[136]. Thermal decomposition products may include lithium hydroxide, lithium hydride and metal oxides. Do not use water, CO_2 or foam. Use Class D extinguishers, dry sand; dry clay; dry limestone, dry graphite. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. Fire may restart after it has been extinguished. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Lithium Aluminum Hydride*, Trenton, NJ (November 1999)

Lithium carbonate L:0290

Formula: Li_2CO_3

Synonyms: Camcolit; Candamide; Carbolith; Carbolithium; Carbonato de litio (Spanish); Carbonic acid, dilithium salt; Carbonic acid lithium salt; Ceglution; CP-15,467-61; Dilithium carbonate; Eskalith; Hypnorex; Limas; Liskonum; Litard; Lithane; Lithea; Lithicarb; Lithinate; Lithium phasal; Lithizine; Lithobid; Litho-carb; Lithonate; Lithotabs; Manialith; Neurolepsin; NSC 16895; PFI-lithium; PFL-lithium; Plenur; Priadel; Quilonorm; Quilonum retard

CAS Registry Number: 554-13-2

HSDB Number: 3351

RTECS Number: OJ5800000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 209-062-5

Regulatory Authority and Advisory Information

California Proposition 65 Developmental/Reproductive toxin 1/1/1991.

Hazard Alert: Poison, Corrosive (aqueous solution), Possible risk of forming tumors, Reproductive toxin: possible risk of gene damage/impaired fertility; Suspected reprotoxic hazard, FDA proprietary drug.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T; risk phrases: R11; R14; R15; R20/21/22; R34; R36/37/38; R41; R62; R63; safety phrases: S7/8; S16; S24/25; S26; S36/37/39; S43; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Lithium carbonate is a white hygroscopic powder. Molecular weight = 73.89; specific gravity (H_2O:1) = 2.11 @ 20°C; boiling point = 1310°C (decomposes below BP); freezing/melting point = 720°C. Hazard identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 1. Slightly soluble in water.

Potential Exposure: Lithium carbonate is used in treatment of manic-depressive psychoses; to make ceramics and porcelain glaze; varnishes, dyes, pharmaceuticals, coating of arc-welding electrodes; battery alloys; nucleonics, luminescent paints; glass ceramics; lubricating greases; in aluminum production.

Incompatibilities: The aqueous solution is a strong base. Reacts violently with acids, powdered calcium and fluorine.

Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong acids, powdered calcium, fluorine, moisture. Corrodes aluminum, copper, zinc.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 3.1 milligram per cubic meter

PAC-2: 34 milligram per cubic meter

PAC-3: 210 milligram per cubic meter

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short-Term Exposure: LD_{50} = (oral-rat) 525 mg/kg. Contact causes skin, eye and respiratory tract irritation. Inhalation can cause nausea, vomiting, diarrhea, and abdominal pain. Can cause lung irritation. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Exposure can cause headache; muscle weakness; muscle twitching; blurred vision; loss of coordination; confusion, seizures, and coma. May affect the CNS; cardiovascular, and GI systems if ingested.

Long-Term Exposure: May cause damage to the developing fetus. May cause skin allergy and dermatitis. High exposure can cause enlarged thyroid (goiter). May damage the stomach, kidneys and may affect the heart function. May cause reproductive toxicity in humans.

Points of Attack: Skin, thyroid, kidneys, heart.

Medical Surveillance: Blood tests for lithium level. Kidney function tests. Thyroid function tests. Consider chest X-ray following acute overexposure. Evaluation by a qualified allergist.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Specific engineering controls are required for drug manufacture by the Food and Drug Administration. Refer to FDA regulation for Good Manufacturing Practices 21CFR210.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from moisture, fluorine, oxidizers, and acids. Where possible, automatically transfer from drums or other storage containers to process containers.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling:. UN2811: Isolation Distance, Spill: 25 m/75 ft (NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Thermal decomposition products may include oxides of metal and carbon. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Lithium Carbonate*, Trenton NJ (September 1998)

Lithium chromate L:0300

Formula: $CrH_2O_4 \cdot 2Li$

Synonyms: Lithium chromate(VI); Chromic acid, dilithium salt; Chromium lithium oxide; Dilithium chromate *dichromate*: Lithium bichromate; Lithium bichromate dihydrate; Lithium dichromate; Lithium dichromate dehydrate

CAS Registry Number: 14307-35-8; 13843-81-7 (lithium dichromate)

HSDB Number: 650

RTECS Number: GB2915000

UN/NA & ERG Number: UN3288 (Toxic solid, inorganic, n.o.s.)/151

EC Number: 238-244-7

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human Sufficient Evidence; Animal Sufficient Evidence, carcinogenic to humans, Group 1, 1997; NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen; EPA (inhalation): Known human carcinogen; EPA (oral): Not Classifiable as to human carcinogenicity; NTP: Known to be a human carcinogen

California Proposition 65 Chemical[102]: (*hexavalent chromium*) Cancer 2/27/1987; Developmental/Reproductive toxin (male, female) 12/19/2008

Hazard Alert: Poison, Strong oxidizer, sensitization hazard (skin), Reproductive toxin, Environmental hazard.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) as chromium compounds

United States National Primary Drinking Water Regulations: MCLG = 0.01 mg[Cr]/L; MCL = 0.1 mg[Cr]/L as Chromium

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Toxic Pollutant (Section 401.15); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992).

EPA EPA ADI: (14307-35-8) Chromium(VI) = 0.175 mg/day/man. EPA EASI levels for chromium: **Infants**: age 0.0−0.5 year: 0.01−0.04 mg/day; age 0.5−1.0 year: 0.02−0.06 mg/day. **Children** age 1−3 years: 0.02−0.08 mg/day; age 4−6 years: 0.03−0.12 mg/day; age 7−10 years: 0.05−0.20 mg/day; age > or = to 11 years: 0.05−0.20 mg/day. **Adults**: 0.05−0.20 mg/day.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, as chromium compounds, waste number not listed.

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg)

EPCRA (Section 313): Includes any unique chemical substance that contains chromium as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: Chromium(VI) compounds: 0.1%.

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: E, O, T + , N; risk phrases: R45; R2; R8; R21; R25; R26; R34; R42; R46; R48/23; R50/53; R60; R61; safety phrases: S29/35; S45; S53; S41; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Lithium chromate is a yellow crystalline powder. Molecular weight = 129.88 (lithium chromate oxide); 165.92; 131.90 (*dilithium chromate*); specific gravity (H_2O:1) = 2.15, no temp. (lithium chromate oxide); freezing/melting point = 75°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. Soluble in water.

Potential Exposure: Used as a corrosion inhibitor, heat transfer agent; and oxidizing agent in leather and metal finishing. Also used in photography, wood preservatives; batteries, safety matches, and cement.

Incompatibilities: Aqueous solution is caustic. A strong oxidizer; strong reaction with reducing agents, combustibles, organic material, hydrazine, chromic acid; sulfur, acids. Attacks plastics and aluminum.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 0.37 milligram per cubic meter

PAC-2: 6.5 milligram per cubic meter

PAC-3: 39 milligram per cubic meter

As Chromium(VI) Inorganic Soluble Compounds:

NIOSH IDLH = 15 mg[Cr(VI)]/m^3

OSHA PEL: 0.005 mg[Cr(VI)]/m^3 TWA Concentration. See 29CFR1910.1026

NIOSH REL: 0.001 mg[Cr]/m^3 TWA, potential carcinogen, limit exposure to lowest feasible level. NIOSH considers all Cr(VI) compounds (including chromic acid, *tert*-butyl chromate, zinc chromate, and chromyl chloride) to be potential occupational carcinogens. See NIOSH Pocket Guide, Appendixes A & C.

ACGIH TLV[1]: 0.05 mg[Cr]/m^3 TWA, Confirmed Human Carcinogen; BEI issued

DFG MAK: [skin] Danger of skin sensitization; Carcinogen Category 1; TRK: 0.05 mg[Cr]/m^3; 20 μg/L [Cr] in urine at end-of-shift

Determination in Air: Use NIOSH Analytical Method (IV) #7024, Chromium.

Permissible Concentration in Water: State Drinking Water Guidelines: California 10 μg[Cr(VI)]/L; Maine 35 μg[Cr(VI)]/L. For the protection of freshwater aquatic life: EPA's maximum drinking water level (MCL) is 0.1 mg/L[62]. United States National Primary Drinking Water Regulations (total chromium): MCLG = 0.01 mg[Cr]/L; MCL = 0.1 mg[Cr]/L.

Determination in Water: Total chromium may be determined by digestion followed by atomic absorption, or by colorimetry (diphenylcarbazide); or by ICP optical emission spectrometry. Chromium(VI) may be determined by extraction and atomic absorption or colorimetry (using diphenylhydrazide). Dissolved total Cr or Cr(VI) may be determined by 0.45 μ filtration followed by the above-cited methods[49].

Routes of Entry: Inhalation, eye and/or skin.

Harmful Effects and Symptoms

Short-Term Exposure: Contact causes severe skin and eye irritation and burns. Inhalation can irritate the nose and throat causing coughing and wheezing. Inhalation may cause cancer.

Long-Term Exposure: Chromium may cause allergic dermatitis. Repeated exposure can cause loss of appetite; nausea, tremor, and convulsions. Lithium chromate is a hexavalent chromium compound, and a possible human carcinogens. Handle with care. Related chromium compounds are teratogenic. Can irritate the lungs; may cause bronchitis to develop. May cause skin allergy. Repeated exposure may cause personality changes of depression, anxiety or irritability. Prolonged exposure may cause deep slow-healing ulcers on the skin, and a sore or hole in nasal septum. May damage the liver and kidneys.

Points of Attack: Lungs, liver, kidneys, skin.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure. NIOSH lists the following tests: Blood gas analysis, CBC; chest X-ray, electrocardiogram, liver function tests; pulmonary function tests; sputum cytology, urine (chemical/metabolite), urinalysis (routine), white blood cell count/differential. Lung function tests. Evaluation by a qualified allergist. Liver and kidney function tests. Check skin daily for blisters or little bumps, the first sign of “chrome ulcers.” If not treated early, these can last for years following exposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH, as chromates: at any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration: SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). Escape: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Store in tightly closed containers in a cool, well-ventilated area away from acids, hydrazine, chromic acid; combustible materials; sulfur, aluminum, plastics; and reducing agents.

Shipping: UN3288 Toxic solids, inorganic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Thermal decomposition products may include oxides of lithium and chromium. Use extinguishing agents suitable for surrounding fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(109); (102); (31); (173); (101); (138); (2); (122); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Lithium Chromate, Trenton*, NJ (August 1998)

United States Environmental Protection Agency, *Health Assessment Document*: *Chromium*, EPA 600/8-83-014F, Washington, DC, (1984)

Lithium hydride L:0310

Formula: HLi; LiH

Synonyms: Hydrure de lithium (French); Hydruro de litio (Spanish); Lithium monohydride; Lithium hydride (fused solid)

CAS Registry Number: 7580-67-8

HSDB Number: 549

RTECS Number: OJ6300000

UN/NA & ERG Number: UN1414/138; UN2805 (fused, solid)/138

EC Number: 231-484-3

Regulatory Authority and Advisory Information

Hazard Alert: Combustible, Pyrophoric hazard, Strong reducing agent, Violently water reactive.

SUPERFUND/EPCRA 302, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: C, T; risk phrases: R10; R14/15; R15/29; R17; R25; R34; R50; safety phrases: S7/8; S16; S25; S26; S27; S36/37/39; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Lithium hydride is an off-white to grayish, translucent, odorless solid or white powder that darkens rapidly on exposure to light. Molecular weight = 7.95; specific gravity (H_2O:1) = 0.783; boiling point = (decomposes below BP) 850°C; freezing/melting point = 689–692°C; Autoignition temperature = 200°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 2₩. Reacts with water releasing caustic lithium hydroxide and flammable hydrogen gas.

Potential Exposure: Lithium hydride is used in preparation of lithium aluminum hydride; as a desiccant; it is used in hydrogen generators and in organic synthesis as a reducing agent and condensing agent with ketones and acid esters; it is reportedly used in thermonuclear weapons.

Incompatibilities: A Strong reducing agent. Incompatible with oxidizers, halogenated hydrocarbons; acids can cause fire and explosion. Reacts with water, forming caustic lithium hydroxide and flammable hydrogen gas; reaction may cause ignition. May ignite spontaneously in moist air and may reignite after fire is extinguished. Dangerous when wet. Reacts with water to form hydrogen and lithium hydroxide. Powdered form and liquid oxygen form an explosive compound. Decomposes exothermically on contact with acids and upon heating to about 500°C, producing flammable hydrogen gas. Reacts with carboxylic acids, lower alcohols; chlorine, and ammonia (at 400°C), forming explosive hydrogen gas.

Permissible Exposure Limits in Air

NIOSH IDLH = 0.5 milligram per cubic meter

OSHA PEL: 0.025 milligram per cubic meter TWA

NIOSH REL: 0.025 milligram per cubic meter TWA

ACGIH TLV[1]: 0.025 milligram per cubic meter TWA

PAC * Ver. 29[138]

PAC-1: **0.025_E** milligram per cubic meter

PAC-2: **0.1_E** milligram per cubic meter

PAC-3: **0.5_E** milligram per cubic meter

*ERPG [Emergency Response Planning Guidelines] are marked with a subscript "**E.**"

DFG MAK: No numerical value established. Data may be available.

Australia: TWA 0.025 milligram per cubic meter, 1993; Austria: MAK 0.025 milligram per cubic meter, 1999; Belgium: TWA 0.025 milligram per cubic meter, 1993; Denmark: TWA 0.025 milligram per cubic meter, 1999; Finland: TWA 0.025 milligram per cubic meter; STEL 0.075 milligram per cubic meter, 1999; France: VME 0.025 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 0.025 milligram per cubic meter, 2003; the Philippines: TWA 0.025 milligram per cubic meter, 1993; Poland: MAC (TWA) 0.025 milligram per cubic meter, 1999; Switzerland: MAK-W 0.025 milligram per cubic meter, 1999; Turkey: TWA 0.025 milligram per cubic meter, 1993; United Kingdom: TWA 0.025 milligram per cubic meter, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, and Vietnam: ACGIH TLV: TWA 0.025 milligram per cubic meter. Several states have set guidelines or standards for lithium hydride in ambient air[60] ranging from 0.4 μ/m^3 (Virginia) to 0.5 μ/m^3 (Connecticut) to 2.0 μ/m^3 (North Dakota) to 6.0 μ/m^3 (Nevada).

Determination in Air: No method available.

Permissible Concentration in Water: No criteria set, but EPA[32] has suggested a permissible ambient goal of 0.3 μg/L based on health effects.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Lithium hydride is an alkaline-corrosive agent. Contact with eyes may result in severe damage to the cornea, conjunctiva, and blood vessels. Extreme caution is advised. Acute exposure to lithium hydride may result in irritation and burning of the skin, eyes, and mucous membranes. Increased salivation, dysphagia (difficulty in swallowing), abdominal pain; and spontaneous vomiting may occur. Stridor (high-pitched, noisy respirations), dyspnea (shortness of breath), and pulmonary edema are also common. Apathy and mental confusion may develop, with progression to coma and death.

Long-Term Exposure: Lithium can cause loss of appetite; nausea, vomiting, diarrhea, and abdominal pain; headache; muscle weakness; loss of coordination; confusion, seizures and coma. Can affect the thyroid gland causing goiter. May cause kidney damage.

Points of Attack: Eyes, skin, respiratory system; CNS; thyroid, kidneys.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Thyroid function tests. Kidney function tests. Lung function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear appropriate clothing to prevent any possibility of contact with air of >0.1 milligram per cubic meter content. Wear eye protection to prevent any possibility of eye contact. Provide emergency showers and eyewash if air containing >0.5 milligram per cubic meter is involved. Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Employees should wash immediately with soap when skin is wet or contaminated.

Respirator Selection: Up to 0.25 milligram per cubic meter: 100XQ (any air-purifying respirator with a high-efficiency particulate filter); or Sa (APF = 10) (any supplied-air respirator); Up to 0.5 milligram per cubic meter: Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or PaprHie* (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). Emergency or planned entry into unknown concentrations or IDLH conditions: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). Escape: 100F (APF = 50) (any air-purifying, full facepiece respirator with an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA). *Substance reported to cause eye irritation or damage; may require eye protection.

Storage: (1) Color code-Red Stripe: Dangerous when wet materials release flammable gases on contact with water. Store under nitrogen in a cool, ventilated area. Do not store this material in a room protected by water sprinkler systems. Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8–10 m or a 1-hour fire wall from flammable or reactive materials. Do not store in a basement. (2) Color code-Yellow Stripe (strong reducing agent): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Protect containers against physical damage. Store in isolated, well-ventilated, cool, dry area.

Shipping: UN1414 Lithium, Hazard Class: 4.3; Labels: 4.3-Dangerous when wet material. UN2805 Lithium hydride, fused solid, Hazard Class: 4.3; Labels: 4.3-Dangerous when wet material.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Do not touch spilled materials. Do not allow material to contact water. Shovel up small spills with noncombustible absorbent material. Confine large spills with dikes, sheets, or tarps to stop spreading. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include caustic fumes of lithium hydroxide and metal oxides. Lithium hydride can form airborne dust clouds which may explode on contact with flame, heat, or oxidizing materials. Additionally, spontaneous ignition occurs when nitrous oxide and lithium hydride are mixed. Lithium hydride also forms explosive mixtures with liquid oxygen. Do not use water, carbon dioxide; dry chemical; or halogenated extinguishing agents; such as carbon tetrachloride. Use Class D extinguishers, dry sand; dry graphite; dry limestone, or ground dolomite-based dry chemical extinguishers, such as "Lith-X." Wear protective goggles or face shield, rubberized gloves; flame-proof outer clothing; respirator, and high boots or shoes. Large fires: withdraw from area and let fire burn, as lithium hydride may continue to re-ignite. A fire, once started, cannot be extinguished by ordinary methods. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Lithium hydride may be mixed with sand, sprayed with butanol and then with water, neutralized and flushed to a sewer with water.

References

(31); (173); (101); (138); (170); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: *Lithium and Lithium Compounds*, Washington, DC (Sept 1, 1976)

United States Environmental Protection Agency, Chemical Hazard Information Profile: *Lithium Hydride*, Washington, DC, Chemical Emergency Preparedness Program (Nov. 30, 1987)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Lithium Hydride, #1128, Bromine*, Trenton, NJ, (April 2004)

Lithium nitrate L:0320

Formula: $LiNO_3$

Synonyms: Nitric acid, lithium salt

CAS Registry Number: 7790-69-4

RTECS Number: QU9200000

UN/NA & ERG Number: UN2722/140

EC Number: 232-218-9

Regulatory Authority and Advisory Information

Hazard Alert: Combustible, Strong oxidizer.

United States National Primary Drinking Water Regulations: MCLG = 10 mg[N]/L; MCL = 10 mg/L as nitrates

Hazard symbols, risk, & safety statements: Hazard symbol: O, Xi; risk phrases: R8; R36/38; safety phrases: S17; S22; S24/25; S26; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Lithium nitrate is a colorless deliquescent powder. Molecular weight = 68.95; specific gravity (H_2O:1) = 2.38; freezing/melting point = 253°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 2 (Oxidizer). Soluble in water.

Potential Exposure: Lithium nitrate is used in ceramics, pyrotechnics, salt baths; refrigeration systems; and rocket propellants.

Incompatibilities: May explode when exposed to sparks, shock and heat. Violent reactions with combustible materials; oxidizers, organic materials; reducing agents; strong acids.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 30 milligram per cubic meter

PAC-2: 330 milligram per cubic meter

PAC-3: 2000 milligram per cubic meter

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short-Term Exposure: Lithium nitrate can affect you when breathed in. Repeated heavy exposure may lead to lithium poisoning. This can cause loss of appetite; nausea, tremor, muscle twitches, apathy, convulsions, coma, and death. Contact with lithium nitrate water solution or powder can cause severe skin and eye burns. A very low sodium diet can increase your risk of health problems from exposure to lithium.

Long-Term Exposure: Lithium can cause loss of appetite; nausea, vomiting, diarrhea, and abdominal pain; headache; muscle weakness; loss of coordination; confusion, seizures and coma. Can affect the thyroid gland causing goiter. May cause kidney damage.

Points of Attack: Thyroid, kidneys.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: serum lithium level. Thyroid function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/ manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof goggles and face shield when working with powders or dust, unless full facepiece respiratory protection is worn. Wear splash-proof chemical goggles and face shield when working with liquid, unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposure to solid lithium nitrate use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. Where there is potential for high exposures to liquid lithium nitrate exists, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Check oxygen content prior to entering storage area. Color code-Yellow: Reactive Hazard; Store in a location separate from other materials, especially organic materials, flammables and combustibles, and other incompatible materials. Oxidizers, including oxidizing gases, should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Lithium nitrate must be stored to avoid contact with wood, paper, oil, and heat; and oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates), since violent reactions occur. Protect containers against physical damage, heat, shock, and sparks. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Store in a cool, well-ventilated area away from incompatible materials listed above. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43A: Code for the Storage of Liquid and Solid Oxidizers for detailed handling and storage.

Shipping: UN2722 Lithium nitrate, Hazard Class: 5.1; Labels: 5.1-Oxidizer.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use water only. Do not use dry chemical, carbon dioxide; or foam extinguishers. Thermal decomposition products may include oxides of nitrogen and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Lithium Nitrate*, Trenton, NJ (September 1999)

Lomustine L:0330

Formula: $C_9H_{16}ClN_3O_2$

Synonyms: Belustine; CCNU; Cecenu; CEENU; 1-(2-chloroethyl)-3-cyclohexyl-1-nitrosourea; (Chloro-2-ethyl)-1-cyclohexyl -3-nitrosourea; *N*-(2-Chloroethyl)-*N*′-cyclohexyl-*N*-nitrosourea; Chloroethylcyclohexylnitrosourea; CINU; ICIG1109; Lomustine; NCI-C04740; NSC-79037; RB 1509; SRI2200

CAS Registry Number: 13010-47-4

HSDB Number: 6519

RTECS Number: YS4900000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n. o.s.)/154; UN3249 (Medicines, toxic, solid, n.o.s.)/151

EC Number: 235-859-2

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC:

Animal Sufficient Evidence; Human Inadequate Evidence, Group 2A, 1999.

California Proposition 65 Chemical[102]: Cancer 1/1/1988; Developmental/Reproductive toxin, as 1-(2-chloroethyl)-3-cyclohexyl-1-nitrosourea 7/1/1990.

Hazard Alert: Poison, Possible risk of forming tumors, Reproductive toxin: possible risk of gene damage/impaired fertility; Suspected reprotoxic hazard.

Hazard symbols, risk, & safety statements: Hazard symbol: T; risk phrases: R45; R/25; R36/37/38; R42; R51; R62; R63; safety phrases: S41; S45; S53 (see Appendix 4)

Description: Lomustine is a pale yellow powder. Molecular weight = 233.73; freezing/melting point = 88−90°C. Insoluble in water.

Potential Exposure: A potential danger to those involved in the manufacture, administration or consumption of this antineoplastic (anti-cancer) agent.

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Long-Term Exposure: There is sufficient evidence that 1-(2-chloroethyl)-3-cyclohexyl-1-nitrosourea (CCNU) is carcinogenic in experimental animals. CCNU caused lung cancers in rats following intraperitoneal or intravenous injection. In mice, intraperitoneal injections of CCNU resulted in a slight increase in the incidence of lymph system neoplasms. Applied to the skin of mice, CCNU did not induce skin tumors, but the duration of the experiment was inadequate. Evidence for the carcinogenicity of CCNU in humans is inadequate. In several reported cases, cancer patients who received CCNU developed leukemia. With one exception, all of these patients also had received other cytotoxic agents and/or irradiation.

Points of Attack: Blood.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. NIOSH lists the following tests: whole blood (chemical/metabolite); blood serum; biologic tissue/biopsy; urine (chemical/metabolite).

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: At any detectable concentration: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA-or European Standard EN 149-approved SCBA that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full-face-piece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN3249 Medicine, solid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft (NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include HCl, and oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: It is inappropriate and possibly dangerous to the environment to dispose of expired or waste drugs and pharmaceuticals by flushing them down the toilet or discarding them to the trash. Household quantities of expired or waste pharmaceuticals may be mixed with wet cat litter or coffee grounds, double-bagged in plastic, discard in trash. Larger quantities shall carefully take into consideration applicable DEA, EPA, and FDA regulations. If possible return the pharmaceutical to the manufacturer for proper disposal being careful to properly label and securely package the material. Alternatively, the waste pharmaceutical shall be labeled, securely packaged and transported by a state licensed medical waste contractor to dispose by burial in a licensed hazardous or toxic waste landfill or incinerator.

References

(109); (102); (31); (173); (101); (138).

M

Magnesium M:0100

Formula: Mg
Synonyms: Magnesium metal; Magnesium pellets; Magnesium powder; Magnesium ribbons; Magnesium scalpings; Magnesium shavings; Magnesium sheet; Magnesium turnings
CAS Registry Number: 7439-95-4
HSDB Number: 654
RTECS Number: OM210000
UN/NA & ERG Number: UN1869 (magnesium or magnesium alloys with >50% Mg in pellets, turnings or ribbons)/138; UN1418 (powder, magnesium or alloys)/138; UN2950 (granules)/138.
EC Number: 012-002-00-9 (pellets); 012-001-00-3 (powder, pyrophoric)

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Theft hazard* 100 (ACG).

Hazard Alert: Flammable solid, Strong reducing agent, Pyrophoric (dust/powder), Water and air reactive

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xn; risk phrases: R11; R15; R17; R19; R22; R34; R36/37/38; R40; safety phrases: S1; S7/8; S16; S26; S33; S36/37; S43; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): Nonhazard to water. (particles >1 mm).

Description: Magnesium is a light, silvery-white metal in various forms, and is a fire hazard. Molecular weight = 24.31; specific gravity (H_2O:1) = 1.74 @ 20°C; boiling point = 1090°C; freezing/melting point = 649°C (pellets); 651°C (powder); autoignition temperature = 473°C (powder). Explosive limits: LEL = 0.03 kg/m^3. Ignition temperature of dust cloud = 520°C; minimum explosive concentration = 0.020 oz/ft^3[209]. Relative explosion hazard of dust: Severe. Hazard identification (based on NFPA-704 M Rating System): (*powder, turnings and ribbon*) Health 0, flammability 1, reactivity 1₩. Reacts with water, releasing flammable hydrogen gas.

Potential Exposure: Magnesium alloyed with manganese, aluminum, thorium, zinc, cerium, and zirconium, is used in aircraft, ships, automobiles, hand tools, etc., because of its lightness. Dow metal is the general name for a large group of alloys containing over 85% magnesium. Magnesium wire and ribbon are used for degassing valves in the radio industry and in various heating appliances; as a deoxidizer and desulfurizer in copper, brass, and nickel alloys; in chemical reagents; as the powder in the manufacture of flares, incendiary bombs, tracer bullets, and flashlight powders; in the nuclear energy process; and in a cement of magnesium oxide and magnesium chloride for floors. Magnesium is an essential element in human and animal nutrition and also in plants, where it is a component of all types of chlorophyll. It is the most abundant intracellular divalent cation in both plants and animals. It is an activator of many mammalian enzymes.

Incompatibilities: Dust may form explosive mixture with air. Capable of self-ignition in moist air. The substance is a strong reducing agent. Reacts violently with, oxidizers, strong acids; acetylene, ammonium salts; arsenic, beryllium fluoride, carbon tetrachloride, carbonates, chloroform, cyanides, chlorinated hydrocarbons; ethylene oxide; hydrocarbons, metal oxides; methanol, phosphates, silver nitrate; sodium peroxide; sulfates, trichloroethylene, and many other substances, causing fire and explosion hazards. Finely divided material, in powdered, chip or sheet form, reacts with moisture or acids, evolving flammable hydrogen gas, causing fire and explosion hazard. Finely divided form is readily ignited by a spark or flame. It splatters and burns at above 1260°C.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC) Ver. 29[138]
PAC-1: 18 milligram per cubic meter
PAC-2: 200 milligram per cubic meter
PAC-3: 1200 milligram per cubic meter
No standards set for elemental magnesium.

Determination in Air: Filter collection and atomic absorption analysis.

Permissible Concentration in Water: The World Health Organization (WHO) has established European and International desirable limits ranging from 30 to 125 mg/L, depending on the sulfate concentration. If the sulfate exceeds 250 mg/L, the magnesium is limited to 30 mg/L. The WHO specifies an absolute maximum of 150 mg/L for magnesium in drinking water. In view of the fact that concentrations of magnesium in drinking water are less than those that impart astringent taste, they pose no health problem and are more likely to be beneficial; no limitation for reasons of health is needed.

Determination in Water: Magnesium in water can be determined by atomic-absorption spectrophotometry, with a sensitivity of 15 mg/L, and by photometry with a sensitivity of 100 μg/L.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes and skin. Inhaling dust can irritate the respiratory tract, causing coughing, wheezing, and/or shortness of breath. Magnesium and magnesium compounds are mild irritants to the conjunctiva and nasal mucosa, but are not specifically toxic. Inhalation may cause metal fume fever; the symptoms may be delayed for 4−12 hours following exposure. On the skin, these hot particles are capable of producing second and third degree burns, but they respond to treatment as other thermal burns do. Metallic magnesium foreign bodies in the skin cause no unusual problems in humans. In animal experiments, however, they have caused “gas-gangrene”-massive localized

DOI: http://dx.doi.org/10.1016/B978-0-323-38968-6.00012-0

gaseous tumors with extensive necrosis. Magnesium salts at levels over 700 g/L (especially magnesium sulfate) have a laxative effect, particularly on new users, although the human body can adapt to the effects of magnesium with time.

Long-Term Exposure: Repeated exposure can cause an accumulation in the body, causing upset stomach.

Medical Surveillance: There is no special test.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If fragments have become imbedded in the skin and removal cannot be ensured by thorough scrubbing, medical attention for thorough removal is recommended. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. The symptoms of metal fume fever may be delayed for 4–12 hours following exposure: it may last less than 36 hours. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. *Note to Physician*: In case of fume inhalation, treat pulmonary edema. Give prednisone or other corticosteroid orally to reduce tissue response to fume. Positive-pressure ventilation may be necessary. Treat metal fume fever with bed rest, analgesics and antipyretics.

Personal Protective Methods: It burns with an intense flame; do not look directly at fire; wear adequate eye protection. Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear or dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures to magnesium, use a National Institute for Occupational Safety and Health (NIOSH)/MSHA (US) or EN149 (Europe)-approved respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: (1) Color code—Red Stripe: Flammability Hazard (*powder, turnings, and ribbon are flammable solids*): Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8–10 m or a 1-hour fire wall from flammable or reactive materials. Store flammable solids up to maximum allowable quantity per control area in an approved flammable storage area. Do not store in a basement. (2) Color code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Magnesium must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine), strong acids (such as hydrochloric, sulfuric, and nitric); and chlorine trifluoride, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from water. Use only nonsparking tools and equipment, especially when opening and closing containers of magnesium. Protect storage containers from physical damage.

Shipping: UN1869 Magnesium pellets, turnings or ribbons, Hazard Class: 4.1; Labels: 4.1-Flammable solid. UN1418 Magnesium, powder or Magnesium alloys, powder, Hazard Class: 4.3; Labels: 4.3-Dangerous when wet material, 4.2-Spontaneously combustible material. UN2950 Magnesium granules, coated, particle size not $<149\ \mu m$, Hazard Class: 4.3; Labels: 4.3-Dangerous when wet material.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Use a vacuum to reduce dust during clean-up. Do not dry sweep. Collect powdered material and deposit in sealed containers. Ventilate area after clean-up is complete. Keep magnesium out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Magnesium is a combustible solid or a flammable powder. It burns with an intense flame. Thermal decomposition products may include poisonous magnesium oxide. Reacts violently with fire extinguishing agents, such as water, carbon dioxide and powder. Dangerous when wet. It burns in a current of steam. Finely divided materials form explosive mixture with air. Fire may restart after it has been extinguished. Use dry sand, MetL-X powder, or G-1 graphite powder, soda ash; Class D extinguishers, or talc. *Do not use water* or hydrous agents. Fire may restart after it has been extinguished. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (170); (100).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 4, No. 2, 79−81 (1984).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Magnesium, Trenton, NJ (September 1999).

Magnesium Chlorate M:0110

Formula: Cl_2MgO_6; $Mg(ClO_3)_2$

Synonyms: Chlorate salt of magnesium; Chloric acid, De-Fol-Ate; Chloric acid, magnesium; E-Z-Off; Magnesium dichlorate; Magnesium salt; Magron; MC defoliant; Ortho MC

CAS Registry Number: 10326-21-3

HSDB Number: 7630 as chlorate compounds

RTECS Number: FO0175000

UN/NA & ERG Number: UN2723/140

EC Number: 233-711-1

Regulatory Authority and Advisory Information

Hazard Alert: Powerful oxidizer, Explosive, Environmental hazard (runoff from fire), Suspected reprotoxic hazard.

Hazard symbols, risk, & safety statements: Hazard symbol: O; risk phrases: R8; R63; safety phrases: S7/8; S36/37/39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Magnesium chlorate is white crystalline solid. Molecular weight = 191.21; boiling point = 120°C; freezing/melting point = 35°C. Soluble in water (reaction).

Potential Exposure: Used as a drying agent and defoliant.

Incompatibilities: A strong oxidizer. Potentially explosive. Violent reactions with arsenic, carbon, charcoal, copper, phosphorus, sulfur, magnesium oxide; metal sulfides (copper sulfide, arsenic sulfide, tin sulfide; fuels, and strong acids. Reacts with moisture.

Permissible Exposure Limits in Air Russia[43] set a MAC in ambient air in residential areas of 0.1 milligram per cubic meter both on a momentary and a daily average basis.

Determination in Air:

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Permissible concentration in Water: *Chlorates*: State Drinking Water Guidelines: California 800 μg/L; Maine 7 μg/L.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Magnesium chlorate can affect you when breathed in. Contact can irritate or even burn the skin and eyes. Inhaling the dust irritates the respiratory system. Exposure can interfere with the ability of the blood to carry oxygen, causing headaches, weakness dizziness, trouble breathing; collapse, and possible death. Breathing the dust can irritate the air passages, cause sore throat and/or cough with phlegm.

Long-Term Exposure: Repeated exposure can cause lung irritation; bronchitis may develop with coughing, phlegm, and/or shortness of breath. May affect the kidneys.

Points of Attack: Lungs, blood.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended. Lung function tests. Kidney function tests. If symptoms develop or overexposure is suspected, the following may be useful: blood methemoglobin level.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to Physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/

manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposure to magnesium chlorate, use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece respirator with a high efficiency particulate filter. Greater protection is provided by a powered-air purifying respirator (PAPR). Where there is potential for high exposure exists, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Check oxygen content prior to entering storage area. Oxidizer. Potentially explosive. Color code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially organic materials, flammables and combustibles, and other incompatible materials. Oxidizers, including oxidizing gases, should have a boundary separation of 8–10 m or a 1-hour fire wall from flammable or reactive materials. Prior to working with magnesium chlorate all handlers should be trained on its proper handling and storage. Magnesium chlorate must be stored to avoid contact with aluminum, arsenic, carbon, copper, phosphorus, sulfur, magnesium oxide, metal sulfides; fuels and strong acids, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from flammable and combustible materials. Store in a cool, well-ventilated area away from incompatible materials listed above. Store in a cool, well-ventilated area away from incompatible materials listed above. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage.

Shipping: UN2723 Magnesium chlorate. Hazard Class: 5.1; Labels: 5.1-Oxidizer, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. Spilled magnesium chlorate tends to become very sensitive to shock or friction and is an explosion hazard. Keep magnesium chlorate out of sewers since it can ignite flammable or combustible materials and thus cause a fire or explosion hazard. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Magnesium chlorate itself does not burn but it will increase the intensity of a fire since it is an oxidizer. Containers may explode in fire; use water spray to keep fire-exposed containers cool. Thermal decomposition products may include hydrogen chlorine and magnesium oxide. Extinguish fire using an agent suitable for type of surrounding fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Magnesium Chlorate, Trenton, NJ (September 1999).

Magnesium Hydride M:0120

Formula: H_2Mg; MgH_2

Synonyms: Dihydride magnesium; Magnesium(II) hydride; Magnesium dihydride

CAS Registry Number: 7693-27-8; 60616-74-2

HSDB Number: 7065 as magnesium compounds

RTECS Number: OM3560000

UN/NA & ERG Number: UN2010/138

EC Number: 231-705-3

Regulatory Authority and Advisory Information

Hazard Alert: Combustible, Pyrophoric hazard, Violently reactive with water, Strong reducing agent.

Hazard symbols, risk, & safety statements: Hazard symbol: F+, Xi; risk phrases: R11; R14/15; R17; R36/37/38; safety phrases: S2; S7; S8; S16; S26; S36/37/39; S41; S43A; S41 (see Appendix 4)

Description: Magnesium hydride is a coarse, gray crystalline solid. Molecular weight = 26.33; freezing/melting point ≥200°C; flash point = 110°C. Hazard identification (NJDHSS): Health 1, flammability 4, reactivity 2₩. Insoluble in water; dangerous reaction releasing magnesium hydroxide, flammable hydrogen gas, and possibly enough heat to ignite the hydrogen.

Potential Exposure: Used in hydrogen production and in production of magnesium alcoholates.

Incompatibilities: A strong reducing agent. Pyrophoric: the powder or dust may ignite spontaneously in air, or in the presence of moisture. Contact with water or steam forms magnesium hydroxide, flammable hydrogen gas, and enough heat to ignite the hydrogen. Violent reaction with oxidizers, alcohols, halogens, chlorinated solvents. Incompatible with strong acids, acid chlorides, alcohols, amines and aldehydes. Store under nitrogen. Decomposes @ 280°C in high vacuum.

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Magnesium hydride can affect you when breathed in. Contact can irritate or even burn the skin and eyes. Breathing the dust can irritate the air passages, causing sore throat and/or cough with phlegm.

Long-Term Exposure: Long-term effects are unknown at this time.

Points of Attack: Lungs.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended. Lung function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures to magnesium hydride, use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece respirator with a particulate (dust/fume/mist) filter. Particulate filters must be checked every day before work for physical damage, such as rips or tears and replaced and needed. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Red Stripe: Store under inert gas. Dangerous when wet materials release flammable gases on contact with water. Do not store this material in a room protected by water sprinkler systems. Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Do not store in a basement. Store under nitrogen in tightly closed containers in cool (decomposes >250°C), well-ventilated area. Keep containers dry at all times. Magnesium hydride reacts violently with water, releasing caustic material, heat, and flammable gas. Sources of ignition, such as smoking and open flames, are prohibited where magnesium hydride is handled, used, or stored.

Shipping: UN2010 Magnesium hydride, Hazard Class: 4.3; Labels: 4.3-Dangerous when wet material.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Use vacuum to reduce dust during clean-up. Do not use dry sweep. Collect powdered material in the most safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. Keep magnesium hydride out of sewers because of possibility of fire or explosion. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Magnesium hydride is a flammable and reactive solid. Thermal decomposition products may include oxides of metal and harmful and irritating gases. Use dry chemical, sand, soda ash; or lime extinguishers. *Do not use water*, carbon dioxide; or foam. Magnesium hydride can catch fire spontaneously in air or in the presence of moisture. Fire may restart after it has been extinguished. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (170).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Magnesium Hydride, Trenton, NJ (August 1999).

Magnesium Nitrate M:0130

Formula: MgN_2O_6; $Mg(NO_3)_2$

Synonyms: Nitric acid, Magnesium salt; Nitromagnesite

CAS Registry Number: 10377-60-3; 10213-15-7 (hexahydrate)

HSDB Number: 660

RTECS Number: OM3750000

UN/NA & ERG Number: UN1474/140

EC Number: 233-826-7; S41 (see Appendix 4).

Regulatory Authority and Advisory Information

Hazard Alert: Strong oxidizer, Irritant.

United States National Primary Drinking Water Regulations: MCLG = 10 mg[N]/L; Maximum Contaminant Level (MCL) = 10 mg/L as nitrates

Hazard symbols, risk, & safety statements: Hazard symbol: O, Xi; risk phrases: R8; R34; R36/37/38; safety phrases: S7/8; S17; S26; S36; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Magnesium nitrate is white crystalline solid. Molecular weight = 148.33; 256.45 (hexahydrate); specific gravity (H_2O:1) = 1.45 @ 20°C (dihydrate); freezing/melting point = 129°C (dihydrate); 95−100°C (hexahydrate). It decomposes @ 330°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 0, reactivity 2 OX. A strong oxidizer. Soluble in water.

Potential Exposure: Magnesium nitrate is used in fireworks and in the production of concentrated nitric acid.

Incompatibilities: A powerful oxidizer. Violent reaction with dimethylformamide, reducing agents; combustibles, fuels, organic and easily oxidizable matter.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 30 milligram per cubic meter

PAC-2: 330 milligram per cubic meter

PAC-3: 2000 milligram per cubic meter

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Magnesium nitrate can affect you when breathed in. Contact can irritate or even burn the skin and eyes. The dust can irritate the eyes and air passages, causing sore throat and/or cough with phlegm. Exposure can interfere with the ability of the blood to carry oxygen, causing headaches, weakness, nausea and a bluish color to the skin and lips (methemoglobinemia). Higher levels can cause trouble breathing; collapse and even death.

Long-Term Exposure: Repeated exposure can cause headache, weakness, and dizziness.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: blood methemoglobin level.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to Physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures to magnesium nitrate, use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece respirator with a with a high efficiency particulate filter. Greater protection is provided by a PAPR. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved

SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Check oxygen content prior to entering storage area. Color code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially organic materials, flammables and combustibles, and other incompatible materials. Oxidizers, including oxidizing gases, should have a boundary separation of 8–10 m or a 1-hour fire wall from flammable or reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Magnesium nitrate must be stored to avoid contact with dimethyl formamide, fuels and strong reducing agents such as hydrides; since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from flammable and combustible materials. Avoid storage on wood floors. Store in a cool, well-ventilated area away from incompatible materials listed above. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage.

Shipping: UN1474 Magnesium nitrate, Hazard Class: 5.1; Labels: 5.1-Oxidizer.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. Keep magnesium nitrate out of sewers since it can ignite flammable and combustible materials and thus cause a fire or explosion hazard. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen, metal, and oxygen. Oxidizers may increase the intensity or violence of fire. Extinguish fire using an agent suitable for type of surrounding fire. Use water spray to keep fire-exposed containers cool. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Magnesium Nitrate, Trenton, NJ (September 1999).

Magnesium Oxide M:0140

Formula: MgO

Synonyms: Akro-mag; Animag; Calcined brucite; Calcined magnesia; Calcined magnesite; Granmag; Magcal; Magchem 100; Maglite; Magnesia; Magnesia fume; Magnesia USTA; Magox; Marmag; Periclase; Seawater magnesia

CAS Registry Number: 1309-48-4

HSDB Number: 1652

RTECS Number: OM3850000

UN/NA & ERG Number: UN1418 (powder)/138

EC Number: 215-171-9

Regulatory Authority and Advisory Information

Hazard Alert: Possible risk of forming tumors, FDA-over the counter drug.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Magnesium oxide forms a finely divided white particulate dispersed in air. Molecular weight = 40.31; specific gravity (H_2O:1) = 3.6 @ 20°C; boiling point = 3600°C; freezing/melting point = 2825°C; vapor pressure = 51.5 mmHg @ 2832°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 0, reactivity 1. Poor solubility in water.

Potential Exposure: Used in oil refining, pulp and paper mills; tire manufacturing; in the manufacture of refractory crucibles; fire bricks; magnesia cements and boiler scale compounds. Exposure may occur when magnesium is burned, thermally cut, or welded upon.

Incompatibilities: Violent reaction with halogens/interhalogens, chlorine trifluoride, bromine pentalfluoride; strong acids. Phosphorus pentachloride and magnesium oxide react with brilliant incandescence (Mellor 8:1016. 1946–1947)[101]. May ignite and explode when heated with sublimed sulfur, magnesium powder, or aluminum powder.

Permissible Exposure Limits in Air

NIOSH IDLH = 750 milligram per cubic meter (fume)

OSHA PEL: 15 milligram per cubic meter (*total particulate; fume*) TWA

NIOSH: There is inadequate data to propose an exposure limit. See Appendix D of *The NIOSH Pocket Guide*

ACGIH TLV[1]: 10 milligram per cubic meter TWA (*inhalable fraction*); not classifiable as a human carcinogen

PAC Ver. 29[138]
PAC-1: 30 milligram per cubic meter
PAC-2: 120 milligram per cubic meter
PAC-3: 730 milligram per cubic meter
DFG MAK: 4 milligram per cubic meter, inhalable fraction; 1.5 milligram per cubic meter, respirable fraction; see Sections V(f) and V(g). See V(h) for fume; Pregnancy Risk Group C
Arab Republic of Egypt: TWA 10 milligram per cubic meter, 1993; Australia: TWA 10 milligram per cubic meter, 1993; Austria: MAK 6 milligram per cubic meter, 1999; Belgium: TWA 10 milligram per cubic meter, 1993; France: VME 10 milligram per cubic meter, 1999; Hungary: TWA 5 milligram per cubic meter; STEL 10 milligram per cubic meter, 1993; Norway: TWA 10 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 10 milligram per cubic meter, 2003; Poland: MAC (TWA) fume 5 milligram per cubic meter, MAC (TWA) dust 10 milligram per cubic meter, 1999; Russia: STEL 5 milligram per cubic meter, 1993; Switzerland: MAK-W 6 milligram per cubic meter, 1999; Turkey: TWA 15 milligram per cubic meter, 1993; United Kingdom: TWA 10 mg[Mg]/m^3, total inhalable dust; TWA 4 mg[Mg]/m^3, fume and respirable dust, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Several states have set guidelines or standards for magnesium oxide fume in ambient air[60] ranging from 100 μ/m^3 (North Dakota) to 160 μ/m^3 (Virginia) to 200 μ/m^3 (Connecticut) to 238 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #7300 (Elements by ICP), #7301, #7303; OSHA Analytical Method #ID-125G.

Permissible Concentration in Water: No criteria set, but EPA[32] has suggested a permissible ambient goal for magnesium oxide of 138 μg/L based on health effects.

Routes of Entry: Inhalation of fume, eye and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes and respiratory tract. Magnesium in the form of nascent magnesium oxide can cause metal fume fever with cough, chest pain; flu-like fever; if inhaled in sufficient quantity. The symptoms of metal fume fever may be delayed for 4−12 hours following exposure.

Long-Term Exposure: It has been noted that magnesium workers show a rise in serum magnesium—although no significant symptoms of ill health have been identified. Some investigators have reported higher incidence of digestive disorders and have related this to magnesium absorption, but the evidence is scant.

Points of Attack: Eyes, respiratory system.

Medical Surveillance: NIOSH lists the following test for fume exposure: whole blood (chemical/metabolite).

First Aid: Breathing: If a person breathes large amounts of this chemical, move the exposed person to fresh air at once. If breathing has stopped, perform mouth-to-mouth resuscitation. Keep the affected person warm and at rest. Get medical attention as soon as possible[77]. If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. The symptoms of metal fume fever may be delayed for 4−12 hours following exposure: it may last less than 36 hours. *Note to Physician*: In case of fume inhalation, treat for pulmonary edema. Give prednisone or other corticosteroid orally to reduce tissue response to fume. Positive-pressure ventilation may be necessary. Treat metal fume fever with bed rest, analgesics and antipyretics.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. magnesium oxide.

Respirator Selection: *as fume* OSHA: *up to 150 milligram per cubic meter*: 95XQ [Any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]. Sa (APF = 10) (any supplied-air respirator). *Up to 375 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PAPRDMFu* (any PAPR with a dust, mist, and fume filter). *Up to 750 milligram per cubic meter*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or PaprTHie (APF = 50) (any PAPR with a tight-fitting facepiece and a high-efficiency particulate filter) SCBAF (APF = 50) (any SCBA with a full facepiece) SaF (APF = 50) (any supplied-air respirator with a full facepiece.) *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode) SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA). *Substance reported to cause eye irritation or damage; may require eye protection.

Storage: (1) Color code—Red Stripe: Dangerous when wet materials release flammable gases on contact with water. Do not store this material in a room protected by water sprinkler systems. Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Do not store in a basement; also Flammability Hazard (4.2): Store flammable solids (spontaneously combustible) up to maximum allowable quantity per control area in an approved flammable storage area. (2) Color code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store finely divided powder, chips or shavings separately in detached fire-resistant building isolated from flammables, combustibles, or other yellow coded materials. Protect against physical damage. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Magnesium oxide must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates, and chlorine trifluoride), halogens, strong acids, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated, "No Smoking" area away from moisture. Use nonsparking type tools and equipment, including explosion proof ventilation. Containers of this material may be hazardous when empty since they retain product residues (dust, solids); observe all warnings and precautions listed for the product.

Shipping: UN1418 Magnesium, powder or Magnesium alloys, powder Hazard Class: 4.3; Labels: 4.3-Dangerous when wet material, 4.2-Spontaneously combustible material.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Thermal decomposition products may include oxides of metal. May ignite and explode when heated with sublimed sulfur, magnesium powder, or aluminum powder. Use any extinguisher suitable for surrounding fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Magnesium Oxide (Fume), Trenton, NJ (January 2007).

Magnesium Perchlorate M:0150

Formula: Cl_2MgO_8; $Mg(ClO_4)_2$

Synonyms: Ammonium perchlorate, anhydrous; Ammonium perchlorate, hexahydride; Anhydrone; Dehydrite; Perchlorate de magnesium (French); Perchloric acid, Magnesium salt

CAS Registry Number: 10034-81-8

HSDB Number: 661

RTECS Number: SC8925000

UN/NA & ERG Number: UN1475/140

EC Number: 233-108-3

Regulatory Authority and Advisory Information

Hazard Alert: Strong oxidizer, Explosive.

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Magnesium perchlorate is a white crystalline solid. Molecular weight; 223.21; specific gravity (H_2O:1) = 2.6 @ 20°C; freezing/melting point ≥ 250°C (decomposes). Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 0, reactivity 3 (Oxidizer). Soluble in water.

Potential Exposure: Magnesium perchlorate is used as a drying agent for gases and as an oxidizing agent.

Incompatibilities: A powerful oxidizer. Violent reaction with reducing agents; alkenes (above 220°C), ammonia gas; organic matter; ethylene oxide, finely divided or powdered metals, combustible materials, phosphorus, dimethylsulfoxide, mineral acids; wet argon; hydrazines, alcohols, wet fluorobutane; butyl fluorides; organic materials. Forms explosive material with ethyl alcohol. Incompatible with many materials. Shock or heat may cause magnesium perchlorate to explode.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 4.9 milligram per cubic meter

PAC-2: 54 milligram per cubic meter

PAC-3: 320 milligram per cubic meter

Permissible concentration in Water: *Chlorates*: State Drinking Water Guidelines: California 800 μg/L; Maine 7 μg/L.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short-Term Exposure: Magnesium perchlorate can affect you when breathed in. Contact can irritate or even burn the skin and eyes. Breathing the dust can irritate the air passages, causing sore throat and/or cough with phlegm. High levels can interfere with the ability of the blood to carry oxygen, causing headaches, dizziness, and a bluish color to the skin. Very high levels could cause death.

Long-Term Exposure: Can irritate the lungs. Repeated exposure may cause bronchitis.

Points of Attack: Lungs, blood.

Medical Surveillance: For those with frequent or potentially high exposure the following are recommended before beginning work and at regular times after that. Lung function tests. If symptoms develop or overexposure is suspected, the following maybe useful: blood methemoglobin level.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to Physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures to magnesium perchlorate, use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece respirator with a high efficiency particulate filter. Greater protection is provided by a PAPR. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Check oxygen content prior to entering storage area. Color code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially organic materials, flammables and combustibles, and other incompatible materials. Oxidizers, including oxidizing gases, should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Magnesium perchlorate must be stored to avoid contact with fuels, finely powdered metals; mineral acids; ammonia, ethylene oxide; phosphorus, dimethyl sulfoxide and trimethyl phosphite, since violent reactions occur. Shock may cause magnesium perchlorate to explode. Store in tightly closed containers in a cool, well-ventilated area away from flammable and combustible materials. Do not store on wood floors. Store in a cool, well-ventilated area away from incompatible materials listed above. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage.

Shipping: UN1475 Magnesium perchlorate, Hazard Class: 5.1; Labels: 5.1-Oxidizer.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Use vacuum to reduce dust during clean-up. Do not dry sweep. Collect powdered material in the most safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Magnesium perchlorate itself does not burn but it will increase the intensity of a fire since it is an oxidizer. Thermal decomposition products may include hydrogen chloride and metal oxide of magnesium. Extinguish fire using an agent suitable for type of surrounding fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Magnesium Perchlorate, Trenton, NJ (November 1999).

Magnesium Peroxide M:0160

Formula: MgO_2

Synonyms: IXPER 25M; Magnesium dioxide; Magnesium superoxol; Peromag; Peróxido de magnesio (Spanish); Peroxyde de magnésium (French)

CAS Registry Number: 14452-57-4 (MgO); 1335-26-8 (MgO_2)

HSDB Number: 7986

RTECS Number: OM4100000

UN/NA & ERG Number: UN1476/140

EC Number: 238-438-1

Regulatory Authority and Advisory Information

Hazard Alert: Strong oxidizer.

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Magnesium peroxide is a white, odorless crystalline solid. Molecular weight = 56.31 (MgO_2); 40.3 (MgO); decomposes above 100°C. Insoluble in water; slow decomposition releasing oxygen.

Potential Exposure: Magnesium peroxide is used as a bleaching and oxidizing agent, and in the manufacture of antacids and antiinfective drugs.

Incompatibilities: Powerful oxidizer. Dangerous fire risk with flammable and combustible materials. Violent reaction with acids. Keep away from moisture; causes the release of oxygen and heat.

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short-Term Exposure: Magnesium peroxide can affect you when breathed in. Contact can irritate or even burn the skin and eyes. Breathing the dust can irritate the air passages, causing sore throat and/or cough with phlegm.

Long-Term Exposure: This chemical is a very irritating substance, and it may cause lung effects or damage.

Points of Attack: Lungs.

Medical Surveillance: For those with frequent or potentially high exposure, the following are recommended before beginning work and at regular times after that. Lung function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Color code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Oxidizers, including oxidizing gases, should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Where there is potential exists for exposures to magnesium peroxide, use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece respirator with a high efficiency particulate filter. Greater protection is provided by a PAPR. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Check oxygen content prior to entering storage area. Color code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially organic materials, flammables and combustibles, and other incompatible materials. Oxidizers, including oxidizing gases, should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Magnesium peroxide must be stored to avoid contact with acids, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from flammable and combustible materials. Keep magnesium peroxide dry. In contact with moisture, it is a dangerous fire hazard because it releases oxygen and much heat. Store in a cool, well-ventilated area away from incompatible materials listed above. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage.

Shipping: UN1476 Magnesium peroxide, Hazard Class: 5.1; Labels: 5.1-Oxidizer.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Use a vacuum or a wet method to reduce dust during clean-up. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Magnesium peroxide itself does not burn but it will increase the intensity of a fire since it is an oxidizer. Thermal decomposition products may include magnesium oxide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Magnesium Peroxide, Trenton, NJ (December 2000).

Magnesium Silicide M:0170

Formula: Mg_2Si

Synonyms: Dimagnesium silicide; Silanediylidenedimagnesium

CAS Registry Number: 22831-39-6; 39404-03-0

HSDB Number: 7065 as magnesium compounds

RTECS Number: OM4367000

UN/NA & ERG Number: UN2624/138

EC Number: 245-254-5

Regulatory Authority and Advisory Information

Hazard Alert: Strong reducing agent, Dangerously water reactive; Possible pyrophoric hazard (moist air).

Hazard symbols, risk, & safety statements: Hazard symbol: F; risk phrases: R11; R14/15; R19; R29; safety phrases: S7/8; S9; S14; S16; S21; S33; S41; S43; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Magnesium silicide is a slate blue crystalline solid. Molecular weight = 76.71; freezing/melting point = 778°C. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 3, reactivity 2~~W~~. Dangerous reaction with water, releasing flammable gases including hydrogen, and possibly silane gas as well.

Potential Exposure: Magnesium silicide is used in the semiconductor industry and to produce certain aluminum alloys.

Incompatibilities: Possibly pyrophoric, especially in moist air. Pyrophoric; mixtures with air are spontaneously explosive. A strong reducing agent. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, mineral acids, strong acids, strong bases. Reacts with water; releasing explosive hydrogen gas and may also release self-igniting toxic silane gas.

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Determination in Air: No criteria set.

Routes of Entry: Inhalation, eye and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Contact can irritate the skin and/or eyes. Breathing the dust can irritate the air passages, causing cough with phlegm. In contact with moisture or acid or acid mist, a highly irritating and flammable gas (silane) is released.

Long-Term Exposure: Unknown at this time.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large

quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures to magnesium silicide, use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece respirator equipped with particulate (dust/fume/mist) filters. More protection is provided by a full facepiece respirator than by a half-mask respirator, and even greater protection is provided by a PAPR. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Flammable solid. Color code—Red: Flammability Hazard: Handle under dry, inert gas; keep away from moisture. Store in a flammable materials storage area. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from acids. Keep dry at all times. Sources of ignition, such as smoking and open flames, are prohibited where magnesium silicide is handled, used, or stored.

Shipping: UN2624 Magnesium silicide, Hazard Class: 4.3; Labels: 4.3-Dangerous when wet material.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Use HEPA vacuum; do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. Keep magnesium silicide out of sewers because of possibility of fire or explosion. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Magnesium silicide is a flammable solid. Releases flammable silane gas on contact with water. Thermal decomposition may include silicon oxide and oxide of metal. Use dry chemical, soda ash; or lime extinguishers. *Do not use water* or foam. May ignite spontaneously in air. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (170); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Magnesium Silicide, Trenton, NJ (December 2000).

Malathion M:0190

Formula: $C_{10}H_{19}O_6PS_2$

Synonyms: Agrichem greenfly spray; AI3-17034; All-purpose garden insecticide; American Cyanamid 4049; Ban-mite; *S*-[1,2-Bis(aethoxy-carbonyl)-aethyl]-*O*,*O*-dimethyl-dithiophosphat (German); *S*-[1,2-Bis(carbethoxy)ethyl] *O*,*O*-dimethyl dithiophosphate; *S*-[1,2-Bis(ethoxycarbonyl) ethyl] *O*,*O*-dimethyl phosphorodithioate; *S*-1,2-Bis(ethoxycarbonyl)ethyl *O*,*O*-dimethyl thiophosphate; Butanedioic acid, [(dimethoxyphosphinothioyl)thio]-, diethyl ester; Calmathion; Carbethoxy malathion; Carbetovur; Carbetox; Chemathion; Cimexan; Compound 4049; Cromocide; Cythion; Detmol 96%; Detmol MA; Detmol malathion; *S*-(1,2-Dicarbethoxyethyl) *O*,*O*-dimethyl phosphorodithioate; Dicarboethoxyethyl *O*,*O*-dimethyl phosphorodithioate; Diethyl [(dimethoxyphosphinothioyl)-thio]butanedioate; Diethyl (dimethoxyphosphinothioylthio)-succinate; Diethyl (dimethoxythiophosphorylthio)succinate; Diethyl mercaptosuccinate, *O*,*O*-dimethyl dithiophosphate, *S*-ester; Diethyl mercaptosuccinate, *O*,*O*-dimethyl phosphorodithioate; Diethyl mercaptosuccinate, *O*,*O*-dimethyl thiophosphate; Diethyl mercaptosuccinate, *S*-ester with *O*,*O*-dimethyl phosphorodithioate; [(Dimethoxyphosphinothioyl)thio]butanedioic acid diethyl ester; *O*,*O*-Dimethyl *S*-(1,2-dicarbaethoxyaethyl)-dithiophosphat (German); *O*,*O*-Dimethyl *S*-(1,2-dicarbethoxyethyl) dithiophosphate; *O*,*O*-Dimethyl *S*-(1,2-dicarbethoxyethyl) phosphorodithioate; *O*,*O*-Dimethyl *S*-1,2-di(ethoxycarbamyl)ethyl phosphorodithioate; *O*,*O*-Dimethyl dithiophosphate diethyl mercaptosuccinate; *O*,*O*-Dimethyl dithiophosphate of diethyl mercaptosuccinate; Dithiophosphate de *O*,*O*-dimethyle et de *S*-(1,2-dicarboethoxyethyle) (French); Duramitex; EL 4049; Emmatos; Emmatos extra; ENT 17,034; Ethiolacar; Etiol; Eveshield captan/malathion; Extermathion; Fisons greenfly and blackfly killer; FOG 3; Formal; Forthion; Fosfothion; Fosfotion; Greenfly aerosol spray; Hilthion (Indian); Karbofos; Kop-thion; Kypfos; Malacide; Malafor; Malagran; Malakill; Malamar; Malamar 50; Malasol; Malaspray; Malataf; Malathion 60; Malathion E50; Malathion LB concentrate; Malathion organophosphorous insecticide; Malathon; Malathyl; Malation (Spanish); Maldison (in Australia, New Zealand); Malmed; Malphos; Mercaptosuccinic acid diethyl ester; Mercaptothion; Moscarda; NCI-C00215; Oleophosphothion; Orthomalathion; PBI crop saver; Phosphothion; Prioderm; Sadofos; Sadophos; SF 60; Siptox I; Spray concentrate; STCC 4941156; Succinic acid, mercapto-, diethyl ester, *S*-ester with *O*,*O*-dimethyl phosphorodithioate; Sumitox; TAK; TM-4049; Vetiol; Zithiol

CAS Registry Number: 121-75-5

HSDB Number: 665

RTECS Number: WM8400000

UN/NA & ERG Number: UN2783 (organophosphorus pesticides, solid, toxic)/152

EC Number: 204-497-7 [*Annex I Index No.*: 015-041-00-X]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Inadequate Evidence; Human No Adequate Data, *not classifiable as carcinogenic to humans*, Group 3, 1987; NCI: Carcinogenesis Bioassay (feed); no evidence: rat; IARC: Animal Inadequate Evidence. United States Environmental Protection Agency Gene-Tox Program, Positive/dose response: In vitro SCE-human; Negative: Carcinogenicity-mouse/rat; Histidine reversion-Ames test; Negative: *D. melanogaster* sex-linked lethal; Negative: In vitro UDS-human fibroblast; TRP reversion; Negative: *S. cerevisiae-homozygosis*; Inconclusive: *B. subtilis* rec assay; *E. coli polA* without S9.

Hazard Alert: Poison, Neurotoxin (cumulative), Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Environmental hazard.

FDA-proprietary drug

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 100 lb (45.4 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: Xn, N, Xi; risk phrases: R22; R33; R43; R50/53; R62; R63; safety phrases: S2; S24; S29/35; S37; S41; S46; S60; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Malathion is a deep-brown to yellow liquid with a garlic-like odor. Clear and colorless when pure; freezing/melting point = 3°C; molecular weight = 330.38; boiling point = 156−157°C; vapor pressure = 8×10^{-6} mmHg @ 20°C; flash point ≥163°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 1, reactivity 0. Slightly soluble in water.

Potential Exposure: Malathion is marketed as 99.6% technical grade liquid. Available formulations include wetable powders (25% and 50%), emulsifiable concentrates, dusts, and aerosols. Malathion is used as a broad spectrum insecticide and acaricide in the control of certain insect pests on fruits, vegetables, and ornamental plants. It has been used in the control of houseflies, mosquitoes, lice; and on farm and livestock animals.

Incompatibilities: Reacts violently with strong oxidizers, magnesium, alkaline pesticides. Attacks metals including iron, steel, tin plate; lead, copper; and some plastics, coatings, and rubbers.

Permissible Exposure Limits in Air

NIOSH IDLH = 250 milligram per cubic meter

OSHA PEL: 15 milligram per cubic meter (*total dust*) TWA[skin]

NIOSH REL: 10 milligram per cubic meter TWA[skin]

ACGIH TLV[1]: 1 milligram per cubic meter TWA measured as inhalable fraction and vapor [skin]; not classifiable as a human carcinogen; TLV-BEI$_A$ issued as Acetylcholinesterase inhibiting pesticides.

PAC* Ver. 29[138]

PAC-1: **15$_{\mathbf{A}}$** milligram per cubic meter

PAC-2: **120$_{\mathbf{A}}$** milligram per cubic meter

PAC-3: **390$_{\mathbf{A}}$** milligram per cubic meter

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60-minute values.

DFG MAK: 15 milligram per cubic meter inhalable fraction TWA; Peak Limitation Category II(4); Pregnancy Risk Group D

Arab Republic of Egypt: TWA 10 milligram per cubic meter [skin], 1993; Australia: TWA 10 milligram per cubic meter [skin], 1993; Austria: MAK: 10 milligram per cubic meter, 1999; Belgium: TWA 10 milligram per cubic meter [skin], 1993; Denmark: TWA 5 milligram per cubic meter [skin], 1999; Finland: TWA 10 milligram per cubic meter; STEL 20 milligram per cubic meter, 1999; France: VME 10 milligram per cubic meter [skin], 1999; the Netherlands: MAC-TGG 10 milligram per cubic meter [skin], 2003; Norway: TWA 5 milligram per cubic meter, 1999; the Philippines: TWA 15 milligram per cubic meter [skin], 1993; Poland: MAC (TWA) 1 milligram per cubic meter, MAC (STEL) 10 milligram per cubic meter, 1999; Russia: STEL 0.5 milligram per cubic meter [skin], 1993; Switzerland: MAK-W 10 milligram per cubic meter [skin], 1999; Thailand: TWA 15 milligram per cubic meter, 1993; Turkey: TWA 15 milligram per cubic meter [skin], 1993; United Kingdom: TWA 10 milligram per cubic meter [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Argentina[35]: STEL 1.5 milligram per cubic meter. Russia[43] has set MAC values in the ambient air of residential areas at 0.015 milligram per cubic meter on a momentary basis and 0.006 milligram per cubic meter on a daily average basis. Several states have set guidelines or standards for malathion, in ambient air[60] ranging from 33.3 μ/m^3 (New York) to 100 μ/m^3 (Florida, North Dakota, South Carolina) to 160 μ/m^3 (Virginia) to 200 μ/m^3 (Connecticut) to 238 μ/m^3 (Nevada).

Determination in Air: OSHA versatile sampler-2; Toluene/Acetone; Gas chromatography/Flame photometric detection for sulfur, nitrogen, or phosphorus; NIOSH Analytical Method (IV) #5600, Organophosphorus Pesticides; OSHA Analytical Method ID-62.

Permissible Concentration in Water: Russia[43] set a MAC in water bodies used for domestic purposes of 0.05 mg/L. The MAC in water bodies used for fishery purposes is zero. Several states have set guidelines for malathion in drinking water[61] ranging from 40 μg/L (Maine to 140 μg/L (Kansas) to 160 μg/L (California).

Determination in Water: Fish Tox = 0.28991000 ppb (EXTRA HIGH).

Routes of Entry: Inhalation of vapor, skin absorption; ingestion and skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Malathion is representative of a general class called organophosphates. The effects caused by many short term exposures during a week's time can be accumulated and felt as one intense response. Sometimes effects are not felt until hours or days after exposure. *Inhalation*: No effects were reported from exposures of up to 86 milligram per cubic meter for 42 days. The only effect reported due to inhalation was the reduction in activity of an important nervous system enzyme. *Skin*: Important route of exposure during formulation and usage. Prolonged contact (hours) along with poor hygiene has resulted in irritation, as well as symptoms listed under ingestion. *Eyes*: Direct contact can lead to irritation and discomfort. *Ingestion*: Swallowing of malathion has caused severe poisoning and death. Swallowing of 1½−3 oz of a moisture (50% malathion) has caused severe poisoning with symptoms which include nausea, vomiting, headache, abdominal pain; diarrhea, difficulty in breathing; fall in blood pressure; muscle spasms; paralysis, loss of reflexes; convulsions, and coma. Between 3½ and 5 oz of a mixture (50% malathion) has caused death. Human Tox = 100.00000 ppb (VERY LOW).

Long-Term Exposure: Prolonged, daily contact with exposed areas of skin has led to skin irritation and sensitization. May cause genetic changes (mutations). High or repeated exposure may damage the nerves, causing weakness, dizziness, and poor coordination in arms and legs. Repeated exposures may cause personality changes; depression, anxiety, or irritability.

Points of Attack: Eyes, skin, respiratory system; liver, blood cholinesterase, central nervous system; cardiovascular system, gastrointestinal tract.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider complete blood count (CBC). Consider chest X-ray following acute overexposure. Preplacement and periodic medical examination shall include: comprehensive initial or interim medical and work histories. A physical examination which shall be directed toward, but not limited to evidence of frequent headache, dizziness, nausea, tightness of the chest; dimness of vision; and difficulty in focusing the eyes. Determination, at the time of the preplacement examination, of a baseline or working baseline erythrocyte ChE activity. A judgment of the worker's physical ability to use negative or positive pressure regulators as defined in 29 CFG 1910.134. Periodic examinations shall be made available on an annual basis or at some other interval determined by the responsible physician. Medical records shall be maintained for all workers engaged in the manufacture or formulation of malathion and such records shall be kept for at least 1 year after termination of employment. Pertinent medical information shall be available to medical representatives of the United States Government, the employer and the employees. Erythrocyte cholinesterase levels should be checked as noted above and as described in detail by NIOSH Criteria Document No. 76-205.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician or trained medical personnel: Administer atropine, 2 mg (0.030 g) intramuscularly or intravenously as soon as any local or systemic signs or symptoms of an intoxication are noted; repeat the administration of atropine every 3−8 minutes until signs of atropinization (mydriasis, dry mouth, rapid pulse; hot and dry skin) occur; initiate treatment in children with 1 mg of atropine. Watch respiration, and remove bronchial secretions if they appear to be obstructing the airway; intubate if necessary. Give 2-PAM (Pralidoxime; Protopam), 2.5 g in 100 mL of sterile water or in 5% dextrose and water, intravenously, slowly, in 15−30 minutes; if sufficient fluid is not available, give 1 g of 2-PAM in 3 mL of distilled water by deep intramuscular injection; repeat this every half hour if respiration weakens or if muscle fasciculation or convulsions recur.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin contact: 4 hours: Teflon gloves, suits, boots; 4H and Silver Shield gloves. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. *Respirator Protection*: Engineering controls shall be used wherever feasible to maintain airborne malathion concentrations below the recommended work-place environment limit. Compliance with the work-place environmental limit by the use of respirators is allowed only when airborne malathion concentrations are in excess of the work-place environmental limit because required engineering controls are being installed or tested, when nonroutine maintenance or repair is being accomplished, or during emergencies. When a respirator is thus permitted, it shall be selected and used in accordance with NIOSH requirements.

Respirator Selection: *100 milligram per cubic meter*: CcrOv95 (APF = 10) [any air-purifying half-mask respirator equipped with an organic vapor cartridge(s) in combination with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator) SCBA (any SCBA). 250 *milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) CcrFOv100 (APF = 50) [any air-purifying full facepiece respirator equipped with organic vapor cartridge(s) in combination with an N100, R100, or P100 filter]; or GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or PaprOvHie (APF = 25) (any PAPR with an organic vapor cartridge in combination with a high-efficiency particulate filter); SCBAF (APF = 50) (any SCBA with full facepiece) SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode) SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA). *Note*: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated, uninhabited area below 25°C. Store to avoid contact with oxidizers and alkaline pesticides. Store where possible leakage from containers cannot endanger the worker. Maintain regular inspection of containers for any leakage. Sources of ignition, such as smoking and open flames are prohibited where this chemical is handled, used, or stored.

Shipping: UN2783 Organophosphorus pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling:

Initial isolation and protective action distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.3/0.4
Night 0.8/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 600/200
Then: Protect persons downwind (mi/km)
Day 1.4/2.3
Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Do not touch spilled material. Do not breathe vapors. Stay upwind; keep out of low areas. Remove all ignition sources. Ventilate area of spill or leak. This material is a combustible liquid. For a spill or leak of a combustible liquid, shut off ignition sources; no flares, smoking, or flames in hazard area. Stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Malathion is combustible but ignites with difficulty. Thermal decomposition products may include oxides of phosphorus, sulfur, nitrogen, and carbon. A fire should be extinguished with agents suitable to the surrounding combustibles. Thermal decomposition products may include sulfur dioxide and phosphoric acid. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Malathion is reported to be "hydrolyzed almost instantly" at pH 12; 50%; hydrolysis at pH 0 requires 12 hours. Alkaline hydrolysis under controlled conditions (0.5 *n* NaOH in ethanol) gives quantitative yields of $(CH_3O)_2P(S)SNa$, whereas hydrolysis in acidic media yields $(CH_3O)_2P(S)OH$. On prolonged contact with iron or iron-containing material, it is reported to break down and completely lose insecticidal activity. Incineration together with a flammable solvent in a furnace equipped with afterburner and scrubber is recommended. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (100).

National Institute for Occupational Safety and Health (NIOSH), "Criteria for a Recommended Standard: Occupational Exposure to Malathion", NIOSH Document Number 76-205, Cincinnati, OH (June 1976).

New York State Department of Health, *Chemical Fact Sheet*: Malathion, Bureau of Toxic Substance Assessment, Albany, NY (Version 2-March 1986).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 7, No. 5, 63−74 (1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Malathion, Trenton, NJ (April 2004).

Maleic Hydrazide M:0220

Formula: $C_4H_4N_2O_2$

Synonyms: BH dock killer; BOS MH; Burtolin; Chemform; De-cut; Desprout D Rexel-super P; 1,2-Dihydropyridazine-3,6-dione; 1,2-Dihydro-3,6-pyradazinedione; 1,2-Dihydro-3,6-pyridazinedione; EC 300; ENT 18,870; Fair 30; Fair plus; Fair ps; Hydrazid hydrazida maleica (Spanish); 6-Hydroxy-3(2*H*)-pyridazinone; KMH; Maintain 3; MAH; Malazide; Maleic acid hydrazide; Maleic hydrazide; Maleic hydrazine acid; Maleic hydrazide fungicide; Malein 30; *N,N*-Maleoylhydrazine; Malzid; Mazide; MH 30; MH 40; MH 36 Bayer; Po-San (with 9*h*-fluorene-9-carboxylic acid, 2-chloro-9-hydroxy-, methyl ester); Regulox; Regulox w; Regulox 50w; Retard; Royal MH 30; Royal Slo-gro; Slo-gro; Sprout-stop; Stuntman; Sucker-stuff; Super DE-sprout; Super sprout stop; 1,2,3-Tetrahydro-3,6-dioxopyridazine; Vondaldhyde; Vondrax

CAS Number: 123-33-1

HSDB Number: 1162

RTECS Number: UR5950000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 204-619-9

Regulatory Authority and Advisory Information

Carcinogenicity[83]: EPA Group E, Evidence of noncarcinogenicity for humans; IARC: Animal Inadequate Evidence; Human No Adequate Data, *not classifiable as carcinogenic to humans*, Group 3, 1987

Hazard Alert: Combustible solid, Irritant, Suspected reprotoxic hazard.

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U148

CERCLA RQ: 5000 lb (2270 kg)

Hazard symbols, risk, & safety statements: Hazard symbol: Xi, Xn, T; risk phrases: R40; R36/37/38; R51; safety phrases: S16; S26; S36/37/39; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Maleic hydrazide is a colorless crystalline solid. Odorless. Molecular weight = 112.10; specific gravity $(H_2O{:}1) = 1.62$ @ 25°C; freezing/melting point = 307°C. Autoignition temperature = >400°C. Hazard identification (based on NFPA-704M Rating System): Health 2, flammability 1, reactivity 0. Highly soluble in water.

Potential Exposure: Maleic hydrazide is a pyridazine/pyridazinone herbicide, plant growth regulator, and fungicide that is registered for use on tobacco, potatoes, onions, nonbearing citrus, turf, utility and highway rights-of-way, airports, industrial land, lawns, recreational areas, ornamental/shade trees and ornamental plants. Most of the use of maleic hydrazide in the United States is on tobacco. Banned for use in EU countries. Actively registered for use in the United States.

Incompatibilities: Contact with flammable material may cause fire and explosions. Contact with combustible or oxidizable materials may form heat-, shock-, and friction-sensitive explosive mixtures. Static electricity may also cause explosions. Keep away from all acids, especially dibasic organic acids, ammonium compounds, antimony sulfide, arsenic trioxide, metal sulfides, powdered metals, calcium aluminum hydride, cyanides, manganese dioxide, phosphorus, selenium, sulfur, thiocyanates, zinc. May be corrosive to brass and its alloys.

Permissible Exposure Limits in Air:

PAC Ver. 29[138]

PAC-1: 11 milligram per cubic meter

PAC-2: 130 milligram per cubic meter

PAC-3: 750 milligram per cubic meter

Determination in Air: Filter; none; Gravimetric; NIOSH IV [Particulates NOR; #0500 (total), #0600 (respirable)][18].

Permissible Concentration in Water: Federal Drinking Water Guidelines: 4000 μg/L; State Drinking Water Guidelines: Maine 3500 μg/L. Runoff from spills or fire control may cause water pollution.

Determination in Water: A lowest observed adverse-effect level (LOAEL) of 500 mg/kg/day has been calculated. On the basis of this, the USEPA has calculated a lifetime health advisory for an adult of 3.5 mg/L. Octanol−water coefficient: Log $K_{ow} = < 1.0$. Unlikely to bioaccumulate in marine organisms. Fish toxicity (threshold)[101]: Very low—19,952.62315 ppb, MATC (Maximum Acceptable Toxicant Concentration).

Routes of Entry: Inhalation, ingestion, skin and/eye contact. Absorbed through the intact skin

Harmful Effects and Symptoms

Short-Term Exposure: Irritation of eyes, skin, and mucous membranes. Ingestion can cause tremors and muscle spasms. Sin contact may cause sensitization. LD_{50} (oral, rat) $= > 3500$ mg/kg; LD_{50} (dermal, rat) ≥ 4000 mg/kg.

Long-Term Exposure: May cause tumors. May cause liver damage and acute central nervous system effects. May cause mutations (genetic changes). Human toxicity (long term)[101]: Very low—4000.00 ppb, Health Advisory.

Points of Attack: Central nervous system, liver, skin

Medical Surveillance: Preliminary medical exam to detect chronic diseases of central nervous system, liver, heart, kidneys, lung, and skin, as well as endocrinological or immunological disturbances, should protect susceptible individuals. Periodical medical exams of internal organs, skin, and eyes are important to avoid chronic occupational intoxications. They should include lab and patch tests when necessary[83]. Liver function tests. Examination by a qualified allergist. Tests of the nervous system. Evaluation by a qualified allergist, including exposure history and testing, may help diagnose allergy.

First Aid: *Skin*: Flood all areas of body that have contacted the substance with water. Don't wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others. *Eyes*: Remove any contact lenses at once. Flush eyes well with copious quantities of water or normal saline for at least 20−23 minutes. Seek medical attention. *Inhalation*: Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion*: If convulsions are not present, give a glass or two of water or milk to dilute the substance. Assure that the person's airway is unobstructed and contact a hospital or poison center immediately for advice on whether or not to induce vomiting.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of dermal and/or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: SCBA >11 milligram per cubic meter. Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Green: General storage may be used. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Store in a refrigerator or a cool, dry place. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: First remove all sources of ignition. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Dampen spilled material with acetone to avoid dust.

Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen and carbon. As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 m/150 ft for liquids and at least 25 m/75 ft for solids. *Fire involving storage or vehicular tanks*: Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. *On a small fire*: use dry chemical, CO_2, water spray or regular *foam. On a large fire*: use water spray, fog, or regular foam. Do not scatter spilled material with high pressure streams of water. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal. *Fire involving tanks*: From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. Always stay away from tanks engulfed in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform to EPA regulations governing storage, transportation, treatment, and waste disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, “Reregistration Eligibility Decision (RED), Maleic Hydrazide,” Office of Prevention, Pesticides and Toxic Substances, Washington, DC (June 1994). http://www.epa.gov/REDs/0381.pdf.

United States Environmental Protection Agency, “Alert: Maleic Hydrazide,” Washington, DC, Office of Drinking Water (August 1987).

United States Environmental Protection Agency, Office of Pesticide Programs, Pesticide Residue Limits, “Maleic Hydrazide”, 40 CFR 180.175, http://www.epa.gov/pesticides/food/viewtols.htm.

Mancozeb M:0235

Formula: $C_4H_6MnN_2S_4 \cdot C_4H_6N_2S_4Zn$

Synonyms: Acrobat (mancozeb + dimethomorph); A coordination product of manganese 16%, zinc 2%, and ethylenebisdithiocarbamate 62%; Ashland solace (cymoxanil + mancozeb); Carbamodithioic acid, 1,2-ethanediylbis-, manganous zinc salt; Carmazine; Cuprofix; Dithane; Emcarb (mancozeb + carbendez); Emthane m-15; Ethylenebis (dithiocarbamic acid manganese zinc complex (8CI); Evolve; F 2966; Fore; Formec; Gaucho (imidacloprid + mancozeb); Gavel (mancozeb + zoxamide); Green-daisen m; Karamate; Kencozeb; Mancofol; Mancozeb^*; Manebzinc; Manganese ethylene-bis(dithiocarbamate)(polymeric) complex with zinc salt; Manoseb; Mantox; Manzate 200; Manzeb; Manzin 80; Marzin; Maxim; Milor; Nemispor; Pace fungicide (mixture of mancozeb and metalaxyl); Penncozeb; Policar; Triziman-d; Triziman; Vondozeb plus; Zimanat; Zimaneb; Zimman-dithane; Zinc ion and manganese ethylenebisdithiocarbamate 80%

CAS Number: 8018-01-7

HSDB Number: 6792

RTECS Number: ZB3200000

UN/NA & ERG Number: UN2771 (solid)/151; UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: [*Annex I Index No*.: 006-076-00-1]

Regulatory Authority and Advisory Information

Carcinogenicity[83]: EPA Group B2, probable human carcinogen

California Proposition 65 Chemical[102]: Carcinogen (1/1/1990)

Hazard Alert: Poison, Possible thyroid effects. Combustible, Possible risk of forming tumors, Sensitization hazard, Suspected of causing genetic defects, Suspected reprotoxic hazard, Suspected reprotoxic hazard (TRI), Possible endocrine disruptor, Environmental hazard, Agricultural chemical.

California EPA AB2588-Air Toxics “Hot Spots” Chemicals (CAL) as manganese or zinc compounds

The “Director’s List” (CAL/OSHA) as manganese and zinc compounds

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) as manganese compounds

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%, manganese compounds, Form R Toxic Chemical Category Code: N450

Clean Water Act: Section 307 Toxic Pollutants as zinc compounds

United States National Primary Drinking Water Regulations: SMCL = 5 mg[Zn]/L as Zinc; SMCL = 0.05 mg[Mg]/L as manganese

Hazardous to aquatic life or environment, with possible long-lasting effects[291]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xi, N; risk phrases: R45; R43; R50; R62, R63; safety phrases: S2; S29/35; S36/37, S41; S46; S61 (see Appendix 4).

Description: Grayish-yellow powder. Molecular weight = 266.31; specific gravity (H_2O:1) = 1.99; boiling point = (decomposes); freezing/melting point = (decomposes). Vapor pressure = very low/negligible. Flash point = >135°C. Low solubility in water.

Potential Exposure: Mancozeb is a dithiocarbamate fungicide. It is used to control a wide variety of fungal diseases, including potato blight, leaf spot, scab (on apples and pears), and rust (on roses). It is used on fruits, vegetables, nuts and field crops, and many more. It is also used as a seed treatment of cotton, potatoes, corn, safflower, sorghum, peanuts, tomatoes, flax, and cereal grains.

Incompatibilities: Combustible material. Dust may form explosive mixture in air. Decomposes in temperatures above 170°C. Keep away from water, acid, oxidizing materials. Dithiocarbamate esters are combustible. They react violently with powerful oxidizers such as calcium hypochlorite. Poisonous gases are generated by the thermal decomposition of Dithiocarbamate compounds, including carbon disulfide, oxides of sulfur, oxides of nitrogen, hydrogen sulfide, ammonia, and methylamine. Thio and dithiocarbamates slowly decompose in aqueous solution to form carbon disulfide and methylamine or other amines. Such decompositions are accelerated by acids. Flammable gases are generated by the combination of dithiocarbamate with aldehydes, nitrides, and hydrides. Dithiocarbamate are incompatible with acids, peroxides, and acid halides. Corrosive to iron, copper brass, and zinc metals, especially in the presence of moisture. Contact with lime, moisture can cause decomposition. Decomposes on prolonged storage. Degradation produces ethylene thiourea.

Permissible Exposure Limits in Air:

Mancozeb

PAC Ver. 29[139]

PAC-1: 3 milligram per cubic meter

PAC-2: 56 milligram per cubic meter

PAC-3: 990 milligram per cubic meter

Manganese:

NIOSH IDLH = 500 mg[Mn]/m^3

OSHA PEL: 5 mg[Mn]/m^3 Ceiling Concentration (inorganic compounds and fume)

NIOSH REL: 1 mg[Mn]/m^3 TWA; 3 mg[Mn]/m^3 STEL

DFG MAK (*inorganic compounds and fume*): 0.5 mg[Mn]/m^3 inhalable fraction (Mn and its inorganic compounds); Pregnancy Risk Group C

Determination in Air: *Manganese*: Use NIOSH Analytical Method, Elements by ICP, #7300; #7301; #7303; #9102; Elements in blood or tissue, #8005; Metals in urine, #8310; OSHA Analytical Method, ID-125G or ID121.

Permissible Concentration in Water: *Manganese*: Federal Drinking Water Guidelines: EPA 50 μg[Mn]/L; State Drinking Water Standards: New York: 300 μg[Mn]/L; State Drinking Water Guidelines: California 500 μg[Mn]/L; Connecticut: 500 μg[Mn]/L; Maine: 500 μg[Mn]/L; Minnesota: 300 μg[Mn]/L; New Hampshire: 100 μg[Mn]/L. *Zinc*: Federal Drinking Water Guidelines: 4 ppb[14] State Drinking Water Guidelines: Maine 25 μg[Zn]/L. Canadian Drinking Water Standards: AO ≤ 5.0 mg[Zn]/L. Safe Drinking Water Act (47FR 9352): SMCL = 5 mg[Zn]/L as Zinc; SMCL = 0.05 mg[Mn]/L as Manganese. WHO limit: 400 μg(Mn)/L

Determination in Water: EPA EMSLC Method 630. The Determination of Dithiocarbamate Pesticides in Municipal and Industrial Wastewater by UV−VIS Spectrophotometry. Octanol−water coefficient: Log K_{ow} = < 1.5. Unlikely to bioaccumulate in marine organisms. Fish toxicity (threshold)[101]: High—3.16731 ppb, MATC (Maximum Acceptable Toxicant Concentration)

Routes of Entry: Poisoning can occur by inhalation, ingestion and absorption through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Low levels of toxicity but may be a thyroid toxin. Concentrated solutions are slightly corrosive to eyes and mucous membranes. Dust inhalation can cause irritation of the respiratory system with sneezing. Eye contact can cause irritation, watering, pain, and inflammation of the eyelids. Dermal contact can cause irritation and minor ulceration. Ingestion can cause nausea, vomiting, fever, muscle twitching, seizure, rapid respiration, slow heartbeat. Severe exposure may result in death. Unlike carbamates, the dithiocarbamates are not cholinesterase inhibitors, but some of them may react with recently ingested alcohol or alcohol-containing products including wine, medications, and cold remedies such as cough-syrups. LD_{50} (oral, rat) = > 5 g/kg.; LD_{50} (dermal, rat) = > 5 g/kg.

Long-Term Exposure: Thyroid function. May cause tumors. May cause thyroid problems. A Reproductive Toxin. May be a Reproductive Toxin (may enlarge ovarian cells). Skin sensitizer. Human toxicity (long term)[101]: High—5.82363 ppb, CHCL (Chronic Human Carcinogen Level).

Points of Attack: Respiratory system, central nervous system, cardiovascular system, skin, eyes. Dithiocarbamates can affect thyroid function.

Medical Surveillance: This chemical is a suspected or known human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and advice for medical monitoring. There are tests available to measure zinc in your blood, urine, hair, saliva, and feces. High levels of zinc in the feces can mean high recent zinc exposure. High levels of zinc in the blood can mean high zinc consumption and/or high exposure.

Tests to measure zinc in hair may provide information on long-term zinc exposure; however, the relationship between levels in your hair and the amount of zinc you were exposed to is not clear. Medical observation is recommended for 24 to 48 hours following breathing overexposure, as pulmonary edema may be delayed. Before employment and at regular times after that, the following are recommended: If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider CBC and chest X-ray following acute overexposure. Evaluation by a qualified allergist, including exposure history and testing, may help diagnose allergy. Thyroid function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious and able to swallow, have victim drink 4 to 8 oz of water. Do not induce vomiting. *Note to physician or authorized medical personnel*: Medical observation is recommended for 24 to 48 hours following breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic might consider administering a drug or other inhalation therapy. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure.

Personal Protective Methods: Reacts with the following absorbent materials: Cellulose-Based; Mineral- and Clay-Based; Dirt/Earth[88]. Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of dermal and/or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: SCBA >3 milligram per cubic meter. NIOSH: *At any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison. Store in a secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN2771 Dithiocarbamate and Thiocarbamate pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: First remove all sources of ignition. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Combustible solid. Thermal decomposition products may include oxides of nitrogen, sulfur, metal, and carbon. Extinguish fire using an agent suitable for type of surrounding fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Disposal Method Suggested: Generators of waste (equal to or greater than 100 kg/mo) containing this contaminant, EPA hazardous waste number N450, must conform to USEPA regulations for storage, transportation, treatment, and disposal of waste. Dispose of waste material as hazardous waste using a licensed disposal contractor to an approved landfill. Dispose of contents and container to an approved waste disposal plant. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office. All federal, state, and local environmental regulations must be observed. Do not discharge into drains or sewers. A potential candidate for liquid injection incineration at a temperature range of 650 to 1600°C and a residence time 0.1 to 2 seconds. Also, a potential candidate for rotary kiln incineration at a temperature range of 820 to 1600°C and residence times of seconds for liquids and gases, and hours for solids[83].

References

(102); (31); (173); (101); (138); (2).

EXTOXNET, Extension Toxicology Network, "Pesticide Information Profile, Mancozeb," Oregon State University, Corvallis, OR (June 1996). http://extoxnet.orst.edu/pips/mancozeb.htm.

United States Environmental Protection Agency, Office of Pesticide Programs, "Pesticide Residue Limits, Mancozeb," 40 CFR 180.176, http://www.epa.gov/pesticides/food/viewtols.htm.

Maleic Acid M:0200

Formula: $C_4H_4O_4$; HOOCCH=CHCOOH

Synonyms: *cis*-Butenedioic acid, (Z)-; Butenedioic acid, (Z)-; *cis*-Butenedioic anhydride; (Z)-1,2-Ethylenedicarboxylic acid; *cis*-1,2-Ethylenedicarboxylic acid; 1,2-Ethylenedicarboxylic acid, (Z); *cis*-1,2-Ethylenedicarboxylic acid, toxilic acid; Maleinic acid; Malenic acid; Toxilic acid

CAS Registry Number: 110-16-7

HSDB Number: 666

RTECS Number: OM9625000

UN/NA & ERG Number: UN2215/156

EC Number: 203-742-5 [*Annex I Index No.*: 607-095-00-3]

Regulatory Authority and Advisory Information

Hazard Alert: Combustible, Corrosive, Sensitization hazard, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 5000 lb (2270 kg)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: C, Xn, Xi; risk phrases: R22; R36/37/38; R43; R62; safety phrases: S2; S24; S26; S28; S37; 46; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Maleic acid is a white crystalline solid. Faint, acid like odor. Molecular weight = 116.08; specific gravity (H_2O:1) = 1.59; boiling point = (decomposes below BP@ 135°C); freezing/melting point = 131°C; also listed @ 138−139°C; vapor pressure = 3.59×10^{-5} mmHg @ 25°C. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 1, reactivity 0. Highly soluble in water; solubility = > 75%. Aqueous solution is a strong acid.

Potential Exposure: Maleic acid is used to make artificial resins, antihistamines, and to preserve (retard rancidity) of fats and oils.

Incompatibilities: Dust may form explosive mixture with air, Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, amines, reducing agents; alkali metals.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 2.1 milligram per cubic meter

PAC-2: 23 milligram per cubic meter

PAC-3: 140 milligram per cubic meter

Permissible Concentration in Water: Russia[43] set a MAC in water bodies used for domestic purposes of 1.0 mg/L.

Determination in Water: Octanol−water coefficient: Log K_{ow} = < −0.6. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, skin contact. Passes through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Maleic acid can affect you when breathed in and by passing through your skin. Contact can cause severe eye burns leading to permanent damage. Contact can irritate the skin. Exposure may cause you to feel dizzy and lightheaded. Exposure can irritate the nose, throat, and lungs and cause coughing or shortness of breath. Very high exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: May cause lung irritation and bronchitis. May affect the kidneys.

Points of Attack: Lungs, kidneys.

Medical Surveillance: For those with frequent or potentially high exposure, the following are recommended before beginning work and at regular times after that. Lung function tests. Kidney function tests. If symptoms develop or overexposure is suspected, the following maybe useful: consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately.

If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. For maleic acid (>70%) Natural rubber, Neoprene, nitrile + PVC, nitrile, polyethylene, and Viton are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated.

Respirator Selection: Where there is potential exists for exposure to maleic acid as dust, mist, of fume, use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece respirator with a high efficiency particulate filer. Greater protection is provided by a PAPR. Where there is potential for exposures to maleic acid as a liquid exists, or for high exposures, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Maleic acid must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates); amines (such as aniline) and alkali metals (such as sodium and potassium), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from moisture. Sources of ignition, such as smoking and open flames are prohibited where this chemical is handled, used, or stored.

Shipping: UN2215 Maleic acid, Hazard class: 8; Labels: 8-Corrosive material.

Spill Handling: Stay upwind and uphill. Isolate the area of release or fire and deny entry. Remove all ignition sources. Stop the release if it can be done safely from a distance. All equipment used to handle this material must be grounded. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. *Small spill*: Cover with *dry* earth, *dry* sand, or other noncombustible material followed with plastic sheet to minimize spreading or contact with water or rain. Use clean nonsparking tools to collect material and place material into loosely covered plastic containers for later disposal. Prevent material and runoff from entering sewers and waterways if it can be done safely well ahead of the release. Use vapor suppressing foam to disperse vapors−contain runoff. Water spray may reduce vapor, but may not prevent ignition in enclosed spaces. Ventilate confined area if it can be done without placing personnel at risk. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical may burn, but does not easily ignite. Thermal decomposition products may include oxides of carbon. Small fire: Use *dry* chemical, CO_2, *dry* sand, or alcohol-resistant foam. May react with foams releasing corrosive/toxic gases. Large fire: Use water spray or alcohol-resistant foam if it is available in sufficient amounts. Under favorable conditions, experienced crews can use coordinated fog streams to sweep the flames off the surface of the burning liquid. Keep exposures cool long after fire is out to protect against reignition. Do not direct straight streams into the liquid. Cool exposed containers with large quantities of water from unattended equipment or remove intact containers if it can be done safely. *DO NOT GET WATER ON SPILLED SUBSTANCE OR INSIDE CONTAINERS*. If cooling streams are ineffective (*venting sound increases in volume and pitch, tank discolors or shows signs of deforming*), withdraw immediately to a secure location. Always stay away from ends of tanks, especially when engulfed in flames. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed. Liquid: incinerate after mixing with a flammable solvent. Use afterburner for complete combustion. Solid: dissolve in a flammable solvent or package in paper and burn. See above.

References

(31); (173); (101); (138); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 7, No. 1, 61−65 (1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Maleic Acid, Trenton, NJ (November 1999).

Maleic Anhydride M:0210

Formula: $C_4H_2O_3$; $(CHCO)_2O$
Synonyms: Acido malico (Spanish); BM 10; *cis*-Butenedioic anhydride; Dihydro-2,5-dioxofuran; 2,5-Dihydrofuran-2,5-dione; 2,5-Furandione; 2,5-Furanedione; Maleic acid anhydride; Toxilic anhydride
CAS Registry Number: 108-31-6
HSDB Number: 183
RTECS Number: ON3675000
UN/NA & ERG Number: UN2215/156
EC Number: 203-571-6 [*Annex I Index No.*: 607-096-00-9]
Regulatory Authority and Advisory Information
Hazard Alert: Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction).
Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)
Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)
United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U147
RCRA, 40CFR261, Appendix 8 Hazardous Constituents
Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 5000 lb (2270 kg)
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
Canada, WHMIS, Ingredients Disclosure List concentration reporting level: 0.1%.
Hazard symbols, risk, & safety statements: Hazard symbol: C; risk phrases: R22; R34; R42/43; R62; R63; safety phrases: S2; S22; S26; S36/37/39; S41; S45 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.
Description: Maleic anhydride is colorless needles, white lumps, or pellets. Irritating, choking odor. Molecular weight = 98.06; specific gravity (H_2O:1) = 1.32 @ 60°C; boiling point = 202.2°C; freezing/melting point = 52.6°C; vapor pressure = 0.2 mmHg @ 20°C; 7.5 mmHg @ 74°C; flash point = 102°C (cc); autoignition temperature = 477°C. Explosive limits: LEL = 1.4%; UEL: 7.1%. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 1, reactivity 1. Soluble in water, slow, possibly dangerous, reaction; solubility = 40%. Maleic anhydride may be transported as hot (70°C) liquid.
Potential Exposure: Maleic anhydride is used in unsaturated polyester resins; Agricultural chemical, and lubricating additives; in the manufacture of unsaturated polyester resins; in the manufacture of fumaric acid; in alkyd resin manufacture; in the manufacture of pesticides e.g., malathion, maleic hydrazide, and captan).
Incompatibilities: Reacts slowly with water (hydrolyzes) to form maleic acid, a medium-strong acid. Dust may form explosive mixture with air. Reacts with strong oxidizers, oil, water, alkali metals; strong acids; strong bases. Violent reaction with alkali metals and amines above 66°C. Dangerous reaction with oxidizers, amines, alkali metals, and hydroxides. Compounds of the carboxyl group react with all bases, both inorganic and organic (i.e., amines) releasing substantial heat, water and a salt that may be harmful. Incompatible with arsenic compounds (releases hydrogen cyanide gas), diazo compounds, dithiocarbamates, isocyanates, mercaptans, nitrides, and sulfides (releasing heat, toxic, and possibly flammable gases), thiosulfates and dithionites (releasing hydrogen sulfate and oxides of sulfur).
Permissible Exposure Limits in Air
Conversion factor: 1 ppm = 4.01 milligram per cubic meter @ 25°C & 1 atm
Odor Threshold = 0.32 ppm.
OSHA PEL: 0.25 ppm/1 milligram per cubic meter/TWA
NIOSH REL: 0.25 ppm/1 milligram per cubic meter/TWA
ACGIH TLV[1]: 0.01 ppm TWA 0.01 milligram per cubic meter (Inhalable fraction & vapor); danger of sensitizaton.
PAC* Ver. 29[138]
PAC-1: $\mathbf{0.2_A}$ ppm
PAC-2: $\mathbf{2_A}$ ppm
PAC-3: $\mathbf{20_A}$ ppm
*AEGLs are marked with a subscript "**A**" and correspond to 60-minute values.
DFG MAK: 0.1 ppm/0.41 milligram per cubic meter TWA; Peak Limitation Category I(1), a momentary value of 0.2 mL/m^3/0.81 milligram per cubic meter should not be exceeded danger of skin and airways; Pregnancy Risk Group C; danger of sensitization of airways and skin.
NIOSH IDLH = 10 milligram per cubic meter; (danger of skin sensitization and airways); Pregnancy Risk Group C
Australia: TWA 0.25 ppm (1 milligram per cubic meter), 1993; Austria: MAK 0.1 ppm (0.4 mg.m^3), 1999; Belgium: TWA 0.25 ppm (1 milligram per cubic meter), 1993; Denmark: TWA 0.2 ppm (0.8 milligram per cubic meter), 1999; Finland: TWA 0.1 ppm, ceiling 0.2 ppm, 1999; France: VLE 1 milligram per cubic meter, 1999; Hungary: TWA 1 milligram per cubic meter; STEL 2 milligram per cubic meter, 1993; the Netherlands: MAC-TGG 0.4 milligram per cubic meter, 2003; Norway: TWA 0.2 ppm (0.8 milligram per cubic meter), 1999; the Philippines: TWA 0.25 ppm (1 milligram per cubic meter), 1993; Poland: TWA 0.5 milligram per cubic meter; STEL 1.0 milligram per cubic meter, 1999; Russia: STEL 1 milligram per cubic meter, 1993; Sweden: NGV 0.3 ppm (1.2 milligram per cubic meter), KTV 0.6 ppm (2.5 milligram per cubic meter), 1999; Switzerland: MAK-W 0.2 ppm (0.8 milligram per cubic meter), KZV-(week) 0.4 ppm (1.6 milligram per cubic meter), 1999; United Kingdom: TWA 1 milligram per

cubic meter; STEL 3 milligram per cubic meter, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen. The Czech Republic: TWA 1.0 milligram per cubic meter with the same value as an STEL[35]. Russia[35,43] set a MAC for ambient air in residential areas of 0.2 milligram per cubic meter on a momentary basis and 0.05 milligram per cubic meter on a daily average basis. Several states have set guidelines or standards for maleic anhydride in ambient air[60] ranging from 0.14 μ/m^3 (Massachusetts) to 3.3 μ/m^3 (New York) to 10.0 μ/m^3 (Florida and South Carolina) to 12.0 μ/m^3 (North Carolina) to 17 μ/m^3 (Virginia) to 20 μ/m^3 (Connecticut) to 24.0 μ/m^3 (Nevada) to 100.0 μ/m^3 (North Carolina and North Dakota).

Determination in Air: Use NIOSH (IV), Method #3512; OSHA Analytical Method 25 or 86.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Maleic anhydride severely irritates the eyes, skin, and respiratory tract. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Inhalation may cause asthmatic reactions. The symptoms of asthma may be delayed for several hours and are aggravated by physical effort. Subacute inhalation of maleic anhydride can cause severe headaches, nosebleeds, nervousness, nausea, and temporary impairment of vision. It can also lead to conjunctivitis and corneal erosion. Maleic anhydride may be transported as hot liquid; skin contact causes burns.

Long-Term Exposure: Repeated or prolonged skin contact may cause allergy and dermatitis. Repeated or prolonged inhalation exposure may cause bronchial asthma. Repeated exposure to concentrations above 1.25 ppm has caused asthmatic responses in workers. Allergies have developed so that lower concentrations of maleic anhydride can no longer be tolerated. An increased incidence of bronchitis and dermatitis has also been noted among workers with long-term exposure to maleic anhydride. Repeated exposure may cause photophobia (abnormal visual intolerance to light), double vision; bronchial asthma.

Points of Attack: Eyes, respiratory system; skin.

Medical Surveillance: Before beginning employment and at regular times after that, the following is recommended. Lung function tests. These may be normal if the person is not having an attack at the time of the test. If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Anyone who has developed symptoms of asthma due to contact with maleic anhydride should avoid all further contact with this chemical. Consider chest X-ray following acute overexposure. Lung function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. The symptoms of asthma may be delayed for several hours and are aggravated by physical effort. Rest and medical observation are highly recommended. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. 8 hours: Responder suits. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. ACGIH recommends rubber, Neoprene, nitrile, polyvinyl chloride, and polystyrene as protective material. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *10 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode) SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA). *Note*: May causes eye damage; eye protection needed.

Storage: Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Maleic anhydride must be stored to avoid contact with water and strong oxidizers (such as chlorine and bromine), since violent reactions occur. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Sources of ignition, such as smoking and open flames are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gal or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN2215 Maleic anhydride, Hazard class: 8; Labels: 8-Corrosive material.

Spill Handling: Stay upwind and uphill. Isolate the area of release or fire and deny entry. Remove all ignition sources. Stop the release if it can be done safely from a distance. All equipment used to handle this material must be grounded. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. *Small spill*: Cover with *dry* earth, *dry* sand, or other noncombustible material followed with plastic sheet to minimize spreading or contact with water or rain. Use clean nonsparking tools to collect material and place material into loosely covered plastic containers for later disposal. Prevent material and runoff from entering sewers and waterways if it can be done safely well ahead of the release. Use vapor suppressing foam to disperse vapors—contain runoff. Water spray may reduce vapor, but may not prevent ignition in enclosed spaces. Ventilate confined area if it can be done without placing personnel at risk. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Maleic anhydride is a combustible solid. Thermal decomposition products may include oxides of carbon. The molten form may explode in the heat of fire. Dust clouds of the vapor of molten maleic anhydride are explosive on contact with spark or flame. Use of dry chemicals or water extinguishers may cause an explosion. Small fire: Use *dry* chemical, CO_2, *dry* sand, or alcohol-resistant foam. May react with foams releasing corrosive/toxic gases. Large fire: Use water spray or alcohol-resistant foam if it is available in sufficient amounts. Under favorable conditions, experienced crews can use coordinated fog streams to sweep the flames off the surface of the burning liquid. Keep exposures cool long after fire is out to protect against reignition. Do not direct straight streams into the liquid. Cool exposed containers with large quantities of water from unattended equipment or remove intact containers if it can be done safely. *DO NOT GET WATER ON SPILLED SUBSTANCE OR INSIDE CONTAINERS.* If cooling streams are ineffective (*venting sound increases in volume and pitch, tank discolors or shows signs of deforming*), withdraw immediately to a secure location. Always stay away from ends of tanks, especially when engulfed in flames. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform to EPA regulations governing storage, transportation, treatment, and waste disposal. Controlled incineration: care must be taken that complete oxidation to nontoxic products occurs.

References

(31); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Maleic Anhydride, Washington, DC (Aug. 1, 1978).

United States Environmental Protection Agency, Maleic Anhydride, Health and Environmental Effects Profile No. 122, Washington, DC, Office of Solid Waste (April 30, 1980).

(173); (101); (138).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 2, No. 3, 79−81 (1982). New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Maleic Anhydride, Trenton, NJ (September 1999).

Maleic Hydrazide M:0220

Formula: $C_4H_4N_2O_2$: $C_4H_4O_2N_2$

Synonyms: BH dock killer; Bos MH; Burtolin; Chemform; De-cut; Desprout; 1,2-Dihydro-3,6-pyradazinedione; 1,2-Dihydro-3,6-pyridazinedione; 1,2-Dihydropyridazine-3,6-dione; Drexel-Super P; EC 300; ENT 18,870; Fair 30; Fair PS; Hydrazida maleica (Spanish); 6-Hydroxy-3(2H)-pyridazinone; KMH; MAH; Maintain 3; Malazide; Maleic acid hydrazide; Maleic hydrazide fungicide; Maleic hydrazine; Malein 30; Maleinsaurehydrazid (German); *N*,*N*-Maleoylhydrazine; Malzid; Mazide; MH; MH 30; MH 36 Bayer; MH 40; Regulox; Regulox 50W; Regulox W; Retard; Royal MH 30; Royal Slo-Gro; Slo-Gro; Sproutstop; Stuntman; Sucker-stuff; Super de-sprout; Super sprout stop; 1,2,3-Tetrahydro-3,6-dioxopyridazine; Vondaldhyde; Vondrax

CAS Registry Number: 123-33-1

HSDB Number: 1162

RTECS Number: UR5950000

UN/NA & ERG Number: UN3082 (environmentally hazardous substances, liquid, n.o.s.)/171

EC Number: 204-619-9

Regulatory Authority and Advisory Information

IARC: Animal Inadequate Evidence; Human No Adequate Data, *not classifiable as carcinogenic to humans*, Group 3, 1987

Hazard Alert: Combustible, Flammable solid (fine material), Possible risk of forming tumors, Suspected of causing genetic defects, Agricultural chemical.

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U148

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 5000 lb (2270 kg).

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xi, Xn; risk phrases: R22; R36/37/38; R40; R51/53; R62; safety phrases: S7; S23; S26; S36; S36/37/39; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Maleic hydrazide is a crystalline solid. Molecular weight = 112.10; specific gravity = 1.6 @ 25°C; freezing/melting point = (decomposes) 260°C; 292°C[136]. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 1, reactivity 0. Slightly soluble in cold water; more soluble in hot.

Potential Exposure: A potential danger to those involved in the manufacture, formulation, and application of this plant growth retardant.

Incompatibilities: Dust may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Slightly corrosive to iron and zinc. Maleic hydrazide forms water-soluble alkali-metal and amine salts. It is slightly acidic and may be titrated as a monobasic acid. Mild oxidation produces a compound which reacts instantly with dienes at −77°C/ − 107°F to form crystalline derivatives. It is incompatible with pesticides that are highly alkaline in reaction. This chemical is slightly corrosive to iron and zinc. In the presence of heavy metal and iron, zinc, calcium, and magnesium ions, sparingly soluble salts are formed[101].

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 11 milligram per cubic meter

PAC-2: 130 milligram per cubic meter

PAC-3: 750 milligram per cubic meter

Permissible Concentration in Water: A LOAEL of 500 mg/kg/day has been calculated. On the basis of this, the United States Environmental Protection Agency has calculated a lifetime health advisory for an adult of 3.5 mg/L.

Routes of Entry: Inhalation, ingestion; skin and/eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritation of eyes, skin and mucous membranes; tremors, muscle spasms, and skin sensitization are among the consequences of MH exposure. LD_{50} (oral-rat) = 3800 mg/kg (slightly toxic).

Long-Term Exposure: May cause liver damage and acute central nervous system effects. May cause mutations (genetic changes).

Points of Attack: Central nervous system; liver, skin.

Medical Surveillance: Liver function tests. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Tests of the nervous system.

First Aid: *Skin Contact*[52]: Flood all areas of body that have contacted the substance with water. Don't wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others. *Eye Contact*: Remove any contact lenses at once. Flush eyes well with copious quantities of water or normal saline for at least 20−23 minutes. Seek medical attention. *Inhalation*: Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion*: If convulsions are not present, give a glass or two of water or milk to dilute the substance. Assure that the person's airway is unobstructed and contact a hospital or poison center immediately for advice on whether or not to induce vomiting.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison. Store in a secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN3082 Environmentally hazardous substances, liquid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Oil-skimming equipment may be used to remove slicks from water. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include oxides of nitrogen and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform to EPA regulations governing storage, transportation, treatment, and waste disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (85); (173); (101); (138); (100).

United States Environmental Protection Agency, "Alert: Maleic Hydrazide," Washington, DC, Office of Drinking Water (August 1987).

Malononitrile M:0230

Formula: $C_3H_2N_2$; $NCCH_2CN$

Synonyms: AI3-24285; Cyanoacetonitrile; α-Cyanoacetonitrile; Dicyanmethane; Dicyanomethane; Malonic acid dinitrile; Malonic dinitrile; Malonodinitrile; Malononitrilo (Spanish); Methane, dicyano-; Methylene cyanide; Methylenedinitrile; NSC 3769; Propanedinitrile; Propanedinitrite

CAS Registry Number: 109-77-3

HSDB Number: 2523

RTECS Number: OO3150000

UN/NA & ERG Number: UN2647/153; UN3439 (nitrile, solid)/151

EC Number: 203-703-2 [*Annex I Index No.*: 608-009-00-7]

Listed on the TSCA inventory. Regulatory Authority and Advisory Information

Hazard Alert: Poison, Combustible, Primary irritant (w/o allergic reaction).

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U149

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1000 lb (454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R23/24/25; R50/53; safety phrases: S1/2; S23; S27; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to waters[206].

Description: Malononitrile is a white powder or colorless, odorless crystalline substance. Molecular weight = 66.07; specific gravity (H_2O:1) = 1.05 @ 34°C; boiling point = 220°C; freezing/melting point = 30.5°C; vapor pressure = 11 mmHg @ 99°C; flash point = 130°C (oc). Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 1, reactivity 0. Soluble in water; solubility = 13%.

Potential Exposure: Malononitrile is used in organic synthesis; as a lubricating oil additive; for thiamine synthesis; for pteridine-type anticancer agent synthesis; and in the synthesis of photosensitizers, acrylic fibers, and dyestuffs. It has also been used in the treatment of various forms of mental illness. It has been used as a leaching agent for gold.

Incompatibilities: Incompatible with strong bases. May polymerize violently on prolonged heating @ 129°C, or in contact with strong bases at lower temperatures. Nitriles may polymerize in the presence of metals and some metal compounds. They are incompatible with acids; mixing nitriles with strong oxidizing acids can lead to extremely violent reactions. Nitriles are generally incompatible with other oxidizing agents such as peroxides and epoxides. The combination of bases and nitriles can produce hydrogen cyanide. Nitriles are hydrolyzed in both aqueous acid and base to give carboxylic acids (or salts of carboxylic acids). These reactions generate heat. Peroxides convert nitriles to amides. Nitriles can react vigorously with reducing agents. Acetonitrile and propionitrile are soluble in water, but nitriles higher than propionitrile have low aqueous solubility. They are also insoluble in aqueous acids[101].

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 2.70 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: None

NIOSH REL: 3 ppm/8 milligram per cubic meter TWA; *Nitriles*: 2 ppm, Ceiling Concentration, not to be exceeded in any 15-minute work period.

PAC* Ver. 29[138]

PAC-1: 0.07 ppm

PAC-2: $\mathbf{0.77}_{\mathbf{A}}$ ppm

PAC-3: $\mathbf{2.3}_{\mathbf{A}}$ ppm

*AEGLs are marked with a subscript "**A**" and correspond to 60-minute values. Connecticut has set a guideline or standard for malononitrile in ambient air[60] of 160 μ/m^3.

Permissible Concentration in Water: Russia[43] set a MAC of 0.02 mg/L in water bodies used for domestic purposes.

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Metabolized by body to cyanide and thiocyanate; effects of inhalation of toxic fumes will be related to cyanide. Causes brain and heart damage related to lack of cellular oxygen. It is classified as extremely toxic. Probable oral lethal dose for humans is 5−50 mg/kg, or between seven drops and one teaspoonful, for a 70 kg (150 lb) person. Symptoms of cyanide poisoning include rapid and irregular breathing; anxiety, confusion, odor of bitter almonds (on breath or vomitus); nausea, vomiting (if oral exposure), irregular heartbeat; a feeling of tightness in the chest; bright pink coloration of the skin; unconsciousness followed by convulsions; involuntary urination and defecation, paralysis and respiratory arrest (heart will beat after breathing stops).

Medical Surveillance: See NIOSH Criteria Document *212 Nitriles*.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *up to 80 milligram per cubic meter*: Sa (APF = 10) (any supplied-air respirator). *Up to 200 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *Up to 400 milligram per cubic meter*: SCBAF (APF = 50) (any SCBA with a full facepiece) SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 667 milligram per cubic meter*: SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). Emergency or planned entry into unknown concentrations or IDLH conditions: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode) SaF:Pd, Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). Escape: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in a refrigerator under an inert atmosphere for prolonged storage. Keep away from strong bases. May polymerize violently on prolonged heating @ 129°C, or in contact with strong bases at lower temperatures. May spontaneously explode on storing above 70−80°C.

Shipping: UN2647 Malononitrile, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN3439 Nitriles, solid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling:

Nitriles spill

Initial isolation and protective action distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency

First: Isolate in all directions (ft/m) 100/30

Then: Protect persons downwind (mi/km)

Day 0.1/0.2
Night 0.1/0.2
Large spills (From a large package or from many small packages)
First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.3/0.5
Night 0.5/0.8

Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Avoid all skin contact, inhalation; and ingestion. Take up *small spills* with sand or other noncombustible material. Dike far ahead of *large spills* for later disposal. Do not touch spilled material; stop leak if you can do so without risk. Stay upwind and out of low areas. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include hydrogen cyanide, oxides of nitrogen and carbon. Use chemical, carbon dioxide; water spray, fog, or foam. Move container from fire area if you can do it without risk. Wear positive pressure breathing apparatus and special protective clothing. May explode spontaneously or polymerize violently on heating. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform to EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (101); (138); (100); (173).

United States Environmental Protection Agency, Malononitrile, Health and Environmental Effects Profile No. 123, Washington, DC, Office of Solid Waste (April 30, 1980).

National Institute for Occupational Safety and Health (NIOSH), "Criteria for a Recommended Standard." Occupational Exposure to Nitriles, United States DHEW (NIOSH) Report No. 78-212, Cincinnati OH (1978).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Malononitrile, Washington, DC, Chemical Emergency Preparedness Program (Nov. 30, 1987).

Maneb M:0240

Formula: $C_4H_6MnN_2S_4$

Synonyms: Aamangan; Akzo Chemie Maneb; BASF-Maneb Spritzpulver (German); Bavistin M, cosmic; Carbamic acid, ethylenebis(dithio-), manganese salt; Carbamodithioic acid, 1,2-ethanediylbis-, manganese salt; Chem neb; Chloroble M; Cleanacres; CR 3029; Delsene M flowable; Dithane M 22 special; EBDC; ENT 14,875; 1,2-Ethanediylbis(carbamodithioato)(2−)-manganese; 1,2-Ethanediylbiscarbamodithioic acid, manganese complex; 1,2-Ethanediylbiscarbamodithioic acid, manganese(2+) salt(1:1); 1,2-Ethanediylbismaneb, manganese(2+) salt (1:1); Ethylenebisdithiocarbamate manganese; *N*,*N*′-Ethylene bis(dithiocarbamate manganeux) (French); Ethylenebis(dithiocarbamato), manganese; Ethylenebis(dithiocarbamic acid), manganese salt; Ethylenebis(dithiocarbamic acid) manganous salt; 1,2-Ethylenediylbis(carbamodithioato) manganese; F 10; Griffin manex; Kypman 80; Lonocol M; Manam; Maneb 80; Maneba; Manebe (French); Manebe 80; Manebgan; Manesan; Manex; Mangan (II)-[*N*,*N*′-aethylen-bis (dithiocarbamate)] (German); Manganese ethylene-1,2-bisdithiocarbamate; Manganese(II) ethylene di(dithiocarbamate); Manganous ethylenebis(dithiocarbamate); Manoc; Manzate; Manzate D; Manzate Maneb fungicide; Manzeb; Manzin; M-Diphar; MEB; MNEBD; Multi-W, kascade; Nespor; Plantifog 160M; Polyram M; Remasan chloroble M; Rhodianehe; Sopranebe; Squadron and Quadrangle Manex; Superman Maneb F; Sup'r flo; Tersan-LSR; Trimangol; Trimangol 80; Trimanoc; Trithac; Tubothane; Unicrop Maneb; Vancide; Vancide Maneb 80; Vassgro Manex

CAS Registry Number: 12427-38-2; *(alt.)* 301-03-1; *(alt.)* 11004-49-2; *(alt.)* 12125-33-6; *(alt.)* 20316-06-7; *(alt.)* 28355-56-8; *(alt.)* 133317-06-3

HSDB Number: 4063

RTECS Number: OP0700000

UN/NA & ERG Number: UN2210 (with not <60% maneb)/135; UN2968 (Maneb or maneb preparation, stabilized against self-heating)/135

EC Number: 235-654-8 [*Annex I Index No.*: 006-077-00-7]

Regulatory Authority and Advisory Information

Carcinogenicity: EPA, Cancer Classification: Group B2, Probable Human Carcinogen; IARC: Animal Inadequate Evidence; Human No Adequate Data, *not classifiable as carcinogenic to humans*, Group 3, 1987. United States Environmental Protection Agency Gene-Tox Program, Positive: *S. cerevisiae-homozygosis*; Weakly Positive: In vitro UDS-human fibroblast; Negative: *S. cerevisiae* gene conversion

California Proposition 65 Chemical[102]: Cancer 1/1/1990.

Hazard Alert: Highly flammable, Possible thyroid effects, Spontaneously combustible (nonstabilized), Dangerously water reactive (dangerous when wet), Sensitization hazard, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Environmental hazard.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112), as manganese compounds

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%, manganese compounds, Form R Toxic Chemical Category Code: N450

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292].

Hazard symbols, risk, & safety statements: Hazard symbol: T, F, Xn, N, Xi; risk phrases: R40; R20; R36; R43; R63; R50/53; R62; R63; safety phrases: S2; S21; S25; S29/35; S36/37; S41; S46; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)].

Description: Maneb is a yellow powder or crystalline solid with a faint odor. Molecular weight = 265.30; freezing/melting point = 130°C (decomposes below MP). Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 3, reactivity 1. Moderately soluble in water. Maneb is likely to generate heat spontaneously, especially when wet. The heat may be sufficient to cause ignition.

Potential Exposure: A potential danger to those involved in manufacture, formulation, and application of this broad spectrum dithiocarbamatefungicide. Some dithiocarbamates have been used as rubber components. DFG warns of danger of skin sensitization. The BPS Pesticide incident in West Helena, AK resulted in an explosion and death of three firemen. The burning of a 1000-lb sack of Azinphos Methyl or the flashing of Maneb which was present on the facility may have caused the explosion[101].

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, water. Dithiocarbamate esters are combustible. They react violently with powerful oxidizers such as calcium hypochlorite. Poisonous gases are generated by the thermal decomposition of Dithiocarbamate compounds, including carbon disulfide, oxides of sulfur, oxides of nitrogen, hydrogen sulfide, ammonia, and methylamine. Thio and dithiocarbamates slowly decompose in aqueous solution to form carbon disulfide and methylamine or other amines. Such decompositions are accelerated by acids. Flammable gases are generated by the combination of dithiocarbamate with aldehydes, nitrides, and hydrides. Dithiocarbamate are incompatible with acids, peroxides, and acid halides.

Permissible Exposure Limits in Air

Manganese:

IDLH = 500 mg[Mn]/m^3 (manganese compounds and fume)

OSHA PEL: 5 mg[Mn]/m^3 Ceiling Concentration (inorganic compounds and fume)

NIOSH REL: 1 mg[Mn]/m^3 TWA; 3 mg[Mn]/m^3 STEL

ACGIH TLV[1] 0.02 mg[Mn]/m^3, respirable fraction; 0.1 mg[Mn]/m^3, inhalable fraction; not classifiable as a human carcinogen.

DFG MAK (*inorganic compounds and fume*): 0.5 mg[Mn]/m^3 inhalable fraction (Mn and its inorganic compounds); Pregnancy Risk Group C

Australia: TWA 5 mg[Mn]/m^3, 1993; Belgium: TWA 5 mg [Mn]/m^3, 1993; Denmark: TWA 2.5 mg[Mn]/m^3, 1999; Finland: TWA 2.5 mg[Mn]/m^3, 1999; Hungary: TWA 0.3 mg [Mn]/m^3, short term exposure limit 0.6 mg[Mn]/m^3, 1993; Poland: MAC (TWA) 0.3 mg[Mn]/m^3, 1993; Russia: STEL 0.5 milligram per cubic meter, 1993; United Kingdom: TWA 5 mg[Mn]/m^3, 2000

Determination in Water: OSHA Analytical Method 107. EPA EMSLC Method 630. The Determination of Dithiocarbamate Pesticides in Municipal and Industrial Wastewater by UV−VIS Spectrophotometry.

Permissible Concentration in Water: A no-adverse-effect-level in drinking water has been determined by MAS/National Response Center (MAS/NRC) to be 0.035 mg/L. An acceptable daily intake (ADI) of 0.005 mg/kg/day has been calculated for maneb. The state of Maine has set a guideline for maneb in drinking water[61] of 10 μg/L. *Manganese*: Federal Drinking Water Guidelines: EPA 50 μg[Mn]/L; State Drinking Water Standards: New York: 300 μg[Mn]/L; State Drinking Water Guidelines: California 500 μg[Mn]/L; Connecticut: 500 μg[Mn]/L; Maine: 500 μg[Mn]/L; Minnesota: 300 μg[Mn]/L; New Hampshire: 100 μg[Mn]/L. WHO limit: 400 μg(Mn)/L

Determination in Water: Fish Tox = 0.00193000 ppb (EXTRA HIGH).

Routes of Entry: Poisoning can occur by inhalation, ingestion and absorption through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Maneb irritates the eyes, skin, and respiratory tract. Maneb is low in acute toxicity and does not present alarming properties during long-term administration to experimental animals, except at very high dosages. However, it is a material of concern because of evidence of mutagenic and teratogenic effects as well as the possibility of nitrosation to carcinogenic nitrosamines. A rebuttable presumption against registration of maneb for pesticide uses was issued by EPA on August 10, 1977 on the basis of oncogenicity, teratogenicity and hazard to wildlife. Human Tox = 5.73770 ppb (HIGH).

Long-Term Exposure: Repeated skin contact can cause skin sensitization and rash. High or repeated exposures may interfere with thyroid function (causing goiter); damage to the central nervous system; affect liver function, or cause kidney damage.

Points of Attack: Skin, thyroid, liver, kidneys, central nervous system.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure. If symptoms develop or overexposure is suspected, the following may be useful: exam of the nervous system. Thyroid function tests. Consider kidney and liver function tests with higher or repeated exposures. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Thyroid function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Based on potential carcinogenicity the following is recommended by NIOSH: *At any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full- facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Red Stripe: Dangerous when wet materials release flammable gases on contact with water. Do not store this material in a room protected by water sprinkler systems. Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Do not store in a basement. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Maneb must be stored to avoid contact with water, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from acids, moisture, heat, and oxidizing materials. Where possible, automatically transfer material from drums or other storage containers to process containers. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2210 Maneb or Maneb preparations with not <60% maneb, Hazard Class: 4.3; Labels: 4.3-Dangerous when wet material, 4.2-Spontaneously combustible material. UN2968 Maneb stabilized or Maneb preparations, stabilized against self-heating, Hazard Class: 4.3; Labels: 4.3-Dangerous when wet material.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during clean-up. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. Keep maneb out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, soda ash; sand, or lime extinguishers. *Do not use water*. Thermal decomposition products may include hydrogen sulfide, carbon disulfide and oxides of nitrogen, sulfur, and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA

1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Generators of waste containing this contaminant (≥100 kg/mo) must conform to EPA regulations governing storage, transportation, treatment, and waste disposal. Maneb is unstable to moisture and is hydrolyzed by acids and hot water. It decomposes at about 100°C but may spontaneously decompose vigorously when stored in bulk. Incineration is the preferred disposal means[22]. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(102); (31); (173); (101); (138); (80); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Maneb, Trenton, NJ (November 1999).

EPA/OSHA Joint Chemical accident Report, PBS, Inc., West Helena, Arkansas, EPA 560-R-99-003, April 1999.

Manganese (Dust & Fume) M:0250

Formula: Mn

Synonyms: Colloidal manganese; Cutaval; Elemental manganese; JIS-G 1213; Manganese-55; Manganese element; Manganeso (Spanish); Tripart liquid; Tronamag

CAS Registry Number: 7439-96-5 (elemental)

HSDB Number: 550

RTECS Number: OO9275000

UN/NA & ERG Number: UN3089 (Metal powder, flammable, n.o.s.)/170; UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 231-105-1

Regulatory Authority and Advisory Information

EPA (*Mn and inorganic compounds*): Not Classifiable as to human carcinogenicity.

Hazard Alert: Pyrophoric (powder), Neurotoxic (cumulative), Flammable solid (powder), Possible risk of forming tumors, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction).

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112), as manganese compounds; also as radionuclides of manganese compounds (Mn 51, 52, 52m, 53, 54, 56).

CERCLA *Reportable Quantities (RQs) for radionuclides of Manganese, radioactive compounds*: Persons in charge of vessels or facilities are required to notify the NRC immediately, when there is a release of this designated hazardous substance, in an amount equal to or greater than its RQ reported in curies (ci)/TBq (terabecquerel):

- Manganese$_{52}$; Manganese$_{54}$: RQ ≥ 10 ci/0.37 × 10^{11} TBq
- Manganese$_{56}$: RQ ≥ 100 ci/3.7 × 10^{12} Tbq
- Manganese$_{51}$; Manganese$_{52m}$; Manganese$_{53}$: RQ ≥ 1000 ci/3.7 × 10^{13} TBq

The toll free number of the NRC is (800) 424-8802. The rule for determining when notification is required is stated in 40 CFR 302.4 (Section IV. D.3.b).

Safe Drinking Water Act (47FR 9352): SMCL = 0.05 mg/L

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%, Form R Toxic Chemical Category Code: N450

EPA TSCA CHEMICAL INVENTORY Section 8(b) as manganese

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, F, Xi; risk phrases: R11; R15; R17; R23/24/25; R34; R36/38; R62; safety phrases: S21; S26; S27; S36/37/39; S43; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): Not hazardous.

Description: Manganese is a combustible, lustrous, brittle, silvery soft metal. It may be found in chunks, powder, or flakes. The most important ore containing manganese is pyrolusite. Manganese may also be produced from ferrous scrap used in the production of electric and open-hearth steel. Molecular weight = 54.94; specific gravity (H_2O:1) = 7.3 (metal); boiling point = 2061°C; freezing/melting point = 1246°C. Hazard identification (based on NFPA-704 M Rating System): (*dust*): Health 0, flammability 2, reactivity 2₩. Insoluble in water, reaction releases flammable hydrogen gas.

Potential Exposure: Manganese is used in the production of steel; and in the manufacture of welding rod coatings and fluxes; in the iron and steel industry in steel alloys, e.g., ferro-manganese, silico-manganese, manganin, spiegeleisen; and as an agent to reduce oxygen and sulfur content of molten steel. Other alloys may be formed with copper, zinc, and aluminum. Manganese and its compounds are utilized in the manufacture of dry cell batteries (MnO_2), paints, varnishes, inks, dyes, matches, and firework; as a fertilizer, disinfectant, bleaching agent; laboratory reagent; drier for oils; an oxidizing agent in the chemical industry particularly in the synthesis of potassium permanganate; and as a decolorizer and coloring agent in the glass and ceramics industry. Exposure may occur during the mining, smelting, and refining of manganese; in the production of various materials; and in welding operations with manganese-coated rods. Manganese normally is ingested as a trace nutrient in food. The average human intake is approximately 10 mg/day.

Incompatibilities: Dust, powder, or finely divided material has been known to be pyrophoric or explosive in air. Compact, solid metallic magnesium is nonflammable. Reacts with water (slowly), steam, or acid producing flammable hydrogen gas. Reacts violently with concentrated hydrogen peroxide. Incompatible with nitrogen gas above 200°C. Oxidizers, nitric acid; nitrogen, finely divided aluminum and other metals; sulfur dioxide; carbon dioxide + heat may cause fire and explosions.

Permissible Exposure Limits in Air

Manganese:

NIOSH IDLH = 500 mg[Mn]/m^3

OSHA PEL: 5 mg[Mn]/m^3 Ceiling Concentration (inorganic compounds and fume)

NIOSH REL: 1 mg[Mn]/m^3 TWA; 3 mg[Mn]/m^3 STEL

ACGIH TLV[1] 0.02 mg[Mn]/m^3, respirable fraction; 0.1 mg[Mn]/m^3, inhalable fraction; not classifiable as a human carcinogen.

DFG MAK (*inorganic compounds and fume*): 0.5 mg[Mn]/m^3 inhalable fraction (Mn and its inorganic compounds); Pregnancy Risk Group C

PAC Ver. 29[138]

PAC-1: 3 milligram per cubic meter

PAC-2: 5 milligram per cubic meter

PAC-3: 1800 milligram per cubic meter

DFG MAK (*inorganic compounds and fume*): 0.5 mg[Mn]/m^3 inhalable fraction (Mn and its inorganic compounds); Pregnancy Risk Group C

Arab Republic of Egypt: TWA 5 milligram per cubic meter, 1993; Australia: TWA 1 milligram per cubic meter; STEL 3 milligram per cubic meter (fume), 1993; Austria: MAK 5 milligram per cubic meter, 1999; Belgium: TWA 1 milligram per cubic meter; STEL 3 milligram per cubic meter (fume), 1993; Denmark: TWA 2.5 mg[Mn]/m^3, 1999; Finland: TWA 1 milligram per cubic meter, 1999; Finland: TWA 0.5 milligram per cubic meter, 1993; France: VME 1 milligram per cubic meter (fume), 1999; the Netherlands: MAC-TGG 1 milligram per cubic meter, 2003; Japan: 0.3 milligram per cubic meter, respirable dust, 1999; Norway: TWA 1 milligram per cubic meter, 1999; the Philippines: TWA 5 milligram per cubic meter, 1993; Russia: STEL 0.2 milligram per cubic meter (fume), 1993; Sweden: NGV 1 milligram per cubic meter, TGV 2.5 milligram per cubic meter (respirable dust); NGV 2.5 milligram per cubic meter, TGV 5 milligram per cubic meter (total dust), 1999; Switzerland: MAK-W 1 milligram per cubic meter (fume); MAK-W 5 milligram per cubic meter, 1999; Thailand: TWA 5 milligram per cubic meter, 1993; Turkey: TWA 5 milligram per cubic meter (fume), 1993; United Kingdom: TWA 1 mg[Mn]/m^3; STEL 3 mg[Mn]/m^3, fume; TWA 5 mg[Mn]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 0.2 mg. The Czech Republic 2.0 milligram per cubic meter (6.0 milligram per cubic meter as a ceiling value). Standards for ambient air in residential areas have been set as follows: The Czech Republic; momentary basis (milligram per cubic meter) 0.03; daily average basis (milligram per cubic meter) 0.01; Russia; momentary basis (milligram per cubic meter) 0.01; daily average basis (milligram per cubic meter) 0.001. Several states have set guidelines or standards for manganese in ambient air[60] ranging from 2.0 μ/m^3 (Rhode Island) to 10 μ/m^3 (North Dakota) to 17 μ/m^3 (Virginia) to 20 μ/m^3 (Connecticut and South Dakota) to 25 μ/m^3 (Pennsylvania) to 119 μ/m^3 (Nevada) to 300 μ/m^3 (North Carolina).

Determination in Air: ***Manganese***: Use NIOSH Analytical Method, Elements by ICP, #7300; #7301; #7303; #9102; Elements in blood or tissue, #8005; Metals in urine, #8310; OSHA Analytical Method, ID-125G or ID121.

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 50 μg[Mn]/L; State Drinking Water Standards: New York: 300 μg[Mn]/L; State Drinking Water Guidelines: California 500 μg[Mn]/L; Connecticut: 500 μg [Mn]/L; Maine: 500 μg[Mn]/L; Minnesota: 300 μg[Mn]/L; New Hampshire: 100 μg[Mn]/L. WHO limit: 400 μg(Mn)/L

Determination in Water: The manganese detection limit by direct flame atomization is 2 μg/L. However, solvent extraction is used for many determinations. Analytic conditions are more critical for the extraction of manganese than for most other metals, because many manganese-chelate complexes are unstable in solution. With pH control and immediate analysis after extraction, accurate determinations are possible. When the graphite furnace is used to increase sample atomization, the detection limit is lowered to 0.01 μg/L or ng/L according to NAS/NRC.

Routes of Entry: Inhalation of dust or fume; limited percutaneous absorption of liquids; ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Manganese dust and fumes are irritants to the eyes and mucous membranes of the respiratory tract, and apparently are completely innocuous to the intact skin. Inhalation of dust may cause bronchitis and pneumonitis. The effects may be delayed.

Long-Term Exposure: The substance may have effects on the lungs and nervous system; resulting in bronchitis, pneumonitis, neurologic, and neuropsychiatric disorders (manganism). Animal tests show that this substance possibly causes toxic effects upon human reproduction. Chronic manganese poisoning has long been recognized as a clinical entity. The dust or fumes (manganous compounds) enter the respiratory tract and are absorbed into the blood stream. Manganese is then deposited in major body organs with a special predilection for the liver, spleen, and certain nerve cells of the brain and spinal cord. Among workers there is a very marked variation in individual susceptibility to manganese. Some workers have worked in heavy exposure for a lifetime and shown no signs of the disease; others have developed manganese intoxication within as little as 49 days of exposure. The early phase of chronic manganese poisoning is most difficult to recognize, but it is also important to recognize since early removal from the exposure may arrest the course of the disease. The onset is insidious, with apathy, anorexia, absthenia. Headache, hypersomnia, spasms, weakness of the legs, arthralgias, and irritability are frequently noted. Manganese psychosis follows with certain definitive features: unaccountable laughter, euphoria, impulsive acts; absent-mindedness, mental confusion; aggressiveness and hallucinations. These symptoms usually disappear with the onset of true neurological disturbances, or may resolve completely with removal from manganese exposure. Progression of the disease presents a range of neurological manifestations that can vary widely among individuals affected. Speech disturbances are common: monotonous tone, inability to speak above a whisper; difficult articulation; incoherence, even complete muteness. The face may take on mask-like quality, and handwriting may be affected by micrographia. Disturbances in gait and balance occur, and frequently propulsion, retropropulsion and lateropropulsion are affected, with no movement for protection when falling. Tremors are frequent, particularly of the tongue, arms, and legs. These will increase with intentional movements and are more frequent at night. Absolute detachment, broken by sporadic or spasmodic laughter, ensues, and as in extrapyramidal affections, there may be excessive salivation and excessive sweating. At this point the disease is indistinguishable from classical Parkinson's disease. Chronic manganese poisoning is not a fatal disease although it is extremely disabling. Manganese dust is no longer believed to be a causative factor in pneumonia. If there is any relationship at all, it appears to be as an aggravating factor to a preexisting condition. Freshly formed fumes have been reported to cause fever and chills similar to metal fume fever.

Points of Attack: Respiratory system, central nervous system, brain, lungs, blood, kidneys.

Medical Surveillance: NIOSH lists the following tests: whole blood (chemical/metabolite); biologic tissue/biopsy; CBC; chest X-ray; pulmonary function tests; urine (chemical/metabolite); urinalysis (routine). For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: A complete exam of the nervous system. CBC. Lung function tests. These may be normal if the person is not having an attack at the time of the test. Kidney function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. The symptoms of metal fume fever may be delayed for 4−12 hours following exposure: it may last less than 36 hours. Medical observation is recommended.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 10 milligram per cubic meter*: 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *Up to 25 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); PaprHie (APF = 25) (any PAPR with a high-efficiency particulate filter). *Up to 50 milligram per cubic meter*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTHie (APF = 50) (any PAPR with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 500 milligram per cubic meter*: Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); ASCBA (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus). *Escape*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: UN3089 (1) Color code—Red Stripe: Flammability Hazard: Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Store flammable solids up to maximum allowable quantity per control area in an approved flammable storage area. Do not store in a basement. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Manganese must be stored to avoid contact with water and steam since flammable hydrogen gas is produced. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates). Protect storage against physical damage.

Shipping: UN3089 Metal powders, flammable, n.o.s., Hazard Class: 4.1; Labels: 4.1-Flammable solid. UN3077

Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemicals appropriate for extinguishing metal fires. *Do not use water*. Thermal decomposition products may include oxides of metal. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Generators of waste (equal to or greater than 100 kg/mo) containing this contaminant, EPA hazardous waste number N450, must conform to USEPA regulations for storage, transportation, treatment, and disposal of waste. Dispose of waste material as hazardous waste using a licensed disposal contractor to an approved landfill. Dispose of contents and container to an approved waste disposal plant. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office. All federal, state, and local environmental regulations must be observed. Do not discharge into drains or sewers. Manganese metal-sanitary landfill. Manganese chloride or sulfate-chemical conversion to the oxide followed by land filling, or conversion to the sulfate for use in fertilizer. Consult with environmental regulatory agencies for guidance on acceptable disposal practices.

References

(31); (173); (101); (138); (2); (170); (100).

Illinois Institute for Environmental Quality, airborne Manganese Health Effects and Recommended Standard, Doc. No. 75-18, Chicago, III (Sept. 1975).

National Academy of Sciences, manganese, (in a series on medical and biologic effects of environmental pollutants), Washington, DC (1973).

National Institute for Occupational Safety and Health (NIOSH), Information Profile on Potential Occupational Hazards, pp 157−168, Report PB-267678, Rockville, MD (Oct. 1977).

National Academy of Sciences, Medical and Biologic Effects of Environmental Pollutants: Manganese, Washington, DC (1973).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 1, No. 2, 44−45 (1980).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Manganese (Dust and Fume), Trenton, NJ (September 1999).

Manganese Dioxide M:0260

Formula: MnO_2

Synonyms: Black manganese oxide; Bog manganese; Braunstein (German); Cement black; C.I. 77728; C.I. Pigment black 14; C.I. Pigment brown 8; Mangandioxid (German); Manganese binoxide; Manganese (bioxyd de) (French); Manganese black; Manganese (dioxyde de) (French); Manganese peroxide; Manganese superoxide; Pyrolusite brown

CAS Registry Number: 1313-13-9

HSDB Number: 6945

RTECS Number: OP0350000

UN/NA & ERG Number: UN1479 (oxidizing solid, n.o.s.)/140; UN3137 (oxidizing solid, flammable)/140

EC Number: 215-202-6 [*Annex I Index No.*: 025-001-00-3]

Regulatory Authority and Advisory Information

Hazard Alert: Powerful oxidizer, Neurotoxin (cumulative), Suspected reprotoxic hazard.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Safe Drinking Water Act (47FR 9352): SMCL = 0.05 mg/L

EPA TSCA CHEMICAL INVENTORY Section 8(b) as manganese

EPCRA Section 313: Includes any unique chemical substance that contains manganese as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: 1.0%, Form R Toxic Chemical Category Code: N450.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. as manganese compounds, n.o.s.

Hazard symbols, risk, & safety statements: Hazard symbol: O, Xn; risk phrases: R8; R9; R20/22; R63; safety phrases: S13; S16; S25; S26; S27; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Manganese dioxide is a black crystalline solid or powder. Molecular weight = 86.94; specific gravity (H_2O:1) = 5.1 @ 20°C; freezing/melting point = (decomposes) 553°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 3 (oxidizer). Insoluble in water.

Potential Exposure: Manganese dioxide is used as depolarizer for dry cell batteries, for production of manganese metal; as an oxidizing agent; laboratory reagent; and in making pyrotechnics and matches; in dry cell batteries.

Incompatibilities: A powerful oxidizer. Incompatible with strong acids; reducing agents; combustible materials (such as fuel and clothing; organic materials. Mixtures with calcium hydride is a heat- and friction-sensitive explosive. Vigorous reaction with hydrogen sulfide, diboron tetrafluoride; calcium hydride; chlorine trifluoride; hydrogen peroxide; hydroxyaluminum chloride; anilinium perchlorate. Decomposes when heated above 553°C producing manganese(III)oxide and oxygen, which increases fire hazard. Reacts violently with aluminum (thermite reaction), potassium azide; rubidium acetylide; in the presence of heat.

Permissible Exposure Limits in Air

Manganese:

NIOSH IDLH = 500 mg[Mn]/m^3

OSHA PEL: 5 mg[Mn]/m^3 Ceiling Concentration (inorganic compounds and fume)

NIOSH REL: 1 mg[Mn]/m^3 TWA; 3 mg[Mn]/m^3 STEL

ACGIH TLV[1] 0.02 mg[Mn]/m^3, respirable fraction; 0.1 mg[Mn]/m^3, inhalable fraction; not classifiable as a human carcinogen.

DFG MAK (*inorganic compounds and fume*): 0.5 mg[Mn]/m^3 inhalable fraction (Mn and its inorganic compounds); Pregnancy Risk Group C

PAC Ver. 29[138]

PAC-1: 4.7 milligram per cubic meter

PAC-2: 7.9 milligram per cubic meter

PAC-3: 690 milligram per cubic meter

DFG MAK: 0.5 mg[Mn]/m^3 inhalable fraction (Mn and its inorganic compounds); Pregnancy Risk Group C

Australia: TWA 5 mg[Mn]/m^3, 1993; Belgium: TWA 5 mg [Mn]/m^3, 1993; Denmark: TWA 2.5 mg[Mn]/m^3, 1999; Finland: TWA 0.5 mg[Mn]/m^3, 1999; Hungary: TWA 0.3 mg[Mn]/m^3; STEL 0.6 mg[Mn]/m^3, 1993; Japan 0.3 mg [Mn]/m^3, respirable dust, 1999; Norway: TWA 2.5 mg [Mn]/m^3, 1999; Poland: MAC (TWA) 0.3 mg[Mn]/m^3, MAC 5 mg[Mn]/m^3, 1999; Sweden: NGV 1 mg[Mn]/m^3, TGV 2.5 mg[Mn]/m^3 (respirable dust), 1993; Sweden: NGV 2.5 mg[Mn]/m^3, TGV 5 mg[Mn]/m^3 (total dust), 1993; United Kingdom: TWA 5 mg[Mn]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 0.2 mg [Mn]/m^3.

Determination in Air: *Manganese*: Use NIOSH Analytical Method, Elements by ICP, #7300; #7301; #7303; #9102; Elements in blood or tissue, #8005; Metals in urine, #8310; OSHA Analytical Method, ID-125G or ID121.

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 50 μg[Mn]/L; State Drinking Water Standards: New York: 300 μg[Mn]/L; State Drinking Water Guidelines: California 500 μg[Mn]/L; Connecticut: 500 μg [Mn]/L; Maine: 500 μg[Mn]/L; Minnesota: 300 μg[Mn]/L; New Hampshire: 100 μg[Mn]/L. WHO limit: 400 μg(Mn)/L

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Manganese dioxide can affect you when breathed in. Inhalation can cause irritation of the respiratory system. Manganese dioxide can cause a flu-like illness, with chills, fever, and aching. Chest congestion can occur with cough and shortness of breath. It can cause an asthma-like lung allergy. The effects may be delayed.

Long-Term Exposure: Repeated exposure can cause permanent brain damage. Early symptoms include poor appetite; weakness and sleepiness. Later effects include speech, balance, and personality changes. Later symptoms are identical to Parkinson's Disease. High or repeated exposure may cause permanent lung damage; kidney and liver damage and cause anemia. May affect the lungs and nervous system; causing bronchitis, pneumonitis, neurologic, and neuropsychiatric disorders (manganism). Animal tests show that this substance may cause toxic effects upon human reproduction.

Points of Attack: Lungs, blood, central nervous system; liver, kidneys.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: complete exam of the nervous system. CBC. Lung function tests. These may be normal if the person is not having an attack at the time of the test. Kidney function test. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Liver function tests. Evaluation for brain effects. Positive and borderline individuals should be referred for neuropsychological testing.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/ manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when

skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 10 milligram per cubic meter*: 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *Up to 25 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); PaprHie (APF = 25) (any PAPR with a high-efficiency particulate filter). *Up to 50 milligram per cubic meter*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTHie (APF = 50) (any PAPR with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 500 milligram per cubic meter*: Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); ASCBA (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus). *Escape*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Check oxygen content prior to entering storage area. Color code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially organic materials, flammables and combustibles, and other incompatible materials. Oxidizers, including oxidizing gases, should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Manganese dioxide must be stored to avoid contact with heat and flammable materials and oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates), since violent reactions occur. See also incompatibilities above. Store in a cool, well-ventilated area away from incompatible materials listed above. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage.

Shipping: UN1479 Oxidizing solid, n.o.s., Hazard Class: 5.1; Labels: 5.1-Oxidizer, Technical Name Required. UN3137 (powder) Oxidizing solid, flammable, Hazard Class: 5.1; Labels: 5.1-Oxidizer, 4.1 Flammable solid, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Manganese dioxide itself does not burn, but it will intensify an existing fire. Thermal decomposition products may include oxides of metal. Use extinguishing agents suitable for surrounding fire if material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Generators of waste (equal to or greater than 100 kg/mo) containing this contaminant, EPA hazardous waste number N450, must conform to USEPA regulations for storage, transportation, treatment, and disposal of waste. Dispose of waste material as hazardous waste using a licensed disposal contractor to an approved landfill. Dispose of contents and container to an approved waste disposal plant. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office. All federal, state, and local environmental regulations must be observed. Do not discharge into drains or sewers.

References

(31); (173); (101); (138); (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Manganese Dioxide," Trenton, NJ (November 1999).

Manganese, Tricarbonyl Methylcyclopentadienyl M:0280

Formula: $C_9H_7MnO_3$: $C_5H_4(CH_3)$-$Mn(CO)_3$
Synonyms: Ak-33X; Antiknock-33; CI-2; Combustion improver-2; Manganese, (methylcyclopentadienyl)-tricarbonyl-; Methylcyclopentadienyl manganese tricarbonyl; 2-Methylcyclopentadienyl manganese tricarbonyl; Methylcyklopentadientrikarbonylmanganium (German); MMT; TDS-1510; Tricarbonyl(methylcyclopentadienyl) manganese
CAS Registry Number: 12108-13-3
HSDB Number: 2014
RTECS Number: OP1450000
UN/NA & ERG Number: UN3281 (metal carbonyls, liquid, n.o.s.)/151
EC Number: 235-166-5
Regulatory Authority and Advisory Information
Hazard Alert: Highly toxic (all routes), Neurotoxin (cumulative), Combustible, Organometallic, Strong reducing agent, Primary irritant (w/o allergic reaction), Light sensitive (decomposition), Environmental hazard.
Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112), as manganese compounds
Safe Drinking Water Act (47FR 9352): SMCL = 0.05 mg/L
EPA TSCA CHEMICAL INVENTORY Section 8(b) as manganese compound
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%, manganese compounds, Form R Toxic Chemical Category Code: N450
Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg)
Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)
Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. as manganese compounds, n.o.s.
Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.
Hazard symbols, risk, & safety statements: Hazard symbol: T, Xi, N; risk phrases: R40, R23/24/25; R36/37/38; R50/53; safety phrases: S1; S23; S26; S29/35; S36/37/39; S41; S45; S61 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.
Description: Manganese, tricarbonyl methylcyclo-pentadienyl is a dark orange liquid. Faintly pleasant, herb-like odor. Molecular weight = 218.10; specific gravity (H_2O:1) = 1.39 @ 20°C; boiling point = 231.67°C; freezing/melting point = 1.11°C; vapor pressure = 7.3 mmHg @ 100°C; flash point = 110°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 0. Practically insoluble in water.
Potential Exposure: MMT is used as an octane improver in unleaded gasoline, other distillate fuels, and fuel oils; as a smoke abater in fuels.
Incompatibilities: Light causes decomposition. May be air-reactive. A strong reducing agent. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, halogens.
Permissible Exposure Limits in Air
OSHA PEL: None [5 mg[Mn]/m^3 Ceiling Concentration (vacated 6/30/1993)]
NIOSH REL: 0.2 mg[Mn]/m^3 TWA [skin]
ACGIH TLV[1]: 0.2 mg[Mn]/m^3 TWA [skin]
PAC Ver. 29[138]
PAC-1: 0.3 milligram per cubic meter
PAC-2: 0.6 milligram per cubic meter
PAC-3: 6.9 milligram per cubic meter
Australia: TWA 0.2 milligram per cubic meter [skin], 1993; Belgium: TWA 0.2 milligram per cubic meter [skin], 1993; Denmark: TWA 0.1 ppm (0.2 mg[Mn]/m^3) [skin], 1999; Finland: TWA 0.2 milligram per cubic meter; STEL 0.6 milligram per cubic meter [skin], 1993; France: VME 0.2 milligram per cubic meter [skin], 1999; Switzerland: MAK-W 0.1 ppm (0.2 mg[Mn]/m^3), 1999; United Kingdom: TWA 0.2 mg[Mn]/m^3; STEL 0.6 mg[Mn]/m^3 [skin], 2000; the Netherlands: MAC-TGG 0.2 milligram per cubic meter [skin], 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 0.2 mg [Mn]/m^3 [skin]. States have set guidelines or standards for MCT in ambient air[60] ranging from 2.0 μ/m^3 (North Dakota) to 3.5 μ/m^3 (Virginia) to 4.0 μ/m^3 (Connecticut) to 5.0 μ/m^3 (Nevada). These compare to values for methyl cyclopentadienyl manganese tricarbonyl of 1.0 μ/m^3 (North Dakota) to 1.6 μ/m^3 (Virginia) to 2.0 μ/m^3 (Connecticut and Nevada).
Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 50 μg[Mn]/L; State Drinking Water Standards: New York: 300 μg[Mn]/L; State Drinking Water Guidelines: California 500 μg[Mn]/L; Connecticut: 500 μg[Mn]/L; Maine: 500 μg[Mn]/L; Minnesota: 300 μg [Mn]/L; New Hampshire: 100 μg[Mn]/L. WHO limit: 400 μg(Mn)/L.
Routes of Entry: Inhalation, ingestion; skin and/or eye contact; absorbed through the skin.
Harmful Effects and Symptoms
Short-Term Exposure: In concentrated form this compound is highly toxic by all routes of exposure. Irritates the eyes, skin, and respiratory tract. Medical observation is indicated. Approximately 5−15 mL, when spilled on the hand and wrist of a worker, produced toxic effects within 3−5 minutes. Giddiness, "thick tongue," nausea, and headache were reported to occur after skin exposure. Human exposure data are limited; the primary site of action is reported to be the central nervous system; may cause tissue lesions. LD_{50}(oral-rat) = 8 mg/kg.

Long-Term Exposure: Can cause kidney and lung damage
Points of Attack: Respiratory system, skin, central nervous system; kidneys.
Medical Surveillance: Examination of the nervous system. Kidney function tests. Lung function tests.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.
Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: *Up to 10 milligram per cubic meter*: 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *Up to 25 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); PaprHie (APF = 25) (any PAPR with a high-efficiency particulate filter). *Up to 50 milligram per cubic meter*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTHie (APF = 50) (any PAPR with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 500 milligram per cubic meter*: Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); ASCBA (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus). *Escape*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).
Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers.
Shipping: UN3281 Metal carbonyls, liquid n.o.s. Hazard class 6.1. Technical name required, Potential Inhalation Hazard (Special Provision 5).
Spill Handling:
Metal carbonyls, liquid n.o.s.
Initial isolation and protective action distances
Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).
Small spills (From a small package or a small leak from a large package)
First: Isolate in all directions (ft/m) 300/90
Then: Protect persons downwind (mi/km)
Day 0.9/1.5
Night 3.4/5.2
Large spills (From a large package or from many small packages)
First: Isolate in all directions (ft/m) 3000/900
Then: Protect persons downwind (mi/km)
Day 7.1+/11+
Night 7.0+/11+*
"+" means distance can be larger in certain atmospheric conditions.
Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Large spills can be cleaned up using JP-4L or JP-5 (jet engine fuels). Isopropyl alcohol may be used to clean up moderate spills, while methyl ethyl ketone should be used for cleaning *small spills* and quick disconnects. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive

concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of metal and carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Generators of waste (equal to or greater than 100 kg/mo) containing this contaminant, EPA hazardous waste number N450, must conform to USEPA regulations for storage, transportation, treatment, and disposal of waste. Dispose of waste material as hazardous waste using a licensed disposal contractor to an approved landfill. Dispose of contents and container to an approved waste disposal plant. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office. All federal, state, and local environmental regulations must be observed. Do not discharge into drains or sewers.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Methylcyclopentadienyl Manganese Tricarbonyl, Washington, DC (October 21, 1983).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Manganese, Tricarbonyl Methylcyclopentadienyl, Washington, DC, Chemical Emergency Preparedness Program (Nov. 30, 1987).

NJ RTK1244, July 2000.

MCPA M:0290

Formula: $C_9H_9ClO_3$; $H_3CC_6H_3ClOCH_2CO_2H$

Synonyms: Acetic acid (4-chloro-2-methylphenoxy)-; Acetic acid [(4-chloro-*o*-tolyl)-oxy]-; ACME MCPA amine 4; Agritox; Agroxone; Anicon kombi; Anicon M; BH MCPA; Bordermaster; (4-Chloro-*o*-cresoxy)acetic acid; Chiptox; 4-Chloro-*o*-cresoxyacetic acid; (4-Chloro-2-methylphenoxy) acetic acid; 4-Chloro-2-methylphenoxyacetic acid; 4-Chloro-*o*-toloxyacetic acid; (4-Chloro-*o*-toloxy)acetic acid; [(4-Chloro-*o*-tolyl)oxy]acetic acid; Chwastox; Cornox M; Ded weed; Dicopur-M; Dicotex; Dow MCP amine weed killer; Emcepan; Empal; Hedapur M 52; Hedarex M; Hedonal M; Herbicide M; Hormotuho; Hornotuho; Kilsem; 4K-2M; Legumex DB; Leuna M; Leyspray; Linormone; M 40; 2M-4C; 2M-4CH; MCP; MCPA; Mephanac; Metaxon; Methoxone; Methylchlorophenoxyacetic acid; 2-Methyl-4-chlorophenoxyacetic acid; (2-Methyl-4-chlorophenoxy)acetic acid; 2-Methyl-4-chlorophenoxyessigsaeure (German); 2M-4KH; Okultin; Phenoxylene 50; Phenoxylene plus; Phenoxylene super; Razol dock killer; Rhonox; B-Selektonon M; Seppic MMD; U 46; U 46 M-Fluid; Vacate; Vesakontuho; Weedar; Weedar MCPA concentrate; Weedone MCPA ester; Weed RHAP; Zelan

CAS Registry Number: 94-74-6

HSDB Number: 1127

RTECS Number: AG1575000

UN/NA & ERG Number: UN3345/153; UN3077 (environmentally hazardous substances, solid, n.o.s.)/171***EC Number:*** 202-360-6 [*Annex I Index No*.: 607-051-00-3]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human Limited Evidence; Animal No Adequate Data, *possibly carcinogenic to humans*, Group 2B, 1987. United States Environmental Protection Agency Gene-Tox Program, Positive: *D. melanogaster* sex-linked lethal; *S. cerevisiae*-reversion; Negative: *D. melanogaster*-whole sex chrom. loss; Negative: *D. melanogaster*-nondisjunction; Host-mediated assay.

Hazard Alert: Poison, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction), Environmental hazard.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: Xn; risk phrases: R22; R38; R41; R51/53; R62; R63; safety phrases: S2; S26; S29; S37; S39; S41; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: MCPA is a colorless crystalline solid. Molecular weight = 200.63; freezing/melting point = 118.8°C; vapor pressure = 1.5×10^{-6} mmHg @ 20°C. Insoluble in water.

Potential Exposure: A potential danger to those involved in the manufacture, formulation, and application of this postemergence herbicide, used for control of broadleaf weeds in agricultural applications.

Incompatibilities: A weak acid. Compounds of the carboxyl group react with all bases, both inorganic and organic (i.e., amines) releasing substantial heat, water and a salt that may be harmful. Incompatible with arsenic compounds (releases hydrogen cyanide gas), diazo compounds, dithiocarbamates, isocyanates, mercaptans, nitrides, and sulfides (releasing heat, toxic, and possibly flammable gases), thiosulfates and dithionites (releasing hydrogen sulfate and oxides of sulfur). Incompatible with alkalis.

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Poland: MAC (TWA) 1 milligram per cubic meter, MAC (STEL) 3 milligram per cubic meter, 1999

Determination in Air: No method available.

Permissible Concentration in Water: Russia set a MAC in surface water of 0.25 mg/L. The United States Environmental Protection Agency has determined a no-observed-adverse-effects-level (NOAEL) of 1.0 mg/kg/day from which they have calculated a long-term advisory of 0.35 mg/L (350 μg/L) for an adult. They have further calculated a lifetime health advisory of 0.0036 mg/L (3.6 μg/L) for an adult. In addition, Maine has set a guideline for MCPA in drinking water[61] of 2.5 μg/L.

Determination in Water: No method available. Fish tox = 17,986.45312000 ppb (VERY LOW). Octanol−water coefficient: Log $K_{ow} = 3.3$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Corrosive. Irritates the eyes, skin, and respiratory tract. This material is moderately toxic. LD_{50}(oral-rat) = 700 mg/kg. Human Tox = 4.00000 (HIGH). The approximate lethal dose to a 150-lb man is 3.3 tablespoonfuls (Sax).

Long-Term Exposure: Animal tests show that this substance possibly causes toxic effects upon human reproduction MCPA is classified as a chlorophenoxy-herbicide. These herbicides are a possible carcinogen to humans. May cause decreased blood pressure. May cause genetic changes.

Medical Surveillance: Monitor blood pressure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN3345 Phenoxyacetic acid derivative pesticide, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Also, can be precipitated with divalent cations. Carbon or peat can be used as sorbents.

Fire Extinguishing: Solid material not combustible. Liquid formulations containing organic solvents may be flammable. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include hydrogen chloride and oxides of carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration with added flammable solvent; incinerator equipped with fume scrubber[22]. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (80); (100).

United States Environmental Protection Agency, Initial Scientific and Minieconomic Review No. 21: MCPA, Washington, DC, Office of Pesticide Programs (1975).

United States Environmental Protection Agency, "Alert: MCPA, Washington, DC, Office of Drinking Water (August 1987).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 8, No. 6, 35−41 (1988).

Mechlorethamine (Agent HN-2)

M:0300

Formula: $C_5H_{11}Cl_2N$; $CH_3N(CH_2CH_2Cl)_2$

Synonyms: *N,N*-Bis(2-chloroethyl)methylamine; Bis(β-chloroethyl)methylamine; Bis(2-chloroethyl)methylamine; Caryolysin; Chloramine; Chlorethazine; Chlormethine; 2-Chloro-*N*-(2-chloroethyl)-*N*-methylethanamine; Cloramin; Dichloramine; Dichloren (German); *β,β*-Dichlorodiethyl-*N*-methylamine; *N,N*-Di(chloroethyl)methylamine; Di(2-chloroethyl)methylamine; 2,2′-Dichloro-*N*-methyldiethylamine; Diethylamine, 2,2′-dichloro-*N*-methyl-(8CI); Embichin; ENT-25294; Ethanamine, 2-chloro-*N*-(2-chloroethyl)-*N*-methyl-; HN-2 (military designation); MBA; Mechlorethamine; *N*-Methyl-bis-chloraethylamin (German); *N*-Methyl-bis(*β*-chloroethyl)amine; *N*-Methyl-bis(2-chloroethyl)amine; Methylbis(β-chloroethyl)amine; Methylbis(2-chloroethyl)amine; *N*-Methyl-2,2′-dichlorodiethylamine; Methyldi(2-chloroethyl)amine; *N*-Methyllost (German); Mostaza de nitrogeno (Spanish); Mustargen; Mustine; Nitrogen Mustard-2; Nitrogen mustard agent HN-2; *N*-Lost (German); NSC 762; TL 146

CAS Registry Number: 51-75-2 (HN-2); 126-85-2 (nitrogen mustard *N*-oxide); 302-70-5 (nitrogen mustard, *N*-oxide hydrochloride); 55-86-7 (hydrochloride *see N:045*)

HSDB Number: 5083

RTECS Number: IA1750000

UN/NA & ERG Number: (PIH) UN2810 (toxic liquids, organic, n.o.s.)/153

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Theft hazard* 2.2 lb. (≥30.00% concentration) (hydrochloride); *Theft hazard* CUM 100 g. (*51-75-2*).

Carcinogenicity: IARC: Human Limited Evidence; Animal Sufficient Evidence, *probably carcinogenic to humans*, Group 2A, 1998; NTP (hydrochloride): Reasonably anticipated to be a human carcinogen.

California Proposition 65 Chemical[102]: (*hydrochloride*) Cancer 4/1/1988; Developmental/Reproductive toxin 7/1/1990.

Hazard Alert: Poison inhalation hazard: exposure can be lethal, Combustible, Unstable chemical (as dry crystals), Possible risk of forming tumors, Reproductive toxin: possible risk of gene damage/impaired fertility; Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction).

United States National Primary Drinking Water Regulations: MRDL = 4.0 mg/L; MRDLG = 4.0 mg/L as chloramines (as Cl_2)

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 10 lb (4.54 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Hazard symbols, risk, & safety statements: Hazard symbol: T+; risk phrases: R45; R19; R27/28; R36/37/38; R50/53; R62; R63; safety phrases: S1; S13; S28; S29/35; S36; S41; S45 (see Appendix 4)

Description: Nitrogen mustard is a pale yellow, oily, mobile liquid with a faint odor of herring. *Nitrogen mustards* are colorless when pure but are typically a yellow to brown oily substance. Odors are variably described as; sweet, agreeable, slightly garlic- or mustard-like. NIOSH reports HN-2 as having "a fruity odor at high concentrations, and a soapy or fishy odor at low concentrations." Molecular weight = 156.07; specific gravity (H_2O:1) = 1.12 @ 25°C; boiling point = 87°C @ 18 mmHg; 75°C @ 10 mmHg (HN-2 decomposes before its boiling point is reached or condenses under all conditions; the reactions involved could generate enough heat to cause an explosion)[77]; freezing/melting point: −60°C; vapor pressure = 0.29 mmHg @ 20°C. Hazard identification (based on NFPA-704 M Rating System): Health 4, flammability 1, reactivity 0. This compound is soluble in water; releases corrosive vapors.

Potential Exposure: Drug used in treatment of cancer. Exposure to nitrogen mustard damages the eyes, skin, and respiratory tract and suppresses the immune system. Although the nitrogen mustards cause cellular changes within minutes of contact, the onset of pain and other symptoms is delayed. Exposure to large amounts can be fatal[77]. Sulfur mustards were formerly used as a gas warfare agent. Nitrogen mustards have not previously been used in warfare[77].

Incompatibilities: HN-2 is not stable except as dry crystals. Polymerization of HN-2 results in components that present an explosion hazard in open air[77]. Avoid contact or contamination with oxidizers e.g., nitrates, oxidizing acids; chlorine bleaches pool chlorine); which may result in ignition. Unstable in the presence of light and heat and forms dimers at temperatures above 50°C. Corrosive to ferrous alloys beginning @ 65°C. Polymerizes slowly, so munitions would be effective for several years. Heated to decomposition emits hydrogen chloride and nitrogen oxide. Contact with metals may evolve flammable hydrogen gas[77]. *Note*: Chlorinating agents destroy nitrogen mustards. Dry chlorinated lime and chloramines with a high content of active chlorine vigorously chlorinate nitrogen mustards to the carbon chain, giving low toxicity products. In the presence of water this interaction proceeds less actively. They are rapidly oxidized by peracids in aqueous solution at weakly alkaline pH. In acid solution the oxidation is much slower.

An amine and a chemical base: will neutralize acids to form salts plus water with an exothermic reaction. May be incompatible with isocyanates, halogenated organics, peroxides, phenols (acidic), epoxides, anhydrides, and acid halides. Flammable gaseous hydrogen is generated by amines in combination with strong reducing agents such as hydrides, nitrides, alkali metals, and sulfides.

Permissible Exposure Limits in Air

The Surgeon General's Working Group (United States Department of Health and Human Services) recommends (for the workplace) 0.003 milligram per cubic meter, Ceiling Concentration. Same for United States military. Several states have set guidelines for nitrogen mustard in ambient sir[60] New York and South Carolina at zero.

PAC HN-2*

51-75-2 [(Bis(b-chloroethyl)methylamine; Nitrogen mustard; Nitrogen mustard-2]

PAC Ver. 29[138]

PAC-1: 0.002 milligram per cubic meter

PAC-2: $\mathbf{0.022}_{\mathbf{A}}$ milligram per cubic meter

PAC-3: $\mathbf{0.37}_{\mathbf{A}}$ milligram per cubic meter

*AEGLs are marked with a subscript "**A**" and correspond to 60-minute values.

DFG MAK: [skin] danger of skin sensitization; Carcinogen Category 2A; Germ Cell Mutation Category 2

Determination in Water: A water contaminant. Octanol−water coefficient: Log K_{ow} = (estimated) 0.91 @ pH 7.4; 1.53[77]

Routes of Entry: Inhalation, ingestion; skin and/or eye contact (vapor or liquid).

Harmful Effects and Symptoms

Nitrogen mustard is a blister agent (vesicant) that causes delayed severe damage to the respiratory tract. It is an alkylating agent that damages the cells within the bone marrow that are necessary for making blood cells. Clinical effects do not appear until hours after exposure. Nitrogen mustards penetrate and bind quickly to cells of the body; their health effects develop slowly. The full extent of cellular injury may not be known for days. The sooner after exposure that health effects occur, the more likely it is that the patient/victim was exposed to a high concentration of HN-2. Similarly, the sooner that health effects occur, the more likely it is that they will progress and become severe. *Eye exposure*: The eyes are the organs that are most sensitive to mustard vapor; eye injury may occur within 1 to 2 hours after severe exposure, or 3 to 12 hours after a mild to moderate exposure. Inhalation exposure: Airway injury may occur within 2 to 6 hours after severe exposure and within 12 to 24 hours after mild exposure. Skin exposure: The symptom-free (latent) period is 6 to 12 hours in temperate conditions; hot, humid weather strikingly increases the action of nitrogen mustards. Some skin injury may appear as late as 48 hours after exposure[77]. Toxic doses as low as 400 mg/kg have been reported in humans. Blood clots may occur at site of intravenous injection and tissue damage if outside vein. Powerful vesicant (causes blisters) when it contacts skin, mucous membranes, or eyes. Delayed toxicity-missed menstrual periods, alopecia (hair loss), hearing loss, tinnitus (ringing in ears), jaundice, impaired spermatogenesis and germinal aplasia, swelling, and hypersensitivity. May damage fetus in pregnant women[88].

Short-Term Exposure: Extremely toxic and may damage the eyes, skin, and respiratory tract and suppress the immune system. Although this agent can cause cellular changes within minutes of contact, the onset of pain and other symptoms is delayed. Irritates and burns the eyes, with possible permanent damage. Skin contact can cause irritation, burns with itching and blisters. Inhalation can cause irritation of the respiratory tract with wheezing and coughing. Higher exposure can cause headache, nausea, vomiting, and dizziness. Symptoms of exposure include nausea and vomiting; bleeding, skin lesions; menstrual irregularities. Toxic doses as low as 400 mg/kg have been reported in humans. Blood clots may occur at site of intravenous injection, and tissue damage if outside vein. Powerful vesicant (causes blisters) when it contacts skin, mucous membranes; or eyes. *Delayed toxicity*-missed menstrual periods, alopecia (hair loss), hearing loss; tinnitus (ringing in ears), jaundice, impaired spermatogenesis and germinal aplasia; swelling, and hypersensitivity. High exposure can cause tinnitus (ringing in the ears) and possible hearing loss.

Long-Term Exposure: Bone marrow suppression resulting in damage to the blood forming (hematopoietic) system. Early signs of bone marrow suppression include: a low white blood cell count; an increased risk for developing infections; a tendency for easy bruising and bleeding. May cause lymph node damage and a weakened immune system. It also causes liver and kidney damage; damage to the reproductive systems of both men and women leading to decreased fertility. It is mutagenic, toxic to the developing embryo, and carcinogenic. Following significant whole-body (systemic) absorption of nitrogen mustard, injury to the bone marrow, lymph nodes, and spleen may cause a drop in white blood cell counts (beginning on days 3 to 5), which can result in an increased risk for developing (life-threatening) infections. Counts of red blood cells and platelets may also fall due to bone marrow damage. Chloramines can cause eye/nose irritation; stomach discomfort; anemia.

Points of Attack: Bone marrow, hearing.

Medical Surveillance: CBC. Audiogram.

First Aid: There is no antidote for nitrogen mustard toxicity. Decontamination of all potentially exposed areas within minutes after exposure is the only effective means of decreasing tissue damage[77]. Because health effects due to nitrogen mustard may not occur until several hours after exposure, patients/victims should be observed in a hospital setting for at least 24 hours. Gastric lavage is contraindicated following ingestion of this agent due to the risk of perforation of the esophagus or upper airway. If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Personal Protective Methods:

General information: first responders should use a NIOSH-certified chemical, biological, radiological, nuclear (CBRN) SCBA with a level a protective suit when entering an area with an unknown contaminant or when entering an area where the concentration of the contaminant is unknown. Level a protection should be used until monitoring results confirm the contaminant and the concentration of the contaminant. *Note*: Safe use of protective clothing and equipment requires specific skills developed through training and experience.

LEVEL A: (*RED ZONE*): select when the greatest level of skin, respiratory, and eye protection is required. This is the maximum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than the AEGL-2. A NIOSH-certified CBRN full-facepiece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle. A totally encapsulating chemical protective (TECP) suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, and a hard hat worn under the TECP suit are optional items.

LEVEL B: (RED ZONE): Select when the highest level of respiratory protection is necessary but a lesser level of skin protection is required. This is the minimum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than AEGL-2. It differs from Level A in that it incorporates a nonencapsulating, splash-protective, chemical-resistant splash suit that provides Level A protection against liquids but is not airtight. A NIOSH-certified CBRN full-facepiece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL C: (YELLOW ZONE): Select when the contaminant and concentration of the contaminant are known and the respiratory protection criteria factors for using air-purifying respirators (APR) or PAPRs are met. This level is appropriate when decontaminating patient/victims. A NIOSH-certified CBRN tight-fitting APR with a canister-type gas mask or CBRN PAPR for air levels greater than AEGL-2. A NIOSH-certified CBRN PAPR with a loose-fitting facepiece, hood, or helmet and a filter or a combination organic vapor, acid gas, and particulate cartridge/filter combination or a continuous flow respirator for air levels greater than AEGL-1. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Escape mask, face shield, coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL D: (GREEN ZONE): Select when the contaminant and concentration of the contaminant are known and the concentration is below the appropriate occupational exposure limit or less than AEGL-1 for the stated duration times. Limited to coveralls or other work clothes, boots, and gloves.

Notes: Take all necessary precautions to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Decontamination: Decontamination of all potentially exposed areas within minutes after exposure is the only effective means of decreasing tissue damage[77]. Remove clothes and place contaminated clothes and personal belongings in a sealed double bag. Decontamination of mustard-exposed victims by either vapor or liquid should be performed within the first 2 minutes following the exposure to prevent tissue damage. If not accomplished within the first several minutes, decontamination should still be performed to ensure any residual liquid mustard is removed from the skin or clothes, or to ensure any trapped mustard vapor is removed with the clothing. Removing trapped mustard vapor will prevent vapor off-gassing or subsequent cross-contamination of other emergency responders/healthcare providers or the healthcare facility. Physical removal of the mustard agent, rather than detoxification or neutralization, is the most important principle in patient decontamination. Mustard is not detoxified by water alone and will remain in decontamination effluent (in dilute concentrations) if hydrolysis has not taken place.

(1) Patients exposed to vapor should be decontaminated by removing all clothing in a clean air environment and shampooing or rinsing the hair to prevent vapor off-gassing. (2) Patients exposed to liquid should be decontaminated by

(a) Washing in warm or hot water at least three times. Use liquid soap (dispose of container after use and replace), large volumes of water, and mild to moderate friction with a single-use sponge or washcloth in the first and second washes. Scrubbing of exposed skin with a brush is discouraged, because skin damage may occur which may enhance absorption. The third wash should be to rinse with large amounts of warm or hot water. Shampoo can be used to wash the hair. The rapid physical removal of a chemical agent is essential. If warm or hot water is not available, but cold water is, use cold water. Do not delay decontamination to obtain warm water. (b) Rinse the eyes, mucous membranes; or open wounds with sterile saline or water.

(3) The healthcare provider should (a) check the victim after the three washes to verify adequate decontamination before allowing entry to the medical treatment facility. If the washes were inadequate, repeat the entire process. (b) Be prepared to stabilize conventional injuries during the decontamination process. Careful decontamination can be a time consuming process. The healthcare provider may have to enter the contaminated area to treat the casualty during this process. Medical personnel should wear the proper PPE and evaluate the exposed workers.

Respirator Selection: *When used as a weapon, use SCBA Respirator Certified By NIOSH For CBRN Environments.* Where a potential exposure to the chemical exists, use a NIOSH-certified CBRN full facepiece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored Store in tightly closed containers in a cool, well-ventilated area. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: UN2810 Toxic liquids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. Military driver shall be given full and complete information regarding shipment and conditions in case of emergency. AR 50-6 deals specifically with the shipment of chemical agents. Shipments of agent will be escorted in accordance with AR 740-32.

Spill Handling:

UN2810 Toxic liquids, organic, n.o.s.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.2/0.3

Night 0.7/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 1000/300

Then: Protect persons downwind (mi/km)

Day 1.1/1.8

Night 2.8/4.5

HN-2, when used as a weapon

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30

Then: Protect persons downwind (mi/km)

Day 0.1/0.2

Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 200/60

Then: Protect persons downwind (mi/km)

Day 0.2/0.3

Night 0.3/0.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include hydrogen chloride and oxides of nitrogen and carbon. *Small fires*: dry chemical, carbon dioxide; water spray; or foam. *Large fires*: water spray, fog, or foam. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Wear positive pressure breathing apparatus and special protective clothing. Move container from fire area if you can do so without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: It is inappropriate and possibly dangerous to the environment to dispose of expired or waste drugs and pharmaceuticals by flushing them down the toilet or discarding them to the trash. Household quantities of expired or waste pharmaceuticals may be mixed with wet cat litter or coffee grounds, double-bagged in plastic, discard in trash. Larger quantities shall carefully take into consideration applicable DEA, EPA, and FDA regulations. If possible return the pharmaceutical to the manufacturer for proper disposal being careful to properly label and securely package the material. Alternatively, the waste pharmaceutical shall be labeled, securely packaged, and transported by a state licensed medical waste contractor to dispose by burial in a licensed hazardous or toxic waste landfill or incinerator.

References

(102); (31); (173); (101); (138).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Mechlorethamine, Washington, DC, Chemical Emergency Preparedness Program (Nov. 30, 1987).

NIOSH.

Mefluidide M:0307

Formula: $C_{11}H_{13}F_3N_2O_3S$

Synonyms: Acetamide, *N*-(2,4-dimethyl-5-[((trifluoromethyl) sulfonyl)amimo)phenyl]-; 5-Acetamido-2,4-dimethyltrifluoromethanesulfonanilide; *N*-[(2,4-Dimethyl-5-((trifluoromethyl) sulfonyl)amino)phenyl] acetamide; 2′,4′-Dimethyl-5-[(trifluoromethyl)sulfonamido] acetanilide; EMmHgK; MBR 12325; Methafluoridamid; S 15733; VEL 3973; Vistar herbicide

CAS Number: 53780-34-0

HSDB Number: 6698

RTECS Number: AE2460000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 258-767-4

Regulatory Authority and Advisory Information

This product is considered hazardous under the criteria of the Federal OSHA Hazard Communication Standard 29 CFR 1910.1200.

SARA Title III, Section 311/312 Hazard Category: Immediate Health Hazard

Description: White crystalline solid. Some formulations are a dark brown liquid. Molecular weight = 310.29; freezing/melting point = 184°C. Vapor pressure = 2.40×10^{-8} mmHg @ 25°C (est)[83]; Henry's law constant = 1.28×10^{-11} atm m^3/mol @ 25°C (est)[83]; flash point ≥ 212°C. Slightly soluble in water. Physical and toxicological properties may be affected by carrier solvents in commercial formulations.

Potential Exposure: Mefluidide is an anilide herbicide and plant growth regulator used to control ornamental and non-ornamental woody plants, ground cover, hedges, trees, turfgrass, and broadleaf weeds. Both the diethanolamine and potassium salts are actively used in the United States Not refistered for use in the EU.

Incompatibilities: May react with strong oxidizers such as chlorates, peroxides, nitrates, etc.

Determination in Air: Filter; none; Gravimetric; NIOSH IV [Particulates NOR; #0500 (total), #0600 (respirable)][18].

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guidelines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg[F]/L. Safe Drinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg[F]/L; SMCL = 2 mg/F/L, as Fluoride.

Determination in Water: Octanol−water coefficient: Log $K_{ow} \geq 3.0$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood. Fish toxicity (threshold)[101]: Very low—19,076.48500 ppb, MATC (Maximum Acceptable Toxicant Concentration).

Routes of Entry: Eyes; dermal contact, inhalation, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: May cause eye, skin, and respiratory tract irritation. May be absorbed through the unbroken skin. Harmful if swallowed, with gastrointestinal irritation. LD_{50} (oral, rat) = >3.5 g/kg; LD_{50} (dermal, rabbit) = > 2 g/kg.

Long-Term Exposure: Fluorides may cause bone disease (pain and tenderness of the bones); mottled teeth in children. Human toxicity (long term)[101]: Very low—2100.00 ppb, Health Advisory.

Points of Attack: Bones.

Medical Surveillance: Preliminary medical exam to detect chronic diseases of central nervous system, liver, heart, kidneys, lung, and skin, as well as endocrinological or immunological disturbances, should protect susceptible individuals. Periodical medical exams of internal organs, skin, and eyes are important to avoid chronic occupational intoxications. They should include lab and patch tests when necessary[83].

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Do not induce vomiting when formulations containing petroleum solvents are ingested

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of dermal and/or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls, and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit. *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration*: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode).

Storage: Color code—Blue: Health Hazard/Poison. Store in a secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: First remove all sources of ignition. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen, sulfur and carbon and hydrogen fluoride gas. As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 m/150 ft for liquids and at least 25 m/75 ft for solids. *Fire involving storage or vehicular tanks*: Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. *On a small fire*: use dry chemical, CO_2, water spray or regular *foam. On a large fire*: use water spray, fog, or regular foam. Do not scatter spilled material with high pressure streams of water. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal. *Fire involving tanks*: From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. Always stay away from tanks engulfed in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (122).

Melamine M:0310

Formula: C_3H_6N6; $NC(NH_2)NC(NH_2)NC(NH_2)$

Synonyms: Cyanuramide; Cyanurotriamide; Cyanurotriamine; 1,3,5-Triazine-2,4,6-triamine; 2,4,6-Triaminotriazine

CAS Registry Number: 108-78-1; *(alt.)* 504-18-7; *(alt.)* 65544-34-5; *(alt.)* 67757-43-1; *(alt.)* 68379-55-5; *(alt.)* 70371-19-6; *(alt.)* 94977-27-2

HSDB Number: 2648

RTECS Number: OS0700000

UN/NA & ERG Number: None

EC Number: 203-615-4

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Sufficient Evidence; Human No Adequate Data, *not classifiable as carcinogenic to humans*, Group 3, 1999; NCI: Carcinogenesis Studies (feed); clear evidence: rat; NCI: Carcinogenesis Studies (feed); no evidence: mouse. United States Environmental Protection Agency Gene-Tox Program, Inconclusive: *D. melanogaster* sex-linked lethal.

Hazard Alert: Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction).

Hazard symbols, risk, & safety statements: Hazard symbol: T; risk phrases: R62; R63;?; safety phrases: (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Melamine is a white crystalline solid. Molecular weight = 126.15; specific gravity (H_2O:1) = 1.6; freezing/melting point = (decomposes) 347°C[138]; vapor pressure = 50 mmHg @ 315°C; flash point ≥ 300°C; autoignition temperature ≥ 500°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 0. Practically insoluble in water.

Potential Exposure: Manufactured from urea, melamine is used in the manufacture of plastics, melamine-formaldehyde resins; rubber, synthetic textiles; laminates, adhesives, and molding compounds.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Melamine neutralizes acids in exothermic reactions to form salts plus water. May be incompatible with isocyanates, halogenated organics, peroxides, phenols (acidic), epoxides, anhydrides, and acid halides. Flammable gaseous hydrogen may be generated in combination with strong reducing agents such as hydrides, nitrides, alkali metals, and sulfides.

Permissible Exposure Limits in Air Kansas[60] has set a guideline for melamine in ambient air of 24.39 μ/m^3.

Determination in Air:

PAC Ver. 29[138]

PAC-1: 30 milligram per cubic meter

PAC-2: 340 milligram per cubic meter
PAC-3: 630 milligram per cubic meter

Routes of Entry: Inhalation and ingestion

Harmful Effects and Symptoms

Short-Term Exposure: Irritates, eyes, skin, and mucous membranes. May cause dermatitis in humans.

Long-Term Exposure: May cause kidney damage. There is limited evidence that melamine causes cancer in animals.

Points of Attack: Kidneys, skin.

Medical Surveillance: Kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers and strong acids. Where possible, automatically pump liquid from drums or other storage containers to process containers. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping:

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Melamine itself does not burn. Use any extinguishing agent suitable for surrounding fire. Thermal decomposition include ammonia fumes, hydrogen cyanide, and oxides of nitrogen and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (101); (138); (100); (173).

United States Environmental Protection Agency, Chemical Hazard Information Profile Draft Report: Melamine, Washington, DC (December 29, 1982).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 8, No. 4, 40–41 (1988).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Melamine, Trenton, NJ (June 1998).

Melphalan M:0320

Formula: $C_{13}H_{19}Cl_2N_2O_2$: $HOOCH(NH_2)CHCH_2C_6H_4N(CH_2CH_2Cl)_2$

Synonyms: Alanine nitrogen mustard; Alkeran; AT-290; 1-3-(*p*-[Bis(2-chloroethyl)amino]phenyl)alanine; *p*,*N*-Bis(2-chloroethyl)amino-l-phenylalanine; 3-[*p*-(*p*-[Bis (2-chloroethyl)amino]phenyl)]-l-alanine; 4-[Bis(2-chloroethyl)amino]-l-phenylalanine; CB 3025; *p*,*N*-Di(chloroethyl)aminophenylalanine; *p*-Di(2-chloroethyl)amino-l-phenylalanine; 3-*p*-[Di(2-chloroethyl)amino]-phenyl-l-alanine; 2-(Diethoxyphosphinylimino)-4-methyl-1,3-dithiolane; I-PAM; L-Sarcolysin; Melfalano (Spanish); NCI-CO4853; NSC-8806; *i*-Phenylalanine nitrogen mustard; Phenylalanine nitrogen mustard; P-I-Sarcolysin; SK-15673

CAS Registry Number: 148-82-3
HSDB Number: 3234
RTECS Number: AY3675000
UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154
EC Number: 205-726-3

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen; IARC: Human Sufficient Evidence; Animal Sufficient Evidence, Group1, 1998.

California Proposition 65 Chemical[102]: Cancer 2/27/1987; Developmental/Reproductive toxin 7/1/1990.

Hazard Alert: Poison, Probably combustible, Possible risk of forming tumors, Reproductive toxin: possible risk of gene damage/impaired fertility; Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction).

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U150

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg)

Hazard symbols, risk, & safety statements: Hazard symbol: T+, Xn; risk phrases: R45; R26/27/28; R36/37/38; R42; R46; R50/53; R62; R63; safety phrases: S22; S26; S36/37/39; S41; S45; S53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)].

Description: Melphalan forms solvated crystals from methanol. Molecular weight = 305.23; freezing/melting point = 182−183°C. (decomposes). Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 0.

Potential Exposure: An alkylating agent. Healthcare workers may be exposed. As a drug it is an immunosuppressant, used in the treatment of multiple myeloma and cancer of the ovary. It is also used in investigation of other types of cancer and as an antineoplastic in animals. Human exposure to melphalan occurs principally during its use in cancer treatment. Melphalan is administered orally or intravenously. Adult dosage is 6 mg/day, 5 days per month. Has been used as a military poison gas (a nitrogen mustard, alkaline, crystals).

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Harmful Effects and Symptoms

Short-Term Exposure: LD_{50}(oral-rat) = 11.2 mg/kg. This material is highly toxic; local irritant of the skin, eyes and, mucous membranes. Skin rash, nausea, vomiting.

Long-Term Exposure: A Confirmed Human Carcinogen capable of causing leukemia and Hodgkin's disease. High or repeated exposure causes marked bone marrow depression with possible anemia, neutropenia, and thrombocytopenia.

Points of Attack: Blood.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure. Pregnant women should avoid contact. Employees should be notified by a physician that this chemical may affect the reproductive system. In addition to comprehensive initial medical and work histories emphasizing reproductive experience and menstrual history, patient should have physical examination and testing of genitourinary tract, sperm count, motility, and morphology. If required, other tests, such as serum testosterone, serum follicle stimulating hormone (FSH), and serum lutenizing hormone (LH) may be indicated.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy. *Skin Contact*[52]: Flood all areas of body that have contacted the substance with water. Speed in removing material from skin is of extreme importance. Don't wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others. *Eye Contact*: Remove any contact lenses at once. Immediately flush eyes well with copious quantities of water or normal saline for at least 20 to 30 minutes. Seek medical attention. *Inhalation*: Leave contaminated area immediately; move to the fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion*: Contact a physician, hospital, or poison center at once. If the victim is unconscious or convulsing, do not induce vomiting or give anything by mouth. Assure the his airway is open and lay him on his side with his head lower than his body and transport immediately to a medical facility. If conscious and not convulsing, give a glass of water to dilute the substance. Vomiting should not be induced without a physician's advice.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full-facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft (NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical may be a combustible solid. Thermal decomposition products may include hydrogen chloride and oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform to EPA regulations governing storage, transportation, treatment, and waste disposal. It is inappropriate and possibly dangerous to the environment to dispose of expired or waste drugs and pharmaceuticals by flushing them down the toilet or discarding them to the trash. Household quantities of expired or waste pharmaceuticals may be mixed with wet cat litter or coffee grounds, double-bagged in plastic, discard in trash. Larger quantities shall carefully take into consideration applicable DEA, EPA, and FDA regulations. If possible return the pharmaceutical to the manufacturer for proper disposal being careful to properly label and securely package the material. Alternatively, the waste pharmaceutical shall be labeled, securely packaged, and transported by a state licensed medical waste contractor to dispose by burial in a licensed hazardous or toxic waste landfill or incinerator.

References

(109); (102); (31); (173); (101); (138); (100).

Mephosfolan M:0330

Formula: $C_8H_{16}NO_3PS_2$

Synonyms: AC 47470; American cyanamid CL-47470; CL-47,470; Cyclic propylene(diethoxyphosphinyl) dithioimdocarbonate; Cytrolane; *p,p*-Diethyl cyclic propylene ester of phosphonodithioimidocarbonic acid; Diethyl(4-methyl-1,3-dithiolan-2-ylidene)phosphoroamidate; 2-(Diethoxyphosphinylimino)-4-methyl-1,3-dithiolane; EI-47470; ENT 25,991; (4-Methyl-1,3-dithiolan-2-ylidene)phosphoramidic acid, diethyl ester

CAS Registry Number: 950-10-7

HSDB Number: 6411

RTECS Number: JP1050000

UN/NA & ERG Number: (PIH) UN3018 (organophosphorus pesticide, liquid, toxic)/152; UN2810 (toxic liquid, organic, n.o.s.)/153

EC Number: 213-447-3 [*Annex I Index No.*: 015-094-00-9]

Regulatory Authority and Advisory Information

Hazard Alert: Poison inhalation hazard: exposure can be lethal, Neurotoxin (cumulative), Combustible, Environmental hazard.

Banned or Severely Restricted (in agriculture) (India) (UN)[13]

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500 lb (227 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 500 lb (227 kg)

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

United States DOT 49CFR172.101, Inhalation Hazard Chemical as organophosphates.

Hazardous to aquatic life or environment, with possible long-lasting effects[293]. Toxic to aquatic life with long-lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, N; risk phrases: R27/28; R33; R51/53; safety phrases: S1/2; S29/35; S36/37/39; S41; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found [2-Hazard to waters (est.)].

Description: Mephosfolan is a yellow to amber liquid. Molecular weight = 269.34; boiling point = 120°C @ 1.0 mmHg. Hazard identification (based on NFPA-704 M Rating System): Health 4, flammability 1, reactivity 0. Moderately soluble in water.

Potential Exposure: A potential danger to those involved in the production, formulation, and application of this insecticide and acaricide. Not currently registered for use in the US.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Similar organic amides react with azo and diazo compounds, releasing toxic gases. Contact with reducing agents can release flammable gases. Amides are very weak bases but they can react as acids, forming salts. Mixing amides with dehydrating agents such as such as phosphorus pentoxide or thionyl chloride generates the corresponding nitrile[101].

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 0.82 milligram per cubic meter

PAC-2: 9 milligram per cubic meter

PAC-3: 54 milligram per cubic meter

Determination in Air: OSHA versatile sampler-2; Toluene/Acetone; Gas chromatography/Flame photometric detection for sulfur, nitrogen, or phosphorus; NIOSH Analytical Method (IV) Method #5600, Organophosphorus Pesticides.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = \sim 1$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: This is a highly to extremely toxic material. LD_{50}(oral-rats) = 9 mg/kg. Organic phosphorus insecticides are absorbed by the skin, as well as by the respiratory and gastrointestinal tracts. They are cholinesterase inhibitors. Symptoms of exposure include headache, giddiness; blurred vision; nervousness, weakness, nausea, cramps, diarrhea, and discomfort in the chest. Signs include sweating, tearing, salivation, vomiting, cyanosis, convulsions, coma, loss of reflexes and loss of sphincter control.

Long-Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, central nervous system; cardiovascular system, skin, eyes, plasma, and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider CBC. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All

protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers; strong acids.

Shipping: UN3018 Organophosphorus pesticides, liquid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN2810 Toxic liquids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling:

Initial isolation and protective action distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.3/0.4
Night 0.8/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 600/200
Then: Protect persons downwind (mi/km)
Day 1.4/2.3
Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Do not touch spilled material. Do not breathe vapors. Stay upwind; keep out of low areas. Remove all ignition sources. Ventilate area of spill or leak. This material is a combustible liquid. For a spill or leak of a combustible liquid, shut off ignition sources; no flares, smoking or flames in hazard area. Stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Combustible material. Thermal decomposition products may include oxides of nitrogen, phosphorus, sulfur, and carbon. Vapors may travel to a source of ignition, and flash back. Use foam, carbon dioxide; or dry chemical. Use water spray to absorb vapors. Avoid breathing vapors. Keep upwind. Wear SCBA. Avoid bodily contact with the material. Wear full protective clothing. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR 165 recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (100); (173); (101); (138).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 3, No. 1, 72−74 (1983).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Mephosfolan, Washington, DC, Chemical Emergency Preparedness Program (Nov. 30, 1987).

Mepiquat Chloride M:0336

Formula: $C_7H_{16}ClN$

Synonyms: *N,N*-Dimethylpiperidinium chloride; 1,1-Dimethylpiperidinium chloride; 1,1-Dimethylpiperidin-1-ium chloride; BAS 08301 W; BAS 85559X; Mepex;

Mepichlor; Mepplus; Pix; Ponnax; Roquat; Terpal (with ethephon)
CAS Number: 24307-26-4
HSDB Number: 7059
RTECS Number: TN4939200
UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171
EC Number: 246-247-6 [*Annex I Index No.*: 613-127-00-7]

Regulatory Authority and Advisory Information

Carcinogenicity[83]: EPA Group E, Evidence of noncarcinogenicity for humans.

Hazard Alert: Environmental hazard.

United States National Primary Drinking Water Regulations: SMCL = 250 mg[Cl^-]/L as Chloride

Hazardous to aquatic life or environment, with possible long-lasting effects[194].

Harmful to aquatic life with long-lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: Xn, N; risk phrases: R22; R52/53 safety phrases: S2; S29/35; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found [2-Hazard to water. (est.)].

Description: White crystalline solid, off-white powder, or pinkish liquid. Slightly sweet, musty odor; molecular weight = 149.63; specific gravity (H_2O:1) = 1.17; boiling point = (decomposes) >100°C; freezing/melting point ≥ 300°C with discoloration ~296°C[83]. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 0, reactivity 0. Highly soluble in water; solubility = 52.9 g/100 mL[83].

Potential Exposure: A quarternary ammonium salt herbicide and plant growth regulator registered solely for use on cotton, to control growth and yield.

Incompatibilities: Decomposes in temperatures above 320°C. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Concentration in Water: Runoff from spills or fire control may cause water pollution.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = < -3$. Unlikely to bioaccumulate in marine organisms. Fish toxicity (threshold)[101]: Very low—100,000.00 ppb, MATC (Maximum Acceptable Toxicant Concentration).

Routes of Entry: Ingestion, inhalation, dermal contact.

Harmful Effects and Symptoms

Short-Term Exposure: This material may cause irritation to the skin, eyes, and respiratory tract. LD_{50} (oral, rat) = < 500 mg/kg; LD_{50} (dermal, rabbit) = > 2 g/kg.

Long-Term Exposure: Human toxicity (long term)[101]: Very low—4200.00 ppb, Health Advisory.

Medical Surveillance: Preliminary medical exam to detect chronic diseases of central nervous system, liver, heart, kidneys, lung, and skin, as well as endocrinological or immunological disturbances, should protect susceptible individuals. Periodical medical exams of internal organs, skin, and eyes are important to avoid chronic occupational intoxications. They should include lab and patch tests when necessary[83].

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Applicators and other handlers must wear: Coveralls worn over long-sleeved shirt and long pants; Chemical-resistant gloves such as DuPont Tychem suit fabrics, barrier laminate, or Viton; Chemical-resistant footwear plus socks; Protective eye wear; Chemical-resistant headgear for overhead exposure; Chemical-resistant apron when cleaning equipment, mixing, or loading[83]. Agricultural Use/Engineering Controls: When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the Worker Protection Standard (WPS) for agricultural pesticides, 40 CFR 170.240(d)(4-6), the handler PPE requirements may be reduced or modified as specified in the WPS. Firefighters should wear NIOSH approved SCBA and full protective clothing.

Respirator Selection: Wherever and whenever workplace conditions warrant respirator use, a respiratory protection program must be followed that meets one or more of the following government standards: OSHA's 29 CFR 1910.134, ANSI Z88.2, or European Standard EN 149.

Storage: Color code—Green: General storage may be used. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, acids, water, or combustible materials.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Eliminate all ignition sources (no smoking, flares, sparks, or flames in immediate area). Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Stop leak if you can do it without risk. Prevent entry into waterways, sewers, basements, or confined areas. Absorb or cover with dry earth, sand, or other noncombustible material and transfer to containers. Do not get water inside containers.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen, carbon, and hydrogen chloride fumes. *Fire involving storage or vehicular tanks*: Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. *Small fire*: Dry chemical, carbon dioxide, or water spray. *Large fire*: dry chemical, carbon dioxide, alcohol-resistant foam, or water spray. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal; do not scatter the material. *Fire involving tanks or car/ trailer loads*: Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Do not get water inside containers. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. Always stay away from tanks engulfed in fire. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies.

Disposal Method Suggested: Do not discharge into drains or sewers. Dispose of waste material as hazardous waste using a licensed disposal contractor to an approved landfill. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Incineration with effluent gas scrubbing is recommended[22]. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Noncombustible containers should be compacted and buried under more than 16 in/40 cm. of soil[83]. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, “Reregistration Eligibility Decision (RED), Mepiquat Chloride,” Office of Prevention, Pesticides and Toxic Substances, Washington, DC (March 1997). http://www.epa.gov/REDs/2375red.pdf.

United States Environmental Protection Agency, Office of Pesticide Programs, Pesticide Residue Limits, “Mepiquat Chloride”, 40 CFR 180.384, http://www.epa.gov/pesticides/food/viewtols.htm.

Mercuric Acetate M:0340

Formula: $C_4H_6HgO_4$; $(CH_3COO)_2Hg$

Synonyms: Acetic acid, mercury(2+) salt; Acetic acid, mercury(II) salt; bis(Acetyloxy)mercury; Diacetoxymercury; Mercuriacetate; Mercuric diacetate; Mercury acetate; Mercury(2+) acetate; Mercury(II) acetate; Mercury diacetate; Mercuryl acetate

CAS Registry Number: 1600-27-7; *(alt.)* 6129-23-3; *(alt.)* 7619-62-7; *(alt.)* 19701-15-6

HSDB Number: 1244

RTECS Number: AI8575000

UN/NA & ERG Number: UN1629/151

EC Number: 216-491-1

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B, 1993. United States Environmental Protection Agency Gene-Tox Program, Negative: In vivo cytogenetics-mammalian oocyte.

California Proposition 65 Chemical, Developmental 7/1/1990, mercury and mercury compounds

Hazard Alert: Poison, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Environmental hazard.

United States National Primary Drinking Water Regulations: MCLG = 0.002 mg[Hg]/L; MCL = 0.002 mg [Hg]/L as mercury

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as mercury and compounds

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed, as mercury compounds, n.o.s.

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 500 lb (227 kg)

EPCRA Section 313 (as mercury compound). Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), severe pollutant

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent (PIC) Procedure] (as mercury compounds, including inorganic mercury compounds, alkyl mercury compounds, and alkyloxyalkyl and aryl mercury compounds).

Hazard symbols, risk, & safety statements: Hazard symbol: T+, N; risk phrases: R26/27/28; R33; R34; R36/37/38; R42; R50/53; R62; R63; safety phrases: S13; S23; S26; S28; S29; S36/37; S39; S45; S57; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Mercuric acetate is a white crystalline solid with a mild vinegar-like odor. Molecular weight = 318.69; specific gravity (H_2O:1) = 3.28 @ 20°C; freezing/melting point = 178−180°C (decomposes). Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 0. Soluble in water.

Potential Exposure: Mercuric acetate is used chiefly for mercuration of organic compounds; for the absorption of ethylene; as a chemical intermediate for phenylmercuric acetate; a mildewcide; and other organomercury compounds. It is used as a catalyst in organic synthesis; and in the manufacture of pharmaceuticals.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Light and heat can cause decomposition.

Permissible Exposure Limits in Air

As mercury alkyl compounds

NIOSH IDLH = 10 mg[Hg]/m^3

OSHA PEL: 0.1 mg[Hg]/m^3 Ceiling Concentration

NIOSH REL: Hg (*vapor*): 0.05 mg[Hg]/m^3 TWA[skin]; Other: 0.1 mg[Hg]/m^3 Ceiling Concentration [skin]

ACGIH TLV[1]: 0.01 mg[Hg]/m^3 TWA; 0.03 milligram per cubic meter (skin) STEL [skin]

PAC Ver. 29[138]

PAC-1: 0.048 milligram per cubic meter

PAC-2: 0.064 milligram per cubic meter

PAC-3: 3.2 milligram per cubic meter

DFG MAK: 0.1 mg[Hg]/m^3; Peak Limitation Category II (8) danger of skin sensitization; Carcinogen Category 3B

Australia: TWA 0.05 mg[Hg]/m^3 [skin], 1993; Belgium: TWA 0.05 mg[Hg]/m^3 [skin], 1993; Denmark: TWA 0.05 mg[Hg]/m^3, 1999; Finland: TWA 0.05 mg[Hg]/m^3, 1993; France: VME 0.1 mg[Hg]/m^3 [skin], 1999; Hungary: TWA 0.02 mg[Hg]/m^3; STEL 0.04 mg[Hg]/m^3, 1993; Japan: 0.05 mg[Hg]/m^3, 1999; Norway: TWA 0.05 mg [Hg]/m^3, 1999; the Philippines: TWA 0.05 mg[Hg]/m^3, 1993; Poland: MAC (TWA) 0.05 mg[Hg]/m^3, MAC (STEL) 0.15 mg[Hg]/m^3, 1999; Russia: TWA 0.05 mg [Hg]/m^3; STEL 0.01 mg[Hg]/m^3, 1993; Sweden: NGV 0.05 mg[Hg]/m^3, 1999; Thailand: STEL 0.05 mg[Hg]/m^3, 1993; United Kingdom: TWA 0.025 mg[Hg]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, ZEALAND, Singapore, Vietnam; ACGIH TLV: TWA 0.01 mg[Hg]/m^3; STEL 0.03 mg[Hg]/m^3 [skin]

Determination in Air: Use NIOSH Analytical Method #6009; OSHA Analytical Method ID-140.

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 2 μg/L; Federal Drinking Water Guidelines: EPA 2 μg/L; State Drinking Water Guidelines: Arizona 3 μg/L.

Determination in Water: Total mercury is determined by flameless atomic absorption. Soluble mercury may be determined by 0.45 μm filtration followed by flameless atomic absorption.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact. Absorbed through the unbroken skin.

Harmful Effects and Symptoms

Short-Term Exposure: Mercuric acetate is corrosive to the eyes, skin, and respiratory tract. Corrosive on ingestion. Inhalation of the aerosol can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Signs and symptoms of acute exposure to mercuric acetate may be severe and include increased salivation; foul breath; inflammation and ulceration of the mucous membranes; abdominal pain; and bloody diarrhea. Oliguria (scanty urination), anuria (suppression of urine formation), and acute renal failure may be noted. Weak pulse, seizures, psychic disturbances; dyspnea (shortness of breath), chest pain, and circulatory collapse may be observed.

Long-Term Exposure: Repeated or prolonged contact with skin may result in dermatitis (red inflamed skin), or cause skin to turn gray. Skin allergy may also occur. Repeated or prolonged exposure may cause death by hypovolemic shock, nephrotic syndrome, or kidney failure. Has been shown to be a teratogen in animals.

Points of Attack: Eyes, skin, central nervous system; peripheral nervous system; kidneys.

Medical Surveillance: NIOSH lists the following tests for inorganic mercury: whole blood (chemical/metabolite); whole blood (chemical/metabolite), end-of-shift; end-of-shift at end-of-work-week; biologic tissue/biopsy; nerve conduction studies; neurologic examination/electromyography; thyroid function test/thyroid profile; urine (chemical/metabolite); urine (chemical/metabolite) prior to shift, prior to next shift; urine (chemical/metabolite), sediment; urinalysis (routine). Before first exposure and every 6−12 months after, a complete medical history and exam is strongly recommended, with: eye exam. Consider lung function tests for persons with frequent exposure. Exam of the nervous system; including handwriting. Routine urine test (UA). Urine test for mercury (should be less than 0.02 mg/L). Consider nerve conduction tests, urinary enzymes and neurobehavioral test. After suspected illness or overexposure, repeat the tests above and get a blood test for mercury. This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Antidotes and Special Procedures for medical personnel: The drug NAP (*n*-acetyl penicillamine) has been used to treat mercury poisoning, with mixed success.

Note to physician: For severe poisoning, BAL (British Anti-Lewisite), dimercaprol, dithiopropanol ($C_3H_8OS_2$) has been used to treat toxic symptoms of certain heavy metals poisoning—including mercury. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Specific engineering controls are recommended in NIOSH Criteria Document #73-11024.

Respirator Selection: *Mercury vapor*: NIOSH: *Up to 0.5 milligram per cubic meter*: CcrS* (APF = 10) [any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern]; or Sa (APF = 10) (any supplied-air respirator). *Up to 1.25 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprS (APF = 25) [any PAPR with cartridge(s) providing protection against the compound of concern] * (canister). *to 2.5 milligram per cubic meter*: CcrFS* (APF = 50) [any chemical cartridge respirator with a full facepiece and cartridge(s) providing protection against the compound of concern]; or GmFS* (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern]; or SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTS (APF = 50) [any PAPR with a tight-fitting facepiece and cartridge(s) providing protection against the compound of concern]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 10 milligram per cubic meter*: Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFS* [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister protection against the compound of concern]; or SCBAE (any appropriate escape-type, SCBA).

*End-of-service life indicator (ESLI) required.

Other mercury compounds: NIOSH/OSHA *Up to 1 milligram per cubic meter*: CcrS* (APF = 10) [any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern]; or Sa (APF = 10) (any supplied-air respirator). *Up to 2.5 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprS (APF = 25) [any PAPR with cartridge(s) providing protection against the compound of concern]* (canister). *Up to 5 milligram per cubic meter*: CcrFS* (APF = 50) [any chemical cartridge respirator with a full facepiece and cartridge(s) providing protection against the compound of concern]; or GmFS* (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern]; or SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTS (APF = 50) [any PAPR with a tight-fitting facepiece and cartridge(s) providing protection against the compound of concern]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 10 milligram per cubic meter*: Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFS* [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister protection against the compound of concern]; or SCBAE (any appropriate escape-type, SCBA).*

*ESLI required.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates); light, heat, and acids.

Shipping: UN1629 Mercury acetate, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Avoid breathing dusts. If material is not involved in fire, keep material out of water sources and sewers. Do not touch spilled material; stop leak if you can do so without risk. Small wet spills: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills*: With clean shovel place material into clean, dry container, and cover; move containers from spill area. *Large spills*: Dike far ahead of spill for later disposal. Acute exposure to mercuric acetate may require decontamination and life support for the victim. Emergency personnel should wear protective clothing appropriate to the type and degree of contamination. Air-purifying or supplied-air respiratory equipment should also be worn, as necessary. Rescue vehicles should carry supplies, such as plastic sheeting and disposable plastic bags to assist in preventing spread of contamination. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120 (q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include mercury oxide and mercury. May burn but is difficult to ignite. Extinguish fire using agent suitable for type of surrounding fire. Material itself does not burn or burns with difficulty. Use water in flooding quantities as fog. Use foam, carbon dioxide, or dry chemical to extinguish fires. Avoid breathing dusts and fumes from burning material. Keep upwind. Avoid bodily contact with the material. Wear boots, protective gloves, and goggles. Do not handle broken packages without protective equipment. Wash away any material which may have contacted the body with copious amounts of water or soap and water. Wear SCBA when fighting fires involving this material. If contact with the material is anticipated, wear full protective clothing. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (2); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 3, 70 (1981).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Mercuric Acetate, Washington, DC, Chemical Preparedness Program (Nov. 30, 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Mercuric Acetate, Trenton, NJ (January 2000).

Mercuric Bromide M:0350

Formula: Br_2Hg; $HgBr_2$

Synonyms: Mercuric bromide, solid; Mercury bromide; Mercury(II) bromide (1:2)

CAS Registry Number: 7789-47-1

HSDB Number: 829

RTECS Number: OV7415000

UN/NA & ERG Number: UN1634/154

EC Number: 232-169-3

Regulatory Authority and Advisory Information

California Proposition 65 Developmental/Reproductive toxin (mercury and mercury compounds) 7/1/1990

Hazard Alert: Poison, Reproductive toxin, Environmental hazard.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

United States National Primary Drinking Water Regulations: MCLG = 0.002 mg[Hg]/L; MCL = 0.002 mg [Hg]/L as mercury

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as mercury and compounds

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed, as mercury compounds, n.o.s.

EPCRA Section 313: Includes any unique chemical substance that contains mercury as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), severe pollutant

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Rotterdam Convention Annex III (Chemicals Subject to the PIC Procedure) (as mercury compounds, including inorganic mercury compounds, alkyl mercury compounds, and alkyloxylalkyl and aryl mercury compounds).

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, N; risk phrases: R26/27/28; R33; R34; R36/37/38; R42; R50/53; safety phrases: S13; S16; S23; S26; S28; S29/35; S36/37; S39; S45; S57; S60; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Mercuric Bromide is a crystalline solid. Molecular weight = 360.41; boiling point = 322°C; freezing/melting point = 236°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 0. Slightly soluble in water.

Potential Exposure: This compound has applications in medicine.

Incompatibilities: Violent reaction with active metals; potassium, sodium. Store away from heat and light.

Permissible Exposure Limits in Air

NIOSH IDLH = 10 mg[Hg]/m^3

OSHA PEL: 0.1 mg[Hg]/m^3 Ceiling Concentration

NIOSH REL: Hg (*vapor*): 0.05 mg[Hg]/m^3 TWA[skin]; Other: 0.1 mg[Hg]/m^3 Ceiling Concentration [skin]

ACGIH TLV[1]: 0.025 mg[Hg]/m^3 TWA [skin]; not classifiable as a carcinogen; Biological Exposure Index (BEI) (preshift) 35 μg[Hg]/100 mL creatinine total inorganic Hg in urine; 15 μg[Hg]/L total inorganic Hg in blood; end-of-shift at end-of-work-week

PAC not available

DFG MAK: 0.1 mg[Hg]/m^3; Peak Limitation Category II (8) danger of skin sensitization; Carcinogen Category 3B

Determination in Air: Use NIOSH Analytical Method #6009; OSHA Analytical Method ID-140.

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 2 μg[Hg]/L; Federal Drinking Water Guidelines: EPA 2 μg[Hg]/L; State Drinking Water Guidelines: Arizona 3 μg[Hg]/L.

Determination in Water: Total mercury is determined by flameless atomic absorption. Soluble mercury may be determined by 0.45 μm filtration followed by flameless atomic absorption.

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Mercuric bromide can affect you when breathed and by passing through skin. Overexposures can cause kidney damage. Mercury poisoning can cause "shakes," irritability, sore gums; memory loss; increased saliva; personality changes and permanent brain damage may result. Skin contact may cause burns or skin allergy, or gray skin color. Contact causes eye burns with permanent damage. Heating or use near acid releases toxic mercury vapors. Mercury can build with permanent damage. Mercury can build up in the body. Health effects have been reported below NIOSH exposure levels.

Long-Term Exposure: Repeated or prolonged contact with skin may result in dermatitis (red inflamed skin). Repeated or prolonged exposure may cause death by hypovolemic shock, nephrotic syndrome; or kidney failure.

Points of Attack: Eyes, skin, respiratory system; central nervous system; kidneys.

Medical Surveillance: NIOSH lists the following tests for inorganic mercury: whole blood (chemical/metabolite); whole blood (chemical/metabolite), end-of-shift; end-of-shift at end-of-work-week; biologic tissue/biopsy; nerve conduction studies; neurologic examination/electromyography; thyroid function test/thyroid profile; urine (chemical/metabolite); urine (chemical/metabolite) prior to Shift, prior to next shift; urine (chemical/metabolite), sediment; urinalysis (routine). Before first exposure and every 6−12 months after, a complete medical history and exam is strongly recommended, with: exam of the nervous system; including handwriting. Routine urine test (UA), urine test for mercury (should be less than 0.02 mg/L). Eye exam. After suspected illness or overexposure, repeat the test above and get a blood test for mercury. Consider chest X-ray after acute overexposure. Consider nerve conduction tests, urinary enzymes and neurobehavioral testing.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy. *Antidotes and Special Procedures for medical personnel*: The drug NAP has been used to treat mercury poisoning, with mixed success. *Note to physician*: For severe poisoning, BAL [dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metals poisoning—including mercury. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when

skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Mercury vapor*: NIOSH: *Up to 0.5 milligram per cubic meter*: CcrS* (APF = 10) [any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern]; or Sa (APF = 10) (any supplied-air respirator). *Up to 1.25 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprS (APF = 25) [any PAPR with cartridge(s) providing protection against the compound of concern] * (canister). *Up to 2.5 milligram per cubic meter*: CcrFS* (APF = 50) [any chemical cartridge respirator with a full facepiece and cartridge(s) providing protection against the compound of concern]; or GmFS* (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern]; or SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTS (APF = 50) [any PAPR with a tight-fitting facepiece and cartridge(s) providing protection against the compound of concern]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 10 milligram per cubic meter*: Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFS* [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister protection against the compound of concern]; or SCBAE (any appropriate escape-type, SCBA).

*ESLI required.

Other mercury compounds: NIOSH/OSHA *Up to 1 milligram per cubic meter*: CcrS* (APF = 10) [any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern]; or Sa (APF = 10) (any supplied-air respirator). *Up to 2.5 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprS (APF = 25) [any PAPR with cartridge(s) providing protection against the compound of concern]* (canister). *Up to 5 milligram per cubic meter*: CcrFS* (APF = 50) [any chemical cartridge respirator with a full facepiece and cartridge(s) providing protection against the compound of concern]; or GmFS* (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern]; or SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTS (APF = 50) [any PAPR with a tight-fitting facepiece and cartridge(s) providing protection against the compound of concern]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 10 milligram per cubic meter*: Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFS* [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister protection against the compound of concern]; or SCBAE (any appropriate escape-type, SCBA).*

*ESLI required.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from light, heat, and acids. Mercuric bromide must be stored to avoid contact with sodium and potassium, since violent reactions occur.

Shipping: UN1634 Mercuric bromides, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Spills should be collected with special mercury vapor suppressants or special vacuums and deposited in sealed containers. Kits specific for clean-up of mercury spills should be available. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Mercuric bromide may burn, but does not readily ignite. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. Thermal decomposition products may include mercury and bromium. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Mercuric Bromide, Trenton, NJ (May 2001).

Mercuric Chloride M:0360

Formula: Cl_2Hg; $HgCl_2$

Synonyms: Bichloride of mercury; Bichlorure de mercure (French); Calochlor; Chlorure mercurique (French); Cloruro mercurico (Spanish); Corrosive mercury chloride; Fungchex; MC; Mercuric bichloride; Mercury bichloride; Mercury(2+) chloride; Mercury(II) chloride; Mercury perchloride; Mercury vichloride; NCI-C60173; Quecksilber chlorid (German); Perchloride of mercury; TL 898

CAS Registry Number: 7487-94-7

HSDB Number: 33

RTECS Number: OV9100000

UN/NA & ERG Number: UN1624/154

EC Number: 231-299-8 [*Annex I Index No.*: 080-010-00-X]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Limited Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1993; NCI: Carcinogenesis Studies (gavage); equivocal evidence: mouse, rat; EPA: Possible Human Carcinogen. United States Environmental Protection Agency Gene-Tox Program, Positive: Cell transformation-SA7/SHE; *B. subtilis* rec assay; Negative: *N crassa-aneuploidy*.

California Proposition 65 Developmental/Reproductive toxin (mercury and mercury compounds) 7/1/1990

Hazard Alert: Poison, Possible risk of forming tumors, Organometallic, Strong reducing agent, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction), Light sensitive, Environmental hazard.

Banned or Severely Restricted (in agriculture) (United Kingdom)[13] FDA-over the counter drug

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

United States National Primary Drinking Water Regulations: MCLG = 0.002 mg[Hg]/L; MCL = 0.002 mg [Hg]/L as mercury; SMCL = 250 mg[Cl^-]/L as Chloride.

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as mercury and compounds

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed, as mercury compounds, n.o.s.

EPCRA Section 313: Includes any unique chemical substance that contains mercury as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Rotterdam Convention Annex III (Chemicals Subject to the PIC Procedure) (as mercury compounds, including inorganic mercury compounds, alkyl mercury compounds and alkyloxylalkyl and aryl mercury compounds).

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), severe pollutant

Hazard symbols, risk, & safety statements: Hazard symbol: T+, N; risk phrases: R28; R34; R48/24/25; R50/53; R62; R63; safety phrases: S1/2; S26; S36/37/39; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Mercury bichloride is an odorless white crystalline solid. Molecular weight = 271.49; specific gravity (H_2O:1) = 5.6 @ 20°C; boiling point = 304°C; freezing/melting point = 277°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 0. Soluble in water; solubility = 7.38% @ 20°C.

Potential Exposure: Mercuric chloride is used as dip for bulbs and tubers; for earthworm control; as repellent to ants, roaches, etc.; in preserving wood and anatomical specimens; embalming, browning, etching steel and iron; as a catalyst for organic synthesis; disinfectant, antiseptic, tanning; textile printing aid; manufacture of dyes; in agricultural chemicals; dry batteries; pharmaceuticals, and photographic chemicals.

Incompatibilities: A strong reducing agent; keep away from oxidizers. Mercuric chloride may explode with friction or application on heat. Mixtures of mercuric chloride and sodium or potassium are shock sensitive and will explode on impact. Avoid contact with acids or acid fumes. Also avoid the presence of formats, sulfites, hypophosphites, phosphates, sulfide; albumin, gelatin, alkalies, alkaloid salts; ammonia, lime water; antimony, arsenic, bromides, borax, carbonates, reduced iron, copper; iron, lead, silver salts; infusions of cinchona; columbo, oak bark or senna; and tannic acid.

Permissible Exposure Limits in Air

NIOSH IDLH = 10 mg[Hg]/m^3

OSHA PEL: 0.1 mg[Hg]/m^3 Ceiling Concentration

NIOSH REL: Hg (*vapor*): 0.05 mg[Hg]/m^3 TWA[skin]; Other: 0.1 mg[Hg]/m^3 Ceiling Concentration [skin]

ACGIH TLV[1]: 0.025 mg[Hg]/m^3 TWA [skin]; not classifiable as a carcinogen; BEI (preshift) 35 μg[Hg]/100 mL creatinine total inorganic Hg in urine; 15 μg[Hg]/L total inorganic Hg in blood; end-of-shift at end-of-work-week

PAC Ver. 29[138]

PAC-1: 0.1 milligram per cubic meter

PAC-2: 0.14 milligram per cubic meter

PAC-3: 38 milligram per cubic meter

DFG MAK: 0.1 mg[Hg]/m^3; Peak Limitation Category II(8) danger of skin sensitization; Carcinogen Category 3B

Australia: TWA 0.05 mg[Hg]/m^3 [skin], 1993; Belgium: TWA 0.05 mg[Hg]/m^3 [skin], 1993; Denmark: TWA 0.05 mg[Hg]/m^3 [skin], 1999; Finland: TWA 1 mg[Hg]/m^3, 1999; France: VME 0.1 mg[Hg]/m^3, 1999; Hungary: TWA 0.02 mg[Hg]/m^3; STEL 0.04 mg[Hg]/m^3, 1993; Japan: 0.05 mg[Hg]/m^3, 1999; Norway: TWA 0.05 mg[Hg]/m^3, 1999; the Philippines: TWA 0.05 mg[Hg]/m^3, 1993; Poland: MAC (TWA) 0.05 mg[Hg]/m^3, MAC (STEL) 0.15 mg[Hg]/m^3, 1999; Russia: TWA 0.05 mg[Hg]/m^3; STEL 0.01 mg[Hg]/m^3, 1993; Sweden: NGV 0.05 mg [Hg]/m^3 [skin], 1999; Thailand STEL 0.05 mg[Hg]/m^3, 1993; United Kingdom: TWA 0.025 mg[Hg]/mg, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen

Determination in Air: Use NIOSH Analytical Method #6009; OSHA Analytical Method ID-140.

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 2 μg[Hg]/L; Federal Drinking Water Guidelines: EPA 2 μg[Hg]/L; State Drinking Water Guidelines: Arizona 3 μg[Hg]/L.

Determination in Water: Total mercury is determined by flameless atomic absorption. Soluble mercury may be determined by 0.45 μm filtration followed by flameless atomic absorption. Octanol−water coefficient: $\text{Log } K_{\text{ow}} = 0.12$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Corrosive. The substance is corrosive to the eyes, the skin, and the respiratory tract. Corrosive on ingestion. Inhalation of its aerosol may cause lung edema. The substance may cause effects on the kidneys. Exposure far above OEL may result in death. The effects may be delayed. Medical observation is indicated. It is classified as extremely toxic. All forms of mercury are poisonous if absorbed. Probable oral lethal dose is 5−50 mg/kg; between seven drops and one teaspoonful for a 150-lb person. Mercuric chloride is one of the most toxic salts of mercury. Material attacks the gastrointestinal tract and renal systems. Signs and symptoms of acute exposure or mercuric chloride may be severe and include increased salivation; foul breath; inflammation and ulceration of the mucous membranes; abdominal pain; and bloody diarrhea. Dermal exposure may result in dermatitis (red, inflamed skin) and burns. Oliguria (scanty urination), anuria (suppression of urine formation), and acute renal failure may be noted. Weak pulse, seizures, psychic disturbances; circulatory collapse; chest pain; and dyspnea (shortness of breath) may be observed.

Long-Term Exposure: Repeated or prolonged contact with skin may result in dermatitis (red inflamed skin). Repeated or prolonged exposure may cause death by hypovolemic shock, nephrotic syndrome; or kidney failure.

Points of Attack: Eyes, skin, central nervous system; peripheral nervous system; kidneys. Organs.

Medical Surveillance: Pregnant women should avoid contact. Employees should be notified by a physician that this chemical may affect the reproductive system. In addition to comprehensive initial medical and work histories emphasizing reproductive experience and menstrual history, patient should have physical examination and testing of genitourinary tract, sperm count, motility, and morphology. If required, other tests, such as serum testosterone, serum FSH, and serum LH may be indicated. NIOSH lists the following tests for inorganic mercury: whole blood (chemical/metabolite); whole blood (chemical/metabolite), end-of-shift; end-of-shift at end-of-work-week; biologic tissue/biopsy; Nerve Conduction Studies; Neurologic Examination/Electromyography; Thyroid Function Test/Thyroid Profile; urine (chemical/metabolite); urine (chemical/metabolite) Prior to Shift, prior to next shift; urine (chemical/metabolite), Sediment; urinalysis (routine). Before first exposure and every 6−12 months after, a complete medical history and exam is strongly recommended, with: exam of the nervous system; including handwriting. Routine urine test (UA). Urine test for mercury (should be less than 0.02 mg/L). Eye exam. Consider lung function tests for persons with frequent exposure. After suspected illness or overexposure, repeat the tests above and get a blood test for mercury. Consider chest X-ray after sudden overexposure. Consider nerve conduction tests, urinary enzymes and neurobehavioral testing.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy. *Antidotes and Special Procedures for medical personnel*: The drug NAP has been used to treat mercury poisoning, with limited success. *Note to physician*: For severe poisoning, BAL [dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metals poisoning—including mercury. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/

manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Mercury vapor*: NIOSH: *Up to 0.5 milligram per cubic meter*: CcrS* (APF = 10) [any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern]; or Sa (APF = 10) (any supplied-air respirator). *Up to 1.25 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprS (APF = 25) [any PAPR with cartridge(s) providing protection against the compound of concern] * (canister). *Up to 2.5 milligram per cubic meter*: CcrFS* (APF = 50) [any chemical cartridge respirator with a full facepiece and cartridge(s) providing protection against the compound of concern]; or GmFS* (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern]; or SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTS (APF = 50) [any PAPR with a tight-fitting facepiece and cartridge(s) providing protection against the compound of concern]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 10 milligram per cubic meter*: Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). Emergency or planned entry into unknown concentrations or IDLH conditions: SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). Escape: GmFS* [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister protection against the compound of concern]; or SCBAE (any appropriate escape-type, SCBA).*

* ESLI required.

Other mercury compounds: NIOSH/OSHA *Up to 1 milligram per cubic meter*: CcrS* (APF = 10) [any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern]; or Sa (APF = 10) (any supplied-air respirator). *Up to 2.5 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprS (APF = 25) [any PAPR with cartridge(s) providing protection against the compound of concern]* (canister). *Up to 5 milligram per cubic meter*: CcrFS (APF = 50) [any chemical cartridge respirator with a full facepiece and cartridge(s) providing protection against the compound of concern];* or GmFS* (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern]; or SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTS (APF = 50) [any PAPR with a tight-fitting facepiece and cartridge(s) providing protection against the compound of concern]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 10 milligram per cubic meter*: Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFS* [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister protection against the compound of concern]; or SCBAE (any appropriate escape-type, SCBA).*

*ESLI required.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Mercuric chloride must be stored to avoid contact with potassium and sodium, since violent reactions occur. See also “Incompatibilities,” above. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: UN1624 Mercuric chloride, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Spills should be collected with special mercury vapor suppressants or special vacuums and deposited in sealed containers. Kits specific for clean-up of mercury spills should be available. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Not combustible. Extinguish with water spray, fog, foam, dry chemical or carbon dioxide.

Move container from fire area. Wear SCBA and full body protective clothing. Thermal decomposition products may include hydrogen chloride mercury fumes and oxides of mercury. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (2); (80); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Mercuric Chloride, Washington, DC, Chemical Emergency Preparedness Program (Nov. 30, 1987).

New York State Department of Health, *Chemical Fact Sheet*: Mercuric Chloride, Bureau of Toxic Substance Assessment, Albany, NY (Feb. 1986 and Version 2).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Mercuric Chloride, Trenton, NJ (January 2000).

Mercuric Cyanide M:0370

Formula: C_2HgN_2; $Hg(CN)_2$

Synonyms: Cianuro mercurico (Spanish); Cyanure de mercure (French); Mercury(2 +) cyanide; Mercury(II) cyanide

CAS Registry Number: 592-04-1

HSDB Number: 1209

RTECS Number: OW1515000

UN/NA & ERG Number: UN1636/154

EC Number: 209-741-6

Regulatory Authority and Advisory Information

Carcinogenicity: ACGIH: A4, not classifiable as a human carcinogen

California Proposition 65 Developmental/Reproductive toxin (mercury and mercury compounds) 7/1/1990

Hazard Alert: Poison, Reproductive toxin, Environmental hazard, Agricultural chemical.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

United States National Primary Drinking Water Regulations: MCLG = 0.002 mg[Hg]/L; MCL = 0.002 mg[Hg]/L as mercury; MCLG = 0.2 mg[CN^-]/L; MCL = 0.2 mg[CN^-]/L as cyanide.

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as mercury and compounds

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed, as mercury compounds, n.o.s.

EPCRA Section 313: Includes any unique chemical substance that contains mercury as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), severe pollutant

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Rotterdam Convention Annex III (Chemicals Subject to the PIC Procedure) (as mercury compounds, including inorganic mercury compounds, alkyl mercury compounds and alkyloxylalkyl and aryl mercury compounds).

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, N; risk phrases: R26/27/28; R33; R34; R36/37/38; R42; R50/53; safety phrases: S13; S16; S23; S26; S28A; S29; S36/37; S39; S45; S57; S60; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Mercuric cyanide is an odorless, white crystalline solid; turns gray to dark brown when exposed to light. Molecular weight = 252.63; specific gravity (H_2O:1) = 4 @ 20°C; decomposes @ 319°C. Explosive limits: LEL = 59,000 ppm; UEL: unknown. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 0. Soluble in water.

Potential Exposure: Mercuric cyanide is used in medicine, germicidal soaps, photography and in making cyanogen gas.

Incompatibilities: Violent reaction with fluorine, magnesium, sodium nitrite, acids. Heating or contact with acid releases toxic mercury and flammable hydrogen cyanide gas. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

*See below NIOSH IDLH values for mercury and cyanide**

PAC Ver. 29[138]

PAC-1: 0.094 milligram per cubic meter

PAC-2: 0.13 milligram per cubic meter

PAC-3: 35 milligram per cubic meter

ACGIH: A4, not classifiable as a human carcinogen

As inorganic mercury compound

*NIOSH IDLH = 10 mg[Hg]/m^3

OSHA PEL: 0.1 mg[Hg]/m^3 Ceiling Concentration

NIOSH REL: Hg (*vapor*): 0.05 mg[Hg]/m^3 TWA[skin]; Other: 0.1 mg[Hg]/m^3 Ceiling Concentration [skin]
ACGIH TLV[1]: 0.025 mg[Hg]/m^3 TWA [skin]; not classifiable as a carcinogen; BEI (preshift) 35 μg[Hg]/100 mL creatinine total inorganic Hg in urine; 15 μg[Hg]/L total inorganic Hg in blood; end-of-shift at end-of-work-week
DFG MAK: 0.1 mg[Hg]/m^3; Peak Limitation Category II (8) danger of skin sensitization; Carcinogen Category 3B
As cyanide compound (for reference)
*NIOSH IDLH = 25 mg[CN]/m^3
OSHA PEL: 5 mg[CN]/m^3/4.7 ppm TWA
NIOSH REL: 5 mg[CN]/m^3/4.7 ppm/10 minutes, Ceiling Concentration
ACGIH TLV[1]: 5 mg[CN]/m^3 [skin] Ceiling Concentration
DFG MAK: 2 mg[CN]/m^3, inhalable fraction TWA; Peak Limitation Category II(1) [skin]; Pregnancy Risk Group: C

Determination in Air: Use NIOSH Analytical Method #6009; OSHA Analytical Method ID-140. See also NIOSH Analytical Method #7904, Cyanides.

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 2 μg[Hg]/L. Federal Drinking Water Guidelines: EPA 2 μg[Hg]/L; State Drinking Water Guidelines: Arizona 3 μg[Hg]/L. Federal Drinking Water Standards: EPA 200 μg[CN$^-$]/L; Federal Drinking Water Guidelines: EPA 200 μg[CN$^-$]/L; State Drinking Water Standards: California 150 μg[CN$^-$]/L; State Drinking Water Guidelines: Arizona 220 μg[CN$^-$]/L; Maine 140 μg[CN$^-$]/L; Minnesota 100 μg[CN$^-$]/L. United States Army field drinking-water standards for cyanide: 2 mg[CN$^-$]/L assuming a water consumption of 15 L/day and 6 mg[CN$^-$]/L assuming a water consumption of 5 L/day. United States Army field drinking-water standards for cyanide, long-term consumption 0.5 mg[CN$^-$]/L; Short-term consumption; Raw water constituents (maximum) 20 mg[CN$^-$]/L.

Determination in Water

Total mercury is determined by flameless atomic absorption. Soluble mercury may be determined by 0.45 μm filtration followed by flameless atomic absorption.

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Mercuric cyanide can affect you when breathed and by passing through skin. Direct contact causes eye irritation and possible damage. Overexposures can cause kidney damage. Mercury poisoning can cause "shakes," irritability, sore gums; memory loss; increased saliva; metallic taste; personality changes and brain damage. Skin contact can cause irritation, skin allergy, or a gray skin color. Mercury can build up in the body. Heating or contact with acid or acid mist causes the release of toxic mercury and cyanide vapors; may cause bronchitis and lung irritation. Overexposure to cyanide can cause sudden death.

Long-Term Exposure: Repeated or prolonged contact with skin may cause dermatitis. Repeated or prolonged exposure may cause death by hypovolemic shock, nephrotic syndrome; or kidney failure. Organic mercury substances have been identified as human teratogens. Some related compounds damage the developing fetus and decrease fertility in males and females. It is unknown for certain if mercuric cyanide causes these effects so care is indicated.

Points of Attack: Eyes, skin, respiratory system; central nervous system; kidneys.

Medical Surveillance: NIOSH lists the following tests for inorganic mercury: whole blood (chemical/metabolite); whole blood (chemical/metabolite), end-of-shift; end-of-shift at end-of-work-week; biologic tissue/biopsy; nerve conduction studies; neurologic examination/electromyography; thyroid function test/thyroid profile; urine (chemical/metabolite); urine (chemical/metabolite) Prior to Shift, prior to next shift; urine (chemical/metabolite), Sediment; urinalysis (routine). Before first exposure and every 6−12 months after, a complete medical history and exam is strongly recommended, with: exam of the nervous system; including handwriting. Routine urine test (UA). Urine test for mercury (should be less than 0.02 mg/L). Eye exam. After suspected illness or overexposure, repeat the tests above and get a blood test for mercury. Consider nerve conduction tests, urinary enzymes and neurobehavioral testing.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Antidotes and Special Procedures for medical personnel: The drug NAP has been used to treat mercury poisoning, with mixed success.

Note to physician: For severe poisoning, BAL [dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metals poisoning—including mercury. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable

probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Mercury vapor*: NIOSH: *Up to 0.5 milligram per cubic meter*: CcrS* (APF = 10) [any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern]; or Sa (APF = 10) (any supplied-air respirator). *Up to 1.25 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprS (APF = 25) [any PAPR with cartridge(s) providing protection against the compound of concern] * (canister). *Up to 2.5 milligram per cubic meter*: CcrFS (APF = 50) [any chemical cartridge respirator with a full facepiece and cartridge(s) providing protection against the compound of concern];* or GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern];* or SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTS (APF = 50) [any PAPR with a tight-fitting facepiece and cartridge(s) providing protection against the compound of concern]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 10 milligram per cubic meter*: Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFS* [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister protection against the compound of concern]; or SCBAE (any appropriate escape-type, SCBA).*

*ESLI required.

Other mercury compounds: NIOSH/OSHA *Up to 1 milligram per cubic meter*: CcrS (APF = 10) [any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern];* or Sa (APF = 10) (any supplied-air respirator). *Up to 2.5 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprS (APF = 25) [any PAPR with cartridge(s) providing protection against the compound of concern]* (canister). *Up to 5 milligram per cubic meter*: CcrFS (APF = 50) [any chemical cartridge respirator with a full facepiece and cartridge(s) providing protection against the compound of concern];* or GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern];* or SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTS (APF = 50) [any PAPR with a tight-fitting facepiece and cartridge(s) providing protection against the compound of concern]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 10 milligram per cubic meter*: Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFS* [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister protection against the compound of concern]; or SCBAE (any appropriate escape-type, SCBA). *Note*: *ESLI required.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Mercuric cyanide must be stored to avoid contact with fluorine, magnesium and sodium nitrite, since violent reactions occur. Mercuric cyanide should not contact acid or heat because it will release flammable hydrogen cyanide gas. Store in tightly closed containers in a cool, well-ventilated area away from light. Protect containers from physical damage.

Shipping: UN1636 Mercuric cyanide, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Spills should be collected with special mercury vapor suppressants or special vacuums and deposited in sealed containers. Kits specific for clean-up of mercury spills should be available. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Mercury cyanide may burn, but does not readily ignite. Decomposes in temperatures above 300°C. Thermal decomposition products may include hydrogen cyanide, mercury fumes and oxides of nitrogen and carbon. Use dry chemical, CO_2, water spray; or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return to supplier for mercury recovery and deactivation.

References

(31); (173); (101); (138); (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Mercuric Cyanide, Trenton, NJ (February 2000).

Mercuric Iodide M:0380

Formula: HgI_2

Synonyms: Hydrargyrum bijodatum (German); Mercuric iodide, red; Mercury biniodide; Mercury diiodide; Mercury (II) iodide; Red mercuric iodide

CAS Registry Number: 7774-29-0

HSDB Number: 1211

RTECS Number: OW5250000

UN/NA & ERG Number: UN1638 (solution and solid)/151

EC Number: 231-873-8

Regulatory Authority and Advisory Information

Carcingenicity: ACGIH: A4, Not classifiable as a human carcinogen

California Proposition 65 Developmental/Reproductive toxin (mercury and mercury compounds) 7/1/1990

Hazard Alert: Poison, Suspected reprotoxic hazard, Environmental hazard.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as mercury and compounds

United States National Primary Drinking Water Regulations: MCLG = 0.002 mg[Hg]/L; MCL = 0.002 mg[Hg]/L as mercury

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed, as mercury compounds, n.o.s.

EPCRA Section 313: Includes any unique chemical substance that contains mercury as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), severe pollutant

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Rotterdam Convention Annex III (Chemicals Subject to the PIC Procedure) (as mercury compounds, including inorganic mercury compounds, alkyl mercury compounds and alkyloxylalkyl and aryl mercury compounds).

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, N; risk phrases: R26/27/28; R33; R34; R36/37/38; R42; R50/53; R63; safety phrases: S13; S16; S23; S26; S28; S29; S36/37; S39; S45; S57; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Mecuric iodide is a heavy, scarlet red, odorless, crystalline solid. It may be shipped as a red solution. It turns to a yellow powder @ 127°C and red upon cooling. Molecular weight = 454.4; specific gravity (H_2O:1) = 6.3 @ 20°C; boiling point = (sublimes) 350°C; freezing/melting point = 259°C; vapor pressure = 100 mmHg @ 262°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 0. Slightly soluble in water.

Potential Exposure: Mercuric iodide is used in medicine and in analytical chemistry.

Incompatibilities: Violent reaction with active metals; potassium, sodium, acids, chlorine trifluoride. Inorganic mercury compounds are incompatible with acetylene, ammonia, chlorine dioxide; azides, calcium (amalgam formation), sodium carbide, lithium, rubidium, copper. Mercury iodide is a mild reducing agent. Keep away from oxidizers. Reacts with sodium azide to form mercury(II) azide, which is shock-, friction-, and heat-sensitive. Incompatible with acetylene, ammonia, chlorine dioxide, azides, chlorine trifluoride, calcium (because of amalgam formation), sodium carbide, lithium, rubidium, copper (NIOSH, 1997).

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 0.17 milligram per cubic meter

PAC-2: 0.23 milligram per cubic meter

PAC-3: 63 milligram per cubic meter

As iodides

ACGIH TLV[1]: 0.01 ppm/0.1 milligram per cubic meter, inhalable fraction and vapor, TWA

As inorganic mercury compound

NIOSH IDLH = 10 mg[Hg]/m^3/m^3

OSHA PEL: 0.1 mg[Hg]/m^3 Ceiling Concentration
NIOSH REL: Hg (*vapor*): 0.05 mg[Hg]/m^3 TWA[skin]; Other: 0.1 mg[Hg]/m^3 Ceiling Concentration [skin]
ACGIH TLV[1]: 0.025 mg[Hg]/m^3 TWA [skin]; not classifiable as a carcinogen; BEI (preshift) 35 μg[Hg]/100 mL creatinine total inorganic Hg in urine; 15 μg[Hg]/L total inorganic Hg in blood; end-of-shift at end-of-work-week
DFG MAK: 0.1 mg[Hg]/m^3; Peak Limitation Category II (8) danger of skin sensitization; Carcinogen Category 3B

Determination in Air: Use NIOSH Analytical Method #6009; OSHA Analytical Method ID-140.

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 2 μg[Hg]/L; Federal Drinking Water Guidelines: EPA 2 μg[Hg]/L; State Drinking Water Guidelines: Arizona 3 μg[Hg]/L.

Determination in Water: Total mercury is determined by flameless atomic absorption. Soluble mercury may be determined by 0.45 μm filtration followed by flameless atomic absorption.

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Mercuric iodide can affect you when breathed and by passing through skin. Skin contact can be fatal. Overexposure can cause kidney damage. Mercury poisoning can cause "shakes," irritability, sore gums; memory loss; increased saliva; metallic taste and personality changes. Permanent brain damage may result. Skin contact may cause skin burns, skin allergy, or a gray skin color. Eye contact can cause permanent damage. Heating or contact with acid or acid mist releases toxic mercury vapors. Mercury accumulates in the body. Health effects have been reported below exposure levels of 0.1 milligram per cubic meter.

Long-Term Exposure: Repeated or prolonged contact with skin may result in dermatitis (red inflamed skin). Repeated or prolonged exposure may cause death by hypovolemic shock, nephrotic syndrome; or kidney failure.

Points of Attack: Eyes, skin, respiratory system; central nervous system; kidneys.

Medical Surveillance: NIOSH lists the following tests for inorganic mercury: whole blood (chemical/metabolite); whole blood (chemical/metabolite), end-of-shift; end-of-shift at end-of-work-week; biologic tissue/biopsy; nerve conduction studies; neurologic examination/electromyography; thyroid function test/thyroid profile; urine (chemical/metabolite); urine (chemical/metabolite) Prior to Shift, prior to next shift; urine (chemical/metabolite), Sediment; urinalysis (routine). Before first exposure and every 6–12 months after, a complete medical history and exam is strongly recommended, with: exam of the nervous system; including handwriting. Routine urine test (UA). Urine test for mercury (should be less than 0.02 mg/L). Consider lung function tests for persons with frequent exposure. Eye exam. Consider nerve conduction tests, urinary enzymes and neurobehavioral testing. After suspected illness or overexposure, repeat the tests above and get a blood test for mercury. Consider chest X-ray after sudden exposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. *Antidotes and Special Procedures for authorized medical personnel*: The drug NAP has been used to treat mercury poisoning, with mixed success.

Note to physician: For severe poisoning, BAL [dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metals poisoning—including mercury. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Mercury vapor*: NIOSH: *Up to 0.5 milligram per cubic meter*: CcrS (APF = 10) [any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern];* or Sa (APF = 10) (any supplied-air respirator). *Up to 1.25 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprS (APF = 25) [any PAPR with cartridge(s) providing protection against the compound of concern]* (canister). *Up to 2.5 milligram per cubic meter*: CcrFS (APF = 50) [any chemical cartridge respirator with a full facepiece and cartridge(s) providing protection against the compound of concern];* or GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern];* or SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTS (APF = 50) [any PAPR with a tight-fitting facepiece and cartridge(s) providing protection against the compound of concern]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 10 milligram per cubic meter*: Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp:ASCBA (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFS* [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister protection against the compound of concern]; or SCBAE (any appropriate escape-type, SCBA).*

*ESLI required.

Other mercury compounds: NIOSH/OSHA *Up to 1 milligram per cubic meter*: CcrS (APF = 10) [any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern];* or Sa (APF = 10) (any supplied-air respirator). *Up to 2.5 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprS (APF = 25) [any PAPR with cartridge(s) providing protection against the compound of concern]* (canister). *Up to 5 milligram per cubic meter*: CcrFS (APF = 50) [any chemical cartridge respirator with a full facepiece and cartridge(s) providing protection against the compound of concern];* or GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern];* or SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTS (APF = 50) [any PAPR with a tight-fitting facepiece and cartridge(s) providing protection against the compound of concern]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 10 milligram per cubic meter*: Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFS* [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister protection against the compound of concern]; or SCBAE (any appropriate escape-type, SCBA).*

*ESLI required.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Mercuric iodide must be stored to avoid contact with chlorine trifluoride; sodium and potassium, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from light, acids and heat. Protect containers from physical damage.

Shipping: UN1638 Mercury iodide, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Spills should be collected with special mercury vapor suppressants or special vacuums and deposited in sealed containers. Kits specific for clean-up of mercury spills should be available. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical may burn but does not readily ignite. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. Thermal decomposition products may include iodine and mercury vapors. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Mercuric Iodide, Trenton, NJ (February 2000).

Mercuric Nitrate M:0390

Formula: HgN_2O_6; $Hg(NO_3)_2$

Synonyms: Mercury(2+) nitrate (1:2); Mercury(II) nitrate (1:2); Mercury nitrate; Mercury pernitrate; Nitrate mercurique (French); Nitrato mercurico (Spanish); Nitric acid, mercury(2+) salt; Nitric acid, mercury(II) salt

CAS Registry Number: 10045-94-0; 7783-34-8 (monohydrate)
HSDB Number: 1161
RTECS Number: OW8225000
UN/NA & ERG Number: UN1625/154
EC Number: 233-152-3 [*Annex I Index No.*: 080-002-00-6] pesticide in the group of plant protection products; banned or severely restricted.

Regulatory Authority and Advisory Information

California Proposition 65 Developmental/Reproductive toxin (mercury and mercury compounds) 7/1/1990

Hazard Alert: Poison, Strong oxidizer, Reproductive toxin, Environmental hazard.

United States National Primary Drinking Water Regulations: MCLG = 0.002 mg[Hg]/L; MCL = 0.002 mg[Hg]/L as mercury; 10 mg[N]/L; MCL = 10 mg/L as nitrates

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR 401.15 Section 307 Toxic Pollutants as mercury and compounds; Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed, as mercury compounds, n.o.s.

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg)

EPCRA Section 313 (as mercury compound). Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), severe pollutant

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Rotterdam Convention Annex III (Chemicals Subject to the PIC Procedure) (as mercury compounds, including inorganic mercury compounds, alkyl mercury compounds and alkyloxylalkyl and aryl mercury compounds).

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, O, N; risk phrases: R8; R26/27/28; R33; R34; R36/37/38; R42; R50/53; R62; safety phrases: S13; S16; S17; S23; S26; S28; S29/35; S36/37; S39; S45; S57; S60; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Mercuric nitrate is a white to yellowish crystalline solid with an odor like nitric acid. Normally exists as the hemihydrate or the dihydrate. Molecular weight = 324.6; specific gravity (H_2O:1) = 4.3 @ 20°C; boiling point = (decomposes); freezing/melting point = 79°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 0. Highly soluble in water.

Potential Exposure: Mercuric nitrate is used in making other chemicals; in felt manufacture and in making mercury fulminate.

Incompatibilities: A strong oxidizer. Reacts violently with combustibles, petroleum hydrocarbons; reducing agents; aldehydes, ammonia, ketones, phosphorus. Reacts with acetylene, alcohol, phosphine, and sulfur to form shock-sensitive compounds. Aqueous solution attacks most metals. Vigorous and dangerous reaction with petroleum hydrocarbons. Incompatible with organic materials; acetylene, ethanol, phosphine, sulfur, hypophosphoric acid. Inorganic mercury compounds are incompatible with acetylene, ammonia, chlorine dioxide; azides, calcium (amalgam formation), sodium carbide; lithium, rubidium, copper. Decomposes in heat or on exposure to light, producing toxic fumes (mercury, nitrogen oxides).

Permissible Exposure Limits in Air

As inorganic mercury compounds

NIOSH IDLH = 10 mg[Hg]/m^3/m^3

OSHA PEL: 0.1 mg[Hg]/m^3 Ceiling Concentration

NIOSH REL: Hg (*vapor*): 0.05 mg[Hg]/m^3 TWA[skin]; Other: 0.1 mg[Hg]/m^3 Ceiling Concentration [skin]

ACGIH TLV[1]: 0.025 mg[Hg]/m^3 TWA [skin]; not classifiable as a carcinogen; BEI (preshift) 35 μg[Hg]/100 mL creatinine total inorganic Hg in urine; 15 μg[Hg]/L total inorganic Hg in blood; end-of-shift at end-of-work-week

PAC Ver. 29[138]

7783-34-8

PAC-1: 0.12 milligram per cubic meter
PAC-2: 0.16 milligram per cubic meter
PAC-3: 45 milligram per cubic meter

DFG MAK: 0.1 mg[Hg]/m^3; Peak Limitation Category II (8) danger of skin sensitization; Carcinogen Category 3B

Australia: TWA 0.05 mg[Hg]/m^3 [skin], 1993; Belgium: TWA 0.05 mg[Hg]/m^3 [skin], 1993; Denmark: TWA 0.05 mg [Hg]/m^3 [skin], 1999; Finland: TWA 0.05 mg[Hg]/m^3, 1999; France: VME 0.1 mg[Hg]/m^3 [skin], 1999; Hungary: TWA 0.02 mg[Hg]/m^3; STEL 0.04 mg[Hg]/m^3, 1993; Japan: 0.05 mg[Hg]/m^3, 1999; Norway: TWA 0.05 mg[Hg]/m^3, 1999; the Philippines: TWA 0.05 mg[Hg]/m^3, 1993; Poland: MAC (TWA) 0.05 mg[Hg]/m^3, MAC (STEL) 0.15 mg[Hg]/m^3, 1999; Russia: TWA 0.05 mg[Hg]/m^3; STEL 0.01 mg[Hg]/m^3, 1993; Sweden: NGV 0.05 mg[Hg]/m^3 [skin], 1999; Thailand: STEL 0.05 mg[Hg]/m^3, 1993; United Kingdom: TWA 0.025 mg[Hg]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen

PAC Ver. 29[138]

7783-34-8 monohydrate

PAC-1: 0.13 milligram per cubic meter
PAC-2: 0.17 milligram per cubic meter
PAC-3: 48 milligram per cubic meter

Determination in Air: Use NIOSH Analytical Method #6009; OSHA Analytical Method ID-140.

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 2 μg[Hg]/L; Federal Drinking Water Guidelines: EPA 2 μg[Hg]/L; State Drinking Water Guidelines: Arizona 3 μg[Hg]/L.

Determination in Water: Total mercury is determined by flameless atomic absorption. Soluble mercury may be determined by 0.45 μm filtration followed by flameless atomic absorption.

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Mercuric nitrate can affect you when breathed in and passed through skin (causing systemic poisoning). Eye contact causes ulceration of conjunctiva and cornea. Skin contact causes irritation and possible dermatitis. Acute systemic poisoning can be fatal within a few minutes. Death by uremic poisoning can be delayed 5−12 days. Overexposure can damage kidneys. Mercury poisoning can cause "shakes," irritability, sore gums; increased saliva; personality change and brain damage. Eye contact may cause burns. Heating or contact with acid or acid mist causes release of toxic mercury vapors and lung effects. Mercury accumulates in the body. Health effects have been reported below TLV levels of 0.1 milligram per cubic meter. Acute poisoning has resulted from inhaling dust concentrations of 1.2−8.5 milligram per cubic meter.

Long-Term Exposure: Repeated or prolonged contact with skin may result in dermatitis (red inflamed skin), or cause skin to turn gray. Skin allergy may occur. Repeated or prolonged exposure may cause death by hypovolemic shock, nephrotic syndrome; or kidney failure. There is limited evidence that this chemical reduces fertility in males and females. Repeated exposures may cause brown staining of the eyes and may affect peripheral vision.

Points of Attack: Eyes, skin, respiratory system; central nervous system; kidneys.

Medical Surveillance: NIOSH lists the following tests for inorganic mercury: whole blood (chemical/metabolite); whole blood (chemical/metabolite), end-of-shift; end-of-shift at end-of-work-week; biologic tissue/biopsy; Nerve Conduction Studies; Neurologic Examination/Electromyography; Thyroid Function Test/Thyroid Profile; urine (chemical/metabolite); urine (chemical/metabolite) Prior to Shift, prior to next shift; urine (chemical/metabolite), Sediment; urinalysis (routine). Before first exposure and every 6−12 months after, a complete medical history and exam is strongly recommended, with: exam of the nervous system; including handwriting. Routine urine test (UA). Urine test for mercury (should be less than 0.02 mg/L). Eye exam. After suspected illness or overexposure, repeat the tests above and get a blood test for mercury. Consider nerve conduction tests, urinary enzymes and neurobehavioral testing. Eye examination.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy. *Antidotes and Special Procedures for authorized medical personnel*: The drug NAP has been used to treat mercury poisoning, with mixed success. *Note to physician*: For severe poisoning, BAL [dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metals poisoning—including mercury. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Mercury vapor*: NIOSH: *Up to 0.5 milligram per cubic meter*: CcrS (APF = 10) [any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern];* or Sa (APF = 10) (any supplied-air respirator). *Up to 1.25 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprS (APF = 25) [any PAPR with cartridge(s) providing protection against the compound of concern]* (canister). *Up to 2.5 milligram per cubic meter*: CcrFS (APF = 50) [any chemical cartridge respirator with a full facepiece and cartridge(s) providing protection against the compound of concern];* or GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern];* or SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTS (APF = 50) [any PAPR with a tight-fitting facepiece and cartridge(s) providing protection against the compound of concern]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 10 milligram per cubic meter*: Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFS* [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister protection against the compound of concern]; or SCBAE (any appropriate escape-type, SCBA).*

*ESLI required.

Other mercury compounds: NIOSH/OSHA *Up to 1 milligram per cubic meter*: CcrS (APF = 10) [any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern];* or Sa (APF = 10) (any supplied-air respirator). *Up to 2.5 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprS (APF = 25) [any PAPR with cartridge(s) providing protection against the compound of concern]* (canister). *Up to 5 milligram per cubic meter*: CcrFS (APF = 50) [any chemical cartridge respirator with a full facepiece and cartridge(s) providing protection against the compound of concern];* or GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern];* or SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTS (APF = 50) [any PAPR with a tight-fitting facepiece and cartridge(s) providing protection against the compound of concern]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 10 milligram per cubic meter*: Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFS* [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister protection against the compound of concern]; or SCBAE (any appropriate escape-type, SCBA).*

*ESLI required.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Mercuric nitrate must be stored to avoid contact with organic materials; acetylene, ethanol, phosphine, sulfur, and hypophosphoric acid, since violent reactions occur. See also "Incompatibilities." Do not store on wooden floors.

Shipping: UN1625 Mercuric nitrate, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Spills should be collected with special mercury vapor suppressants or special vacuums and deposited in sealed containers. Kits specific for clean-up of mercury spills should be available. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Not combustible but enhances combustion of other substances. Mercuric nitrate is a dangerous fire risk on contact with combustible and organic materials (wood, paper, oils, etc.). Thermal decomposition products may include mercury and oxides of nitrogen and carbon. Use dry chemical, CO_2, water spray. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Mercuric Nitrate, Trenton, NJ (February 2000).

Mercuric Oxide M:0400

Formula: HgO

Synonyms: C.I. 77760; Kankerex; Mercuric oxide, red; Mercuric oxide, yellow; Mercury monoxide; Mercury oxide; Oxido mercurico rojo (Spanish); Oxido mercurico amarillo (Spanish); Oxyde de mercure (French); Red mercuric oxide; Red oxide of mercury; Red precipitate; Santar; Yellow mercuric oxide; Yellow oxide of mercury; Yellow precipitate

CAS Registry Number: 21908-53-2; *(alt.)* 1344-45-2; *(alt.)* 8028-34-0

HSDB Number: 1265

RTECS Number: OW8750000

UN/NA & ERG Number: UN1641/151

EC Number: 244-654-7

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1993 California Proposition 65 Developmental/Reproductive toxin (mercury and mercury compounds) 7/1/1990 Banned or Severely Restricted (in agriculture) (EEC) (UK)[13]

Hazard Alert: Poison, Powerful oxidizer, Possible risk of forming tumors, Reproductive toxin: Suspected of causing genetic defects, Environmental hazard.

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as mercury and compounds

United States National Primary Drinking Water Regulations: MCLG = 0.002 mg[Hg]/L; MCL = 0.002 mg [Hg]/L as mercury

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed, as mercury compounds, n.o.s.

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 500 lb (227 kg)

EPCRA Section 313 (as mercury compound): Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), severe pollutant

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Rotterdam Convention Annex III (Chemicals Subject to the PIC Procedure) (as mercury compounds, including inorganic mercury compounds, alkyl mercury compounds and alkyloxylalkyl and aryl mercury compounds).

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, O, N, Xn; risk phrases: R8; R26/27/28; R33; R34; R36/37/38; R42; R50/53; R62; R63; safety phrases: S13; S16; S17; S23; S26; S28; S29/35; S36/37; S39; S45; S57; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Mercuric oxide is a red or orange-red heavy crystalline powder; yellow when finely powdered. Molecular weight = 216.59; specific gravity (H_2O:1) = 11.14 @ 20°C; freezing/melting point = (decomposes) 500°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 0. Insoluble in water.

Potential Exposure: Mercuric oxide is used for wound sealing and canker treatment of fruit and rubber trees; chemical intermediate for mercury salts; organic mercury compounds; chlorine monoxide; as an antiseptic in pharmaceuticals; component of dry cell batteries; pigment and glass modifier; fungicide; preservative in cosmetics; analytical reagent; formerly used in antifouling paints.

Incompatibilities: A powerful oxidizer. Decomposes on exposure to light, when heated above 500°C, producing highly toxic fumes including mercury and oxygen, which will add to the intensity of an existing fire. Violent reaction with combustible materials; other oxidizers; acetyl nitrate; aluminum, diboron tetrafluoride; reducing agents; phospham, hydrogen trisulfide (on ignition); hydrazine hydrate; hydrogen peroxide; hypophosphorous acid; acetyl nitrate; chlorine, hypophosphorous acid; magnesium (when heated), disulfur dichloride; alcohols, alkali metals (i.e., lithium, sodium, potassium, rubidium, cesium, francium). Forms heat- or impact-sensitive explosive mixtures with sulfur, phosphorus and other nonmetals, potassium, magnesium, sodium, and other chemically active metals. Incompatible with strong bases and light.

Permissible Exposure Limits in Air

NIOSH IDLH = 10 mg[Hg]/m^3/m^3

OSHA PEL: 0.1 mg[Hg]/m^3 Ceiling Concentration

NIOSH REL: Hg (*vapor*): 0.05 mg[Hg]/m^3 TWA[skin]; Other: 0.1 mg[Hg]/m^3 Ceiling Concentration [skin]

ACGIH TLV[1]: 0.025 mg[Hg]/m^3 TWA [skin]; not classifiable as a carcinogen; BEI (preshift) 35 μg[Hg]/100 mL creatinine total inorganic Hg in urine; 15 μg[Hg]/L total inorganic Hg in blood; end-of-shift at end-of-work-week

PAC Ver. 29[138]

PAC-1: 1.5 milligram per cubic meter

PAC-2: 16 milligram per cubic meter

PAC-3: 30 milligram per cubic meter

DFG MAK: 0.1 mg[Hg]/m^3; Peak Limitation Category II(8) danger of skin sensitization; Carcinogen Category 3B

Australia: TWA 0.05 mg[Hg]/m^3 [skin], 1993; Belgium: TWA 0.05 mg[Hg]/m^3 [skin], 1993; Denmark: TWA 0.05 mg[Hg]/m^3 [skin], 1999; Finland: TWA 0.05 mg [Hg]/m^3, 1999; France: VME 0.1 mg[Hg]/m^3 [skin], 1999; Hungary: TWA 0.02 mg[Hg]/m^3; STEL 0.04 mg[Hg]/m^3, 1993; Japan: 0.05 mg[Hg]/m^3, 1999; Norway: TWA 0.05 mg[Hg]/m^3, 1999; the Philippines: TWA 0.05 mg [Hg]/m^3, 1993; Poland: MAC (TWA) 0.05 mg[Hg]/m^3, MAC (STEL) 0.15 mg[Hg]/m^3, 1999; Russia: TWA 0.05 mg[Hg]/m^3; STEL 0.01 mg[Hg]/m^3, 1993; Sweden: NGV 0.05 mg[Hg]/m^3 [skin], 1999; Thailand: STEL 0.05 mg[Hg]/m^3, 1993; United Kingdom: LTEL 0.05 mg [Hg]/m^3; STEL 0.15 mg[Hg]/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Russia set a MAC for ambient air in residential areas of 0.003 milligram per cubic meter on a daily average basis.

Determination in Air: Use NIOSH Analytical Method #6009; OSHA Analytical Method ID-140.

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 2 μg[Hg]/L; Federal Drinking Water Guidelines: EPA 2 μg[Hg]/L; State Drinking Water Guidelines: Arizona 3 μg[Hg]/L.

Determination in Water: Total mercury is determined by flameless atomic absorption. Soluble mercury may be determined by 0.45 μm filtration followed by flameless atomic absorption.

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Mercuric oxide dust has a corrosive effect on eyes, skin, and respiratory tract. This material is highly toxic by ingestion, inhalation, or skin absorption. Very short exposure to small quantities may cause death or permanent injury. Following ingestion, mercuric oxide is readily converted to mercuric chloride, the most dangerous mercury compounds. Signs and symptoms of acute exposure to mercuric oxide may be severe and include increased salivation; foul breath; inflammation and ulceration of the mucous membranes; abdominal pain; and bloody diarrhea. Oliguria (scanty urination), anuria (suppression of urine formation), and acute renal failure may be noted. Weak pulse, seizures, psychic disturbances; circulatory collapse; chest pain; and dyspnea (shortness of breath) may be observed.

Long-Term Exposure: Repeated or prolonged contact with skin may result in dermatitis and allergy. Repeated or prolonged exposure may cause brain damage and nervous system damage. Repeated or prolonged exposure may cause death by hypovolemic shock, nephrotic syndrome; and kidney failure. There is limited evidence that this chemical is a teratogen in animals. Can cause mercury to accumulate in the body and cause mercury poisoning. May cause permanent damage, such as gray colored skin, brown staining of the eyes; and decreased peripheral vision.

Points of Attack: Eyes, skin, respiratory system; central nervous system; kidneys.

Medical Surveillance: NIOSH lists the following tests for inorganic mercury: whole blood (chemical/metabolite); whole blood (chemical/metabolite), end-of-shift; end-of-shift at end-of-work-week; biologic tissue/biopsy; nerve conduction studies; neurologic examination/electromyography; thyroid function test/thyroid profile; urine (chemical/metabolite); urine (chemical/metabolite) prior to shift, prior to next shift; urine (chemical/metabolite), Sediment; urinalysis (routine). Before first exposure and every 6–12 months after, a complete medical history and exam is strongly recommended, with: exam of the nervous system; including handwriting. Routine urine test (UA), Urine test for mercury (should be less than 0.02 mg/L). Eye exam. After suspected illness or overexposure, repeat the test above and get a blood test for mercury. Consider chest X-ray after acute overexposure. Consider nerve conduction tests, urinary enzymes and neurobehavioral testing. Evaluation by a qualified allergist. Eye examination. Consider chest X-ray following acute overexposure.

First Aid: Remove victims from exposure. Emergency personnel should avoid self-exposure to mercuric oxide. Evaluate vital signs, including pulse and respiratory rate, and note any trauma. If no pulse is detected, provide CPR. If not breathing, provide artificial respiration. If breathing is labored, administer oxygen or other respiratory support.

Remove contaminated clothing as soon as possible. If eye exposure has occurred, remove any contact lenses at once; eyes must be flushed with lukewarm water for at least 15 minutes. Wash exposed skin areas for 15 minutes with soap and water. Obtain authorization and/or further instructions from the local hospital for administration of an antidote or performance of other invasive procedures in the event of inhalation or ingestion of HgO. Rush to a healthcare facility.

Antidotes and Special Procedures for medical personnel: The drug NAP has been used to treat mercury poisoning, with mixed success.

Note to physician: For severe poisoning, BAL [dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metals poisoning—including mercury. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Mercury vapor*: NIOSH: *Up to 0.5 milligram per cubic meter*: CcrS (APF = 10) [any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern]; * or Sa (APF = 10) (any supplied-air respirator). *Up to 1.25 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprS (APF = 25) [any PAPR with cartridge(s) providing protection against the compound of concern]* (canister). *Up to 2.5 milligram per cubic meter*: CcrFS (APF = 50) [any chemical cartridge respirator with a full facepiece and cartridge(s) providing protection against the compound of concern];* or GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern];* or SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTS (APF = 50) [any PAPR with a tight-fitting facepiece and cartridge(s) providing protection against the compound of concern]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 10 milligram per cubic meter*: Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp:ASCBA (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). Escape: GmFS* [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister protection against the compound of concern]; or SCBAE (any appropriate escape-type, SCBA).* *ESLI required.

Other mercury compounds: NIOSH/OSHA Up to 1 milligram per cubic meter: CcrS (APF = 10) [any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern];* or Sa (APF = 10) (any supplied-air respirator). *Up to 2.5 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprS (APF = 25) [any PAPR with cartridge(s) providing protection against the compound of concern]* (canister). *Up to 5 milligram per cubic meter*: CcrFS (APF = 50) [any chemical cartridge respirator with a full facepiece and cartridge(s) providing protection against the compound of concern];* or GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern];* or SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTS (APF = 50) [any PAPR with a tight-fitting facepiece and cartridge(s) providing protection against the compound of concern]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). Up to 10 milligram per cubic meter: Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). Emergency or planned entry into unknown concentrations or IDLH conditions: SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFS* [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister protection against the compound of concern]; or SCBAE (any appropriate escape-type, SCBA).* *Note*: *ESLI required.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from chlorine, hydrogen peroxide; hypophosphorous acid; hydrazine hydrate; magnesium (when heated), disulfur dichloride; hydrogen trisulfide; reducing agents. See also "Incompatibilities."

Shipping: UN1641 Mercuric oxide, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Spills should be collected with special mercury vapor suppressants or special vacuums. Kits specific for clean-up of mercury are available. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Not combustible but enhances combustion of other substances. Thermal decomposition products may include mercury fumes and oxides of metal (mercury). For small fires, use dry chemical, carbon dioxide; water spray; or foam. For large fires, use water spray, fog, or foam. Wear full body protective clothing and SCBA. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (101); (138); (2); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Mercuric Oxide, Washington, DC, Chemical Emergency Preparedness Program (Nov. 30, 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Mercuric Oxide, Trenton, NJ (February 2001).

Mercuric Sulfate M:0420

Formula: HgO_4S; $HgSO_4$
Synonyms: Mercury bisulfate; Mercury persulfate; Mercury (2+) sulfate (1:1); Mercury(II) sulfate (1:1); Sulfate mercurique (French); Sulfato mercurico (Spanish); Sulfuric acid, mercury(2+) salt (1:1); Sulfuric acid, mercury(II) salt (1:1)
CAS Registry Number: 7783-35-9
HSDB Number: 1247
RTECS Number: OX0500000
UN/NA & ERG Number: UN1645/151
EC Number: 231-992-5 [*Annex I Index No*.: 080-002-00-6]
Regulatory Authority and Advisory Information
California Proposition 65 Developmental/Reproductive toxin (mercury and mercury compounds) 7/1/1990
Hazard Alert: Poison, Water reactive, Reproductive toxin, Environmental hazard.
Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR 401.15 Section 307 Toxic Pollutants as mercury and compounds; Section 313 Water Priority Chemicals (57FR41331, 9/9/1992).
United States National Primary Drinking Water Regulations: MCLG = 0.002 mg[Hg]/L; MCL = 0.002 mg [Hg]/L as mercury
RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed, as mercury compounds, n.o.s.
Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg)
EPCRA Section 313 (as mercury compound). Form R *de minimis* concentration reporting level: 1.0%.
United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), severe pollutant as mercuric sulfate
United States National Primary Drinking Water Regulations: MCLG = 0.002 mg[Hg]/L; MCL = 0.002 mg [Hg]/L as mercury; SMCL = 250 mg[SO_4^{-2}]/L as Sulfate
Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.; 0.1%. as persulfate compounds.
Rotterdam Convention Annex III (Chemicals Subject to the PIC Procedure) (as mercury compounds, including inorganic mercury compounds, alkyl mercury compounds and alkyloxylalkyl and aryl mercury compounds).
Hazard symbols, risk, & safety statements: Hazard symbol: T+, N; risk phrases: R6; R26; R48/23; R50/53; safety phrases: S29/35; S53; S45; S60; S61 (see Appendix 4).
Hazardous to aquatic life or environment, with possible long-lasting effects[291,292].
WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.
Description: Mercuric sulfate is a white, odorless, crystalline solid. Molecular weight = 296.65; specific gravity (H_2O:1) = 6.47 @ 20°C; freezing/melting point = (decomposes). Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 0₩. Decomposes in water to yellow mercuric subsulfate and sulfuric acid.
Potential Exposure: Mercuric sulfate is used in making other chemicals; as a battery electrolyte and in extracting gold and silver from rock.
Incompatibilities: Contact with water produces sulfuric acide and insoluble basic mercuric subsulfate. Reacts with acids producing mercury vapors. Violent reaction with gaseous hydrogen chloride above 121°C. Decomposes in heat or on exposure to light, producing toxic fumes of mercury and sulfur oxides. Attacks magnesium, aluminum, zinc, iron, lead, copper.
Permissible Exposure Limits in Air
NIOSH IDLH = 10 mg[Hg]/m^3/m^3
OSHA PEL: 0.1 mg[Hg]/m^3 Ceiling Concentration
NIOSH REL: Hg (*vapor*): 0.05 mg[Hg]/m^3 TWA[skin]; Other: 0.1 mg[Hg]/m^3 Ceiling Concentration [skin]
ACGIH TLV[1]: 0.025 mg[Hg]/m^3 TWA [skin]; not classifiable as a carcinogen; BEI (preshift) 35 μg[Hg]/100 mL creatinine total inorganic Hg in urine; 15 μg[Hg]/L total inorganic Hg in blood; end-of-shift at end-of-work-week
ACGIH TLV[1]: 0.1 milligram per cubic meter TWA *as persulfates*
PAC Ver. 29[138]
PAC-1: 0.11 milligram per cubic meter
PAC-2: 0.15 milligram per cubic meter
PAC-3: 41 milligram per cubic meter
DFG MAK: 0.1 mg[Hg]/m^3; Peak Limitation Category II (8) danger of skin sensitization; Carcinogen Category 3B
Australia: TWA 0.05 mg[Hg]/m^3 [skin], 1993; Belgium: TWA 0.05 mg[Hg]/m^3 [skin], 1993; Denmark: TWA 0.05 mg[Hg]/m^3 [skin], 1999; Finland: TWA 0.05 mg [Hg]/m^3, 1999; France: VME 0.1 mg[Hg]/m^3 [skin], 1999; Hungary: TWA 0.02 mg[Hg]/m^3; STEL 0.04 mg[Hg]/m^3, 1993; Japan: 0.05 mg[Hg]/m^3, 1999; Norway: TWA 0.05 mg[Hg]/m^3, 1999; the Philippines: TWA 0.05 mg [Hg]/m^3, 1993; Poland: MAC (TWA) 0.05 mg[Hg]/m^3, MAC (STEL) 0.15 mg[Hg]/m^3, 1999; Russia: TWA 0.05 mg [Hg]/m^3; STEL 0.01 mg[Hg]/m^3, 1993; Sweden: NGV 0.05 mg[Hg]/m^3 [skin], 1999; Thailand: STEL 0.05 mg [Hg]/m^3, 1993; United Kingdom: LTEL 0.05 mg[Hg]/m^3; STEL 0.15 mg[Hg]/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen
Determination in Air: Use NIOSH Analytical Method #6009; OSHA Analytical Method ID-140.
Permissible Concentration in Water: Federal Drinking Water Standards: EPA 2 μg[Hg]/L; Federal Drinking Water Guidelines: EPA 2 μg[Hg]/L; State Drinking Water Guidelines: Arizona 3 μg[Hg]/L.
Determination in Water: Total mercury is determined by flameless atomic absorption. Soluble mercury may be determined by 0.45 μm filtration followed by flameless atomic absorption.
Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Mercuric sulfate can affect you when breathed in and by passing through skin. Irritates the skin and is corrosive to the eyes and the respiratory tract. Corrosive if ingested. Inhalation of the aerosol can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Overexposure can cause kidney damage. Mercury poisoning can cause "shakes," irritability, sore gums; memory loss; increased saliva; personality change and even permanent brain damage. Heating or contact with acid or acid "mist" causes release of toxic mercury vapors, and lung effects have been reported below permissible exposure levels. The substance may cause effects on the gastrointestinal tract. Very high exposure may result in death.

Long-Term Exposure: Repeated or prolonged contact with skin may result in dermatitis and allergy. Repeated or prolonged exposure may cause brain damage and nervous system damage. Repeated or prolonged exposure may cause death by hypovolemic shock, nephrotic syndrome; and kidney failure. Organic mercury substances have been identified as a teratogen in humans. Can cause mercury to accumulate in the body and cause mercury poisoning. May cause permanent damage, such as gray colored skin, brown staining of the eyes; and decreased peripheral vision.

Points of Attack: Eyes, skin, respiratory system; central nervous system; kidneys.

Medical Surveillance: NIOSH lists the following tests for inorganic mercury: whole blood (chemical/metabolite); whole blood (chemical/metabolite), end-of-shift; end-of-shift at end-of-work-week; biologic tissue/biopsy; nerve conduction studies; neurologic examination/electromyography; thyroid function test/thyroid profile; urine (chemical/metabolite); urine (chemical/metabolite) Prior to Shift, prior to next shift; urine (chemical/metabolite), Sediment; urinalysis (routine). Before first exposure and every 6−12 months after, a complete medical exam and history is strongly recommended, with: exam of the nervous system; including handwriting. Routine urine test (UA). Urine test for mercury (should be less than 0.02 mg/L). Eye exam. After suspected illness or overexposure, repeat the tests above and get a blood test for mercury. Consider nerve conduction tests, urinary enzymes and neurobehavioral testing.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Antidotes and Special Procedures for medical personnel: The drug NAP has been used to treat mercury poisoning with limited success.

Note to physician: For severe poisoning, BAL [dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metals poisoning—including mercury. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Mercury vapor: NIOSH: *Up to 0.5 milligram per cubic meter*: CcrS (APF = 10) [any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern];* or Sa (APF = 10) (any supplied-air respirator). *Up to 1.25 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprS (APF = 25) [any PAPR with cartridge(s) providing protection against the compound of concern]* (canister). *Up to 2.5 milligram per cubic meter*: CcrFS (APF = 50) [any chemical cartridge respirator with a full facepiece and cartridge(s) providing protection against the compound of concern];* or GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern];* or SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTS (APF = 50) [any PAPR with a tight-fitting facepiece and cartridge(s) providing protection against the compound of concern]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 10 milligram per cubic meter*: Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFS* [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister protection against the compound of concern]; or SCBAE (any appropriate escape-type, SCBA).*

*ESLI required.

Other mercury compounds: NIOSH/OSHA *Up to 1 milligram per cubic meter*: CcrS (APF = 10) [any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern];* or Sa (APF = 10) (any supplied-air respirator). *Up to 2.5 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprS (APF = 25) [any PAPR with cartridge(s) providing protection against the compound of concern]* (canister). *Up to 5 milligram per cubic meter*: CcrFS (APF = 50) [any chemical cartridge respirator with a full facepiece and cartridge(s) providing protection against the compound of concern];* or GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern];* or SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTS (APF = 50) [any PAPR with a tight-fitting facepiece and cartridge(s) providing protection against the compound of concern]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 10 milligram per cubic meter*: Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFS* [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister protection against the compound of concern]; or SCBAE (any appropriate escape-type, SCBA).*

*ESLI required.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from light, water and gaseous hydrogen chloride.

Shipping: UN1645 Mercury sulfates, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Spills should be collected with special mercury vapor suppressants or special vacuums and deposited in sealed containers. Kits specific for clean-up of mercury spills should be available. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material is nonflammable. Use agent suitable to surrounding fire. Thermal decomposition products may include mercury and sulfur oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Mercuric Sulfate, Trenton, NJ (February 2000).

Mercury and Inorganic Compounds M:0430

Formula: Hg

Synonyms: Colloidal mercury; Hydragyrum; Kwik; Liquid silver; Mercure (French); Mercury, metallic; Metallic mercury; NCI-C60399; Quecksilber (German); Quicksilver

CAS Registry Number: 7439-97-6; *(alt.)* 8030-64-6; *(alt.)* 51887-47-9; *(alt.)* 92355-34-5; *(alt.)* 92786-62-4; *(alt.)* 123720-03-6

HSDB Number: 1208

RTECS Number: OV4550000

UN/NA & ERG Number: UN2809/172

EC Number: 231-106-7 [*Annex I Index No.*: 080-001-00-0]

Regulatory Authority and Advisory Information
Carcinogenicity: IARC: Human Inadequate Evidence, animal Inadequate Evidence Group 3, 1993; EPA: Not Classifiable as to human carcinogenicity.
California Proposition 65: Developmental/Reproductive toxin (mercury and mercury compounds) 7/1/1990
Hazard Alert: Lung damaging agent, Possible risk of forming tumors, Reproductive toxin: possible risk of gene damage/impaired fertility; Suspected reprotoxic hazard, Environmental hazard.
Banned or Severely Restricted (in agriculture) (many countries) (UN)[13]
United States National Primary Drinking Water Regulations: MCLG = 0.002 mg[Hg]/L; MCL = 0.002 mg[Hg]/L as mercury
Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as mercury and compounds; Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)
United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U151
RCRA, 40CFR261, Appendix 8 Hazardous Constituents
RCRA Toxicity Characteristic (Section 261.24), Maximum Concentration of Contaminants, regulatory level, 0.2 mg/L
RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.15; Nonwastewater (mg/L), 0.25 TCLP; Wastewater from retort, N/A; Nonwastewater from retort (mg/L), 0.20 TCLP
RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 7420 (2) as mercury, total dust
Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg)
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.
Rotterdam Convention Annex III (Chemicals Subject to the PIC Procedure) (as mercury compounds, including inorganic mercury compounds, alkyl mercury compounds and alkyloxylalkyl and aryl mercury compounds).
Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.
Hazard symbols, risk, & safety statements: Hazard symbol: T+, N, Xn; risk phrases: R20/21/22; R23/24/25; R25; R26/27/28; R33; R34; R36/37/38; R42; R48/21/22; R50/53; R62; R63; safety phrases: S7; S13; S16; S23; S26; S28; S29; S36/3739; S45; S57; S60; S61; S41 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Mercury is a silvery, mobile, odorless liquid. Molecular weight = 200.59; boiling point = 356−357°C; freezing/melting point = −39°C. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 0, reactivity 0. Insoluble in water.

Potential Exposure: Mercury is used as a catalyst, in dental applications; and in pharmaceuticals; as a liquid cathode in cells for the electrolytic production of caustic and chlorine. It is used in electrical apparatus (lamps, rectifiers, and batteries) and in control instruments (switches, thermometers, and barometers).

Incompatibilities: Heating mercury causes the formation of toxic mercury oxide fumes. Reacts violently with alkali metals; acetylene, azides, ammonia gas; chlorine, chlorine dioxide; many acids; most metals; ground mixtures of sodium carbide, and ethylene oxide. Contact with methyl azide forms shock- and spark-sensitive explosives. Attacks copper and many other metals, forming amalgams.

Permissible Exposure Limits in Air
NIOSH IDLH = 10 mg[Hg]/m^3/m^3
OSHA PEL: 0.1 mg[Hg]/m^3 Ceiling Concentration
NIOSH REL: (*Hg vapor*): 0.05 mg[Hg]/m^3 TWA[skin]; 0.1 mg[Hg]/m^3 Ceiling Concentration; [skin]
ACGIH TLV[1]: 0.025 mg[Hg]/m^3 TWA [skin]; not classifiable as a carcinogen; BEI (preshift) 35 μg[Hg]/100 mL creatinine total inorganic Hg in urine; 15 μg[Hg]/L total inorganic Hg in blood; end-of-shift at end-of-work-week
PAC Mercury* Ver. 29[138]
(vapor)
PAC-1: 0.15 milligram per cubic meter
PAC-2: **1.7**$_{\mathbf{A}}$ milligram per cubic meter
PAC-3: **8.9**$_{\mathbf{A}}$ milligram per cubic meter
*AEGLs are marked with a subscript "**A**" and correspond to 60-minute values. Emergency Response Planning Guidelines
ERPG-1: Inappropriate
ERPG-2: 0.25 ppm
ERPG-3: 0.5 ppm
DFG MAK (*elemental and inorganic compounds*): 0.1 mg [Hg]/m^3; Peak Limitation Category II(8) danger of skin sensitization; Carcinogen Category 3B
Arab Republic of Egypt: TWA 0.05 milligram per cubic meter, 1993; Australia: TWA 0.1 milligram per cubic meter [skin], 1993; Austria: MAK 0.005 ppm (0.05 milligram per cubic meter, 1999; Belgium: TWA 0.1 milligram per cubic meter [skin], 1993; Denmark: TWA 0.05 mg[Hg]/m^3 [skin], 1999; Finland: TWA 0.05 milligram per cubic meter, 1993; France: VME 0.05 milligram per cubic meter [skin] (*vapor*), 1999; the Netherlands: MAC-TGG 0.05 milligram per cubic meter, 2003; Japan: 0.05 milligram per cubic meter, 1999; Norway: TWA 0.05 milligram per cubic meter, 1999; Poland: MAC (TWA) vapors 0.025 milligram per cubic meter, MAC (STEL) vapors 0.2 milligram per cubic meter, 1999; Sweden: NGV 0.05 milligram per cubic meter (*vapor*), 1999; Switzerland: MAK-W 0.005 ppm (0.05 milligram per cubic meter) [skin], 1999; Switzerland: MAK-W 0.01 milligram per cubic meter [skin], 1993; Turkey: TWA 0.1 milligram per cubic meter [skin], 1993; United Kingdom: TWA 0.025 mg[Hg]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand,

Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Russia[35,43] set a MAC for ambient air in residential areas of 0.0003 milligram per cubic meter. Several states have set guidelines or standards for mercury in ambient air[60] ranging from 0.024 μ/m^3 (Kansas) to 0.01−0.08 milligram per cubic meter (Montana) to 0.167 μ/m^3 (New York) to 0.2−2.0 μ/m^3 (Connecticut) to 0.24 μ/m^3 (Pennsylvania) to 0.25 μ/m^3 (South Carolina) to 0.5 μ/m^3 (North Dakota) to 0.5−1.0 μ/m^3 (Florida) to 0.8 μ/m^3 (Virginia) to 2.0 μ/m^3 (Nevada) to 3.0 μ/m^3 (North Carolina).

Determination in Air: Use NIOSH Analytical Method #6009; OSHA Analytical Method ID-140.

Permissible Concentration in Water: Safe Drinking Water Act (47FR 9352): MCL, 0.002 mg/L; MCLG, 0.002 mg/L. Federal Drinking Water Standards: EPA 2 μg[Hg]/L; Federal Drinking Water Guidelines: EPA 2 μg[Hg]/L; State Drinking Water Guidelines: Arizona 3 μg[Hg]/L.

Determination in Water: Total mercury is determined by flameless atomic absorption. Soluble mercury may be determined by 0.45 μm filtration followed by flameless atomic absorption.

Routes of Entry: Inhalation, skin absorption, eye and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: *Inhalation*: Exposure to levels below 1 milligram per cubic meter has been shown to produce nonspecific symptoms, such as shyness, insomnia, anxiety and loss of appetite. Higher levels (1−3 milligram per cubic meter for 2−5 hours) may cause headache, salivation, metallic taste; chills, cough, fever, tremors, abdominal cramps; diarrhea, nausea, vomiting, tightness in the chest; difficult breathing; fatigue, lung irritation and possible lung tissue damage. Symptoms may begin several hours after exposure and may last a week. Large doses may result in flu-like symptoms, which, in severe cases, may result in death due to pneumonia. *Lethal blood level in humans*: 0.4−22 mg/mL. *Skin*: Can be absorbed through the skin. Can cause irritation. Prolonged contact with skin can result in symptoms listed above. *Eyes*: Can cause eye irritation. *Ingestion*: Generally does not produce ill effects.

Long-Term Exposure: May cause skin allergy. Mercury accumulates in the brain quickly during exposure but is released from the brain very slowly. This will result in a build-up in brain tissue over a long time. The liver and kidneys may also be damaged by mercury accumulation. It may cause headache, dizziness, restlessness, irritability, sleepiness, tremors, defective muscle control; increased salivation; loose teeth; irritation of the gums with a Blue line between teeth and gums; loss of appetite; nausea, vomiting, diarrhea, liver damage; changes in urine; raised red areas and blisters of skin; impaired memory and possible permanent brain damage. Repeated exposure (usually more than 5 years) may cause clouding of the eyes; gray skin color. Frequency of complaints and severity of symptoms increase with levels of exposure, most notably above 0.1 milligram per cubic meter. However, many of these symptoms have been reported at levels below recommended limits due to the accumulation of mercury over long term. There is limited evidence that mercury may cause an increase in spontaneous abortions in exposed women.

Points of Attack: Eyes, skin, respiratory system; central nervous system; kidneys.

Medical Surveillance: NIOSH lists the following tests for inorganic mercury: whole blood (chemical/metabolite); whole blood (chemical/metabolite), end-of-shift; end-of-shift at end-of-work-week; biologic tissue/biopsy; nerve conduction studies; neurologic examination/electromyography; thyroid function test/thyroid profile; urine (chemical/metabolite); urine (chemical/metabolite) prior to shift, prior to next shift; urine (chemical/metabolite), sediment; urinalysis (routine). For those with frequent or potentially high exposure (half the TLV or greater, or significant skin contact), the following are recommended before beginning work and at regular times after that: exam of the nervous system (including handwriting test to detect early hand tremor). Urine mercury level (usually less than 0.02 mg/L). Kidney function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and do induce vomiting. Do not make an unconscious person vomit.

Antidotes and Special Procedures for medical personnel: The drug NAP has been used to treat mercury poisoning, with mixed success.

Note to physician: For severe poisoning, BAL [dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metals poisoning—including mercury. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods:

General information: first responders should use a NIOSH-certified CBRN SCBA with a level a protective suit when entering an area with an unknown contaminant or when entering an area where the concentration of the contaminant is unknown. Level a protection should be used until monitoring results confirm the contaminant and the concentration of the contaminant. *Note*: safe use of protective clothing and equipment requires specific skills developed through training and experience.

LEVEL A: (*RED ZONE*): select when the greatest level of skin, respiratory, and eye protection is required. This is the maximum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than the AEGL-2. A NIOSH-certified CBRN full-facepiece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle. A TECP suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, and a hard hat worn under the TECP suit are optional items.

LEVEL B: (RED ZONE): Select when the highest level of respiratory protection is necessary but a lesser level of skin protection is required. This is the minimum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than AEGL-2. It differs from Level A in that it incorporates a nonencapsulating, splash-protective, chemical-resistant splash suit that provides Level A protection against liquids but is not airtight. A NIOSH-certified CBRN full- facepiece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL C: (YELLOW ZONE): Select when the contaminant and concentration of the contaminant are known and the respiratory protection criteria factors for using APRs or PAPRs are met. This level is appropriate when decontaminating patient/victims. A NIOSH-certified CBRN tight-fitting APR with a canister-type gas mask or CBRN PAPR for air levels greater than AEGL-2. A NIOSH-certified CBRN PAPR with a loose-fitting facepiece, hood, or helmet and a filter or a combination organic vapor, acid gas, and particulate cartridge/filter combination or a continuous flow respirator for air levels greater than AEGL-1. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Escape mask, face shield, coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL D: (GREEN ZONE): Select when the contaminant and concentration of the contaminant are known and the concentration is below the appropriate occupational exposure limit or less than AEGL-1 for the stated duration times. Limited to coveralls or other work clothes, boots, and gloves.

Notes: Take all necessary precautions to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Mercury vapor: NIOSH: *Up to 0.5 milligram per cubic meter*: CcrS (APF = 10) [any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern];* or Sa (APF = 10) (any supplied-air respirator). *Up to 1.25 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprS (APF = 25) [any PAPR with cartridge(s) providing protection against the compound of concern]* (canister). *Up to 2.5 milligram per cubic meter*: CcrFS (APF = 50) [any chemical cartridge respirator with a full facepiece and cartridge(s) providing protection against the compound of concern];* or GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern];* or SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTS (APF = 50) [any PAPR with a tight-fitting facepiece and cartridge(s) providing protection against the compound of concern]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 10 milligram per cubic meter*: Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp:ASCBA (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFS* [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister protection against the compound of concern]; or SCBAE (any appropriate escape-type, SCBA).*
*ESLI required.

Other mercury compounds: NIOSH/OSHA *Up to 1 milligram per cubic meter*: CcrS (APF = 10) [any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern];* or Sa (APF = 10) (any supplied-air respirator). *Up to 2.5 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprS (APF = 25) [any PAPR with cartridge(s) providing protection against the compound of concern]* (canister). *Up to 5 milligram per cubic meter*: CcrFS (APF = 50) [any chemical cartridge respirator with a full facepiece and cartridge(s) providing protection against the compound of concern];* or GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern];* or SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTS (APF = 50) [any PAPR with a tight-fitting facepiece and cartridge(s) providing protection against the compound of concern]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 10 milligram per cubic meter*: Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd, Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFS* [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister protection against the compound of concern]; or SCBAE (any appropriate escape-type, SCBA).*

*ESLI required.

Storage: (1) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. (2) Color code—Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Mercury must be stored to avoid contact with chlorine dioxide; nitric acid; nitrates, ethylene oxide; chlorine and methylazide, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from acetylene, ammonia and nickel.

Shipping: UN2809 Mercury, Hazard class: 8; Labels: 8-Corrosive material, 6.1-Poisonous material.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Wearing protective equipment and clothing, clean up the spill with an industrial vacuum cleaner with a charcoal filter to absorb mercury vapor. For mercury spilled in cracks, cover with zinc dust to form an amalgam, or cover with calcium polysulfide with excess sulfur. Do not sweep or use compressed air to blow mercury droplets as it can increase air concentrations. Store contaminated or waste mercury in tightly covered or vapor-proof containers pending removal. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Mercury is not combustible. Use agent suitable for surrounding fire. Thermal decomposition products may include oxides of metal. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform to EPA regulations governing storage, transportation, treatment, and waste disposal. Accumulate for purification and re-use if possible. Mercury vapors may be adsorbed or treated with sulfide solutions and then sent to mercury recovery operations[22].

References

(31); (173); (101); (138); (2); (100).

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United States Environmental Protection Agency, Status Assessment of Toxic Chemicals: Mercury, Report EPA-600/2-79-210i, Cincinnati, OH (Dec. 1979).

United States Environmental Protection Agency, Mercury, Health and Environmental Effects Profile No. 124, Washington, DC, Office of Solid Waste (April 30, 1980).

World Health Organization, Mercury, Environmental Health Criteria No. 1, Geneva, Switzerland (1976).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 1, No. 3, 70−72 (1981).

United States Public Health Service, "Toxicological Profile for Mercury," Atlanta, Georgia, agency for Toxic Substances and Disease Registry (Dec. 1988).

New York State Department of Health, *Chemical Fact Sheet*: Mercury (Metallic), Bureau of Toxic Substance Assessment, Albany, NY (Feb. 1986 and Version 2).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Mercury, Trenton, NJ (February 2007).

Mercury Alkyl Compounds M:0440

Formula: CH_3ClHg; CH_3HgCl
Synonyms: *Methyl mercury chloride*: Caspan; Chloromethylmercury; Methylmercuric chloride; Methylmercury chloride; MMC; Monomethyl mercury chloride. *Dimethyl mercury*: Mercury dimethyl
CAS Registry Number: 115-09-3 (methyl mercury chloride); 593-74-8 (dimethyl mercury); 22967-92-6 (methyl mercury cation)
HSDB Number: 7785 (115-09-3); 3930 (22967-92-6)
RTECS Number: OW6320000 (methyl mercury ion); OW1225000 (methyl mercury chloride)
UN/NA & ERG Number: UN2025 (mercury compounds, solid, n.o.s.)/151
EC Number: 204-064-2 (chloromethylmercury); 209-805-3 [*Annex I Index No*.: 080-007-00-3] (dimethylmercury)
Regulatory Authority and Advisory Information
Carcinogenicity: IARC: Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B, 1993 (dimethyl mercury); EPA: Possible Human Carcinogen; Methylmercury compounds are possibly carcinogenic to humans (Group 2B).
California Proposition 65: Developmental/Reproductive toxin (7/1/1987), Cancer (5/1/1996) as methyl mercury compounds.
Hazard Alert: Poison, High acute toxicity (dimethyl mercury and other Hg organics), Reproductive toxin, Organometallic, Potential reducing agent, Environmental hazard.
MCLs (Safe Drinking Water Act)
United States Environmental Protection Agency Gene-Tox Program, Negative: In vivo cytogenetics-mammalian oocyte; Inconclusive: Rodent dominant lethal (dimethyl mercury)
Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)
Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as mercury and compounds
United States National Primary Drinking Water Regulations: MCLG = 0.002 mg[Hg]/L; MCL = 0.002 mg[Hg]/L as mercury
RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed, as mercury compounds, n.o.s.
EPCRA Section 313: Includes any unique chemical substance that contains mercury as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: 1.0% (dimethyl mercury)
United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), severe pollutant
California Proposition 65 Developmental/Reproductive toxin (mercury and mercury compounds) 7/1/1990
Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.
Rotterdam Convention Annex III (Chemicals Subject to the PIC Procedure) (as mercury compounds, including inorganic mercury compounds, alkyl mercury compounds and alkyloxylalkyl and aryl mercury compounds).
Hazardous to aquatic life or environment, with possible long-lasting effects[194]. Harmful to aquatic life with long-lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.
European/International Regulations (*593-74-8*): Hazard symbol: T+, N; risk phrases: R45; R26/27/28; R33; R50/53; safety phrases: S1/2; S13; S28; S36; S41; S45; S60; S61 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): No value found [3-Severe hazard to waters (est. based on GHS Class)].
Description: Dimethyl mercury is a volatile colorless liquid with faint sweet odor. Molecular weight = 230.66; specific gravity (H_2O:1) = 3.17 @ 20°C; boiling point = 93°C; vapor pressure = 79 mmHg @ 29°C. Soluble in water. Methyl mercury chloride is a colorless, crystalline solid. Molecular weight = 251.08; freezing/melting point = 170°C. Practically insoluble in water; solubility = < 0.1 mg/mL @ 21°C.
Potential Exposure: Alkyl mercury compounds have been used as seed disinfectants and for fungicides. They have also been used in organic synthesis.
Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. May be sensitive to light.
Permissible Exposure Limits in Air
NIOSH IDLH = 2 mg[Hg]/m^3
OSHA PEL: 0.01 mg[Hg]/m^3 TWA; 0.04 mg[Hg]/m^3 Ceiling Concentration
NIOSH REL: 0.01 mg[Hg]/m^3 TWA; 0.03 mg[Hg]/m^3 STEL [skin]
ACGIH TLV[1]: 0.01 mg[Hg]/m^3 TWA; 0.03 mg[Hg]/m^3 STEL [skin]
PAC Ver. 29[138]
593-74-8, dimethyl mercury
PAC-1: 0.034 milligram per cubic meter
PAC-2: 0.046 milligram per cubic meter
PAC-3: 2.3 milligram per cubic meter
22967-92-6, methyl mercury cation
PAC-1: 0.032 milligram per cubic meter
PAC-2: 0.043 milligram per cubic meter
PAC-3: 2.1 milligram per cubic meter
DFG MAK: 0.01 mg[Hg]/m^3 [skin] Danger of skin sensitization; Carcinogen Category 3B
Australia: TWA 0.01 mg[Hg]/m^3; STEL 0.03 mg[Hg]/m^3 [skin], 1993; Austria: MAK 0.01 mg[Hg]/m^3, 1999; Belgium: TWA 0.01 mg[Hg]/m^3; STEL 0.03 mg[Hg]/m^3 [skin], 1993; Denmark: TWA 0.01 mg[Hg]/m^3 [skin], 1999; Finland: TWA 0.01 mg[Hg]/m^3 [skin], 1999; France: VME 0.01 mg[Hg]/m^3 [skin], 1999; Norway: TWA 0.01 mg[Hg]/m^3, 1999; the Philippines: TWA 0.01 mg [Hg]/m^3, 1993; Poland: MAC (TWA) 0.01 mg[Hg]/m^3, MAC (STEL) 0.01 mg[Hg]/m^3, 1999; Sweden: NGV 0.01 mg [Hg]/m^3 [skin], 1999; Thailand: TWA 0.01 mg[Hg]/m^3;

STEL 0.04 mg[Hg]/m^3, 1993; Turkey: TWA 0.01 mg[Hg]/m^3 [skin], 1993; United Kingdom: TWA 0.01 mg[Hg]/m^3; STEL 0.03 mg[Hg]/m^3 [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 0.01; STEL 0.03 milligram per cubic meter [skin]. In addition, North Dakota has set guidelines for alkyl mercury compounds in ambient air[60] of 1−3 μ/m^3 (0.0001−0.0003 milligram per cubic meter).

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 2 μg[Hg]/L; Federal Drinking Water Guidelines: EPA 2 μg[Hg]/L; State Drinking Water Guidelines: Arizona 3 μg[Hg]/L.

Determination in Water: Total mercury is determined by flameless atomic absorption. Soluble mercury may be determined by 0.45 μm filtration followed by flameless atomic absorption.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Alkyl mercury compounds can be absorbed through the skin. When deposited on the skin, they give no warning, and if contact is maintained, can cause second-degree burns. Sensitization may occur. Alkyl mercurials have very high toxicity. *Systemic*: The central nervous system; including the brain, is the principal target tissue for this group of toxic compounds. Severe poisoning may produce irreversible brain damage resulting in loss of higher functions. The effects of chronic poisoning with alkyl mercury compounds are progressive. In the early stages, there are fine tremors of the hands; and in some cases, of the face and arms.

Long-Term Exposure: Repeated or prolonged contact with skin may result in dermatitis (red inflamed skin). Repeated or prolonged exposure may cause death by hypovolemic shock, nephrotic syndrome; or kidney failure. With repeated or continued exposure, tremors may become coarse and convulsive; scanning speech with moderate slurring and difficulty in pronunciation may also occur. The worker may then develop an unsteady gait of a spastic nature which can progress to severe ataxia of the arms and legs. Sensory disturbances including tunnel vision, blindness, and deafness are also common. A late symptom, constriction of the visual fields, is rarely reversible and may be associated with loss of understanding and reason which makes the victim completely out of touch with his environment. Severe cerebral effects have been seen in infants born to mothers who had eaten large amounts of methylmercury-contaminated fish.

Points of Attack: Eyes, skin, central nervous system; peripheral nervous system; kidneys.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure. Preplacement and periodic physical examinations should be concerned particularly with the skin, vision, central nervous system; and kidneys. Consideration should be given to the possible effects on the fetus of alkyl mercury exposure in the mother. Constriction of visual fields may be a useful diagnostic sign. Blood and urine levels of mercury have been studied, especially in the case of methylmercury. A precise correlation has not been found between exposure levels and concentrations. They may be of some value in indicating that exposure has occurred, however.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Antidotes and Special Procedures for medical personnel: The drug NAP has been used to treat mercury poisoning, with mixed success.

Note to physician: For severe poisoning, BAL [dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metals poisoning—including mercury. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full-facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. These compounds should be stored in a refrigerator or a cool, dry place away from oxidizers. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2025 Mercury compounds, solid, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Spills should be collected with special mercury vapor suppressants or special vacuums and deposited in sealed containers. Kits specific for clean-up of mercury spills should be available. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include (for methyl mercury chloride) hydrogen chloride and toxic fumes of chlorine and mercury. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

National Institute for Occupational Safety and Health (NIOSH), Information Profiles on Potential Occupational Hazards: Organomercurials, pp 287−296, 678, Rockville, MD (Oct. 1977).

United States Environmental Protection Agency, Mercury: Ambient Water Quality Criteria, Washington, DC (1979).

Mercury Thiocyanate M:0450

Formula: C_2HgN_2S2; $Hg(CNS)_2$

Synonyms: Bis(thyocyanato)-mercury; Mercuric sulfo cyanate, solid; Mercuric sulfocyanate; Mercuric sulfocyanide; Mercury dithiocyanate; Mercury thiocyanate; Tiocianato mercurico (Spanish)

CAS Registry Number: 592-85-8

HSDB Number: 1224

RTECS Number: XL1550000

UN/NA & ERG Number: UN1646/151

EC Number: 209-773-0

Regulatory Authority and Advisory Information

California Proposition 65 Developmental/Reproductive toxin (mercury and mercury compounds) 7/1/1990

Hazard Alert: Poison, Combustible, Reproductive toxin, Environmental hazard.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as mercury and compounds

United States National Primary Drinking Water Regulations: MCLG = 0.002 mg[Hg]/L; MCL = 0.002 mg[Hg]/L as mercury

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed, as mercury compounds, n.o.s.

EPCRA Section 313: Includes any unique chemical substance that contains mercury as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: 1.0%; Category D1A.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), severe pollutant as mercury based pesticides, liquid, flammable, toxic, n.o.s.; mercury based pesticides, liquid, toxic, n.o.s.; mercury based pesticides, solid, toxic, n.o.s.; mercury compounds, liquid, n.o.s.; mercury compounds, solid, n.o.s.; mercury(I) (mercurous) compounds (pesticides); mercury(II) (mercuric) compounds (pesticides)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Rotterdam Convention Annex III (Chemicals Subject to the PIC Procedure) (as mercury compounds, including inorganic mercury compounds, alkyl mercury compounds and alkyloxylalkyl and aryl mercury compounds).

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, N; risk phrases: R26/27/28; R33; R34; R36/37/38; R42; R50/53; R62; R63; safety phrases: S13; S16; S23;

S26; S28; S29/35; S36/37; S39; S45; S57; S60; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Mercury thiocyanate is a white, odorless powder. Molecular weight = 316.79; freezing/melting point = (decomposes) ~165°C. Explosive limits: LEL = 23,000 ppm; UEL: unknown. Slightly soluble in cold water.

Potential Exposure: Mercury thiocyanate is used in photography and fireworks.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Mercury thiocyanate is sensitive to heat; expands to many times its original volume and then decomposes at freezing/melting point forming toxic fumes of sulfur oxides, mercury cyanide, and nitrogen oxides. Contact with acid or acid fumes causes release of toxic mercury and cyanide vapors. Incompatible with chlorine, reducing agents such as hydrides, sulfides.

Permissible Exposure Limits in Air

As organo mercury compounds

NIOSH IDLH = 2 mg[Hg]/m^3

OSHA PEL: 0.01 milligram per cubic meter TWA; 0.04 milligram per cubic meter Ceiling Concentration

NIOSH REL: 0.01 milligram per cubic meter TWA; 0.03 milligram per cubic meter STEL [skin]

ACGIH TLV[1]: 0.01 milligram per cubic meter TWA; 0.03 milligram per cubic meter STEL [skin]

PAC Ver. 29[138]

PAC-1: 0.12 milligram per cubic meter

PAC-2: 0.16 milligram per cubic meter

PAC-3: 44 milligram per cubic meter

DFG MAK: 0.01 mg[Hg]/m^3 [skin] Danger of skin sensitization; Carcinogen Category 3 [skin] Danger of skin sensitization; Carcinogen Category 3

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 2 μg[Hg]/L; Federal Drinking Water Guidelines: EPA 2 μg[Hg]/L; State Drinking Water Guidelines: Arizona 3 μg[Hg]/L.

Determination in Water: Total mercury is determined by flameless atomic absorption. Soluble mercury may be determined by 0.45 μm filtration followed by flameless atomic absorption.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Mercury thiocyanate can affect you when breathed in. High or repeated exposures can cause kidney damage. Mercury poisoning can cause "shakes," irritability, sore gums; memory loss; increased saliva; metallic taste; personality change and/or brain damage. Skin and eye contact can cause irritation, allergy and a gray skin color. Heating or contact with acid or acid "fumes" causes release of toxic mercury or cyanide vapors and lung effects. Health effects may occur below recommended exposure levels.

Long-Term Exposure: Repeated or prolonged contact with skin may result in allergy, dermatitis, rash. Repeated or prolonged exposure may cause death by hypovolemic shock, nephrotic syndrome; or kidney failure. Related mercury compounds may damage the developing fetus and decrease fertility in males and females.

Points of Attack: Eyes, skin, central nervous system; peripheral nervous system; kidneys.

Medical Surveillance: NIOSH lists the following tests for inorganic mercury: whole blood (chemical/metabolite); whole blood (chemical/metabolite), end-of-shift; end-of-shift at end-of-work-week; biologic tissue/biopsy; Nerve Conduction Studies; Neurologic Examination/ Electromyography; Thyroid Function Test/Thyroid Profile; urine (chemical/metabolite); urine (chemical/metabolite) Prior to Shift, prior to next shift; urine (chemical/metabolite), Sediment; urinalysis (routine). Before first exposure and every 6−12 months after, a complete medical history and exam is strongly recommended with: exam of the nervous system; including handwriting. Kidney function tests. Urine test for mercury (should be less than 0.02 mg/L). After suspected illness or overexposure, repeat the tests above and get a blood test for mercury. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Antidotes and Special Procedures for medical personnel: The drug NAP has been used to treat mercury poisoning, with mixed success.

Note to physician: For severe poisoning, BAL [dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metals poisoning—including mercury. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/ manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 0.1 milligram per cubic meter*: Sa (APF = 10) (any supplied-air respirator). *Up to 0.25 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *Up to 0.5 milligram per cubic meter*: SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 2 milligram per cubic meter*: Sa:Pd,Pp (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from light, heat, and acids, including fumes.

Shipping: UN1646 Mercury thiocyanate, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Restrict persons not wearing protective equipment from the danger area of spill until clean-up is complete. Spills should be collected with special mercury vapor suppressants or special vacuums. Kits specific for clean-up of mercury spills should be available. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Mercury thiocyanate may burn, but does not readily ignite. Thermal decomposition products may include hydrogen cyanide and oxides of nitrogen, sulfur; metal (mercury). Use dry chemical, CO_2, water spray; or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Mercury Thiocyanate, Trenton, NJ (February 2000).

Metalaxyl M:0475

Formula: $C_{15}H_{21}NO_4$

Synonyms: Agrox premiere; *dl*-Alanine, *N*-(2,6-dimethylphenyl)-*N*-(methoxyacetyl)-, methyl ester; Allegience; Apron; CG 117; CGA-48988; Chloraxyl; Cotguard; *N*-(2,6-Dimethylphenyl)-*N*- (methoxyacetyl)alanine, methyl ester; *N*-(2,6-Dimethylphenyl)-*N*-(methoxyacetyl)-*dl*-alanine methyl ester; Delta-coat; Eperon; Folio gold; Gaucho; Gold/Bravo; Kodiak; Metalaxil; Metaxanin; Pace; Prevail; Raxil (tebuconazole + metalaxyl); Ridomil; Ridomil 2E; Subdue

CAS Number: 57837-19-1; 70630-17-0 (*m*-isomer)

HSDB Number: 7061

RTECS Number: AY691000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 260-979-7 [*Annex I Index No*.: 607-425-00-6]; (*m*-isomer)[*Annex I Index No*.: 612-163-00-0]

Regulatory Authority and Advisory Information

Carcinogenicity[83]: EPA Group E, Evidence of noncarcinogenicity for humans.

Hazard Alert: Combustible, Sensitization hazard, Suspected reprotoxic hazard, Environmental hazard.

Hazardous to aquatic life or environment, with possible long-lasting effects[194]. Harmful to aquatic life with long-lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: Xi, Xn, N; risk phrases: R22; R43; R51/53; R61; safety phrases: S2; S13; S24; S29/35; S37; S41; S46; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found [2-Hazard to water. (est. based on GHS class)].

Description: Combustible, white crystalline solid or powder. Odorless. Molecular weight = 297.34; specific gravity (H_2O:1) = 1.22; boiling point = 294°C; freezing/melting point = 67−68°C; 69−72°C; vapor pressure = 6×10^{-6} mmHg @ 20°C; flash point = > 100°C (cc).

Hazard identification (based on NFPA-704M Rating System): Health 2, flammability 2, reactivity 0. Highly soluble in water; solubility = 7.0 g/L @ 20°C.

Potential Exposure: Metalaxyl is phenylamide systemic fungicide used on a variety of food and nonfood crops including tobacco, turf and conifers, and ornamentals. Used in combination with fungicides of different mode of action as a foliar spray on tropical and subtropical crops; as a seed treatment to control downy mildew; and as a soil fumigant to control soil-borne pathogens. Banned for use in EU.

Incompatibilities: Incompatible with alkaline materials, strong acids, oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Compounds of the carboxyl group react with all bases, both inorganic and organic (i.e., amines) releasing substantial heat, water and a salt that may be harmful. Incompatible with arsenic compounds (releases hydrogen cyanide gas), diazo compounds, dithiocarbamates, isocyanates, mercaptans, nitrides, and sulfides (releasing heat, toxic, and possibly flammable gases), thiosulfates and dithionites (releasing hydrogen sulfate and oxides of sulfur).

Permissible Concentration in Water: Federal Drinking Water Guidelines: 400 ppb[93] State Drinking Water Guidelines: Maine 420 μg/L Runoff from spills or fire control may cause water pollution.

Determination in Water: Octanol−water coefficient: Log K_{ow} = <2.0. Unlikely to bioaccumulate in marine organisms. Fish toxicity (threshold)[101]: Very low—9099.97083 ppb, MATC (Maximum Acceptable Toxicant Concentration)

Routes of Entry: Ingestion, inhalation, dermal contact

Harmful Effects and Symptoms

Short-Term Exposure: Contact may burn eyes, skin, and respiratory tract. Eye contact may cause permanent damage. May cause skin allergy. Toxic if ingested. LD_{50} (oral, rat) = 600−700 mg/kg.; LD_{50} (dermal, rat) = > 2000 mg/kg.

Long-Term Exposure: Prolonged or frequent exposure may cause liver damage; skin allergy. Human toxicity (long term)[101]: Very low—518.00 ppb, Health Advisory

Points of Attack: Skin, eyes, liver.

Medical Surveillance: Check liver function. Consult a physician if poisoning is suspected or if redness, itching, or burning of the eyes or skin develop. Evaluation by a qualified allergist, including exposure history and testing, may help diagnose allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. *Do not induce vomiting when formulations containing petroleum solvents are ingested.* Otherwise, give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of dermal and/or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure exists, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison. Store in a secure poison location. Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers; strong acids; strong alkalies. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: First remove all sources of ignition. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen and carbon. As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 m/150 ft for liquids and at least 25 m/75 ft for solids. *Fire involving storage or vehicular tanks*: Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. *On a small fire*: use dry chemical, CO_2, water spray or regular *foam. On a large fire*: use water spray, fog, or regular foam. Do not scatter spilled material with high pressure streams of water. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal. *Fire involving tanks*: From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. Always stay away from tanks engulfed in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Small amounts may be destroyed by alkaline hydrolysis. Admixture with alkali can be followed by soil burial. Larger quantities can be disposed of by incineration in admixture with acetone or xylene and using effluent gas scrubbing. Do not reuse empty container; proper disposal required.

References

(31); (173); (101); (138); (100).

EXTOXNET, Extension Toxicology Network, “Pesticide Information Profile, Metalaxyl,” Oregon State University, Corvallis, OR (June 1996). http://extoxnet.orst.edu/pips/metalaxy.htm.

United States Environmental Protection Agency, Office of Pesticide Programs, Pesticide Residue Limits, “Metalaxyl”, 40 CFR 180.408, http://www.epa.gov/pesticides/food/viewtols.htm.

Mesitylene M:0460

Formula: C_9H_{12}; $C_6H_3(CH_3)_3$

Synonyms: Benzene, 1,3,5-trimethyl-; *sym*-Trimethylbenzene; *symmetrical*-Trimethylbenzene; TMB; 1,3,5-Trimethylbenzene; Trimethyl benzol

CAS Registry Number: 108-67-8

HSDB Number: 92

RTECS Number: OX6825000

UN/NA & ERG Number: UN2325/129

EC Number: 203-604-4 [*Annex I Index No.*: 601-025-00-5]

Regulatory Authority and Advisory Information

Hazard Alert: Flammable liquid, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction), Environmental hazard.

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Extremely Hazardous Substance (EPA-SARA, Dropped From Listing in 1988).

Hazardous to aquatic life or environment, with possible long-lasting effects[293]. Toxic to aquatic life with long-lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xi, N; risk phrases: R10; R36/37/38; R51/53; R61; R62; safety phrases: S2; S29; S41; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to waters.

Description: Mesitylene is a clear, colorless liquid. Distinctive, aromatic odor. Molecular weight = 120.19; specific gravity (H_2O:1) = 0.86; boiling point = 164.7°C; freezing/melting point = −44.7°C; vapor pressure = 0.79 mmHg @ 9°C; flash point = 50°C (cc); autoignition temperature = 559°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 2, reactivity 0. Practically insoluble in water; solubility = 0.002%.

Potential Exposure: Mesitylene is used as raw material in chemical synthesis and as ultraviolet stabilizer; as a paint thinner, solvent, and motor fuel component; as an intermediate in organic chemical manufacture.

Incompatibilities: Vapors forms explosive mixture with air. Violent reaction with nitric acid. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 4.92 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: None

NIOSH REL: 25 ppm/125 milligram per cubic meter TWA

ACGIH TLV[1]: 25 ppm TWA (lists a single CAS number for mixed isomers)

PAC* Ver. 29[138]

PAC-1: $\mathbf{140}_{\mathbf{A}}$ ppm

PAC-2: $\mathbf{360}_{\mathbf{A}}$ ppm

PAC-3: 480 ppm

*AEGLs are marked with a subscript “**A**” and correspond to 60-minute values.

DFG MAK: 20 ppm/100 milligram per cubic meter; Pregnancy Risk Group C (all isomers of trimethylbenzene)

Denmark: TWA 25 ppm (120 milligram per cubic meter), 1999; Japan: 25 ppm (120 milligram per cubic meter), 1999; Norway: TWA 20 ppm (100 milligram per cubic meter), 1999; Sweden: NGV 25 ppm (120 milligram per cubic meter), KTV 35 ppm (170 milligram per cubic meter), 1999; Switzerland: MAK-W 25 ppm (125 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 100 milligram per cubic meter; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 25 ppm

Determination in Air: Use OSHA Analytical Method PV-2091.

Permissible Concentration in Water: No method available.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 3.4$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin, and respiratory tract. Exposure can cause you to feel dizzy, lightheaded, and to pass out. Symptoms of exposure can also include headache, drowsiness, fatigue, dizziness, nausea, a lack of coordination; vomiting, confusion. Acute-lowest toxic concentration for humans is 10 ppm, resulting in central nervous system effects. Liquid deposition in lungs causes chemical pneumonitis. Symptoms of exposure include: nervousness, tension, anxiety, asthmatic bronchitis, and skin irritation.

Long-Term Exposure: Repeated exposures can cause headaches, tiredness, and a feeling of nervous tension. Can affect the blood cells and the blood's clotting ability; hypochromic anemia. Delayed or chronic health hazard is possible asthmatic bronchitis with coughing and/or shortness of breath. The use of alcoholic beverages enhances the effect. May cause liver damage. The liquid destroys the skin's natural oils, causing drying, and cracking.

Points of Attack: Eyes, skin, respiratory system; central nervous system; blood.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended. Lung function tests. CBC and platelet count. If symptoms develop or overexposure is suspected, the following may be useful: liver function tests. Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures *over 25 ppm*; Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator with an organic vapor cartridge/canister. More protection is provided by a full facepiece respirator than by a half-mask respirator, and even greater protection is provided by a PAPR. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. This chemical must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates); and strong oxidizers (such as chlorine, bromine, and fluorine), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gal or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical.

Shipping: UN1993 Flammable liquids, n.o.s., Hazard Class: 3; Labels: 3-Flammable liquid, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are

required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of carbon. *Small fires*: dry chemical, carbon dioxide; water spray; or alcohol foam. *Large fires*: water spray, fog, or alcohol foam. Move container from fire area if you can do so without risk. Spray cooling water on containers that are exposed to flames until well after fire is out. For massive fire in cargo area, use unmanned hose holder or monitor nozzles; if this is impossible, withdraw from area and let fire burn. Withdraw immediately in case of rising sound from venting safety device or any discoloration of tank due to fire. Isolate for one-half mile in all directions if tank car or truck is involved in fire. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Mesitylene, Washington, DC, Chemical Emergency Preparedness Program (Oct. 31, 1985).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Trimethyl Benzene (mixed isomers), Trenton, NJ (May 2003).

Mesityl Oxide M:0470

Formula: $C_6H_{10}O$; $CH_3COCH{=}C(CH_3)_2$

Synonyms: Isobutenyl methyl ketone; Isopropylideneacetone; Mesityloxid (German); Methyl isobutenyl ketone; 4-Methyl-3-pentene-2-one; 4-Methyl-3-penten-2-on (German); 2-Methyl-2-penten-4-one; 4-Methyl-3-penten-2-one; Oxyde de mesitylе (French)

CAS Registry Number: 141-79-7

HSDB Number: 1195

RTECS Number: SB4200000

UN/NA & ERG Number: UN1229/129

EC Number: 205-502-5 [*Annex I Index No.*: 606-009-00-1]

Regulatory Authority and Advisory Information

Hazard Alert: Highly flammable, Primary irritant (w/o allergic reaction).

Hazard symbols, risk, & safety statements: Hazard symbol: Xn; risk phrases: R11; R20/21/22; R36/37/38; safety phrases: S2; S21; S25 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Mesityl oxide is a clear, pale yellow, or colorless liquid with a strong peppermint odor. The odor threshold is 0.05 ppm. Molecular weight = 98.16; specific gravity $(H_2O{:}1) = 0.854$; boiling point = 130°C; freezing/melting point = −59°C; vapor pressure = 10 mmHg @ 26°C; flash point = 30.6°C; autoignition temperature = 343°C. Explosive limits: LEL = 1.4%; UEL: 7.2%. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 3, reactivity 1. Slightly soluble in water; solubility = 3%[77].

Potential Exposure: Mesityl oxide is used as a solvent for cellulose esters and ethers and other resins in lacquers and inks. It is used in paint and varnish removers and as an insect repellent.

Incompatibilities: May form explosive mixture with air. May be able to form explosive peroxides. May react violently with nitric acid; aliphatic amines; alkanolamines, 2-aminoethanol, ethylene diamine; chlorosulfonic acid; oleum (fuming sulfuric acid). Not compatible with oxidizers, strong acids; strong bases; reducing agents; halogens. Dissolves some forms of plastics, resins and rubber. Attacks copper.

Permissible Exposure Limits in Air

NIOSH IDLH = 1400 ppm [LEL]

OSHA PEL: 25 ppm/100 milligram per cubic meter TWA

NIOSH REL: 10 ppm/40 milligram per cubic meter TWA

ACGIH TLV[1]: 15 ppm/60 milligram per cubic meter TWA; 25 ppm/100 milligram per cubic meter STEL

PAC Ver. 29[138]

PAC-1: 25 ppm

PAC-2: 830 ppm

PAC-3: 5000 ppm

DFG MAK: 5 ppm/20 milligram per cubic meter TWA; Peak Limitation Category I(2) [skin]; Pregnancy Risk Group D

Australia: TWA 15 ppm (60 milligram per cubic meter); STEL 25 ppm, 1993; Austria: MAK 25 ppm (100 milligram per cubic meter), 1999; Denmark: TWA 10 ppm (40 milligram per cubic meter), 1999; Finland: TWA 25 ppm (100 milligram per cubic meter); STEL 75 ppm (300 milligram per cubic meter) [skin], 1999; France: VME 15 ppm (60 milligram per cubic meter), 1999; Norway: TWA 10 ppm

(40 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 60 milligram per cubic meter, 2003; Poland: MAC (TWA) 20 milligram per cubic meter, MAC (STEL) 100 milligram per cubic meter, 1999; Russia: STEL 1 milligram per cubic meter [skin], 1993; Switzerland: MAK-W 15 ppm (60 milligram per cubic meter), 1999; Turkey: TWA 25 ppm (100 milligram per cubic meter), 1993; United Kingdom: TWA 15 ppm (61 milligram per cubic meter); STEL 25 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 25 ppm. Several states have set guidelines or standards for mesityl oxide in ambient air[60] ranging from 0.6 to 1.0 milligram per cubic meter (North Dakota to 0.8 milligram per cubic meter (Connecticut) to 1.0 milligram per cubic meter (Virginia) to 1.429 milligram per cubic meter (Nevada).

Determination in Air: Charcoal adsorption, workup with CS_2, analysis by gas chromatography/flame ionization. Use NIOSH Analytical Method #1301 for Ketones (II)[18]

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 1.7$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates and burns the eyes and skin. May cause permanent eye damage. Irritates the respiratory tract causing coughing, wheezing and shortness of breath. Exposure causes headache, sleepiness, dizziness, loss of coordination. Exposure far above OEL may result in narcosis, unconsciousness, coma.

Long-Term Exposure: The liquid destroys the skin's natural oils. May affect the liver, kidneys and lungs. May cause anemia.

Points of Attack: Eyes, skin, respiratory system; blood, liver, kidneys, lungs, central nervous system.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Liver and kidney function tests. Lung function tests. CBC.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin contact: 8 hours: Responder suits. Also, Viton/chlorobutyl rubber is among the recommended protective materials. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. For more information about engineering controls, see NIOSH Criteria Document 78-173, *Ketones*.

Respirator Selection: NIOSH: *250 ppm*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOv (APF = 25) [any PAPR with organic vapor cartridge(s)]. *500 ppm*: CcrFOv (APF = 50) [any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s)]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister]; or PaprTOv (APF = 50) [any PAPR with a tight-fitting facepiece and organic vapor cartridge(s)]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *1400 ppm*: SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd, Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA). *Note*: Substance causes eye irritation or damage; eye protection needed.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, strong acids. See incompatibilities above. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: UN1229 Mesitly oxide, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive

limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. Oil-skimming equipment and sorbent foams can be applied to slick if done immediately. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; alcohol foam; or polymer foam extinguishers. Water may be ineffective. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (2); (100).

National Institute for Occupational Safety and Health (NIOSH), "Criteria for a Recommended Standard: Occupational Exposure to Ketones", NIOSH Document Number 78-173, Washington, DC (1978).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Mesityl Oxide, Trenton, NJ (June 1999).

Metaldehyde M:0480

Formula: $C_8H_{16}O_4$

Synonyms: Acetaldehyde, tetramer; Antimilace; Ariotox; Cekumeta; Halizan; META; Metacetaldehyde; Metaldehyd (German); Metason; Namekil; Slug-tox; 1,3,5,7-Tetroxocane, 2,4,6,8-tetramethyl-

CAS Registry Number: 108-62-3

HSDB Number: 1735

RTECS Number: XF9900000

UN/NA & ERG Number: UN1332/133

EC Number: 203-600-2 [*Annex I Index No.*: 605-005-00-7]

Regulatory Authority and Advisory Information

Hazard Alert: Highly flammable solid, Highly toxic inhalation hazard. TSCA: 40CFR716.120(d)1 as aldehydes.

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xn; risk phrases: R11; R22; R26/27/28; safety phrases: S2; S13; S16; S21; S25; S46; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Metaldehyde is a white crystalline powder with a mild menthol odor. Molecular weight = 176.24; boiling point = 112−116°C; freezing/melting point = 47°C; flash point = 36°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 3, reactivity 1. Practically insoluble in water.

Potential Exposure: It is used as a poison for slugs and snails, and as a fuel in small heaters.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Inhalation may be fatal. Contact can irritate the eyes, skin and respiratory tract. Exposure can cause nausea, vomiting, diarrhea, abdominal pain; irritability, sleepiness, muscle twitching; convulsions, coma, and death.

Long-Term Exposure: May cause kidney and liver damage. May damage the developing fetus.

Points of Attack: Kidneys, liver.

Medical Surveillance: Kidney function tests. Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get

medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Red Stripe: Flammability Hazard: Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Store flammable solids up to maximum allowable quantity per control area in an approved flammable storage area. Do not store in a basement. Prior to working with metaldehyde all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers. Where possible, transfer automatically transfer material from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1332 Metaldehyde, Hazard Class: 4.1; Labels: 4.1-Flammable solid.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during clean-up. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable solid. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Fire may restart after it has been extinguished. Thermal decomposition products may include oxides of carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Metaldehyde, Trenton, NJ (June 1999).

Methanearsonic Acid M:0532

Formula: CH_5AsO_3

Synonyms: ANSAR; Arsonic acid, methyl-; MAA; Methylarsinic acid; Methylarsonic acid; Monomethylarsonic acid; MSMA

CAS Number: 124-58-3

HSDB Number: 845

RTECS Number: PA1575000

UN/NA & ERG Number: UN3465 (organoarsenic compound, solid, n.o.s.)/151

EC Number: 204-705-6 [*Annex I Index No.*: 033-002-00-5]

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Suspected reprotoxic hazard, Environmental hazard.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) as arsenic compounds

Clean Water Act: Toxic Pollutant (Section 401.15) as arsenic and compounds

RCRA Section 261 Hazardous Constituents, waste number D004 (arsenic compounds) EPCRA Section 304 RQ: CERCLA, 1 lb (0.454 kg)

EPCRA (Section 313): Includes any unique chemical substance that contains arsenic as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: 1.0% (organic arsenic)

United States DOT Regulated marine pollutant (49CFR172.101, Appendix B) arsenical pesticides liquid, toxic, flammable, n.o.s.

California EPA AB2588-Air Toxics "Hot Spots" Chemicals (CAL) as arsenic compounds Permissible Exposure Limits for Chemical Contaminants (CAL/OSHA) as arsenic compounds

The "Director's List" (CAL/OSHA) as arsenic compounds

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R23; R25; R50/53; safety phrases: S1/2; S20/21; S28; S45; S60; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found [3-Severe hazard to waters (est.)].

Description: White crystalline solid. Molecular weight = 140.01; freezing/melting point = 161°C. Highly soluble in water.

Potential Exposure: Methanearsonic acid is an organoarsenic herbicide.

Incompatibilities: A strong acid. Incompatible with caustics, ammonia, amines, amides, organic anhydrides, isocyanates, vinyl acetate, alkylene oxides, epichlorohydrin. May not be compatible with nitrates. Moisture may cause hydrolysis or other forms of decomposition. Attacks metals in the presence of moisture

Permissible Exposure Limits in Air:

Arsenic, organic compounds

OSHA PEL: 0.5 mg[As]/m^3 TWA

ACGIH TLV[1]: 0.01 mg[As]/m^3 TWA; Confirmed Human Carcinogen; BEI: Determinant: Inorganic arsenic plus methylated metabolites in urine; Sampling Time: end of workweek; BEI = 35 μg[As]/L. The determinant may be present in biological specimens collected from subjects who have not been occupationally exposed, at a concentration which could affect interpretation of the result. Such background concentrations are incorporated in the BEI value.

NIOSH IDLH = 5 mg[As]/m^3

PAC *as arsenic, organic compounds* Ver. 26, no value in Ver. 29[138]

PAC-1: 1.5 milligram per cubic meter

PAC-2: 2.5 milligram per cubic meter

PAC-3: 350 milligram per cubic meter

Determination in Air: Filter; Reagent: Ion chromatography/hydride atomic absorption: NIOSH IV [#5022, Arsenic, organo-][18].

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 10 μg[As]/L; State Drinking Water Guidelines: Arizona 10 μg[As]/L; Connecticut 10 μg[As]/L EPA MCL: 0.010 mg[As]/L[40 CFR 141.62]. Canadian Drinking Water Standards: IMAC 0.025 [As] mg/L.

Determination in Water: *For arsenic*: The atomic absorption graphite furnace technique is often used for measurement of total arsenic in water. It also has been standardized by EPA. Total arsenic may be determined by digestion followed by silver diethyldithiocarbamate; an alternative is atomic absorption; another is inductively coupled plasma optical emission spectrometry. See OSHA Method #ID-105 for arsenic[58]

Routes of Entry: Inhalation, eyes, ingestion, dermal and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Symptoms of arsenic poisoning usually appear one-half to 1 hour after ingestion, but may be delayed many hours. Symptoms include a sweetish metallic taste and garlicky odor; difficulty in swallowing; abdominal pain; vomiting and painful diarrhea; dehydration, thirst, and cramps; dizziness, stupor, and delirium, rapid heartbeat, headache, skin disorders, and coma. LD_{50} (oral, rat) = 1700 mg/kg; LD_{50} (dermal, rabbit) = > 2.5 g/kg.

Long-Term Exposure: Chronic exposure to arsenic compounds can cause dermatitis and digestive disorders. Renal damage may develop. May be a liver and kidney toxin.

Points of Attack: Skin, liver, and kidneys.

Medical Surveillance: Test for urine arsenic. Levels should not be greater than 100 μg/g of creatinine in the urine. Examine the skin for abnormal growths. Liver and kidney function tests. Preliminary medical exam to detect chronic diseases of central nervous system, liver, heart, kidneys, lung, and skin, as well as endocrinological or immunological disturbances, should protect susceptible individuals. Periodical medical exams of internal organs, skin, and eyes are important to avoid chronic occupational intoxications. They should include lab and patch tests if necessary[83,30]. Liver and kidney function tests. Examination by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. *Do not induce vomiting when formulations containing petroleum solvents are ingested.* Otherwise, give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of dermal and/or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Specific engineering controls are required under OSHA 1910.1018, *Inorganic Arsenic*. See also NIOSH Criteria Document #75-149, "*Inorganic Arsenic.*"

Respirator Selection: *At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration*: Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFAg100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code−Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with Calcium arsenate all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. The United States Environmental Protection Agency recommends storing pesticides in their original containers, complete with labels listing ingredients, use directions, and first aid for poisoning. Do not store pesticides in places where flooding is possible or where they might spill or leak into wells, drains, ground water, basements, or surface water.

Shipping: UN3465 Organoarsenic compound, solid, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling:

Organoarsenic compound, solid or liquid

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.5/0.8

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m)) 500/60
Then: Protect persons downwind (mi/km)
Day 1.1/1.8
Night 2.8/4.5

Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources and dampen spilled material with toluene to avoid airborne dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include arsine and oxides of arsenic. This chemical is a noncombustible solid. Use any extinguishing agent suitable for surrounding fires. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Do not discharge into drains or sewers. Dispose of waste material as hazardous waste using a licensed disposal contractor to an approved landfill. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. If allowed, Incineration with effluent gas scrubbing is recommended. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office. Chemical Treatability of Arsenic—(1) Concentration Process: Chemical Precipitation; Chemical Classification: Metal; Scale of Study: Pilot Scale; Type of Wastewater Used: Domestic Wastewater + Pure Compound; Results of Study: 5 ppm @ 4 gpm @ pH = 7.0. Iron system—90% reduction; low lime system—80% reduction; high lime system—76% reduction; (3 coagulant systems were used; Iron system used 45 ppm as Fe of $Fe_2(SO_4)_3$ @ pH = 6.0. Low lime system used 20 ppm Fe of $Fe_2(SO_4)_3$ and 260 ppm of CaO @ pH = 10.0. High line system used 600 ppm of CaO @ pH = 11.5. Chemical coagulation was followed by multimedia filtration); (2) Concentration Process: Chemical Precipitation; Chemical Classification: Metal; Scale of Study: Full Scale

Continuous Flow; Type of Wastewater Used: Domestic Wastewater; Results of Study: Effluent character (ppb): 2.5, 56% reduction with lime; 3.3, 24% reduction with lime; (lime dose of 350−400 ppm as calcium oxide @ pH = 11.3)[72]

References

(31); (173); (101); (138); (204); (100).

International Programme on Chemical Safety (IPCS), "Health and Safety Guide, Dimethylarsenic Acid, Methanearsonic Acid, and Salts," Geneva, Switzerland (1992).

Fishel, Frederick M., Document PI-89, Pesticide Information Office, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, FL, October 2005; Revised February 2011.

United States Environmental Protection Agency, Office of Pesticide Programs, Pesticide Residue Limits, "Methanearsonic Acid di- and mono-sodium salts," 40 CFR 180.289 http://www.setonresourcecenter.com/40CFR/Docs/wcd0004c/wcd04cfe.asp.

United Nations Environmental Programme, United Nations. Treatment and Disposal Method s for Waste Chemicals, Data Profile Series No. 5., p. 233, Geneva, Switzerland (December 1985).

Methacrylic Acid M:0490

Formula: $C_4H_6O_2$: $CH_2{=}C(CH_3)COOH$

Synonyms: Acide methacrylique (French); Acido metacrilico (Spanish); Acido α-metacrilico (Spanish); Acrylic acid, 2-methyl-; Glacial methacrylic acid; Methacrylic acid, inhibited; α-Methyl-acrylic acid; Methacrylsaeure (German); 2-Methylpropenoic acid; 2-Methyl-2-propenoic acid; 2-Propenoic acid, 2-methyl-; Propionic acid, 2-methylene

CAS Registry Number: 79-41-4

HSDB Number: 2649

RTECS Number: OZ2975000

UN/NA & ERG Number: UN2531 (stabilized)/153 (P)

EC Number: 201-204-4 [*Annex I Index No*.: 607-088-00-5]

Regulatory Authority and Advisory Information

Hazard Alert: Flammable, Corrosive, Reducing agent, Polymerization hazard (nonstabilized), Suspected of causing genetic defects.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: C, F; risk phrases: R10; R19; R21/22; R35; R61; R62; safety phrases: S1/2; S26; S36/37/39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Methacrylic acid is a colorless liquid. Molecular weight = 86.1; specific gravity (H_2O:1) = 1.01 (liquid); boiling point = 162.8°C; freezing/melting point = 16.1°C; vapor pressure = 1 mmHg @ 25.5°C; flash point = 77°C (oc); 68°C (cc); autoignition temperature = 68°C. Explosive limits: LEL = 1.6; UEL: 8.8. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 2, reactivity 2. Soluble in water; solubility = 9% @ 25°C. Aqueous solution is a strong acid.

Potential Exposure: Methacrylic acid is used in preparation of methacrylates and carboxylated polymers; in the production of the material or its alkyl esters, as monomers or comonomers for synthetic resins for the production of plastic sheets, moldings, and fibers.

Incompatibilities: Vapor may form explosive mixture with air. A reducing agent; incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Aqueous solution is strongly acidic: incompatible with strong acids; caustics, ammonia, amines, isocyanates, alkylene oxides; epichlorohydrin. Will polymerize readily from heating above 59°F/15°C, or due to the presence of light, oxidizers (e.g., peroxides); or in the presence of traces of hydrochloric acid, with fire or explosion hazard. Attacks metals. *Note*: Typically contains 100 ppm of monomethyl ether hydroquinone (150-76-5) as an inhibitor to prevent polymerization.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 3.52 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: None

NIOSH REL: 20 ppm/70 milligram per cubic meter TWA [skin]

ACGIH TLV[1]: 20 ppm/70 milligram per cubic meter TWA

PAC* Ver. 29[138]

PAC-1: $\mathbf{6.7}_{\mathbf{A}}$ ppm

PAC-2: $\mathbf{61}_{\mathbf{A}}$ ppm

PAC-3: $\mathbf{220}_{\mathbf{A}}$ ppm

*AEGLs are marked with a subscript "**A**" and correspond to 60-minute values.

DFG MAK: 5 ppm/18 milligram per cubic meter TWA; Peak Limitation Category I(2) [skin]; Pregnancy Risk Group C

Australia: TWA 20 ppm (70 milligram per cubic meter), 1993; Austria: MAK 20 ppm (70 milligram per cubic meter), 1999; Belgium: TWA 20 ppm (70 milligram per cubic meter), 1993; Denmark: TWA 20 ppm (70 milligram per cubic meter), 1999; Finland: TWA 20 ppm, 1999; France: VME 20 ppm (70 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 70 milligram per cubic meter, 2003; Russia: STEL 10 milligram per cubic meter [skin], 1993; Sweden: NGV 20 ppm (70 milligram per cubic meter), KTV 30 ppm (100 milligram per cubic meter), 1999; Switzerland: MAK-W 20 ppm (70 milligram per cubic meter), 1999; United Kingdom: TWA 20 ppm (72 milligram per cubic meter); STEL 40 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 20 ppm. Several states have set guidelines or standards for methacrylic acid in ambient air[60] ranging from 0.7 milligram per cubic meter (North Dakota) to 1.2 milligram per cubic meter (Virginia) to 1.4 milligram per cubic meter (Connecticut) to 1.67 milligram per cubic meter (Nevada).

Determination in Air: Use OSHA Analytical Method PV-2005

Permissible Concentration in Water: Russia[43] set a MAC in water bodies used for domestic purposes of 1.0 mg/L.

Determination in Water: Octanol–water coefficient: Log $K_{ow} = < 1.0$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Methacrylic acid can affect you when breathed in. A corrosive substance. Exposure can irritate the nose and throat. Methacrylic acid is a corrosive chemical and contact can burn the eyes, causing permanent damage. It can irritate and burn the skin. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: High or repeated exposure may damage the kidneys. Methacrylic acid can cause an allergic skin rash.

Points of Attack: Lungs, kidneys, skin.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: kidney and liver function tests. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin contact: 8 hours: butyl rubber gloves, suits, boots; Viton gloves, suits; 4H and Silver Shield gloves, Responder suits; Trychem 1000 suits. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures *over 20 ppm*; Use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: (1) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. (2) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. (3) Color code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates). Methacrylic acid should be stored at temperatures below 15°C. Sources of ignition, such as smoking and open flames are prohibited where methacrylic acid is handled, used, or stored. Wherever methacrylic acid is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN2531 Methacrylic acid, stabilized, Hazard class: 8; Labels: 8-Corrosive material.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Using caution, neutralize remainder with aqueous sodium carbonate or lime. Then wash away with plenty of water. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Sealed containers may rupture explosively at elevated temperatures from polymerization. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Methacrylic Acid, Trenton, NJ (August 2004).

Methacrylonitrile M:0500

Formula: C_4H_6N; $CH_2{=}CH(CH_3)CN$

Synonyms: AI3-52399; 2-Cyano-1-propene; 2-Cyanopropene-1; 2-Cyanopropene; Isopropene cyanide; Isopropenylnitrile; Metacrilonitrilo (Spanish); α-Methacrylonitrile; α-Methylacrylonitrile; Methyl acrylonitrile; 2-Methylacrylonitrile; 2-Methylpropenenitrile; 2-Methyl-2-propenenitrile; NSC 24145; 2-Propenenitrile, 2-methyl; Usafst-40

CAS Registry Number: 126-98-7

HSDB Number: 5613

RTECS Number: UD1400000

UN/NA & ERG Number: UN3079 (stabilized)/131(P)

EC Number: 204-817-5 [*Annex I Index No.*: 608-010-00-2]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Carcinogenicity: NCI: Carcinogenesis Studies (gavage); no evidence: mouse, rat; NTP: Toxicity studies, RPT#TOX-47, October 2000.

Hazard Alert: Exposure can be lethal, Poison (inhalation) hazard, High acute toxicity, Highly flammable liquid, Polymerization hazard (nonstabilized), Possible risk of forming tumors, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction).

OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 250 lb

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U152

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.24; Nonwastewater (mg/kg), 84

RCRA Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8015 (5); 8240 (5)

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500 lb (227 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1000 lb (454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: F, T+; risk phrases: R11; R19; R23/24/25; R36/37/38; R62; safety phrases: S1/2; S9; S16; S18; S21; S29; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Methylacrylonitrile is a colorless liquid with an odor like bitter almonds. It is reported that methacrylonitrile cannot be detected by its smell even at concentrations which are already dangerous for humans. Hence, special attention must be given to ventilation and estimations of the amount of poison present must be carried out frequently. Molecular weight = 67.1; specific gravity (H_2O:1) = 0.81; boiling point = 90.6°C; freezing/melting point = −35.8°C; vapor pressure = 40 mmHg @ 12.8°C; flash point = 1.1°C (cc). Explosive limits: LEL = 2%; UEL: 6.8%. Hazard identification (based on NFPA-704 M Rating System): Health 4, flammability 3, reactivity 2. Slightly soluble in water; solubility in water = 3%.

Potential Exposure: This material is used as a monomer in the preparation of polymeric coatings and elastomers.

Incompatibilities: May form explosive mixture with air. Methacrylonitrile evolves flammable concentrations of vapor at temperatures down to 12.8°C. Thus, at room temperatures, flammable concentrations are liable to be present[101]. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, aliphatic amines, alkanolamines, alkali, and light. Heat sensitive; polymerization may occur due to elevated temperature, visible light, or contact with a concentrated alkali. *Note*: Typically contains 50 pm of monoethyl ether hydroquinone (662-62-8) as an inhibitor to prevent polymerization.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 2.74 milligram per cubic meter @ 25°C & 1 atm

Odor threshold = 7.0 ppm.

OSHA PEL: None

NIOSH REL: 1 ppm/3 milligram per cubic meter TWA [skin]; *Nitriles*: 2 ppm, Ceiling Concentration, not to be exceeded in any 15-minute work period.

ACGIH TLV[1]: 1 ppm/2.7 milligram per cubic meter TWA [skin]

PAC* Ver. 29[138]

PAC-1: $\mathbf{0.091}_{\mathbf{A}}$ ppm

PAC-2: $\mathbf{1.0}_{\mathbf{A}}$ ppm

PAC-3: $\mathbf{3.1}_{\mathbf{A}}$ ppm

*AEGLs are marked with a subscript "**A**" and correspond to 60-minute values. Australia: TWA 1 ppm (3 milligram per cubic meter) [skin], 1993; Belgium: TWA 1 ppm (2.7 milligram per cubic meter) [skin], 1993; Denmark: TWA 1 ppm (3 milligram per cubic meter) [skin], 1999; Finland: TWA 1 ppm (3 milligram per cubic meter); STEL 3 ppm (9 milligram per cubic meter) [skin], 1999; France: VME 1 ppm (3 milligram per cubic meter) [skin], 1999; Norway: TWA 1 ppm (3 milligram per cubic meter), 1999; Switzerland: MAK-W 1 ppm (3 milligram per cubic meter) [skin], 1993; the Netherlands: MAC-TGG 3 milligram per cubic meter [skin], 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 1 ppm [skin]. Several states have set guidelines or standards for methacrylonitrile in ambient air[60] ranging from 0.7 milligram per cubic meter (North Dakota) to 1.2 milligram per cubic meter (Virginia) to 1.4 milligram per cubic meter (Connecticut) to 1.667 milligram per cubic meter (Nevada).

Determination in Water: Octanol–water coefficient: Log $K_{ow} = 0.7$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Converted to cyanide in the body! A lacrimator (causes tearing); an insidious poison which causes delayed skin reactions. Very readily absorbed through skin. Highly toxic by all routes of exposure. Signs and symptoms of acute exposure to methylacrylonitrile may include hypertension (high blood pressure) and tachycardia (rapid heart rate), followed by hypotension (low blood pressure) and bradycardia (slow heart rate). Cherry-red mucous membranes and blood, cardiac arrhythmias, and other cardiac abnormalities are common. Cyanosis (blue tint to the skin and mucous membranes) is not a consistent finding. Tachypnea (rapid respiratory rate) may be followed by respiratory depression. Lung hemorrhage and pulmonary edema may also occur. Headache, vertigo (dizziness), agitation, and giddiness may be followed by combative behavior, convulsions, paralysis, protruding eyeballs; dilated and unreactive pupils; and coma. Methylacrylonitrile is irritating to the skin and mucous membranes. Lacrimation (tearing) and a burning sensation of the mouth and throat are common. Excessive salivation; nausea, and vomiting may also occur.

Long-Term Exposure: May cause liver damage. May cause nervous system damage, causing weakness in the legs. See NIOSH Criteria Document 212 *Nitriles*.

Points of Attack: Eyes, skin, liver, central nervous system.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater, or significant skin contact), the following are recommended before beginning work and at regular times after that: exam of the nervous system. Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. butyl rubber is among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See NIOSH Criteria Document 212 *Nitriles*.

Respirator Selection: Where there is potential exists for exposures *over 1 ppm*; Use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Poison inhalation chemical (PIH); check oxygen content prior to entering storage area. (1) Color code—Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. (2) Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames are prohibited where methylacrylonitrile is handled, used, or stored. Metal containers involving the transfer of 5 gal or more of methylacrylonitrile should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of methylacrylonitrile. Wherever methylacrylonitrile is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN3079 Methacrylonitrile, stabilized, Labels: 6.1; Hazard class: 6.1, 3-Flammable liquid, Inhalation Hazard Zone B.

Spill Handling:

Methacrylonitrile, *Initial isolation and protective action distances*

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 48-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m)) 200/60
Then: Protect persons downwind (mi/km)
Day 0.3/0.5
Night 0.5/0.8

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Oil-skimming equipment and sorbent foams can be applied to slick if done immediately. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This is a flammable liquid. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, CO_2, water spray; or alcohol foam extinguishers. Methacrylonitrile evolves flammable concentrations of vapor at temperatures down to 12.8°C. Thus, at room temperatures, flammable concentrations are liable to be present[101]. Also, the chemical will explode due to its tendency to polymerize violently. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform to EPA regulations governing storage, transportation, treatment, and waste disposal. Add alcoholic NaOH, then oxidize with sodium hypochlorite. After reaction, flush to sewer with water[24].

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Methacrylonitrile, Washington, DC, Chemical Emergency Preparedness Program (Nov. 30, 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Methylacrylonitrile, Trenton, NJ (March 2000).

Methallyl Alcohol M:0510

Formula: C_4H_8O; $CH_2{=}C(CH_3)CH_2OH$
Synonyms: Isopropenyl carbinol; 2-Methyl-2-propen-1-ol; 2-Propen-1-ol, 2-methyl-
CAS Registry Number: 513-42-8
RTECS Number: UD5250000
UN/NA & ERG Number: UN2614/129
EC Number: 208-161-0

Regulatory Authority and Advisory Information

Hazard Alert: Highly flammable liquid, Primary irritant (w/o allergic reaction).

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xi; risk phrases: R11; R36/37/38; R50 Safety phrases: S16; S21; S26; S36/37/39; S51 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found [2-Hazard to water. (est.)].

Description: Methallyl alcohol is a colorless liquid. Pungent odor. Molecular weight = 72.12; boiling point = 114°C; flash point = 33°C. Autoignition temperature = > 300°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 3, reactivity 0. Slightly soluble in water.

Potential Exposure: Used as an intermediate in organic synthesis.

Incompatibilities: Vapors may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, aliphatic amines; isocyanates, DMSO.

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Determination in Air: Use NIOSH Analytical Method (IV) #1402, for Alcohols III

Routes of Entry: Inhalation, ingestion; skin and/or eye contact. Passes through the skin.

Routes of Entry: Inhalation; dermal contact.

Harmful Effects and Symptoms

Short-Term Exposure: Methallyl alcohol can cause irritation to the skin, eyes and respiratory tract. May be able to pass through the unbroken skin.

Long-Term Exposure: Similar allyl compounds cause liver damage. However, it is not known for certain that this chemical causes the same effects.

Points of Attack: Liver. Respiratory system.

Medical Surveillance: Respiratory system and liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures to methallyl alcohol, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers and other incompatible materials. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure is chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2614 Methallyl alcohol, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Methallyl alcohol is a flammable liquid. Thermal decomposition products may include oxides of carbon. Water may be ineffective. Alcohol foam is the recommended extinguishing agent. Acrid fumes and smoke are released in fire. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Methallyl Alcohol, Trenton, NJ (April 2000).

Methamidophos M:0520

Formula: $C_2H_8NO_2PS$; $CH_3OP(O)(NH_2)SCH_3$

Synonyms: Acephate-met; Bay 71625; Bayer 71628; Chevron 9006; Chevron ortho 9006; *O*,*S*-Dimethyl ester of amide of amidothioate; *O*,*S*-Dimethyl phosphoramidothioate; ENT 27,396; GS-13005; Hamidop; Metamidofos (Spanish); Metamidofos estrella; Monitor; MTD; MTD 600; NSC 190987; Ortho 9006; Pillaron; SRA 5172; Supracide; Tahmabon; Tamaron; Thiophosphorsaeure-*O*, *S*-dimethylesteramid (German)

CAS Registry Number: 10265-92-6

HSDB Number: 1593

RTECS Number: TB4970000

UN/NA & ERG Number: (PIH) UN2783 (organophosphorus pesticides, solid, toxic)/152

EC Number: 233-606-0 [*Annex I Index No*.: 015-095-00-4]

Regulatory Authority and Advisory Information

Hazard Alert: Poison inhalation hazard, Neurotoxin (cumulative), Combustible.

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)

United States DOT 49CFR172.101, Inhalation Hazard Chemical as organophosphates.

Rotterdam Convention Annex III (Chemicals Subject to the PIC Procedure) [methamidophos (soluble liquid formulations of the substance that exceed 600 g active ingredient/L)]

Hazard symbols, risk, & safety statements: Hazard symbol: T+, N; Risk phrases R24; R26/28; R33; S41; R50; safety phrases: S1/2; S28; S36/37; S41; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Methamidophos is an off-white crystalline solid. Molecular weight = 141.14; specific gravity (H_2O:1) = 1.31 @ 44.5°C; freezing/melting point = 40°C; vapor pressure = 3×10^{-4} mmHg @ 25°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 1, reactivity 0. Slightly soluble in water.

Potential Exposure: A potential danger to those involved in the manufacture, formulation, and application of this insecticide on vegetables and cotton.

Incompatibilities: Incompatible with strong acids or alkali. Attacks mild steel and copper-containing alloys (technical grade).

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 0.11 milligram per cubic meter

PAC-2: 1.2 milligram per cubic meter

PAC-3: 7.1 milligram per cubic meter

Determination in Air: OSHA versatile sampler-2; Toluene/Acetone; Gas chromatography/Flame photometric detection for sulfur, nitrogen, or phosphorus; NIOSH Analytical Method (IV) Method #5600, Organophosphorus Pesticides.

Determination in Water: Fish Tox = 165.16992000 ppb (LOW).

Routes of Entry: Inhalation, ingestion, skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes. Organic phosphorus insecticides are absorbed by the skin, as well as by the respiratory and gastrointestinal tracts. They are cholinesterase inhibitors. Symptoms of exposure include headache, giddiness; blurred vision; nervousness, weakness, nausea, cramps, diarrhea, and discomfort in the chest. Signs include sweating, tearing, salivation, vomiting, cyanosis, convulsions, coma; loss of reflexes and loss of sphincter control. Acute exposure to methamidophos may produce the following signs and symptoms: pinpoint pupils; blurred vision; headache, dizziness, muscle spasms; and profound weakness. Vomiting, diarrhea, abdominal pain; seizures, and coma may also occur. The heart rate may decrease following oral exposure or increase following dermal exposure. Chest pain may be noted. Hypotension (low blood pressure) may be noted, although hypertension (high blood pressure) is not uncommon. Respiratory symptoms include dyspnea (shortness of breath), respiratory depression; and respiratory paralysis. Psychosis may occur. This material is highly toxic; LD_{50}(oral-rat) = 7.5 mg/kg. Human Tox = 7.00000 ppb (HIGH).

Long-Term Exposure: The substance may have effects on the nervous system; resulting in delayed neuropathy. Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, central nervous system; cardiovascular system, skin, eyes, plasma, and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider CBC. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Obtain authorization of an antidote or performance of other invasive procedures. The effects may be delayed. Medical observation recommended.

Note to Physician: 1,1′-trimethylenebis(4-formylpyridinium bromide)dioxime (aka TMB-4 dibromide and TMV-4) has been used as an antidote for organophosphate poisoning.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area

Shipping: UN2783 Organophosphorus pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling:

Initial isolation and protective action distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.3/0.4
Night 0.8/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m)) 600/200
Then: Protect persons downwind (mi/km)
Day 1.4/2.3
Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Do not touch spilled material. Do not breathe vapors. Stay upwind; keep out of low areas. Remove all ignition sources. Ventilate area of spill or leak. This material is a combustible liquid. For a spill or leak of a combustible liquid, shut off ignition sources; no flares, smoking or flames in hazard area. Stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material may burn, but does not ignite readily. Thermal decomposition products may include oxides of phosphorus, sulfur, nitrogen, and carbon. *For small fires*, use dry chemical, carbon dioxide; water spray; or foam. *For large fires*: use water spray, fog, or foam. Stay upwind; keep out of low areas. Move containers from fire area if you can do it without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Wear positive pressure breathing apparatus and special protective clothing. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR 165 recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Methamidophos, Washington, DC, Chemical Emergency Preparedness Program (Nov. 30, 1987).

Metham–Sodium M:0526

Formula: $C_2H_4NNaS_2$; $C_2H_4NNaS_2 \cdot 2H_2O$ (dihydrate)

Synonyms: A7-Vapam; Basamid-fluid; Busan; Carbam; Carbamic acid, methyldithio-, monosodium salt; Carbamic acid, *N*-methyldithio-, monosodium salt; Carbamic acid, *N*-methyldithio-, sodium salt; Carbamodithioic acid, methyl-, monosodium salt; Carbam, sodium salt; Carbathion; Carbathione; Carbation; Carbothion; Chap-fume; Diethylamino-2,6-acetoxylidide; Discovery; Herbatim (dihydrate); Karbation; Karbation (dihydrate); Maposol; Maposol (dihydrate); Metacide; Metham dihydrate; Metam-fluid BASF; Methan-sodium; *N*-Methylaminodithioformic acid sodium salt; *N*-Methylaminomethanethionothiolic acid sodium salt; Methylcarbamodithioic acid sodium salt; Methyldithiocarbamic acid, sodium salt; Monam (dihydrate); N-869; N 869 (dihydrate); Nematin; Sectagon; Sistan; SMDC (dihydrate); SMDC; Sodium Metam; Sodium Metham; Sodium *N*-methylaminodithioformate; Sodium *N*-methylaminomethanethionothiolate; Sodium methylcarbamodithioate; Sodium methyldithiocarbamate; Sodium *N*-methyldithiocarbamate; Sodium monomethyldithiocarbamate; Solasan 500; Solesan 500; Sometam; Trapex; Trimaton (dihydrate); Trimatron; Ucetam; Vapam; Vapam (dihydrate); Vaporooter (dihydrate); VPM (dihydrate); VPM fungicide; VPN; Woodfume VAPAM

CAS Number: 137-42-8; 6734-80-1 (dihydrate)

HSDB Number: 1767

RTECS Number: FC2100000

UN/NA&ERG Number: UN3267 (Corrosive liquid, basic, organic, n.o.s.)/153; UN2771(Dithiocarbamate, solid)/151

EC Number: 205-293-0 [*Annex I Index No*.: 006-013-00-8]

Regulatory Authority and Advisory Information

Carcinogenicity[83]: EPA Group B2, Probable human carcinogen.

California Proposition 65 Chemical[102]: Carcinogen, 11/6/1998; developmental toxin 5/15/1998

Hazard Alert: Poison, Possible thyroid effects, Endocrine disruptor (high), Corrosive, Suspected reprotoxic hazard, Water reactive, Sensitization hazard, Environmental hazard, Agricultural chemical.

EPA Hazardous Waste Number (RCRA No.): U384

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%

United States DOT Regulated marine pollutant (49CFR172.101, Appendix B)

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292].

Hazard symbols, risk, & safety statements: Hazard symbol: Xn, Xi, C, N; risk phrases: R20/21/22; R31/34; R43;

R50/53; R63; safety phrases: S1/2; S26; S29/35; S36/37/39; S45; S60; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found [3-Severe hazard to water. (est.)].

Description: A yellow to nearly clear yellow-green solution. Also described as a colorless to white crystalline solid. Unpleasant sulfur-amine odor, similar to that of carbon disulfide. Molecular weight = 129.18, 165.21 (dihydrate); freezing/melting point decomposes; boiling point = 110°C (technical product); vapor pressure = 20 mmHg @ 20°C. Readily soluble in water; solubility = 722 g/L @ 20°C. ₩ Water reactive. Slow reaction upon dilution, releasing toxic gases of hydrogen sulfide and methylisothiocyanate. This reaction is accelerated by the addition of acid[101].

Potential Exposure: A dithiocarbamate fungicide, nematicide, herbicide, soil fumigant, and algaecide A general soil biocide that is used to control weeds, weed seeds, roots, tubers, rhizomes, insects, nematodes and soil inhabiting fungi on all food and nonfood crops. Also used as a preplanting fumigant in seed beds, vine crops, fruit trees, row crops, flowers and ornamentals. Environmental friendly; it breaks down after two weeks into carbon dioxide, water, and sodium and sulfur in small amounts. A United States Environmental Protection Agency Restricted Use Pesticide (RUP).

Incompatibilities: Slow reaction upon dilution in water releasing toxic gases of hydrogen sulfide and methyl isothiocyanate. This reaction is accelerated by the addition of acid[88]. May liberate toxic gas when in contact with acids. Combustible; vapors when heated or dust from dry material may form explosive mixture in air. Dithiocarbamate esters are combustible. They react violently with powerful oxidizers such as calcium hypochlorite. Poisonous gases are generated by the thermal decomposition of Dithiocarbamate compounds, including carbon disulfide, oxides of sulfur, oxides of nitrogen, hydrogen sulfide, ammonia, and methylamine. Thio and dithiocarbamates slowly decompose in aqueous solution to form carbon disulfide and methylamine or other amines. Such decompositions are accelerated by acids. Flammable gases are generated by the combination of dithiocarbamate with aldehydes, nitrides, and hydrides. Dithiocarbamate are incompatible with acids, peroxides, and acid halides. Corrosive to iron, copper brass and zinc metals, especially in the presence of moisture. Heat alkalies (lime), moisture can cause decomposition. Degradation produces ethylene thiourea.

Determination in Air: Filter; none; Gravimetric; NIOSH IV [Particulates NOR; #0500 (total), #0600 (respirable)][18].

Permissible Concentration in Water: State Drinking Water Guidelines: California 20 μg/L. Runoff from spills or fire control may cause water pollution.

Determination in Water: EPA EMSLC Method 630. The Determination of Dithiocarbamate Pesticides in Municipal and Industrial Wastewater by UV–VIS Spectrophotometry. Octanol–water coefficient: Log $K_{ow} = < 0.5$. Unlikely to bioaccumulate in marine organisms. Fish toxicity (threshold)[101]: Intermediate—60.02431 ppb, MATC (Maximum Acceptable Toxicant Concentration).

Routes of Entry: Poisoning can occur by inhalation, ingestion and absorption through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: The acute symptoms of exposure to metam sodium are excessive salivation, sweating, fatigue, weakness, nausea, headache, dizziness, eye and respiratory tract irritation, and skin irritation in the form of rashes[88]. Concentrated solutions are corrosive to eyes and mucous membranes. Dust inhalation can cause irritation of the respiratory system with sneezing. Eye contact can cause irritation, watering, pain, and inflammation of the eyelids. Dermal contact can cause irritation and minor ulceration. Ingestion can cause nausea, vomiting, fever, muscle twitching, seizure, rapid respiration, slow heartbeat. Severe exposure may result in death. Unlike carbamates the dithiocarbamates are not cholinesterase inhibitors, but some of them may react with recently ingested alcohol or alcohol-containing products including wine, medications, and cold remedies such as cough-syrups. LD_{50} (oral, rat) = LD_{50} (oral, rat) = 845 mg/kg[83]; LD_{50} (dermal, rat) ≥ 500 mg/kg.

Long-Term Exposure: Thyroid effects. May cause skin sensitization; Liver and urinary tract effects. Human toxicity (long term)[101]: High—1.76768 ppb, CHCL (Chronic Human Carcinogen Level).

Points of Attack: Thyroid (possible goiter). Respiratory system, central nervous system, cardiovascular system, skin and eyes, liver, urinary tract.

Medical Surveillance: This chemical is a suspected or known human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and advice for medical monitoring. Medical observation is recommended for 24 to 48 hours following breathing overexposure, as pulmonary edema may be delayed. Before employment and at regular times after that, the following are recommended: If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider CBC and chest X-ray following acute overexposure. Evaluation by a qualified allergist, including exposure history and testing, may help diagnose allergy. Thyroid function tests.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves.[31]

Personal Protective Methods: Reacts with the following absorbent materials: Cellulose-Based; Mineral- and Clay-Based; Dirt/Earth[88]. Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of dermal and/or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: (1) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. (2) Color code—Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN3267 Corrosive liquid, basic, organic, n.o.s., Hazard class: 8; Labels: 8-Corrosive material, Technical Name Required. UN2771 Dithiocarbamate and Thiocarbamate pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: First remove all sources of ignition. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Stop leak if you can do it without risk. Prevent entry into waterways, sewers, basements, or confined areas. Absorb or cover with dry earth, sand or other noncombustible material and transfer to containers. *Do not get water inside containers*.[31] Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen, disodium oxide, sulfur, and carbon. Extinguish fire using an agent suitable for type of surrounding fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Do not discharge into drains or sewers. Dispose of waste material as hazardous waste using a licensed disposal contractor to an approved landfill. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform to EPA regulations governing storage, transportation, treatment, and waste disposal. A potential candidate for liquid injection incineration at a temperature range of 650 to 1600°C and a residence time 0.1 to 2 seconds. Also, a potential candidate for rotary kiln incineration at a temperature range of 820 to 1600°C and residence times of seconds for liquids and gases, and hours for solids[83].

References

(102); (31); (173); (101); (138); (100).

"In-Row Sprayblade Fumigation with Metam Sodium to Control Weeds and Diseases," *Skagit Veg Trials*, Anderson, W. C. "Andy," and Haglund, William A., Washington State University, Mount Vernon, WA. http://www.mtvernon.wsu.edu/SkagitVegTrials/methamsodium.html.

Methane M:0530

Formula: CH_4

Synonyms: Biogas; Fire damp; Marsh gas; Metano (Spanish); Methyl hydride; Natural gas

CAS Registry Number: 74-82-8

HSDB Number: 167

RTECS Number: PA1490000

UN/NA & ERG Number: UN1971 (compressed gas)/115; UN1972 (liquefied gas)/115

EC Number: 200-812-7 [*Annex I Index No.*: 601-001-00-4]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Hazard Alert: Extremely flammable gas; Strong reducing agent, Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg).

Hazard symbols, risk, & safety statements: Hazard symbol: F+; risk phrases: R5; R12; R21; safety phrases: S1; S2; S9; S16; S33; S38; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): Nonhazard to water.

Description: Methane is an odorless, colorless gas. Molecular weight = 16.05; boiling point = −162°C; freezing/melting point = −183°C; autoignition temperature = 537°C. Explosive limits: LEL = 5.0%; UEL: 15.0%. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 4, reactivity 0. Insoluble in water. Natural gas consists primarily of methane (85%) with lesser amounts of ethane (9%), propane (3%), nitrogen (2%), and butane (1%).

Potential Exposure: Methane is used as a fuel and in the manufacture of organic chemicals, acetylene, hydrogen cyanide, and hydrogen. It may also be a cold liquid. Natural gas is used principally as a heating fuel. It is transported as a liquid under pressure. It is also used in the manufacture of various chemicals including acetaldehyde, acetylene, ammonia, carbon black; ethyl alcohol; formaldehyde, hydrocarbon fuels; hydrogenated oils; methyl alcohol; nitric acid; synthesis gas; and vinyl chloride. Helium can be extracted from certain types of natural gas.

Incompatibilities: May form explosive mixture with air. A strong reducing agent. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Reacts violently with bromine pentafluoride, chlorine dioxide, nitrogen trifluoride, oxygen difluoride and liquid oxygen. In general, avoid contact with all oxidizers.

Permissible Exposure Limits in Air Any loss of containment of Methane in a confined area can lower the oxygen content and cause suffocation. Oxygen content should be tested to ensure that it is at least 19% by volume.

OSHA PEL: Simple asphyxiant-inert gas and vapor

ACGIH TLV[1]: ACGIH TLV[1]: 1000 ppm TWA *as aliphatic hydrocarbon gas* (C_1-C_4)

PAC Ver. 29[138]

PAC-1: 65,000 ppm

PAC-2: 2.30E + 05 ppm

PAC-3: 4.00E + 05 ppm

Australia: asphyxiant, 1993; Belgium: asphyxiant, 1993; Hungary: asphyxiant, 1993; Switzerland: MAK-W 10,000 ppm (6700 milligram per cubic meter), 1999; United Kingdom: asphyxiant, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Simple asphyxiant

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short-Term Exposure: High levels can cause suffocation. Symptoms are due to a decrease in the concentration of oxygen available for breathing and include dizziness, difficult breathing; bluish color of the skin and loss of consciousness. Any contact with liquid can cause freezing burns.

Long-Term Exposure: No effects reported.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Polyethylene is among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Where exposure to cold equipment, vapors, or liquid may occur, employees should be equipped with special clothing designed to prevent freezing of body tissues.

Respirator Selection: Exposure to methane is dangerous because it can replace oxygen and lead to suffocation. Only

NIOSH/MSHA or European Standard EN 149-approved SCBA with a full facepiece operated in positive-pressure mode should be used in oxygen deficient environments. Chemical cartridge respirators should not be used where methane exposure occurs. For high exposures use air supplied respirators.

Storage: Check oxygen content prior to entering storage area. Flammable gas. Color code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Methane must be stored to avoid contact with oxidizers (such as oxygen, chlorine, bromine, perchlorates, peroxides, nitrates, and permanganates), since violent reactions occur. Sources of ignition, such as smoking and open flames are prohibited where methane is handled, used, or stored. Use only nonsparking tools and equipment, especially when opening and closing containers of methane. Wherever methane is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: UN1971 Methane, compressed or Natural gas, compressed (with high methane content), Hazard Class: 2.1; Labels: 2.1-Flammable gas. UN1972 Methane, refrigerated liquid (cryogenic liquid) or Natural gas, refrigerated liquid (cryogenic liquid), with high methane content), Hazard Class: 2.1; Labels: 2.1-Flammable gas. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Stop the flow of gas if it can be done safely. If source of leak is a cylinder and the leak cannot be stopped in place, remove leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. Keep this chemical out of confined space, such as a sewer because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable gas. The flame may be invisible. Thermal decomposition products may include oxides of carbon. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Incomplete combustion of natural gas may produce carbon monoxide. Use water spray to disperse vapors. *Small fires*: use dry chemical or carbon dioxide extinguishers. *Large fires*: use water spray, fog, or foam. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Incineration (flaring).

References

(31); (173); (101); (138); (100).

New York State Department of Health, *Chemical Fact Sheet*: Methane, Albany, Bureau of Toxic Substance Assessment (March 1986).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Methane, Trenton, NJ (June 2003).

Methane Sulfonyl Chloride M:0533

Formula: CH_3ClO_2S

Synonyms: Chloromethyl sulfone; Chlorure de sulfonylméthane (French); Cloruro de metansulfonilo (Spanish); Mesyl chloride; Methanesulfonic acid chloride; Methyl sulfochloride; Methylsulfonyl chloride

CAS Registry Number: 124-63-0

HSDB Number: 5605
RTECS Number: PB2790000
UN/NA & ERG Number: (PIH) UN3246/156
EC Number: 204-706-1
Regulatory Authority and Advisory Information

United States National Primary Drinking Water Regulations: SMCL = 250 mg[Cl^-]/L as chloride

Hazard Alert: Poison inhalation hazard, Corrosive, Suspected of causing genetic defects, Water Reactive (danger) United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Hazard symbols, risk, & safety statements: Hazard symbol: T+, C; risk phrases: R24/25; R26/27/28; R34; R36/37; R51; safety phrases: S24/25; S27; S41; S45; S53; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Pale yellow corrosive liquid. Unpleasant, pungent odor. Molecular weight = 114.55; specific gravity (H_2O:1) = 1.477 @ 18°C; boiling point = 161°C; freezing/melting point = −33°C; vapor pressure = 3.09 mmHg @ 25°C[72]; flash point = > 100°C. Henry's law constant = 4.38×10^{-5} atm m^3/mol @ 25°C (est)[72]. Practically insoluble in water; solubility = 8.6×10^3 mg/mL @ 25°C (est.)[72]; ₩ Slow, dangerous decomposition, forming hydrogen chloride

Potential Exposure: Chemical intermediate in various industries including pesticides, flame retardants, pharmaceuticals, plastics. A solvent, curing agent, and chemical stabilizer. Laboratory chemical.

Incompatibilities: Vapors may form explosive mixture with air. Slowly reacts with water, releasing toxic and corrosive hydrogen chloride gas. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, DMSO, ethers, strong acids, strong bases.

Permissible Exposure Limits in Air:

PAC* Ver. 29[138]
PAC-1: 0.19 ppm
PAC-2: **2.1$_{\mathbf{A}}$** ppm
PAC-3: **6.2$_{\mathbf{A}}$** ppm
*AEGLs are marked with a subscript "**A**" and correspond to 60-minute values.

Determination in Water: Octanol−water coefficient: Log K_{ow} = < 1.5. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion, skin/eye absorption.

Harmful Effects and Symptoms

Short-Term Exposure: Can be fatal if inhaled. Very toxic by ingestion, inhalation, or skin absorption. Corrosive to the skin, eyes, and respiratory tract. Exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. May affect the blood and central nervous system. Acute effects reported[138]: Central nervous system; Respiratory toxin-acute effects other than severe or moderate irritation; Eye-acute effects other than irritation, Gastrointestinal tract, Kidney. LD_{50}(oral-rat) = < 100 mg/kg.

Long-Term Exposure: Gastrointestinal tract-chronic effects; Narcotic, may be addictive.

Points of Attack: CNS, kidney, blood

Medical Surveillance: Medical observation is recommended for 24 to 48 hours following breathing overexposure, as pulmonary edema may be delayed. Before employment and at regular times after that, the following are recommended: If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider CBC and chest X-ray following acute overexposure. Evaluation by a qualified allergist, including exposure history and testing, may help diagnose allergy.

First Aid: Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear positive-pressure, SCBA. Wear chemical protective clothing which is specifically recommended by the manufacturer. Structural firefighter's protective clothing provides only limited protection.

Respirator Selection: *At any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full-facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA)

Storage: Poison inhalation chemical (PIH); check oxygen content prior to entering storage area. (1) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. (2) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with cacodylic acid you should be trained on its proper handling and storage.

Shipping: UN3246 Methanesulfonyl chloride, Hazard Class 6.1; Labels: 6.1-Poison Inhalation Hazard, 8-Corrosive material, Inhalation Hazard Zone B.

Spill Handling:

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank,

portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).
Small spills (From a small package or a small leak from a large package)
First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.1/0.2
Large spills (From a large package or from many small packages)
First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.2/0.3
Stay upwind and uphill. Isolate the area of release or fire and deny entry. Remove all ignition sources. Stop the release if it can be done safely from a distance. All equipment used to handle this material must be grounded. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. *Small spill*: Cover with *dry* earth, *dry* sand, or other noncombustible material followed with plastic sheet to minimize spreading or contact with water or rain. Use clean nonsparking tools to collect material and place material into loosely covered plastic containers for later disposal. Prevent material and runoff from entering sewers and waterways if it can be done safely well ahead of the release. Use vapor suppressing foam to disperse vapors—contain runoff. Water spray may reduce vapor, but may not prevent ignition in enclosed spaces. Ventilate confined area if it can be done without placing personnel at risk. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of sulfur, carbon and toxic and corrosive hydrogen chloride gas. Combustible. *Small fire*: Use *dry* chemical, CO_2, *dry* sand, or alcohol-resistant foam. May react with foams releasing corrosive/toxic gases. *Large fire*: use water spray or alcohol-resistant foam if it is available in sufficient amounts. Under favorable conditions, experienced crews can use coordinated fog streams to sweep the flames off the surface of the burning liquid. Combustible material: may burn but does not ignite readily. Most vapors are heavier than air. They will spread along ground and collect in low or confined areas (sewers, basements, tanks). Vapors may travel to source of ignition and flash back. Containers may explode when heated or if contaminated with water. Keep exposures cool long after fire is out to protect against reignition. Do not direct straight streams into the liquid. Cool exposed containers with large quantities of water from unattended equipment or remove intact containers if it can be done safely. *Do not get water on spilled substance or inside containers*. If cooling streams are ineffective (*venting sound increases in volume and pitch, tank discolors or shows signs of deforming*), withdraw immediately to a secure location. Always stay away from ends of tanks, especially when engulfed in flames. If material or contaminated runoff from fire control enters waterways, notify downstream users of potentially contaminated water. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156.

Disposal Method Suggested: Use a licensed professional waste disposal service to dispose of this material. Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References
(31); (173); (101); (138); (100).

Methidathion M:0540

Formula: $C_6H_{11}N_2O_4PS_3$
Synonyms: Ciba-geigy GS 13005; *S*-(2,3-Dihydro-5-methoxy-2-*oxo*-1,4,4-thiadiazol-3-methyl); (*O*,*O*-Dimethyl)-*S*-[2-methoxy-1,4,4-thiadiazole-5-(4*H*)-onyl-(4)-methyl]-dithiophosphat (German); *O*,*O*-Dimethyl *S*-[2-methoxy-1,3,4-thiadiazole-5(4*H*)-on-4-ylmethyl] phosphorodithioate; *O*,*O*-Dimethyl phosphorodithioate *S*-ester with 4-(mercaptomethyl)-2-methoxy-δ-1,3,4-thiadiazolin-5-one; DMTP (Japan); ENT 27,193; Fisons NC 2964; Geigy 13005; GS-13005; *S*-([5-Methoxy-2-*oxo*-1,3,4-thiadiazol-3 (2*H*)-yl]methyl) *O*,*O*-dimethyl phosphordithioate; Metidation (Spanish); Somonil; Supracide; Ultracide
CAS Registry Number: 950-37-8
HSDB Number: 1594
RTECS Number: TE2100000
UN/NA & ERG Number: (PIH) UN2783 (organophosphorus pesticides, solid, toxic)/152; UN2811 (toxic solid, organic, n.o.s.)/153
EC Number: 213-449-4 [*Annex I Index No*.: 015-069-00-2]
Regulatory Authority and Advisory Information
Hazard Alert: Poison inhalation hazard, Possible cumulative neurotoxin, Suspected of causing genetic defects, Agricultural Chemical Primary irritant (w/o allergic reaction), Environmental hazard.
Banned or Severely Restricted (Philippines) (UN)[13]

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 500 lb (227 kg)

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

United States DOT 49CFR172.101, Inhalation Hazard Chemical as organophosphates.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, N; risk phrases: R21; R28; R33; R36/37/38; R50/53; R62; safety phrases: S1/2; S22; S28; S36/37; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Methidathion is a colorless crystalline solid. Molecular weight = 302.34; specific gravity (H_2O:1) = 1.5 @ 20°C; freezing/melting point = 39−40°C; vapor pressure = 1×10^{-6} mmHg @ 24°C. Very slightly soluble in water.

Potential Exposure: A potential danger to those involved in the manufacture, formulation, and application of this nonsystemic insecticide.

Incompatibilities: None listed.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 1.8 milligram per cubic meter

PAC-2: 20 milligram per cubic meter

PAC-3: 160 milligram per cubic meter

Determination in Water: Fish Tox = 0.15019000 ppb (EXTRA HIGH)

Routes of Entry: Inhalation, ingestion; skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: This material is poisonous to humans. Its toxic effects are by action on the nervous system. Organic phosphorus insecticides are absorbed by the skin, as well as by the respiratory and gastrointestinal tracts. They are cholinesterase inhibitors. Symptoms of exposure include headache, giddiness; blurred vision; nervousness, weakness, nausea, cramps, diarrhea, and discomfort in the chest. Signs include sweating, tearing, salivation, vomiting, cyanosis, convulsions, coma, loss of reflexes and loss of sphincter control. Human volunteers ingesting 0.11 mg/kg/day for 6 weeks had no clinical effects. LD_{50}(oral-rat) = 20 mg/kg (highly toxic). Symptoms are similar to parathion poisoning and may include nausea, vomiting, abdominal cramps; diarrhea, excessive salivation; headache, dizziness, giddiness, weakness, muscle twitching; difficult breathing; sensation of tightness of chest; blurring or dimness of vision; and loss of muscle coordination. Death may occur from failure of the respiratory center; paralysis of the respiratory muscles; intense bronchoconstriction, or all three. Human Tox = 1.05000 ppb (HIGH).

Long-Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, central nervous system; cardiovascular system, skin, eyes, plasma, and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider CBC. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area

Shipping: UN2783 Organophosphorus pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling:

Initial isolation and protective action distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.3/0.4
Night 0.8/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 600/200
Then: Protect persons downwind (mi/km)
Day 1.4/2.3
Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Do not touch spilled material. Do not breathe vapors. Stay upwind; keep out of low areas. Remove all ignition sources. Ventilate area of spill or leak. This material is a combustible liquid. For a spill or leak of a combustible liquid, shut off ignition sources; no flares, smoking or flames in hazard area. Stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material may burn, but does not ignite readily. Thermal decomposition products may include oxides of phosphorus, sulfur, nitrogen, and carbon. *For small fires*, use dry chemical, carbon dioxide; water spray; or foam. *For large fires*, use water spray, fog, or foam. Stay upwind; keep out of low areas. Move container from fire area if you can do so without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Wear positive pressure breathing apparatus and special protective clothing. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Treat with strong alkali, mix with soil and bury in the case of small quantities[22]. For large quantities, use incineration with effluent gas scrubbing.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Methidathion, Washington, DC, Chemical Emergency Preparedness Program (Nov. 30, 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Methidathion, Trenton, NJ (July 1999).

Methiocarb M:0550

Formula: $C_{11}H_{15}NO_2S$; $C_6H_2(SCH_3)(CH_3)_2OCONHCH_3$

Synonyms: AI3-25726; B 37344; Bay 37344; Bay 5024; Bay 9026; Bayer 37344; Carbamic acid, methyl-, 3,5-dimethyl-4-(methylthio)phenyl ester; Carbamic acid, *N*-methyl-, 4-(methylthio)-3,5-xylyl ester; Carbamic acid, methyl-, 4-(methylthio)-3,5-xylyl ester; DCR 736; 3,5-Dimethyl-4-methylmercaptophenyl *N*-methylcarbamate; 3,5-Dimethyl-4-(methylthio)phenol methylcarbamate; 3,5-Dimethyl-4-(methylthio)phenyl methylcarbamate; 3,5-Dimethyl-4-methylthiophenyl *N*-methylcarbamate; Draza;

Draza G micropellets; ENT 25,726; H 321; Mercaptodimethur; Mesurol; Methiocarbe; Methyl carbamic acid 4-(methylthio)-3,5-xylyl ester; 4-Methylmercapto-3,5-dimethylphenyl *N*-methylcarbamate; 4-Methylmercapto-3,5-xylyl methylcarbamate; 4-Methylthio-3,5-dimethylphenyl methylcarbamate; 4-(Methylthio)-3,5-xylyl *N*-methylcarbamate; 4-(Methylthio)-3,5-xylyl methylcarbamate; Metiocarb (Spanish); Metmercapturon; OMS-93; PBI Slug Gard; Phenol, 3,5-dimethyl-4-(methylthio)-, methylcarbamate; SD 9228

CAS Registry Number: 2032-65-7

HSDB Number: 782

RTECS Number: FC5775000

UN/NA & ERG Number: UN2757 (carbamate pesticides, solid, toxic)/151; UN2811 (toxic solid, organic, n.o.s.)/153

EC Number: 217-991-2 [*Annex I Index No*.: 006-023-00-2]

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Possible neurotoxic effects (methyl carbamate), Combustible, Environmental hazard, Agricultural chemical.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P199

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.056; Nonwastewater (mg/kg), 1.4

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as mercaptodimethur.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R25; R50/53; safety phrases: S1/2; S22; S29/35; S37; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Methiocarb is a colorless crystalline powder. Molecular weight = 225.34; boiling point = 325°C; freezing/melting point = 121.5°C; vapor pressure = 2.7×10^{-7} mmHg @ 25°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 1, reactivity 0. Practically insoluble in water.

Potential Exposure: A potential danger to those involved in the manufacture, formulation, and application of this nonsystemic acaricide and insecticide.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 1.4 milligram per cubic meter

PAC-2: 15 milligram per cubic meter

PAC-3: 90 milligram per cubic meter

Determination in Air: Organonitrogen pesticides. OSHA versatile sampler-2; Reagent; High-pressure liquid chromatography/Ultraviolet detection; NIOSH Analytical Method (IV) #5601.

Determination in Water: Fish Tox = 0.04597000 ppb (EXTRA HIGH)

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Contact irritates the skin and eyes. Inhalation will irritate the respiratory tract. As a carbamate insecticide, this compound is a reversible cholinesterase inhibitor and acts on the nervous system. It is classified as very toxic, and the probable oral lethal dose for humans is 50−500 mg/kg or between 1 teaspoon and 1 oz for a 150-lb adult. Symptoms include salivation, slowed heartbeat; spontaneous urination and defecation; labored breathing; headache; blurred vision; tremor, slight paralysis; and muscle twitching. Exposure to carbamate poisoning can also result in nausea, vomiting, diarrhea, abdominal pain; convulsions, coma and death. LD_{50} = 60 mg/kg[77]

Long-Term Exposure: The substance may have effects on the nervous system; liver.

Points of Attack: Central nervous system; liver, plasma and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of “normal.” Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider CBC. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area

Shipping: UN2757 Carbamate pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during clean-up. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical does not burn. Thermal decomposition products may include oxides of nitrogen, sulfur, and carbon. Extinguish with dry chemical, carbon dioxide; water spray, fog, or foam. Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Wear positive pressure breathing apparatus and special protective clothing. Remove and isolate contaminated clothing at the site. Move container from fire area if you can do it without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR 165 recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform to EPA regulations governing storage, transportation, treatment, and waste disposal. Remove material with contaminated soil and place in impervious containers. May be incinerated in a pesticide incinerator at the specified temperature/dwell-time combination. Any liquids, sludges, or solid residues generated should be disposed of in accordance with all applicable federal, state, and local pollution control requirements. If appropriate incineration facilities are not available, material may be buried in a chemical waste landfill. May be amenable to biological treatment at a municipal sewage treatment plant. (Sax/DPIMR).

References

(31); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Methiocarb, Washington, DC, Chemical Emergency Preparedness Program (Nov. 30, 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Mercaptodimethur, Trenton, NJ (November 1999).

NIOSH Manual of Analytical Methods, 4th Edition, Issue 1, *Organonitrogen pesticides*, page 7 of 21, Cincinnati, OH, 1/15/1998.

Methomyl M:0560

Formula: $C_5H_{10}N_2O_2S$

Synonyms: Acetimidic acid, thio-*N*-(methylcarbamoyl) oxy-, methyl ester; Acetimidothioic acid, methyl-*N*-(methylcarbamoyl) ester; Dupont insecticide 1179; ENT

27,341; Ethanimidothic acid, *N*-[(methylamino)carbonyl]; Fram fly kill; Improved Blue Malrin sugar bait; Improved golden Malrin bait; Insecticide 1179; Lannate; Lanox 216; Lanox 90; Mesomile; Methomex; Methyl *N*-([methylamino (carbonyl)oxy]ethanimido)thioate; *S*-Methyl *N*-(methylcarbamoyloxy)thioacetimidate; Methyl *N*-[methyl (carbamoyl)oxy]thioacetimidate; 2-Methylthio-propionaldehyd-*o*-(methylcarbamoyl)oxim (German); Metomilo (Spanish); Nu-bait II; Nudrin; Rentokil fram fly bait; Rentokill; Ridect; SD 14999; Sorex golden fly bait; 3-Thiabutan-2-one, *O*-(methylcarbamoyl) oxime; WL 18236

CAS Registry Number: 16752-77-5

HSDB Number: 1736

RTECS Number: AK2975000

UN/NA & ERG Number: UN2757 (carbamate pesticides, solid, toxic)/151; UN2811 (toxic solid, organic, n.o.s.)/153

EC Number: 240-815-0 [*Annex I Index No*.: 006-045-00-2]

Regulatory Authority and Advisory Information

United States Environmental Protection Agency Gene-Tox Program, Negative: *D. melanogaster* sex-linked lethal; Negative: In vitro UDS-human fibroblast; TRP reversion; Negative: *S. cerevisiae-homozygosis*; Inconclusive: *B. subtilis* rec assay; *E. coli polA* without S9; Inconclusive: Histidine reversion-Ames test.

Hazard Alert: Poison, Possible neurotoxic effects (methyl carbamate), Combustible, Suspected reprotoxic hazard, Agricultural chemical, Environmental hazard.

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P066

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.028; Nonwastewater (mg/kg), 0.14

Safe Drinking Water Act (47FR 9352): Priority List (55 FR 1470)

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

Hazard symbols, risk, & safety statements: Hazard symbol: T+, N; risk phrases: R28; R33; R50/53; safety phrases: S1/2; S28; S36/37; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found [3-Severe hazard to waters (est.)].

Description: Methomyl is a white crystalline solid with a slight sulfurous odor. A noncombustible solid, that may be dissolved in flammable liquids that may alter physical properties listed here. Molecular weight = 162.24; specific gravity (H_2O:1) = 1.295; boiling point = 335°C; freezing/melting point = 78−79°C; vapor pressure = 5×10^{-5} mmHg @ 25°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 1, reactivity 0. Moderately soluble in water; solubility 58 g/L @ 25°C.

Potential Exposure: Methomyl is a broad-spectrum insecticide used as insecticide in many vegetables, field crops; certain fruit crops; and ornamentals.

Incompatibilities: Keep away from strong bases, strong oxidizers. Heat causes decomposition forming toxic and irritating fumes including nitrogen oxides; sulfur oxides; hydrogen cyanide; methylisocyanate.

Permissible Exposure Limits in Air

OSHA PEL: None

NIOSH REL: 2.5 milligram per cubic meter TWA

ACGIH TLV[1]: 2.5 milligram per cubic meter TWA not classifiable as a human carcinogen; TLV-BEI$_A$ issued for Acetylcholinesterase inhibiting pesticides.

PAC Ver. 29[138]

PAC-1: 0.91 milligram per cubic meter

PAC-2: 10 milligram per cubic meter

PAC-3: 23 milligram per cubic meter

Australia: TWA 2.5 milligram per cubic meter, 1993; Belgium: TWA 2.5 milligram per cubic meter, 1993; Denmark: TWA 2.5 milligram per cubic meter [skin], 1999; France: VME 2.5 milligram per cubic meter [skin], 1999; Norway: TWA 2.5 milligram per cubic meter, 1999; Switzerland: MAK-W 2.5 milligram per cubic meter [skin], 1999; United Kingdom: TWA 2.5 milligram per cubic meter, 2000; the Netherlands: MAC-TGG 2.5 milligram per cubic meter [skin], 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Several states have set guidelines or standards for methomyl in ambient air[60] ranging from 25 μ/m^3 (North Dakota) to 40 μ/m^3 (Virginia) to 50 μ/m^3 (Connecticut) to 59.5 μ/m^3 (Nevada).

Determination in Air: OSHA versatile sampler-2; Reagent; High-pressure liquid chromatography/Ultraviolet detection; NIOSH Analytical Method (IV) #5601. Organonitrogen pesticides. OSHA versatile sampler-2; Reagent; High-pressure liquid chromatography/Ultraviolet detection; NIOSH Analytical Method (IV) #5601.

Permissible Concentration in Water: The United States Environmental Protection Agency has calculated a NOAEL of 2.5 mg/kg/day from which a lifetime health advisory of 175 μg/L has been calculated. The state of Maine has set a guideline for methomyl in drinking water[61] of 50 μg/L.

Determination in Water: By high-performance liquid chromatography as described in EPA Health Advisory cited below. Fish Tox = 80.25646000 ppb (INTERMEDIATE). Octanol−water coefficient: Octanol−water coefficient: Log K_{ow} = 0.63. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Cholinesterase inhibitor. Irritates the eyes. May affect the nervous system; resulting in respiratory failure; convulsions. Exposure may result in death. Methomyl has high oral toxicity, moderate inhalation toxicity, and low skin toxicity. The probable oral lethal dose for humans is between seven drops and one teaspoon for a 150-lb adult. Death is due to respiratory arrest. Acute exposure to methomyl usually leads to a cholinergic crisis. Signs and symptoms may include increased salivation; lacrimation (tearing), spontaneous defecation; and spontaneous urination. Pinpoint pupils; blurred vision; tremor, muscle twitching; and loss of muscle coordination may occur. Mental confusion; convulsions, and coma may also be noted. Gastrointestinal effects include nausea, vomiting, diarrhea, and abdominal pain. Bradycardia (slow heart rate) occurs frequently. Dyspnea (shortness of breath), pulmonary edema; and respiratory arrest may also occur. LD_{50} = 17 mg/kg[77].

Long-Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. Methomyl may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage. May cause anemia.

Points of Attack: Eyes, respiratory system; central nervous system; cardiovascular system, liver, kidneys, blood cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of “normal.” Reassignment to work not involving carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider CBC. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin contact: **8 hours**: Tychem 1000 suits. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid, unless full facepiece respiratory protection is worn. Wear dust-proof goggles and face shield when working with powders or dust, unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures over 2.5 milligram per cubic meter, use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece respirator with a pesticide cartridge. Greater protection is provided by a PAPR. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong bases; strong oxidizers (such as chlorine, bromine, and fluorine). Do not store in area where temperature is less than 32°F/0°C.

Shipping: UN2757 Carbamate pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/ 75 ft (NJ). Isolation Distance, Fire: 800 m/0.5 mi.[70] Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Keep unnecessary people away; isolate hazard areas and deny entry. Stay upwind and keep out of low areas. Do not touch spilled material, or handle broken packages without protective equipment. Do not breathe dust, vapors, or the fumes from burning material. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. Use HEPA vacuum or wet method to reduce dust during clean-up. Do not dry sweep. Collect powdered material in the most convenient manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Methomyl does not burn. Use any agent suitable for surrounding fire. Thermal decomposition products may include nitrogen oxides; sulfur oxides; hydrogen cyanide; methylisocyanate. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform to EPA regulations governing storage, transportation, treatment, and waste disposal. Alkaline hydrolysis leads to complete degradation to nontoxic products[22]. May be dissolved in water and sprayed into a furnace with effluent gas scrubbing also. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (80); (100).

United States Environmental Protection Agency, Methomyl, Health and Environmental Effects Profile No. 125, Washington, DC, Office of Solid Waste (April 30, 1980).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 2, No. 5, 79−81 (1982).

United States Environmental Protection Agency, "Alert: Methomyl," Washington, DC, Office of Drinking Water (August 1987).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Methomyl, DC, Chemical Emergency Preparedness Program (Nov. 30, 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Methomyl, Trenton, NJ (September 1999).

NIOSH Manual of Analytical Methods, 4th Edition, Issue 1, *Organonitrogen pesticides*, page 7 of 21, Cincinnati, OH, 1/15/1998.

Methoprene M:0565

Formula: $C_{19}H_{34}O_3$

Synonyms: Altosid; Apex; Diacon; Dianex; 2,4-Dodecadienoic acid, 11-methoxy-3,7,11-trimethyl-, ispropyl ester, (E,E)-; 2,4-Dodecadienoic acid, 11-methoxy-3,7,11-trimethyl-, 1-methylethyl ester, (E,E)-; Ent 70,460; Extinguish; Fleatrol; Isopropyl (2E,4E)-11-methoxy-3,7,11-trimethyl-2,4-dodecadienoate; Isopropyl (E,E)-11-methoxy-3,7,11-trimethyl-2,4-dodecadienoate; Kabat; Manta; (E,E)-11-Methoxy-3,7,11-trimethyl-2,4-dodecandienoate; 1-Methylethyl (E,E)-11-methoxy-3,7,11-trimethyl-2,4-dodecadienoate; Moorman's IGR cattle concentrate; Ovitrol; Pharorid; Precor; ZR-515

CAS Number: 40596-69-8

HSDB Number: 6926

RTECS Number: JR1685000

UN/NA & ERG Number:

UN3082 (environmentally hazardous substances, liquid, n.o.s.)/171

EC Number: 254-993-2

Regulatory Authority and Advisory Information

Carcinogenicity[83]: IARC, Group 3 not classifiable as to its carcinogenicity in humans.

Description: Amber colored liquid. Faint fruity odor. Molecular weight = 310.47; specific gravity (H_2O:1) = 0.93; boiling point = 135 @ 0.06 mmHg; flash point ≥ 90°C. Slightly soluble in water; solubility = 1.40 ppm.

Potential Exposure: Methoprene is a natural insect growth regulator (IGR) that mimics juvenile hormone(s) and is used against a variety of insects including horn flies, mosquitoes, beetles, tobacco moths, sciarid flies, fleas (eggs and larvae), fire ants, pharoah ants, midge flies and Indian meal moths. Controlling some of these insects, methoprene is used in the production of a number of foods including meat, milk, mushrooms, peanuts, rice and cereals. It also has several uses on domestic animals (pets) for controlling fleas and to control insects in wastewater, sludge beds and ponds. For oral use in dogs, 9 weeks of age and older and 4 lb body weight or greater, for the prevention and control of flea populations [21 CFR 520.1390].

Incompatibilities: This material may react as an ester. Esters react with acids to liberate heat along with alcohols and acids. Strong oxidizing acids may cause a vigorous reaction that is sufficiently exothermic to ignite the reaction products. Heat is also generated by the interaction of esters with caustic solutions. Flammable hydrogen is generated by mixing esters with alkali metals and hydrides.

Determination in Water: Octanol−water coefficient: Log $K_{ow} \geq 5.0$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Dermal contact, eye contact, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Moderately toxic by skin absorption and if ingested. Contact with eyes or skin may cause irritation or injury. Inhalation should be avoided LD_{50} (oral, rat) = > 25 g/kg; (dermal, rat) = > 2 g/kg. Very low toxicity.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Do not induce vomiting when formulations containing petroleum solvents are ingested

Respirator Selection: Wherever and whenever workplace conditions warrant respirator use, a respiratory protection program must be followed that meets one or more of the following government standards: OSHA's 29 CFR 1910.134, ANSI Z88.2, or European Standard EN 149. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Storage: Color code—Blue: Health Hazard/Poison: Store in a tightly closed container in a dry, well-ventilated and secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Where possible, automatically transfer material from other storage containers to process containers.

Shipping: UN3082 Environmentally hazardous substances, liquid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required

Spill Handling: First remove all sources of ignition. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Combustible. Thermal decomposition products include acrid smoke, and oxides of nitrogen, sodium, sulfur and carbon. Combustible. As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 m/150 ft for liquids and at least 25 m/75 ft for solids. *Fire involving storage or vehicular tanks*: Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. *On a small fire*: use dry chemical, CO_2, water spray or regular *foam. On a large fire*: use water spray, fog, or regular foam. Do not scatter spilled material with high pressure streams of water. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal. *Fire involving tanks*: From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. Always stay away from tanks engulfed in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Disposal Method Suggested: It is the responsibility of chemical waste generators to determine if a discarded chemical is classified as a hazardous waste. See 40 CFR Parts 261.3 for United States Environmental Protection Agency guidelines for the classification determination. In addition, in order to ensure complete and accurate classification, waste generators must consult state and local hazardous waste regulations. Incineration might be an effective disposal procedure where permitted. If an efficient incinerator is not available, the product should be mixed with large amounts of combustible material and contact with the smoke should be avoided. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers.

References

(31); (173); (101); (138).

United States Environmental Protection Agency, Office of Pesticide Programs, "Insect Growth Regulators Fact Sheet:" (December 6, 2001). http://www.epa.gov/oppbppd1/biopesticides/ingredients/factsheets/factsheet_igr.htm.

United States Environmental Protection Agency, "Reregistration Eligibility Decision (RED) Fact Sheet: Methoprene," Office of Prevention, Pesticides and Toxic Substances, Washington, DC (June 2001). http://www.epa.gov/oppbppd1/biopesticides/ingredients/factsheets/factsheet_105401.pdf.

United States Environmental Protection Agency, Office of Pesticide Programs, Pesticide Residue Limits, "Methoprene," 40 CFR 180.1033, http://www.epa.gov/pesticides/food/viewtols.htm.

EXTOXNET, Extension Toxicology Network, "Pesticide Information Profile, Methoprene," Oregon State University, Corvallis, OR (June 1996). http://extoxnet.orst.edu/pips/methopre.htm.

Methotrexate M:0570

Formula: $C_{20}H_{22}N_8O_5$

Synonyms: Amethopterin; 4-Amino-4-deoxy-N^{10}-methylpteroyl glutamate; 4-Amino-4-deoxy-N^{10}-methylpteroylglutamic;

4-Amino-10-methylfolic acid; 4-Amino-N^{10}-methylpteroylglutamic acid; Antifolan; *N*-Bismethylpteroylglutamic acid; CL-14377; L-(+)-*N*-[*p*-([(2,4-Diamino-6-pteridinyl)methyl] methylamino)-benzoylglutamic acid; EMT 25,299; Emtexate; HDMTX; Methopterin; Methotextrate; Methylaminopterin; MTX; NCI-C04671; NSC-740; R 9985

CAS Registry Number: 59-05-2

HSDB Number: 3123

RTECS Number: MA1225000

UN/NA & ERG Number: UN1544 (Alkaloids, solid, n.o.s.)/151; UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 200-413-8

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human Inadequate Evidence, animal Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1987; NCI: Carcinogenesis Studies (ipr); no evidence: mouse, rat

California Proposition 65 Developmental/Reproductive toxin 1/1/1989.

Hazard Alert: Poison, Reproductive toxin, Drug, Agricultural chemical.

Hazard symbols, risk, & safety statements: Hazard symbol: T; risk phrases: R25; R36/37; R61; R62; safety phrases: S26; S36/37/39; S45; S63; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found [3-Severe hazard to water. (est.)].

Description: Methotrexate is an orange-brown crystalline powder. Molecular weight = 454.50; freezing/melting point = (decomposes) 185−204°C. Insoluble in water.

Potential Exposure: Methotrexate is an alkaloid anticancer drug available in tablet or injectable liquid form. A chemotherapy drug that interferes with DNA and RNA synthesis. It is also an insect chemosterilant.

Incompatibilities: Combustible. Compounds of the carboxyl group react with all bases, both inorganic and organic (i.e., amines) releasing substantial heat, water and a salt that may be harmful. Incompatible with arsenic compounds (releases hydrogen cyanide gas), diazo compounds, dithiocarbamates, isocyanates, mercaptans, nitrides, and sulfides (releasing heat, toxic, and possibly flammable gases), thiosulfates and dithionites (releasing hydrogen sulfate and oxides of sulfur). Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, light, UV, moisture.

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Routes of Entry: Inhalation, skin and/or eyes.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes.

Long-Term Exposure: Methotrexate causes mutations (genetic changes). Such chemicals may have a cancer or reproductive risk. Methotrexate is a probable teratogen in humans. There is limited evidence that methotrexate may affect sperm production in males. When taken as a medical drug, methotrexate can cause nausea, vomiting, loss of appetite; weight loss; bloody diarrhea; sores inside the mouth; hair loss and skin rash. It can also damage the liver and kidneys. Methotrexate can damage bone marrow causing low blood cell count. It is not known if the effects can occur from work-place exposures.

Points of Attack: Blood, liver, kidneys.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: CBC. Liver and kidney function tests.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof goggles when working with powders or dust, unless full facepiece respiratory protection is worn. Wear splash-proof chemical goggles when working with liquid, unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures to methotrexate exists, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. A regulated, marked area should be established where methotrexate is handled, used, or stored. Store in tightly closed containers in a cool, well-ventilated area away from light and oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates). A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN1544 Alkaloids, solid, n.o.s. or Alkaloid salts, solid, n.o.s. poisonous, Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft (NJ). Isolation Distance, Fire: 800 m/0.5 mi.[70] Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen and carbon. Extinguish fire using an agent suitable for type of surrounding fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire-fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: It is inappropriate and possibly dangerous to the environment to dispose of expired or waste drugs and pharmaceuticals by flushing them down the toilet or discarding them to the trash. Household quantities of expired or waste pharmaceuticals may be mixed with wet cat litter or coffee grounds, double-bagged in plastic, discard in trash. Larger quantities shall carefully take into consideration applicable DEA, EPA, and FDA regulations. If possible return the pharmaceutical to the manufacturer for proper disposal being careful to properly label and securely package the material. Alternatively, the waste pharmaceutical shall be labeled, securely packaged, and transported by a state licensed medical waste contractor to dispose by burial in a licensed hazardous or toxic waste landfill or incinerator.

References

(31); (173); (101); (138); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 1, No. 4, 82−83 (1981)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Methotrexate, Trenton, NJ (April 1986).

Methoxyethyl Acetate M:0590

Formula: $C_5H_{10}O_3$; $CH_3COOCH_2CH_2OCH_3$

Synonyms: EGMEA; Ethylene glycol monomethyl ether acetate; Glycol monomethyl ether acetate; 2-Methoxyacetate ethanol; 2-Methoxyethyl acetate; 2-Methoxyethyl acrylate; Methyl Cellosolve acetate; Methyl glycol acetate

CAS Registry Number: 110-49-6

HSDB Number: 156

RTECS Number: KL5950000

UN/NA & ERG Number: UN1189/129

EC Number: 203-772-9 [*Annex I Index No*.: 607-036-00-1]

Regulatory Authority and Advisory Information

California Proposition 65 Chemical[102]: Developmental/Reproductive toxin 1/1/1993

Hazard Alert: Highly Flammable, Suspected reprotoxic hazard, Suspected of causing genetic defects, Hormone, Primary irritant (w/o allergic reaction).

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%. as 2-Methoxyethyl acetate

Hazard symbols, risk, & safety statements: Hazard symbol: F, T; risk phrases: R11; R20/21/22; R36/37/38; R62; R63; safety phrases: S53; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Methoxyethyl acetate is a colorless liquid. Mild, ethereal odor. Molecular weight = 118.15; specific gravity (H_2O:1) = 1.005 @ 20°C; boiling point = 143°C; freezing/melting point = −70°C; vapor pressure = 2 mmHg @ 20°C; flash point = 48.9°C (cc); autoignition temperature = 380°C. Explosive limits: LEL = 1.7%; UEL: 8.2%. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 2, reactivity 0. Soluble in water.

Potential Exposure: Methoxyethyl acetate is used as a solvent for resins, oils, greases and inks. It is also an ingredient of lacquers, paints and adhesives.

Incompatibilities: May form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, nitrates. May be able to form explosive peroxides.

Permissible Exposure Limits in Air

NIOSH IDLH = 200 ppm
Conversion factor: 1 ppm = 4.83 milligram per cubic meter @ 25°C & 1 atm
Odor threshold = 0.33 ppm.
OSHA PEL: 25 ppm/120 milligram per cubic meter TWA [skin]
NIOSH REL: 0.1 ppm/0.5 milligram per cubic meter TWA [skin]
ACGIH TLV[1]: 0.1 ppm/0.5 milligram per cubic meter TWA [skin]; BEI issued.
PAC Ver. 29[138]
PAC-1: 0.3 ppm
PAC-2: 670 ppm
PAC-3: 4000 ppm
DFG MAK: 1 ppm/4.9 milligram per cubic meter (sum of the concentrations of EGMEA and its acetate in air); Peak Limitation Category II(8) [skin]; Pregnancy Risk Group B
Australia: TWA 5 ppm (24 milligram per cubic meter) [skin], 1993; Austria: MAK 5 ppm (25 milligram per cubic meter) [skin], 1999; Belgium: TWA 5 ppm (24 milligram per cubic meter) [skin], 1993; Denmark: TWA 5 ppm (24 milligram per cubic meter) [skin], 1999; Finland: TWA 25 ppm (120 milligram per cubic meter); STEL 40 ppm (180 milligram per cubic meter) [skin], 1999; France: VME 5 ppm (24 milligram per cubic meter) [skin], 1999; Hungary: TWA 25 milligram per cubic meter; STEL 50 milligram per cubic meter [skin], 1993; the Netherlands: MAC-TGG 1.5 milligram per cubic meter [skin], 2003; Norway: TWA 5 ppm (22 milligram per cubic meter), 1999; the Philippines: TWA 25 ppm (120 milligram per cubic meter) [skin], 1993; Poland: MAC (TWA) 25 milligram per cubic meter, MAC (STEL) 100 milligram per cubic meter, 1999; Russia: TWA 5 ppm, 1993; Sweden: NGV 5 ppm (25 milligram per cubic meter), KTV 10 ppm (50 milligram per cubic meter) [skin], 1999; Switzerland: MAK-W 5 ppm (25 milligram per cubic meter), KZG-W 10 ppm (50 milligram per cubic meter) [skin], 1999; Turkey: TWA 25 ppm (120 milligram per cubic meter) [skin], 1993; United Kingdom: TWA 5 ppm (25 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 5 ppm [skin]. Several states have set guidelines or standards for methoxyethyl acetate in ambient air[60] ranging from 0.24 milligram per cubic meter (North Dakota) to 0.4 milligram per cubic meter (Virginia) to 0.48 milligram per cubic meter (Connecticut) to 0.571 milligram per cubic meter (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #1451, Methyl cellosolve acetate; OSHA Analytical methods 53, 79.

Determination in Water: Octanol—water coefficient: Log $K_{ow} = 0.1$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: 2-Methoxyethyl acetate can affect you when breathed in and by passing through your skin. Exposure to the vapor can irritate the eyes. High levels of exposure can cause headache, vomiting, dizziness, fatigue, confusion, lightheadedness, and unconsciousness. Higher exposure can cause irritation of the nose, throat, and lungs, causing coughing and/or shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. May affect the blood and central nervous system.

Long-Term Exposure: Repeated high exposures can damage the brain and nervous system. May affect the blood, liver and kidneys. May cause low blood count (anemia). In animals: narcosis; reproductive, teratogenic effects.

Points of Attack: Eyes, respiratory system; kidneys, brain, central nervous system; peripheral nervous system; reproductive system, hematopoietic system.

Medical Surveillance: Pregnant women should avoid contact. Employees should be notified by a physician that this chemical may affect the reproductive system. In addition to comprehensive initial medical and work histories emphasizing reproductive experience and menstrual history, patient should have physical examination and testing of genitourinary tract, sperm count, motility, and morphology. If required, other tests, such as serum testosterone, serum FSH, and serum LH may be indicated. For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: lung function tests; liver function tests; kidney function tests. If symptoms develop or overexposure is suspected, the following may be useful: CBC. Exam of the nervous system. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin contact: **8 hours**: butyl rubber gloves, suits, boots; Tychem 1000 suits. **4 hours**: Saranex coated suits; 4H and Silver Shield gloves. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *1 ppm*: Sa (APF = 10) (any supplied-air respirator). *2.5 ppm* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *5 ppm*: SCBAF (APF = 50) (any SCBA with a full facepiece); SaF (APF = 50) (any supplied-air respirator with a full facepiece). *100 ppm*: Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *200 ppm*: Sa:Pd,Pp (APF = 1000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd, Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-, mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA). *Note*: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. 2-Methoxyethyl acetate must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates) and strong caustics, since violent reactions occur. Sources of ignition, such as smoking and open flames are prohibited where 2-methoxyethyl acetate is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever 2-methoxyethyl acetate is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1189 Ethylene glycol monomethyl ether acetate, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; alcohol, or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed. Beware of possible presence of peroxides[22] in which case open burning may be used.

References

(102); (31); (173); (101); (138); (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: 2-Methoxyethyl Acetate, Trenton, NJ (November 1999).

Methoxyfenozide M:0603

Formula: $C_{22}H_{28}N_2O_3$

Synonyms: Benzoic acid, 3-methoxy-2-methyl-2-(3,5-dimethylbenzoyl)-2-(1,1-dimethylethyl)hydrazide; Intrepid; Prodigy

CAS Number: 161050-58-4

HSDB Number: 7936

RTECS Number: Not found

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: Not assigned

Regulatory Authority and Advisory Information

Carcinogenicity: EPA Not likely a human carcinogen

Acute Hazard Warning Label: 3 Cautions

Hazard Alert: Suspected groundwater pollutant

Description: White crystalline solid or powder. Molecular weight = 368.47; specific gravity (H_2O:1) = 0.63; boiling point = (decomposes); freezing/melting point = 204−207°C; vapor pressure = 3.5×10^{-11} mmHg @ 25°C[83]. Henry's law constant = 3.84×10^{-12} atm m^3/mol @ 25°C (est)[83]. Low solubility in water.

Potential Exposure: Methoxyfenozide is a diacylhydrazine insecticide used to prevent insects from molting, or shedding their exoskeleton in order to grow, e.g., caterpillars and lychee webworms.

Permissible Concentration in Water: Federal Drinking Water Guidelines: 700 ppb[14].

Determination in Water: Octanol−water coefficient: Log K_{ow} = > 3.5. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Dermal contact, inhalation, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Contact with eyes or skin may cause irritation or injury. Inhalation should be avoided; use NIOSH- or CEN (UK)-approved APRs for pesticides. Harmful if swallowed. At high levels of exposure may affect glandular systems. LD_{50} (oral, dermal, rat) = > 5 g/kg.

Long-Term Exposure: At high levels of exposure may affect endocrine system, thyroid and adrenal glands.

Points of Attack: Adrenal glands, Endocrine system, thyroid

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: Exam of the nervous system. Thyroid function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Applicators and other handlers must wear: Coveralls worn over long-sleeved shirt and long pants; Chemical-resistant gloves such as DuPont Tychem suit fabrics, barrier laminate, or Viton; Chemical-resistant footwear plus socks; Protective eye wear; Chemical-resistant headgear for overhead exposure; Chemical-resistant apron when cleaning equipment, mixing, or loading[83]. Agricultural Use/Engineering Controls: When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the WPS for agricultural pesticides, 40 CFR 170.240(d) (4-6), the handler PPE requirements may be reduced or modified as specified in the WPS. Firefighters should wear NIOSH approved SCBA and full protective clothing.

Respirator Selection: Wherever and whenever workplace conditions warrant respirator use, a respiratory protection program must be followed that meets one or more of the following government standards: OSHA's 29 CFR 1910.134, ANSI Z88.2, or European Standard EN 149.

Storage: Color code—Blue: Health Hazard/Poison. Store in a secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: First remove all sources of ignition. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen and carbon. As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 m/150 ft for liquids and at least 25 m/75 ft for solids. *Fire involving storage or vehicular tanks*: Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. *On a small fire*: use dry chemical, CO_2, water spray or regular *foam. On a large fire*: use water spray, fog, or regular foam. Do not scatter spilled material with high pressure streams of water. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal. *Fire involving tanks*: From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. Always stay away from tanks engulfed in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138).

United States Environmental Protection Agency, Office of Pesticide Programs, Pesticide Residue Limits, "Methoxyfenozide," 40 CFR 180.544. http://www.epa.gov/fedrgstr/EPA-PEST/2002/September/Day-20/p23996.htm

Methoxyethylmercuric Acetate M:0600

Formula: $C_5H_{10}HgO_3$; $CH_3OCH_2CH_2HgOOCCH_3$

Synonyms: Acetato(2-methoxyethyl)mercury; Acetoxy(2-methoxyethyl)mercury; Cekusil Universal A; Landisan; MEMA; Mercuran; Mercury, acetoxy(2-methoxyethyl)-; Methoxyethylmercury acetate; 2-Methoxyethylmerkuriacetat (German); Panogen; Panogen M; Panogen Metox; Radosan

CAS Registry Number: 151-38-2

HSDB Number: 6387

RTECS Number: OV6300000

UN/NA & ERG Number: UN2777/151; UN2025 (mercury compounds, solid, n.o.s.)/151

EC Number: 205-790-2

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B, 1993 (dimethyl mercury); EPA: Possible Human Carcinogen; Methylmercury compounds are possibly carcinogenic to humans (Group 2B).

California Proposition 65: Developmental/Reproductive toxin (7/1/1987), Cancer (5/1/1996) as methyl mercury compounds.

Hazard Alert: Poison, Combustible, Organometallic, Strong reducing agent, Water reactive, Reproductive toxin: Suspected of causing genetic defects, Environmental hazard, Agricultural chemical.

Banned or Severely Restricted (in agriculture) (In United Kingdom)[13]

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as mercury and compounds

United States National Primary Drinking Water Regulations: MCLG = 0.002 mg[Hg]/L; MCL = 0.002 mg [Hg]/L as mercury

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 500 lb (227 kg)

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. as mercury compounds.

Rotterdam Convention Annex III (Chemicals Subject to the PIC Procedure) (as mercury compounds, including inorganic mercury compounds, alkyl mercury compounds and alkyloxylalkyl and aryl mercury compounds).

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

European/International Regulations (*593-74-8*): Hazard symbol: T+, N; risk phrases: R45; R15; R26/27/28; R33; R50/53; R62; safety phrases: S1/2; S13; S28; S29/35; S36; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found [3-Severe hazard to water. (est.)].

Description: Methoxyethylmercuric acetate is a crystalline solid. Molecular weight = 318.74; freezing/melting point = 42°C; vapor pressure = 1×10^{-5} mmHg @ 25°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 1, reactivity 0₩. Soluble in water; reactive, may release toxic or flammable vapors[101].

Potential Exposure: Used as a pesticide in seed treatment for cotton and small grains. It is no longer approved for this use. It exhibits high fungicidal activity against leaf stripe of barley; stinking smut of wheat; snow mold of rye; against seedling diseases in beets and legumes; and for dressing "seed" potatoes, bulbs, and tubers. Not registered as a pesticide in the United States.

Incompatibilities: Strong reducing agent. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Compounds of the carboxyl group react with all bases, both inorganic and organic (i.e., amines) releasing substantial heat, water and a salt that may be harmful. Incompatible with arsenic compounds (releases hydrogen cyanide gas), diazo compounds, dithiocarbamates, isocyanates, mercaptans, nitrides, and sulfides (releasing heat, toxic, and possibly flammable gases), thiosulfates and dithionites (releasing hydrogen sulfate and oxides of sulfur). Corrosive to iron and other metals.

Permissible Exposure Limits in Air

NIOSH IDLH = 2 mg[Hg]/m^3

OSHA PEL: 0.01 mg[Hg]/m^3 TWA; 0.04 milligram per cubic meter Ceiling Concentration

NIOSH REL: 0.01 mg[organomercury]/m^3 TWA; 0.03 milligram per cubic meter STEL [skin]

ACGIH TLV[1]: 0.01 mg[Hg]/m^3 TWA; 0.03 milligram per cubic meter STEL [skin]

PAC Ver. 29[138]
PAC-1: 0.048 milligram per cubic meter
PAC-2: 0.064 milligram per cubic meter
PAC-3: 3.2 milligram per cubic meter
DFG MAK: 0.01 mg[Hg]/m^3 [skin] Danger of skin sensitization; Carcinogen Category 3
In addition, North Dakota has set guidelines for alkyl mercury compounds in ambient air[60] of 1−3 μ/m^3 (0.0001−0.0003 milligram per cubic meter).

Permissible Concentration in Water: Presumably this material is covered in the Priority Toxic Pollutant Category. It is not specifically cited as an organomercurial as is methyl mercury. Very Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment

Determination in Water: Total mercury is determined by flameless atomic absorption. Soluble mercury may be determined by 0.45 μm filtration followed by flameless atomic absorption.

Routes of Entry: Inhalation, ingestion skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Highly toxic. Target organs are brain and central nervous system. Inhalation can cause lung damage; ingestion can cause kidney damage. Women of childbearing age should avoid exposure. Patients complain of headache, paresthesia of tongue, lips, fingers, and toes; a metallic taste in mouth; gastrointestinal disturbances; gas, and diarrhea. Nervous system symptoms may appear first after a relatively slight exposure or have a latency period: slight loss of coordination; loss of coordination of speech; writing and gait. Uncoordination may progress to loss of ability to control voluntary movements. Irritability and bad temper may progress to mania. Stupor or coma may develop. Blisters or dermatitis may be present on skin. Symptoms persist for years even in cases of mild exposure.

Long-Term Exposure: Repeated or prolonged contact with skin may result in dermatitis and allergy. Repeated or prolonged exposure may cause brain damage and nervous system damage. Repeated or prolonged exposure may cause death by hypovolemic shock, nephrotic syndrome; and kidney failure. Organic mercury substances have been identified as teratogen in humans. Can cause mercury to accumulate in the body and cause mercury poisoning. May cause permanent damage, such as gray colored skin, brown staining of the eyes; and decreased peripheral vision.

Points of Attack: Eyes, skin, brain, central nervous system; peripheral nervous system; kidneys.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure. Before first exposure and every 6−12 months after, a complete medical history and exam is strongly recommended, with: eye exam. Consider lung function tests for persons with frequent exposure. Exam of the nervous system. Routine urine test (UA). Urine test for mercury (should be less than 0.02 mg/L). Consider nerve conduction tests, urinary enzymes and neurobehavioral test. After suspected illness or overexposure, repeat the tests above and get a blood test for mercury. Evaluation by a qualified allergist, including exposure history and testing, may help diagnose allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Antidotes and Special Procedures for medical personnel: The drug NAP has been used to treat mercury poisoning, with mixed success.

Note to physician: For severe poisoning, BAL [dimercaprol, dithiopropanol ($C_3H_8OS_2$)] has been used to treat toxic symptoms of certain heavy metals poisoning—including mercury. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full-facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area

Shipping: UN2025 Mercury compounds, solid, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN2777 Mercury based pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Spills should be collected with special mercury vapor suppressants or special vacuums. Kits specific for clean-up of mercury are available. Ventilate area after clean-up is complete. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include metal fumes of mercury. *Small fires*: dry chemical, carbon dioxide; water spray; or foam. *Large fires*: water spray, fog, or foam. Move container from fire area if you can do so without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Runoff from fire control or dilution water may cause pollution. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR 165 recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Methoxyethylmercuric Acetate, Washington, DC, Chemical Emergency Preparedness Program (Nov. 30, 1987).

4-Methoxyphenol M:0610

Formula: $C_7H_8O_2$: $HOC_6H_4OCH_3$

Synonyms: *p*-Guaicol; Hydroquinone monomethyl ether; Hydroquinone monomethyl ether and *p*-hydroxyanisole; 1-Hydroxy-4-methoxybenzene; Mequinol; *p*-Methoxyphenol; MME; Mono methyl ether hydroquinone; Phenol, *p*-methoxy

CAS Registry Number: 150-76-5

HSDB Number: 4258

RTECS Number: SL7700000

UN/NA & ERG Number: UN3335/171

EC Number: 205-769-8 [*Annex I Index No*.: 604-044-00-7]

Regulatory Authority and Advisory Information

Hazard Alert: Combustible, Suspected reprotoxic hazard, Irritant; Sensitization hazard (skin).

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: Xn, Xi; risk phrases: R22; R36; R43; R63; safety phrases: S2; S24/25; S26; S37/39; S46; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: 4-Methoxyphenol is a colorless to white, waxy solid with an odor of caramel and phenol. A combustible solid. Molecular weight = 124.15; specific gravity (H_2O:1) = 1.55 @ 20°C; boiling point = 246°C; freezing/melting point = 52−53°C; flash point = 132°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 1, reactivity 0. Slightly soluble in water.

Potential Exposure: This compound is used in the manufacture of antioxidants, pharmaceuticals, plasticizers and dyestuffs. It is used as a stabilizer and UV inhibitor in various polymers.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, acid chlorides; acid anhydrides. Under certain conditions, a dust cloud can probably explode if ignited by a spark or flame.

Permissible Exposure Limits in Air

OSHA PEL: None

NIOSH REL: 5 milligram per cubic meter TWA

ACGIH TLV[1]: 5 milligram per cubic meter TWA

PAC Ver. 29[138]
PAC-1: 15 milligram per cubic meter
PAC-2: 49 milligram per cubic meter
PAC-3: 320 milligram per cubic meter
Australia: TWA 5 milligram per cubic meter, 1993; Belgium: TWA 5 milligram per cubic meter, 1993; Denmark: TWA milligram per cubic meter, 1999; France: VME 5 milligram per cubic meter, 1999; Norway: TWA 5 milligram per cubic meter, 1999; United Kingdom: TWA 5 milligram per cubic meter, 2000; the Netherlands: MAC-TGG 5 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 5 milligram per cubic meter

Determination in Air: No NIOSH Analytical Method available. See OSHA Analytical Method 32.

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: 4-Methoxyphenol can affect you when breathed in and by passing through your skin. Contact can cause severe eye burns and permanent damage. Irritates the skin, nose, throat, upper respiratory system. A central nervous system depressant.

Long-Term Exposure: Prolonged contact can cause severe skin burns and scars. Repeated exposure may cause discoloration of the eye and skin. Damage to the vision may occur. May cause skin sensitization.

Points of Attack: Eyes, skin, respiratory system; central nervous system.

Medical Surveillance: Evaluation by a qualified allergist, including exposure history and testing, may help diagnose allergy. If symptoms develop or overexposure is suspected, the following may be useful: exam of the eyes and vision, including a "slit-lamp" exam. Examination of the central nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Where there is potential exists for exposures over 5 milligram per cubic meter*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece respirator with a high efficiency particulate filter. Greater protection is provided by a PAPR. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode; or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Protect containers from physical damage. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames are prohibited where 4-methoxyphenol is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN3335 Aviation regulated solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: 4-Methoxyphenol may burn, but does not readily ignite. Use dry chemical or carbon dioxide extinguishers. Thermal decomposition products may include oxides of carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: 4-Methoxyphenol, Trenton, NJ (March 2000).

Methyl Acetate M:0620

Formula: $C_3H_6O_2$: CH_3COOCH_3
Synonyms: Acetate de methyle (French); Acetic acid, methyl ester; Devoton; Methylacetat (German); Methyl acetic ester; Methyle (acetate de) (French); Methyl ethanoate; Tereton
CAS Registry Number: 79-20-9
HSDB Number: 95
RTECS Number: AI9100000
UN/NA & ERG Number: UN1231/129
EC Number: 201-185-2 [*Annex I Index No.*: 607-021-00-X]

Regulatory Authority and Advisory Information
Hazard Alert: Highly flammable, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction).
Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.
Hazard symbols, risk, & safety statements: Hazard symbol: F, Xi; risk phrases: R11; R36; R41; R63; R66; R67; safety phrases: S16; S21; S26; S29; S33; S45 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Methyl acetate is a colorless liquid with a fruity odor. Molecular weight = 74.09; specific gravity (H_2O:1) = 0.924; boiling point = 57.8°C; freezing/melting point = −99°C; vapor pressure = 100 mmHg @ 9.4°C; flash point = −10°C; autoignition temperature = 455°C. The explosive limits are LEL = 3.1%; UEL: 16%. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 3, reactivity 0₩. Soluble in water; solubility = 25%.

Potential Exposure: Methyl acetate is used as a solvent in lacquers and paint removers; and as an intermediate in pharmaceutical manufacture.

Incompatibilities: Vapor may form explosive mixture with air. A Strong reducing agent. Incompatible water, acids, nitrates, strong oxidizers; alkalis. Attacks some plastics. Attacks many metals in presence of water. Reacts slowly with water, forming acetic acid and methanol. Decomposes in heat; on contact with air, bases, strong oxidizers; UV-light; possible fire and explosion hazard.

Permissible Exposure Limits in Air
NIOSH IDLH = 3100 ppm [LEL]
Conversion factor: 1 ppm = 3.03 milligram per cubic meter @ 25°C & 1 atm
Odor threshold = 4.6 ppm.
OSHA PEL: 200 ppm/610 milligram per cubic meter TWA
NIOSH REL: 200 ppm/610 milligram per cubic meter TWA; 250 ppm/760
milligram per cubic meter STEL
ACGIH TLV[1]: 200 ppm/606 milligram per cubic meter TWA; 250 ppm/757 milligram per cubic meter STEL
PAC Ver. 29[138]
PAC-1: 250 ppm
PAC-2: 1700 ppm
PAC-3: 10,000 ppm
DFG MAK: 100 ppm/310 milligram per cubic meter TWA; Peak Limitation Category I(4); Pregnancy Risk Group C
Australia: TWA 200 ppm (610 milligram per cubic meter); STEL 250 ppm, 1993; Austria: MAK 200 ppm (610 milligram per cubic meter), 1999; Belgium:
TWA 200 ppm (610 milligram per cubic meter); STEL 250 ppm (760 milligram per cubic meter), 1993; Denmark: TWA 150 ppm (455 milligram per cubic meter), 1999; Finland: TWA 200 ppm (610 milligram per cubic meter); STEL 250 ppm (765 milligram per cubic meter), 1993; France: VME 200 ppm (610 milligram per cubic meter), VLE 250 ppm (760 milligram per cubic meter), 1999; Hungary: TWA 200 milligram per cubic meter; STEL 500 milligram per cubic meter [skin] 1993; the Netherlands: MAC-TGG 610 milligram per cubic meter, 2003; Norway: TWA 100 ppm (305 milligram per cubic meter), 1999; the Philippines: TWA 200 ppm (610 milligram per cubic meter), 1993; Poland: MAC (TWA) 100 milligram per cubic meter, MAC (STEL) 750 milligram per cubic meter, 1999; Russia: TWA 200 ppm; STEL 100 milligram per cubic meter, 1993; Sweden: TWA 150 ppm (450 milligram per cubic meter); STEL 300 ppm (900 milligram per cubic meter), 1999; Switzerland: MAK-W 200 ppm (610 milligram per cubic meter), KZG-W 400 ppm (1220 milligram per cubic meter), 1999; Turkey: TWA 200 ppm (610 milligram per cubic meter), 1993; United Kingdom: TWA 200 ppm (616 milligram per cubic meter); STEL 250 ppm (770 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 250 ppm. Several states have set guidelines or standards for methyl acetate in ambient air[60] ranging from 6.1−7.6 milligram per cubic meter (North Dakota) to 12.2 milligram per cubic meter (Connecticut) to 14.524 milligram per cubic meter (Nevada) to 15 milligram per cubic meter (Virginia).

Determination in Air: Use NIOSH Analytical Method (IV) #1458.

Permissible Concentration in Water: Russia[43] set a MAC in water bodies used for domestic purposes of 0.1 mg/L.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 0.2. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms
Short-Term Exposure: Methyl acetate can affect you when breathed in and by passing through your skin. Irritates the eyes and respiratory tract. Eye irritation may be serious. May affect the central nervous system; causing dizziness, lightheadedness, and unconsciousness Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: The liquid destroys the skin's natural oils. Repeated or high exposure may cause irritation, dryness and cracking. Repeated or high exposures may cause methanol poisoning, which can cause headaches, dizziness, coma; and affect the optic nerve, causing blindness. Death can occur.

Points of Attack: Eyes, skin, respiratory system; central nervous system.

Medical Surveillance: For those with frequent or potentially high exposures (half the TLV or greater), the following are recommended before beginning work and at regular times after that. Lung function tests. Vision exam. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin contact: **8 hours:** 4H and Silver Shield gloves. **4 hours:** Teflon gloves, suits, boots. Also, butyl rubber is among the recommended protective materials. Safety equipment suppliers and manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *2000 ppm*: CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)]; or Sa (APF = 10) (any supplied-air respirator); *3100 ppm*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or CcrFOv (APF = 50) [any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s)]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-, mounted organic vapor canister]; or PaprOv (APF = 25) [any PAPR with organic vapor cartridge(s)]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd, Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-, mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA). *Note*: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: (1) Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. (2) Color code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Methyl acetate must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine), and strong acids (such as hydrochloric, sulfuric and nitric), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from strong alkalis and nitrates. Sources of ignition, such as smoking and open flames, are prohibited where methyl acetate is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Use only nonsparking tools and equipment, especially when opening and closing containers of methyl acetate.

Shipping: UN1231 Methyl acetate, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Methyl Acetate, Trenton, NJ (June 2003).

Methyl Acetylene M:0630

Formula: C_3H_4; $CH_3C{=}CH$

Synonyms: Acetylene, methyl-; Allylene; Propine; Propyne

CAS Registry Number: 74-99-7

HSDB Number: 2508

RTECS Number: UK4250000

UN/NA & ERG Number: UN3161/115 (P)

EC Number: 200-828-4

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Hazard Alert: Extremely flammable gas. Polymerization hazard, Suspected reprotoxic hazard, Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: F+, Xi; risk phrases: R5; R12; R17; R19; R20/21/22; R36/37/38; S61; safety phrases: S1; S2; S6; S16; S26; S27; S33; S36/37/39; S38; S43; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): Nonhazard to water.

Description: Methyl acetylene is a flammable, colorless gas. Sweet odor. A fuel that is shipped as a liquefied compressed gas. Molecular weight = 40.07; boiling point = −23.3°C; freezing/melting point = −104°C; vapor pressure = 3876 @ 20°C; relative vapor density (air = 1) = 1.41. Explosive limits: LEL = 1.7%; UEL: 11.7%. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 4, reactivity 3. Practically insoluble in water; solubility 0.4%.

Potential Exposure: This material may be used as a liquid rocket propellant, in admixture with propadiene as an industrial cutting fuel.

Incompatibilities: Forms explosive gas mixture with air. The liquid material in cylinders contains about 30% propadiene. Detonation may occur at 95°C.[136] May form explosive peroxides. Can decompose explosively on heating and @ 4.5−5.6 atmospheres of pressure. Strong oxidizers may cause fire and explosions. Forms shock sensitive compounds with copper, magnesium, silver and their alloys. Copper or copper alloys containing more than 67% copper should not be used in handling equipment. Attacks some plastics, rubber and coatings.

Permissible Exposure Limits in Air

NIOSH IDLH = 1700 ppm [LEL]

Conversion factor = 1 ppm = 1.64 milligram per cubic meter

OSHA PEL: 1000 ppm/1650 milligram per cubic meter TWA

NIOSH REL: 1000 ppm/1650 milligram per cubic meter TWA

ACGIH TLV[1]: 1000 ppm/1640 milligram per cubic meter TWA

PAC Ver. 29[138]

PAC-1: 230 ppm

PAC-2: 2500 ppm

PAC-3: 15,000 ppm

Australia: TWA 1000 ppm (1650 milligram per cubic meter); STEL 1250 ppm, 1993; Austria: MAK 1000 ppm (1650 milligram per cubic meter), 1999; Belgium: TWA 1000 ppm (1640 milligram per cubic meter); STEL 1250 ppm (2050 milligram per cubic meter), 1993; Denmark: TWA 1000 ppm (1650 milligram per cubic meter), 1999; Finland: TWA 1000 ppm (1650 milligram per cubic meter); STEL 1250 ppm (2065 milligram per cubic meter), 1999; France: VME 1000 ppm (1650 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 1650 milligram per cubic meter, 2003; the Philippines: TWA 1000 ppm (1650 milligram per cubic meter), 1993; Switzerland: MAK-W 1000 ppm (1650 milligram per cubic meter), 1999; Turkey: TWA 1000 ppm (1650 milligram per cubic meter), 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 1000 ppm

The Federal standard[58] the DFG MAK value[3] and the ACGIH TWA value is 1000 ppm (1650 milligram per cubic meter). Several states have set guidelines or standards for methyl acetylene in ambient air[60] ranging from 16.5−20.4 milligram per cubic meter (North Dakota) to 30 milligram per cubic meter (Virginia) to 33 milligram per cubic meter (Connecticut) to 39.286 milligram per cubic meter (Nevada).

Determination in Air: Gas collection bag; none; Gas chromatography/Flame ionization detection; NIOSH (II-5), Method #S8.

Routes of Entry: Inhalation, skin and/or eye contact (liquid).

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the respiratory tract. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Rapid evaporation of the liquid may cause frostbite. Exposure can cause headache, dizziness, convulsions, and loss of consciousness.

Long-Term Exposure: Can irritate the lungs. May cause bronchitis with coughing, phlegm, and/or shortness of breath.

Points of Attack: Central nervous system; lungs.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy. If frostbite has occurred, seek medical attention immediately; do NOT rub the affected areas or flush them with water. In order to prevent further tissue damage, do NOT attempt to remove frozen clothing from frostbitten areas. If frostbite has NOT occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 1700 ppm*: Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd, Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). Escape: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Check oxygen content prior to entering storage area. Flammable gas. Color code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. May form peroxides in storage. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: UN3161 Liquefied gas, flammable, n.o.s., Hazard Class: 2.1; Labels: 2.1-Flammable gas, Technical Name Required. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: If in a building, evacuate building and confine vapors by closing doors and shutting down HVAC systems. Restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit and to disperse the gas. Wear chemical protective suit with SCBA to combat spills. Stay upwind and use water spray to “knock down” vapor; contain runoff. Stop the flow of gas, if it can be done safely from a distance. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place; and repair leak or allow cylinder to empty. Keep this chemical out of confined spaces, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable gas. Thermal decomposition products may include oxides of carbon. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode. *Note*: Stopping the flow of gas is a better course of action than trying to extinguish the fire[17]. It may be dangerous to extinguish the flame and allow the gas to continue to flow; as an explosive mixture may be formed with air which may cause greater damage than the original fire if allowed to burn.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Methyl Acetylene, Trenton, NJ (May 1999).

Methyl Acrylate M:0650

Formula: $C_4H_6O_2$: $CH_2 = CHCOOCH_3$

Synonyms: Acrilato de metilo (Spanish); Acrylate de methyle (French); Acrylic acid methyl ester; Acrylsaeuremethylester (German); Curithane 103; Methoxycarbonylethylene; Methyl-acrylat (German); Methyl acrylate; Methyl propenate; Methyl 2-propenoate; Methyl propenoate; 2-Propenoic acid, methyl ester; Propenoic acid methyl ester

CAS Registry Number: 96-33-3

HSDB Number:194

RTECS Number: AT2800000

UN/NA & ERG Number: UN1919 (stabilized)/129 (P)

EC Number: 202-500-6 [*Annex I Index No*.: 607-034-00-0]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human No Adequate Data, animal Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1999; EPA: Not Classifiable as to human carcinogenicity.

Hazard Alert: Highly flammable liquid, Polymerization hazard (nonstabilized), Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction), Sensitization risk (skin, resp.).

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U328

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xi; risk phrases: R11; R19; R23/24/25; R36; R43; R51; R62; R63; R66; R67; safety phrases: S2; S16; S21; S26; S29; S33; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Methyl acrylate is a clear, colorless liquid with a sharp, fruity odor. Molecular weight = 86.1; specific gravity (H_2O:1) = 0.96; boiling point = 85°C; freezing/melting point = −76.5°C; vapor pressure = 100 mmHg @ 28°C; flash point = −3°C (oc); autoignition temperature = 468°C. Explosive limits: LEL = 2.8%; UEL: 25%. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 3, reactivity 2. Slightly soluble in water; solubility = 6%.

Potential Exposure: Methyl acrylate is used in production of acrylates, copolymers, barrier resins; and surfactants for shampoos; as a monomer in the manufacture of polymers for plastic films, textiles, paper, and leather coating resins. It is also used as a pesticide intermediate and in pharmaceutical manufacture.

Incompatibilities: Forms explosive mixture in air. Incompatible with nitrates, oxidizers, such as peroxides, strong alkalis. Polymerizes easily from heat, light, peroxides; usually contains an inhibitor, such as hydroquinone.

Permissible Exposure Limits in Air

NIOSH IDLH = 250 ppm

Conversion factor: 1 ppm = 3.52 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 10 ppm/35 milligram per cubic meter TWA [skin]

NIOSH REL: 10 ppm/35 milligram per cubic meter TWA [skin]

ACGIH TLV[1]: 2 ppm/7 milligram per cubic meter TWA [skin]; danger of sensitization.
PAC Ver. 29[138]
PAC-1: 6 ppm
PAC-2: 170 ppm
PAC-3: 1000 ppm
DFG MAK: 5 ppm/18 milligram per cubic meter, Peak Limitation Category I(1) danger of skin sensitization; Pregnancy Risk Group D
Several states have set guidelines or standards for methyl acrylate in ambient air[60] ranging from 4.8 μ/m^3 (Massachusetts) to 350 μ/m^3 (North Dakota) to 500 μ/m^3 (Virginia) to 700 μ/m^3 (Connecticut) to 833 μ/m^3 (Nevada).
Determination in Air: Charcoal adsorption, workup with CS_2, analysis by gas chromatography/flame ionization detection; NIOSH Analytical Method (IV) #1459; #2552; OSHA Analytical Method 92.
Permissible Concentration in Water: Russia[43] set a MAC in water bodies used for domestic purposes of 0.02 mg/L.
Determination in Water: Octanol−water coefficient: Log $K_{ow} = 0.79$. Unlikely to bioaccumulate in marine organisms.
Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.
Harmful Effects and Symptoms
Short-Term Exposure: Methyl acrylate can affect you when breathed in and by passing through your skin. Irritates the eyes, skin, and respiratory tract. Eye and skin contact can cause severe irritation and burns. A lacrimator. Breathing high levels may cause severe lung irritation and may lead to fluid in the lungs (pulmonary edema). This can cause death. Prolonged contact can cause severe damage to the skin and eyes.
Long-Term Exposure: Prolonged or repeated exposure to methyl acrylate may cause liver and kidney damage. Exposure may cause skin sensitization and allergy to develop.
Points of Attack: Eyes, skin, respiratory system.
Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Consider chest X-ray after acute overexposure. Liver and kidney function tests.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.
Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin contact: **8 hours**: butyl rubber gloves, suits, boots; Tychem 1000 suits. **4 hours**: Teflon gloves, suits, boots. Also, polyvinyl alcohol is among the recommended protective materials. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: NIOSH: *Up to 100 ppm*: Sa (APF = 10) (any supplied-air respirator). *250 ppm*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).
Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Methyl acrylate must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat and moisture. At temperatures above 20°C a violent reaction could take place. Methyl acrylate should always be used with an inhibitor. Check that the correct concentration of inhibitor is used; if it is not, a violent reaction

could occur. Sources of ignition, such as smoking and open flames, are prohibited where methyl acrylate is handled, used, or stored. Metal containers involving the transfer of 5 gal or more of methyl acrylate should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of methyl acrylate. Wherever methyl acrylate is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1919 Methyl acrylate, stabilized, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform to EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Methyl Acrylate, Trenton, NJ (March 2006).

Methylal M:0660

Formula: $C_3H_8O_2$: $CH_3OCH_2OCH_3$

Synonyms: Anesthenyl; Dimethoxymethane; Dimethylacetal formaldehyde; Formal; Formaldehyde dimethyl acetal; Methane, dimethoxy-; Methyl, dimethoxy-; Methylene dimethyl ether; Methyl formal

CAS Registry Number: 109-87-5

HSDB Number: 1820

RTECS Number: PA8750000

UN/NA & ERG Number: UN1234/127 (P)

EC Number: 203-714-2

Regulatory Authority and Advisory Information

Hazard Alert: Highly flammable, Polymerization hazard, Primary irritant (w/o allergic reaction).

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xi; risk phrases: R11; R19; R36/37/38; safety phrases: S7/9; S16; S21; S25; S26; S33; S37/39; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Methylal is a colorless liquid with a pungent odor. Molecular weight = 76.1; specific gravity (H_2O:1) = 0.86 @ 20°C; boiling point = 42°C; freezing/melting point = −105°C; vapor pressure = 750 mmHg @ 42°C; flash point = −32°C; autoignition temperature = 237°C. Explosive limits: LEL = 2.2%; 10,000 ppm[138]; UEL: 13.8%. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 3, reactivity 2. Soluble in water; solubility = 33%.

Potential Exposure: Methylal is used as a specialty fuel and as a solvent in adhesives and protective coatings.

Incompatibilities: Vapors may form explosive mixture with air. Methylal may be able to form unstable and explosive peroxides. Heating may cause explosion. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Hydrolyzes readily in presence of acids to generate aldehydes.

Permissible Exposure Limits in Air

NIOSH IDLH = 2200 ppm. [LEL]

Conversion factor: 1 ppm = 3.11 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 1000 ppm/3100 milligram per cubic meter TWA

NIOSH REL: 1000 ppm/3100 milligram per cubic meter TWA
ACGIH TLV[1]: 1000 ppm; 3110 milligram per cubic meter TWA
PAC Ver. 29[138]
PAC-1: 230 ppm
PAC-2: 2500 ppm [= > 10% LEL, lower explosive limit but <50% LEL]
PAC-3: 15,000 ppm (LEL, lower explosive limit)
DFG MAK: 1000 ppm/3200 milligram per cubic meter TWA; Peak Limitation II(2); Pregnancy Group C
Australia: TWA 1000 ppm (3100 milligram per cubic meter), 1993; Austria: MAK 1000 ppm (3100 milligram per cubic meter), 1999; Belgium: TWA 1000 ppm (3110 milligram per cubic meter), 1993; Denmark: TWA 1000 ppm (3100 milligram per cubic meter), 1999; Finland: TWA 1000 ppm (3100 milligram per cubic meter); STEL 1250 ppm (3900 milligram per cubic meter), 1999; France: VME 1000 ppm (3100 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 3100 milligram per cubic meter, 2003; the Philippines: TWA 1000 ppm (3100 milligram per cubic meter), 1993; Poland: MAC (TWA) 1000 milligram per cubic meter, MAC (STEL) 3500 milligram per cubic meter, 1999; Russia: STEL 10 milligram per cubic meter, 1993; Switzerland: MAK-W 1000 ppm (3100 milligram per cubic meter), 1999; Turkey: TWA 1000 ppm (3100 milligram per cubic meter), 1993; United Kingdom: TWA 1000 ppm (3160 milligram per cubic meter); STEL 1250 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 1000 ppm. Several states have set guidelines or standards for methylal in ambient air[60] ranging from 3.875−31.0 milligram per cubic meter (North Dakota) to 62.0 milligram per cubic meter (Connecticut) to 73.8 milligram per cubic meter (Nevada).

Determination in Air: Use NIOSH Analytical Method #1611[18].

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Methylal can affect you when breathed in. Irritates the eyes, skin, and respiratory tract. Exposure to high levels may cause you to feel dizzy, lightheaded, and to pass out. Methylal can irritate the eyes, nose, throat and skin. Very high levels may irritate the lungs. High exposure may damage the liver and kidneys.

Long-Term Exposure: The liquid removes the skin's natural oils. Repeated exposure may damage the liver and kidneys.

Points of Attack: Skin, eyes, respiratory system; central nervous system.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function tests. Lung function tests. Consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 2200 ppm*: Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with a full facepiece). Unknown concentrations or IDLH conditions: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Methylal must be stored to avoid contact with strong oxidizers, such as chlorine, chlorine dioxide, bromine, nitrates and permanganates, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where methylal is handled, used, or stored. Metal containers involving the transfer of 5 gal or more of methylal should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of methylal. Wherever methylal is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1234 Methylal, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: *Concentrated waste containing no peroxides*: discharge liquid at a controlled rate near a pilot flame. *Concentrated waste containing peroxides*: perforation of containers of the waste from a safe distance followed by open burning.

References

(31); (173); (101); (138); (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Methylal, Trenton, NJ (April 2004).

Methyl Alcohol M:0670

Formula: CH_4O; CH_3OH

Synonyms: Alcohol metilico (Spanish); Alcool methylique (French); Carbinol; Colonial spirit; Columbian spirit; Metanol (Spanish); Methyl alcohol; Methylalkohol (German); Methyl hydroxide; Methylol; Monohydroxymethane; Pyroxylic spirit; Wood alcohol; Wood naphtha; Wood spirit

CAS Registry Number: 67-56-1; *(alt.)* 54841-71-3

HSDB Number: 93

RTECS Number: PC1400000

UN/NA & ERG Number: UN1230/131

EC Number: 200-659-6 [*Annex I Index No.*: 603-001-00-X]

Regulatory Authority and Advisory Information

United States Environmental Protection Agency Gene-Tox Program, Negative: SHE-clonal assay; Cell transformation-SA7/SHE; Negative: *N crassa-aneuploidy*; In vitro SCE-nonhuman.

Hazard Alert: Poison, Systemic agent, Highly flammable liquid, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction). Listed for Tier 1 screening as an endocrine disruptor.[88]

Banned or Severely Restricted (Thailand and Sweden) (UN)[13]

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 5000 lb (2270 kg)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U154

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 5.6; Nonwastewater (mg/L/TCLP), 0.75

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 5000 lb (2270 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.; Class B2, D1B, D2B.

Hazard symbols, risk, & safety statements: Hazard symbol: F, T; risk phrases: R11; R23/24/25; R39/23/24/25; R62; R63; safety phrases: S1/2; S7; S16; S21; S35/36; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Methyl alcohol is a colorless, volatile liquid with a mild odor. Molecular weight = 32.04; specific gravity (H_2O:1) = 0.79 @ 20°C; boiling point = 64.6°C; freezing/melting point = −98°C; vapor pressure = 75 mmHg @ 15°C; flash point = 12°C; autoignition temperature = 464°C. Explosive limit: LEL = 6.0%; UEL: 36.0%. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 3, reactivity 0. Soluble in water.

Potential Exposure: Methyl alcohol is used as a starting material in organic synthesis of chemicals, such as formaldehyde, methacrylates, methyl amines, methyl halides; ethylene glycol and pesticides and as an industrial solvent for inks, resins, adhesives, and dyes. It is an ingredient in paint and varnish removers, cleaning and dewaxing preparations; spirit duplicating fluids; embalming fluids; antifreeze mixtures; and enamels and is used in the manufacture of photographic film; plastics, celluloid, textile soaps; wood stains; coated fabrics; shatterproof glass; paper coating; waterproofing formulations; artificial leather; and synthetic indigo and other dyes. It has also found use as an extractant in many other processes; an antidetonant fuel-injection fluid for aircraft; a rubber accelerator; and a denaturant for ethyl alcohol.

Incompatibilities: Methanol reacts violently with strong oxidizers, causing a fire and explosion hazard.

Permissible Exposure Limits in Air

NIOSH IDLH = 6000 ppm

Conversion factor: 1 ppm = 1.31 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 200 ppm/260 milligram per cubic meter TWA [skin]

NIOSH REL: 200 ppm/260 milligram per cubic meter TWA; 250 ppm/325 milligram per cubic meter STEL [skin]

ACGIH TLV[1]: 200 ppm/262 milligram per cubic meter TWA; 250 ppm/328 milligram per cubic meter STEL [skin]; BEI issued (2004)

PAC* Ver. 29[138]

PAC-1: **530**$_{\mathbf{A}}$ ppm

PAC-2: **2100**$_{\mathbf{A}}$ ppm

PAC-3: **7200**$_{\mathbf{A}}$ ppm

*AEGLs are marked with a subscript "**A**" and correspond to 60-minute values. Emergency Response Planning Guidelines (DOE)

ERPG-1: 200 ppm

ERPG-2: 1000 ppm

ERPG-3: 5000 ppm

DFG MAK: 200 ppm/270 milligram per cubic meter Peak Limitation Category II(4) [skin]; Pregnancy Risk Group C; BAT: 30 mg/L methanol in urine/end-of-shift; for long-term exposure, after several shifts

Arab Republic of Egypt: TWA 200 ppm (260 milligram per cubic meter) [skin], 1993; Australia: TWA 200 ppm (260 milligram per cubic meter); STEL 250 ppm [skin], 1993; Austria: MAK 200 ppm (260 milligram per cubic meter) [skin], 1999; Belgium: TWA 200 ppm (262 milligram per cubic meter); STEL 250 ppm [skin], 1993; Denmark: TWA 200 ppm (260 milligram per cubic meter) [skin], 1999; Finland: TWA 200 ppm (260 milligram per cubic meter); STEL 250 ppm [skin], 1999; France: VME 200 ppm, VLE 1000 ppm, 1999; Hungary: TWA 50 milligram per cubic meter; STEL 100 milligram per cubic meter [skin], 1993; Japan 200 ppm (260 milligram per cubic meter) [skin], 1999; the Netherlands: MAC-TGG 260 milligram per cubic meter [skin], 2003; Norway: TWA 100 ppm (130 milligram per cubic meter), 1999; the Philippines: TWA 200 ppm (260 milligram per cubic meter), 1993; Poland: MAC (TWA) 100 milligram per cubic meter, MAC (STEL) 300 milligram per cubic meter, 1999; Russia: TWA 200 ppm; STEL 5 milligram per cubic meter [skin], 1993; Sweden: NGV 200 ppm (250 milligram per cubic meter), KTV 250 ppm (350 milligram per cubic meter) [skin], 1999; Thailand: TWA 200 ppm (260 milligram per cubic meter), 1993; Turkey: TWA 200 ppm (260 milligram per cubic meter), 1993; United Kingdom: TWA 200 ppm (255 milligram per cubic meter); STEL 250 ppm [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 250 ppm [skin]. Russia[43] set a MAC in ambient air in residential areas of 1.0 milligram per cubic meter on a momentary basis and 0.5 milligram per cubic meter on a daily average basis. Several states have set guidelines or standards for methanol in ambient air[60] ranging from 0.036 milligram per cubic meter (Massachusetts) to 0.62 milligram per cubic meter (Kansas) to 2.6−3.1 milligram per cubic meter (North Dakota) to 4.3 milligram per cubic meter (Virginia) to 5.2 milligram per cubic meter (Connecticut and South Dakota) to 6.19 milligram per cubic meter (Nevada).

Determination in Air: Use NIOSH Analytical Method #2000, Methanol[18]; #2549 Volatile organic compounds; OSHA Analytical Method 91.

Permissible Concentration in Water: EPA[32] has suggested a permissible ambient goal of 3600 μg/L based on health effects. Russia[43] set a MAC in water bodies used for domestic purposes of 3 mg/L and in water bodies used for fishery purposes of 0.1 mg/L.

Determination in Water: Octanol−water coefficient: Log K_{ow} = (estimated) < -0.77. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation of vapor; percutaneous absorption of liquid; ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin, and respiratory tract. *Inhalation*: Below 500 ppm symptoms are rarely felt. Can cause headache, vomiting, irritation of the nose and throat; dilation of the pupils; feeling of intoxication; loss of muscle coordination; excessive sweating; bronchitis and convulsions. Very high exposures may result in stupor, cramps and visual difficulties, such as spotted vision; sensitivity to light; eye tenderness and blindness. Recovery is not always complete and symptoms may recur without additional exposure. *Skin*: Can cause dry and cracked skin, irritation and reddening. Skin absorption can be enough to contribute to symptoms described under inhalation. *Eyes*: Can cause irritation of eyes. *Ingestion*: Symptoms are similar to those under inhalation, plus damage to liver, kidneys and heart. Nerve damage may occur causing loss of coordination and blindness. Recovery is not always complete. Death may occur. Usual fatal dose is about 100−250 mL but death from ingestion has occurred from as little as 30 mL (about 1 ounce).

Long-Term Exposure: Exposure to low levels may cause many of the symptoms listed above. Skin contact causes dryness and cracking. May cause liver damage. Because methyl alcohol is slowly eliminated from body, repeated low exposures may build-up to high levels, causing severe symptoms. Recovery is not always complete. Methanol has been found to be a teratogen (changes in the genetic material) in animals. Whether it does in humans is unknown.

Points of Attack: Eyes, skin, respiratory system; central nervous system; gastrointestinal tract.

Medical Surveillance: NIOSH lists the following tests: whole blood (chemical/metabolite); whole blood (chemical/metabolite) pH (Hydrogen ion concentration); whole blood (chemical/metabolite), pre- and postshift; blood plasma, bicarbonate, expired air, liver function tests; urine (chemical/metabolite); urine (chemical/metabolite), end-of-shift; urine (chemical/metabolite) end-of-work-week; urine (chemical/metabolite) prior to next shift.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods:

General information: first responders should use a NIOSH-certified CBRN SCBA with a level a protective suit when entering an area with an unknown contaminant or when entering an area where the concentration of the contaminant is unknown. Level a protection should be used until monitoring results confirm the contaminant and the concentration of the contaminant. *Note*: safe use of protective clothing and equipment requires specific skills developed through training and experience.

LEVEL A: (*RED ZONE*): select when the greatest level of skin, respiratory, and eye protection is required. This is the maximum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than the AEGL-2. A NIOSH-certified CBRN full-facepiece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle. A TECP suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, and a hard hat worn under the TECP suit are optional items.

LEVEL B: (RED ZONE): Select when the highest level of respiratory protection is necessary but a lesser level of skin protection is required. This is the minimum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than AEGL-2. It differs from Level A in that it incorporates a nonencapsulating, splash-protective, chemical-resistant splash suit that provides Level A protection against liquids but is not airtight. A NIOSH-certified CBRN full- facepiece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL C: (YELLOW ZONE): Select when the contaminant and concentration of the contaminant are known and the respiratory protection criteria factors for using APRs or PAPRs are met. This level is appropriate when decontaminating patient/victims. A NIOSH-certified CBRN tight-fitting APR with a canister-type gas mask or CBRN PAPR for air levels greater than AEGL-2. A NIOSH-certified CBRN PAPR with a loose-fitting facepiece, hood, or helmet and a filter or a combination organic vapor, acid gas, and particulate cartridge/filter combination or a continuous flow respirator for air levels greater than AEGL-1. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Escape mask, face shield, coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL D: (GREEN ZONE): Select when the contaminant and concentration of the contaminant are known and the concentration is below the appropriate occupational exposure limit or less than AEGL-1 for the stated duration times. Limited to coveralls or other work clothes, boots, and gloves.

Notes: Take all necessary precautions to prevent any reasonable probability of skin or eye contact. **8 hours:** butyl rubber gloves, suits, boots; Teflon gloves, suits, boots; Viton gloves, suits, Saranex coated suits; 4H and Silver Shield gloves, Responder suits, Trellchem HPS suits; Trychem 1000 suits. Also, Viton/chlorobutyl rubber, polyvinyl acetate, styrene/butadiene rubber, Viton/Neoprene, butyl/Neoprene, and chlorinated polyethylene are among the recommended protective materials. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *2000 ppm*: Sa (APF = 10) (any supplied-air respirator). *5000 ppm*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *6000 ppm*: SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*:

SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Methyl alcohol must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine). Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames are prohibited where methyl alcohol is handled, used, or stored. Metal containers involving the transfer of 5 gal or more should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of methyl alcohol.

Shipping: UN1230 Methanol, Hazard Class: 3; Labels: 3-Flammable liquid, 6.1-Poisonous material. (International)

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform to EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration.

References

(31); (173); (101); (138); (2); (80); (100).

National Institute for Occupational Safety and Health (NIOSH), “Criteria for a Recommended Standard: Occupational Exposure to Methyl Alcohol”, NIOSH Document Number 76-148, Cincinnati, OH (1976).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Methanol, Washington, DC (July 11, 1977) (Revised 1979).

United States Environmental Protection Agency, Methyl alcohol, Health and Environmental Effects Profile No. 126, Washington, DC, Office of Solid Waste (April 30, 1980).

Sax, N. I., Ed., “*Dangerous Properties of Industrial Materials Report*” 5, No. 5, 58−64 (1985).

New York State Department of Health, *Chemical Fact Sheet*: Methyl alcohol, Bureau of Toxic Substance Assessment, Albany, NY (Feb. 1986).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Methyl alcohol, Trenton, NJ (April 2002).

Methylamine M:0680

Formula: CH_5N; CH_3NH_2

Synonyms: Aminomethane; Carbinamine; Mercurialin; Methanamine; Methylamine; Metilamino (Spanish); Monomethylamine

CAS Registry Number: 74-89-5

HSDB Number: 810

RTECS Number: PF6300000

UN/NA & ERG Number: (PIH) UN1061 (anhydrous)/118; UN1235 (aqueous solution)/132

EC Number: 200-820-0 [*Annex I Index No.*: 612-001-00-9]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 ($\geq$1.00% concentration).

Hazard Alert: Poison inhalation hazard, Suspected of causing genetic defects, Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated, Primary irritant (w/o allergic reaction).

List 1, DEA chemical code 8520 (Title 21 CFR1310.02) as Methylamine and its salts.

OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 1000 lb (450 kg)

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg)

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazard symbols, risk, & safety statements: Hazard symbol: F+, Xn; risk phrases: R5; R12; R20; R21; R37/38; R41; safety phrases: S1; S2; S16; S26; S33; S38; S39; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Methylamine is a colorless gas with a fish- or ammonia-like odor; at low concentrations a fishy odor. Shipped as a liquefied compressed gas. The odor threshold is 3.2 ppm. Molecular weight = 31.06; specific gravity (H_2O:1) = 0.7 @ 20°C (liquid); boiling point = -6.3°C; freezing/melting point = -94°C; relative vapor density (air = 1) = 1.08; vapor pressure = 750 mmHg @° -7°C; flash point = flammable gas; autoignition temperature = 430°C. Explosive limits: LEL = 4.9%; UEL: 20.7%. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 4, reactivity 0. Soluble in water.

Potential Exposure: Methylamine is used in organic synthesis; a starting material for *N*-oleyltaurine, a surfactant; and *p*-*N*-methylaminophenol sulfate, a photographic developer. It has possible uses in solvent extraction systems in separation of aromatics from aliphatic hydrocarbons. It is also used in the synthesis of many different pharmaceuticals; pesticides and rubber chemicals.

Incompatibilities: A medium-strong base. Reacts violently with strong acids; mercury, strong oxidizers; nitromethane. Corrosive to copper, zinc alloys; aluminum, and galvanized surfaces.

Permissible Exposure Limits in Air

NIOSH IDLH = 100 ppm

Conversion factor: 1 ppm = 1.27 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 10 ppm/12 milligram per cubic meter TWA

NIOSH REL: 10 ppm/12 milligram per cubic meter TWA

ACGIH TLV[1]: 5 ppm/6.4 milligram per cubic meter; 15 ppm/19 milligram per cubic meter STEL

PAC* Ver. 29[138]

PAC-1: $\mathbf{15_A}$ ppm

PAC-2: $\mathbf{64_A}$ ppm

PAC-3: $\mathbf{350_A}$ ppm

*AEGLs are marked with a subscript "**A**" and correspond to 60-minute values.

DFG MAK: 10 ppm/13 milligram per cubic meter TWA; Peak Limitation Category I(1); a momentary value of 10 mL/m^3/13 milligram per cubic meter should not be exceeded; Pregnancy Risk Group D

Australia: TWA 10 ppm (12 milligram per cubic meter), 1993; Austria: MAK 10 ppm (12 milligram per cubic meter), 1999; Belgium: TWA 10 ppm (13 milligram per cubic meter), 1993; Denmark: TWA 10 ppm (12 milligram per cubic meter) [skin], 1999; Finland: STEL 10 ppm (12 milligram per cubic meter) [skin], 1999; France: VLE 10 ppm (12 milligram per cubic meter), 1999; Japan: 10 ppm (13 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 6.4 milligram per cubic meter, 2003; Norway: TWA 10 ppm (12 milligram per cubic meter), 1999; the Philippines: TWA 10 ppm (12 milligram per cubic meter), 1993; Poland: MAC (TWA) 5 milligram per cubic meter, MAC (STEL) 15 milligram per cubic meter, 1999; Russia: TWA 10 ppm; STEL 1 milligram per cubic meter [skin], 1993; Sweden: NGV 10 ppm (13 milligram per cubic meter), KTV 20 ppm (25 milligram per cubic meter) [skin], 1999; United Kingdom: TWA 10 ppm (13 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 15 ppm. Several states have set guidelines or standards for methylamine in ambient air[60] ranging from 28.6 μ/m^3 (Kansas) to 40.0 μ/m^3 (New York) to 120 μ/m^3 (Florida and North Dakota) to 200 μ/m^3 (Virginia) to 240 μ/m^3 (Connecticut) to 286 μ/m^3 (Nevada) to 300 μ/m^3 (South Carolina).

Determination in Air: Use OSHA Analytical Method 40.

Permissible Concentration in Water: Russia[43] set a MAC in water bodies used for drinking purposes of 1.0 mg/L.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = -0.69$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion, skin absorption, eye and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Methylamine can affect you when breathed and by passing through your skin. Contact with the liquid can cause frostbite and severe burns of the eyes and skin. The vapor can irritate the eyes, nose, throat, and lungs. Higher levels can cause a build-up of fluid (pulmonary edema). This can cause death.

Long-Term Exposure: Repeated or prolonged contact with skin may cause drying and cracking. May cause lung irritation and bronchitis.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended: lung function test. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek

medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin contact: **8 hours:** Responder suits; Trychem 1000 suits. **4 hours:** Teflon gloves, suits, boots. Also, nitrile rubber, Styrene-butadiene rubber, Neoprene, Silvershield, and PVC are among the recommended protective materials. Prevent possible skin freezing from direct liquid contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with the liquid. Wear gas-proof chemical goggles and face shield when working with the gas, unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Wear eye protection to prevent any possibility of eye contact. Employees should wash immediately when skin is wet or contaminated. Remove clothing immediately if wet or contaminated to avoid flammability hazard. Provide emergency showers and eyewash.

Respirator Selection: *100 ppm*: CcrFS (APF = 50) [any chemical cartridge respirator with a full facepiece and cartridge(s) providing protection against the compound of concern]; or GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern]; or PaprS (APF = 25) [any PAPR with cartridge(s) providing protection against the compound of concern]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd, Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern]; or SCBAE (any appropriate escape-type, SCBA). *Note*: Substance causes eye irritation or damage; eye protection needed.

Storage: Check oxygen content prior to entering storage area. Flammable gas. Color code—Red: Flammability Hazard: Store in a flammable (liquid or solid materials) storage area or approved cabinet away from sources if ignition. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Methylamine must be stored to avoid contact with mercury, flammable materials; and strong oxidizers, (such as chlorine dioxide, or bromine); since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames are prohibited where methylamine is handled, used, or stored. Metal containers involving the transfer of 5 gal or more of methylamine should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of methylamine. Wherever methylamine is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: UN1061 Methylamine, anhydrous, Hazard Class: 2.1; Labels: 2.1-Flammable gas. UN1235 Methylamine, aqueous solution, Hazard Class: 3; Labels: 3-Flammable liquid, 8-Corrosive material. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: *Liquid*: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Alternatively, spread heavily with sodium bisulfate and sprinkle with water. Then drain into a sewer (see next sentence) with a large amount of water. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Gas: If in a building, evacuate building and confine vapors by closing doors and shutting down HVAC systems. Restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit and to disperse the gas. Wear chemical protective suit with SCBA to combat spills. Stay upwind and use water spray to "knock down" vapor; contain runoff. Stop the flow of gas, if it can be done safely from a distance. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place; and repair leak or allow cylinder to empty. Keep this chemical out of confined spaces, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Methylamine is a flammable liquid or gas. If you are dealing with gas, stop the flow of gas if it can be done safely. Use water to keep fire-exposed containers cool and to protect people attempting shut-off. For water solutions, use water spray, CO_2, dry chemical, and alcohol foam extinguishers. Thermal decomposition products may include oxides of nitrogen. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Controlled incineration (incinerator equipped with a scrubber or thermal unit to reduce nitrogen oxides emissions).

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Methylamines, Washington, DC (May 1, 1978).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 5, No. 4, 48–50 (1985).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Methylamine, Trenton, NJ (April 2004).

Methyl *n*-Amyl Ketone M:0690

Formula: $C_7H_{14}O$; $CH_3COC_5H_{11}$

Synonyms: Amyl-methyl-cetone (French); Amyl methyl ketone; Butyl acetone; Methyl amyl ketone; Methyl-amyl-cetone (French); 2-Heptanone; 2-Ketoheptane; Methyl pentyl ketone; Pentyl methyl ketone

CAS Registry Number: 110-43-0

HSDB Number: 1122

RTECS Number: MJ5075000

UN/NA & ERG Number: UN1110/127

EC Number: 203-767-1 [*Annex I Index No*.: 606-024-00-3]

Regulatory Authority and Advisory Information

Hazard Alert: Flammable liquid, Primary irritant (w/o allergic reaction).

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: Xn; risk phrases: R10; R20/22; R26/28; R36/37/38; R40; R48/20/22; RSafety phrases: S2; S22/25; S24/25; S36; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Methyl amyl ketone is a clear colorless liquid with a mild, banana-like odor. Molecular weight = 114.19; specific gravity (H_2O:1) = 0.81 @ 20°C; boiling point = 151.1°C; freezing/melting point = −35.6°C; vapor pressure = 7.5 mmHg @ 36°C; flash point = 39°C; autoignition temperature = 393°C. Explosive limits: LEL = 1.1% @ 66°C; 15,000 ppm[138]; UEL: 7.9% @ 121°C. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 2, reactivity 0. Poor solubility in water; solubility = 0.4%.

Potential Exposure: Methyl amyl ketone is used as a solvent in metal roll coatings and in synthetic resin finishes; as a solvent for nitrocellulose in lacquers and as a relatively inert reaction medium.

Incompatibilities: May form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkalis, alkaline materials, strong acids, strong bases. Attacks some forms of plastics.

Permissible Exposure Limits in Air

NIOSH IDLH = 800 ppm
Conversion factor: 1 ppm = 4.67 milligram per cubic meter @ 25°C & 1 atm
OSHA PEL: 100 ppm/465 milligram per cubic meter TWA
NIOSH REL: 100 ppm/465 milligram per cubic meter TWA
ACGIH TLV[1]: 50 ppm/233 milligram per cubic meter TWA
PAC Ver. 29[138]
PAC-1: 150 ppm
PAC-2: 670 ppm
PAC-3: 4000 ppm
Australia: TWA 50 ppm (235 milligram per cubic meter), 1993; Belgium: TWA 50 ppm (233 milligram per cubic meter), 1993; Denmark: TWA 50 ppm (230 milligram per cubic meter), 1999; Finland: TWA 50 ppm (230 milligram per cubic meter); STEL 75 ppm (345 milligram per cubic meter), 1999; France: VME 50 ppm (235 milligram per cubic meter), 1999; Norway: TWA 25 ppm (115 milligram per cubic meter), 1999; Sweden: TWA 25 ppm (120 milligram per cubic meter); STEL 50 ppm (250 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 233 milligram per cubic meter, 2003; United Kingdom: LTEL 50 ppm (240 milligram per cubic meter), 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 50 ppm. Several states have set guidelines or standards for methyl *n*-amyl ketone in ambient air[60] ranging from 2.35−4.65 milligram per cubic meter (North Dakota) to 3.9 milligram per cubic meter (Virginia) to 4.7 milligram per cubic meter (Connecticut) to 5.595 milligram per cubic meter (Nevada).

Determination in Air: Use NIOSH Analytical Methods #1301; #2553, Ketones II[18]

Permissible Concentration in Water: No criteria set.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Methyl *n*-amyl ketone can affect you when breathed in and by passing through your skin. Irritates the eyes and the respiratory tract. May affect the central nervous system. Breathing the vapor can cause dizziness and lightheadedness, and can make you pass out.

Long-Term Exposure: Causes skin irritation with cracking and drying; destroys the skin's natural oils. May cause liver and kidney damage. May affect the nervous system.

Points of Attack: Eyes, skin, respiratory system; central nervous system; peripheral nervous system.

Medical Surveillance: NIOSH lists the following tests: pulmonary function tests. If symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function tests; examination of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin contact: **4 hours**: 4H and Silver Shield gloves. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See NIOSH Criteria Document 78-173, *Ketones.*

Respirator Selection: *800 ppm*: CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge (s)]; or PaprOv (APF = 25) [any PAPR with organic vapor cartridge(s)]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister]; or Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd, Pp (APF = 10,000) (any SCBA that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-, mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA). *Note*: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Methyl (*n*-amyl) ketone must be stored to avoid contact with oxidizers, such as perchlorates, peroxides, chlorates, nitrites, and permanganates, since violent reaction occur. Store in tightly closed containers in a cool, well-ventilated area away from heat or flame. Sources of ignition, such as smoking and open flames are prohibited where methyl (*n*-amyl) ketone is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN1110 *n*-Amyl Methyl ketone, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (2); (100).

National Institute for Occupational Safety and Health (NIOSH), "Criteria for a Recommended Standard: Occupational Exposure to Ketones", NIOSH Document Number 78-173, Washington, DC (1978).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Methyl *n*-Amyl Ketone, Trenton, NJ (April 2004)

N-Methylaniline M:0700

Formula: C_7H_9N; $C_6H_5NH(CH_3)$

Synonyms: Anilinomethane; Benzenenamine, *N*-methyl-; MA; (Methylamino)benzene; *N*-Methylaminobenzene; Methyl aniline; Methylaniline (mono); *N*-Methylbenzenamine; 4,4′-Methylene-bis-(*N,N*-dimethylaniline); *N*-Methylphenylamine; Methylphenyl amine; *N*-Monomethylaniline; Monomethyl aniline; *N*-Phenylmethylamine

CAS Registry Number: 100-61-8

HSDB Number: 1654

RTECS Number: BY4550000

UN/NA & ERG Number: UN2294/153

EC Number: 202-870-9 [*Annex I Index No*.: 612-015-00-5]

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Flammable, Suspected reprotoxic hazard.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, F, N; risk phrases: R10; R23/24/25; R33; R50/53; R61; safety phrases: S1/2; S28; S33; S36/37; S45; S50/53; S41; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: *N*-Methylaniline is a yellow to light brown oily liquid with a weak, ammonia-like odor. Turns reddish-brown if left standing. The odor threshold is 1.7 ppm. Molecular weight = 107.17; specific gravity (H_2O:1) = 0.99 @ 20°C; boiling point = 195.6°C; freezing/melting point = −57°C; vapor pressure = 0.3 mmHg @ 20°C; flash point = 79.4°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 2, reactivity 0. Practically insoluble in water.

Potential Exposure: The material is used as an intermediate in organic synthesis, as a solvent and as an acid acceptor.

Incompatibilities: Reacts violently with strong acids; acid chlorides; acid anhydrides; strong oxidizers. Attacks some plastic.

Permissible Exposure Limits in Air

NIOSH IDLH = 100 ppm

Conversion factor: 1 ppm = 4.38 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 2 ppm/9 milligram per cubic meter [skin] TWA

NIOSH REL: 0.5 ppm/2 milligram per cubic meter TWA [skin]

ACGIH TLV[1]: 0.5 ppm/2.2 milligram per cubic meter TWA [skin]

PAC Ver. 29[138]

PAC-1: 1.5 ppm

PAC-2: 17 ppm

PAC-3: 100 ppm

DFG MAK: 0.5 ppm/2.2 milligram per cubic meter TWA; Peak Limitation Category II(2) [skin]; Pregnancy Risk Group D

Arab Republic of Egypt: TWA 2 ppm (9 milligram per cubic meter) [skin], 1993; Australia: TWA 0.5 ppm (2 milligram per cubic meter) [skin], 1993; Austria: MAK 0.5 ppm (2 milligram per cubic meter) [skin], 1999; Belgium: TWA 0.5 ppm (2.2 milligram per cubic meter) [skin], 1993; Denmark: TWA 0.5 ppm (2.25 milligram per cubic meter) [skin], 1999; France: VME 0.5 ppm (2 milligram per cubic meter) [skin], 1999; the Netherlands: MAC-TGG 2 milligram per cubic meter, 2003; Poland: MAC (TWA) 2 milligram per cubic meter, 1999; Turkey: TWA 2 ppm (9 milligram per cubic meter) [skin], 1993; United Kingdom: TWA 0.5 ppm (2.2 milligram per cubic meter) [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 0.5 ppm [skin]. Russia[43] set a MAC in ambient air in residential areas of 0.04 milligram per cubic meter (40 μ/m^3) both on a momentary and a daily average basis. Several states have set guidelines or standards for *n*-methylaniline in ambient air[60] ranging from 20 μ/m^3 (North Dakota) to 35 μ/m^3 (Virginia) to 40 μ/m^3 (Connecticut) to 47.6 μ/m^3 (Nevada).

Determination in Air: Bubbler; sodium hydroxide; Gas chromatography/Flame ionization detection; NIOSH Analytical Method (IV) #3511.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 1.69$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Methylaniline can affect you when breathed in and by passing through your skin. Irritates the eyes, skin, and respiratory tract. Exposure to methylaniline can interfere with the ability of the blood to carry oxygen (methemoglobinemia). This can cause headaches, weakness, dizziness, dyspnea (breathing difficulty), cyanosis, a bluish color of the lips and nose. Higher exposure can cause shortness of breath; collapse and even death. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Exposure can damage the bladder, causing bloody urine.

Long-Term Exposure: Repeated exposures may cause liver and kidney damage, and a low blood count (anemia). Repeated or prolonged contact may cause skin sensitization.

Points of Attack: Respiratory system, liver, kidneys, blood, central nervous system.

Medical Surveillance: NIOSH lists the following tests: whole blood (chemical/metabolite), methhemoglobin; CBC; urinalysis (routine). Also, if symptoms develop or overexposure is suspected, the following may be considered: Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Note to Physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *5 ppm*: Sa (APF = 10) (any supplied-air respirator). *12.5 ppm*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *25 ppm*: SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *100 ppm*: SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Methylaniline must be stored to avoid contact with strong acids (such as hydrochloric, sulfuric and nitric), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where methylaniline is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2294 *N*-Methylaniline, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Controlled incineration whereby oxides of nitrogen are removed from the effluent gas by scrubber, catalytic or thermal device.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Methylaniline, Trenton, NJ (November 1999).

Methyl Benzoate M:0710

Formula: $C_8H_8O_2$

Synonyms: Benzoato de metilo (Spanish); Benzoic acid, methyl ester; Essence of niobe; Methyl benzenecarboxylate; Niobe oil; Oil of niobe

CAS Registry Number: 93-58-3

HSDB Number: 5283

RTECS Number: DH3850000

UN/NA & ERG Number: None

EC Number: 202-259-7

Regulatory Authority and Advisory Information

Hazard Alert: Combustible liquid, Sensitization hazard, Chemical pneumonia hazard (if swallowed).

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xn; risk phrases: R10; R22; R36/37/38; R43; R50/53; safety phrases: S16; S26; S36/37; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Methyl benzoate is a colorless, oily, transparent, liquid. Pleasant odor. Molecular weight = 136.16; specific gravity (H_2O:1) = 1.08 @ 20°C; boiling point = 199.9°C; freezing/melting point = −12.5°C; vapor pressure = 1 mmHg @ 39°C; flash point = 83°C. Explosive limits: LEL = 17,000 ppm; UEL: unknown. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 2, reactivity 0. Insoluble in water.

Potential Exposure: Used as food additive and as a solvent for cellulose esters and ethers, resins and rubber.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 5.57 milligram per cubic meter @ 25°C & 1-atm.

PAC Ver. 29[138]

PAC-1: 1.1 ppm

PAC-2: 12 ppm

PAC-3: 42 ppm

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 2.1$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin and respiratory tract. Inhalation can cause coughing and wheezing. Swallowing the liquid may cause chemical pneumonia.

Long-Term Exposure: May cause skin sensitization and allergy. May cause an asthma-like allergy. Can affect the nervous system causing tremors and muscle weakness.

Points of Attack: Skin, lungs, nervous system.

Medical Surveillance: Evaluation by a qualified allergist. Lung function tests. Examination of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. *Note to Physician*: *Inhalation*: Bronchodialators, decongestants and oxygen may be used if necessary. Corticosteroids are useful for treating pneumonitis.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with methyl benzoate all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong acids; strong bases; oxidizers, nitrates. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: None found.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Methyl Benzoate, Trenton, NJ (May 1999).

Methyl Bromide M:0720

Formula: CH_3Br

Synonyms: Bromomethane; Brom-*o*-gas; Dawson 100; Dowfume; EDCO; Embafume; Halon 1001; Iscobrome; Kayafume; Methane, bromo-; Methogas; M-B-C fumigant; Monobromomethane; R 40BL; Rotox; Terabol; Terr-*o*-gas 100; Zytox

CAS Registry Number: 74-83-9

HSDB Number: 779
RTECS Number: PA4900000
UN/NA & ERG Number: UN1062/123
EC Number: 200-813-2 [*Annex I Index No.*: 602-002-00-3]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human Inadequate Evidence, animal Limited Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1999; NCI: Carcinogenesis Studies (inhalation); no evidence: mouse; EPA: Not Classifiable as to human carcinogenicity; NIOSH: Potential occupational carcinogen. 3B; (Animal Suspected) IARC[9]: DFG[3]: (ACGIH)[1] (suspected occupational carcinogen, NIOSH)

California Proposition 65 Developmental/Reproductive toxin (methyl bromide, as a structural fumigant) 1/1/1993.

Hazard Alert: Poison inhalation hazard (gas); Combustible, Possible risk of forming tumors, Water reactive (extremely slow), Reproductive toxin: Suspected of causing genetic defects, Environmental hazard.

OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 2500 lb (1135 kg)

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); Stratospheric ozone protection (Title VI, Subpart A, Appendix A), Class I, Ozone Depletion Potential (ODP) = 0.7

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR 41331, 9/9/1992)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U029

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.11; Nonwastewater (mg/kg), 15

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8010 (20); 8240 (10)

Safe Drinking Water Act (47FR 9352): Priority List (55 FR 1470)

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1000 lb (454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) Only as methyl bromide and ethylene dibromide mixture, liquid

United States DOT 49CFR172.101, Inhalation Hazardous Chemical (PIH).

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R23/25; R36/37/38; R48/20; R50; R59; R61; R62; R68; safety phrases: S1/2; S15; S27; S36/39; S38; S41; S45; S57; S59; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Methyl bromide is a colorless gas with a chloroform-like odor at high concentrations. A liquid below 3.3°C. Shipped as a liquefied compressed gas. Molecular weight = 94.95; specific gravity (H_2O:1) = 1.73; boiling point = 3.3°C; freezing/melting point = −93.7°C; relative vapor density (air = 1) = 3.36; vapor pressure = 1.9 atm; flash point = practically nonflammable except in presence of a high energy ignition sources; autoignition temperature = 537°C. Explosive limits: LEL = 10.0%; UEL: 16.0%. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 1, reactivity 0₩. Slightly soluble in water; solubility = 2%. Reacts with water; reaction is extremely slow, releasing methanol and hydrobromic acid.

Potential Exposure: Methyl bromide is used in fire extinguishers; as a fumigant in pest control and as a methylation agent in industry as an insect fumigant for soil, grain, warehouses, mills, ships, etc. It is also used as a chemical intermediate and a methylating agent; a refrigerant; a herbicide; a low-boiling solvent in aniline dye manufacture; for degreasing wool; for extracting oils from nuts, seeds, and flowers; and in ionization chambers. It is used as an intermediate in the manufacture of many drugs.

Incompatibilities: Attacks aluminum to form *spontaneously* flammable aluminum trimethyl. Incompatible with strong oxidizers, aluminum, dimethylsulfoxide, ethylene oxide; water. Attacks zinc, magnesium, alkali metals and their alloys. Attacks some rubbers and coatings. Methyl bromide reacts with water to generate hydrobromic acid and methanol but the reaction is so slow that it can be disregarded for most practical purposes[101].

Permissible Exposure Limits in Air

NIOSH IDLH = Ca. [250 ppm]

Conversion factor: 1 ppm = 3.89 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 20 ppm/80 milligram per cubic meter Ceiling Concentration [skin]

NIOSH REL: A potential occupational carcinogen. Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A

ACGIH TLV[1]: 1 ppm/3.9 milligram per cubic meter [skin]; not classifiable as a human carcinogen

DFG MAK: [skin], Carcinogen Category 3B

PAC* Ver. 29[138]

PAC-1: 19 ppm

PAC-2: **210**$_{\mathbf{A}}$ ppm

PAC-3: **740**$_{\mathbf{A}}$ ppm

*AEGLs are marked with a subscript "**A**" and correspond to 60-minute values.

Arab Republic of Egypt: TWA 5 ppm (20 milligram per cubic meter) [skin] 1993; Australia: TWA 5 ppm (20 milligram per cubic meter) [skin], 1993; Austria: Suspected: carcinogen, 1999; Denmark: TWA 5 ppm (20 milligram per cubic meter) [skin], 1999; Finland: TWA 5 ppm (20 milligram per cubic meter); STEL 10 ppm (40 milligram per cubic meter) [skin], 1999; France: VME 5 ppm (20 milligram per cubic meter), 1999; Hungary: TWA 10 milligram per cubic meter; STEL 20 milligram per cubic meter [skin], 1993; the Netherlands: MAC-TGG 1 milligram per cubic meter [skin], 2003; Norway: TWA 5 ppm (20 milligram per cubic meter), 1999; the Philippines: TWA 20 ppm (80 milligram per cubic meter) [skin], 1993; Poland: MAC (TWA) 5 milligram per cubic meter, MAC (STEL) 40 milligram per cubic meter, 1999; Russia: STEL 1 milligram per cubic meter, 1993; Sweden: NGV 5 ppm (19 milligram per cubic meter), KTV 10 ppm (40 milligram per cubic meter) [skin], 1999; Switzerland: MAK-W 5 ppm (20 milligram per cubic meter), KZG-W 10 ppm (40 milligram per cubic meter) [skin], 1999; Thailand: TWA 20 ppm (80 milligram per cubic meter), 1993; Turkey: TWA 20 ppm (80 milligram per cubic meter), 1993; United Kingdom: TWA 5 ppm (20 milligram per cubic meter); STEL 15 ppm [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen. The Czech Republic: MAC 1.0 milligram per cubic meter. Russia has set MAC values for the ambient air in residential areas of 0.02 milligram per cubic meter on a momentary basis and 0.01 milligram per cubic meter on a daily average basis. Several states have set guidelines or standards for methyl bromide in ambient air[60] ranging from 2.6 μ/m^3 (Massachusetts) to 47.6 μ/m^3 (Kansas) to 100 μ/m^3 (South Carolina) to 200 μ/m^3 (North Dakota) to 350 μ/m^3 (Virginia) to 400 μ/m^3 (Connecticut) to 476 μ/m^3 (Nevada) to 480 μ/m^3 (Pennsylvania).

Determination in Air: Charcoal adsorption, workup with CS_2, analysis by gas chromatography/flame ionization. Use NIOSH Analytical Method 2520[18]; OSHA Analytical Method PV-2040.

Permissible Concentration in Water: *To protect human health*: preferably zero. An additional lifetime cancer risk of 1 in 100,000 is posed by a concentration of 1.9 μg/L[6]. States which have set guidelines for methyl bromide in drinking water[61] include Arizona @ 2.5 μg/L and Kansas at 0.19 μg/L.

Determination in Water: Inert gas purge followed by gas chromatography with halide specific detection (EPA Method 601) or gas chromatography plus mass spectrometry (EPA Method 624). Octanol−water coefficient: $\text{Log } K_{ow} = 1.2$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, percutaneous absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Methyl bromide irritates the respiratory tract. Inhalation of the gas can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. May affect the central nervous system; causing psychological disturbances. Signs and symptoms of acute exposure to methyl bromide may be severe and include tremors, convulsions, brain hemorrhage; paralysis, coma, and permanent brain damage. Respiratory effects include cough, tachypnea (rapid respiratory rate), pulmonary edema; and respiratory collapse. Cyanosis (blue tint to the skin and mucous membranes), pallor, ventricular fibrillation; and circulatory collapse may also occur. Lethargy, profound weakness; headache, dizziness, mental confusion; slurring of speech; staggering gait; and blurred or double vision are often found. Gastrointestinal signs and symptoms include nausea, vomiting, abdominal pain; and anorexia. Oliguria (scanty urination), anuria (lack of urine formation), kidney hemorrhage; and kidney failure may occur. Contact with methyl bromide may cause dermatitis (red, inflamed skin) and conjunctivitis (red, inflamed eyes). *Inhalation*: A level of 35 ppm can cause nausea, vomiting, loss of appetite; headache, dizziness, drowsiness and dimming of vision. These effects go away soon after exposure ceases. Headaches, dizziness, and weakness can be felt @ 100 ppm and can last for months after exposure. Higher levels have caused coughing, nose and throat irritation; disturbed speech and walk; visual disturbances; twitching, numbness, paralysis, convulsions and permanent nerve damage. Symptoms are often delayed 24 to 48 hours. Exposures of 10,000 ppm for a few minutes can cause death. Can cause abdominal cramps; respiratory failure resulting in death. *Skin*: Contact with liquid can cause burning or tingling sensation; itching, redness and swelling. Large amounts can cause blisters, numbness or aching pain. Methyl bromide can be absorbed through the skin and cause symptoms described under inhalation. Death has occurred from skin absorption. *Eye*: Can cause irritation, tearing, reddening or burning pain. *Ingestion*: Can cause throat and stomach irritation as well as symptoms described under inhalation. *Note*: Do not wear *ordinary rubber gloves* or *adhesive bandages* while using methyl bromide. It can dissolve rapidly through rubber or adhesive tape and cause severe symptoms.

Long-Term Exposure: Levels between 20 and 35 ppm can cause symptoms as described under short term inhalation. Symptoms can last months or years, or can be permanent. Repeated or prolonged contact with skin may cause dermatitis, lung damage and broncho-spasms. Methyl bromide may affect the central nervous system; causing paralysis, poor vision; psychological disorders; hallucinations, numbness in the arms and legs; brain damage. May cause liver and kidney damage. Methyl bromide is a mutagen and may have a cancer risk. May damage the testes.

Points of Attack: Eyes, skin, respiratory system; central nervous system; brain. Cancer site in animals: lung, kidney, and fore-stomach tumors.

Medical Surveillance: NIOSH lists the following tests: whole blood (chemical/metabolite); blood serum; chest X-ray, expired air, pulmonary function tests: forced vital capacity, forced expiratory volume (1 second); urine (chemical/metabolite). Evaluate the central nervous system; respiratory tract, and skin in preplacement and periodic examinations. Blood test for bromides (unexposed persons usually have serum levels of 5 mg/L or below). Kidney function tests. Evaluation for brain effects.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the

skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid: **8 hours:** Responder suits; Trychem 1000 suits. **4 hours:** butyl rubber gloves, suits, boots; Neoprene rubber gloves, suits, boots; Teflon gloves, suits, boots. Also, Saranex and styrene-butadiene rubber are among the recommended protective materials. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear eye protection to prevent any reasonable probability of eye contact. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, SCBA).

Storage: Poison inhalation chemical (PIH); check oxygen content prior to entering storage area. Poison gas. Color code—Blue: Health Hazard/Poison: Store in a secure poison location. This gas is highly toxic. Even slight exposure to these gasses can cause death. Store outdoors in a secure, restricted area that containing warning signs. This area must be roofed and shaded with the cylinders stored off the ground and separated from all other products assigned to other hazard categories and radiant heat sources on non-wooden floors. If indoors, store in a well-ventilated areas in temperatures not to exceed 50°C. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in well-ventilated area away from direct sunlight. Maintain temperature below 40°C; avoid heat sources. Protect against physical damage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: UN1062 Methyl bromide, Hazard Class: 2.3; Labels: 2.3-Poisonous gas, Inhalation Hazard Zone C. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling:

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 48-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.3/0.3

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 300/90
Then: Protect persons downwind (mi/km)
Day 0.4/0.6
Night 1.2/1.9

If in a building, evacuate building and confine vapors by closing doors and shutting down HVAC systems. Restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak to disperse the gas. Wear chemical protective suit with SCBA to combat spills. Stay upwind and use water spray to "knock down" vapor; contain runoff. Stop the flow of gas, if it can be done safely from a distance. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place; and repair leak or allow cylinder to empty. Keep this chemical out of confined spaces, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable gas, but only in presence of a high energy ignition source. It is nonflammable at room temperature. Thermal decomposition products may include hydrogen bromide and carbon monoxide. Establish forced ventilation to keep levels below explosive limit. If liquid is spilled, evacuate area of spill; absorb liquid in vermiculite, dry sand; earth, or similar material and deposit in sealed containers for later disposal. If gas is leaked, do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform to EPA regulations governing storage, transportation, treatment, and waste disposal. A poisonous gas. Must be handled by experts: the recommended disposal procedure is to spray the gas into the fire box of an incinerator equipped with an afterburner and scrubber (alkali)[22].

References

(31); (173); (101); (138); (2); (100).

United States Environmental Protection Agency, Halomethanes: Ambient Water quality Criteria, Washington, DC (1980).

United States Environmental Protection Agency, Bromomethane, Health and Environmental Effects Profile No. 29, Washington, DC, Office of Solid Waste (April 30, 1980).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Methyl Bromide, Washington, DC, Office of Toxic Substances (Feb. 20, 1985).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Methyl Bromide, Washington, DC, Chemical Emergency Preparedness Program (Nov. 30, 1987).

New York State Department of Health, *Chemical Fact Sheet*: Methyl Bromide, Bureau of Toxic Substance Assessment, Albany, NY (March 1986 and Version 3).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 5, No. 6, 37−40 (1985).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Methyl Bromide, Trenton, NJ (March 2006).

Methyl-*tert*-Butyl Ether M:0730

Formula: $C_5H_{12}O$

Synonyms: Ether, *tert*-butyl methyl-; 2-Methoxy-2-methylpropane; Methyl 1,1-dimethylethyl ether; Methyl *tert*-butyl ether; MTBE; Propane, 2-methoxy-2-methyl-

CAS Registry Number: 1634-04-4

HSDB Number: 5847

RTECS Number: KN5250000

UN/NA & ERG Number: UN2398/127 (P)

EC Number: 216-653-1 [*Annex I Index No.*: 603-181-00-X]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human Inadequate Evidence, animal Limited Evidence, *not classifiable as carcinogenic to humans*, Group 3.

Hazard Alert: Highly flammable, Polymerization hazard, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard. Listed for Tier 1 screening as an endocrine disruptor.[88]

Hazard symbols, risk, & safety statements: Hazard symbol: T, F; risk phrases: R11; R19; R48/23; R62; R63; R67; safety phrases: S1/2; S21; S36/37; R45; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Methyl-*tert*-butyl ether is a colorless liquid. Molecular weight = 88.15; specific gravity (H_2O:1) = 0.74 @ 20°C; boiling point = 55°C; freezing/melting point = −109°C; vapor pressure = 75 mmHg @ −2°C;

flash point = −10°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 3, reactivity 1. Soluble in water.

Potential Exposure: Used as an organic solvent; as an octane booster in unleaded gasolines; in making other chemicals; and in medicine to dissolve gall stones.

Incompatibilities: May form explosive mixture with air. May be able to form unstable peroxides. Much less likely to form peroxides than other ethers. Incompatible with strong acids. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. May accumulate static electrical charges, and cause ignition of its vapors.

Permissible Exposure Limits in Air

OSHA PEL: None

NIOSH REL: None

ACGIH TLV[1]: 50 ppm/180 milligram per cubic meter TWA [skin]; confirmed animal carcinogen with unknown relevance to humans.

PAC* Ver. 29[138]

PAC-1: $\mathbf{50_A}$ ppm

PAC-2: $\mathbf{570_A}$ ppm

PAC-3: $\mathbf{5300_A}$ ppm

*AEGLs are marked with a subscript "**A**" and correspond to 60-minute values.

DFG MAK: 50 ppm/180 milligram per cubic meter TWA; Peak Limitation Category I(1.5); Carcinogen Category 3B; Pregnancy Risk Group C.

Russia: STEL 100 milligram per cubic meter, 1993; Sweden: TWA 50 ppm (180 milligram per cubic meter); STEL 75 ppm (250 milligram per cubic meter), 1999; United Kingdom: TWA 25 ppm (92 milligram per cubic meter); STEL 75 ppm
(275 milligram per cubic meter), 2000; the Netherlands: MAC-TGG 180 milligram per cubic meter, 2003

Determination in Air: Use NIOSH Analytical Method #1615, MTBE.

Routes of Entry: Inhalation, skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin, and respiratory tract. Exposure can cause difficulty concentrating and thinking. Higher levels can cause headache, nausea, dizziness, weakness and lightheadedness.

Long-Term Exposure: May cause kidney damage. May cause tumors.

Points of Attack: Kidneys.

Medical Surveillance: Kidney function tests. The use of alcoholic beverages should be avoided before or during use.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Do not drink any alcoholic beverages before or during use.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with MTBE all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers; strong acids. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN2398 Methyl *tert*-butyl ether, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Solid streams of water may spread fire. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Methyl-*tert*-Butyl Ether, Trenton, NJ (March 2006).

Methyl *n*-Butyl Ketone M:0740

Formula: $C_6H_{12}O$; $CH_3CO(CH_2)_3CH_3$

Synonyms: *n*-Butyl methyl ketone; Butyl methyl ketone; 2-Hexanone; Hexanone-2; Ketone, butyl methyl; MBK; Methyl butyl ketone; MNBK; Propylacetone

CAS Registry Number: 591-78-6

HSDB Number: 543

RTECS Number: MP1400000

UN/NA & ERG Number: UN1224/127

EC Number: 209-731-1 [*Annex I Index No.*: 606-030-00-6]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human Inadequate Evidence, animal Limited Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1999; EPA: Available data are inadequate for an assessment of human carcinogenic potential.

California Proposition 65 Chemical[102]: Developmental/Reproductive toxin (male) 8/7/2009

Hazard Alert: Highly flammable, Reproductive toxin: Suspected of causing genetic defects, Static charge accumulator.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, F; risk phrases: R11; R48/23; R62; R67; safety phrases: S1/2; S21; S33; S36/37; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [1-Low hazard to water. (est.)].

Description: MNBK is a colorless liquid with an acetone-like odor. The odor threshold is 0.08 ppm. Molecular weight = 100.18; specific gravity (H_2O:1) = 0.83 @ 20°C; boiling point = 127°C; freezing/melting point = −57°C; vapor pressure = 10 mmHg @ 39°C; flash point = 25°C (cc); autoignition temperature = 423°C. Explosive limits: LEL = 1.2%; UEL: 8.0%. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 3, reactivity 0. Slightly soluble in water; solubility = 2%.

Potential Exposure: The material is used as a solvent.

Incompatibilities: Vapors may form explosive mixture with air. Violent reaction with oxidizers. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. May form unstable peroxides. Attacks plastics. May accumulate static electrical charges, and cause ignition of its vapors.

Permissible Exposure Limits in Air

NIOSH IDLH = 1600 ppm

Conversion factor: 1 ppm = 4.10 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 100 ppm/410 milligram per cubic meter TWA

NIOSH REL: 1 ppm/4 milligram per cubic meter TWA

ACGIH TLV[1]: 5 ppm/20 milligram per cubic meter TWA; 10 ppm/40 milligram per cubic meter STEL [skin]

DFG MAK: 5 ppm/21 milligram per cubic meter TWA; Peak Limitation Category II(8) [skin]; BAT: 5 mg [hexane-2,5-dione + 4,5-dihydroxy-2-hexanone]/L in urine at end-of-shift

PAC Ver. 29[138]

PAC-1: 10 ppm

PAC-2: 830 ppm

PAC-3: 5000 ppm

Australia: TWA 5 ppm (20 milligram per cubic meter), 1993; Austria: MAK 5 ppm (21 milligram per cubic meter), 1999; Belgium: TWA 5 ppm (20 milligram per cubic meter) [skin], 1993; Denmark: TWA 1 ppm (4 milligram per cubic meter) [skin], 1999; Finland: TWA 5 ppm (20 milligram per cubic meter); STEL 10 ppm (40 milligram per cubic meter) [skin], 1999; France: VME 5 ppm (20 milligram per cubic meter), VLE 8 ppm (35 milligram per cubic meter), 1999; Hungary: TWA 20 milligram per cubic meter; STEL 40 milligram per cubic meter [skin], 1993; the Netherlands:

MAC-TGG 2 milligram per cubic meter, 2003; Norway: TWA 1 ppm (4 milligram per cubic meter), 1999; the Philippines: TWA 100 ppm (410 milligram per cubic meter), 1993; Poland: MAC (TWA) 10 milligram per cubic meter, MAC (STEL) 50 milligram per cubic meter, 1999; Russia: TWA 5 ppm, 1993; Sweden: NGV 1 ppm (4 milligram per cubic meter), KTV 2 ppm (8 milligram per cubic meter) [skin], 1999; Turkey: TWA 100 ppm (410 milligram per cubic meter), 1993; United Kingdom: TWA 5 ppm (21 milligram per cubic meter) [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 10 ppm [skin]. Several states have set guidelines or standards for MBK in ambient air[60] ranging from 54 μ/m^3 (Massachusetts) to 80 μ/m^3 (Connecticut) to 200 μ/m^3 (North Dakota) to 350 μ/m^3 (Virginia) to 476 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method #1300, Ketones, #2555; OSHA Analytical Method PV-2031[18].

Determination in Water: Octanol–water coefficient: $\text{Log } K_{ow} = 1.4$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Methyl-*n*-butyl ketone can affect you when breathed in and by passing through your skin. Irritates the eyes, skin, and respiratory tract. May affect the nervous system. Exposure may result in unconsciousness. Overexposure can cause you to feel dizzy and lightheaded and to pass out.

Long-Term Exposure: Repeated or prolonged contact with skin may cause drying and cracking. Exposure can damage the nerves, causing numbness and weakness, especially in the hands and feet. The vapor can irritate eyes, nose, and throat. There is limited evidence that this chemical may have reproductive effects. It may damage the male reproductive system. Handle with extreme caution. Exposure to other aliphatic monoketones e.g., methyl ketone, methyl propyl ketone, methyl amyl ketone, hexyl ketone, etc.) may exacerbate the nerve damage caused by this chemical.

Points of Attack: Eyes, skin, respiratory system; central nervous system; peripheral nervous system.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure. Before beginning employment and at regular times after that, the following are recommended: exam of the nervous system. CBC. If symptoms develop or overexposure has occurred, the following may be useful: Nerve conduction tests should be considered. For males who suspect any problems conceiving a child, semen analysis and sperm count may be useful.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Saranex is recommended in the literature. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See NIOSH Criteria Document 78-173, *Ketones*.

Respirator Selection: NIOSH: *10 ppm*: Sa (APF = 10) (any supplied-air respirator). *25 ppm*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *50 ppm*: SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *1600 ppm*: SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd, Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv (APF = 50) [any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Methyl *n*-butyl ketone must be stored to avoid contact with strong oxidizers (such as peroxides, chlorates, perchlorates, permanganates, and nitrates) because violent reactions occur. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from heat, sparks, and flames. Sources of ignition, such as smoking and open flames are prohibited where methyl *n*-butyl ketone is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers used in the transfer of 5 gal or more of methyl *n*-butyl ketone should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of methyl *n*-butyl ketone.

Shipping: UN1224 Ketones, liquid, n.o.s., Hazard Class: 3; Labels: 3-Flammable liquid, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(102); (31); (173); (101); (138); (2); (100).

National Institute for Occupational Safety and Health (NIOSH), "Criteria for a Recommended Standard: Occupational Exposure to Ketones", NIOSH Document Number 78-173, Washington, DC (1978).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Methyl *n*-Butyl Ketone, Trenton, NJ (April 2004).

Methyl Chloride M:0750

Formula: CH_3Cl

Synonyms: Artic; Chlor-methan (German); Chloromethane; Chlorure de methyle (French); Methylchlorid (German); Monochloromethane; Methane, chloro-

CAS Registry Number: 74-87-3

HSDB Number: 883

RTECS Number: PA6300000

UN/NA & ERG Number: UN1063/115

EC Number: 200-817-4 [*Annex I Index No*.: 602-001-00-7]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 ($\geq$1.00% concentration).

Carcinogenicity: EPA Group 3, possibly carcinogenic to humans; NIOSH: Potential occupational carcinogen. IARC: Human Inadequate Evidence, animal Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1999.

United States Environmental Protection Agency Gene-Tox Program, Positive: Histidine reversion-Ames test.

California Proposition 65 Developmental/Reproductive toxin 3/10/2000; male 8/7/2009.

Hazard Alert: Possible risk of forming tumors, Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated, Reproductive toxin: possible risk of gene damage/impaired fertility; Suspected reprotoxic hazard.

OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 15,000 lb

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg)

United States National Primary Drinking Water Regulations: SMCL = 250 mg[Cl^-]/L as Chloride

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR 41331, 9/9/1992)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U045

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Safe Drinking Water Act (47FR 9352): Priority List (55 FR 1470)

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.19; Nonwastewater (mg/kg), 30

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8010 (1); 8240 (10)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: F+, Xn; risk phrases: R40; R5; R12; R21; R40; R48/20; R62; R63; safety phrases: S1; S2; S9; S16; S33; S38; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Methyl chloride is a colorless gas with a faint, sweet odor which is not noticeable at dangerous concentrations. The odor threshold is 10 ppm. Shipped as a liquefied compressed gas. Molecular weight = 50.49; specific gravity (H_2O:1) = 0.92; boiling point = −24.1°C; freezing/melting point = −97.7°C; relative vapor density (air = 1) = 1.78; vapor pressure = 750 mmHg @ −24.4°C; flash point = flammable gas; autoignition temperature = 632°C. Explosive limits: LEL = 8.1%; 55,000 ppm[138]; UEL: 17.4%. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 4, reactivity 0. Slightly soluble in water (reaction); solubility 0.5%.

Potential Exposure: Methyl chloride is used as a methylating and chlorinating agent in organic chemistry; Used in production of silicones and tetramethyl lead. In petroleum refineries it is used as an extractant for greases, oils, and resins. Methyl chloride is also used as a solvent in the synthetic rubber industry; as a refrigerant; and as a propellant in polystyrene foam production. In the past it has been used as a local anesthetic (freezing). It is an intermediate in drug manufacture.

Incompatibilities: Violent reaction with chemically active metals, such as potassium, powdered aluminum; zinc, and magnesium. Reaction with aluminum trichloride, ethylene. Reacts with water (hydrolyzes) to form hydrochloric acid. Attacks many metals in the presence of moisture.

Permissible Exposure Limits in Air

NIOSH IDLH = 2000 ppm, potential occupational carcinogen

OSHA PEL: 100 ppm TWA; 200 ppm Ceiling Concentration; 300 ppm [5 minutes max peak in any 3 hours] [skin]

NIOSH REL: A potential occupational carcinogen. Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A

ACGIH TLV[1]: 50 ppm/103 milligram per cubic meter TWA; 100 ppm/207 milligram per cubic meter STEL; [skin]; not classifiable as a human carcinogen

PAC* Ver. 29[138]

PAC-1: 150 ppm

PAC-2: **910**$_{\mathbf{A}}$ ppm

PAC-3: **3000**$_{\mathbf{A}}$ ppm

*AEGLs are marked with a subscript "**A**" and correspond to 60-minute values.

DFG MAK: 50 ppm/100 milligram per cubic meter TWA; Peak Limitation Category II(2) [skin]; Pregnancy Risk Group B; Carcinogen Category 3

Arab Republic of Egypt: TWA 50 ppm (105 milligram per cubic meter), 1993; Australia: TWA 50 ppm (105 milligram per cubic meter); STEL 100 ppm, 1993; Austria: MAK 50 ppm (105 milligram per cubic meter), Suspected: carcinogen, 1999; Belgium: TWA 50 ppm (103 milligram per cubic meter); STEL 100 ppm (207 milligram per cubic meter), 1993; Denmark: TWA 50 ppm (105 milligram per cubic meter), 1999; Finland: TWA 50 ppm (105 milligram per cubic meter); STEL 75 ppm (160 milligram per cubic meter), 1999; France: VME 50 ppm (105 milligram per cubic meter), VLE 100 ppm, carcinogen, 1999; the Netherlands: MAC-TGG 52 milligram per cubic meter, 2003; Japan: 50 ppm (100 milligram per cubic meter), 1999; Norway: TWA 25 ppm (50 milligram per cubic meter), 1999; the Philippines: TWA 100 ppm (210 milligram per cubic meter), 1993; Poland: MAC (TWA) 20 milligram per cubic meter; STEL 160 milligram per cubic meter, 1999; Russia: TWA 50 ppm; STEL 5 milligram per cubic meter, 1993; Sweden: NGV 50 ppm (100 milligram per cubic meter), KTV 100 ppm (200 milligram per cubic meter), 1999; Switzerland: MAK-W 50 ppm (105 milligram per cubic meter), KZG-W 100 ppm (210 milligram per cubic meter); Thailand: TWA 100 milligram per cubic meter; STEL 200 milligram per cubic meter, 1993; Turkey: TWA 100 ppm (210 milligram per cubic meter), 1993; United Kingdom: TWA 50 ppm (105 milligram per cubic meter); STEL 100 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, IN New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 100 ppm [skin]. Several states have set guidelines or standards for methyl chloride in ambient air[60] ranging from 1.6 μ/m^3 (Michigan) to 74.12 μ/m^3 (Kansas) to 1050−2050 μ/m^3 (North Dakota) to 1750 μ/m^3 (Virginia) to 2100 μ/m^3 (Connecticut and New York) to 2500 μ/m^3 (Nevada) to 2520 μ/m^3 (Pennsylvania).

Determination in Air: Use NIOSH Analytical Method (IV) #1001.

Permissible Concentration in Water: *To protect human health*: preferably zero. An additional lifetime cancer risk of 1 in 100,000 is posed by a concentration of 1.9 μg/L[6]. In addition, Several states have set guidelines for methyl chloride in drinking water[61] ranging from 0.19 μg/L (Kansas) to 0.50 μg/L (Arizona).

Determination in Water: Gas chromatography (EPA Method 601) or gas chromatography and mass spectrometry (EPA Method #624). Octanol−water coefficient: Log $K_{ow} = 0.9$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, skin and/or eye contact (liquid).

Harmful Effects and Symptoms

Short-Term Exposure: *Inhalation*: Illness has been reported at concentrations of 500 ppm. 10,000 ppm for 30 minutes has caused death. Can cause nausea, vomiting, painful neck; loss of appetite. More severe exposure may result in the above plus headache; diarrhea, dizziness, loss of coordination; tremors of hands and lips; drooping eyelids and eye twitch. Very severe exposure may include the above plus burning sensation in mouth and throat; mustard-like taste; difficulty in swallowing; hallucinations, loss of memory; cold and clammy skin; rapid breathing; unconsciousness, coma and death. Onset of symptoms may be delayed several hours after exposure. Effects may last weeks or months. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. *Skin*: Contact with liquefied gas may cause freezing of skin, burns and permanent damage. Other symptoms are muscular pain, anemia, muscle weakness and fever. *Eyes*: Contact with the liquid can cause frostbite and severe burns, leading to permanent damage. May cause dimness of sight and abnormally dilated pupils. *Ingestion*: Ingestion of liquefied gas will cause freezing of mouth and throat.

Long-Term Exposure: Long-term exposure may affect the testes, causing decreased production of male hormones and sperm. There is limited evidence that methyl chloride causes kidney cancer in animals. May damage the liver and kidneys. May cause brain damage. May cause blurred or double vision, and "drunken" behavior.

Points of Attack: Central nervous system; liver, kidneys, brain, reproductive system.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure. NIOSH lists the following tests: whole blood (chemical/metabolite), expired air, urine (chemical/metabolite). For those with frequent or potentially high exposure (half the TLV or greater, or significant skin contact), the following are recommended before beginning work and at regular times after that. Lung function tests. Exam of the nervous system. If symptoms develop or overexposure is suspected, the following may be useful: exam of the nervous system. Kidney function tests. Liver function tests. Examination for brain effects. Consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If frostbite has occurred, seek medical attention immediately; do NOT rub the affected areas or flush them with water. In order to prevent further tissue damage, do NOT attempt to remove frozen clothing from frostbitten areas. If frostbite has NOT occurred, immediately and thoroughly wash contaminated skin with soap and water. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid: **8 hours:** Viton gloves, suits, Saranex coated suits, Barricade coated suits; Responder suits, Trellchem HPS suits; Trychem 1000 suits. **4 hours:** Teflon gloves, suits, boots. Prevent possible skin freezing from direct liquid contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear eye protection to prevent any reasonable probability of eye contact. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Based on potential carcinogenicity the following is recommended by NIOSH: *At any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full- facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Check oxygen content prior to entering storage area. Flammable gas. Color code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Methyl chloride must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, chlorates, nitrates, and permanganates) or chemically active metals (such as sodium, potassium; powdered aluminum; zinc, and magnesium), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat and direct sunlight. Sources of ignition, such as smoking and open flames are prohibited where methyl chloride is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever methyl chloride is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN1063 Methyl chloride, or Refrigerant gas R 40, Hazard Class: 2.1; Labels: 2.1-Flammable gas. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Stop the flow of gas if it can be done safely. If source of leak is a cylinder and the leak cannot be stopped in place, remove leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. Keep this chemical out of confined space, such as a sewer because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable gas. Thermal decomposition products may include hydrogen chloride and oxides of carbon. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform to EPA regulations governing storage, transportation, treatment, and waste disposal. Controlled incineration with adequate scrubbing and ash disposal facilities.

References

(31); (173); (101); (138); (2); (100).

United States Environmental Protection Agency, Halomethanes: Ambient Water Quality Criteria, Report PB-296, 797 Washington, DC (1980).

National Institute for Occupational Safety and Health (NIOSH), Information Profiles on Potential Occupational Hazards: Methyl Chloride, Report PB-276-678, Rockville, MD, pp 29-36 incl. (Oct. 1977).

United States Environmental Protection Agency, Chloromethane, Health and Environmental Effects Profile No. 48, Washington, DC, Office of Solid Waste (April 30, 1980).

New York State Department of Health, *Chemical Fact Sheet*: Methyl Chloride, Bureau of Toxic Substance Assessment, Albany, NY (March 1986 and Version 2).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 2, No. 4, 76−78 (1982).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Methyl Chloride, Trenton, NJ (August 2004).

Methyl 2-Chloroacrylate M:0760

Formula: $C_4H_5ClO_2$: $CH_2Cl{=}CHCOOCH_3$
Synonyms: 2-Chloroacrylate de méthyle (French); 2-Chloroacrylic acid, methyl ester; 2-Chloropropenoic acid, methyl ester; 2-Chloro-2-propenoic acid methyl ester; 2-Cloroacrilato de metilo (Spanish); Methyl-α-chloroacrylate
CAS Registry Number: 80-63-7
HSDB Number: 5238
RTECS Number: AS6380000
UN/NA & ERG Number: UN2929/131 (P)
EC Number: 201-298-7
Regulatory Authority and Advisory Information
Hazard Alert: Highly flammable liquid, Highly toxic, Corrosive, Polymerization hazard, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction)
Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500 lb (227 kg)
Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 500 lb (227 kg)
Hazard symbols, risk, & safety statements: Hazard symbol: C, F, T+; risk phrases: R11; R19; R23/24/25; R34; R50/53; safety phrases: S9; S16; S21; S25; S26; S28; S33; S38; S36/37/39; S41; S45 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): No value found [3-Severe hazard to water. (est.)].
Description: Methyl 2-chloroacrylate is a colorless liquid. Molecular weight = 120.54; specific gravity (H_2O:1) = 1.89 @ 20°C; boiling point = 52.22°C; vapor pressure = 12 mmHg @ 25°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 3, reactivity 0. Slightly soluble in water; solubility = < 1 mg/mL @ 22°C.
Potential Exposure: Used to make acrylic high polymer with properties closely resembling those of polymethylmethacrylate. Monomer for specialty polymers e.g., aircraft glazing)[72]. Corrosive. Lacrimator.
Incompatibilities: Vapor may form explosive mixture with air. May hydrolyze upon contact with moisture. Incompatible with nitrates. Methyl 2-chloroacrylate is sensitive to prolonged exposure to light, moisture and heat[101]. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, and polymerizers. Compounds of the carboxyl group react with all bases, both inorganic and organic (i.e., amines) releasing substantial heat, water and a salt that may be harmful. Incompatible with arsenic compounds (releases hydrogen cyanide gas), diazo compounds, dithiocarbamates, isocyanates, mercaptans, nitrides, and sulfides (releasing heat, toxic, and possibly flammable gases), thiosulfates and dithionites (releasing hydrogen sulfate and oxides of sulfur). May be a polymerization hazard.
Permissible Exposure Limits in Air
PAC Ver. 29[138]
PAC-1: 0.091 ppm
PAC-2: 1 ppm
PAC-3: 36 ppm
Routes of Entry: Inhalation.
Harmful Effects and Symptoms
Short-Term Exposure: Corrosive and a lacrimator. It is a skin, eye, and lung irritant; may cause skin burns and eye damage. A trace on skin causes large blisters. Inhalation of high concentrations may cause rapid breathing; headache, nausea, lethargy, convulsions, and death. Also, high exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.
Points of Attack: Lungs.
Medical Surveillance. Lung function tests. Consider chest X-ray following acute overexposure.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.
Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: (1) Color code—Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. (2) Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. (3) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers and reducing agents. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: UN2929 Toxic liquids, flammable, organic, n.o.s., Hazard class: 6.1; Labels: 6.1-Poison Inhalation Hazard, 3-Flammable liquid, Technical Name Required.

Spill Handling:

Toxic liquids, flammable, organic, n.o.s.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.3/0.4
Night 0.8/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 600/180
Then: Protect persons downwind (mi/km)
Day 1.4/2.3
Night 2.9/4.6

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120 (q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include hydrogen chloride and oxides of carbon. *Small fires*: dry chemical, carbon dioxide; water spray; or foam. *Large fires*: water spray, fog, or foam. Move container from fire area if you can do so without risk. Fight fire from maximum distance. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Wear positive pressure breathing apparatus and special protective clothing. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Methyl 2-Chloroactrylate, Washington, DC, Chemical Emergency Preparedness Program (Nov. 30, 1987).

Methyl Chloroformate M:0770

Formula: $C_2H_3ClO_2$

Synonyms: Carbonochloridic acid, methyl ester; Chlorameisensaeure methylester (German); Chlorocarbonate de methyle (French); Chlorocarbonic acid methyl ester; Chloroformic acid methyl ester; MCF; Methoxycarbonyl chloride

CAS Registry Number: 79-22-1

HSDB Number: 1116

RTECS Number: FG3675000

UN/NA & ERG Number: (PIH) UN1238/155

EC Number: 201-187-3 [*Annex I Index No.*: 607-019-00-9]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Hazard Alert: Poison inhalation hazard, High acute toxicity, Highly flammable liquid, Corrosive, Dangerously water reactive.

OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 500 lb (227 kg)
Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 5000 lb (2270 kg)
United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U156
RCRA, 40CFR261, Appendix 8 Hazardous Constituents
Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500 lb (227 kg)
Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1000 lb (454 kg)
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
United States DOT 49CFR172.101, Inhalation Hazardous Chemical (PIH).
Hazard symbols, risk, & safety statements: Hazard symbol: T+, F, C, Xn; risk phrases: R11; R21/22; R26; R34; safety phrases: S1/2; S14; S21; S26; S28; S36/37/39; S45; S46; S63; S41 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Methyl chloroformate is a colorless liquid with an unpleasant, acrid odor. This is a highly corrosive and flammable material. Molecular weight = 94.5; specific gravity (H_2O:1) = 1.22; boiling point = 71°C; freezing/melting point = −61°C; flash point = 17°C; autoignition temperature = 504°C. Explosive limits: LEL = 55,000 ppm; UEL: unknown. Flammability limits: LEL = 6.7%; UEL: unknown. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 3, reactivity 1₩. Slightly soluble in water reacts forming hydrogen chloride, methanol and oxides of carbon.

Potential Exposure: Used in synthesis of pharmaceuticals; herbicides, plastics and other organic chemicals; as a solvent in the photographic industry; as a chemical intermediate in the production of other chemicals. In WWI it was used as military tear-producing warfare agent.

Incompatibilities: May form explosive mixture with air. Violent reaction with alkali metals; ethers. Incompatible with strong acids; strong bases; alcohols, oxidizers, dimethylsulfoxide; dimethyl formamide. Contact with water or moisture produces corrosive and poisonous hydrogen chloride gas, methanol and carbon monoxide. Corrodes metals in the presence of moisture. Attacks some plastics, rubber and coatings.

Permissible Exposure Limits in Air
PAC* Ver. 29[138]
PAC-1: 0.6 ppm
PAC-2: **2.2**$_{\mathbf{A}}$ ppm
PAC-3: **6.7**$_{\mathbf{A}}$ ppm
*AEGLs are marked with a subscript "**A**" and correspond to 60-minute values.
DFG MAK: 0.2 ppm/0.78 milligram per cubic meter TWA; Peak Limitation Category I(2); Pregnancy Risk Group C

Routes of Entry: Ingestion, inhalation, skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Can be fatal if ingested or inhaled. A concentration of 190 ppm has been lethal in 10 minutes. Highly corrosive, contact can irritate and burn the skin and eyes, with possible permanent damage. Inhalation irritates the respiratory tract causing coughing and/or shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: Can cause sensitization and skin allergy. Can cause lung irritation and bronchitis. After 2−3 inhalations, brief initial irritation may occur followed by massive symptoms (heavy cough) after 36 hours. Relapse may occur in the following days with eventual recovery.

Points of Attack: Skin, lungs.

Medical Surveillance. Lung function tests. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Poison inhalation chemical (PIH); check oxygen content prior to entering storage area.(1) Color code—Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. (2) Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with methyl chloroformate all handlers should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from all forms of moisture, oxidizers, strong acids; strong bases. See incompatibilities for other materials to avoid. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1238 Methyl chloroformate, Hazard class: 6.1; Labels: 6.1-Poison Inhalation Hazard, 3-Flammable liquid, 8-Corrosive material Inhalation Hazard Zone A.

Spill Handling:

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 0.4/0.6

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 500/150
Then: Protect persons downwind (mi/km)
Day 0.7/1.1
Night 1.4/2.3

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include hydrogen chloride, phosgene and oxides of carbon. *Do not use water*. Use dry chemical, carbon dioxide; alcohol foam; or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform to EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Methyl Chloroformate, Trenton, NJ (June 1999).

Methyl Cyanoacrylate M:0790

Formula: $C_5H_5NO_2$: $CH_2{=}C(CN)COOCH_3$

Synonyms: Acrylic acid, 2-cyano-, methyl ester; Adhere; 2-Cyanoacrylic acid methyl ester; Eastman 910 monomer; Mecrylate; 2-Propenoic acid, 2-cyano-, methyl ester; Super Bonder; Super Glue

CAS Registry Number: 137-05-3

HSDB Number: 1207
RTECS Number: AS7000000
UN/NA & ERG Number: UN3334 (Aviation regulated liquid, n.o.s.)/171 (ICOA/IATA)
EC Number: 205-275-2 [*Annex I Index No.*: 607-235-00-3]

Regulatory Authority and Advisory Information

Hazard Alert: Flammable, Suspected reprotoxic hazard, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction).

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xi; risk phrases: R10; R36/37/38; R62; safety phrases: S2; S23; 24/25; S26; S41 (see Appendix 4).

Description: Methyl cyanoacrylate is a thick, clear liquid adhesive. The odor threshold is 2.2 ppm. Molecular weight = 111.11; specific gravity (H_2O:1) = 1.10 @ 27°C; boiling point = 201°C; freezing/melting point = −23°C; vapor pressure = 0.2 mmHg @ 20°C; flash point = 78.9°C. Explosive limits: LEL = 15,000 ppm; UEL: unknown. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 2, reactivity 1. Insoluble in water.

Potential Exposure: Methyl 2-cyanoacrylate is used in production of coatings and textiles; in the manufacture of quick-setting, high-strength, adhesive cements. Often found around the home; bonds eyes and skin in seconds. *Keep out of the reach of children*.

Incompatibilities: Compounds of the carboxyl group react with all bases, both inorganic and organic (i.e., amines) releasing substantial heat, water and a salt that may be harmful. Incompatible with arsenic compounds (releases hydrogen cyanide gas), diazo compounds, dithiocarbamates, isocyanates, mercaptans, nitrides, and sulfides (releasing heat, toxic, and possibly flammable gases), thiosulfates and dithionites (releasing hydrogen sulfate and oxides of sulfur). Reacts violently with water, bases, and peroxides. Contact with alcohols, water, amines, and alkalis can cause rapid polymerization.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 4.54 milligram per cubic meter @ 25°C & 1 atm
OSHA PEL: None
NIOSH REL: 2 ppm/8 milligram per cubic meter TWA; 4 ppm/16 milligram per cubic meter STEL
ACGIH TLV[1]: 0.2 ppm/1 milligram per cubic meter TWA
PAC Ver. 29[138]
PAC-1: 0.6 ppm
PAC-2: 0.85 ppm
PAC-3: 5.1 ppm
DFG MAK: 2 ppm/9.2 milligram per cubic meter TWA; Peak Limitation Category I(1); Pregnancy Risk Group D

Australia: TWA 2 ppm (8 milligram per cubic meter); STEL 4 ppm, 1993; Austria: MAK 2 ppm (8 milligram per cubic meter), 1999; Belgium: TWA 2 ppm (9.1 milligram per cubic meter); STEL 4 ppm (18 milligram per cubic meter), 1993; Denmark: TWA 2 ppm (8 milligram per cubic meter), 1999; Finland: TWA 2 ppm (9 milligram per cubic meter); STEL 4 ppm (18 milligram per cubic meter) [skin], 1993; France: VME 2 ppm (8 milligram per cubic meter), VLE 4 ppm (16 milligram per cubic meter), 1999; Norway: TWA 2 ppm (8 milligram per cubic meter), 1999; Sweden: NGV 2 ppm (9 milligram per cubic meter), KTV 4 ppm (18 milligram per cubic meter), 1999; Switzerland: MAK-W 2 ppm (9 milligram per cubic meter), 1999; United Kingdom: STEL 0.3 ppm (1.4 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 0.2 ppm. Several states have set guidelines or standards for methyl cyanoacrylate in ambient air[60] ranging from 48 μ/m^3 (Nevada) to 80−160 μ/m^3 (North Dakota) to 130 μ/m^3 (Virginia) to 160 μ/m^3 (Connecticut).

Determination in Air: Use OSHA Analytical Method 55.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Methyl 2-cyanoacrylate can affect you when breathed in. Exposure can irritate the eyes, nose and throat. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Inhalation of vapor may cause an asthmatic reaction. Contact can irritate the eyes and skin. Capable of instantly gluing skin tissue.

Long-Term Exposure: Methyl 2-cyanoacrylate may cause a skin allergy to develop. Once an allergy has developed, even very small future exposures will cause rash and itching. Repeated exposure may affect the liver and kidneys. May be able to cause lung damage.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function tests. Consider chest X-ray after acute overexposure. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with plenty of soap and water. Remove cured adhesive with hot soapy water. Do not pull or scrape off adhesive as skin can also come off. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures *over 2* ppm; Use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA approve SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Methyl 2-cyanoacrylate must be stored to avoid contact with water, alkaline materials or peroxides, since violent reactions occur. Store in original containers under refrigerated conditions at 2 to 8°C. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: UN3334 Aviation regulated liquid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material. Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include cyanide and nitrogen oxides. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Avoid water unless you can flood the area. Water causes methyl 2-cyanoacrylate to polymerize and possibly to ignite spontaneously. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Methyl 2-Cyanoacrylate, Trenton, NJ (February 2000).

Methylcyclohexane M:0800

Formula: C_7H_{14}; $C_6H_{11}CH_3$

Synonyms: Cyclohexane, methyl-; Cyclohexylmethane; Heptanaphthene; Hexahydrotoluene; MCH; Sextone B; Toluene hexahydride

CAS Registry Number: 108-87-2

HSDB Number: 98

RTECS Number: GV6125000

UN/NA & ERG Number: UN2296/128

EC Number: 203-624-3 [*Annex I Index No.*: 601-018-00-7]

Regulatory Authority and Advisory Information

Hazard Alert: Highly flammable, Primary irritant (w/o allergic reaction), Static charge accumulation possible/low flash point and LEL.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: F; Xn, N; risk phrases: R11; R38; R51/53; R38; R65; R67; safety phrases: S2; S9; S16; S21; S33; S61; S62; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Methylcyclohexane, an alkene, is a colorless liquid with a faint benzene-like odor. The odor threshold is

630 ppm (this is above the OEL). Molecular weight = 98.21; specific gravity (H_2O:1) = 0.79 @ 20°C; boiling point = 100°C; freezing/melting point = −126°C; vapor pressure = 40 mmHg @ 22°C; flash point = −3.9°C (cc), −5.9°C (oc); autoignition temperature = 258°C. Explosive limits: LEL = 1.1%; UEL: 6.7%. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 3, reactivity 0. Insoluble in water.

Potential Exposure: Methylcyclohexane is used as a solvent for cellulose derivatives particularly with other solvents; and as an organic intermediate in organic synthesis. A component of jet fuel.

Incompatibilities: Vapor may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Attacks some plastics, rubber and coatings.

Permissible Exposure Limits in Air

NIOSH IDLH = 1200 ppm

OSHA PEL: 500 ppm/2000 milligram per cubic meter TWA

NIOSH REL: 400 ppm/1600 milligram per cubic meter TWA

ACGIH TLV[1]: 400 ppm/1610 milligram per cubic meter TWA

PAC Ver. 29[138]

PAC-1: 1200 ppm (10−49% LEL)

PAC-2: 1700 ppm (10−49% LEL)

PAC-3: 10,000 ppm (50−99% LEL)

DFG MAK: 200 ppm/810 milligram per cubic meter TWA; Peak Limitation Category II(2); Pregnancy Risk Group D

Australia: TWA 400 ppm (1600 milligram per cubic meter), 1993; Belgium: TWA 400 ppm (1610 milligram per cubic meter), 1993; Denmark: TWA 200 ppm (805 milligram per cubic meter), 1999; Finland: TWA 400 ppm (1600 milligram per cubic meter); STEL 500 ppm (2000 milligram per cubic meter), 1999; France: VME 400 ppm (1600 milligram per cubic meter), 1999; Japan: 400 ppm (1600 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 1600 milligram per cubic meter, 2003; the Philippines: TWA 500 ppm (2000 milligram per cubic meter), 1993; Poland: MAC (TWA) 500 milligram per cubic meter, MAC (STEL) 2000 milligram per cubic meter, 1999; Russia: TWA 400 ppm; STEL 50 milligram per cubic meter, 1993; Switzerland: MAK-W 400 ppm (1600 milligram per cubic meter), KZG-W 800 ppm (3200 milligram per cubic meter), 1999; Turkey: TWA 500 ppm (2000 milligram per cubic meter), 1993; United Kingdom: LTEL 400 ppm (1600 milligram per cubic meter); STEL 500 ppm, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 400 ppm. Several states have set guidelines or standards for methyl cyclohexane in ambient air[60] ranging from 16−20 milligram per cubic meter (North Dakota) to 27 milligram per cubic meter (Virginia) to 32 milligram per cubic meter (Connecticut) to 38.095 milligram per cubic meter (Nevada).

Determination in Air: Charcoal adsorption, workup with CS_2, analysis by gas chromatography/flame ionization. Use NIOSH Analytical Method #1500 for Hydrocarbons, BP 36−126°C[18].

Permissible Concentration in Water: Vermont has set a guideline for drinking water of 28.6 mg/L[61].

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Harmful if inhaled or swallowed. Vapor or mist is irritating to the eyes, mucous membrane and upper respiratory tract and skin. Narcotic effects and dermatitis[136,1999].

Short-Term Exposure: Methylcyclohexane can affect you when breathed in. Irritates the eyes, skin and respiratory tract. May affect the central nervous system; exposure may cause dizziness, lightheadedness. High levels may act as an anesthetic. Unconsciousness and death may occur at higher levels. Aspiration hazard. Ingesting or breathing the liquid may cause chemical pneumonitis. Effects may include severe pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of chemical pneumonitis or pulmonary edema are aggravated by physical effort. This can result in death.

Long-Term Exposure: Prolonged or repeated skin contact can cause cracking and drying of exposed areas. May affect the liver and kidneys. Possible sensitization of the skin or lungs.

Points of Attack: Eyes, skin, respiratory system; central nervous system; kidneys, liver.

Medical Surveillance: Liver and kidney function tests. Check for chemical pneumonia. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. Evaluation by a dermatologist. Evaluation by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 1200 ppm*: Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd, Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Methylcyclohexane must be stored to avoid contact with strong oxidizers, (such as chlorine, bromine, chlorine oxide, nitrates and permanganates), since violent reactions occur. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where methylcyclohexane is handled, used, or stored. Metal containers involving the transfer of 5 gal or more of methylcyclohexane should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of methylcyclohexane.

Shipping: UN2296 Methylcyclohexane, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire-fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Methylcyclohexane,(2). Washington, DC (1979).

(173); (101); (138).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Methyl Cyclohexane, Trenton, NJ (April 2004).

Methylcyclohexanol M:0810

Formula: $C_7H_{14}O$; $H_3CC_6H_{10}OH$

Synonyms: Hexahydrocresol; Hexahydromethyl phenol; Methylcyclohexanol; Methylcyclohexane

CAS Registry Number: 25639-42-3

HSDB Number: 2910

RTECS Number: GW0175000
UN/NA & ERG Number: UN2617/129
EC Number: 247-152-6
Regulatory Authority and Advisory Information
Hazard Alert: Flammable liquid.
Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.
Hazard symbols, risk, & safety statements: Hazard symbol: F, Xn; risk phrases: R10; R20/22; safety phrases: S24/25; R45 (see Appendix 4) F, R10.
WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: 2-Methylcyclohexanol is a straw-colored liquid. Weak, menthol-like odor. The odor threshold is 490 ppm. (higher than the OEL). Molecular weight = 114.21; specific gravity (H_2O:1) = 0.92; boiling point = 155−180°C (technical grade); freezing/melting point = −50°C; vapor pressure = 2 mmHg @ 30°C; flash point = 65−68°C; autoignition temperature = 296°C. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 2, reactivity 0. Slightly soluble in water.

Potential Exposure: Methylcyclohexanol is used as a lacquer solvent; as a blending agent in textile soaps and as an antioxidant in lubricants.

Incompatibilities: Vapors may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Attacks some plastics, rubber, and coatings.

Permissible Exposure Limits in Air
NIOSH IDLH = 500 ppm, *Note*: Odor Threshold = 490 ppm.
Conversion factor: 1 ppm = 4.67 milligram per cubic meter @ 25°C & 1 atm
OSHA PEL: 100 ppm/470 milligram per cubic meter TWA
NIOSH REL: 50 ppm/235 milligram per cubic meter TWA
ACGIH TLV[1]: 50 ppm/234 milligram per cubic meter TWA
PAC not available
DFG MAK: MAK 50 ppm/235 milligram per cubic meter
Australia: TWA 50 ppm (235 milligram per cubic meter), 1993; Belgium: TWA 50 ppm (234 milligram per cubic meter), 1993; Denmark: TWA 50 ppm (235 milligram per cubic meter), 1999; Finland: TWA 50 ppm (235 milligram per cubic meter); STEL 75 ppm (355 milligram per cubic meter), 1993; France: VME 50 ppm (235 milligram per cubic meter), 1999; Japan: 50 ppm (230 milligram per cubic meter), 1999; Norway: TWA 25 ppm (115 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 50 milligram per cubic meter [skin], 2003; the Philippines: TWA 100 ppm (470 milligram per cubic meter), 1993; Poland: MAC (TWA) 50 milligram per cubic meter, MAC (STEL) 350 milligram per cubic meter, 1999; Russia: TWA 50 ppm, 1993; Switzerland: MAK-W 50 ppm (235 milligram per cubic meter), KZG-W 100 ppm (470 milligram per cubic meter), 1999; Turkey: TWA 100 ppm (470 milligram per cubic meter), 1993; United Kingdom: LTEL 50 ppm (235 milligram per cubic meter); STEL 75 ppm, 1993; United Kingdom: TWA 50 ppm (237 milligram per cubic meter); STEL 75 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 50 ppm. Several states have set guidelines or standards for methyl cyclohexanol in ambient air[60] ranging from 2.35−3.5 milligram per cubic meter (North Dakota) to 3.9 milligram per cubic meter (Virginia) to 4.7 milligram per cubic meter (Connecticut) to 5.595 milligram per cubic meter (Nevada).

Determination in Air: Charcoal tube; CH_2Cl_2; Gas chromatography/Flame ionization detection; NIOSH Analytical Method (IV) #1404. See also NIOSH: Methylcyclohexanol Method #S374.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 2.1. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Methylcyclohexanol can affect you when breathed in and by passing through your skin. Irritates the eyes and the skin. High levels of the vapor may cause irritation of eyes and upper respiratory tract. Repeated or prolonged exposure can cause headaches, irritation of the eyes, nose, and throat; and can also cause a skin rash. High exposures from skin contact or inhalation may cause damage to the heart, liver, kidneys, and lungs, and may result in death.

Long-Term Exposure: Repeated or prolonged contact with skin may cause skin rash. Animal studies have shown this chemical to cause liver and kidney damage.

Points of Attack: Eyes, skin, respiratory system; central nervous system; kidneys, liver.

Medical Surveillance: If symptoms develop or overexposure has occurred, the following may be useful. Lung function tests. Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable

probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *500 ppm*: Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd, Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister]; or SCBAE (any appropriate escape-type, SCBA). *Note*: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Methylcyclohexanol must be stored to avoid contact with strong oxidizers (such as peroxides, chlorates, perchlorates, nitrates, and permanganates), since violent reactions occur. Sources of ignition, such as smoking and open flames are prohibited where methylcyclohexanol is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2617 Methylhexylhexanone, flammable, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Methyl Cyclohexanol, Trenton, NJ (March 2000)

2-Methylcyclohexanone M:0820

Formula: $C_7H_{12}O$; $H_3CC_6H_9O$

Synonyms: Methyl anone; *o*-Methyl-cyclohexanon (German); Methylcyclohexanone; *o*-Methylcyclohexanone; 1-Methylcyclohexan-2-one

CAS Registry Number: 583-60-8

HSDB Number: 2917

RTECS Number: GW1750000

UN/NA & ERG Number: UN2297/128

EC Number: 209-513-6 [*Annex I Index No.*: 606-011-00-2]

Regulatory Authority and Advisory Information

Hazard Alert: Highly flammable.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xn; risk phrases: R3; R11; R20/21; R36/37; safety phrases: S2; S25; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: *o*-Methylcyclohexanone is a colorless liquid with a weak peppermint-like odor (also reported to be acetone-like). Molecular weight = 112.19; specific gravity (H_2O:1) = 0.92 @ 20°C; boiling point = 165°C; freezing/melting point = −13.9°C; flash point = 47.8°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 2, reactivity 0. Insoluble in water.

Potential Exposure: Methylcyclohexanone is used as a solvent in making varnish, plastics, and as a rust remover. Also used in the leather industry.

Incompatibilities: Vapors may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Contact with peroxides may form unstable heat- and shock-sensitive explosives.

Permissible Exposure Limits in Air

NIOSH IDLH = 600 ppm

Conversion factor: 1 ppm = 4.59 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 100 ppm/460 milligram per cubic meter TWA [skin]

NIOSH REL: 50 ppm/230 milligram per cubic meter TWA; 75 ppm/345 milligram per cubic meter STEL [skin]

ACGIH TLV[1]: 50 ppm/229 milligram per cubic meter TWA; 75 ppm/344 milligram per cubic meter STEL [skin]

PAC Ver. 29[138]

PAC-1: 75 ppm

PAC-2: 420 ppm

PAC-3: 2500 ppm

DFG MAK: 50 ppm/230 milligram per cubic meter [skin]

Australia: TWA 50 ppm (230 milligram per cubic meter); STEL 75 ppm [skin], 1993; Austria: MAK 50 ppm (230 milligram per cubic meter) [skin], 1999; Belgium: TWA 50 ppm (229 milligram per cubic meter); STEL 75 ppm (344 milligram per cubic meter) [skin], 1993; Denmark: TWA 50 ppm (230 milligram per cubic meter) [skin], 1999; Finland: TWA 50 ppm (230 milligram per cubic meter); STEL 75 ppm (345 milligram per cubic meter) [skin], 1999; France: VME 50 ppm (230 milligram per cubic meter) [skin], 1999; Japan: 50 ppm (230 milligram per cubic meter) [skin], 1999; the Netherlands: MAC-TGG 230 milligram per cubic meter [skin], 2003; Norway: TWA 25 ppm (115 milligram per cubic meter), 1999; the Philippines: TWA 100 ppm (460 g/m^3) [skin], 1993; Poland: MAC (TWA) 50 milligram per cubic meter, MAC (STEL) 340 milligram per cubic meter, 1999; Russia: TWA 50 ppm, 1993; Switzerland: MAK-W 50 ppm (230 milligram per cubic meter), KZG-W 100 ppm (470 milligram per cubic meter) [skin], 1999; Turkey: TWA 100 ppm (460 milligram per cubic meter) [skin], 1993; United Kingdom: TWA 50 ppm (237 milligram per cubic meter); STEL 75 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 75 ppm [skin]. Several states have set guidelines or standards[60] for methylcyclohexanone in ambient air ranging from 2.3−3.45 milligram per cubic meter (North Dakota) to 3.9 milligram per cubic meter (Virginia) to 4.6 milligram per cubic meter (Connecticut) to 5.476 milligram per cubic meter (Nevada).

Determination in Air: Collection in an adsorption tube, workup with acetone; analysis by gas chromatography/flame ionization. Use NIOSH Analytical Method #2521[18].

Routes of Entry: Inhalation, ingestion; skin and/or eye contact. Passes through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: *o*-Methylcyclohexanone can affect you when breathed in and by passing through your skin. It can irritate the skin, eyes, nose, and throat. Breathing the vapor can cause headaches, dizziness, or lightheadedness. Contact can strongly irritate and even damage the eyes.

Long-Term Exposure: Repeated or prolonged contact with skin may cause dermatitis to develop with thickening and cracking. May affect the liver, kidneys, and lungs.

Points of Attack: Skin, respiratory system; liver, kidneys, central nervous system.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function tests. Lung function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *500 ppm*: Sa (APF = 10) (any supplied-air respirator). *600 ppm*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front—or back-mounted acid gas canister]; or SCBAE (any appropriate escape-type, SCBA). *Note*: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. *o*-methylcyclohexanone must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine) because violent reactions occur. Sources of ignition, such as smoking and open flames are prohibited where *o*-Methylcyclohexanone is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gal or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN2297 Methylcyclohexanone, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: *o*-Methylcyclohexanone," Trenton, NJ (December 2000).

Methylcyclopentane M:0830

Formula: C_6H_{12}; $C_5H_9CH_3$

Synonyms: Cyclopentane, methyl-; MCP; Methylcyclopentane; Methylpentamethylene

CAS Registry Number: 96-37-7

HSDB Number: 876

RTECS Number: GY4640000

UN/NA & ERG Number: UN2298/128

EC Number: 202-503-2

Regulatory Authority and Advisory Information

Hazard Alert: Extremely flammable, Electrostatic hazard, Narcotic fumes.

Hazard symbols, risk, & safety statements: Hazard symbol: F+, Xn; risk phrases: R12; R22; R20/21/22; R36/37/38; R65; safety phrases: S16; S21; S24/25; S26; S36/37; S45; S62 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found [1-Low hazard to water. (est.)].

Description: Methyl cyclopentane is a colorless liquid with a sweet gasoline-like odor. Molecular weight = 84.18; specific gravity (H_2O:1) = 0.75 @ 20°C; boiling point = 71.8°C; freezing/melting point = −142°C; vapor pressure = 100 mmHg @ 17.9°C; flash point = < −23.8°C; autoignition temperature = 228.9°C. Explosive limits: LEL = 1.0%; UEL: 8.35%. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 3, reactivity 0.

Potential Exposure: This material is used as a solvent; as a fuel; and in chemical synthesis.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 3.53 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: None

NIOSH: 100 ppm/350 milligram per cubic meter TWA; STEL 510 ppm/1800 milligram per cubic meter [15 minutes]

ACGIH TLV[1]: 500 ppm/1760 milligram per cubic meter TWA; 1000 ppm/3500 milligram per cubic meter STEL

PAC Ver. 29[138]

PAC-1: 14 ppm

PAC-2: 160 ppm

PAC-3: 940 ppm

DFG MAK: 500 ppm/1800 milligram per cubic meter TWA; Peak Limitation Category II(2); Pregnancy Risk Group D.

Determination in Air: Charcoal tube; CS_2; Gas chromatography/Flame ionization detection; NIOSH Analytical Method (IV) #1500, for Hydrocarbons, BP 36−126°C.

Determination in Water: Log $K_{ow} = > 3$. Values above 3.0 are likely to bioaccumulate in aquatic organisms.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Methylcyclopentane can affect you when breathed in. Exposure can cause you to feel dizzy, lightheaded, and to pass out. Higher levels can cause death. Exposure can irritate the eyes, nose and throat. Contact can irritate the skin. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Can cause central nervous system excitement followed by depression.

Long-Term Exposure: May cause damage to the nervous system.

Points of Attack: Eyes, skin, respiratory system; central nervous system.

Medical Surveillance: Examination of the respiratory system and nervous system. Medical observation and rest is recommended for 24 to 48 hours after breathing overexposure, as asthma symptoms may be delayed. If signs of allergy are detected, the exposed person(s) should avoid all further contact with this chemical. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to liquid methyl cyclopentane exists, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Methyl cyclopentane must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates) and strong acids, since violent reactions occur. Sources of ignition, such as smoking and open flames, are prohibited where methyl cyclopentane is handled, used, or stored. Metal containers involving the transfer of 5 gal or more of methyl cyclopentane should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of methyl cyclopentane. Wherever methyl cyclopentane is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN2298 Methyl cyclo pentane, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Methyl cyclopentane is a flammable liquid. Use dry chemical, carbon dioxide; alcohol foam; or polymer foam extinguishers. Water may be ineffective on fire. Thermal decomposition products may include oxides of carbon. Establish forced ventilation to keep levels below explosive limit. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Methyl Cyclopentane, Trenton, NJ (December 1999).

Methyl Dichlorosilane M:0840

Formula: CH_4Cl_2Si; CH_3SiHCl_2

Synonyms: Dichloromethylsilane; Monomethyl-dichlorosilane; Silane, dichloromethyl-

CAS Registry Number: 75-54-7

HSDB Number: 1167

RTECS Number: VV3500000

UN/NA & ERG Number: (PIH) UN1242/139

EC Number: 200-877-1

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade).

Hazard Alert: Poison inhalation hazard: exposure can be lethal, Highly flammable liquid, Pyrophoric hazard, Violently reactive with water (dangerous when wet), Corrosive, Primary irritant (w/o allergic reaction).

United States DOT 49CFR172.101, Inhalation Hazardous Chemical (PIH).

Hazard symbols, risk, & safety statements: Hazard symbol: F, T+, C; Xn; risk phrases: R11; R14/15; R17; R20/22; R28; R29; R34; R35; R36/37/38; R34; R40; R43; R45; R51; safety phrases: S1; S7/9; S16; S21; S22; S26; S30; S36/37/39; S41; S43; S45; S53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Methyl dichlorosilane is a clear, straw-colored liquid. Molecular weight = 115.04; specific gravity (H_2O:1) = 1.1 @ 27°C; boiling point = 41°C; freezing/melting point = −93°C; vapor pressure = 429 mmHg @ 25°C; flash point = −9°C; autoignition temperature = 316°C. Explosive limits: LEL = 6.0%; 2000 ppm[138]; UEL: 55.0%. Hazard identification (based on NFPA-704 M Rating System): Health 4, flammability 3, reactivity 2₩. Reacts violently with water, rapidly releasing heat, gaseous hydrogen chloride and flammable hydrogen.

Potential Exposure: This material is used to make siloxanes and other silicone polymer (polysiloxane) materials.

Incompatibilities: May form explosive mixture with air. Reacts violently with water producing heat, corrosive hydrochloric acid and flammable hydrogen. Methyl dichlorosilane may spontaneously ignite on contact with air (even under inert gas) and on contact with potassium permanganate, lead(II) oxide; copper oxide; silver oxide. Violent reaction with oxidizers. Decomposes on contact with hot surfaces or flames producing toxic and corrosive fumes including silicon oxides, hydrogen chloride, and phosgene. Decomposes on contact with alkaline compounds producing highly flammable hydrogen gas. Corrodes many metals in presence of water. Attacks some plastics, rubber and coatings.

Permissible Exposure Limits in Air

PAC* Ver. 29[138]

PAC-1: **0.90**$_{\mathbf{A}}$ ppm

PAC-2: **11**$_{\mathbf{A}}$ ppm

PAC-3: **50**$_{\mathbf{A}}$ ppm

*AEGLs are marked with a subscript "**A**" and correspond to 60-minute values. ***face***.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Methyl dichlorosilane is a corrosive chemical and contact can cause severe eye and skin burns leading to permanent damage. Exposure can irritate the lungs, causing coughing and/or shortness of breath. Higher exposures can cause a build-up of fluid in the lungs (pulmonary edema). This can cause death.

Long-Term Exposure: May cause bronchitis with cough, phlegm, and/or shortness of breath.

Points of Attack: Lungs.

Medical Surveillance: For those with frequent or potentially high exposure the following are recommended before beginning work and at regular times after that. Lung function tests. If symptoms develop or overexposure is suspected the following may be useful: consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposure to methyl dichlorosilane, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Protect from all forms of moisture. (1) Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. (2) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. (3) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Methyl dichlorosilane must be stored to avoid contact with water; violent reactions occur once hydrogen chloride and heat is produced. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where methyl dichlorosilane is handled, used, or stored. Metal containers involving the transfer of 5 gal or more of methyl dichlorosilane should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of methyl dichlorosilane. Wherever methyl dichlorosilane is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1242 Methyldichlorosilane Hazard Class: 4.3; Labels: 4.3-Dangerous when wet material; 8-Corrosive material, 3-Flammable liquid.

Spill Handling:

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

when spilled in water

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.2/0.3

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.5/0.8
Night 1.6/2.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in dry lime, dry sand; soda ash or a similar material and deposit in sealed containers. Following cleanup neutralize spill area by flushing with large quantities of water and then treat spill area with sodium bicarbonate. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Methyl dichlorosilane is a flammable liquid and may spontaneously ignite in air. Thermal decomposition products may include hydrogen chloride, phosgene and oxides of silicon and carbon. Use dry chemical or CO_2 extinguishers. *Do not use water*. Fire may restart after it has been extinguished. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: See “Spill Handling.”

References

(31); (173); (101); (138); (170); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Methyl Dichlorosilane, Trenton, NJ (December 1999)

4,4′-Methylenebis(2-Chloroaniline) M:0850

Formula: $C_{13}H_{12}Cl_2N_2$; $(C_6H_3ClNH_2)CH_2(C_6H_3ClNH_2)$

Synonyms: Aniline, 4,4′-methylenebis(2-chloro-); Benzenamine, 4,4′-methylenebis(2-chloro-); Bis amine; Bis (4-amino-3-chlorophenyl)methane; Bis(3-chloro-4-aminophenyl) methane; BOCA; Cuamine MT; Curalin M; Curene 442; Cyanaset; DACPM; Diamet KH; Di-(4-amino-3-chlorophenyl)methane; 4,4′-Diamino-3,3′-dichlorodiphenylmethane; 3,3′-Dichloro-4,4′-diaminodiphenylmethan (German); 3,3′-Dichloro-4,4′-diaminodiphenylmethane; MBOCA; Methylenebis(3-chloro-4-aminobenzene); *p,p*′-Methylenebis (α-chloroaniline); *p,p*′-Methylenebis(*o*-chloroaniline); 4,4′-Methylene(bis)-chloroaniline; 4,4′-Methylenebis(*o*-chloroaniline); Methylene-4,4′-bis(*o*-chloroaniline); 4,4′-Methylenebis-2-chlorobenzenamine; 4,4′-Methylenebis (2-chloro-benzeneamine); Methylenebis(*o*-chloroaniline); *p,p*′-Metilenbis (*o*-cloroanilina) (Spanish); Millionate M; MOCA; Quodorole

CAS Registry Number: 101-14-4; *(alt.)* 29371-14-0; *(alt.)* 51065-07-7; *(alt.)* 78642-65-6

HSDB Number: 2629

RTECS Number: CY1050000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171; UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 202-918-9 [*Annex I Index No*.: 612-078-00-9]

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Animal Sufficient Evidence; Human Inadequate Evidence, Group 2A, 1993; NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; NIOSH: Potential occupational carcinogen. United States Environmental Protection Agency Gene-Tox Program, Positive: Carcinogenicity-mouse/rat; Positive: Cell transformation-RLV F344 rat embryo; Positive: Cell transformation-SA7/SHE; Mammalian micronucleus; Positive: Histidine reversion-Ames test; Positive/dose response: Cell transformation-BALB/c-3T3

California Proposition 65 Chemical[102]: Cancer 7/1/1987.

Hazard Alert: Poison, Combustible, Possible risk of forming tumors, Suspected reprotoxic hazard. Banned or Severely Restricted (Sweden) (UN)[13]

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U158

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.50; Nonwastewater (mg/kg), 30

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R45; R22; R50/53; safety phrases: S41; S45; S53; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found [3-Severe hazard to waters (est.)].

Description: 4,4′-Methylenebis (2-chloroaniline) is a yellow to light gray-tan pellet and is also available in liquid form. Molecular weight = 267.15; specific gravity (H_2O:1) = 1.44; freezing/melting point = 110°C; vapor pressure =

1×10^{-5} mmHg @ 25°C. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 1, reactivity 0. Slightly soluble in water.

Potential Exposure: 4,4′-Methylenebis(2-chloroaniline) is used as a curing agent in the polyurethane industry for isocyanate containing polymers; in the production of solid elastomeric parts. Other uses are in the manufacture of crosslinked urethane foams used in automobile seats and safety padded dashboards; it is also used in the manufacture of gun mounts; jet engine turbine blades; radar systems; and components in home appliances.

Incompatibilities: Reacts with chemically active metals e.g., potassium, sodium, magnesium, and zinc). May ignite on contact with cellulose nitrate of high surface area. Incompatible with acrolein, acrylonitrile, *tert*-butyl nitroacetylene; ethylene oxide; isopropyl chlorocarbonate; maleic anhydride, triisobutylaluminum.

Permissible Exposure Limits in Air

OSHA PEL: None

NIOSH REL: 0.003 milligram per cubic meter TWA [skin]; A potential occupational carcinogen. Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A

ACGIH TLV[1]: 0.01 ppm/0.11 milligram per cubic meter TWA; Suspected Human Carcinogen [skin] BEI issued.

PAC Ver. 29[138]

PAC-1: 0.03 ppm

PAC-2: 0.94 ppm

PAC-3: 21 ppm

DFG MAK: [skin] Carcinogen Category 2

Australia: TWA 0.02 ppm (0.22 milligram per cubic meter) [skin], carcinogen, 1993; Austria: carcinogen, 1999; Belgium: TWA 0.02 ppm (0.22 milligram per cubic meter) [skin], carcinogen, 1993; Finland: TWA 0.02 ppm (0.2 milligram per cubic meter); STEL 0.06 ppm [skin], 1993; Finland: TWA 0.02 ppm (0.2 milligram per cubic meter); STEL 0.06 ppm, carcinogen, 1999; France: VME 0.02 ppm (0.22 milligram per cubic meter), carcinogen, 1999; Japan: 0.005 milligram per cubic meter [skin], 2A carcinogen, 1999; the Netherlands: MAC-TGG 0.02 milligram per cubic meter, 2003; Sweden: carcinogen, 1999; Switzerland: MAK-W 0.02 milligram per cubic meter, carcinogen, 1999; United Kingdom: TWA 0.005 milligram per cubic meter [skin], carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Suspected Human Carcinogen. Several states have set guidelines or standards for MOCA in ambient air[60] ranging from zero (Nevada and North Dakota); to 0.015 μ/m^3 (Connecticut); to 0.55 μ/m^3 (Pennsylvania); to 1.0 μ/m^3 (Rhode Island); to 2.2 μ/m^3 (Virginia).

Determination in Air: Use NIOSH Analytical Method #8302, MBOCA in urine; OSHA Analytical Method 24; ID-71

Determination in Water: Octanol−water coefficient: Log K_{ow} = ~4. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact. Passes through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: 4,4′-Methylenebis(2-chloroaniline) can affect you when breathed in and by passing through your skin. 4,4′-Methylenebis(2-chloroaniline) is a carcinogen; handle with extreme caution. Exposure can interfere with the ability of the blood to carry oxygen causing headaches, dizziness, nausea, and a bluish color to the skin and lips. High levels can cause trouble breathing; collapse and death. Contact can irritate the eyes. High or repeated exposures may affect the kidneys, cause a low blood count and cause bloody urine.

Long-Term Exposure: May cause methemoglobinemia, anemia, kidney irritation. A potential occupational carcinogen. May affect the kidneys.

Points of Attack: Liver, blood, kidneys. Cancer site in animals: liver, lung and bladder tumors.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: blood methemoglobin level. CBC. Kidney function tests. Preplacement and periodic examinations should include a history of exposure to other carcinogens, alcohol and smoking habits; use of medications; and family history. Special attention should be given to liver size and function and to any changes in lung symptoms or X-rays.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. *Note to Physician*: Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin contact: **8 hours:** Saranex coated suits, Barricade coated suits. **4 hours:** 4H and Silver Shield gloves. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin

is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFAg100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. 4,4′-Methylenebis(2-chloroaniline) must be stored to avoid contact with chemically active metals (such as potassium, sodium, magnesium and zinc), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft (NJ). Isolation Distance, Fire: 800 m/0.5 mi.[70] Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during clean-up. Do not dry sweep. Dampen spilled material with alcohol to avoid dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include chlorine and nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform to EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(109); (102); (31); (173); (101); (138); (2); (100).

Lunch, a. L. O'Connor, G. B., Barnes, J. R., Killian, a. S. Jr., and Neeld, W. E. Jr., "Methylene-bis-ortho-chloroaniline (MOCA): Evaluations of Hazards and Exposure Control," Am. Ind. Hyg. Assoc. J. 32: 802 (1971).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: 4,4′-Methylenebis (2-Chloroaniline), Trenton, NJ (April 2004).

Methylenebis(4-Cyclohexyl Isocyanate) M:0860

Formula: $C_{15}H_{22}N_2O_2$: $OCNC_6H_{10}CH_2C_6H_{10}NCO$

Synonyms: Bis(4-isocyanatocyclohexyl)methane; Dicyclohexylmethane 4,4′-diisocyanate; DMDI; HMDI; Hydrogenated MDI; Nacconate H 12; Reduced MDI; Saturated MDI

CAS Registry Number: 5124-30-1

HSDB Number: 7189

RTECS Number: NQ9250000

UN/NA & ERG Number: UN2206 (Isocyanates, toxic, n.o.s. or Isocyanate solutions, toxic, n.o.s., FP>61°C & BP <300°C)/155

EC Number: 225-863-2 [*Annex I Index No.*: 615-009-00-0]

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Combustible, Sensitization hazard, Primary irritant (w/o allergic reaction).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xi; risk phrases: R23; R36/37/38; R42/43; safety phrases: S1/2; S26; S28; S38; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: DMDI is a clear, colorless to light-yellow liquid. Molecular weight = 262.39; specific gravity (H_2O:1) = 1.07 @ 25°C; freezing/melting point = 19−23°C; vapor pressure = 0.001 mmHg @ 20°C; flash point ≥202°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 1, reactivity 1 Insoluble in water; reactive, slow decomposition.

Potential Exposure: A potential danger to those involved in the manufacture of this compound or its use in the production of light-stable, nonyellowing polyurethane resins.

Incompatibilities: May form explosive mixture with air. Isocyanates are highly flammable and reactive with many compounds, even with themselves. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Reaction with moist air, water or alcohols may form amines and insoluble polyureas and react exothermically, releasing toxic, corrosive or flammable gases, including carbon dioxide; and, at the same time, may generate a violent release of heat increasing the concentration of fumes in the air. Incompatible with amines, aldehydes, alkali metals, ammonia, carboxylic acids, caprolactum, alkaline materials, glycols, ketones, mercaptans, hydrides, organotin catalysts, phenols, strong acids, strong bases, strong reducing agents such as hydrides, urethanes, ureas. Elevated temperatures or contact with acids, bases, tertiary amines, and acylchlorides may cause explosive polymerization. Attacks some plastics, rubber and coatings. Contact with metals may evolve flammable hydrogen gas. May accumulate static electrical charges, and may cause ignition of its vapors. May slowly polymerize if heated above 122°F/50°C. Contact with metals may evolve flammable hydrogen gas.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 10.73 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: None

NIOSH REL: 0.01 ppm/0.11 milligram per cubic meter Ceiling Concentration

ACGIH TLV[1]: 0.005 ppm/0.054 milligram per cubic meter TWA

PAC Ver. 29[138]

PAC-1: 0.015 ppm

PAC-2: 0.29 ppm

PAC-3: 1.7 ppm

Belgium: TWA 0.005 ppm (0.054 milligram per cubic meter), 1993; Denmark TWA 0.005 ppm (0.054 milligram per cubic meter), 1999; Norway: TWA 0.005 ppm (0.05 milligram per cubic meter), 1999; Sweden: TWA 0.005 ppm; STEL 0.01 ppm, 1999; United Kingdom: TWA 0.02 mg(NCO)/m^3; STEL 0.07 mg[NCO]/m^3, 2000; the Netherlands: MAC-0.11 milligram per cubic meter [skin], 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 0.005 ppm. Several states have set guidelines or standards for ambient air[60] ranging from 0.8 μ/m^3 (Virginia) to 1.1 μ/m^3 (North Dakota 0−3.0 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method #5525; OSHA Analytical Method PV-2092

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Methylene bis(4-cyclohexylisocyanate) can affect you when breathed in. Exposure can irritate the eyes, nose and throat. Higher levels can irritate the lungs, causing a build-up of fluid (pulmonary edema). This can cause death. Contact can irritate and burn the eyes, causing permanent damage. Skin contact can cause blisters.

Long-Term Exposure: Methylenebis(4-cyclohexylisocyanate) can cause an asthma-like allergy to develop. Future exposures can cause asthma attacks with shortness of breath; wheezing, cough; and/or chest tightness. Repeated exposures may permanently damage the lungs.

Points of Attack: Lungs.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended. Lung function tests. These may be normal at first if person is not having an attack at the time. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Evaluation by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *Up to 0.1 ppm*: Sa (APF = 10) (any supplied-air respirator). * *Up to 0.25 ppm*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode.)* *Up to 0.5 ppm*: SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 1 ppm*: SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA). *Note*: *Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Methylene bis(4-cyclohexylisocyanate) must be stored to avoid contact with alcohols, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from moisture, heat, air, amines, strong bases and chemically active metals.

Shipping: UN2206 Isocyanates, toxic, n.o.s. or Isocyanate solutions, toxic, n.o.s., flash point >61°C and boiling point <300°C, Hazard Class: 6.1; Labels: 6.1-Poisonous materials., Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Use HEPA vacuum or wet method to reduce dust during clean-up. Do not dry sweep. Dampen spilled solid material with 60%−70% ethanol to avoid airborne dust. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Methylene bis(4-cyclohexylisocyanate) may burn, but does not readily ignite. Use dry chemical, CO_2, or foam extinguishers. Thermal decomposition products may include hydrogen cyanide, cyanides, ammonia, nitriles, and oxides of nitrogen. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Methylene bis (4-Cyclohexylisocyanate), Trenton, NJ (January 2001).

4,4′-Methylenebis(*N,N*-Dimethyl) aniline M:0870

Formula: $C_{17}H_{22}N_2$; $(CH_3)_2N\text{-}C_6H_4\text{-}CH_2\text{-}C_6H_4\text{-}N(CH_3)_2$

Synonyms: Aniline, 4,4′-methylenebis(*N*,*N*-dimethyl)-; Arnold's base; *tetra* Base; Benzenamine, 4,4′-methylenebis-(*N*,*N*-dimethyl-); *p*,*p*′-Bis(dimethylamino)diphenylmethane; 4,4′-Bis(dimethylamino)diphenylmethane; 4,4′-Bis(dimethylaminophenyl)methane; Bis[*p*-(*N*,*N*-dimethylamino)phenyl] methane; Bis[*p*-(dimethylamino)-phenyl]methane; Bis[4-(*N*,*N*-dimethylamino)-phenyl]methane; Bis[4-(dimethylamino) phenyl]methane; 4,4′-Methylene bis(*N*,*N*-dimethylaniline); Michler's base; Michler's hydride; Michler's methane; NCI-C01990; Reduced Michler's ketone; *N*,*N*,*N*′,*N*′-Tetramethyl-*p*,*p*′-diaminodiphenyl-methane; *N*,*N*,*N*′,*N*′-Tetramethyl-4,4′-diaminodiphenyl-methane; *p*,*p*′-Tetramethyldiamino-diphenylmethane; 4,4′-Tetramethyldiaminodiphenylmethane; Tetramethyldiamino-diphenylmethane

CAS Registry Number: 101-61-1

HSDB Number: 2856

RTECS Number: BY5250000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171; UN3259/154; UN3143 (Dyes, solid, toxic, n.o.s. [or] Dye intermediates, solid, toxic, n.o.s.)/151

EC Number: 202-959-2 [*Annex I Index No*.: 612-201-00-6]

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies.

California Proposition 65 Chemical[102]: Cancer 10/1/1981

Hazard Alert: Combustible, Corrosive, Possible risk of forming tumors, Suspected of causing genetic defects, Environmental hazard.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292].

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R45; R34; R50/53; R62; safety phrases: S29/35; S41; S45; S53; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)].

Description: 4,4′-Methylenebis(*N*,*N*-dimethyl)benzenamine is a yellow crystalline compound. Molecular weight = 254.41; boiling point = 390°C; freezing/melting point = 90−91°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 1, reactivity 0. Insoluble in water.

Potential Exposure: 4,4′-methylenebis(*N*,*N*-dimethyl) benzenamine is used as an intermediate in dye manufacture and as an analytical reagent in the determination of lead.

Incompatibilities: Strong acids, oxidizers, acid chlorides; acid anhydrides.

Permissible Exposure Limits in Air

No standards or PAC available. This substance is a potential carcinogen; follow safe work and usage practices.

DFG MAK: Carcinogen Category 2

The state of North Dakota has set a guideline for ambient air[60] of zero concentration.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact. Passes through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: 4,4′-Methylenebis (*N*,*N*′-dimethyl) aniline can affect you when breathed in and by passing through your skin. 4,4′-Methylenebis(*N*,*N*-dimethyl)aniline is a carcinogen; handle with extreme caution. High exposure can interfere with the ability of the blood to carry oxygen (a condition called methemoglobinemia). This can cause headaches, dizziness, weakness and a bluish color to the skin and lips. Higher levels can cause trouble breathing; collapse and death.

Long-Term Exposure: May be a carcinogen. It has been shown to cause liver and thyroid cancer in animals.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure. If symptoms develop or overexposure is suspected, the following may be useful: blood test for methemoglobin.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material (s) involved and take precautions to protect themselves. *Note to Physician*: Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Methylenebis(*N*,*N*-dimethyl)benzenamine. Wear protective gloves and clothing. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day and put on before work.

Respirator Selection: Based on potential carcinogenicity the following is recommended by NIOSH: *At any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full- facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: (1) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location; keep acids away from bases and red, yellow, and blue—coded chemicals. (2) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. 4,4′-Methylenebis(N,N-dimethyl)benzenamine must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates) and strong acids (such as hydrochloric, sulfuric and nitric), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN3259 Amines, solid, corrosive, n.o.s, or Polyamines, solid, corrosive, n.o.s., Hazard class: 8; Labels: 8-Corrosive material, Technical Name Required. UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Dampen spilled material with 60%−70% acetone to avoid airborne dust. Use HEPA vacuum or wet method to reduce dust during clean-up. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; water spray, alcohol or polymer foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(109); (102); (31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: 4,4′-Methylenebis (*N,N*-Dimethyl)Benzenamine, Trenton, NJ (November 1999).

Methylenebis(phenylisocyanate)

M:0880

Formula: $C_{15}H_{10}N_2O_2$: $OCNC_6H_4CH_2C_6H_4NCO$

Synonyms: AI3-15256; Benzene, 1,1′-methylenebis (4-isocyanato-); Bis(*p*-isocyanatophenyl)methane; Bis(1,4-isocyanatophenyl)methane; Bis(4-isocyanatophenyl) methane; Caradate 30; Desmodur 44; 4,4′-Diisocyanatodiphenylmethane; Di-(4-isocyanatophenyl)methane; *p,p*′-Diphenylmethane diisocyanate; 4,4′-Diphenylmethane diisocyanate; Diphenyl methane diisocyanate; Diphenylmethane *p,p*′-diisocyanate; Diphenylmethane 4,4′-diisocyanate; Diphenylmethane diisocyanate; Hylene M-50; Isocyanic acid, ester with diphenylmethane; Isocyanic acid, methylenedi-*p*-phenylene ester; Isonate 125M; Isonate 125 MF; MDI; MDR; Methyl bisphenylisocyanate; 1,1′-Methylenebis(4-isocyanatobenzene); 1,1-Methylenebis (4-isocyanatobenzene); Methylenebis(4-isocyanatobenzene); Methylenebis(*p*-phenylene isocyanate); Methylenebis(4-phenylene isocyanate); *p,p*′-Methylenebis(phenylisocyanate); 4,4′-Methylenebis(phenylisocyanate); Methylene bis(4-phenylisocyanate); Methylene bisphenylisocyanate; Methylenebis (*p*-phenylisocyanate); Methylenebis(4,4′-phenylisocyanate); Methylenebis(4-phenylisocyanate); 4,4′-Methylenedi(phenyldiisocyanate); 4,4′-Methylenedi-*p*-phenylene diisocyanate; Methylenedi(*p*-phenylene diisocyanate); Methylenedi-*p*-phenylene diisocyanate; 4,4′-Methylenedi(phenylene isocyanate); Methylene di(phenylene isocyanate); Methylenedi(*p*-phenylene isocyanate); Methylenedi-*p*-phenylene isocyanate; 4,4′-Methylene diphenylisocyanate; Metilenbis(fenilisocianato) (Spanish); Nacconate 300; NCI-C50668; Rubinate 44

CAS Registry Number: 101-68-8

HSDB Number: *2630*

RTECS Number: NQ9350000

UN/NA & ERG Number: (PIH) UN2811 (toxic solid, organic, n.o.s.)/154; UN3082 (environmentally hazardous substances, liquid, n.o.s.)/171

EC Number: 202-966-0 [*Annex I Index No.*: 615-005-01-6]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human Inadequate Data, animal No Adequate Data, *not classifiable as carcinogenic to humans*, Group 3, 1999; EPA: Not Classifiable as to human carcinogenicity.

Hazard Alert: Poison inhalation hazard, Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Sensitization hazard, Primary irritant (w/o allergic reaction).

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazard symbols, risk, & safety statements: Hazard symbol: Xn; risk phrases: R20; R36/37/38; R40; R42/43; R48/20; R62; R63; safety phrases: S1/2; S23; S23; S36/37; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: MDI is a white to light-yellow, odorless flakes. A liquid above 37°C. Molecular weight = 250.27; specific gravity (H_2O:1) = 1.23 (solid @ 25°C); 1.19

(liquid @ 50°C); boiling point = 313.9°C @ 5 mm; freezing/melting point = 37.2°C; vapor pressure = 0.0000005 mmHg @ 20°C; flash point = 198.9°C (cc); autoignition temperature = 240°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 1, reactivity 1. Slightly soluble in water (reaction).

Potential Exposure: MDI is used in the production of polyurethane foams and plastics; polyurethane coatings; elastomers, and thermoplastic resins.

Incompatibilities: May form explosive mixture with air. Isocyanates are highly flammable and reactive with many compounds, even with themselves. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Reaction with moist air, water or alcohols may form amines and insoluble polyureas and react exothermically, releasing toxic, corrosive or flammable gases, including carbon dioxide; and, at the same time, may generate a violent release of heat increasing the concentration of fumes in the air. Incompatible with amines, aldehydes, alkali metals, ammonia, carboxylic acids, caprolactum, alkaline materials, glycols, ketones, mercaptans, hydrides, organotin catalysts, phenols, strong acids, strong bases, strong reducing agents such as hydrides, urethanes, ureas. Elevated temperatures or contact with acids, bases, tertiary amines, and acylchlorides may cause explosive polymerization. Attacks some plastics, rubber and coatings. May accumulate static electrical charges, and may cause ignition of its vapors. Unstable above 100°F/38°C. Polymerizes at temperatures above 204°C. Contact with metals may evolve flammable hydrogen gas.

Permissible Exposure Limits in Air

NIOSH IDLH = 75 milligram per cubic meter

Conversion factor: 1 ppm = 10.24 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 0.02 ppm/0.2 milligram per cubic meter Ceiling Concentration

NIOSH REL: 0.005 ppm/0.05 milligram per cubic meter TWA; 0.2 milligram per cubic meter/0.020 ppm/10 minutes, Ceiling Concentration

ACGIH TLV[1]: 0.005 ppm TWA, measured as inhalable fraction and vapor [skin]; BEI_A issued as Acetylcholinesterase inhibiting pesticides.

PAC* Ver. 29[138]

PAC-1: 0.45 milligram per cubic meter

PAC-2: **5_E** milligram per cubic meter

PAC-3: **55_E** milligram per cubic meter

*ERPG [Emergency Response Planning Guidelines] are marked with a subscript "**E.**"

DFG MAK: 0.05 milligram per cubic meter, inhalable fraction; danger of sensitization of the airways and skin; Peak Limitation Category I(1); a momentary value of 0.1 milligram per cubic meter should not be exceeded; Carcinogen Category 4; Pregnancy Risk Group C; BAT: 10 μg[4,4′-Diaminodiphenylmetane]/DL-creatinine in urine/end-of-shift.

Austria: MAK 0.005 ppm (0.05 milligram per cubic meter), Suspected: carcinogen, 1999; Belgium TWA 0.005 ppm (0.051 milligram per cubic meter); STEL 0.02 ppm, 1993; Denmark TWA 0.005 ppm (0.05 milligram per cubic meter), 1999; France: VME 0.01 ppm (0.1 milligram per cubic meter), VLE 0.02 ppm (0.2 milligram per cubic meter), 1999; Hungary TWA 0.05 milligram per cubic meter; STEL 0.1 milligram per cubic meter, 1993; Japan 0.05 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 0.05 milligram per cubic meter, 2003; the Philippines: TWA 0.02 ppm (0.2 milligram per cubic meter), 1993; Poland: MAC (TWA) 0.05 milligram per cubic meter, MAC 0.2 milligram per cubic meter, 1999; Russia: STEL 0.5 milligram per cubic meter [skin] 1993; Sweden: NGV 0.005 ppm, TGV 0.01 ppm, 1999; Switzerland: MAK-week 5 ppm (15 milligram per cubic meter); STEL 25 ppm (75 milligram per cubic meter), 1999; Thailand TWA 0.02 ppm (0.2 milligram per cubic meter), 1993; United Kingdom TWA 0.02 mg[NCO]/m^3; STEL 0.07 mg[NCO]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 0.005 ppm. Several states have set guidelines or standards for MDI in ambient air[60] ranging from 0.2 μ/m^3 (Rhode Island) to 0.67 μ/m^3 (New York) to 1.0 μ/m^3 (Connecticut) to 1.6 μ/m^3 (Virginia) to 2.0 μ/m^3 (North Dakota and South Carolina) to 5.0 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #5521, #5522, #5525; OSHA Analytical Method 18, 33, 47.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: *Inhalation*: A lacrimator. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Vapors are irritating at 0.001−0.026 ppm and may cause shortness of breath; asthma, sore throat; coughing, wheezing, chest tightness; depression, headache, nasal discharge and insomnia. May cause allergic respiratory reactions. Symptoms may be delayed Up to 8 hours after exposure. *Skin*: Causes irritation, redness, and pain. May cause a rash. Irritation begins at levels of 0.05−0.1 ppm. May adhere firmly to skin. Attempts to remove it may increase or produce irritation. *Eyes*: Irritation at 0.05−0.1 ppm causing redness, pain and blurred vision. *Ingestion*: Causes abdominal spasms and vomiting.

Long-Term Exposure: Repeated or prolonged contact may cause skin sensitization and allergy. Repeated or prolonged inhalation exposure may cause asthma-like allergy. Prolonged exposure may lead to permanent breathing or respiratory problems.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: NIOSH lists the following tests: Blood Gas Analysis; chest X-ray, electrocardiogram, pulmonary function tests: forced vital capacity, forced expiratory volume (1 second); red blood cells/count; sputum cytology; urine (chemical/metabolite); white blood cell count/differential. Evaluation by a qualified allergist. Preplacement and periodic medical examinations should include chest rentgenography, pulmonary function tests; and an evaluation of any respiratory disease or history of allergy. Periodic pulmonary function tests may be useful in detecting the onset of pulmonary sensitization.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin contact: **8 hours**: 4H and Silver Shield gloves; Barricade coated suits; Responder suits. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *0.5 milligram per cubic meter*: Sa (APF = 10) (any supplied-air respirator); or SCBA (any SCBA). *1.25 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *2.5 milligram per cubic meter*: SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *75 milligram per cubic meter*: SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd, Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv100 (APF = 50) [Any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA). *Note*: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store at temperatures indicated on labels; separately from acids, bases, amines, alcohols and ammonia; with ventilation along the floor. Since MDI will react with moisture in the air, the storage area should be a dry place, away from all sources of fire or ignition.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft (NJ). Isolation Distance, Fire: 800 m/0.5 mi.[70] Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Dampen spilled material with toluene to avoid dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include hydrogen cyanide and oxides of nitrogen and carbon. Use carbon dioxide, dry chemical, or halons. In case of large fires, water spray may be used to cool drums, taking care to prevent direct contact between water and MDI. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Controlled incineration (oxides of nitrogen are removed from the effluent gas by scrubbers and/or thermal devices).

References

(31); (173); (101); (138); (2); (100).

New York State Department of Health, *Chemical Fact Sheet*: 4,4′-Methylene Diphenyl Diisocyanate, Bureau of Toxic Substance Assessment, Albany, NY (May 1986 and Version 2).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Methylene Diphenyl Diisocyanate, Washington, DC, Office of Toxic Substances (June 28, 1984).

Methylene Bromide M:0890

Formula: CH_2Br_2

Synonyms: Bromuro de metileno (Spanish); Dibromomethane; Methane, dibromo-; Methylene dibromide

CAS Registry Number: 74-95-3

HSDB Number: 1334

RTECS Number: PA7350000

UN/NA & ERG Number: UN2664/160

EC Number: 200-824-2 [*Annex I Index No.*: 602-003-00-8]

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Suspected reprotoxic hazard.

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U068

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.11; Nonwastewater (mg/kg), 15

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8010 (15); 8240 (5)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1000 lb (454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazard symbols, risk, & safety statements: Hazard symbol: Xn, N; risk phrases: R20; R52/53; safety phrases: S2; S24; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water. (Manufacturer[206]).

Description: Methylene bromide is a colorless liquid with a sweet, pleasant odor. Molecular weight = 173.85; specific gravity (H_2O:1) = 2.49 @ 20°C; boiling point = 96−97°C; freezing/melting point = −53°C; vapor pressure = 44 mmHg @ 25°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 1. Slightly soluble in water.

Potential Exposure: Methylene bromide is used as a solvent and as a chemical intermediate.

Incompatibilities: Mixture with potassium forms a shock-sensitive explosive. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, sodium amide, strong acids, strong bases, alkaline earth metals, aluminum, magnesium. The substance decomposes on contact with hot surfaces producing hydrogen bromide.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 3 ppm

PAC-2: 33 ppm

PAC-3: 200 ppm

Russia: STEL: 10 milligram per cubic meter, 1993

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Methylene bromide can affect you when breathed in. Contact can irritate the eyes and skin. May affect the nervous system and blood, resulting in impaired functions and formation of carboxyhemoglobinemia. Exposure can cause you to feel dizzy, lightheaded and to pass out. High levels can cause death. Methylene bromide can cause the heart to beat irregularly or stop. This can cause death.

Long-Term Exposure: Repeated skin contact can cause dryness and itching; removal of the skin's natural oils. May cause liver and kidney damage.

Points of Attack: Blood, kidneys, liver, skin.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function tests. Serum bromine level. Carboxyhemoglobin level. Holter monitor (a special 24-hour EKG to look for irregular heartbeat).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/ manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Polyvinyl alcohol is among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to methylene bromide exists, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed container in a well-ventilated area away from potential high heat sources. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: UN2664 Dibromomethane, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Use HEPA vacuum or wet method to reduce dust during clean-up. Do not dry sweep. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Methylene bromide may burn, but does not readily ignite. Thermal decomposition products may include bromine and bromide. Use dry chemical, carbon dioxide; alcohol or polymer foam extinguishers. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform to EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (173); (101); (138); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 7, No. 2, 48–50 (1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Methylene Bromide, Trenton, NJ (November 1999).

Methylene Chloride M:0900

Formula: CH_2Cl_2

Synonyms: Aerothene MM; Chlorure de methylene (French); Cloruro de metileno (Spanish); DCM; Dichloromethane; Diclorometano (Spanish); Freon 30; Methane, dichloro-; Methane dichloride; Methylene bichloride; Methylene dichloride; Narkotil; NCI-C50102; R 30; Solaesthin; Solmethine

CAS Registry Number: 75-09-2

HSDB Number: 66

RTECS Number: PA8050000

UN/NA & ERG Number: UN1593/160

EC Number: 200-838-9 [*Annex I Index No*.: 602-004-00-3]

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen: dichloromethane; IARC: Animal Sufficient Evidence; Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B, 1999; NCI: Carcinogenesis Studies (inhalation); clear evidence: mouse, rat; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies; United States Environmental Protection Agency Gene-Tox Program, Positive: Cell transformation-RLV F344 rat embryo; Positive: Histidine reversion-Ames test; Positive: *S. cerevisiae* gene conversion; *S. cerevisiae-homozygosis*; Positive: *S. cerevisiae*-reversion; Negative: *D. melanogaster* sex-linked lethal; OSHA Regulated carcinogen; NIOSH suspected occupational carcinogen; See *NIOSH Pocket Guide*, Appendix A.

California Proposition 65 Chemical[102]: Cancer 4/1/1988.

Hazard Alert: Poison, Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction). Listed for Tier 1 screening as an endocrine disruptor.[88]

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U080

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

United States National Primary Drinking Water Regulations: MCL = 0 mg/L; MCL = 0.005 mg/L as Dichloromethane.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.089; Nonwastewater (mg/kg), 30

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8010 (5); 8240 (5)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1000 lb (454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xn; risk phrases: R40; R62; R63; safety phrases: S2; S23; S24/25; S36/37; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Methylene chloride is a nonflammable, colorless liquid with a chloroform-like odor. A gas above 40°C/104°F. The odor is noticeable @ 250 ppm. However, this level substantially exceeds the OSHA STEL and must not be relied upon as an adequate warning of unsafe concentrations. Molecular weight = 84.93; specific gravity (H_2O:1) = 1.33 @ 20°C; boiling point = 40°C; freezing/melting point = −97°C; relative vapor density (air = 1) = 2.91; vapor pressure = 750 mmHg @ 39.3°C; autoignition temperature = 556°C. Explosive limits: LEL = 13%; UEL: 23%. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 1, reactivity 0. Soluble in water; solubility = 2%.

Potential Exposure: Methylene chloride is used mainly as a low-temperature extractant of substances which are adversely affected by high temperature. It can be used as a solvent for oil, fats, waxes, bitumen, cellulose acetate; and esters. It is also used as a paint remover; as a degreaser; and in aerosol propellants.

Incompatibilities: Incompatible with strong oxidizers, caustics; chemically active metals, such as aluminum, magnesium powders; potassium, lithium, and sodium; concentrated nitric acid causing fire and explosion hazard. Contact with hot surfaces or flames causes decomposition producing fumes of hydrogen chloride and phosgene gas. Attacks some forms of plastics, rubber and coatings. Attacks metals in the presence of moisture.

Permissible Exposure Limits in Air

NIOSH IDLH = 2300 ppm, potential occupational carcinogen.

Conversion factor: 1 ppm = 3.47 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL] 25 ppm TWA; 125 ppm STEL, a potential occupational carcinogen, see 29CFR1910.1052; for Construction see 56FR57036.

NIOSH REL: A potential occupational carcinogen. Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A

ACGIH TLV[1]: 50 ppm/174 milligram per cubic meter TWA; BEI: 0.2 mg[dichloromethane]/L in urine/end-of-shift; confirmed animal carcinogen with unknown relevance to humans.

PAC* Ver. 29[138]

PAC-1: $\mathbf{200_A}$ ppm

PAC-2: $\mathbf{560_A}$ ppm

PAC-3: $\mathbf{6900_A}$ ppm [> 50% LEL but <100% LEL]

*AEGLs are marked with a subscript "**A**" and correspond to 60-minute values.

DFG MAK: 100 ppm/350 milligram per cubic meter; BAT: 5% [CO-Hb] in blood, at end-of-shift; 1 mg[dichloromethane]/L in blood/end-of-shift; Carcinogen Category 3A

Australia: TWA 100 ppm (350 milligram per cubic meter), carcinogen, 1993; Austria: MAK 100 ppm (360 milligram per cubic meter), Suspected: carcinogen, 1999; Belgium: TWA 50 ppm (174 milligram per cubic meter), carcinogen, 1993; Denmark: TWA 35 ppm (122 milligram per cubic meter) [skin], 1999; Finland: TWA 100 ppm (350 milligram per cubic meter); STEL 250 ppm (870 milligram per cubic meter), 1999; France: VME 50 ppm (180 milligram per cubic meter), VLE 100 ppm, continuous carcinogen, 1999; Hungary: STEL 10 milligram per cubic meter, carcinogen, 1993; the Netherlands: MAC-TGG 350 milligram per cubic meter, 2003; Norway: TWA 35 ppm (125 milligram per cubic meter), 1999; the Philippines: TWA 500 ppm (1740 milligram per cubic meter), 1993; Poland: MAC (TWA) 20 milligram per cubic meter; STEL 50 milligram per cubic meter, 1999; Russia: TWA 100 ppm; STEL 50 milligram per cubic meter, 1993; Sweden: NGV 35 ppm (120 milligram per cubic meter), KTV 70 ppm (250 milligram per cubic meter) [skin] 1999; Switzerland: MAK-W 100 ppm (360 milligram per cubic meter), KZG-W 500 ppm (1800 milligram per cubic meter), 1999; Thailand: TWA 500 milligram per cubic meter; STEL 1000 milligram per cubic meter, 1993; Turkey: TWA 500 ppm (1740 milligram per cubic meter), 1993; United Kingdom: TWA 100 ppm (350 milligram per cubic meter); STEL 300 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: confirmed animal carcinogen with unknown relevance to humans; the Czech Republic: TWA 500 milligram per cubic meter; Standards for methylene chloride in ambient air in residential areas have been set by Russia[43] @ 8.8 milligram per cubic meter on a momentary basis and by the Czech Republic[35] @ 3.0 milligram per cubic meter on a momentary basis and 1.0 milligram per cubic meter on a daily average basis. Several states have set guidelines or standards for methylene chloride in ambient air[60] ranging from 0.2 μ/m^3 (Rhode Island) to 2.4 μ/m^3 (Massachusetts and North Carolina) to 55.55 μ/m^3 (Kansas) to 1167 μ/m^3 (New York) to 3500 μ/m^3 (South Dakota) to 3500−17,400 μ/m^3 (North Dakota) to 58,000 μ/m^3 (Virginia) to 7000 μ/m^3 (Connecticut) to 8333 μ/m^3 (Pennsylvania) to 8700 μ/m^3 (Indiana) to 8750 μ/m^3 (South Carolina).

Determination in Air: Use NIOSH Analytical Method #1005, Methylene chloride; #3800, Organic and Inorganic Gases, #2549, Volatile organic compounds; OSHA Analytical Methods 59 and 80.

Permissible Concentration in Water: Safe Drinking Water Act (47FR 9352): MCL, 0.005 mg/L; MCLG, zero. *To protect human health*: preferably zero. An additional lifetime cancer risk of 1 in 100,000 results at a level of 1.9 μg/L[6]. A lifetime health advisory could not be calculated by EPA[48]. Several states have set standards and guidelines for methylene chloride in drinking water[61] ranging from standards of 2 μg/L (New Jersey) to 100 μg/L (New Mexico) and guidelines of 4.7 μg/L (Arizona) to 25 μg/L (Connecticut) to 40 μg/L (California) to 48 μg/L (Minnesota and Vermont) to 50 μg/L (Kansas) to 150 μg/L (Maine). Russia set a MAC[35] of 7.5 mg/L.

Determination in Water: Inert gas purge followed by gas chromatography with halide specific detection (EPA Method 601) or gas chromatography, plus mass spectrometry (EPA Method #624). Octanol−water coefficient: Log $K_{ow} = 1.25$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation of vapors, percutaneous absorption of liquid; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin, and respiratory tract. May affect the blood, causing the formation of methemoglobin, and carboxyhemoglobin. Exposure can cause irregular heartbeat or cause heart to stop. This can cause death. *Inhalation*: Levels of 300−700 ppm for 3−5 hours has caused slight loss of muscle control and coordination. Effects of high concentrations include headaches, stupor, dizziness, fatigue, drunken behavior; chest pain; arm and leg pains; loss of feeling; loss of appetite; hot flashes and death. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. *Skin*: Contact is painful and highly irritating if confined on the skin by gloves or clothing. Absorbed slowly through the skin to cause symptoms listed under inhalation. *Eyes*: May cause pain, irritation, burns, and permanent damage. *Ingestion*: The liquid may cause chemical pneumonitis. Accidental ingestion of paint removers containing methylene chloride as the main ingredient have reportedly caused headache, nausea, vomiting, visual disturbance; presence of blood in the urine; and unconsciousness. *Note*: Methylene chloride is changed to carbon monoxide in the human body. This is a particularly hazardous condition for those who have a history of heart trouble or those who are also exposed to carbon monoxide. See “Carbon monoxide” Fact Sheet. These persons should take extra precautions.

Long-Term Exposure: Liver problems; increased risk of cancer. Repeated or prolonged skin contact may cause drying and cracking. May be carcinogenic to humans. It has been shown to cause liver and lung cancer in animals. May affect the central nervous system and liver, causing degenerative brain disease and enlargement of the liver. See symptoms as above. Prolonged exposure can cause changes in blood, hallucinations, and decreased response to visual and auditory stimulation. Most of the effects will disappear after exposure stops. Methylene chloride caused genetic effects in certain bacteria and caused birth defects in chickens. In laboratory studies, methylene chloride has also been shown to cause tumors in mice and rats. Whether methylene chloride causes birth defects or tumors in humans is not known.

Points of Attack: Eyes, skin, cardiovascular system; central nervous system. Cancer site in animals: lung, liver, salivary and mammary gland tumors.

Medical Surveillance: OSHA mandates the following tests: laboratory surveillance; carboxyhemoglobin; eectrocardiogram (resting); hematocrit; liver function tests; cholesterol level. NIOSH lists the following tests: whole blood (chemical/metabolite); whole blood (chemical/metabolite), carboxyhemoglobin; whole blood (chemical/metabolite), carboxyhemoglobin, end-of-shift; whole blood (chemical/metabolite), carboxyhemoglobin, prior to next shift; whole blood (chemical/metabolite), end-of-shift; CBC; expired air, expired air, end-of-shift; liver function tests; urine (chemical/metabolite). If symptoms develop or overexposure is suspected, the following may be useful: Special 24 hours EKG (Holter monitor) to look for irregular heartbeat. Blood carboxyhemoglobin (this must be done within a few hours after exposure). Consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin contact: **8 hours:** polyvinyl alcohol gloves; 4H and Silver Shield gloves, Responder suits, Trellchem HPS suits; Trychem 1000 suits. **4 hours:** Teflon gloves, suits, boots; Barricade coated suits 4,4′-Methylenedianiline 101-77-9 Prevent skin contact. **8 hours:** 4H and Silver Shield gloves. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Methylene chloride (1910.1052): < or = 625 ppm (parts per million) (25 × PEL): Continuous-flow supplied-air respirator, hood or helmet. < or = 1250 ppm (50 × PEL): (1) Full-facepiece supplied-air respirator operated in negative-pressure (demand) mode; or (2) Full-facepiece SCBA operated in negative-pressure (demand) mode. < or = 5000 ppm (200 × PEL): (1) Continuous-flow supplied-air respirator, full-facepiece; (2) Pressure-demand supplied-air respirator, full-facepiece; or (3) Positive-pressure full-facepiece SCBA. >5000 ppm or unknown concentration: (1) Positive-pressure full-facepiece SCBA; or (2) Full-facepiece pressure-demand supplied-air respirator with an auxiliary self-contained air supply. *Firefighting*: Positive-pressure full-facepiece SCBA. *Emergency escape*: (1) Any continuous-flow or pressure-demand SCBA; or (2) Gas mask with organic vapor canister.

Shipping: UN1593Dichloromethane, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform to EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration, preferably after mixing with another combustible fuel; care must be exercised to assure complete combustion to prevent the formation of phosgene; an acid scrubber is necessary to remove the halo acids produced.

References

(109); (102); (31); (101); (138); (2); (80); (100).

National Institute for Occupational Safety and Health (NIOSH), “Criteria for a Recommended Standard: Occupational Exposure to Methylene Chloride”, NIOSH Document Number 76-138, Cincinnati, OH (1976).

United States Environmental Protection Agency, Halomethanes: Ambient Water Quality Criteria, Washington, DC (1980).

United States Environmental Protection Agency, Dichloromethane, Health and Environmental Effects Profile No. 74, Washington, DC, Office of Solid Waste (April 30, 1980).

Sax, N. I., Ed., “*Dangerous Properties of Industrial Materials Report*” 1, No. 2, 45−47 (1980) and 6, No. 5, 51−52 (1986).

United States Public Health Service, “Toxicological Profile for Methylene Chloride,” Atlanta, Georgia, agency for Toxic Substances and Disease Registry (Dec. 1987).

New York State Department of Health, *Chemical Fact Sheet*: Methylene Chloride, Bureau of Toxic Substance Assessment, Albany, NY (March 1986 and Version 2).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Methylene Chloride, Trenton, NJ (May 2001).

Methyl Ethyl Ether M:0910

Formula: C_3H_8O

Synonyms: Ether, ethyl methyl; Ethane, methoxy-; Ethyl methyl ether; Methane, ethoxy; Methoxyethane

CAS Registry Number: 540-67-0

HSDB Number: 414

RTECS Number: KO0260000

UN/NA & ERG Number: UN1039/115 (P)

EC Number: [*Annex I Index No.*: 603-020-00-3]

Regulatory Authority and Advisory Information

Hazard Alert: Extremely flammable gas, Polymerization hazard

Hazard symbols, risk, & safety statements: Hazard symbol: F+; risk phrases: R2; R12; R19; safety phrases: S9; S16; S33; S45 (see Appendix 4)

Description: Methyl ethyl ether is a colorless liquid or gas at room temperature. Molecular weight = 60.11; boiling point = 11°C; flash point = −37°C; autoignition temperature = 190°C. Explosive limits: LEL = 2.0%; UEL: 10.1%; hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 4, reactivity 1. Soluble in water.

Potential Exposure: Used as a medicine and anesthetic.

Incompatibilities: May form explosive mixture with air. Incompatible, dangerous reaction with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.). Keep away from alkaline materials, strong acids (may be explosive), strong bases. May form explosive peroxides on standing.

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short-Term Exposure: Contact irritates the skin, eyes, and nose. Inhalation can cause lightheadedness and can reduce concentration. Higher levels of exposure may cause unconsciousness and even cause death.

Long-Term Exposure: Repeated contact may cause skin dryness and cracking. Prolonged high exposure may affect the brain.

Points of Attack: Brain, skin.

Medical Surveillance: Evaluate for brain effect, such as memory, concentration, sleeping patterns and mood; headache and fatigue. Positive and borderline individuals should be referred for neuropsychological testing.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Prior to working with methyl ethyl ether all handlers should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, strong acids. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1039 Methyl ethyl ether or Ethyl methyl ether, Hazard Class: 2.1; Labels: 2.1-Flammable gas.

Spill Handling: *Liquid*: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Gas: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit and to disperse the gas. Stop the flow of gas if it can be done safely. If source of leak is a cylinder and the leak cannot be stopped in place, remove leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. Keep this chemical out of confined space, such as a sewer because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: *Liquid*: This chemical is a combustible liquid. Thermal decomposition products may include oxides of carbon. Use alcohol foam extinguishers. Water may not be effective. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to

cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Gas: Thermal decomposition products may include oxides of carbon. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Methyl Ethyl Ether, Trenton, NJ (November 1999).

Methyl Ethyl Ketone M:0920

Formula: C_4H_8O; $CH_3COCH_2CH_3$

Synonyms: Acetone, methyl-; Aethylmethylketon (German); Butanone; 2-Butanone; Butanone 2 (French); Ethyl methyl cetone (French); Ethyl methyl ketone; MEK; Methyl acetone; Methyl ketone; Ketone, ethyl methyl; Meetco; Metil etil cetona (Spanish)

CAS Registry Number: 78-93-3

HSDB Number: 99

RTECS Number: EL6475000

UN/NA & ERG Number: UN1193/127

EC Number: 201-159-0 [*Annex I Index No*.: 606-002-00-3]

Regulatory Authority and Advisory Information

Carcinogenicity: EPA: Available data are inadequate for an assessment of human carcinogenic potential.; United States Environmental Protection Agency Gene-Tox Program, Inconclusive: *B. subtilis* rec assay.

Hazard Alert: Highly flammable, Suspected reprotoxic hazard, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction).

List II, DEA chemical code 6714 (Title 21 CFR1310.02) as 2-Butanone or MEK

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U159

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA Toxicity Characteristic (Section 261.24), Maximum Concentration of Contaminants, regulatory level, 200.0 mg/L

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.28; Nonwastewater (mg/kg), 36

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8015 (10); 8240 (100)

Safe Drinking Water Act (47FR 9352): Priority List (55 FR 1470)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 5000 lb (2270 kg)

EPCRA Section 313: Removed from the TRI list 2004 as a result of a court decision.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xi; risk phrases: R11; R36/37; R62; R63; R66; R67; safety phrases: S2; S9; S16; S21; S25; S33; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: MEK is a clear, colorless liquid. Fragrant, mint-like, moderately sharp odor. Molecular weight = 72.11; specific gravity (H_2O:1) = 0.81; boiling point = 79.8°C; freezing/melting point = −87°C; vapor pressure = 75 mmHg @ 21.2°C; flash point = −9°C (cc); autoignition temperature = 505°C. Explosive limits: LEL = 1.4% @ 93°C; 14,000 ppm[138]; UEL: 11.4% @ 93°C. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 3, reactivity 0. Soluble in water; solubility = 28%.

Potential Exposure: MEK is used as a solvent in nitrocellulose coating and vinyl film manufacture; in smokeless powder manufacture; in cements and adhesives and in the dewaxing of lubricating oils. It is also an intermediate in drug manufacture.

Incompatibilities: May form explosive mixture with air. Violent reaction with strong oxidizers, amines, ammonia, inorganic acids; caustics, isocyanates, pyridines.

Incompatible with potassium *tert*-butoxide, 2-propanol, chlorosulfonic acid; oleum. Attacks some plastics. Ketones are incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, nitrated amines, azo, diazo, azido compounds, carbamates, organic cyanates.

Permissible Exposure Limits in Air

NIOSH IDLH = 3000 ppm

Conversion factor: 1 ppm = 2.95 milligram per cubic meter @ 25°C & 1 atm

Odor Threshold = 5.4 ppm

OSHA PEL: 200 ppm/590 milligram per cubic meter TWA

NIOSH REL: 200 ppm/590 milligram per cubic meter TWA; 300 ppm/885 milligram per cubic meter STEL

ACGIH TLV[1]: 200 ppm/590 milligram per cubic meter TWA; 300 ppm/885 milligram per cubic meter STEL

PAC Ver. 29[138]

PAC-1: 200 ppm

PAC-2: **2700**$_{\mathbf{A}}$ ppm

PAC-3: **4000**$_{\mathbf{A}}$ ppm

*AEGLs are marked with a subscript "**A**" and correspond to 60-minute values.

DFG MAK: 200 ppm/590 milligram per cubic meter [skin]; Peak Limitation Category I(1); Pregnancy Risk Group C; BAT: 5 milligram per cubic meter in urine, at end-of-shift

Australia: TWA 150 ppm (445 milligram per cubic meter); STEL 300 ppm, 1993; Austria: MAK 200 ppm (590 milligram per cubic meter), 1999; Belgium: TWA 200 ppm (590 milligram per cubic meter); STEL 300 ppm (885 milligram per cubic meter), 1993; Denmark: TWA 50 ppm (145 milligram per cubic meter) [skin], 1999; Finland: STEL 100 ppm, 1993; France: VME 200 ppm (600 milligram per cubic meter), 1999; Hungary: TWA 200 milligram per cubic meter; STEL 600 milligram per cubic meter, 1993; India: TWA 200 ppm (590 milligram per cubic meter); STEL 300 ppm (885 milligram per cubic meter), 1993; the Netherlands: MAC-TGG 590 milligram per cubic meter [skin], 2003; Norway: TWA 75 ppm (220 milligram per cubic meter), 1999; the Philippines: TWA 200 ppm (590 milligram per cubic meter), 1993; Poland: MAC (TWA) 200 milligram per cubic meter, MAC (STEL) 850 milligram per cubic meter, 1999; Russia: TWA 200 ppm; STEL 200 milligram per cubic meter, 1993; Sweden: NGV 50 ppm (150 milligram per cubic meter), KTV 100 ppm (300 milligram per cubic meter), 1999; Switzerland: MAK-W 200 ppm (590 milligram per cubic meter), KZG-V 400 ppm (1180 milligram per cubic meter), 1999; Turkey: TWA 200 ppm (590 milligram per cubic meter), 1993; United Kingdom: TWA 200 ppm (600 milligram per cubic meter), STE 300 ppm [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 300 ppm. The Czech Republic: (ambient air in residential areas) have been set[35] at 0.3 milligram per cubic meter on a momentary and a daily average basis; Russia (in ambient air in residential areas): 0.1 milligram per cubic meter on a momentary basis. Several states have set guidelines or standards for methyl ethyl ketone in ambient air[60] ranging from 0.16 milligram per cubic meter (Massachusetts) to 1.967 milligram per cubic meter (New York) to 3.7−88.5 milligram per cubic meter (North Carolina) to 5.9 milligram per cubic meter (Florida) to 5.9−8.85 milligram per cubic meter (North Dakota) to 9.8 milligram per cubic meter (Virginia) to 11.8 milligram per cubic meter (Connecticut and South Dakota) to 14.048 milligram per cubic meter (Nevada) to 14.75 milligram per cubic meter (South Carolina).

Determination in Air: Use NIOSH Analytical Method #2500, Methyl ethyl ketone; #2555; #3800; #8002 in blood; #2549 Volatile organic compounds; OSHA Analytical Methods 16, 84, and 1004.

Permissible Concentration in Water: Russia[43] set a MAC in water bodies used for domestic purposes of 1.0 mg/L. The EPA[48] has set a lifetime health advisory @ 170 μg/L. Several states have set guidelines for methyl ethyl ketone in drinking water[61] ranging from 60 μg/L (Massachusetts) to 170 μg/L (Arizona) to 172 μg/L (Minnesota) to 270 μg/L (New Jersey)[59] to 750 μg/L (Maine) to 1000 μg/L (Connecticut).

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 0.29$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes and the respiratory tract. May affect the central nervous system. *Inhalation*: Human exposures to levels of 350 ppm caused irritation of the nose and throat. Exposure can cause dizziness, lightheadedness, headache, nausea, blurred vision. Numbness in fingers, arms and legs, accompanied by headache, nausea, vomiting and fainting have occurred after exposure to levels of 300−600 ppm. *Skin*: Contact can irritate the skin causing rash and burning feeling. Liquid is absorbed readily and may cause numbing of fingers and arms. *Eyes*: Contact can irritate and cause burns and permanent damage. Exposure to levels of 200 ppm produced irritation. *Ingestion*: Can cause irritation of the mouth, throat, and stomach, the severity of which will be dependent upon amount swallowed. Symptoms of poisoning include nausea, vomiting, stomach pain and diarrhea. Death can occur from ingestion of as little as 1 ounce.

Long-Term Exposure: Repeated exposure can cause drying and cracking of the skin. Has been implicated in certain nervous system and brain disorders characterized by weakness, fatigue, sleep disturbances; reduced coordination; heaviness in chest and numbness of hands and feet. These symptoms may develop after 1 year of exposure to vapor concentrations of 50−200 ppm. Improvement is gradual and may take years after exposure is discontinued. Animal tests show that this chemical is a teratogen in animals and possibly causes toxic effects upon human reproduction.

Points of Attack: Eyes, skin, respiratory system; central nervous system.

Medical Surveillance: NIOSH lists the following tests: whole blood (chemical/metabolite), expired air, urine (chemical/metabolite); urine (chemical/metabolite), end-of-shift. If symptoms develop, or overexposure is suspected, exam of the nervous system is recommended. Special tests for nerve damage, called nerve conduction studies, may be useful.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. butyl rubber and chlorobutyl rubber are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See NIOSH Criteria Document 78-173, *Ketones*.

Respirator Selection: *Up to 3000 ppm*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOv (APF = 25) [any PAPR with organic vapor cartridge(s)]; or CcrOv (APF = 10) [any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s)]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: *NIOSH*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Methyl ethyl ketone must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat, sparks, or flame. Sources of ignition, such as smoking and open flames are prohibited where methyl ethyl ketone is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gal or more of methyl ethyl ketone should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of methyl ethyl ketone.

Shipping: UN1193 Methyl ethyl ketone or Ethyl methyl ketone, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform to EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration[22].

References

(31); (173); (101); (138); (2); (80); (100).

National Institute for Occupational Safety and Health (NIOSH), "Criteria for a Recommended Standard: Occupational Exposure to Ketones", NIOSH Document Number 78-173, Cincinnati, OH (1978).

United States Environmental Protection Agency, Methyl Ethyl Ketone, Health and Environmental Effects Profile No. 128, Washington, DC, Office of Solid Waste (April 30, 1980).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 1, No. 4, 85−87 (1981).

New York State Department of Health, *Chemical Fact Sheet*: 2-Butanone, Bureau of Toxic Substance Assessment, Albany, NY (March 1986).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Methyl Ethyl Ketone, Trenton, NJ (August 2002).

Methyl Ethyl Ketone Peroxide M:0930

Formula: $C_8H_{16}O_4$

Synonyms: 2-Butanone, peroxide; Butanox; Hi-Point 90; Ketonox; Luperox; Lupersol; MEKP; MEK peroxide; Methyl ethyl ketone hydroperoxide; NCI-C55447; Peroxido de metil etil cetona (Spanish); Quickset extra; Sprayset MEKP; the rmacure

CAS Registry Number: 1338-23-4

HSDB Number: 4181

RTECS Number: EL9450000

UN/NA & ERG Number: UN3105/145

EC Number: 215-661-2

Regulatory Authority and Advisory Information

Hazard Alert: Flammable, Strong oxidizer, Highly Reactive Substance/Explosive decomposition hazard, Polymerization hazard (nonstabilized), Static charge accumulation possible, Possible risk of forming tumors, Primary irritant (w/o allergic reaction).

OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 5000 lb (2270 kg)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U160

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: MEKP, an organic peroxide, is a colorless liquid. Molecular weight = 176.21; specific gravity (H_2O:1) = 1.12 @ 15°C; boiling point = (decomposes) 117.8°C; flash point = 82.22°C (oc) 60% MEKP[52]. Autoignition temperature = 555.56°C. Explosive limits: LEL = 20,000 ppm; UEL: unknown. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 2, reactivity 2. Insoluble in water.

Potential Exposure: MEKP is used as a curing agent for thermosetting polyester resins and as a crosslinking agent and catalyst in the production of other polymers.

Incompatibilities: Forms explosive mixture with air (flash point varies). MEKP may exist in several different structures; decomposition temperatures may vary. Pure substance is shock-sensitive. Explosive decomposition above 176°F/80°C (also reported @ 230°F/110°C). Keep away from sources of ignition, heat, sunlight. A strong oxidizer. Violent reaction with strong acids; strong bases; reducing agents; combustible substances, organic materials; chemical accelerants; oxides of heavy metals; salts, trace contaminants; amines. May accumulate static electrical charges, and cause ignition of its vapors. Commercial product is diluted with 40% dimethyl phthalate, cyclohexane peroxide; or diallyl phthalate to reduce sensitivity to shock.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 7.21 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: None

NIOSH REL: 0.2 ppm/1.5 milligram per cubic meter Ceiling Concentration

ACGIH TLV[1]: 0.2 ppm/1.5 milligram per cubic meter Ceiling Concentration

PAC Ver. 29[138]

PAC-1: 0.18 ppm

PAC-2: 20 ppm

PAC-3: 22 ppm

DFG MAK: Produces very severe skin effects. See Section X(a).

Australia: TWA 0.2 ppm (1.5 milligram per cubic meter), 1993; Belgium: STEL 0.2 ppm (1.5 milligram per cubic meter), 1993; Denmark: TWA 1 milligram per cubic meter, 1999; Finland: STEL 0.2 ppm (1.5 milligram per cubic meter) [skin], 1999; France: VLE 0.2 ppm (1.5 milligram per cubic meter), 1999; Norway: TWA 1 milligram per cubic meter, 1999; the Netherlands: MAC 1.5 milligram per cubic meter, 2003; Switzerland: MAK-W 0.2 ppm (1.5 milligram per cubic meter), 1999; United Kingdom: STEL 0.2 ppm (1.5 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Ceiling Concentration 0.2 ppm. Several states have set guidelines or standards for MEK peroxide in ambient air[60] ranging from 11.0 μ/m^3 (Virginia) to 15.0 μ/m^3 (North Dakota) to 30.0 μ/m^3 (Connecticut and South Dakota) to 36.0 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #3508; OSHA Analytical Method 77.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Methyl ethyl ketone peroxide can affect you when breathed in and by passing through your skin. Contact can irritate the skin, and burn and permanently damage the eyes. Exposure can irritate the nose and throat. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: Methyl ethyl ketone peroxide may affect the liver and kidneys. May cause lung irritation and bronchitis. May cause skin allergy.

Points of Attack: Eyes, skin, respiratory system; liver, kidneys.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater) the following are recommended before beginning work and at regular times after that. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function test. Evaluation by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. butyl rubber; Neoprene, and Viton are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures *over 0.2* ppm; Use an NIOSH/MSHA or European Standard EN 149-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use an NIOSH/MSHA or European Standard EN 149-approved SCBA with a full facepiece operated in pressure-demand or other positive mode.

Storage: Color code—Yellow Stripe: Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Methyl ethyl ketone peroxide must be stored to avoid contact with heat, shock and organics, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from organics. Use only nonsparking tools and equipment, especially when opening and closing containers of methyl ethyl ketone peroxide. Sources of ignition, such as smoking and open flames are prohibited where methyl ethyl ketone peroxide is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever methyl ethyl ketone peroxide is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN3105 Organic peroxide type D, liquid, Hazard Class: 5.2; Labels: 5.2-Organic peroxide, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; alcohol or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform to EPA regulations governing storage, transportation, treatment, and waste disposal. MEKP may be destroyed by adding 20% NaOH solution slowly in a quantity about 10 times the weight of MEKP. Incineration is recommended if NaOH treatment is not used.

References

(2).(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Methyl Ethyl Ketone Peroxide, Washington, DC (1979).

National Institute for Occupational Safety and Health, *Information Profiles on Potential Occupational Hazards*: *Methyl Ethyl Ketone Peroxide, pp 37–41, Report PB-276,678*, Rockville, MD (Oct. 1977).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 2, No. 6, 35–37 (1982) and 5, No. 4, 50–55 (1985).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: *Methyl Ethyl Ketone Peroxide*, Trenton, NJ (October 1999).

2-Methyl-5-Ethyl Pyridine M:0940

Formula: $C_8H_{11}N$

Synonyms: Aldehydecollidine; Aldehydine; Collidine, aldehydecollidine; 3-Ethyl-6-methylpyridine; 5-Ethyl-2-methylpyridine; 5-Ethyl-2-picoline; MEP; 6-Methyl-3-ethylpyridine; Methyl ethyl pyridine; 2-Methyl-5-ethylpyridine

CAS Registry Number: 104-90-5

HSDB Number: 5137

RTECS Number: TJ6825000

UN/NA & ERG Number: UN2300/153

EC Number: 203-250-0

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Flammable, Corrosive.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: C, N; risk phrases: R10; R20/21/22; R34; R41; R52/53; safety phrases: S24/25; S26; S36/37/39; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: 2-Methyl-5-ethyl pyridine is a colorless liquid with a sharp, aromatic odor. Molecular weight = 121.20; boiling point = 128°C; flash point = 39°C; also listed @ 68°C; autoignition temperature = 538°C. Explosive limits: LEL = 1.1%; UEL: 6.6%. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 2, reactivity 0. Slightly soluble in water.

Potential Exposure: In manufacture of nicotinic acid, vinyl pyridine monomer; in intermediates for insecticides, germicides and textile chemicals.

Incompatibilities: Vapors may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, aldehydes, acid chlorides; chloroformates, isocyanates, phenols, cresols.

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Russia: MAC 2 milligram per cubic meter[43].

Routes of Entry: Inhalation, ingestion, eye and/or skin contact. Passes through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates and may be corrosive to the eyes, skin, and respiratory tract. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Exposure can cause headache, nausea, vomiting, and diarrhea. Moderately toxic by oral and dermal routes.

Long-Term Exposure: May affect the central nervous system causing muscle weakness, loss of coordination; and loss of consciousness.

Points of Attack: Lungs, nervous system.

Medical Surveillance: Consider chest X-ray following acute overexposure. Examination of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the

skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gal or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN23002-Methyl-5-ethylpyridine, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Oil-skimming equipment and sorbent foams can be applied to slick if done immediately. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; alcohol or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 2, No. 2, 54−55 (1982) and 3, No. 6, 48−49 (1983).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: 2-Methyl-5-Ethylpyridine, Trenton, NJ (June 1999).

Methyleugenol M:0945

Formula: $C_{11}H_{14}O_2$
Synonyms: 4-Allyl-1,2-dimethoxybenzene; 1-Allyl-3,4-dimethoxybenzene; 4-Allylveratrole; Benzene, 4-Allyl-1, 2-dimethoxy-; Chavibetol methyl ether; 1,2-Dimethoxy-4-allylbenzene; 3,4-Dimethoxyallylbenzene; 1-(3,4-Dimethoxyphenyl)-2-propene; 3-(3,4-Dimethoxyphenyl) propene; 1,2-Dimethoxy-4-(2-propenyl)benzene; Eugenol methyl ether; 1,3,4-Eugenol methyl ether; Eugenyl methyl ether; Methyl eugenol ether; *o*-Methyleugenol; Veratrole, 4-allyl-; Veratrole methyl ether
CAS Registry Number: 93-15-2
HSDB Number: 4505
RTECS Number: CY2450000
UN/NA & ERG Number: UN2810 (toxic liquid, organic, n.o.s.)/153
EC Number: 202-223-0
Regulatory Authority and Advisory Information
Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen.
California Proposition 65 Chemical[102]: Cancer 11/16/2001
Hazard Alert: Poison, Agricultural Chemical; Possible risk of forming tumors, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction).
Hazard symbols, risk, & safety statements: Hazard symbol: T, Xn; risk phrases: R22; R36/37/38; R40; R62; safety phrases: S2; S26; S36/37/39; S41 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.
Description: Clear colorless to pale yellow liquid. Spicy, earthy odor. Bitter burning taste. This chemical is combustible. Molecular weight = 178.23; specific gravity (H_2O:1) = 1.0396 @ 20°C; vapor density = > 1.0; boiling point = 249°C; 254.7°C @ 760 mmHg; melting point = −4°C; vapor pressure = 0.02 mmHg @ 20°C; 1 mmHg @ 85°C; flash point = 99°C; 109°C. Hazard identification (based on NFPA-704 M Rating System): Health 0; flammability 1; reactivity 0. Practically insoluble in water; solubility = < 1 mg/mL at 20°C; 500 mg/L.
Potential Exposure: Methyl eugenol is a naturally occurring substance found in the essential oils of several plant species. Methyleugenol is used as a flavoring agent in jellies, baked goods, nonalcoholic beverages, chewing gum, candy, pudding, relish, and ice cream. Methyleugenol has been used as an anesthetic in rodents. It also is used as an insect attractant in combination with insecticides.[NTP 2000]
Incompatibilities: Methyleugenol is Incompatible with strong oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Contact with reducing agents may cause the release of hydrogen gas.
Permissible Exposure Limits in Air: No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.
Determination in Air:
No NIOSH or OSHA method available.
Permissible Concentration in Water: Not found.
Determination in Water: Bluegill (*Lepomis macrochirus*) LC_{50} = 8233 μg/L, Moderately Toxic; Rainbow trout, donaldson trout (*Oncorhynchus mykiss*) LC_{50} = 6450 μg/L, Moderately Toxic. Octanol−water coefficient: Log K_{ow} = > 3. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.
Routes of Entry: Skin, eyes, inhalation, ingestion.
Harmful Effects and Symptoms
Short-Term Exposure: This compound is a Primary irritant (w/o allergic reaction) and sensitizer and may cause contact dermatitis. Symptoms of exposure to this compound include nausea, vomiting, diarrhea, circulatory collapse, dizziness, rapid and shallow breathing, unconsciousness, convulsions, abdominal burning, dysuria, hematuria, tachycardia, bronchial irritation, anuria, pulmonary edema, bronchial pneumonia, and renal damage. LD_{50}(oral-rat 810 mg/kg; LC_{50} = (inhal.-rat) = > 4800 milligram per cubic meter.
Long-Term Exposure: This compound may be irritating to the skin and eyes.
Points of Attack: Liver, kidneys; skin, respiratory tract.
Medical Surveillance: Consideration should be given to the skin, eyes, and respiratory tract (lung function tests) in any placement or periodic examinations. Evaluation by a qualified allergist, including careful exposure history and special testing may help diagnose skin or respiratory tract allergy.
First Aid: *Eyes*: Consideration should be given to the skin, eyes, and respiratory tract (lung function tests) in any placement or periodic examinations. Evaluation by a qualified allergist, including careful exposure history and special testing may help diagnose skin or respiratory tract allergy.
Personal Protective Methods: Wear protective eyeglasses or chemical safety goggles as described in OSHA regulations 29CFR1910.133 or European Standard EN166. Recommended gloves: Ansell 5.109 (Latex); thickness: 0.18 mm; Breakthrough time: *15 minutes*; Edmont 29-870 (Neoprene); thickness: 0.51 mm; Breakthrough time: *135 minutes*; North Model F-091 (Viton); thickness: 0.41 mm; Breakthrough time: *480 minutes*.
Respirator Selection: Follow the regulations in OSHA 29CFR1910.134 or European Standard EN 149. Use a NIOSH/MSHA or European Standard EN 149-approved respirator; or use Follow regulations in OSHA 29CFR1910.134 or European Standard EN 149. Use a NIOSH/MSHA or European Standard EN 149-approved respirator such as a half face respirator equipped with an organic vapor/acid gas cartridge (specific for organic vapors, HCl, acid gas and SO_2) with a dust/mist filter.

Storage: Color code—Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. You should protect this material from exposure to light, and store it under ambient temperatures.

Shipping: UN2810 Toxic liquids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling:

UN2810 Toxic liquids, organic, n.o.s.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 0.7/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 1000/300
Then: Protect persons downwind (mi/km)
Day 1.1/1.8
Night 2.8/4.5

First remove all sources of ignition. Then, use absorbent paper to pick up all liquid spill material. All contaminated clothing and absorbent paper should be sealed in a vapor-tight plastic bag for eventual disposal. Solvent wash all contaminated surfaces with 60%−70% ethanol followed by washing with a soap and water solution. Do not reenter the contaminated area until the safety officer (or other responsible person) has verified that the area has been properly cleaned.

Fire Extinguishing: Thermal decomposition products may include oxides of carbon. Wear a SCBA in pressure-demand, NIOSH/MSHA or European Standard EN 149-approved respirator, and full protective gear. Use water spray to keep fire-exposed containers cool. Containers may explode in the heat of a fire. Extinguishing media; cool containers with flooding quantities of water until well after fire is out. Fires involving this material can be controlled with a dry chemical, carbon dioxide, or Halon extinguisher. A water spray may also be used.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(109); (102); (31); (173); (101); (138); (100).

Methyl Formate M:0950

Formula: $C_2H_4O_2$: $HCOOCH_3$

Synonyms: Formiate de methyle (French); Formiato de metilo (Spanish); Formic acid, methyl ester; Methyle (formiate de) (French); Methylformiat (German); Methyl methanoate

CAS Registry Number: 107-31-3

HSDB Number: 232

RTECS Number: LQ8925000

UN/NA & ERG Number: UN1243/129

EC Number: 203-481-7 [*Annex I Index No.*: 607-014-00-1]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Hazard Alert: Extremely flammable, Agricultural Chemical.

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: F+, Xn; risk phrases: R12; R20/22; R36/37; safety phrases: S1; S2; S9; S16; S24; S26; S33 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Methyl formate is a colorless liquid with a pleasant odor. Molecular weight = 60.06; specific gravity (H_2O:1) = 0.98; boiling point = 3.7°C; freezing/melting point = −100°C; vapor pressure = 476 mmHg @ 20°C; flash point = −32.8°C; autoignition temperature = 449°C. Explosive limits: LEL = 4.5%; UEL: 23.0%. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 4, reactivity 0₩. Soluble in water; solubility = 30%. Releases formic acid.

Potential Exposure: Methyl formate is used as a solvent; as an intermediate in pharmaceutical manufacture; and as a fumigant.

Incompatibilities: May form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Reacts slowly with water to form methanol and formic acid. Contact with water, steam releases formic acid. Compounds of the carboxyl group react with all bases, both inorganic and organic (i.e., amines) releasing substantial heat, water and a salt that may be harmful. Incompatible with arsenic compounds (releases hydrogen cyanide gas), diazo compounds, dithiocarbamates, isocyanates, mercaptans, nitrides, and sulfides (releasing heat, toxic, and possibly flammable gases), thiosulfates and dithionites (releasing hydrogen sulfate and oxides of sulfur).

Permissible Exposure Limits in Air

NIOSH IDLH = 4500 ppm

Conversion factor: 1 ppm = 2.46 milligram per cubic meter @ 25°C & 1 atm

Odor threshold = 2000 ppm.

OSHA PEL: 100 ppm/250 milligram per cubic meter TWA

NIOSH REL: 100 ppm/250 milligram per cubic meter TWA; 150 ppm/375 milligram per cubic meter STEL

ACGIH TLV[1]: 100 ppm/246 milligram per cubic meter TWA; 150 ppm/368 milligram per cubic meter STEL

PAC Ver. 29[138]

PAC-1: 100 ppm

PAC-2: 830 ppm

PAC-3: 5000 ppm

DFG MAK: 50 ppm/120 milligram per cubic meter TWA; Peak Limitation Category II(4); [skin]; Pregnancy Risk Group C

Australia: TWA 100 ppm (250 milligram per cubic meter); STEL 150 ppm, 1993; Austria: MAK 100 ppm (250 milligram per cubic meter), 1999; Belgium: TWA 100 ppm (246 milligram per cubic meter); STEL 150 ppm (369 milligram per cubic meter), 1993; Denmark: TWA 100 ppm (250 milligram per cubic meter), 1999; Finland: TWA 100 ppm (250 milligram per cubic meter); STEL 150 ppm (375 milligram per cubic meter), 1999; France: VME 100 ppm (250 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 250 milligram per cubic meter, 2003; Sweden: TWA 100 ppm (250 milligram per cubic meter); STEL 150 ppm (350 milligram per cubic meter), 1999; Switzerland: MAK-W 100 ppm (250 milligram per cubic meter), KZG-W 200 ppm (500 milligram per cubic meter), 1999; Turkey: TWA 100 ppm (250 milligram per cubic meter), 1993; United Kingdom: TWA 100 ppm (250 milligram per cubic meter); STEL 150 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 150 ppm. Several states have set guidelines or standards for methyl formate in ambient air[60] ranging from 2.50−3.75 milligram per cubic meter (North Dakota) to 4.2 milligram per cubic meter (Virginia) to 5.0 milligram per cubic meter (Connecticut) to 5.952 milligram per cubic meter (Nevada).

Determination in Air: Use NIOSH (II-5) Method #S-291. OSHA Analytical Method PV-2041

Determination in Water: Octanol−water coefficient: Octanol−water coefficient: Log $K_{\text{ow}} = -0.2$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact. Passes through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Methyl formate can affect you when breathed in and by passing through your skin. Exposure can irritate the eyes, nose, and throat. Higher levels can irritate the lungs and cause a build-up of fluid (pulmonary edema). This can cause death. High levels attack the nervous system and cause you to become dizzy, lightheaded; and may cause unconsciousness and death.

Long-Term Exposure: Prolonged or repeated contact can cause cracking and drying of the skin. Repeated exposure can irritate the lungs and may cause bronchitis to develop.

Points of Attack: Eyes, lungs, central nervous system.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *1000 ppm*: Sa (APF = 10) (any supplied-air respirator). *2500 ppm*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *4500 ppm*: SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentration or IDLH conditions*: SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv (APF = 50) [any air-purifying, full face-piece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister]; or SCBAE (any appropriate escape-type, SCBA). *Note*: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Methyl formate must be stored to avoid contact with strong oxidizers, such as chlorine, bromine, chlorine dioxide; nitrates, and permanganates; since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames are prohibited where methyl formate is handled, used, or stored. Metal containers involving the transfer of 5 gal or more of methyl formate should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of methyl formate. Wherever methyl formate is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1243 Methyl formate, Hazard Class: 3; Labels: 3-Flammable liquid

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration; atomizing in a suitable combustion chamber.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Methyl Formate, Trenton, NJ (August 2004).

Methyl Hydrazine M:0960

Formula: CH_6N_2; CH_3NHNH_2

Synonyms: Hydrazine, methyl-; Hydrazomethane; *N*-Methyl hydrazine; 1-Methyl hydrazine; Metilhidrazina (Spanish); MMH; Monomethylhydrazine

CAS Registry Number: 60-34-4

HSDB Number: 1172

RTECS Number: MV5600000

UN/NA & ERG Number: (PIH) UN1244/131

EC Number: 200-471-4

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 15,000 ($\geq$1.00% concentration).

Carcinogenicity: ACGIH A3 Confirmed animal carcinogen with unknown relevance to humans; NIOSH: Suspected occupational carcinogen. United States Environmental Protection Agency Gene-Tox Program, Positive: Histidine reversion-Ames test; TRP reversion; Positive/limited: Carcinogenicity-mouse/rat; Negative: Rodent dominant lethal; In vitro UDS-human fibroblast; Negative: S *cerevisiae* gene conversion.

California Proposition 65 Chemical[102]: Cancer (methylhydrazine and its salts) 7/1/1992.

Hazard Alert: Poison inhalation hazard: exposure can be lethal, Highly flammable, Pyrophoric hazard, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard.

OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 100 lb (45 kg)

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 15,000 lb (6810 kg)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P068

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500 lb (227 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazard symbols, risk, & safety statements: Hazard symbol: T + , F + , N; risk phrases: R45; R11; R17; R24/25; R26; R23/24/25; R34; R36/37/38; R39; R40; R41; R50/51/53; R62; R63; safety phrases: S1; S16; S21; S26; S24/25; S28; S36/37; S39; S41; S45; S53; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Methyl hydrazine is a fuming, colorless liquid with an ammonia-like odor. The odor threshold is 1.3−1.7 ppm. Molecular weight = 46.07; specific gravity (H_2O:1) = 0.88 @ 20°C; boiling point = 87.8°C; freezing/melting point = −52.4°C; vapor pressure = 38 mmHg @ 20°C; 75 mmHg @ 33°C; flash point = 70°C[101]; autoignition temperature = 194°C. Explosive limits: LEL = 2.5%; UEL: 92.0%[17]. Hazard identification (based on NFPA-704 M Rating System): Health 4, flammability 3, reactivity 2. Slightly soluble in water.

Potential Exposure: MMH has been used as the propellant in liquid propellant rockets; it is also used as a solvent and as an organic intermediate.

Incompatibilities: May form explosive mixture with air. Methyl hydrazine is a highly reactive reducing agent and a medium strong base. May explode if heated. Violent reaction with strong oxidizers, such as fluorine, chlorine, combustibles, nitric acid; hydrogen peroxide. Incompatible with acids, alcohols, glycols, isocyanates, phenols, cresols; porous materials, such as earth, asbestos, wood and cloth. Oxides of iron or copper, manganese, lead, copper or their alloys can lead to fire and explosions. Attacks cork, some plastics, coatings and rubber.

Permissible Exposure Limits in Air

NIOSH IDLH = 20 ppm, potential occupational carcinogen

Conversion factor: 1 ppm = 1.89 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 0.2 ppm/0.35 milligram per cubic meter Ceiling Concentration [skin]

NIOSH REL: 0.04 ppm/0.08 milligram per cubic meter [120-minute] Ceiling Concentration; A potential occupational carcinogen. Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A

ACGIH TLV[1]: 0.01 ppm/0.019 milligram per cubic meter [skin]; confirmed animal carcinogen with unknown relevance to humans.

PAC* Ver. 29[138]

PAC-1: 0.028 ppm

PAC-2: $\mathbf{0.90_A}$ ppm

PAC-3: $\mathbf{2.7_A}$ ppm

*AEGLs are marked with a subscript "**A**" and correspond to 60-minute values.

DFG MAK: [skin] danger of skin sensitization.

Australia: TWA 0.2 ppm (0.35 milligram per cubic meter) [skin], carcinogen, 1993; Belgium: STEL 0.2. ppm (0.38 milligram per cubic meter) [skin], Carcinogen 1993; Denmark: TWA 0.04 ppm (0.08 milligram per cubic meter) [skin], 1999; Finland: STEL 0.2 ppm (0.35 milligram per cubic meter) [skin], 1999; France: VME 0.2 ppm (0.35 milligram per cubic meter), 1999; Norway: TWA 0.08 milligram per cubic meter, 1999; the Netherlands: MAC 0.35 milligram per cubic meter [skin], 2003; Poland: MAC (TWA) 0.02 milligram per cubic meter, MAC (STEL) 0.1 milligram per cubic meter, 1999; Switzerland: MAK-W 0.2 ppm (0.35 milligram per cubic meter) [skin], 1999; Thailand: TWA 0.2 ppm (0.35 milligram per cubic meter), 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: confirmed animal carcinogen with unknown relevance to humans. Several states have set guidelines or standards for methyl hydrazine in ambient air[60] ranging from 0 (Maryland, North Dakota and Texas) to 0.88 μ/m^3 (Pennsylvania) to 1.17 μ/m^3 (New York) to 1.75 μ/m^3 (South Carolina) to 3.5 μ/m^3 (Virginia) to 8.0 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #3510.

Permissible Concentration in Water: No criteria set, but EPA[32] has suggested a permissible ambient goal of 5 μg/L based on health effects.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = -1.03$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Corrosive to the eyes, skin, respiratory tract; and if ingested; may cause permanent damage. Inhalation can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. May affect the central nervous system; liver and blood; causing excitability, vomiting, tremors, convulsions, formation of methemoglobin; and death. Exposure at high concentrations may result in death. The effects may be delayed. Symptoms of acute exposure to methyl hydrazine may include facial numbness, facial swelling; and increased salivation. Headache, twitching, seizure, convulsions, and coma may also occur. Gastrointestinal signs and symptoms include anorexia, nausea, and vomiting. Methyl hydrazine is toxic to the liver, ruptures red blood cells; and may cause kidney damage. Methyl hydrazine vapors are extremely toxic and the liquid is corrosive to skin. Methyl hydrazine is the strongest convulsant and the most toxic of methyl-substituted hydrazine derivatives. It is more toxic than hydrazine. At high doses, it is a strong central nervous system poison.

Long-Term Exposure: May damage the liver, kidneys, and blood, resulting in formation of methemoglobin. This substance causes liver cancer in animals and is possibly carcinogenic to humans.

Points of Attack: Eyes, skin, respiratory system; central nervous system; liver, blood, cardiovascular system. Cancer site in animals: lung, liver, blood vessels; and intestine tumors.

Medical Surveillance: NIOSH lists the following tests: whole blood (chemical/metabolite), methemoglobin; pulmonary function tests. Before beginning employment and at regular times after that, the following is recommended: CBC. If symptoms develop or overexposure has occurred, the following may be useful: consider lung function tests, especially if lung symptoms are present. Test for kidney and liver function. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Note to Physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin contact: **8 hours:** Responder suits; Trychem 1000 suits. Also, Viton, chlorobutyl rubber, and CR-39 may offer some protection. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *at any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: SCBAE (any appropriate escape-type, SCBA).

Storage: Poison inhalation chemical (PIH); check oxygen content prior to entering storage area.(1) Color code—Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. (2) Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Methyl hydrazine must be stored to avoid contact with oxides of iron and copper; manganese, lead, and copper alloys; porous materials (such as earth, asbestos, wood and cloth); oxidizers (such as perchlorates, hydrogen peroxide, chlorates, nitrates, permanganates); and fuming nitric acid; since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat and sparks. Sources of ignition, such as smoking and open flames, are prohibited where methyl hydrazine is handled, used, or stored. Metal containers involving the transfer of 5 gal or more of methyl hydrazine should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of methyl hydrazine. Wherever methyl hydrazine is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN1244 Methylhydrazine, Hazard class: 6.1; Labels: 6.1-Poison Inhalation Hazard, 3-Flammable liquid, 8-Corrosive material, Inhalation Hazard Zone A

Spill Handling:

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase

with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 48-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 0.4/0.6

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 300/90
Then: Protect persons downwind (mi/km)
Day 0.9/1.5
Night 1.4/2.3

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of nitrogen and carbon. For small fires, use dry chemical, carbon dioxide; water spray, and alcohol foam. For large fires, use water spray, fog, or foam. Keep unnecessary people away and isolate the hazardous area. Stay upwind and keep out of low-lying areas. Fire exposed containers should be kept cool with water. Use water spray to disperse vapors and protect responders attempting to stop a leak which has not ignited. Move container from fire area if it can be done without risk. Wear positive pressure breathing apparatus and special (full) protective clothing. No skin surface should be exposed. See "Isolation Distances" above. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform to EPA regulations governing storage, transportation, treatment, and waste disposal. There are 2 alternatives[24]: Dilute with water, neutralize with sulfuric acid, then flush to sewer with large volumes of water or incinerate with added flammable solvent in furnace equipped with afterburner and alkaline scrubber.

References

(102); (31); (173); (101); (138); (2); (170); (100).

National Institute for Occupational Safety and Health (NIOSH), "Criteria for a Recommended Standard: Occupational Exposure to Hydrazines", NIOSH Document Number 78-172, Washington, DC (1978).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 2, No. 5, 86−90 (1982) and 5, No. 4, 55−59 (1985).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Methyl Hydrazine, Washington, DC, Chemical Emergency Preparedness Program (Nov. 30, 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Methyl Hydrazine, Trenton, NJ (July 2005).

Methyl Iodide M:0970

Formula: CH_3I

Synonyms: Halon 10001; Iodomethane; Iodure de methyle (French); Jod-methan (German); Methyljodid (German); Methane, iodo-; Yoduro de metilo (Spanish)

CAS Registry Number: 74-88-4

HSDB Number: 1336

RTECS Number: PA9450000

UN/NA & ERG Number: (PIH) UN2644/151

EC Number: 200-819-5 [*Annex I Index No.*: 602-005-00-9]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human No Adequate Data, animal Limited Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1999; NIOSH: Potential occupational carcinogen. United States Environmental Protection Agency Gene-Tox Program, Positive: Carcinogenicity-mouse/rat; SHE-clonal assay; Positive: L5178Y cells In vitro-TK test; *E. coli polA* without S9; Positive: *S. cerevisiae-homozygosis*.

California Proposition 65 Chemical[102]: Cancer 4/1/1988.

Hazard Alert: Poison inhalation hazard, Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction).

OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 7500 lb

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U138

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.19; Nonwastewater (mg/kg), 65

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8010 (40); 8240 (5)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazard symbols, risk, & safety statements: Hazard symbol: T; risk phrases: R21; R23/25; R37/38; R40; R51; R62; safety phrases: S1/2; S36/37; S38; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Methyl iodide is a colorless liquid. Pungent, ethereal odor. Turns yellow, red, or brown on exposure to light and moisture. Molecular weight = 141.94; specific gravity (H_2O:1) = 2.28 @ 20°C; boiling point = 42.4°C; freezing/melting point = −66.4°C; vapor pressure = 750 mmHg @ 42°C. Explosive limits: LEL = 20,000 ppm; UEL: unknown. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 1, reactivity 0. ₩Slightly soluble in water; solubility = 1%. Slowly reacts with water forming poisonous hydrogen iodide.

Potential Exposure: Methyl iodide is used in fire extinguishers; as an intermediate in the manufacture of pharmaceuticals and some pesticides.

Incompatibilities: May form explosive mixture with air. Slowly reacts with water forming poisonous hydrogen iodide. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Violent reaction with strong oxidizers, strong reducing agents, strong bases; trialkylphosphines, silver chlorite; calcium, oxygen, sodium. Decomposes @ 270°C. Halogenated aliphatic compounds are moderately or very reactive. Halogenated organics generally become less reactive as more of their hydrogen atoms are replaced with halogen atoms. Low molecular weight haloalkanes are highly flammable and can react with some metals to form dangerous products. Materials in this group are incompatible with strong oxidizing and reducing agents. Also, they are incompatible with many amines, alkylphosphines, nitrides, azo/diazo compounds, alkali metals (sodium), and epoxides[101].

Permissible Exposure Limits in Air

NIOSH IDLH = 100 ppm, potential occupational carcinogen

Conversion factor: 1 ppm = 5.80 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 5 ppm/28 milligram per cubic meter TWA [skin]

NIOSH REL: 2 ppm/10 milligram per cubic meter TWA [skin]; A potential occupational carcinogen. Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A

ACGIH TLV[1]: 2 ppm/12 milligram per cubic meter TWA [skin]

PAC Ver. 29[138]

PAC-1: $\mathbf{25_E}$ ppm

PAC-2: $\mathbf{50_E}$ ppm

PAC-3: $\mathbf{125_E}$ ppm

*ERPG [Emergency Response Planning Guidelines] are marked with a subscript "**E**."

DFG MAK: [skin] Carcinogen Category 2

Australia: TWA 2 ppm (10 milligram per cubic meter) [skin], carcinogen, 1993; Austria: [skin], carcinogen, 1999; Belgium: TWA 2 ppm (12 milligram per cubic meter) [skin], Carcinogen 1993; Denmark: TWA 1 ppm (5.6 milligram per cubic meter) [skin], 1999; Finland: TWA 5 ppm (28 milligram per cubic meter); STEL 10 ppm (56 milligram per cubic meter) [skin], 1999; Norway: TWA 1 ppm (5 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 10 milligram per cubic meter [skin], 2003; Poland: MAC (TWA) 10 milligram per cubic meter; MAC (STEL) 30 milligram per cubic meter, 1999; Sweden: NGV 1 ppm (6 milligram per cubic meter), KTV 5 ppm (30 milligram per cubic meter) [skin], carcinogen, 1999; Switzerland: MAK-W 0.3 ppm (2 milligram per cubic meter) [skin], carcinogen, 1999; United Kingdom: TWA 2 ppm (12 milligram per cubic meter) [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 2 ppm [skin]

Determination in Air: Use NIOSH Analytical Method #1014[18].

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 1.63$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact. Passes through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Methyl iodide can affect you when breathed in and by passing through your skin. Methyl iodide is a carcinogen; handle with extreme caution. Contact can irritate the eyes and cause severe skin burns. It can cause brain damage leading to disorientation and psychotic behavior. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Exposure may cause nausea, vomiting, diarrhea, dizziness, slurred speech; visual disturbances; irritability, loss of muscle control, drowsiness, delirium, serious mental disorders; coma; and death.

Long-Term Exposure: Can cause lung irritation and bronchitis. May cause kidney damage. May affect the brain leading to disorientation and personality changes. Exposure can cause nausea, vomiting, vertigo (an illusion of movement), ataxia, slurred speech; drowsiness, dermatitis. A potential occupational carcinogen.

Points of Attack: Eyes, skin, respiratory system; kidneys, central nervous system.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure. Before beginning employment and at regular times after that, the following are recommended. Lung function tests. Kidney function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider urine test for iodine. Consider chest X-ray after acute overexposure. Evaluate for brain effects.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin contact: **8 hours:** Viton gloves, suits; Responder suits; Trychem 1000 suits. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Poison inhalation chemical (PIH); check oxygen content prior to entering storage area. Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2644 Methyl iodide, Hazard Class: 6.1; Labels: 6.1-Poison Inhalation Hazard, Inhalation Hazard Zone B.

Spill Handling:

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental

Protection Agency Environmental Response Team at (908) 48-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30

Then: Protect persons downwind (mi/km)

Day 0.1/0.2

Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 300/100

Then: Protect persons downwind (mi/km)

Day 0.2/0.3

Night 0.5/0.8

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Methyl iodide itself does not burn. Thermal decomposition products may include iodine. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform to EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(102); (31); (173); (101); (138); (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Methyl Iodide, Trenton, NJ (November 1999).

Methyl Isoamyl Ketone M:0980

Formula: $C_7H_{14}O$; $CH_3COCH_2CH_2CH(CH_3)_2$

Synonyms: 2-Hexanone, 5-methyl-; Isoamyl methyl ketone; Isopentyl methyl ketone; Ketone, methyl isoamyl; 5-Methylhexan-2-one; 2-Methyl-5-hexanone; 5-Methyl-2-hexanone; MIAK

CAS Registry Number: 110-12-3

HSDB Number: 2885

RTECS Number: MP3850000

UN/NA & ERG Number: UN2302/127

EC Number: 203-737-8 [*Annex I Index No.*: 606-026-00-4]

Regulatory Authority and Advisory Information

Hazard Alert: Highly flammable liquid, Static charge accumulation possible, Primary irritant (w/o allergic reaction).

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xn; risk phrases: R11; R20; safety phrases: S2; S21; S23; S24/25; S33; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: MIAK is a colorless liquid with a pleasant, fruity odor. Molecular weight = 114.21; specific gravity (H_2O:1) = 0.81; boiling point = 144°C; freezing/melting point = −74°C; vapor pressure = 5 mmHg @ 20°C; flash point = 43.3°C; autoignition temperature = 191°C. Explosive limits: LEL = 1.0% @ 93.3°C; UEL: 8.2% @ 93.3°C. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 3, reactivity 0. Slightly soluble in water; solubility = 0.5%.

Potential Exposure: MIAK is used as a solvent for cellulose esters, acrylics, and vinyl copolymers.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, nitrated amines, azo, diazo, azido compounds, carbamates, organic cyanates. Attacks some plastics and coatings.

Permissible Exposure Limits in Air

OSHA PEL: 100 ppm/475 milligram per cubic meter TWA

NIOSH REL: 50 ppm/240 milligram per cubic meter TWA

ACGIH TLV[1]: 50 ppm/234 milligram per cubic meter TWA

PAC Ver. 29[138]

PAC-1: 50 ppm

PAC-2: 69 ppm
PAC-3: 190 ppm
DFG MAK: 10 ppm/47 milligram per cubic meter TWA; Peak Limitation Category I(2) [skin]; Pregnancy Risk Group D
Australia: TWA 50 ppm (240 milligram per cubic meter), 1993; Belgium: TWA 50 ppm (234 milligram per cubic meter), 1993; Denmark: TWA 50 ppm (230 milligram per cubic meter), 1999; Finland: TWA 50 ppm (230 milligram per cubic meter); STEL 75 ppm (350 milligram per cubic meter), 1999; France: VME 50 ppm (240 milligram per cubic meter), 1999; Norway: TWA 25 ppm (115 milligram per cubic meter), 1999; Sweden: TWA 25 ppm (120 milligram per cubic meter); STEL 50 ppm (250 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 233 milligram per cubic meter, 2003; United Kingdom: TWA 50 ppm (237 milligram per cubic meter); STEL 100 ppm [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 50 ppm. In addition, Several states have set guidelines or standards for MIAK in ambient air[60] ranging from 2.4 milligram per cubic meter (North Dakota) to 4.0 milligram per cubic meter (Virginia) to 4.6 milligram per cubic meter (Connecticut) to 5.714 milligram per cubic meter (Nevada).

Determination in Air: OSHA Analytical Method PV-2042

Determination in Water: Octanol−water coefficient: Log K_{ow} = 1.72 (estimated). Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Methyl isoamyl ketone can affect you when breathed in and by passing through your skin. Exposure can cause you to become dizzy, lightheaded and to pass out. Contact can irritate the eyes and skin. Repeated exposure can cause a skin rash. Methyl isoamyl ketone vapors can irritate the nose and throat. MIAK may affect the kidneys.

Long-Term Exposure: Skin contact causes skin rash and drying and cracking. High exposures may cause liver damage and may affect the kidneys.

Points of Attack: Eyes, skin, respiratory system; central nervous system; liver, kidneys.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See NIOSH Criteria Document 78-173, *Ketones*.

Respirator Selection: NIOSH: *Up to 500 ppm*: CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)];* or Sa (APF = 10) (any supplied-air respirator.) * *Up to 1250 ppm*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode);* or PaprOv (APF = 25) [any PAPR with organic vapor cartridge(s)]* *Up to 2500 ppm*: CcrFOv (APF = 50) [any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s)]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or PaprTOv (APF = 50) [any PAPR with a tight-fitting facepiece and organic vapor cartridge(s)];* or SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode);* or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 5000 ppm*: SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd, Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA). *Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates), strong oxidizers (such as chlorine, bromine, and fluorine; reducing agents; and aldehydes. Sources of ignition, such as smoking and open flames are prohibited where methyl isoamyl ketone is handled, used, or stored. Metal containers involving the transfer of 5 gal or more of methyl isoamyl ketone should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters.

Shipping: UN23025-Methylhexan-2-one, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Methyl Isoamyl Ketone, Trenton, NJ (October 1999).

Methyl Isobutyl Carbinol M:0990

Formula: $C_6H_{14}O$; $CH_3CHOHCH_2CH(CH_3)_2$

Synonyms: Alcool methyl amylique (French); Isobutylmethylcarbinol; Isobutylmethylmethanol; MAOH; Methyl amyl alcohol; Methylisobutyl carbinol; 2-Methyl-4-pentanol; 4-Methylpentanol-2; 4-Methyl-2-pentanol; MIBC; MIC; 3-MIC; 2-Pentanol, 4-methyl-

CAS Registry Number: 108-11-2

HSDB Number: 1154

RTECS Number: SA7350000

UN/NA & ERG Number: UN2053/129

EC Number: 203-551-7 [*Annex I Index No.*: 603-008-00-8]

Regulatory Authority and Advisory Information

Hazard Alert: Flammable liquid.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: Xi; risk phrases: R10; R37; safety phrases: S2; S24/25 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: MIBC is a colorless liquid with a mild odor. The odor threshold is 0.52 ppm. Molecular weight = 102.20; specific gravity (H_2O:1) = 0.81; boiling point = 132.8°C; freezing/melting point = −90°C; vapor pressure = 3 mmHg @ 20°C; flash point = 48.9°C. The explosive limits are LEL = 1.0%; UEL: 5.5%. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 2, reactivity 0. Slightly soluble in water; solubility = 2%.

Potential Exposure: MIBC is used as a solvent; in the formulation of brake fluids; as an intermediate in organic synthesis.

Incompatibilities: Vapor may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong acids, peroxysulfuric acid, strong bases, caustics, aliphatic amines; isocyanates. Contact with alkali metals produces hydrogen gas.

Permissible Exposure Limits in Air

NIOSH IDLH = 400 ppm

Conversion factor: 1 ppm = 4.18 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 25 ppm/100 milligram per cubic meter TWA [skin]

NIOSH REL: 25 ppm/100 milligram per cubic meter TWA; 40 ppm/165 milligram per cubic meter STEL [skin]
ACGIH TLV[1]: 25 ppm/104 milligram per cubic meter TWA; 40 ppm/167 milligram per cubic meter STEL [skin]
PAC not available
DFG MAK: 20 ppm/85 milligram per cubic meter TWA; Peak Limitation Category I(1); Pregnancy Risk Group D
Australia: TWA 25 ppm (100 milligram per cubic meter); STEL 40 ppm [skin], 1993; Austria: MAK 25 ppm (50 milligram per cubic meter) [skin], 1999; Belgium: TWA 25 ppm (104 milligram per cubic meter); STEL 40 ppm [skin] 1999; Denmark: TWA 25 ppm (100 milligram per cubic meter) [skin], 1999; Finland: TWA 25 ppm (100 milligram per cubic meter); STEL 40 ppm (170 milligram per cubic meter) [skin], 1999; France: VME 25 ppm (100 milligram per cubic meter) [skin], 1999; the Netherlands: MAC-TGG 100 milligram per cubic meter [skin], 2003; Russia: STEL 10 milligram per cubic meter [skin], 1993; Poland: MAC (TWA) 100 milligram per cubic meter; MAC (STEL) 160 milligram per cubic meter, 1999; Switzerland: TWA 25 ppm (100 milligram per cubic meter); STEL 125 ppm [skin], 1993; Switzerland: MAK-W 25 ppm (100 milligram per cubic meter), KZG-W 125 ppm (500 milligram per cubic meter) [skin], 1999; United Kingdom: TWA 25 ppm (106 milligram per cubic meter); STEL 40 ppm [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 40 ppm [skin]. North Dakota has set a guideline for MIBC in ambient air[60] of 1.0−1.65 milligram per cubic meter.

Determination in Air: Use NIOSH Analytical Method #1402, alcohols II; #1405; OSHA Analytical Method 7[18].

Determination in Water: Octanol−water coefficient: $\text{Log}\, K_{ow} = 1.4$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: MIBC can affect you when breathed in and by passing through your skin. Breathing the vapor can irritate the eyes, nose, and throat. Contact with the liquid can burn the eyes and can irritate the skin. Exposure to high concentrations can cause you to feel dizzy, lightheaded, and to pass out.

Long-Term Exposure: Long-term contact can cause drying and cracking of the skin.

Points of Attack: Eyes, skin, central nervous system.

Medical Surveillance: NIOSH lists the following tests: whole blood (chemical/metabolite), expired air, pulmonary function tests; urine (chemical/metabolite), end-of-shift; urine (chemical/metabolite) end-of-work-week.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *250 ppm*: Sa (APF = 10) (any supplied-air respirator). *400 ppm*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode) or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Methyl amyl alcohol must be stored to avoid contact with peroxides, chlorates, perchlorates, permanganates, and nitrates, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames are prohibited where methyl amyl alcohol is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2053Methyl isobutyl carbinol, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak

until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration; other, more flammable solvent may be added.

References

(31); (173); (101); (138); (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Methyl *n*-Amyl Alcohol, Trenton, NJ (April 2004).

Methyl Isobutyl Ketone M:1000

Formula: $C_6H_{12}O$; $CH_3COCH_2CH(CH_3)_2$

Synonyms: Hexone; Isobutyl methyl ketone; Isopropylacetone; KTI COP Rinse I; KTI PMMA Rinse; Methyl-isobutyl-cetone (French); 2-Methyl-4-pentanone; 4-Methyl-2-pentanone; MIBK; MIK; 2-Pentanone, 4-methyl-; Metil isobutil cetona (Spanish); RN-10 E beam negative resist rinse; Shell MIBK

CAS Registry Number: 108-10-1

HSDB Number: 148

RTECS Number: SA9275000

UN/NA & ERG Number: UN1245/127

EC Number: 203-550-1 [*Annex I Index No*.: 606-004-00-4]

Regulatory Authority and Advisory Information

Carcinogenicity: EPA: Available data are inadequate for an assessment of human carcinogenic potential.

Hazard Alert: Highly flammable liquid, Polymerization hazard, Possible risk of forming tumors, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction).

List II, DEA chemical code 6715 (Title 21 CFR1310.02)

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U161

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.14; Nonwastewater (mg/kg), 33

Safe Drinking Water Act (47FR 9352): Priority List (55 FR 1470)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 5000 lb (2270 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xn; risk phrases: R11; R19; R20; R36/37; R62; R66; safety phrases: S2; S9; S16; S21; S29; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: MIBK is a colorless liquid with a pleasant, sweet, fruity odor. Molecular weight = 100.16; specific gravity (H_2O:1) = 0.80 @ 20°C; boiling point = 117°C; freezing/melting point = −84°C; vapor pressure = 16 mmHg @ 20°C; 7.5 mmHg @ 9°C; flash point = 18°C; autoignition temperature: 450°C. Explosive limits: LEL = 1.2% @ 93°C; UEL: 8.0% @ 93°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 3, reactivity 1. Slightly soluble in water; solubility = 2%.

Potential Exposure: MIBK is used as a solvent; a denaturant; and as an extractant; in the manufacture of methyl amyl alcohol; as a solvent in paints, varnishes, and lacquers; as an alcohol denaturant; as a solvent in uranium extraction from fission products.

Incompatibilities: Able to form unstable and explosive peroxides on contact with air. Reacts violently with strong oxidizers, potassium *tert*-butoxide; strong acids; aliphatic amines; reducing agents.

Permissible Exposure Limits in Air

NIOSH IDLH = 500 ppm

Conversion factor: 1 ppm = 4.10 milligram per cubic meter @ 25°C & 1 atm

Odor Threshold = 0.88 ppm.

OSHA PEL: 100 ppm/410 milligram per cubic meter TWA

NIOSH REL: 50 ppm/205 milligram per cubic meter TWA; 75 ppm/300 milligram per cubic meter STEL
ACGIH TLV[1]: 20 ppm/82 milligram per cubic meter TWA; 75 ppm/307 milligram per cubic meter STEL; BEI issued.
PAC Ver. 29[138]
PAC-1: 75 ppm
PAC-2: 500 ppm
PAC-3: 3000 ppm
DFG MAK: 20 ppm/83 milligram per cubic meter Peak Limitation Category I(2) [skin]; Pregnancy Risk Group C; BAT: 3.5 mg[hexone]/L in urine/end-of-shift.
Austria: MAK 100 ppm (400 milligram per cubic meter), 1999; Denmark: TWA 25 ppm (100 milligram per cubic meter) [skin], 1999; France: VME 50 ppm (205 milligram per cubic meter), 1999; Japan: 50 ppm (105 milligram per cubic meter) [skin], 1999; Norway: TWA 25 ppm (105 milligram per cubic meter), 1999; Poland: MAC (TWA) 200 milligram per cubic meter; MAC (STEL) 300 milligram per cubic meter, 1999; Sweden: NGV 25 ppm (100 milligram per cubic meter), KTV 50 ppm (200 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 104 milligram per cubic meter, 2003. For ambient air in residential areas: The Czech Republic[35] MAC 0.2 milligram per cubic meter both on a momentary and a daily average basis; Russia[35]: MAC of 0.1 milligram per cubic meter on a once daily basis. Several states have set guidelines or standards for MIBK in ambient air[60] ranging from 0.28 milligram per cubic meter (Massachusetts) to 0.683 milligram per cubic meter (New York) to 2.05 milligram per cubic meter (Florida, North Dakota, South Carolina) to 2.50 milligram per cubic meter to 3.4 milligram per cubic meter (Virginia) to 4.1 milligram per cubic meter (Connecticut) to 4.76 milligram per cubic meter (Nevada) to 30.8 milligram per cubic meter (North Carolina).

Determination in Air: Charcoal adsorption, workup with CS_2; analysis by gas chromatography/flame ionization. See NIOSH (I) Method #1300, Ketones; #2555; OSHA Analytical Method 1004[18].

Permissible Concentration in Water: The state of Massachusetts has set[61] a guideline for MIBK in drinking water of 40 μg/L (0.04 mg/L). Russia has set a limit in surface water of 0.2 mg/L.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Methyl isobutyl ketone can affect you when breathed in. Exposure to high concentrations can cause you to feel dizzy and lightheaded, and to pass out. Breathing the vapor may cause loss of appetite; nausea, vomiting, and diarrhea. Contact or the vapor can irritate the eyes, nose, mouth, throat. Contact can irritate the skin. Ingestion may cause chemical pneumonitis. Effects may include severe pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: Long-term exposure may damage the liver and kidneys. Repeated or prolonged contact with skin may cause drying and cracking.

Points of Attack: Eyes, skin, respiratory system; central nervous system; liver, kidneys.

Medical Surveillance: Medical observation is recommended for 24 to 48 hours after breathing overexposure, as chemical pneumonitis or pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. If symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Teflon and styrene-butadiene rubber are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *500 ppm*: CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or PaprOv (APF = 25) [any PAPR with organic vapor cartridge(s)]; or Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with a full facepiece). *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode) or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Methyl isobutyl ketone must be stored to avoid contact with strong oxidizers because violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat, sparks, and flames. Sources of ignition, such as smoking and open flames are prohibited where methyl isobutyl ketone is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gal or more of methyl isobutyl ketone should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of methyl isobutyl ketone.

Shipping: UN1245 Methyl isobutyl ketone, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Oil-skimming equipment and sorbent foams can be applied to slick if done immediately. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform to EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration[22].

References

(31); (173); (101); (138); (100).

National Institute for Occupational Safety and Health (NIOSH), “Criteria for a Recommended Standard: Occupational Exposure to Ketones”, NIOSH Document Number 78-173, Washington, DC (1978).

United States Environmental Protection Agency, Methyl Isobutyl Ketone, Health and Environmental Effects Profile No. 129, Wash. DC, Office of Solid Waste (April 30, 1980).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Methyl Isobutyl Ketone, Trenton, NJ (August 2005).

Methyl Isocyanate M:1010

Formula: C_2H_3NO; CH_3NCO

Synonyms: Isocyanate de methyle (French); Isocianato de metilo (Spanish); Isocyanatomethane; Isocyanic acid, methyl ester; Isocyanate methane; Methane, isocyanato-; Methylcarbamyl amine; Methyl carbonimide; Methyl ester of isocyanic acid; Methyl isocyanat (German)

CAS Registry Number: 624-83-9

HSDB Number: 1165

RTECS Number: NQ9450000

UN/NA & ERG Number: (PIH) UN2480/155

EC Number: 210-866-3 [*Annex I Index No.*: 615-001-00-7]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 ($\geq$1.00% concentration); ($\geq$1.00% concentration).

California Proposition 65 Chemical[102]: Developmental/Reproductive toxin (female) 11/12/2010
Hazard Alert: Poison inhalation hazard: exposure can be lethal, Highly flammable, Water reactive, sensitization hazard, Polymerization hazard, Reproductive toxin, Serious eye damage.
OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 250 lb
Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg)
United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P064
RCRA, 40CFR261, Appendix 8 Hazardous Constituents
Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500 lb (227 kg)
Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg)
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
United States DOT 49CFR172.101, Inhalation Hazardous Chemical
Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.
Hazard symbols, risk, & safety statements: Hazard symbol: F, T+; R11; R19; R24/25; R26; R37/38; R41; R42; R42/43; R51; R63; safety phrases: S1/2; S16; S21; S26; S27/28; S36/37/39; S41; S43; S45; S63 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): *Note*: Methyl isocyanate "Caused the death of thousands in 1984 in Bhopal, India when released accidentally as a vapor following an exothermic reaction caused by contamination with water" [*Chemical Engineering News*, 1985, 63(6), p. 27][101].

Description: Methyl isocyanate is a colorless liquid. Sharp odor which is a lachrymator (causes tears) and has poor warning properties: IDLH = 3 ppm; odor threshold = 2.1 ppm. Molecular weight = 57.05; specific gravity (H_2O:1) = 0.96; boiling point = 38°C; freezing/melting point = −45°C; vapor pressure = 348 mmHg @ 20°C; 750 mmHg @ 39°C; flash point = −7°C; autoignition temperature = 534°C. Explosive limits: LEL = 5.3%; 73,330 ppm[138]; UEL: 26°C. Hazard identification (based on NFPA-704 M Rating System): Health 4, flammability 3, reactivity 2. ₩ Reacts with water; solubility = 10% @ 15°C. Reaction with water is slow and violent.

Potential Exposure: Methyl isocyanate is used in carbamates and as chemical intermediate; in the manufacture of a wide variety of pesticides; in the production of polyurethane foams and plastics. A release of this chemical was involved in the world's largest chemical accident, causing the death of thousands of industrial workers in 1984 in Bhopal, India.

Incompatibilities: Highly flammable liquid. Vapors may form explosive mixture with air. Rapid reaction in presence of acid, alkalis, amine; iron, tin, copper, their salts; or their catalysts (such as triphenylarsenic oxide, triethylphosphine, and tributyltin oxide). Exothermic reaction with water, producing carbon dioxide, highly flammable and air-reactive methylamine, dimethylurea and/or trimethyl biuret. The reaction with water is slow @ ≤20°C, but violent at elevated temperatures and/or in the presence of acids and bases. *Elevated temperatures may cause explosive polymerization*. This chemical usually contains inhibitors to prevent polymerization. Reacts with water, acids, alcohols, glycols, amines, amides, ammonia, caprolactum, caustics, strong oxidizers. Attacks some plastics, rubber or coatings. Attacks some forms of plastic, rubber and coatings.

Permissible Exposure Limits in Air
NIOSH IDLH = 3 ppm
Odor threshold = 2.1 ppm (poor warning properties)
Conversion factor: 1 ppm = 2.34 milligram per cubic meter @ 25°C & 1 atm
OSHA PEL: 0.02 ppm/0.05 milligram per cubic meter TWA [skin]
NIOSH REL: 0.02 ppm/0.05 milligram per cubic meter TWA [skin]
ACGIH TLV[1]: 0.02 ppm/0.047 milligram per cubic meter TWA [skin]
PAC* Ver. 29[138]
PAC-1: **0.025**$_{\mathbf{A}}$ ppm
PAC-2: **0.067**$_{\mathbf{A}}$ ppm
PAC-3: **0.20**$_{\mathbf{A}}$ ppm
*AEGLs are marked with a subscript "**A**" and correspond to 60-minute values.
DFG MAK: 0.01 ppm/0.024 milligram per cubic meter TWA; Peak Limitation Category I(1); Pregnancy Risk Group D
Austria: MAK 0.01 ppm (0.025 milligram per cubic meter), 1999; Belgium: TWA 0.02 ppm (0.047 milligram per cubic meter) [skin], 1993; Denmark: TWA 0.01 ppm (0.03 milligram per cubic meter) [skin], 1999; France: VME 0.02 ppm (0.05 milligram per cubic meter) [skin], 1999; Hungary: TWA 0.05 milligram per cubic meter; STEL 0.06 milligram per cubic meter [skin], 1993; Norway: TWA 0.005 ppm (0.015 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 0.05 milligram per cubic meter [skin], 2003; Russia: STEL 0.05 milligram per cubic meter [skin], 1993; Sweden: TWA 0.005 ppm, ceiling 0.01 ppm, 1999; Switzerland: MAK-W 0.01 ppm (0.025 milligram per cubic meter), KZG-W 0.02 ppm (0.05 milligram per cubic meter), 1999; United Kingdom: TWA 0.02 mg[NCO]/m^3; STEL 0.07 mg[NCO]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 0.02 ppm [skin]. Several states have set guidelines or standards for methyl isocyanate in ambient air[60] ranging from 0.17 μ/m^3 (New York) to 0.5 μ/m^3 (North Dakota) to 0.8 μ/m^3 (Virginia) to 1.0 μ/m^3 (Connecticut and South Dakota).

Determination in Air: Use OSHA Analytical Method 54.

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: *Inhalation*: Corrosive to the respiratory tract. Causes irritation of eyes, nose, throat, and lungs; bronchitis, cough, shortness of breath; increased secretions; chest pain; difficulty in breathing; and increased blood acidity. Allergic reactions may occur and trigger asthmatic response in sensitized individuals. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Results of human volunteer experiments indicate the exposure for 1−5 min at 0.4 ppm causes no irritation of eyes, nose or throat; @ 2 ppm, irritation and tearing; @ 4 ppm, stronger symptoms; and @ 21 ppm exposure is unbearable; NIOSH reports that 3 ppm is immediately dangerous to life and health (IDLH). Improvement will occur in a few days if the dose is very low, and proper supportive therapy is given. At higher doses and longer durations of exposure, death may be immediate or delayed more than a month. *Skin*: Corrosive. Extremely irritating; can cause chemical burns. *Eyes*: Corrosive to the eyes. Levels of 2 ppm may cause irritation and tearing. Ulceration has occurred at high levels. Very high levels may lead to permanent damage and blindness. *Ingestion*: Corrosive; causes vomiting, diarrhea, and abdominal pain.

Long-Term Exposure: May cause allergic sensitization of skin and respiratory tract. Subsequent exposure even at extremely low levels may cause asthma attacks. May cause chronic lung disease and increased susceptibility to lung infection. May affect the lungs, causing tissue lesions. Exposure may cause miscarriages among pregnant women.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: NIOSH lists the following tests: Blood Gas Analysis; chest X-ray, electrocardiogram, pulmonary function tests: forced vital capacity, forced expiratory volume (1 second); sputum cytology; white blood cell count/differential. Before beginning employment and at regular times after that, the following are recommended. Lung function tests. These may be normal at first if person is not having an attack at the time. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: Warning: Effects may be delayed for up to 15 hours. If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin contact: Prevent skin contact. **8 hours:** polyvinyl alcohol gloves; Barricade coated suits; Responder suits, Trellchem HPS suits; Trychem 1000 suits. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *0.2 ppm*: Sa (APF = 10) (any supplied-air respirator). *0.5 ppm*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *1 ppm*: SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *3 ppm*: SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister]; or SCBAE (any appropriate escape-type, SCBA). *Note*: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Poison inhalation chemical (PIH); check oxygen content prior to entering storage area. Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Methyl isocyanate must be stored to avoid contact with water, acid, alkali, amines, or iron, tin, copper (or their salts); and certain other catalysts, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from water or heat. Sources of ignition, such as smoking and open flames are prohibited where methyl isocyanate is handled, used, or stored. Metal containers involving the transfer of 5 gal or more of methyl isocyanate should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of methyl isocyanate. Wherever methyl isocyanate is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN2480 Methyl isocyanate Hazard class: 6.1; Labels: 6.1-Poison Inhalation Hazard, 3-Flammable liquid, Inhalation Hazard Zone A

Spill Handling:

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 48-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 500/150
Then: Protect persons downwind (mi/km)
Day 1.1/1.8
Night 3.6/5.8

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 3000/1000
Then: Protect persons downwind (mi/km)
Day 7.0+/11.0+*
Night 7.0+/11.0+*

*+ means distance can be larger in certain atmospheric conditions.

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. For spills Up to 5 gal, cover with 6 inches of activated carbon for each 1 inch of liquid depth and let stand. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. *Do not use water* or wet method. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120 (q) may be applicable.

Fire Extinguishing: *Elevated temperatures can cause explosion*. Highly flammable liquid. Thermal decomposition products may include hydrogen cyanide and oxides of nitrogen and carbon. Material is extremely hazardous to health; areas must be entered with extreme care. Full protective clothing, including SCBA (coat, pants, gloves, boots, and bands around legs, arms and waist) should be provided. No skin surface should be exposed. Vapors are heavier than air and will collect in low areas. Small fires: dry chemical, carbon dioxide, water spray, or foam. Large fires: water spray, fog, or foam[101]. Vapors may travel long distances to ignition sources and flashback. Containers may explode in fire. Stay away from ends of tanks. Do not get water inside container. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. Spray cooling water on containers that are exposed to flames until well after fire is out. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full face pieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform to EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration in the presence of a flammable solvent[22]. A flue gas scrubber is recommended as well.

References

(102); (31); (173); (101); (138); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 5, No. 2, 68−70 (1985)

United States Environmental Protection Agency, Chemical Hazard Information Profile: *Methyl Isocyanate*, Washington, DC, Chemical Emergency Preparedness Program (Nov. 30, 1987)

New York State Department of Health, *Chemical Fact Sheet*: *Methyl Isocyanate*, Albany, NY, Bureau of Toxic Substance Assessment (May 1986)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Methyl Isocyanate, Trenton, NJ (April 2002)

Methyl Isopropyl Ketone M:1020

Formula: $C_5H_{10}O$; $CH_3COCH(CH_3)_2$
Synonyms: 2-Acetyl propane; Isopropyl methyl ketone; 3-Methyl-2-butanone; 3-Methyl butan-2-one; MIPK
CAS Registry Number: 563-80-4
HSDB Number: 7915
RTECS Number: EL9100000
UN/NA & ERG Number: UN2397/127
EC Number: 209-264-3 [*Annex I Index No.*: 606-007-00-0]
Regulatory Authority and Advisory Information
California Proposition 65 Chemical[102]: Developmental/ Reproductive toxin, *delisted 4/4/2014*
Hazard Alert: Highly flammable, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction).
Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.
Hazard symbols, risk, & safety statements: Hazard symbol: F+; risk phrases: R12; R36/37/38; R62; safety phrases: S2; S7; S9; S16; S33; S41; S45 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.
Description: MIPK is a colorless liquid with an acetone-like odor. Molecular weight = 86.15; specific gravity (H_2O:1) = 0.81 @ 16°C; boiling point = 93°C. Freezing = −92°C; vapor pressure = 42 mmHg @ 20°C; flash point = 21.1°C; autoignition temperature = 475°C. Explosive limits: LEL = 1.2%; UEL: 8%. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 4, reactivity 0. Slightly soluble in water; solubility = 0.5% @ 20°C.
Potential Exposure: This ketone is used as a solvent for nitrocellulose lacquers.
Incompatibilities: Vapors may form explosive mixture with air. Ketones are incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, nitrated amines, azo, diazo, azido compounds, carbamates, organic cyanates.
Permissible Exposure Limits in Air
Conversion factor: 1 ppm = 3.53 milligram per cubic meter @ 25°C & 1 atm
OSHA PEL: None
NIOSH REL: 200 ppm/705 milligram per cubic meter TWA
ACGIH TLV[1]: 200 ppm/705 milligram per cubic meter TWA, Excursion Limit Recommendation: Excursions in worker exposure levels may exceed 3 times the TLV-TWA for no more than a total of 30 minutes during a work day, and under no circumstances should they exceed 5 times the TLV-TWA, provided that the TLV-TWA is not exceeded.
PAC Ver. 29[138]
PAC-1: 60 ppm
PAC-2: 660 ppm
PAC-3: 4000 ppm
Australia: TWA 200 ppm (705 milligram per cubic meter), 1993; Belgium: TWA 200 ppm (705 milligram per cubic meter), 1993; Denmark: TWA 200 ppm (705 milligram per cubic meter), 1999; Finland: TWA 200 ppm (700 milligram per cubic meter); STEL 250 ppm (875 milligram per cubic meter), 1999; France: VME 200 ppm (705 milligram per cubic meter), 1999; Norway: TWA 100 ppm (350 milligram per cubic meter), 1999; Switzerland: MAK-W 200 ppm (720 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 705 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 200 ppm. Several states have set guidelines or standards for MIPK in ambient air[60] ranging from 7.05 milligram per cubic meter (North Dakota) to 11.75 milligram per cubic meter (Virginia) to 14.1 milligram per cubic meter (Connecticut) to 16.786 milligram per cubic meter (Nevada).
Determination in Air: No NIOSH Analytical Method available.
Routes of Entry: Inhalation of vapor, skin absorption; ingestion; skin and/or eye contact.
Harmful Effects and Symptoms
Short-Term Exposure: Eye, nose, throat and skin irritation. In high concentrations, narcosis may be produced with symptoms of headache, nausea, vomiting, lightheadedness, dizziness, a lack of coordination; narcosis, and unconsciousness.
Long-Term Exposure: Removes the skin's natural oils; causes drying and cracking.
Points of Attack: Eyes, skin, respiratory system.
Medical Surveillance: There is no special test for this chemical. However, if illness occurs or overexposure is suspected, medical attention is recommended.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.
Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/ manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working

with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See NIOSH Criteria Document 78-173, *Ketones*.

Respirator Selection: Where there is potential exists for exposures *over 200* ppm; Use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece respirator with an organic vapor cartridge/canister. Greater protection is provided by a PAPR. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from aldehydes. Sources of ignition, such as smoking and open flames are prohibited where methyl isopropyl ketone is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Use only nonsparking tools and equipment, especially when opening and closing containers of methyl isopropyl ketone. Wherever methyl isopropyl ketone is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN23973-Methylbutan-2-one, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(102); (31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Methyl Isopropyl Ketone, Trenton, NJ (January 2001).

Methyl Isothiocyanate M:1030

Formula: C_2H_3NS; CH_3NCS

Synonyms: AI3-28257; Di-Trapex; EP-161E; Isothiocyanate de methyle (French); Isothiocyanatomethane; Isothiocyanic acid, methyl ester; Methane, isothiocyanato-; Methyl-isothiocyanat (German); Methyl mustard; Methyl mustard oil; Methylsenfoel (German); MIC; MIT; MITC; Morton WP-161E; Trapex; Trapex-40; Trapexide; Vorlex; Vorlex 201; Vortex; WN 12

CAS Registry Number: 556-61-6

HSDB Number: 6396

RTECS Number: PA6925000

UN/NA & ERG Number: (PIH) UN2477/131

EC Number: 209-132-5 [*Annex I Index No*.: 615-002-00-2]

Regulatory Authority and Advisory Information

Hazard Alert: Poison inhalation hazard, Highly flammable solid, Corrosive, Water reactive, Possible sensitization hazard. Environmental hazard, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction).

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500 lb (227 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 500 lb (227 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT 49CFR172.101, Inhalation Hazardous Chemical (PIH).

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292].

Hazard symbols, risk, & safety statements: Hazard symbol: T, F, N, Xi; risk phrases: R11; R23/25; R29; R34; R43; R50/53; safety phrases: S1/2; S21; S29/35; S36/37; S38; S41; S45; S60, S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Methyl isothiocyanate is a crystalline solid. Horseradish, acrid odor. Molecular weight = 73.12; boiling point = 119°C; freezing/melting point = 35−36°C; flash point = 32°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 3, reactivity 0₩. Slightly soluble in water; reacts, releasing carbon dioxide and methylamine gases.

Potential Exposure: It is used as a soil fumigant. A mixture of methyl isothiocyanate and chlorinated C-3 hydrocarbons is used as a soil fumigant for control of weeds, fungi, insects, and nematodes.

Incompatibilities: Dust may form explosive mixture with air. Reacts with water, releasing carbon dioxide and methylamine gases. Unstable and reactive; sensitive to oxygen and to light. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, alcohols, strong bases, amines, water, heat and cold. Attacks iron, zinc and other metals.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: $\mathbf{0.27_A}$ milligram per cubic meter

PAC-2: $\mathbf{17_A}$ milligram per cubic meter

PAC-3: $\mathbf{50_A}$ milligram per cubic meter

*AEGLs are marked with a subscript "**A**" and correspond to 60-minute values. Russia[43] set a MAC in work-place air of 0.1 milligram per cubic meter.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Highly irritating to the eyes, skin, and mucous membranes. Coughing, wheezing, and/or shortness of breath and other symptoms of extreme pulmonary irritation would be expected if vapors are inhaled. Very high exposures may cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Exposure can cause headache, dizziness, depression, seizures, and even loss of consciousness. This material is very toxic; probable human oral lethal dose is 50−500 mg/kg or between 1 teaspoon and 1 oz for a 70-kg (150 lb) person. Human oral minimum lethal dose: approximately 1 g/kg.

Long-Term Exposure: May cause skin allergy, and bronchitis. May affect the thyroid gland.

Points of Attack: Lungs, skin, thyroid.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended. Lung function tests. These may be normal if person is not having an attack at the time. If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Evaluation of thyroid function.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to methyl isothiocyanate exists, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Poison inhalation chemical (PIH); check oxygen content prior to entering storage area. (1) Color code—

Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. (2) Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. (2) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where methyl isothiocyanate is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gal or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN2477 Methyl isothiocyanate, Hazard class: 6.1; Labels: 6.1-Poison Inhalation Hazard, 3-Flammable liquid, Inhalation Hazard Zone B.

Spill Handling:

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 0.2/0.3

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and wash area following clean-up. Ventilate and wash spill areas when clean-up is complete. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Methyl isothiocyanate is a flammable solid. Thermal decomposition products may include cyanides, oxides of sulfur, nitrogen, and carbon. Use dry chemical, CO_2, water spray; or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR 165 recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Methyl Isothiocyanate, Washington, DC, Chemical Emergency Preparedness Program (Nov. 30, 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Methyl Isothiocyanate, Trenton, NJ (November 1999).

Methyl Mercaptan M:1040

Formula: CH_4S; CH_3SH

Synonyms: Mercaptan methylique (French); Mercaptomethane; Methanethiol; 1-Methanethiol; Methanthiol (German); Methyl sulfhydrate; Metilmercaptano (Spanish); Thiomethanol; Thiomethyl alcohol

CAS Registry Number: 74-93-1

HSDB Number: 813

RTECS Number: PB4375000

UN/NA & ERG Number: (PIH) UN1064/117

EC Number: 200-822-1 [*Annex I Index No.*: 016-021-00-3]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).; *Theft hazard* 500 (≥45.00% concentration).

Hazard Alert: Poison inhalation hazard, Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated, Suspected reprotoxic hazard, Environmental hazard.

OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 5000 lb (2270 kg)

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg)

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U153

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500 lb (227 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%. *Note*: Subject to an administrative stay under EPCRA Section 313. Not reportable until stay is lifted. See 8/22/94 (59 FR 43048)

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: F+, T, N; risk phrases: R5; R12; R21; R23; R50/53; safety phrases: S1; S2; S9; S16; S25; S33; S38; S41; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Methyl mercaptan is a colorless gas or white liquid with a disagreeable odor like garlic or rotten cabbage. Shipped as a liquefied compressed gas. The odor threshold is 0.002 ppm. Molecular weight = 48.11; specific gravity (H_2O:1) = 8.7 @ 20°C (liquid @ 0°C); boiling point = 5.9°C; freezing/melting point = −123°C; vapor pressure = 1.7 atm; 750 mmHg @ 5.7°C; relative vapor density (air = 1) = 1.66; flash point = −17°C (liquid). Explosive limits: LEL = 3.9%; 100,000 ppm[138]; UEL: 21.8%. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 4, reactivity 0. Soluble in water; solubility = 2%.

Potential Exposure: Methyl mercaptan is used in methionine synthesis, and widely as an intermediate in pesticide manufacture. A foul-smelling odorant usually added to chemicals, including pesticides.

Incompatibilities: Violent reaction with strong oxidizers, bleaches, copper, nickel and their alloys; aluminum. Reacts with acids producing flammable and toxic hydrogen sulfide.

Permissible Exposure Limits in Air

NIOSH IDLH = 150 ppm

Conversion factor: 1 ppm = 1.97 milligram per cubic meter @ 25°C & 1 atm

Odor Threshold = 0.0016 ppm.

OSHA PEL: 10 ppm/20 milligram per cubic meter Ceiling Concentration

NIOSH REL: 0.5 ppm/1 milligram per cubic meter [15-minute] Ceiling Concentration

ACGIH TLV[1]: 0.5 ppm/0.98 milligram per cubic meter TWA

PAC* Ver. 29[138]

PAC-1: $\mathbf{0.005_A}$ ppm

PAC-2: $\mathbf{23_A}$ ppm

PAC-3: $\mathbf{68_A}$ ppm

*AEGLs are marked with a subscript "**A**" and correspond to 60-minute values.

DFG MAK: 0.5 ppm/1.0 milligram per cubic meter TWA; Peak Limitation Category II(2); Pregnancy Risk Group D

Australia: TWA 0.5 ppm (1 milligram per cubic meter), 1993; Austria: MAK 0.5 ppm (1 milligram per cubic meter), 1999; Belgium: TWA 0.5 ppm (0.98 milligram per cubic meter), 1993; Denmark: TWA 0.5 ppm (1 milligram per cubic meter), 1999; Finland: TWA 0.5 ppm (1 milligram per cubic meter); STEL 1.5 ppm (3 milligram per cubic meter), 1999; France: VME 0.5 ppm (1 milligram per cubic meter), 1999; Hungary: STEL 1 milligram per cubic meter, 1993; the Netherlands: MAC-TGG 1 milligram per cubic meter, 2003; Norway: TWA 0.5 ppm (1 milligram per cubic meter), 1999; the Philippines: TWA 10 ppm (20 milligram per cubic meter), 1993; Poland: MAC (TWA) 1 milligram per cubic meter; MAC (STEL) 2 milligram per cubic meter, 1999; Russia: STEL 0.8 milligram per cubic meter, 1993; Sweden: NGV 1 ppm, 1999; Switzerland: MAK-W 0.5 ppm (1 milligram per cubic meter), KZG-W 1 ppm (2 milligram per cubic meter), 1999; Thailand: TWA 10 ppm (20 milligram per cubic meter), 1993; Turkey: TWA 10 ppm (20 milligram per cubic meter), 1993; United Kingdom: TWA 0.5 ppm (1 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 0.5 ppm. Russia[43] set a MAC in ambient air in residential areas of 9×10^{-6} milligram per cubic meter on a momentary basis. Several states have set guidelines or standards for methyl mercaptan in ambient air[60] ranging from 3.3 μ/m^3 (New York) to 10 μ/m^3 (Florida, North Dakota, South Carolina) to 16 μ/m^3 (Virginia) to 20 μ/m^3 (Connecticut) to 24 μ/m^3 (Nevada) to 50 μ/m^3 (North Carolina).

Determination in Air: Use NIOSH Analytical Method (IV) #2542, Mercaptans; OSHA Analytical Method 26.

Permissible Concentration in Water: EPA[32] has suggested a permissible ambient goal of 13.8 μg/L based on health effects. Russia[43] set a MAC in water bodies used for domestic purposes of 0.2 μg/L.

Routes of Entry: Inhalation, skin and/or eye contact (liquid).

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin and respiratory tract. Skin contact can cause frostbite. Inhalation can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. May affect the central nervous system. Signs and symptoms of acute exposure to methyl mercaptan may include fever, cough, shortness of breath; a feeling of tightness and burning in the chest; respiratory distress; respiratory paralysis; and respiratory failure/collapse. Headache, loss of the sense of smell, dizziness, staggering gait, and heightened emotions may occur. Gastrointestinal symptoms include difficulty in swallowing; redness of the tongue and pharynx; nausea, vomiting, abdominal pain; and diarrhea. Urinary disturbances may also be found.

Long-Term Exposure: May cause liver and kidney damage. Repeated exposure may cause bronchitis. Memory loss, damage to the central and peripheral nervous systems; tremor, convulsions, and coma may also occur. May affect the blood cell causing anemia.

Points of Attack: Eyes, skin, respiratory system; liver, kidneys, central nervous system; blood.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater) the following are recommended before beginning work and at regular times after that. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Liver function tests. CBC.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid: **8 hours:** Barricade coated suits; Responder suits; Trychem 1000 suits. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear the proper chemical goggles (indirect vent, impact and slash-resistant with liquids; nonvented, impact resistant with fumes, gases, or vapors) and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *5 ppm*: CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)]; or Sa (APF = 10) (any supplied-air respirator). *12.5 ppm*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOv (APF = 25) [any PAPR with organic vapor cartridge(s)]. *25 ppm*: CcrFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-, mounted organic vapor canister]; or PaprTOv (APF = 50) [any PAPR with a tight-fitting facepiece and organic vapor cartridge(s)]; or SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-, mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Check oxygen content prior to entering storage area. Poison gas. (1) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. This gas is highly toxic. Even slight exposure to these gasses can cause death. Store outdoors in a secure, restricted area that containing warning signs. This area must be roofed and shaded with the cylinders stored off the ground and separated from all other products assigned to other hazard categories and radiant heat sources on nonwooden floors. If indoors, store in a well-ventilated areas in temperatures not to exceed 50°C. (2) Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Methyl mercaptan must be stored to avoid contact with water; steam; or strong acids (such as hydrochloric, sulfuric, and nitric); because toxic flammable vapors will be released. It should not contact oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area sway from heat or sparks. Sources of ignition, such as smoking and open flames are prohibited where methyl mercaptan is handled, used, or stored. Metal containers involving the transfer of 5 gal or more of methyl mercaptan should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of methyl mercaptan. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. The storage area for flammable toxic gases should have electrical equipment conforming to Article 500 of the National Electrical Code.

Shipping: UN1064 Methyl mercaptan, Hazard Class: 2.3; Labels: 2.3-Poisonous gas, 2.1-Flammable gas, Inhalation Hazard Zone C. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling:

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 48-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.2/0.3

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 500/150
Then: Protect persons downwind (mi/km)
Day 0.7/1.1
Night 2.0/3.2

If in a building, evacuate building and confine vapors by closing doors and shutting down HVAC systems. Restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit and to disperse the gas. Wear chemical protective suit with SCBA to combat spills. Stay upwind and use water spray to “knock down” vapor; contain runoff. Stop the flow of gas, if it can be done safely from a distance. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place; and repair leak or allow cylinder to empty. Keep this chemical out of confined spaces, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Wear positive pressure breathing apparatus and special protective clothing. Evacuate area endangered by gas. See isolation distances above. Combustion produces irritating sulfur dioxide. Very dangerous when exposed to heat, flame, or oxidizers. On decomposition it emits highly toxic fumes of sulfur oxides. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform to EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration followed by effective scrubbing of the effluent gas.

References

(31); (173); (101); (138); (2); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Methyl Mercaptans, Washington, DC, Chemical Emergency Preparedness Program (Nov. 30, 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Methyl Mercaptan, Trenton, NJ (January 2000).

Methylmercuric Dicyanamide M:1050

Formula: $C_3H_6HgN_4$

Synonyms: Agrosol; Cyanoguanidine methyl mercury derivative; Cyano(methylmercury)guanidine; Guanidine, cyano-, methylmercury derivative; MEMA; Methylmercuric cyanoguanidine; Methylmercury dicyanandimide; Methylmercury dicyandiamide; Methylmerkuridikyandiamid (German); MMD; Morsodren; Morton EP-227; Morton soil drench; Pandrinox; Pano-Drench 4; Panodrin A-13; Panogen; Panogen 15; Panogen 43; Panogen PX; Panogen turf fungicide; Panogen turf spray; Panospray 30; R 8; R 8 fungicide

CAS Registry Number: 502-39-6

HSDB Number: 1551

RTECS Number: OW1750000

UN/NA & ERG Number: UN2777/151

EC Number: 207-935-5

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B, 1993 (dimethyl mercury); EPA: Possible Human Carcinogen; Methylmercury compounds are possibly carcinogenic to humans (Group 2B).

California Proposition 65: Developmental/Reproductive toxin (7/1/1987), Cancer (5/1/1996) as methyl mercury compounds.

Hazard Alert: Poison, Combustible, Organometallic, Strong reducing agent, Suspected reprotoxic hazard, Environmental hazard.

United States National Primary Drinking Water Regulations: MCLG = 0.002 mg[Hg]/L; MCL = 0.002 mg [Hg]/L as mercury

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as mercury and compounds

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 500 lb (227 kg)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. as mercury compounds.

Rotterdam Convention Annex III (Chemicals Subject to the PIC Procedure) (as mercury compounds, including inorganic mercury compounds, alkyl mercury compounds and alkyloxylalkyl and aryl mercury compounds).

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

European/International Regulations (*593-74-8*): Hazard symbol: T+, N; risk phrases: R45; R26/27/28; R33; R50/53; R63; safety phrases: S1/2; S13; S28; S29/35; S36; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)].

Description: Methylmercuric dicyanamide is a crystalline solid. Molecular weight = 298.72; freezing/melting point = 156°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 1, reactivity 0. Soluble in water.

Potential Exposure: This material is used as a fungicide; a seed, soil, and turf treatment especially for cereals, sorghum, sugar beets, cotton, and flax. Not registered for use as a pesticide in the United States.

Incompatibilities: A strong reducing agent. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

as organo mercury compound

NIOSH IDLH = 2 mg[Hg]/m^3

OSHA PEL: 0.01 mg[Hg]/m^3 TWA; 0.04 milligram per cubic meter Ceiling Concentration

NIOSH REL: 0.01 mg[organomercury]/m^3 TWA; 0.03 milligram per cubic meter STEL [skin]

ACGIH TLV[1]: 0.01 mg[Hg]/m^3 TWA; 0.03 milligram per cubic meter STEL [skin]

PAC Ver. 29[138]

PAC-1: 0.045 milligram per cubic meter

PAC-2: 0.06 milligram per cubic meter

PAC-3: 3 milligram per cubic meter

DFG MAK: 0.01 mg[Hg]/m^3 [skin] Danger of skin sensitization; Carcinogen Category 3

North Dakota has set guidelines for alkyl mercury compounds in ambient air[60] of $1-3\ \mu/m^3$

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 2 μg[Hg]/L; Federal Drinking Water Guidelines: EPA 2 μg[Hg]/L; State Drinking Water Guidelines: Arizona 3 μg[Hg]/L.

Determination in Water: Total mercury is determined by flameless atomic absorption. Soluble mercury may be determined by 0.45 μm filtration followed by flameless atomic absorption.

Routes of Entry: Inhalation, ingestion, eye, and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Alkyl mercury compounds are primary skin irritants and may cause dermatitis. When deposited on the skin, they give no warning, and if contact is maintained, can cause second-degree burns and blisters. Sensitization may occur. In the case of ingestion there is nausea and abdominal pain. Vomiting and diarrhea may occur. Burning or prickling of the lips, tongue, and extremities. The patient may be confused, hallucinate, be irritable, have disturbed sleep; loss of muscular coordination; and memory loss. Visual fields may narrow concentrically; emotional instability may occur as well as inability to concentrate, with stupor and coma. Methylmercuric dicyanamide is extremely toxic to humans. The probable lethal dose for humans is 5−50 mg/kg of body weight (between seven drops and one teaspoon for a 150-lb person). Humans may be poisoned by feeding on the flesh of animals which have ingested this fungicide. Eating treated seeds may also cause poisoning. The poisoning may show delayed manifestations on the nervous system. Patients frequently become gradually worse after their illness is recognized and exposure is stopped.

Long-Term Exposure: Repeated or prolonged contact with skin may result in dermatitis (red inflamed skin). Repeated or prolonged exposure may cause death by hypovolemic shock, nephrotic syndrome; or kidney failure. The central nervous system; including the brain, is the principal target tissue for this group of toxic compounds. Severe poisoning may produce irreversible brain damage resulting in loss of higher functions. The effects of chronic poisoning with alkyl mercury compounds are progressive. In the early stages, there are fine tremors of the hands; and in some cases, of the face and arms. With continued exposure, tremors may become coarse and convulsive; scanning speech with moderate slurring and difficulty in pronunciation may also occur. The worker may then develop an unsteady gait of a spastic nature which can progress to severe ataxia of the arms and legs. Sensory disturbances including tunnel vision, blindness, and deafness, are also common. A late symptom, constriction of the visual fields, is rarely reversible and may be associated with loss of understanding and reason which makes the victim completely out of touch with his environment. Severe cerebral effects have been seen in infants born to mothers who had eaten large amounts of methyl mercury-contaminated fish.

Points of Attack: Eyes, skin, central nervous system; peripheral nervous system; kidneys.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure. Before first exposure and every 6−12 months after, a complete medical history and exam is strongly recommended: eye exam. Consider lung function tests for persons with frequent exposure. Exam of the nervous system. Routine urine test (UA). Urine test for mercury (should be less than 0.02 mg/L). Consider nerve conduction tests, urinary enzymes and neurobehavioral test. After suspected illness or overexposure, repeat the tests above and get a blood test for mercury. Examination of the central nervous system; and kidneys. Consideration should be given to the possible effects on the fetus of alkyl mercury exposure in the mother. Constriction of visual fields may be a useful diagnostic sign. Blood and urine levels of mercury have been studied, especially in the case of methylmercury.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full- facepiece respirator with and N100, R100, or

P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: UN2777 Mercury based pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material may burn but does not ignite readily. Thermal decomposition products may include oxides of mercury, nitrogen and carbon. Fire and runoff from fire control water may produce irritating or poisonous gases of mercury and nitrogen oxides. For small fires, use dry chemical, carbon dioxide; water spray; or foam. For large fires, use water spray, fog, or foam. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR 165 recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Methylmercuric Dicyanamide, Washington, DC, Chemical Emergency Preparedness Program (Nov. 30, 1987)

Methyl Methacrylate Monomer M:1060

Formula: $C_5H_8O_2$: $CH_2{=}C(CH_3)COOCH_3$

Synonyms: Acrylic acid, 2-methyl-, methyl ester; Diakon; MER; Metacrilato de metilo (Spanish); Methacrylate de methyle (French); Methacrylic acid Met; Methacrylic acid, methyl ester; Methacrylsaeuremethyl ester (German); Methyl ester of methacrylic acid; Methyl-methacrylat (German); Methyl methacrylate monomer; Methyl α-methylacrylate; Methyl 2-methyl-2-propenoate; Methyl 2-methylpropenoate; 2-Methyl propenoic acid, methyl ester; MMA; Monocite methacrylate monomer; NCI-C50680; Pegalan; 2-Propenoic acid, 2-methyl-, methyl ester

CAS Registry Number: 80-62-6

HSDB Number: 195

RTECS Number: OZ5075000

UN/NA & ERG Number: UN1247/129 (P)

EC Number: 201-297-1 [*Annex I Index No*.: 607-035-00-6]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human Inadequate Evidence, animal lacks carcinogenicity, *not classifiable as carcinogenic to humans*, Group 3, 1994;EPA Group E, Evidence of non-carcinogenicity for humans; NCI: Carcinogenesis Studies (inhalation); no evidence: mouse, rat.

Hazard Alert: Highly flammable liquid, Polymerization hazard (nonstabilized), Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction), Sensitization hazard (skin), Environmental hazard.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U162

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.14; Nonwastewater (mg/kg), 160

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8015 (2); 8240 (5)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1000 lb (454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xi; risk phrases: R11; R19; R36/37/38; R43;

R62; R63; safety phrases: S2; S21; S24; S37; S46; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Methyl methacrylate is a colorless liquid. Acrid, fruity odor. The odor threshold is 0.05−0.083 ppm. Molecular weight = 100.12; specific gravity (H_2O:1) = 0.94; boiling point = 101°C; freezing/melting point = −48°C; vapor pressure = 29 mmHg @ 20°C; 75 mmHg @ 40°C; flash point = 10°C; autoignition temperature = 421°C. Explosive limits: LEL = 1.7%; 53,000 ppm[138]; UEL: 8.2 to 12.5%. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 3, reactivity 2. Slightly soluble in water; solubility = 1.5%. Physical and toxicological properties may be affected by the inhibitor such as hydroquinone.

Potential Exposure: Virtually all of the methyl methacrylate monomer produced is used in the production of polymers, such as surface coating resins; plastics (Plexiglas and Lucite); ion exchange resins; and plastic dentures.

Incompatibilities: Vapor may form explosive mixture with air. Reacts in air to form a heat-sensitive explosive product @ 60°C. Incompatible with nitrates, oxidizers, peroxides, strong acids; strong alkalis; oxidizers, reducing agents; amines, moisture. Contact with benzoyl peroxide may cause ignition, fire and explosion. May polymerize if subjected to heat, polymerization catalysts e. g., azoisobutyronitrile, dibenzoyl peroxide; di-*tert*-butyl peroxide, propionaldehyde); strong oxidizers; or ultraviolet light. May contain an inhibitor, such as hydroquinone.

Permissible Exposure Limits in Air

NIOSH IDLH = 1000 ppm

Conversion factor: 1 ppm = 4.09 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 100 ppm/410 milligram per cubic meter TWA

NIOSH REL: 100 ppm/410 milligram per cubic meter TWA

ACGIH TLV[1]: 50 ppm/205 milligram per cubic meter TWA; 100 ppm/410 milligram per cubic meter STEL, sensitizer, not classifiable as a human carcinogen

PAC* Ver. 29[138]

PAC-1: **17**$_{\mathbf{A}}$ ppm

PAC-2: **120**$_{\mathbf{A}}$ ppm

PAC-3: **570**$_{\mathbf{A}}$ ppm

*AEGLs are marked with a subscript "**A**" and correspond to 60-minute values.

DFG MAK: 50 ppm/210 milligram per cubic meter TWA; Peak Limitation Category I(2); danger of skin sensitization; Pregnancy Risk Group C

Australia: TWA 100 ppm (410 milligram per cubic meter), 1993; Austria: MAK 50 ppm (210 milligram per cubic meter), 1999; Belgium: TWA 100 ppm (410 milligram per cubic meter), 1993; Finland: TWA 100 ppm (410 milligram per cubic meter); STEL 150 ppm (615 milligram per cubic meter), 1999; France: VME 100 ppm (410 milligram per cubic meter), VLE 200 ppm (820 milligram per cubic meter), 1999; Hungary: TWA 50 milligram per cubic meter; STEL 150 milligram per cubic meter, 1993; the Netherlands: MAC-TGG 40 milligram per cubic meter, 2003; the Philippines: TWA 100 ppm (410 milligram per cubic meter), 1993; Poland: MAC (TWA) 50 milligram per cubic meter; MAC (STEL) 400 milligram per cubic meter, 1999; Russia: STEL 10 milligram per cubic meter, 1993; Sweden: NGV 50 ppm (200 milligram per cubic meter), KTV 150 ppm (600 milligram per cubic meter) [skin], 1999; Switzerland: MAK-W 50 ppm (210 milligram per cubic meter), KZG-W 100 ppm (420 milligram per cubic meter), 1999; United Kingdom: TWA 50 ppm (208 milligram per cubic meter); STEL 100 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 100 ppm. Russia has set MAC values for ambient air in residential areas of 0.1 milligram per cubic meter on a momentary basis and also on a daily average basis. Several states have set guidelines or standards for methyl methacrylate in ambient air[60] ranging from 7.0 μ/m^3 (Massachusetts) to 1367 μ/m^3 (New York) to 4100 μ/m^3 (Florida and North Dakota) to 6800 μ/m^3 (Virginia) to 8200 μ/m^3 (Connecticut) to 9742 μ/m^3 (Nevada) to 10,250 μ/m^3 (South Carolina).

Determination in Air: Use NIOSH Analytical Method (IV) #2537, Methyl methacrylate; OSHA Analytical Method 94

Permissible Concentration in Water: A limit in drinking water has been set by Russia[43] at 0.01 mg/L. Maine[61] has set a guideline for methyl methacrylate in drinking water of 200 μg/L.

Determination in Water: Octanol−water coefficient: Log K_{ow} = < 1.5. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Contact can irritate eyes and skin. Inhalation irritates the respiratory tract. High exposure can cause dizziness, lightheadedness narcosis, and unconsciousness.

Long-Term Exposure: Repeated or prolonged contact may cause skin sensitization and allergy. Repeated or prolonged inhalation exposure may cause asthma. May affect the central nervous system and the peripheral nervous system. May affect the kidneys and liver. May damage the developing fetus.

Points of Attack: Central nervous system; kidneys, liver, skin.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater) the following are recommended before beginning work and at regular times after that. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: exam of the nervous system. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Liver and kidney function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin contact: **8 hours**: polyvinyl alcohol gloves; 4H and Silver Shield gloves; Barricade coated suits; Trellchem HPS suits. **4 hours**: Teflon gloves, suits, boots. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *1000 ppm*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or CcrFOv (APF = 50) [any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s)]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister]; or PaprOv (APF = 25) [any PAPR with organic vapor cartridge(s)]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:PD, PP (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-, mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA). *Note*: Substance causes eye irritation or damage; eye protection needed.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Methyl methacrylate must be stored to avoid contact with oxidizers, such as nitrates, permanganates, perchlorates, chlorates, and peroxides; strong alkalis, such as sodium hydroxide and potassium hydroxide; and strong acids, such as nitric acid, hydrochloric acid, and sulfuric acid; since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from light, heat, and ionizing radiation, because methyl methacrylate will react and release heat quickly causing an explosion. Store and use with an appropriate inhibitor. Lack of an appropriate inhibitor may cause an explosive reaction.

Shipping: UN1247 Methyl methacrylate monomer, stabilized, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition includes oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform to EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration may be allowed.

References

(31); (173); (101); (138); (2); (100).

United States Environmental Protection Agency, Methyl Methacrylate, Health and Environmental Effects Profile No. 130, Washington, DC, Office of Solid Waste (April 30, 1980).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 6, No. 1, 86−90 (1986).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Methyl Methacrylate, Trenton, NJ (July 2002).

Methyl Methanesulfonate M:1065

Formula: $C_2H_6O_3S$

Synonyms: AS-Dimethyl sulfite; Methanesulphonic acid, methyl ester; Methyl ester of methanesulfonic acid; Methanesulfonic acid, methyl ester; Methyl ester of methanesulphonic acid; Methyl mesylate; Methyl methansulfonate; Methylmethansulfonat; Methyl methanesulphonate; Methyl methansulphonate; MMS; NSC-50256

CAS Registry Number: 66-27-3

HSDB Number: 5103

RTECS Number: PB2625000

UN/NA & ERG Number: UN2810 (toxic liquid, organic, n.o.s.)/153

EC Number: 200-625-0

Regulatory Authority and Advisory Information

Carcinogenicty: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen.

California Proposition 65 Chemical[102]: Cancer 4/1/1988.

Hazard Alert: Poison, Corrosive, Poison, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard.

Hazard symbols, risk, & safety statements: Hazard symbol: T; risk phrases: R22; R34; R36/37/38 R45; R62; R63; R68; safety phrases: S26; S36/37/39; S45; S53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Clear, colorless to amber liquid. Molecular weight = 110.14; specific gravity = 1.29 @ 20°C; boiling point = 202°C @ 760.0 mmHg; freezing/melting point = 20°C; vapor pressure = 0.31 mmHg @ 25°C (est.)[72]; flash point = 104°C (cc); Henry's law constant = 4×10^{-6} atm m^3/mol @ 25°C (est)[72]. Soluble in water; solubility = $\geq$ 150 g/L @ 20°C.

Potential Exposure: Research chemical and cancer drug. No longer produced commercially in the United States.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Esters are generally incompatible with nitrates. Moisture may cause hydrolysis or other forms of decomposition.

Determination in Water: Octanol−water coefficient: Log K_{ow} = < 1. Unlikely to bioaccumulate in marine organisms. EPA Method 8250; 3540; 3550; EAD-1625

Routes of Entry: Inhalation, dermal contact.

Harmful Effects and Symptoms

Short-Term Exposure: A corrosive material. May cause irritation and burns of the skin, eyes, and respiratory tract. May cause permanent damage. Inhalation can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. LD_{50}(oral-rat) = < 300 mg/kg

Long-Term Exposure: Potential carcinogen. Possible risk of forming tumors. Suspected of causing genetic defects.

Points of Attack: GI tract, kidneys, brain.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered.

First Aid Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: UN2810 Toxic liquids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling:

UN2810 Toxic liquids, organic, n.o.s.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 0.7/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 1000/300
Then: Protect persons downwind (mi/km)
Day 1.1/1.8
Night 2.8/4.5

First remove all sources of ignition. Then, use absorbent paper to pick up all liquid spill material. All contaminated clothing and absorbent paper should be sealed in a vapor-tight plastic bag for eventual disposal. Solvent wash all contaminated surfaces with 60%−70% ethanol followed by washing with a soap and water solution. Do not reenter the contaminated area until the safety officer (or other responsible person) has verified that the area has been properly cleaned.

Fire Extinguishing: Wear a SCBA in pressure-demand, NIOSH/MSHA or European Standard EN 149-approved respirator, and full protective gear. During a fire or heated to decomposition, irritating and highly toxic gases may be generated and it emits acrid smoke, irritating fumes and toxic fumes of carbon monoxide and carbon dioxide. Use water spray to keep fire-exposed containers cool. Containers may explode in the heat of a fire. Extinguishing media; cool containers with flooding quantities of water until well after fire is out. Fires involving this material can be controlled with a dry chemical, carbon dioxide, or Halon extinguisher. A water spray may also be used.

Disposal Method Suggested: It is inappropriate and possibly dangerous to the environment to dispose of lab chemicals or expired or waste drugs and pharmaceuticals by flushing them down the toilet or discarding them to the trash. Household quantities of expired or waste pharmaceuticals may be mixed with wet cat litter or coffee grounds, double-bagged in plastic, discard in trash. Larger quantities shall carefully take into consideration applicable DEA, EPA, and FDA regulations. If possible return the pharmaceutical to the manufacturer for proper disposal being careful to properly label and securely package the material. Alternatively, the waste pharmaceutical shall be labeled, securely packaged, and transported by a state licensed medical waste contractor to dispose by burial in a licensed hazardous or toxic waste landfill or incinerator.

References

(109); (102); (31); (173); (101); (138); (100); (173); (101); (138).

Methyl Parathion M:1070

Formula: $C_8H_{10}NO_5PS$

Synonyms: 8056HC; A-Gro; AI3-17292; Azofos; Azophos; Bay 11405; Bay E-601; Bladan M; Cekumethion; DALF; Devithion; *O*,*O*-Dimethyl *O*-(4-nitrophenyl)-monothiophosphat (German); Dimethyl-*p*-nitrophenyl monothiophosphate; Dimethyl *p*-nitrophenyl monothiophosphate; *O*,*O*-Dimethyl

O-(*p*-nitrophenyl) phosphorothioate; *O*,*O*-Dimethyl *O*-(4-nitrophenyl) phosphorothioate; *O*,*O*-Dimethyl *O*,*p*-nitrophenyl phosphorothioate; *O*,*O*-Dimethyl *O*-4-nitrophenyl phosphorothioate; Dimethyl *p*-nitrophenyl phosphorothionate; Dimethyl 4-nitrophenyl phosphorothionate; *O*,*O*-Dimethyl *O*-(*p*-nitrophenyl) thionophosphate; *O*,*O*-Dimethyl *O*-(*p*-nitrophenyl) thiophosphate; *O*,*O*-Dimethyl *O*,*p*-nitrophenyl thiophosphate; Dimethyl *p*-nitrophenyl thiophosphate; Dimethyl parathion; Drexel methyl parathion 4E; E 601; ENT 17,292; Folidoc; Folidol-80; Folidol M; Folidol M-40; Fosferno M 50; ME-Parathion; Meptox; Metacid 50; Metacide; Metafos (Pesticide); Metaphos; Methyl-E 605; Methyl fosferno; Methyl niran; Methylthiophos; Metilparationa (Spanish); Metron; M-Parathion; NCI-C02971; *p*-Nitrophenyldime thylthionophosphate; Nitrox; Nitrox 80; Oleovofotox; Parapest M-50; Parathion-methyl; Parathion metile; Partron M; Penncap M; Penncap MLS; Phenol, *p*-nitro-, *O*-ester with *O*,*O*-dimethyl phosphorothioate; Phosphorothioic acid, *O*,*O*-dimethyl *O*-(*p*-nitrophenyl) ester; Phosphorothioic acid, *O*,*O*-dimethyl *O*-(4-nitrophenyl) ester; Quinophos; Sinafid M-48; Sixty-three special E.C. insecticide; Thiophenit; Thylpar M-50; Toll; Vertac methyl parathion technisch 80%; Wofatox 50 EC

CAS Registry Number: 298-00-0

HSDB Number: 1168

RTECS Number: TG175000

UN/NA & ERG Number: (PIH) UN3017 (organophosphorus pesticides, liquid, toxic, flammable)/131; UN2783 (organophosphorus pesticide, solid, n.o.s.)/152; UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 206-050-1 [*Annex I Index No.*: 015-035-00-7]

Regulatory Authority and Advisory Information

Carcinogenicity: NCI: Carcinogenesis Bioassay (feed); no evidence: mouse, rat, 1979; IARC: Human No Adequate Data, animal No Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1987. United States Environmental Protection Agency Gene-Tox Program, Positive: *S. cerevisiae-homozygosis*; Negative: Carcinogenicity-mouse/rat; In vitro UDS-human fibroblast; Negative: TRP reversion; Inconclusive: *B. subtilis* rec assay; *E. coli polA* without S9; Inconclusive: Histidine reversion-Ames test

Hazard Alert: Poison inhalation hazard: exposure can be lethal, Neurotoxin (cumulative), Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Environmental hazard.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P071

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.014; Nonwastewater (mg/kg), 4.6

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8140 (0.5); 8270 (10)

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), severe pollutant as Parathion-methyl.

Rotterdam Convention Annex III (Chemicals Subject to the PIC Procedure)[methyl-parathion (emulsifiable concentrates (EC) @ or $>$ 19.5% active ingredient and dusts @ or $>$ 1.5% active ingredient)].

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, F, N; risk phrases: R5; R10; R24; R26/28; R33; R48/22; R50/53; safety phrases: S1/2; S22-; S28; S29/35; S36/37/39; S41; S45; S60; 61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Methyl parathion is a white to yellow-brown, crystalline solid with a garlic odor. Molecular weight = 263.22; specific gravity (H_2O:1) = 1.36; boiling point = 147.8; freezing/melting point = 37.2°C. The commercial product in xylene is a tan liquid (80% methyl parathion/20% xylene); vapor pressure = 0.00001 mmHg @ 20°C; flash point (in xylene) = 46°C[101]. Hazard identification (based on NFPA-704 M Rating System): Health 4, flammability 1, reactivity 2. Slightly soluble in water; solubility = 0.006% @ 25°C. Commercial product may contain xylene. Physical and toxicological properties may be affected by the carrier solvents used in commercial formulations.

Potential Exposure: A severely hazardous pesticide formulation. Alert: This material is used as an insecticide on over 50 crops, primarily cotton, and on several ornamentals.

Incompatibilities: Incompatible with oxidizers, strong bases; heat. Mixtures with magnesium, or endrin may be violent or explosive. Slightly decomposed by acid solutions. Rapidly decomposed by alkalies. Explosive risk when heated above 50°C. The liquid xylene solution decomposes violently @ 120°C.

Permissible Exposure Limits in Air

OSHA PEL: None

NIOSH REL: 0.2 milligram per cubic meter TWA [skin]

ACGIH TLV[1]: 0.2 milligram per cubic meter TWA, measured as inhalable fraction and vapor [skin]; not classifiable as a human carcinogen; BEI_A issued as Acetylcholinesterase inhibiting pesticides.

PAC* Ver. 29[138]

PAC-1: 0.11 milligram per cubic meter

PAC-2: **1.2_A** milligram per cubic meter
PAC-3: **3.5_A** milligram per cubic meter
*AEGLs are marked with a subscript "**A**" and correspond to 60-minute values. Australia: TWA 0.2 milligram per cubic meter [skin], 1993; Belgium: TWA 0.2 milligram per cubic meter [skin], 1993; Denmark: TWA 0.2 milligram per cubic meter [skin], 1999; Finland: TWA 0.2 milligram per cubic meter; STEL 0.6 milligram per cubic meter [skin], 1999; France: VME 0.2 milligram per cubic meter [skin], 1999; Hungary: TWA 0.1 milligram per cubic meter; STEL 0.2 milligram per cubic meter [skin], 1993; Norway: TWA 0.2 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 0.2 milligram per cubic meter [skin], 2003; Russia: STEL 0.1 milligram per cubic meter [skin], 1993; Switzerland: MAK-W 0.2 milligram per cubic meter [skin], 1999; United Kingdom: LTEL 0.2 milligram per cubic meter; STEL 0.6 milligram per cubic meter [skin], 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Russia set a MAC for ambient air in residential areas of 0.008 milligram per cubic meter on a once daily basis. Several states have set guidelines or standards for methyl parathion in ambient air[60] ranging from 2.0 μ/m^3 (North Dakota) to 3.5 μ/m^3 (Virginia) to 4.0 μ/m^3 (Connecticut) to 5.0 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #5600, Organophosphorus Pesticides; OSHA Analytical Method PV-2112, Methyl parathion.

Permissible Concentration in Water: Russia set a MAC in water bodies used for domestic purposes of 0.02 mg/L. Two states have set guidelines for methyl parathion in drinking water of 30 μg/L-in California and Kansas[61]. A lifetime health advisory of 2 μg/L has been developed by EPA.

Determination in Water: Fish Tox = 5.59677000 ppb (HIGH). Octanol–water coefficient: Log K_{ow} = 2.7 (pure); 2.04(V). Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Methyl parathion may affect the nervous system; causing convulsions, respiratory failure; and possible death. A cholinesterase inhibitor. Acute exposure to parathion-methyl may produce the following symptoms: pinpoint pupils; blurred vision; headache, dizziness, muscle spasms; and profound weakness. Vomiting, diarrhea, abdominal pain; seizures, and coma may also occur. High exposure may result in death. The heart rate may decrease following oral exposure or increase following dermal exposure. Hypotension (low blood pressure) may occur although hypertension (high blood pressure) is not uncommon. Chest pain may be noted. Respiratory symptoms include dyspnea (shortness of breath), respiratory depression; and respiratory paralysis. Psychosis may occur. Because this is a potential mutagen, handle it as a possible carcinogen-with extreme caution. Methyl parathion may damage the developing fetus. This material is extremely toxic; the probable oral lethal dose is 5–50 mg/kg, or between seven drops and one teaspoonful for a 150-lb person. Human Tox = 2.00000 ppb (HIGH).

Long-Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause personality changes; depression, anxiety, irritability. May cause liver damage. May damage the developing fetus.

Points of Attack: Respiratory system, lungs, central nervous system; cardiovascular system, skin, eyes, plasma, and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1–2 weeks while red blood cell levels may be reduced for 1–3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider CBC. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Effects of exposure may be delayed. Medical monitoring is advised[101].

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working

with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *2 milligram per cubic meter*: CcrOv95 (APF = 10) [any air-purifying half-mask respirator equipped with an organic vapor cartridge(s) in combination with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *5 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOvHie (APF = 25) (any PAPR with an organic vapor cartridge in combination with a high-efficiency particulate filter). *10 milligram per cubic meter*: CcrFOv100 (APF = 50) [any air-purifying full facepiece respirator equipped with organic vapor cartridge(s) in combination with an N100, R100, or P100 filter]; or GmFOv100 (APF = 50) [Any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or PaprTOvHie (APF = 50) [any PAPR with a tight-fitting facepiece and organic vapor cartridge(s) in combination with a high-efficiency particulate filter]; or SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or SCBAF (APF = 50) (any SCBA with full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *200 milligram per cubic meter*: SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:PD, PP (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Store in tightly closed containers in a cool, well-ventilated area away from heat sources, since violent reactions may occur. See incompatible material listed above. Sources of ignition, such as smoking and open flames are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gal or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN3017 Organophosphorus pesticides, liquid, toxic, flammable, flash point not <23°C, Hazard class: 6.1; Labels: 6.1-Poisonous materials, 3.-Flammable liquid. UN2783 Organophosphorus pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous material. UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling:

Initial isolation and protective action distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.3/0.4
Night 0.8/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 600/200
Then: Protect persons downwind (mi/km)
Day 1.4/2.3
Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Do not touch spilled material. Do not breathe vapors. Stay upwind; keep out of low areas. Remove all ignition sources. Ventilate area of spill or leak. This material is a combustible liquid. For a spill or leak of a combustible liquid, shut off ignition sources; no flares, smoking or flames in hazard area. Stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Often available and used in a flammable liquid solution Thermal decomposition products may include oxides of phosphorus, nitrogen and carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors from the liquid are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform to EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration (816°C, 0.5 second minimum for primary combustion; 1204°C, 1.0 second for secondary combustion) with adequate scrubbing and ash disposal facilities. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (2); (80); (100).

National Institute for Occupational Safety and Health (NIOSH), "Criteria for a Recommended Standard: Occupational Exposure to Methyl Parathion", NIOSH Document Number 77-106, Cincinnati, OH (1977).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 6, No. 1, 90−97 (1986).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Parathion-Methyl, Washington, DC, Chemical Emergency Preparedness Program (Nov. 30, 1987).

United States Environmental Protection Agency, "Alert: Methyl Parathion, Washington, DC, Office of Drinking Water (August 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Methyl Parathion, Trenton, NJ (November 1999).

Methylphosphonic Dichloride M:1090

Formula: CH_3Cl_2OP; CH_3POCl_2

Synonyms: Dichloromethylphosphine; Dicloruro de metilfosfonico (Spanish); Methyl phosphonous dichloride; Methyl phosphonothioic dichloride, anhydrous; Methyldichlorophosphine; Methylphosphinic dichloride; Methylphosphinous dichloride; Methylphosphonous dichloride; Methylphosphorus dichloride; Phosphine, dichloromethyl-; Phosphonic dichloride

CAS Registry Number: 676-97-1

HSDB Number: 6328

RTECS Number: TA1840000

UN/NA & ERG Number: (PIH) UN9206/137; UN3390/154

EC Number: 211-634-4

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade).

Hazard Alert: Poison inhalation hazard, Corrosive, Violently water reactive.

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg).

United States National Primary Drinking Water Regulations: SMCL = 250 mg[Cl^-]/L as Chloride

United States DOT 49CFR172.101, Inhalation Hazardous Chemical (PIH).

Hazard symbols, risk, & safety statements: Hazard symbol: T + ; risk phrases: R14; R26; R29; R34; safety phrases: S1; S26; S36/37/39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)].

Description: Methyl phosphonic dichloride is a low melting solid or colorless to pale yellow liquid. Pungent odor. Molecular weight = 132.91; specific gravity (H_2O:1) = 1.385 @ 20°C; boiling point = 162°C; freezing/melting point = 32°C; vapor pressure = 760 mmHg @ 163°C; flash point $\geq$ 50°C (oc). Explosive limits: LEL = 17,000 ppm; UEL: Unknown. ₩ Mixes violently with water, forming hydrogen chloride. Physical and toxicological properties may be affected by the carrier solvents used in commercial formulations.

Potential Exposure: Used as a chemical intermediate in pesticide manufacture.

Incompatibilities: Highly flammable; mists or Vapors may form explosive mixture with air. Reacts with moist air forming fumes of hydrogen chloride; may spontaneously ignite. Reacts with water or alcohol, forming hydrochloric acid. The reaction may be violent and ignite unreacted material. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, amines, ethers. May react violently, possibly explosively, when mixed with ethers and trace amounts of metal salts.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 0.13 milligram per cubic meter

PAC-2: 1.4 milligram per cubic meter

PAC-3: 6.2 milligram per cubic meter

Routes of Entry: Inhalation, ingestion, skin, and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Poisonous if inhaled or swallowed. Highly corrosive. Contact causes severe burns to skin and eyes. May cause permanent damage. Inhalation causes irritation. High levels of exposure can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: May cause lung irritation; bronchitis to develop.

Points of Attack: Lungs, eyes, skin.

Medical Surveillance. Lung function tests. Consider chest X-ray following acute overexposure. Evaluation by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Keep victim quiet and maintain normal body temperature. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Poison inhalation chemical (PIH); check oxygen content prior to entering storage area. Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames are prohibited where this chemical is handled, used, or stored. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN9206 Methyl phosphonic dichloride, Hazard class: 6.1; Labels: 6.1-Poisonous materials, 8-Corrosive material. Domestic (United States), Inhalation Hazard Zone B. UN3390 Toxic by inhalation liquid, corrosive, n.o.s. with an $LC_{50} \leq 1000\,mL/m^3$ and saturated vapor concentration ≥ 10 LC_{50} Hazard Class: 6.1; Labels: 6.1-Poisonous materials, 8-Corrosive material, Technical Name Required, Inhalation Hazard Zone B.

Spill Handling:

Fully encapsulating, vapor protective clothing should be worn for spills and leaks with no fire. *Eliminate* all ignition sources (no smoking, flares, sparks or flames in immediate area). Do not touch or walk through spilled material. Stop leak if you can do it without risk.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30

Then: Protect persons downwind (mi/km)

Day 0.1/0.2

Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 200/60

Then: Protect persons downwind (mi/km)

Day 0.3/0.5

Night 0.4/0.6

Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Do not breathe vapors. Do not get water inside container; stop leak if you can do so without risk. Do not touch spilled material. Use water spray to reduce vapors but do not put water on leak or spill area. Keep combustibles (wood, paper, oil, etc.) away from spilled material. Dike spill for later disposal; do not apply water unless directed to do so. Clean up only under supervision of an expert. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: If tank, rail car or tank truck is involved in a fire, *isolate* for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. Thermal decomposition releases corrosive and irritation hydrogen chloride gas, and oxides of phosphorus and carbon. Containers may explode in heat of fire. Approach fire with extreme caution: If possible let fire burn; there is a good chance of explosive reignition. Do NOT use water, foam, or CO_2 on material itself. Do NOT use water on adjacent fires. Runoff may create fire or explosion hazard. Also, runoff from fire control may cause pollution. *Small fire*: Use *dry* chemical, *dry* graphite, soda ash, lime, or *dry* sand. *Large fire*: Specially trained personnel operating from a safe distance can fight fire using *dry* sand, *dry* chemical, soda ash, lime, or other inert material if it is available in sufficient amounts; or, withdraw from area and let fire burn. IF material is not leaking, cool exposed containers with large quantities of water from unattended equipment or remove intact containers if it can be done safely. *Do not allow water to get inside containers*. If cooling streams are ineffective (*venting sound increases in volume and pitch, tank discolors or shows signs of deforming*), withdraw immediately to a secure location. Always stay away from ends of tanks, especially when engulfed in flames. May reignite after fire is extinguished. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Use a licensed professional waste disposal service to dispose of this material. Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Methyl Phosphonic Dichloride, Washington, DC, Chemical Emergency Preparedness Program (Nov. 30, 1987).

Methyl Propionate M:1200

Formula: $C_4H_8O_2$

Synonyms: Methyl propanoate; Methyl propylate; Propanoic acid, methyl ester; Propionate de methyle (French); Propionato de metilo (Spanish)

CAS Registry Number: 554-12-1

HSDB Number: 5688

RTECS Number: UF5970000

UN/NA & ERG Number: UN1248/129

EC Number: 209-060-4 [*Annex I Index No.*: 607-027-00-2]

Regulatory Authority and Advisory Information

Hazard Alert: Highly flammable, Primary irritant (w/o allergic reaction).

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: F; Xn; risk phrases: R2; R11; R20/21; safety phrases: S2; S15; S16; S21; S24; S29; S33; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Methyl propionate is colorless liquid with a sweet, fruity, rum-like odor. Molecular weight = 88.12; boiling point = 80°C; freezing/melting point = −87°C; flash point = −2.2°C; autoignition temperature = 469°C. Explosive limits: LEL = 2.5%; UEL: 13.0%; hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 3, reactivity 0. Slightly soluble in water.

Potential Exposure: Used as a solvent; and in making paints, lacquers, and varnishes. Also used in flavorings and fragrances.

Incompatibilities: May form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Keep away from heat and moisture.

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Russia: STEL 10 milligram per cubic meter, 1993

Routes of Entry: Inhalation, skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Contact can cause skin and eye irritation. Harmful if inhaled.

Long-Term Exposure: Repeated high exposures may cause dizziness, lightheadedness, loss of coordination; and difficult breathing.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/ manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with methyl propionate all handlers should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, strong acids; strong bases. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1248 Methyl propionate, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a highly flammable. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; alcohol foam; or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Methyl Propionate, Trenton, NJ (May 1999).

Methyl Propyl Ketone M:1220

Formula: $C_5H_{10}O$; $CH_3COCH_2CH_2CH_3$

Synonyms: Ethyl acetone; Methyl-*n*-propyl ketone; MPK; 2-Pentanone

CAS Registry Number: 107-87-9

HSDB Number: 158

RTECS Number: SA7875000

UN/NA & ERG Number: UN1249/127

EC Number: 203-528-1

Regulatory Authority and Advisory Information

Hazard Alert: Highly flammable, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction).

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xn: Risk phrases: R11; R22; R36/37/38; R62; safety phrases: S9; S16; S21; S26; S29; S33; S37/38/39; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: MPK is a colorless to water-white liquid with a strong odor resembling acetone and ether. Molecular weight = 86.15; specific gravity (H_2O:1) = 0.81 @ 20°C; boiling point = 102°C; freezing/melting point = −78°C; vapor pressure = 27 mmHg @ 20°C; flash point = 7.22°C (cc); autoignition temperature = 452°C. Explosive limits: LEL = 1.5%; UEL: 8.2%. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 3, reactivity 0. Slightly soluble in water; solubility = 6%.

Potential Exposure: MPK is used as a solvent; as a synthetic food flavoring agent; and in organic synthesis; as a solvent replacement for diethyl ketone and acetone.

Incompatibilities: Ketones are incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, nitrated amines, azo, diazo, azido compounds, carbamates, organic cyanates. Attacks some plastics.

Permissible Exposure Limits in Air

NIOSH IDLH = 1500 ppm

Conversion factor: 1 ppm = 3.52 milligram per cubic meter @ 25°C & 1 atm

Odor Threshold = 7.7 ppm.

OSHA PEL: 200 ppm/700 milligram per cubic meter TWA

NIOSH REL: 150 ppm/530 milligram per cubic meter TWA

ACGIH TLV[1]: 150 ppm/529 milligram per cubic meter STEL

PAC Ver. 29[138]

PAC-1: 150 ppm

PAC-2: 830 ppm

PAC-3: 5000 ppm

DFG MAK: No numerical value established. Data may be available.

Australia: TWA 200 ppm (700 milligram per cubic meter), STEL 250 ppm, 1993; Austria: MAK 200 ppm (700 milligram per cubic meter), 1999; Belgium: TWA 200 ppm (705 milligram per cubic meter), STEL 250 ppm (881 milligram per cubic meter), 1993; Denmark: TWA 200 ppm (700 milligram per cubic meter), 1999; Finland: TWA 200 ppm (700 milligram per cubic meter), STEL 250 ppm (875 milligram per cubic meter), 1999; France: VME 200 ppm (700 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 700 milligram per cubic meter, 2003; the Philippines: TWA 200 ppm (700 milligram per cubic meter), 1993; Poland: MAC (TWA) 100 milligram per cubic meter; MAC (STEL) 800 milligram per cubic meter, 1999; Russia: STEL 200 milligram per cubic meter, 1993; Switzerland: MAK-W 200 ppm (700 milligram per cubic meter), KZG-W 400 ppm (1400 milligram per cubic meter), 1999; Turkey: TWA 200 ppm (700 milligram per cubic meter), 1993; United Kingdom: TWA 200 ppm (716 milligram per cubic meter), STEL 250 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 250 ppm

Determination in Air: Use NIOSH Analytical Method #1300, Ketones, #2555 Ketones I[18].

Determination in Water: Octanol−water coefficient: Log $K_{ow} = < 1$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Methyl propyl ketone can affect you when breathed in and by passing through your skin. Exposure to the vapor can irritate the eyes, nose, throat, and lungs. Skin exposure to the liquid can cause a rash or burning feelings on contact. Contact irritates the eyes. Inhalation causes coughing, wheezing, and/or shortness of breath. Exposure to high concentrations can cause you to feel dizzy and lightheaded and to pass out.

Long-Term Exposure: Long-term exposure can cause drying and cracking of the skin. Can irritate the lungs and may cause bronchitis to develop.

Points of Attack: Lungs, skin.

Medical Surveillance: NIOSH lists the following tests: chest X-ray; pulmonary function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *1500 ppm*: CcrFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister]; or PaprOv (APF = 25) [any PAPR with organic vapor cartridge(s)]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-, mounted organic vapor canister]; or Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-, mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA). *Note*: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Methyl propyl ketone must be stored to avoid contact with oxidizers, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat, sparks or flame. Sources of ignition, such as smoking and open flames are prohibited where methyl propyl ketone is handled, used, or stored. Metal containers used in the transfer of 5 gal or more of methyl propyl ketone should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of methyl propyl ketone. Wherever methyl propyl ketone is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1249 Methyl propyl ketone, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Methyl propyl ketone is a flammable liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; alcohol foam; or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (2); (100).

National Institute for Occupational Safety and Health (NIOSH), “Criteria for a Recommended Standard: Occupational Exposure to Ketones”, NIOSH Document Number 78-173, Cincinnati, OH (1973).

United States Environmental Protection Agency, Chemical Hazard Information Profile: 2-Pentanone, Washington, DC (December 6, 1977).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Methyl Propyl Ketone, Trenton, NJ (October 1999).

Methyl Silicate M:1230

Formula: $C_4H_{12}O_4Si$; $(CH_3O)_4Si$

Synonyms: Methyl orthosilicate; Silicid acid, tetramethyl ester; Tetramethoxysilane; Tetramethyl ester of silicic acid; Tetramethyl silicate

CAS Registry Number: 681-84-5

HSDB Number: 5511

RTECS Number: VV9800000

UN/NA & ERG Number: (PIH) UN2606/155

EC Number: 211-656-4

Regulatory Authority and Advisory Information

Hazard Alert: Poison inhalation hazard, Inhalation hazard, Highly flammable, Corrosive

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T+; risk phrases: R11; R26; R27/28; R37/38; R41; safety phrases: S16; S26; S28; S36/37/39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water (mfg.); 3-Severe hazard to water (lit.).

Description: Methyl silicate is a liquid. Molecular weight = 152.22; specific gravity (H_2O:1) = 1.02 @ 20°C; boiling point = 121°C; freezing/melting point = −1.3°C; vapor pressure = 12 mmHg @ 25°C; 7.5 mmHg @ 14.4°C; flash point = 20°C (cc). ₩ Practically insoluble in water; decomposes releasing toxic, flammable gases.

Potential Exposure: Methyl silicate is used in coating screens of television picture tubes. It may be used in mold binders and in corrosion-resistant coatings; as well as in catalyst preparation and as a silicone intermediate.

Incompatibilities: Vapor may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, including alkaline earth metals, metals, strong acids, strong bases; water, moisture, steam decomposes releasing toxic, flammable gases. Violent reaction with metal hexafluorides of rhenium, molybdenum, and tungsten. Contact with metals may evolve flammable hydrogen gas.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 6.23 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: None

NIOSH REL: 1 ppm/6 milligram per cubic meter TWA

ACGIH TLV[1]: 1 ppm/6 milligram per cubic meter TWA

PAC* Ver. 29[138]

PAC-1: 0.083 ppm

PAC-2: $\mathbf{0.91}_{\mathbf{A}}$ ppm

PAC-3: $\mathbf{1.4}_{\mathbf{A}}$ ppm

*AEGLs are marked with a subscript "**A**" and correspond to 60-minute values.

DFG MAK: Danger of skin sensitization

Australia: TWA 1 ppm (6 milligram per cubic meter), 1993; Belgium: TWA 1 ppm (6 milligram per cubic meter), 1993; Denmark: TWA 1 ppm (6 milligram per cubic meter), 1999; Finland: TWA 5 ppm (30 milligram per cubic meter), STEL 10 ppm (60 milligram per cubic meter), 1999; France: VME 1 ppm (6 milligram per cubic meter), 1999; Japan: 1 ppm (6 milligram per cubic meter), 1999; Norway: TWA 1 ppm (6 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 6 milligram per cubic meter, 2003; United Kingdom: TWA 1 ppm (6.3 milligram per cubic meter), STEL 5 ppm (32 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 1 ppm

Determination in Air: No method available.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Methyl silicate can affect you when breathed in. Severely irritates and burns the eyes and skin. Exposure to the vapor can cause severe eye damage and cause permanent blindness. This can occur Up to 12 hours after exposure has ceased, even if no irritation is noticed at the time. Inhalation irritates the respiratory tract. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Exposure to high levels can damage the lungs and kidneys.

Long-Term Exposure: May cause liver and/or kidney damage. Can irritate the lungs and may cause bronchitis to develop.

Points of Attack: Eyes, respiratory system; kidneys, liver.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: exam of the eyes and vision; kidney function tests. Evaluation by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working

with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures *over 1 ppm* to liquid methyl silicate, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Where there is potential for high exposures exists, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from water and moisture. Sources of ignition, such as smoking and open flames are prohibited where methyl silicate is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2606 Methyl orthosilicate, Hazard class: 6.1; Labels: 6.1-Poisonous materials, 3-Flammable liquid.

Spill Handling:

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 48-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 0.3/0.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120 (q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include silicon oxide. Use dry chemical, carbon dioxide; alcohol or polymer foam extinguishers. *Do not use water*. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Methyl Silicate, Trenton, NJ (October 1999).

α-Methylstyrene M:1240

Formula: C_9H10; $C_6H_5C(CH_3){=}CH_2$

Synonyms: AMS; Benzene, (1-methylethenyl)-; Isopropenyl benzene; 1-(Methylethyl) benzene; 1-Methyl-1-phenyl-ethene; 1-Methyl-1-phenyl-ethylene; Phenylpropylene; 2-Phenylpropylene; β-Phenylpropylene; Styrene, α-methyl-

CAS Registry Number: 98-83-9

HSDB Number: 196
RTECS Number: WL5250000
UN/NA & ERG Number: UN2303/128 (P)
EC Number: 202-705-0 [*Annex I Index No.*: 601-027-00-6]

Regulatory Authority and Advisory Information

Carcinogenicity: NTP: Carcinogenesis studies; on test (prechronic studies), October 2000

California Proposition 65 Chemical[102]: Developmental/Reproductive toxin, female, *delisted 4/4/2014*.

Hazard Alert: Flammable, Polymerization Hazard, Possible risk of forming tumors, Reproductive toxin: Suspected of causing genetic defects, Primary irritant (w/o allergic reaction), Environmental hazard.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%

Hazardous to aquatic life or environment, with possible long-lasting effects[293]. Toxic to aquatic life with long-lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xi, N; risk phrases: R10; R19; R36/37; R51/53; R62; safety phrases: S2; S29; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [2-Hazard to water.(est.)].

Description: Methylstyrene is a colorless liquid with a characteristic odor. Molecular weight = 118.19; specific gravity (H_2O:1) = 0.91 @ 17°C; boiling point = 165.6°C; freezing/melting point = −23.3°C; vapor pressure = 2 mmHg @ 20°C; flash point = 46.11°C; autoignition temperature = 574°C. Explosive limits: LEL = 1.9%; UEL: 6.1%. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 2, reactivity 0. Insoluble in water.

Potential Exposure: Methylstyrene is used as additive, plasticizer, and copolymer; used in the production of modified polyester and alkyd resin formulations.

Incompatibilities: Vapors may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, peroxides, halogens, catalysts for vinyl or ionic polymers; aluminum, iron chloride; copper. Methylstyrene may form unstable peroxides; may polymerize. Usually contains an inhibitor, such as *tert*-butyl catechol.

Permissible Exposure Limits in Air

NIOSH IDLH = 700 ppm

Conversion factor: 1 ppm = 4.83 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 100 ppm/480 milligram per cubic meter Ceiling Concentration

NIOSH REL: 50 ppm/240 milligram per cubic meter TWA; 100 ppm/485 milligram per cubic meter STEL

ACGIH TLV[1]: 10 ppm/48 milligram per cubic meter TWA, confirmed animal carcinogen with unknown relevance to humans

PAC Ver. 29[138]
PAC-1: 100 ppm
PAC-2: 830 ppm
PAC-3: 5000 ppm

DFG MAK: 50 ppm/250 milligram per cubic meter TWA; Peak Limitation Category I(2); Pregnancy Risk Group D

Australia: TWA 50 ppm (240 milligram per cubic meter); STEL 100 ppm, 1993; Austria: MAK 100 ppm (480 milligram per cubic meter), 1999; Belgium: TWA 50 ppm (242 milligram per cubic meter); STEL 100 ppm (484 milligram per cubic meter), 1993; Denmark: TWA 50 ppm (240 milligram per cubic meter), 1999; Finland: TWA 100 ppm (480 milligram per cubic meter); STEL 150 ppm (720 milligram per cubic meter), 1999; France: VME 50 ppm (240 milligram per cubic meter), 1999; Norway: TWA 50 ppm (240 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 240 milligram per cubic meter, 2003; Switzerland: MAK-W 50 ppm (240 milligram per cubic meter), 1999; Thailand: TWA 100 ppm (480 milligram per cubic meter), 1993; United Kingdom: STEL 100 ppm (491 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 100 ppm. Russia[43] set a MAC for ambient air in residential areas of 0.04 milligram per cubic meter (40 μ/m^3) both on a momentary and a daily average basis. Several states have set guidelines or standards for methylstyrene in ambient air[60] ranging from 2.4−4.85 milligram per cubic meter (North Dakota) to 4.0 milligram per cubic meter (Virginia) to 4.8 milligram per cubic meter (Connecticut) to 5.714 milligram per cubic meter (Nevada).

Determination in Air: Use NIOSH Analytical Method 1501, aromatic hydrocarbons; OSHA Analytical Method 7[18].

Permissible Concentration in Water: Russia[43] set a MAC in water bodies used for domestic purposes of 0.1 mg/L.

Determination in Water: Octanol−water coefficient: Log K_{ow} = > 3. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact. Passes through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: The substance irritates the eyes, skin, and the respiratory tract. Prolonged skin contact causes a burning sensation; redness and blisters. Exposure can cause headache, dizziness, lightheadedness, and difficult breathing.

Long-Term Exposure: Repeated or prolonged contact with skin may cause skin sensitization and allergy with itching and skin rash. May affect the central nervous system; kidneys, and liver. May cause brain effects or damage.

Points of Attack: Eyes, skin, respiratory system; central nervous system; liver and kidneys.

Medical Surveillance: NIOSH lists the following tests: urine (chemical/metabolite). Consider the points of attack in preplacement and periodic physical examinations. Evaluation by a qualified allergist. Evaluate for brain effects. Evaluate nervous system. Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *500 ppm*: CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)]; Sa (APF = 10) (any supplied-air respirator). *700 ppm*: Sa: Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or CcrFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-, mounted organic vapor canister]; or PaprOv (APF = 25) [any PAPR with organic vapor cartridge(s)]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-, mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA). *Note*: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: UN2303 Isopropenylbenzene, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible and reactive liquid. Thermal decomposition products may include oxides of carbon. Water may be ineffective. Use dry chemical, carbon dioxide; alcohol foam; or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration, often by admixture with a more flammable solvent[24].

References

(102); (31); (173); (101); (138); (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Isopropenyl Benzene, Trenton, NJ (June 1999).

Methyltetrahydrofuran M:1250

Formula: $C_5H_{10}O$

Synonyms: Furan, tetrahydromethyl-; 2-Methyl-tetrahydrofuran; Methyltetrahydrofuran, 2-

CAS Registry Number: 96-47-9; 25265-68-3

HSDB Number: 5115

RTECS Number: LU6208000

UN/NA & ERG Number: UN2536/127 (P)

EC Number: 246-769-8

Regulatory Authority and Advisory Information

Hazard Alert: Highly flammable, Polymerization hazard.

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xi; risk phrases: R11; R19; R36/37/38; R41; R51; safety phrases: S2; S16; S21 S23; S24/25; S26; S33; S39; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to waters (*CAS*: *96-47-9*).

Description: Methyltetrahydrofuran is a colorless liquid. Ethereal odor. Molecular weight = 86.2; specific gravity (H_2O:1) = 0.85 @ 20°C; boiling point = 80°C; freezing/melting point = −136°C; flash point = −11°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 3, reactivity 1. Explosive limits: LEL: 1.2%, UEL: 5.5%. Slightly soluble in water.

Potential Exposure: Used as a chemical intermediate and a solvent.

Incompatibilities: Vapor may form explosive mixture with air. Unless stabilized with BHT (butylated hydroxytoluene) this chemical may form unstable and explosive peroxides in the presence of air or light. Liquid forms explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

96-47-9

PAC-1: 4 ppm

PAC-2: 44 ppm

PAC-3: 260 ppm

Routes of Entry: Inhalation, skin and/or eye contact, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Contact irritates the skin and eyes. May cause serious eye damage. Irritates the respiratory tract. Harmful when ingested.

Long-Term Exposure: Closely related chemicals affect the nervous system; although it is not known whether this chemical has this effect.

Medical Surveillance: There is no special test for this chemical. However, if illness occurs or overexposure is suspected, medical attention is recommended.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with methyltetrahydrofuran all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN2536 Methyltetrahydrofuran, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Methyltetrahydrofuran, Trenton, NJ (June 1999).

Methyl Thiocyanate M:1260

Formula: C_2H_3NS; CH_3CNS

Synonyms: Methyl rhodanate; Methylrhodanid (German); Methyl sulfocyanate; Methylthiokyanat; Thiocyanic acid, methyl ester

CAS Registry Number: 556-64-9

HSDB Number: 5691

RTECS Number: XL1575000

UN/NA & ERG Number: UN2929/131; UN1992/131

EC Number: 209-134-6

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Flammable, Fast acting poison (ingestion)

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 20,000

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 20,000 lb (9080 kg)

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 10,000 lb (4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10,000 lb (4540 kg).

Hazard symbols, risk, & safety statements: Hazard symbol: T, F; risk phrases: R10; R23/24/24; R36/37/38; safety phrases: S1/2; S16; S26; S27; S28; S36/37/39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)].

Description: Methyl thiocyanate is a colorless liquid. Onion-like odor. Molecular weight = 73.12; specific gravity $(H_2O:1) = 1.07$ @ 20°C; boiling point = °C; boiling point = 130−133°C; freezing/melting point = −51°C[72]; flash point = ∼35°C. Very slightly soluble in water. Carrier solvents used in commercial formulations may change physical and toxicological properties.

Potential Exposure: It is used as an agricultural insecticide; a fumigant; and as a research chemical. No evidence of commercial production in the United States.

Incompatibilities: Incompatible with nitric acid. Violent reactions have occurred when mixed with chlorates, nitrates, nitric acid; peroxides, potassium chlorate; and sodium chlorate.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 17 milligram per cubic meter

PAC-2: 28 milligram per cubic meter

PAC-3: 140 milligram per cubic meter

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Prolonged skin absorption may produce various eruptions; runny nose; dizziness, cramps, nausea, vomiting and mild or severe disturbances of the nervous system. This material is highly toxic if ingested. The ingestion of a concentrated solution may lead to vomiting. The principal systemic reaction is probably one of central nervous system depression, interrupted by periods of restlessness; abnormally fast and deep respiratory movements and convulsions. Death is usually due to respiratory arrest from paralysis of the medullary centers.

Long-Term Exposure: May cause injury to the liver and kidneys.

Points of Attack: Liver, kidneys.

Medical Surveillance: Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. *Note*: Because cyanide is probably largely responsible for poisonings, antidotal measures against cyanide should be instituted promptly. Use amyl nitrate capsules if symptoms develop. All area employees should be trained regularly in emergency measures for cyanide poisoning and in CPR. A cyanide antidote kit should be kept in the immediate work area and must be rapidly available. Kit ingredients should be replaced every 1−2 years to ensure freshness. Persons trained in the use of this kit; oxygen use, and CPR must be quickly available.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *(for cyanides) Up to 25 milligram per cubic meter*: Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFS100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern and having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area separated from strong oxidants, strong bases; strong acids. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2929 Toxic liquids, flammable, organic, n.o.s., Hazard class: 6.1; Labels: 6.1-Poison Inhalation Hazard, 3-Flammable liquid, Technical Name Required. UN1992 Flammable liquids, toxic, n.o.s., Hazard Class: 3; Labels: 3-Flammable liquid, 6.1-Poisonous materials, Technical Name Required.

Spill Handling:

Toxic liquids, flammable, organic, n.o.s.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.3/0.5
Night 0.8/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 600/180
Then: Protect persons downwind (mi/km)
Day 1.4/2.3
Night 2.9/4.6

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Small fires: dry chemical, carbon dioxide; water spray; or foam. *Large fires*: water spray, fog, or foam. Move container from fire area if you can do so without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Wear positive pressure breathing apparatus and special protective clothing. Thermal decomposition products may include nitrogen oxides; sulfur oxides. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Methyl Thiocyanate, Washington, DC, Chemical Emergency Preparedness Program (Nov. 30, 1987).

(173); (101); (138).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Methyl thiocyanate, #2562, Trenton, NJ (June 2002).

Methyl Trichlorosilane M:1280

Formula: CH_3Cl_3Si

Synonyms: Methylsilicochloroform; Methylsilyl trichloride; KA 13; LS 40 (silane); Methylsilicon trichloride; Trichloromethylsilicon; Silane, trichloromethyl-; Trichloromethylsilane

CAS Registry Number: 75-79-6; *(alt.)* 175446-71-6

HSDB Number: 840

RTECS Number: VV4550000

UN/NA & ERG Number: UN1250/155

EC Number: 200-902-6 [*Annex I Index No.*: 014-004-00-5]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Hazard Alert: Exposure can be lethal, Highly flammable, Violently reactive with water, Primary irritant (w/o allergic reaction).

OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 500 lb (227 kg)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U164

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg).

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xi; risk phrases: R2; R11; R14; R36/37/38; safety phrases: S1; S2; S21, S26; S39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Methyltrichlorosilane is a colorless liquid with a sharp hydrochloric acid-like odor. Molecular weight = 149.48; specific gravity (H_2O:1) = 1.3 @ 20°C; boiling point = 66°C; freezing/melting point = −90°C; vapor pressure = 146.7 mmHg @ 18°C; 757 mmHg @ 7°C; flash point = −6.2°C; −8°C (cc); autoignition temperature ≥404°C. Explosive limits: LEL = 7.6%; 14,000 ppm[138]; UEL ≥20%. Hazard identification (based on NFPA-704 M Rating System): Health 4, flammability 3, reactivity 2₩. Reacts violently with water, rapidly releasing corrosive hydrogen chloride gas.

Potential Exposure: Methyltrichlorosilane is used as an intermediate to make silicones; for making water repellants, electrical insulation; and heat resistant paints; and other products.

Incompatibilities: Vapors may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Chlorosilanes react vigorously with bases and both organic and inorganic acids generating toxic and/or flammable gases. Chlorosilanes react with water, moist air, or steam to produce heat and toxic, corrosive fumes of hydrogen chloride. They may also produce flammable gaseous hydrogen. Attacks metals and rubbers and plastics in the presence of moisture.

Permissible Exposure Limits in Air

PAC* Ver. 29[138]

PAC-1: $\mathbf{0.6_A}$ ppm

PAC-2: $\mathbf{7.3_A}$ ppm

PAC-3: $\mathbf{33_A}$ ppm

*AEGLs are marked with a subscript "**A**" and correspond to 60-minute values.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: If the eyes have come in contact with methyltrichlorosilane, then irritation, pain, swelling, corneal erosion; and blindness may result. Dermatitis (red, inflamed skin), severe burns, pain, and shock generally follow dermal exposure. As with other chlorosilanes, acute exposures may be highly toxic and may cause death or permanent injury after very short exposures to small quantities. Skin contact may produce severe burns with pain and risk of secondary infections. Ingestion may produce oral, esophageal, and stomach burns; intensity will vary from mild to very severe; gastrointestinal damage is rare but may occur. Signs and symptoms of acute ingestion of methyltrichlorosilane may include excessive salivation; intense thirst; difficulty in swallowing; chills, pain, and shock. Oral, esophageal, and stomach burns are common. Vomitus generally has a coffee-ground appearance. The potential for circulatory collapse is high following ingestion of methyltrichlorosilane. Acute inhalation exposure may result in hoarseness, laryngitis, a feeling of suffocation, dyspnea (shortness of breath), choking, respiratory tract irritation; chest pain. Inhalation can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Sneezing, bleeding of the nose and gums; and ulceration of the nasal and oral mucosa may also occur.

Long-Term Exposure: Very irritating material may affect the lungs and bronchitis may develop. Renal toxicity has been observed in animals.

Points of Attack: Lungs, kidneys.

Medical Surveillance: For those with frequent or potentially high exposure the following are recommended before beginning work and at regular times after that. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure, kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water or milk. Do not induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to methyltrichlorosilane exists, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Methyl trichlorosilane must be stored to avoid contact with water, acids, chemically active metals (such as potassium, sodium, magnesium, and zinc); and alkalis, since violent reactions occur and hydrogen chloride is produced. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames are prohibited where methyltrichlorosilane is handled, used, or stored. Metal containers involving the transfer of 5 gal or more of methyl trichlorosilane should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of methyl trichlorosilane. Wherever methyltrichlorosilane is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1250 Methyltrichlorsilane, Hazard Class: 3; Labels: 3-Flammable liquid, 8-Corrosive material.

Spill Handling:

Methyltrichlorsilane when spilled in water

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)
First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.2/0.3
Large spills (From a large package or from many small packages)
First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.4/0.6
Night 1.3/2.0

Consider consulting an expert. Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Spills can be neutralized by flushing with large quantities of water followed by treatment with sodium bicarbonate. Provide adequate protection against generated hydrogen chloride. Do not allow water to get into container since resulting pressure could cause container to rupture. Protect against potentially violent reaction with water. Avoid breathing vapors and contact with skin. Establish forced ventilation to keep levels below explosive limit. Collect leaking liquid in sealable, dry containers; *do not use plastic containers*. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Remove to a safe place. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include hydrogen chloride and oxides of carbon. Dry chemical or carbon dioxide may be used for small fires. *Do not use water* or hydrous agents. However, water may be used for large fires if firefighters are protected from violent reactions of methyltrichlorosilane with water. Water may be used to keep containers cool. SCBA is required as combustion/decomposition yields acid gases/pulmonary irritants. Corrosion-resistant protective clothing, as well as appropriate foot, hand, arm, head, eye, and face protection are required where contact is possible. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform to EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (173); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Methyltrichlorosilane, Washington, DC, Chemical Emergency Preparedness Program (Nov. 30, 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Methyl Trichlorosilane, Trenton, NJ (January 2000).

Methyl Vinyl Ketone M:1290

Formula: C_4H_6O; $CH_2{=}CHCOCH_3$

Synonyms: Acetyl ethylene; 3-Butene-2-one; Methylene acetone; Methyl-vinyl-cetone (French); Methylvinylketon (German); Metil vinil cetona (Spanish); MVK; γ-Oxo-α-butylene; Vinyl methyl ketone

CAS Registry Number: 78-94-4

HSDB Number: 716

RTECS Number: EM9800000

UN/NA & ERG Number: (PIH) UN1251 (stabilized)/131 (P)

EC Number: 201-160-6

Regulatory Authority and Advisory Information

Hazard Alert: Poison inhalation hazard: exposure can be lethal, Highly flammable liquid, High acute toxicity, Lacrimator, Highly flammable liquid, Polymerization hazard, Corrosive, Suspected of causing genetic defects, Sensitizer hazard (skin), Environmental hazard.

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 10 lb (4.54 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg)

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, C, F, N, Xi: Risk phrases: R11; R19; R20/21/22; R26/27/28; R34; R43; R50/53; R62; safety phrases: S16; S21; S26; S28; S29/35; S36/37/39; S38; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Methyl vinyl ketone is a colorless liquid. Pungent odor. Molecular weight = 70.1; specific gravity (H_2O:1) = 0.84 @ 20°C; boiling point = 81.4°C; flash point = −7°C; autoignition tem evaluation by a dermatologist. Temperature = 491°C. Explosive limits: LEL = 2.1%; 13,000 ppm[138]; UEL: 15.6%. Hazard identification (based on NFPA-704 M Rating System): Health 4, flammability 3, reactivity 2. Easily mixes with water.

Potential Exposure: Methyl vinyl ketone is used as an alkylating agent, a starting material for plastics; and an intermediate in the synthesis of steroids and Vitamin A.

Incompatibilities: Vapors may form explosive mixture with air. Heat or shock may cause explosive polymerization. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, nitrated amines, azo, diazo, azido compounds, carbamates, organic cyanates.

Permissible Exposure Limits in Air

Odor Threshold = 0.5 milligram per cubic meter.

ACGIH TLV[1]: 0.2 ppm/0.6 milligram per cubic meter [skin] danger of skin sensitization, Ceiling Concentration

PAC* Ver. 29[138]

PAC-1: $\mathbf{0.17_A}$ ppm

PAC-2: $\mathbf{1.2_A}$ ppm

PAC-3: $\mathbf{2.4_A}$ ppm

*AEGLs are marked with a subscript "**A**" and correspond to 60-minute values.

DFG MAK: [skin] danger of skin sensitization.

Russia: STEL 0.1 milligram per cubic meter [skin], 1993

Determination in Water: Octanol−water coefficient: Log K_{ow} = < 0.5. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion, skin, and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: *Warning*: Methyl vinyl ketone is easily absorbed through the skin, causing general poisoning; inhalation has central nervous system depressant effects. It is irritating to mucous membranes and respiratory tract and to the skin; it is a lachrymator and can cause eye injury. Liquid or high concentration of vapors causes blistering of the skin. Similar to other ketones; can cause sore throat, sneezing, coughing, and salivation. Inhalation may cause nausea and vomiting; inhalation of high concentrations can cause headache, dizziness, fainting, tremor, lack of coordination, lowered body temperature; depressed respiratory and heart rate; gasping, coma, and death. Direct aspiration of liquid into lungs can cause chemical pneumonia. Exposure may cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: May cause skin sensitization.

Points of Attack: Lungs, skin, nervous system.

Medical Surveillance: Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. Evaluation by an allergist and/or dermatologist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: For emergency situations, wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Protect against physical damage. Outside or detached storage is preferred. Inside storage should be in a standard flammable liquids storage room. Separate from oxidizing materials. MVK vapors are uninhibited and may form polymers in the flame arresters of storage tanks, resulting in stoppage of vent.

Shipping: UN1251 Methyl vinyl ketone, stabilized, Hazard class: 6.1; Labels: 6.1-Poison Inhalation Hazard, 3-Flammable liquid, 8-Corrosive material, Inhalation Zone A.

Spill Handling:

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 48-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 300/90
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 0.5/0.8

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 2500/800
Then: Protect persons downwind (mi/km)
Day 1.0/1.5
Night 1.9/3.1

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, alcohol foam, or carbon dioxide. Water spray may be ineffective as an extinguishing agent. *Small fires*: dry chemical, carbon dioxide; and foam. *Large fires*: fog or foam. Move container form fire area if you can do so without risk. Dike fire control water for later disposal; do not scatter the material. Spray cooling water on containers that are exposed to flames until well after fire is out. Wear positive pressure breathing apparatus and special protective clothing. *See above for isolation distances*. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Methyl Vinyl Ketone, Washington, DC, Chemical Emergency Preparedness Program (Nov. 30, 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Methyl vinyl ketone, #1301, Trenton, NJ (June 2000).

2-Methyl-5-Vinyl Pyridine M:1300

Formula: C_8H_9N

Synonyms: 5-Ethenyl-2-methylpyridine; MVP; 5-Vinyl-2-picoline

CAS Registry Number: 140-76-1

HSDB Number: 6325

RTECS Number: UT2975000

UN/NA & ERG Number: UN2810 (toxic liquid, organic, n.o.s.)/153 P; UN3073 (stabilized)/131 (P)

EC Number: 205-432-5

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Inhalation hazard, Flammable, Polymerization Hazard, Primary irritant (w/o allergic reaction).

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500 lb (227 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 500 lb (227 kg)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, F; risk phrases: R10; R19; R20/21/22; safety phrases: S16; S24/25; S28; S30; S45; S46; S53(see Appendix 4)

Description: 2-Methyl-5-vinylpyridine is a clear to faintly opalescent liquid. Molecular weight = 119.18; specific gravity (H_2O:1) = 0.99 @ 20°C; boiling point = 181°C; vapor pressure = 1.71 mmHg @ 25°C; flash point = 74°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 2, reactivity 0.

Potential Exposure: 2-Methyl-5-vinylpyridine is used as a monomer for resins; oil additive; ore flotation agent; and dye acceptor.

Incompatibilities: Can polymerize exothermically. May form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, hydrides and other strong reducing agents. 2-Methyl-5-vinylpyridine neutralizes acids in exothermic reactions to form salts plus water. May be incompatible with isocyanates, halogenated organics, peroxides, phenols (acidic), epoxides, anhydrides, and acid halides. Flammable gaseous hydrogen may be generated in combination with strong reducing agents, such as hydrides[101].

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 0.17 milligram per cubic meter

PAC-2: 1.9 milligram per cubic meter

PAC-3: 6.6 milligram per cubic meter

Russia[43] set a MAC in work-place air of 2.0 milligram per cubic meter.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: This material is poisonous by ingestion, inhalation, and absorption through the skin. Vapors may cause dizziness or suffocation. Inhalation may be fatal

Long-Term Exposure: May cause liver and kidney damage.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area separated from strong oxidants, strong bases; strong acids. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN3073 Vinylpyridines, stabilized, Hazard class: 6.1; Labels: 6.1-Poison Inhalation Hazard, 3-Flammable liquid, 8-Corrosive material. UN2810 Toxic liquids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: *Danger*: This chemical is a poisonous inhalation hazard. Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Pyridine, 2-Methyl-5-Vinyl, Washington, DC, Chemical Emergency Preparedness Program (Nov. 30, 1987)

Metiram M:1306

Formula: $C_{16}H_{33}N_{11}S_{16}Zn_3$

Synonyms: *tris*[Amine(ethylenebis(dithiocarbamato))] zinc (2 + 1) (tetrahydro-1,2,4,7-dithiadiazocine-3,8-dithione) polymer; Atlas brand Metiram; Amarex; Carbamic acid, 1*H*-benzimidazol-2-yl-, carbatene; Carbamodithioic acid, 1,2-ethanydiylbis-, polymer with ammonia complex of zinc EBDC; Caswell No. 041A; EBDC, polymer with ammonia complex of zinc EBDC; Ethylenebis(dithiocarbamic acid), polymer with ammonia complex of zinc EBDC; Mixture of 5.2 parts by weight (83.9%) of [ethylenebis(dithiocarbamato)] zinc with 1 part by weight (16.1%) ethylenebis(dithiocarmabic acid), bimolecular and trimolecular cyclic anhydrosulfides and disulfides; NIA 9102; Niagara 9102; Polycarbacin; Polycarbacine; Polycarbazin; Polycarbazine; Polymarcin; Polymarcine; Polymarsin; Polymarzin; Polymarzine; Polyram; Zinc ammoniate ethylenebis(dithiocarbamate)-poly(ethylenethiuram disulfide); Zinc metiram; Zineb-ethylene thiuram disulfide adduct

CAS Number: 9006-42-2; 9063-14-3

HSDB Number: 6705

RTECS Number: TR6250000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171; UN2771(thiocarbamate pesticide, solid, toxic)/151

EC Number: Not assigned

Regulatory Authority and Advisory Information

Carcinogenicity[83]: EPA Group B2, probable human carcinogen

California Proposition 65 Chemical[102]: Carcinogen (1/1/1990) and developmental toxin (3/30/1999)

Hazard Alert: Poison, Possible thyroid effects, Suspected reprotoxic hazard, Developmental Toxin; Endocrine Disruptor (Confirmed, German Environmental Agency)

EPA ADI = 0.0003 mg/kg

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%

EPA Hazardous Waste Number (RCRA No.): U114

Clean Water Act: Section 307(a)(1) Toxic Pollutants subject to effluent limitations as zinc and compounds

United States National Primary Drinking Water Regulations: SMCL = 5 mg[Zn]/L as Zinc

California EPA AB2588-Air Toxics "Hot Spots" Chemicals (CAL) as zinc compounds

The "Director's List" (CAL/OSHA) as zinc compounds

Description: Light yellow solid or powder at room temperature. Characteristic dithiocarbamate odor. Molecular weight 1088.7; specific gravity (H_2O:1) = 1.86; boiling point = (decomposes); freezing/melting point = (decomposes) $>140°C$; vapor pressure $\leq 10^{-7}$ mmHg @ 20°C. Practically insoluble in water.

Potential Exposure: Metiram is a dithiocarbamate fungicide used on fruits, vegetables, field crops and other crops and on ornamentals to protect against many types of fungi and other foliar diseases.

Incompatibilities: Combustible material. Dust may form explosive mixture in air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Dithiocarbamate esters are combustible. They react violently with powerful oxidizers such as calcium hypochlorite. Poisonous gases are generated by the thermal decomposition of dithiocarbamate compounds, including carbon disulfide, oxides of sulfur, oxides of nitrogen, hydrogen sulfide, ammonia, and methylamine. Thio and dithiocarbamates slowly decompose in aqueous solution to form carbon disulfide and methylamine or other amines. Such decompositions are accelerated by acids. Flammable gases are generated by the combination of dithiocarbamate with aldehydes, nitrides, and hydrides. Dithiocarbamate are incompatible with acids, peroxides, and acid halides. Thermal decomposition products in fire includes oxides of nitrogen and sulfur. Corrosive to iron, copper brass and zinc metals, especially in the presence of moisture. Heat alkalies (lime), moisture can cause decomposition. Decomposes on prolonged storage. Degradation produces ethylene thiourea.

Permissible Concentration in Water: Safe Drinking Water Act (47FR 9352): SMCL = 5 mg[Zn]/L as Zinc. Canadian Drinking Water Standards: AO $\leq$ 5.0 mg[Zn]/L. Runoff from spills or fire control may cause water pollution.

Determination in Water: EPA EMSLC Method 630. The Determination of Dithiocarbamate Pesticides in Municipal and Industrial Wastewater by UV−VIS Spectrophotometry. Octanol−water coefficient: Log $K_{ow} = < 2.0$. Unlikely to bioaccumulate in marine organisms. Fish toxicity (threshold)[101]: Intermediate—24.87820 ppb, MATC (Maximum Acceptable Toxicant Concentration)

Routes of Entry: Poisoning can occur by inhalation, ingestion and absorption through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Low levels of toxicity. Concentrated solutions are slightly corrosive to eyes and mucous membranes. Dust inhalation can cause irritation of the respiratory system with sneezing. Eye contact can cause irritation, watering, pain, and inflammation of the eyelids. Dermal contact can cause irritation and minor ulceration. Ingestion can cause nausea, vomiting, fever, muscle twitching, seizure, rapid respiration, slow heartbeat. Severe exposure may result in death. Unlike carbamates the dithiocarbamates are not cholinesterase inhibitors, but some of them may react with recently ingested alcohol or alcohol-containing products including wine, medications, and cold remedies such as cough-syrups. LD_{50} (oral, rat) = > 2.5 g/kg; LD_{50} (dermal, rat) ≥ 2 g/kg.

Long-Term Exposure: May cause cancer; skin sensitization. Dithiocarbamates can affect thyroid function. Human toxicity (long term)[101]: High—2.10 ppb, Health Advisory.

Points of Attack: Thyroid function (may cause goiter). Respiratory system, central nervous system, cardiovascular system, skin, eyes. Repeated or prolonged contact with skin may result in dermatitis (red inflamed skin).

Medical Surveillance: This chemical is a suspected or known human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and advice for medical monitoring. There are tests available to measure zinc in your blood, urine, hair, saliva, and feces. High levels of zinc in the feces can mean high recent zinc exposure. High levels of zinc in the blood can mean high zinc consumption and/or high exposure. Tests to measure zinc in hair may provide information on long-term zinc exposure; however, the relationship between levels in your hair and the amount of zinc you were exposed to is not clear. Before employment and at regular times after that, the following are recommended: If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider CBC and chest X-ray following acute overexposure. Evaluation by a qualified allergist, including exposure history and testing, may help diagnose allergy. Thyroid function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious and able to swallow, have victim drink 4 to 8 oz of water. Do not induce vomiting. *Note to physician or authorized medical personnel*:

Personal Protective Methods: Reacts with the following absorbent materials: Cellulose-Based; Mineral- and Clay-Based; Dirt/Earth[88]. Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of dermal and/or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a tightly closed container in a dry, well-ventilated and secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Where possible, automatically transfer material from other storage containers to process containers.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: First remove all sources of ignition. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen, carbon, sulfur and zinc. As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 m/150 ft for liquids and at least 25 m/75 ft for solids. *Fire involving storage or vehicular tanks*: Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. *On a small fire*: use dry chemical, CO_2, water spray or regular *foam. On a large fire*: use water spray, fog, or regular foam. Do not scatter spilled material with high pressure streams of water. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal. *Fire involving tanks*: From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. Always stay away from tanks engulfed in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Do not discharge into drains or sewers. Dispose of waste material as hazardous waste using a licensed disposal contractor to an approved landfill. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform to EPA regulations governing storage, transportation, treatment, and waste disposal. A potential candidate for liquid injection incineration at a temperature range of 650 to 1600°C and a residence time 0.1 to 2 seconds. Also, a potential candidate for rotary kiln incineration at a temperature range of 820 to 1600°C and residence times of seconds for liquids and gases, and hours for solids[83].

References

(102); (31); (173); (101); (138).

EXTOXNET, Extension Toxicology Network, "Pesticide Information Profile, Metiram," Oregon State University, Corvallis, OR (June 1996). http://extoxnet.orst.edu/pips/metiram.htm.

United States Environmental Protection Agency, Office of Pesticide Programs, Pesticide Residue Limits, "Metiram," 40 CFR 180.217, http://www.epa.gov/pesticides/food/viewtols.htm.

Metobromuron M:1308

Formula: $C_9H_{11}BrN_2O_2$

Synonyms: 3-(4-Bromophenyl)-1-methoxy-1-methylurea; 3-(*p*-Bromophenyl)-1-methoxy-1-methylurea; *N*′-(4-Bromophenyl)-*N*-methoxy-*N*-methylurea; 3-(*p*-Bromophenyl)-1-methyl-1-methoxyurea; C-3126; CIBA 3126; Metobromuron [3-(*p*-bromophenyl)-1-methoxy-1-methylurea]; Patoran; Pattonex; Urea, *N*′-(4-bromophenyl)-*N*-methoxy-*N*-methyl-

CAS Number: 3060-89-7

HSDB Number: 1741

RTECS Number: YS3325000

UN/NA & ERG Number: UN3021 (liquid)/131; UN2767 (phenylurea, solid)/151

EC Number: 221-301-5

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Herbicide and aquatic algicide, Primary irritant (w/o allergic reaction), Agricultural chemical.

Hazard symbols, risk, & safety statements: Hazard Symbol (solid in a flammable hydrocarbon carrier): F, Xn; phrases; R11; R21/22/23; R36; R51; safety phrases: S16; S26; S36; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: White crystalline solid or powder. Commercial product may be dissolved in a flammable hydrocarbon carrier. Molecular weight = 259.11; specific gravity (H_2O:1) = 1.59; boiling point = (decomposes); freezing/melting point = 95°C; vapor pressure = 3×10^{-6} mmHg @ 20°C; soluble in water; solubility = 8.8 mg/L@ 20°C. Physical and toxicological properties may be affected by carrier solvents in commercial formulations.

Potential Exposure: Preemergence substituted urea herbicide used to control grasses and broadleaf weeds on flax, groundnuts, potatoes, beans, soybeans, sunflowers, tomatoes, and tobacco.

Incompatibilities: This organic bromine compound may react with strong oxidizers such as chlorates, peroxides, nitrates, permanganates, perchlorates, chlorine, fluorine, etc. Keep away from strong acids.

Determination in Water: FDA Method 242.4 *Method for Substituted Urea Herbicides* High Performance Liquid Chromatography with Fluorescence Detection with no detection limit reported. Octanol—water coefficient:

Log $K_{ow} = \sim 2.5$. Unlikely to bioaccumulate in marine organisms.

Determination in Air: Filter; none; Gravimetric; NIOSH IV [Particulates NOR; #0500 (total), #0600 (respirable)][18].

Harmful Effects and Symptoms

Short-Term Exposure: Contact with eyes or skin may cause irritation or injury. Inhalation should be avoided; use NIOSH- or CEN (UK)-approved APRs for pesticides. May be harmful if swallowed. Dermal contact may cause severe irritation or burns. LD_{50} (oral, rat) ≥ 5 g/kg.

Long-Term Exposure: May cause skin sensitization.

Points of Attack: Skin.

Medical Surveillance: Evaluation by a qualified allergist, including exposure history and testing, may help diagnose allergy. Preliminary medical exam to detect chronic diseases of central nervous system, liver, heart, kidneys, lung, and skin, as well as endocrinological or immunological disturbances, should protect susceptible individuals. Periodical medical exams of internal organs, skin, and eyes are important to avoid chronic occupational intoxications. They should include lab and patch tests when necessary[83].

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water. Do not induce vomiting when formulations containing petroleum solvents are ingested. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of dermal and/or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison. Store in a secure poison location. Prior to working with Chloroxuron all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN3021 Pesticides, liquid, flammable, toxic, flash point <23°C, Hazard Class: 3; Labels: 3-Flammable liquid, 6.1-Poisonous materials. Technical Name Required. UN2767 Phenyl urea pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: First remove all sources of ignition. Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Do not touch spilled material; stop leak if you can do it without risk. Use water spray to reduce vapors. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. *Large spills*: dike far ahead of spill for later disposal. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen and carbon, and corrosive fumes of bromine. Use dry chemical, carbon dioxide; water spray; or standard foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Hydrolysis is not recommended as a disposal procedure because of the generation of the toxic products, 3,4-dichloroaniline and dimethylamine. Incinerate in a unit with effluent gas scrubbing.

Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (100).

United States National Library of Medicine, *ChemIDplus Advanced*, Bethesda MD, http://chem.sis.nlm.nih.gov/chemidplus/rn/3060-89-7.

Metolachlor M:1310

Formula: $C_{15}H_{22}ClNO_2$

Synonyms: 2-Aethyl-6-methyl-*N*-(1-methyl-2-methoxyaethyl)-chloracetanilid (German); Bicep; CGA-24705; α-Chlor-6′-aethyl-*N*-(2-methoxy-1-methylaethyl)-acet-*o*-toluidin (German); 2-Chloro-6′-ethyl-*N*-(2-methoxy-1-methylethyl)acet-*o*-toluidide; α-Chloro-2′-ethyl-6′-methyl-*N*-(1-methyl-2-methoxyethyl)-acetanilide; 2-Chloro-*N*-(2-ethyl-6-methylphenyl)-*N*-(2-methoxy-1-methylethyl) acetamide; 2-Chloro-*N*-(6-ethyl-*o*-tolyl)-*N*-(2-methoxy-1-methylethyl)-acetamide; Codal; Cotoran Multi; Dual; 2-Ethyl-6-methyl-1-*N*-(2-methoxy-1-methylethyl)chloroacetanilide; Metelilachlor; Milocep; Ontrack 8E; Primagram; Primextra

CAS Registry Number: 51218-45-2; *(alt.)* 63150-68-5; *(alt.)* 94449-58-8

HSDB Number: 6706

RTECS Number: AN3430000

UN/NA & ERG Number: UN2902 (Pesticides, liquid, toxic, n.o.s.)/151; UN3082 (environmentally hazardous substances, liquid, n.o.s.)/171

EC Number: 257-060-8

Regulatory Authority and Advisory Information

Carcinogenicity: EPA: Group C, Possible Human Carcinogen

Hazard Alert: Poison, Combustible, Suspected reprotoxic hazard, Suspected of causing genetic defects, Sensitization hazard (skin), Primary irritant (w/o allergic reaction), Environmental hazard.

EPA ADI: EPA/OPP oral reference dose (RfD) = 0.15 mg/kg.

Hazard symbols, risk, & safety statements: Hazard symbol: Xi, Xn, N; risk phrases: R40; R11; R20/21/22; R36/37; R43; R60; R61; R62 Safety phrases: S16; S26; S29/35; S36/37; S57; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water (mfg.).

Description: Metolachlor is a colorless or tan to brown, oily liquid. Slightly sweet odor. Molecular weight = 283.79. Boiling point = 100°C @ 0.001 mmHg. It is stable to about 300°C. Vapor pressure = 1.5×10^{-5} mmHg @ 20°C. Flash point = 190°C. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 1, reactivity 0. Very slightly soluble in water; solubility = 510 ppm @ 20°C.

Potential Exposure: Metolachlor is a chlorinated acetamide selective herbicide used for weed control in corn and for controlling grasses in a variety of crops including cotton and peanuts.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, nitrates. Compounds of the carboxyl group react with all bases, both inorganic and organic (i.e., amines) releasing substantial heat, water and a salt that may be harmful. Incompatible with arsenic compounds (releases hydrogen cyanide gas), diazo compounds, dithiocarbamates, isocyanates, mercaptans, nitrides, and sulfides (releasing heat, toxic, and possibly flammable gases), thiosulfates and dithionites (releasing hydrogen sulfate and oxides of sulfur).

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Permissible Concentration in Water: Federal Drinking Water Guidelines (EPA): 700 μg/L. State Drinking Water Guidelines: Florida 110 μg/L; Massachusetts 110 μg/L; Maine 100 μg/L; Minnesota 800 μg/L for both metolachlor-ESA (ethane sulfonic acid) and metolachlor-OXA (oxanilic acid); Wisconsin 15 μg/L.

Determination in Water: Extraction with methylene chloride followed by separation by gas chromatography and measurement using a nitrogen-phosphorus detector. Fish Tox = 1117.14617000 ppb (VERY LOW).

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes and skin. The acute oral LD_{50} for rats is 2780 mg/kg (slightly toxic). Signs of human intoxication from metolachlor and/or its formulations (presumably following acute deliberate or accidental exposures) include abdominal cramps; anemia, ataxia, dark urine; methemoglobinemia, cyanosis, hypothermia, collapse, convulsions, diarrhea, gastrointestinal irritation; jaundice, weakness, nausea, shock, sweating, vomiting, CNS depression; dizziness, dyspnea, liver damage; nephritis, cardiovascular failure; skin irritation; dermatitis, sensitization dermatitis; eye and mucous membrane irrigation; corneal opacity and adverse reproductive effects. Human Tox = 100.00000 ppb (VERY LOW).

Long-Term Exposure: May cause tumors.

Points of Attack: Blood.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure. Test for methemoglobinemia. CBC.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least

15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to Physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Based on potential carcinogenicity the following is recommended by NIOSH: *At any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA—or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full-facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: UN2902 Pesticides, liquid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN3082 Environmentally hazardous substances, liquid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include hydrogen chloride, and oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR 165 recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, *Health Advisory*, Washington, DC, Office of Drinking Water (August 1987).

Metolcarb M:1320

Formula: $C_9H_{11}NO_2$: $C_6H_4(CH_3)OCONHCH_3$

Synonyms: Carbamic acid, methyl-, 3-methylphenyl ester; Carbamic acid, methyl-, 3-tolyl ester; *m*-Cresyl ester of *N*-methylcarbamic acid; *m*-Cresyl methyl carbamate; *m*-Cresyl methylcarbamate; Dicresyl; Dicresyl *N*-methylcarbamate; DRC 3341; Kumiai; Metacrate; Metholcarb;

Methylcarbamic acid *m*-toyl ester; *m*-Methylphenyl methylcarbamate; 3-Methylphenyl *N*-methylcarbamate; Metolcarb; MTMC; S 1065; *m*-Tolyester kyseliny methyl karbaminove; *m*-Tolyl *N*-methylcarbamate; 3-Tolyl *N*-methylcarbamate; Tsumacide; Tsumaunka

CAS Registry Number: 1129-41-5

HSDB Number: 6416

RTECS Number: FC8050000

UN/NA & ERG Number: UN2757(carbamate pesticides, solid, toxic)/151; UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 214-446-0 [*Annex I Index No*.: 006-056-00-2]

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Possible neurotoxin (methyl carbamate), Agricultural chemical.

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P190

Superfund/EPCRA [40CFR 302 and 355, F R: 8/16/06,Vol 71, No. 158] RQ: 1000 lb (454 kg)

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.056; Nonwastewater (mg/kg), 1.4

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1000 lb (454 kg).

Hazard symbols, risk, & safety statements: Hazard symbol: Xn, N; risk phrases: R22; R33; R51/53 Safety phrases: S2; S41; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [2-Hazard to water.(est.)].

Description: Metolcarb is a colorless crystalline solid. Molecular weight = 165.21; boiling point = 360°C; freezing/melting point = 74−75°C; vapor pressure = 1×10^{-5} mmHg @ 25°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 0.

Potential Exposure: Metolcarb is an insecticide used for the control of rice leafhoppers, plant-hoppers; codling moth; citrus mealy bug; onion thrips; fruit flies; bollworms and aphids. Not registered as a pesticide in the United States.

Incompatibilities: Carbamates are incompatible with reducing agents such as hydrides, strong acids, oxidizing acids, peroxides, and bases. Contact with active metals or nitrides cause the release of flammable, and potentially explosive, hydrogen gas. May react violently with bromine, ketones. Incompatible with azo dyes, caustics, ammonia, amines, boranes, hydrazines, strong oxidizers.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 0.44 milligram per cubic meter

PAC-2: 4.8 milligram per cubic meter

PAC-3: 21 milligram per cubic meter

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Metolcarb is a carbamate insecticide. Signs and symptoms of poisoning by carbamates are similar to those for organic phosphorus compounds. Symptoms of poisoning by organic phosphorus compounds include headache, giddiness, nervousness; blurred vision; weakness, nausea, cramps, diarrhea, and discomfort in the chest. Signs include sweating, myosis, tearing, salivation and other excessive respiratory tract secretion; vomiting, cyanosis, uncontrollable muscle twitches followed by muscular weakness; convulsions, coma, loss of reflexes; and loss of muscular control. Metolcarb exhibits high oral and skin toxicity, and moderate inhalation toxicity. Some carbamates appear to be carcinogenic, teratogenic, and/or mutagenic. Carbamates are cholinesterase inhibitors.

Long-Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, central nervous system; cardiovascular system, skin, eyes, plasma, and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of “normal.” Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider CBC. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature. Carefully observe victim since effects may be delayed.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location under cool conditions. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers.

Shipping: UN2757 Carbamate pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Solid carbamate pesticides may burn but do not ignite readily. For small fires, use dry chemical, carbon dioxide; water spray, and foam. For large fires, use water spray, fog, or foam. Dike fire control water for later disposal. Stay upwind and keep out of low areas. Wear positive pressure breathing apparatus and special protective clothing. Move container from fire area if you can do it without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Thermal decomposition products may include oxides of nitrogen and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform to EPA regulations governing storage, transportation, treatment, and waste disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Metolcarb, Washington, DC, Chemical Emergency Preparedness Program (Nov. 30, 1987).

Metribuzin M:1330

Formula: $C_8H_{14}N_4OS$

Synonyms: 4-Amino-6-*tert*-butyl-3-(methylthio)-1,2,4-triazin-5-one; 4-Amino-6-*tert*-butyl-3-methylthio-As-triazin-5-one; 4-Amino-6-(1,1-dimethylethyl)-3-(methylthio)-1,2,4-triazin-5-(4*H*)-one; As-triazin-5(4*H*)-one,4-amino-6-*tert*-butyl-3-(methylthio)-; Bay 61597; Bay DIC 1468; Bayer 6159H; Bayer 6443H; Bayer 94337; DIC 1468; Lexone; Lexoneex; Metribuzina (Spanish); Sencor; Sencoral; Sencorer; Sencorex; 1,2,4-Triazin-5-(4*H*)-one, 4-amino-6-(1,1-dimethylethyl)-3-(methylthio)-

CAS Registry Number: 21087-64-9

HSDB Number: 6844

RTECS Number: XZ2990000

UN/NA & ERG Number: UN2763 (triazine pesticide, solid, poisonous)/151

EC Number: 244-209-7 [*Annex I Index No*.: 606-034-00-8]

Regulatory Authority and Advisory Information

EPA: Not Classifiable as to human carcinogenicity.

Hazard Alert: Poison, Combustible, Highly flammable liquid, Agricultural chemical (triazine pesticide), Environmental hazard.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Safe Drinking Water Act (47FR 9352): Priority List (55 FR 1470).

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292].

Hazard symbols, risk, & safety statements: Hazard symbol: F(liquid), Xn, N; risk phrases: R11; R20/21/22; R36; R50/53; safety phrases: S16; S26; S29/35; S36/37; S41; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [2-Hazard to water. (est.)].

Description: Metribuzin is a colorless crystalline solid. Commercial product may be a flammable solution. Mild, sulfurous odor. Molecular weight = 214.33; melting/freezing point = 125−127°C; vapor pressure = 4×10^{-7} mmHg; flash point (flammable liquid) = < 5°C. Slightly soluble in water; solubility = 1.2×10^3 ppm. Available in different concentrations (4%, 50%, 75%). Carrier solvents used in commercial formulations may change physical and toxicological properties.

Potential Exposure: A potential danger to those involved in manufacture, formulation, and application of this herbicide. A laboratory chemical. Used to make other chemicals.

Incompatibilities: Liquid is incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

OSHA PEL: None

NIOSH REL: 5 milligram per cubic meter TWA

ACGIH TLV[1]: 5 milligram per cubic meter TWA, not classifiable as a human carcinogen

PAC not available

Guidelines or standards for metribuzin in ambient air[60] have been set by Several states ranging from 50 μ/m³ (North Dakota) to 100 μ/m³ (Connecticut) to 119 μ/m³ (Nevada).

Determination in Air: No method available.

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 70 μg/L; State Drinking Water Guidelines: Florida 180 μg/L; Maine 175 μg/L; Minnesota 200 μg/L; Wisconsin 250 μg/L

Determination in Water: Solvent extraction with methylene chloride followed by exchange to acetone; separation by gas chromatography and measurement with a thermionic bead detector. Fish Tox = 7683.76758000 ppb (VERY LOW).

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Metribuzin can affect you when breathed in and by passing through your skin. Acute poisoning can cause difficult breathing and drowsiness. High exposures may cause upset stomach; fatigue, and depression of the central nervous system; causing poor coordination; tremors and weakness.

Long-Term Exposure: Repeated or high exposure may cause liver enzyme changes; goiter, and affect thyroid function.

Points of Attack: Central nervous system; thyroid, liver.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: thyroid function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures *over 5 milligram per cubic meter*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece respirator with a pesticide cartridge. Greater protection is provided by a PAPR. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Store in tightly closed containers in a cool, dry area under inert gas. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Where possible, automatically transfer material from other storage containers to process containers.

Shipping: UN2763 Triazine pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is

complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Metribuzin itself does not burn. The solution is highly flammable. Thermal decomposition products may include oxides of nitrogen, sulfur, and carbon. Extinguish fire using an agent suitable for type of surrounding fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office. Use a licensed professional waste disposal service to dispose of this material. Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, “Alert: Metribuzin, Washington, DC, Office of Drinking Water (August 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Metribuzin, Trenton, NJ (January 2001).

Metsulfuron-methyl M:1345

Formula: $C_{14}H_{15}N_5O_6S$

Synonyms: Allie; Ally; Ally-20DF; Answer; Benzoic acid, 2-[((((4-methoxy-6-methyl-1,3,5-triazin-2-yl)amino) carbonyl)amino)sulfonyl]-methyl ester; Brush-off; Canvas; Cimarron; DMC weed control; DPD 63760H; DPX 6376; DPX-T 6376; Escort; Finesse; Gropper; Methyl-2-[[(4-methoxy-6-methyl-1,3,5-triazyn-2-yl)aminocarbonyl] aminosulfonyl]benzoate; Methyl 2-[((((4-methoxy-6-methyl-1,3,5-triazin-2-yl)amino)carbonyl) amino) sulfonyl]benzoate; Methyl 2-[3-(4-methoxy-6-methyl-1,3,5-triazin-2-yl)ureidosulphonyl]benzoate; NUP; Parti-san; Pasture MD; Riverdale; Rosulfuron

CAS Number: 74223-64-6

HSDB Number: 6849

RTECS Number: DH3563000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 616-063-8 [*Annex I Index No*.: 613-139-00-2]

Regulatory Authority and Advisory Information

Carcinogenicity[83]: EPA, Not likely to be carcinogenic to humans.

Hazard Alert: Suspected reprotoxic hazard

Marine pollutant: IMDG, some formulations

Environmental hazard: IATA, some formulations

Hazard symbols, risk, & safety statements: Hazard symbol: N; risk phrases: R50/53; R63; safety phrases: S2; S60; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)].

Description: White, off-white or pale yellow crystalline solid. Slight, sweet odor; ester-like. Molecular weight = 381.37; specific gravity (H_2O:1) = 1.47; freezing/melting point = 158°C; 163°C; vapor pressure = 3×10^{-12} mmHg @ 25°C. Soluble in water; solubility = 108 mg/L @ 25°C.

Potential Exposure: Metsulfuron-methyl is a preemergence and postemergence sulfonylurea herbicide used to control annual grasses, brush, woody plants and broadleaf weeds. It can be applied to cereals including barley, rye and wheat and to pastures. It is primarily used to control brush, woody plants and broadleaf weeds on rights-of-way, fence rows, storage areas, highways and other noncrop areas.

Incompatibilities: Strong oxidizers. Stable in air to about 140 C. It is hydrolyzed in acid solutions.

Determination in Air: Filter; none; Gravimetric; NIOSH IV [Particulates NOR; #0500 (total), #0600 (respirable)][18].

Determination in Water: Hazardous to marine organisms with long-lasting effects. Octanol−water coefficient: Log $K_{ow} = < 2.5$. Unlikely to bioaccumulate in marine organisms. Fish toxicity (threshold)[101]: Very low—31,167.38603 ppb, MATC (Maximum Acceptable Toxicant Concentration).

Routes of Entry: Inhalation, dermal contact, ingestion

Harmful Effects and Symptoms

Human health effects from the sulfonylurea herbicides at low environmental doses or at biomonitored levels from low environmental exposures are unknown. The sulfonylurea herbicides are generally of low toxicity in mammalian studies. Animal studies showed low acute toxicity and little chronic, reproductive, or developmental toxicity or teratogenic effects. Developmental or teratogenic effects tended only to occur at high or maternally toxic doses. At high sublethal, chronic oral doses, such nonspecific effects as weight loss and anemia were observed. Some chemical-specific effects were noted at high doses in animals[96].

Short-Term Exposure: May cause skin and eye irritation. Moderately poisonous if ingested or inhaled. LD_{50} (oral, rat) = > 5 g/kg; LD_{50} (dermal, rat) = > 2 g/kg.

Long-Term Exposure: May cause reproduction problems. Human toxicity (long term)[101]: Very low—1750.00 ppb, Health Advisory.

Points of Attack: Reproductive cells.

Medical Surveillance: Preliminary medical exam to detect chronic diseases of central nervous system, liver, heart, kidneys, lung, and skin, as well as endocrinological or immunological disturbances, should protect susceptible individuals. Periodical medical exams of internal organs, skin, and eyes are important to avoid chronic occupational intoxications. They should include lab and patch tests when necessary[83]. Comprehensive physical examination with emphasis on the genitourinary tract analysis to include sperm count, motility and morphology. Other tests, such as serum testosterone, serum FSH, and serum LH may be carried out if, in the opinion of a physician, they are indicated. Urinary levels of the sulfonylurea herbicides reflect recent exposure. There is very limited information on the biomonitoring of sulfonylurea herbicides or their metabolites. Detection of the metabolites may reflect exposure to more than one particular sulfonylurea herbicide or from exposure to environmental degradation products. The urinary metabolites dimethoxypyrimidine and dimethylpyrimidine can be used as nonspecific markers of exposure to the pyrimidinylsulfonylureas, a group that includes bensulfuron-methyl, halosulfuron, primisulfuron-methyl, and sulfosulfon. The urinary metabolite methoxymethyl triazine can be used as a nonspecific marker of exposure to the triazinylsulfonylureas, a group that includes chlorosulfuron, prosulfuron, and triasulfuron[96].

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of dermal and/or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Wherever and whenever workplace conditions warrant respirator use, a respiratory protection program must be followed that meets one or more of the following government standards: OSHA's 29 CFR 1910.134, ANSI Z88.2, or European Standard EN 149.

Storage: Color code—Blue: Health Hazard/Poison. Store in a secure poison location. Store in a refrigerator and protect from exposure to oxidizers or moisture[52]. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. If a spill occurs, clean it up promptly. Don't wash it away. Instead, sprinkle the spill with sawdust, vermiculite, or kitty litter. Sweep it into a plastic garbage bag, and dispose of it as directed on the pesticide product label. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen, sulfur, and carbon. As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 m/150 ft for liquids and at least 25 m/75 ft for solids. *Fire involving storage or vehicular tanks*: Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. *On a small fire*: use dry chemical, CO_2, water spray or regular *foam. On a large fire*: use water spray, fog, or regular foam. Do not scatter spilled material with high pressure streams of water. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal. *Fire involving tanks*: From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. Always stay away from tanks engulfed in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: It is the responsibility of chemical waste generators to determine the toxicity and physical properties and of a discarded chemical and to properly identify its classification and certification as a hazardous waste and to determine the disposal method. United States Environmental Protection Agency guidelines for the classification determination are listed in 40 CFR Parts 261.3. In addition, waste generators must consult and follow all regional, national, state and local hazardous waste laws to ensure complete and accurate classification and disposal methods. Recycle any unused portion of the material for its approved use or return it to the manufacturer or supplier. Offer surplus and nonrecyclable solutions to a licensed disposal company. Dissolve or mix the pesticide with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber.

References

(31); (173); (101); (138); (100).

EXTOXNET, Extension Toxicology Network, "Pesticide Information Profile, Metsulfuron-methyl," Oregon State University, Corvallis, OR (October 1996). http://extoxnet.orst.edu/pips/metsulfu.htm.

Metronidazole M:1340

Formula: $C_6H_9N_3O_3$

Synonyms: Acromona; Anagiardil; Atrivyl; Bayer 5360; Bexon; Clont; Cont; Danizol; Deflamon-wirkstoff; Efloran; Elyzol; Entizol; 1-(β-Ethylol)-2-methyl-5-nitro-3-azapyrrole; Eumin; Flagemona; Flagesol; Flagil; Flagyl; Giatricol; Gineflavir; 1-(β-Hydroxyethyl)-2-methyl-5-nitroimidazole; 1-(2-Hydroxy-1-ethyl)-2-methyl-5-nitroimidazole; 1-(2-Hydroxyethyl)-2-methyl-5-nitroimidazole; 1-Hydroxyethyl-2-methyl-5-nitroimidazole; Klion; Meronidal; 2-Methyl-1-(2-hydroxyethyl)-5-nitroimidazole; 2-Methyl-3-(2-hydroxyethyl)-4-nitroimidazole; Metronidaz; Metronidazol; Metronidazolo; Monagyl; Nalox; Neo-Tric; NIDA; Novonidazol; NSC-50364; Orvagil; 1-(β-Oxyethyl)-2-methyl-5-nitroimidazole; RP 8823; Sanatrichom; SC 10295; Trichazol; Trichocide; Trichomol; Trichomonacid "Pharmachim;" Trichopol; Tricom; Tricowas B; Trikojol; Trimeks; Trivazol; Vagilen; Vagimid; Vertisal

CAS Registry Number: 443-48-1

HSDB Number: 3129

RTECS Number: NI5600000

UN/NA & ERG Number: UN3249 (Medicine, solid, toxic, n.o.s.)/151

EC Number: 207-136-1

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Animal Sufficient Evidence; Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B; European GHS, Category 2.

California Proposition 65 Chemical[102]: Cancer 1/1/1988

Hazard Alert: Poison, Possible risk of forming tumors, Suspected of causing genetic defects, Drug

Hazard symbols, risk, & safety statements: Hazard symbol: T, F, Xn; risk phrases: R45; R11; R22; R23/24/25; R36/37/38; R39/23/24/25; SR40; R46; R50; R61; safety phrases: S7; S16; S26; S36/37; S41; S45; S53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)].

Description: Metronidazole is an odorless, white, yellow, or cream-colored crystalline solid. Darkens on exposure to light. Bitter, salty taste (do not test). Molecular weight = 171.18; freezing/melting point = 158−160°C. Practically insoluble in water; solubility = < 1 mg/mL @ 20°C.

Potential Exposure: Metronidazole is an orally administered drug for the treatment of infections due to *entamoeba histolytica*; *trichomonas vaginalis*; *giardia lamblia*, and has also been used for treating Vincent's infection. It can be used as a trichomonacide in veterinary medicine. One firm has petitioned EPA to use metronidazole as a disinfectant for cooling tower water.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = < -0.1$. Unlikely to bioaccumulate in marine organisms.

Harmful Effects and Symptoms

Short-Term Exposure: Symptoms of exposure include headache, anorexia, nausea, occasional vomitin; diarrhea and rash.

Long-Term Exposure: There is evidence that this substance is mutagenic, teratogenic and carcinogenic in animals. Possibly carcinogenic to humans.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure.

First Aid: *Skin Contact*[52]: Flood all areas of body that have contacted the substance with water. Don't wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others. *Eye Contact*: Remove any contact lenses at once. Flush eyes well with copious quantities of water or normal saline for at least 20−30 minutes. Seek medical attention. *Inhalation*: Leave area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion*: If convulsions are not present, give a glass or two of water or milk to dilute the substance. Assure that the person's airway is unobstructed and contact a hospital or poison center immediately for advice on whether or not to induce vomiting.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full- facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in a refrigerator. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN3249 Medicine, solid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Dampen spilled material with water to avoid dust. Use HEPA vacuum or wet method to reduce dust during clean-up. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include oxides of nitrogen and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dispose of contents and container to an approved waste disposal plant. All federal, state, and local environmental regulations must be observed. It is inappropriate and possibly dangerous to the environment to dispose of expired or waste drugs and pharmaceuticals by flushing them down the toilet or discarding them to the trash. Household quantities of expired or waste pharmaceuticals may be mixed with wet cat litter or coffee grounds, double-bagged in plastic, discard in trash. Larger quantities shall carefully take into consideration applicable DEA, EPA, and FDA regulations. If possible return the pharmaceutical to the manufacturer for proper disposal being careful to properly label and securely package the material. Alternatively, the waste pharmaceutical shall be labeled, securely packaged, and transported by a state licensed medical waste contractor to dispose by burial in a licensed hazardous or toxic waste landfill or incinerator.

References

(109); (102); (31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Metronidazole, Trenton, NJ (September 2001).

Mevinphos M:1350

Formula: $C_7H_{13}O_6P$

Synonyms: AI3-22374; Apavinphos; 2-Butenoic acid, 3-[(dimethoxyphosphinyl)oxy]-, methyl ester; 2-Carbomethoxy-1-methylvinyl dimethyl phosophate, α-isomer;

α-2-Carbomethoxy-1-methylvinyl dimethyl phosphate; (α-2-Carbomethoxy-1-methylvinyl) dimethyl phosphate; 2-Carbomethoxy-1-methylvinyl dimethyl phosphate; 2-Carbomethoxy-1-propen-2-yl dimethyl phosphate; Caswell No. 160B; CMDP; Compound 2046; Crotonic acid, 3-hydroxy-, methyl ester, dimethyl phosphate; Crotonic acid, 3-hydroxy-, methyl ester, dimethyl phosphate, (*E*)-; 3-[(Dimethoxyphosphinyl)oxy]-2-butenoic acid methyl ester; *O*,*O*-Dimethyl *O*-(2-carbomethoxy-1-methylvinyl) phosphate; *O*,*O*-Dimethyl 1-carbomethoxy-1-propen-2-yl phosphate; Dimethyl-1-carbomethoxy-1-propen-2-yl phosphate; Dimethyl (2-methoxycarbonyl-1-methylvinyl) phosphate; Dimethyl methoxycarbonylpropenyl phosphate; Dimethyl (1-methoxycarboxypropen-2-yl) phosphate; *O*, *O*-Dimethyl *O*-(1-methyl-2-carboxyvinyl) phosphate; Dimethyl phosphate of methyl 3-hydroxy-*cis*-crotonate; Duraphos; ENT 22,374; EPA pesticide chemical code 015801; Gesfid; Gestid; 3-Hydroxycrotonic acid methyl ester dimethyl phosphate; Menite; (*cis*-2-Methoxycarbonyl-1-methylvinyl) dimethyl phosphate; *cis*-2-Methoxycarbonyl-1-methylvinyl dimethylphosphate; 2-Methoxycarbonyl-1-methylvinyl dimethyl phosphate; 1-Methoxycarbonyl-1-propen-2-yl dimethyl phosphate; Methyl 3-[(dimethoxyphosphinyl)oxy]-2-butenoate; Methyl-3-[(dimethoxyphosphinyl)oxy]-2-butenoate, α-isomer; Methyl 3-(dimethoxyphosphinyloxy)crotonate; Methyl 3-hydroxy-α-crotonate dimethyl phosphate; Methyl 3-hydroxycrotonate dimethyl phosphate ester; Methyl-3-hydroxy-α-crotonate, dimethyl phosphate ester; Mevinfos (Spanish); NSC 46470; PD 5; *cis*-Phosdrin; Phosdrin; Phosfene; Phosphene; Phosphoric acid, dimethyl ester, with methyl 3-hydroxycrotonate; Phosphoric acid, (1-methoxycarboxypropen-2-yl) dimethyl ester

CAS Registry Number: 7786-34-7

HSDB Number: 777

RTECS Number: GQ5250000

UN/NA & ERG Number: (PIH) UN3018 (organophosphorus pesticide, liquid, toxic)/152; UN2783 (organophosphorus pesticide, solid, n.o.s.)/152

EC Number: 232-095-1 [*Annex I Index No.*: 015-020-00-5]

Regulatory Authority and Advisory Information

Hazard Alert: Poison inhalation hazard: exposure can be lethal, Super toxic, Neurotoxin (cumulative), Suspected of causing genetic defects, Agricultural chemical.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500 lb (227 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT 49CFR172.101, Inhalation Hazard Chemical as organophosphates.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, N; risk phrases: R27/28; R33; R50/53; R62; safety phrases: S1/2; S23; S28; S36/37; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Mevinphos is a pale yellow to orange high-boiling liquid. Weak odor. The carrier solvent may change the physical properties listed here. Molecular weight = 224.17; specific gravity (H_2O:1) = 1.25; boiling point = decomposes; freezing/melting point = 7°C (*trans*-); 21°C (*cis*-); vapor pressure = 0.0001 mmHg @ 20°C; flash point = 79.5°C (oc).[ICSC] Hazard identification (based on NFPA-704 M Rating System): Health 4, flammability 1, reactivity 0. Soluble in water. Commercial product is a mixture of the *cis*- and *trans*-isomers. Insecticide that may be absorbed on a dry carrier.

Potential Exposure: Those engaged in the manufacture, formulation, and application of this super toxic contact and systemic insecticide and acaricide.

Incompatibilities: Decomposes in heat (below boiling point @ 300°C) producing phosphoric acid and phosphorous oxides fumes. Strong oxidizers may cause release of toxic phosphorus oxides. Organophosphates, in the presence of strong reducing agents such as hydrides, may form highly toxic and flammable phosphine gas. Keep away from alkaline materials. Corrosive to cast iron, some stainless steels and brass. Attacks some forms of plastics, rubber and coatings.

Permissible Exposure Limits in Air

NIOSH IDLH = 4 ppm

Conversion factor: 1 ppm = 9.17 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 0.1 milligram per cubic meter TWA [skin]

NIOSH REL: 0.01 ppm/0.1 milligram per cubic meter TWA; 0.03 ppm/0.3 milligram per cubic meter STEL [skin]

ACGIH TLV[1]: 0.01 milligram per cubic meter measured as inhalable fraction and vapor TWA [skin]; not classifiable as a human carcinogen; BEI_A issued as Acetylcholinesterase inhibiting pesticides.

PAC Ver. 29[138]

PAC-1: 0.3 milligram per cubic meter

PAC-2: 4 milligram per cubic meter

PAC-3: 40 milligram per cubic meter

DFG MAK: 0.01 ppm/0.093 milligram per cubic meter TWA; Peak Limitation Category II(2) [skin]

Arab Republic of Egypt: TWA 0.01 ppm (0.1 milligram per cubic meter) [skin] 1993; Australia: TWA 0.01 ppm (0.1 milligram per cubic meter); STEL 0.03 ppm [skin] 1993; Austria: MAK 0.01 ppm (0.1 milligram per cubic meter) [skin] 1999; Belgium: TWA 0.01 ppm (0.09 milligram per cubic meter); STEL 0.03 ppm [skin] 1993; Denmark: TWA 0.01 ppm (0.1 milligram per cubic meter) [skin] 1999; Finland: TWA 0.001 ppm, 1999; France: VME 0.01 ppm (0.1 milligram per cubic meter) [skin] 1999; the Netherlands: MAC-TGG 0.1 milligram per cubic meter [skin] 2003; Norway: TWA 25 ppm (125 milligram per cubic meter), 1999; the Philippines: TWA 0.1 milligram per cubic meter [skin] 1993; Switzerland: MAK-W

0.01 ppm (0.1 milligram per cubic meter) [skin] 1999; Thailand: TWA 0.1 milligram per cubic meter, 1993; United Kingdom: TWA 0.01 ppm (0.09 milligram per cubic meter); STEL 0.03 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 0.27 milligram per cubic meter (skin)

Several states have set guidelines or standards for mevinphos in ambient air[60] ranging from 1−3 μ/m^3 (North Dakota) to 1.6 μ/m^3 (Virginia) to 2.0 μ/m^3 (Connecticut and Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #5600, Organophosphorus Pesticides.

Permissible Concentration in Water: No criteria set. This chemical is highly toxic to aquatic life.

Determination in Water: Fish Tox = 0.96183000 ppb (EXTRA HIGH).

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Short-Term Exposure: Cholinesterase inhibitor. Mevinphos may affect the nervous system; causing convulsions, respiratory failure. This material is super toxic; the probable oral lethal dose for humans is less than 5 mg/kg, or a taste (less than seven drops) for a 150-lb person. It has direct and immediate effects whether it is swallowed, inhaled, or absorbed through the skin. Symptoms include nausea, vomiting, abdominal cramps; diarrhea, excessive salivation; headache, giddiness, dizziness, runny nose; tightness in the chest; blurring and dimming of vision; slurring of speech; twitching of muscles; mental confusion; disorientation, troubled breathing; bluing of skin, convulsions, coma, and death. Human Tox = 1.75000 ppb (HIGH)

Long-Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, central nervous system; cardiovascular system, skin, eyes, plasma, and red blood cell cholinesterase.

Medical Surveillance: NIOSH lists the following tests: Blood serum; Cholinesterase, Blood Serum, Red blood cells/count. Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider CBC. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *0.1 ppm*: Sa (APF = 10) (any supplied-air respirator). *0.25 ppm*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *0.5 ppm*: SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *4 ppm*: Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers.

Shipping: UN3018 Organophosphorus pesticides, liquid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN2783 Organophosphorus pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous material.

Spill Handling:

Initial isolation and protective action distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30

Then: Protect persons downwind (mi/km)

Day 0.3/0.4

Night 0.8/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 600/200

Then: Protect persons downwind (mi/km)

Day 1.4/2.3

Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Do not touch spilled material. Do not breathe vapors. Stay upwind; keep out of low areas. Remove all ignition sources. Ventilate area of spill or leak. This material is a combustible liquid. For a spill or leak of a combustible liquid, shut off ignition sources; no flares, smoking or flames in hazard area. Stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include phosphoric acid and oxides of phosphorus and carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Mevinphos is 50% hydrolyzed in aqueous solutions at an unspecified temperature in 1.4 hours at pH 11, 35 days at pH 7; and 120 days at pH 6. Thermal decomposition is rapidly accomplished by lime sulfur. Mevinphos may also incinerated. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (80); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 6, No. 1, 97−101 (1986)(2).

United States Environmental Protection Agency, Chemical Hazard Information Profile: *Mevinphos*, Washington, DC, Chemical Emergency Preparedness Program (Nov. 30, 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: *Mevinphos*, Trenton, NJ (March, 2007).

Mexacarbate M:1360

Formula: $C_{12}H_{18}N_2O_2$

Synonyms: Carbamate, 4-dimethylamino-3,5-xylyln-methyl-; Carbamic acid, methyl-, 4-(dimethylamino)-3,5-xylyl ester; Carbamic acid, methyl-, methylcarbamate (ester); 4-(Dimethylamine)-3,5-xylyl *N*-methylcarbamate; 4-(Dimethylamino)-3,5-dimethylphenol methylcarbamate (ester); 4-(Dimethylamino)-3,5-dimethylphenyl *N*-methylcarbamate; 4-(Dimethylamino)-3,5-xylenol, methylcarbamate (ester); 4-(*N*,*N*-Dimethylamino)-3,5-xylyl *N*-methylcarbamate; 4-Dimethylamino-3,5-xylyl *N*-methylcarbamate; 4-Dimethylamino-3,5-xylyl methylcarbamate; 5-Dimethylphenol methylcarbamate ester; DowCo 139; ENT 25766; Methylcarbamic acid, 4-(dimethylamino)-3,5-xylyl ester; Methyl 4-dimethylamino-3,5-xylyl carbamate; Methyl-4-dimethylamino-3,5-xylyl ester of carbamic acid; Mexacarbato (Spanish); NCI-C00544; OMS-47; Phenol, 4-(dimethylamino)-3,5-dimethyl-methylcarbamate (ester); 3,5-Xylenol, 4-(dimethylamino)-, methylcarbamate; Zactran; Zectane; Zectran; Zextran

CAS Registry Number: 315-18-4

HSDB Number: 1042

RTECS Number: FC0700000

UN/NA & ERG Number: UN2757(carbamate pesticides, solid, toxic)/151

EC Number: 206-249-3 [*Annex I Index No.*: 006-054-00-1]

Regulatory Authority and Advisory Information

Carcinogenicity: NCI: Carcinogenesis Bioassay (feed); no evidence: mouse, rat, 1979; IARC: Human No Adequate Data, animal No Evidence, *not classifiable as carcinogenic to humans*, Group 3

Hazard Alert: Poison, Possible neurotoxic effects (methyl carbamate), Combustible, Environmental hazard, Agricultural chemical.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P128

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.056; Nonwastewater (mg/kg), 1.4

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1000 lb (454 kg)

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, N; risk phrases: R21; R28; R33; R50/53; safety phrases: S1/2; S36/37; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)].

Description: Mexacarbate is an odorless, white to tan crystalline solid. Molecular weight = 222.32; freezing/melting point = 85°C; vapor pressure = 0.1 mmHg @ 20°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 1, reactivity 0. Insoluble in water.

Potential Exposure: It is an insecticide for nonagricultural uses, e.g., lawn and turf, flowers, gardens, vines, forest lands; woody shrubs and trees; and also a molluscicide. It is not produced or used commercially in the United States.

Incompatibilities: Alkalis, strong oxidizers.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 1.3 milligram per cubic meter

PAC-2: 14 milligram per cubic meter

PAC-3: 84 milligram per cubic meter

Determination in Water: Fish Tox = 31.03658000 ppb (INTERMEDIATE). Highly toxic to aquatic life with long-lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Routes of Entry: Inhalation, ingestion, skin, and/or contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Extremely toxic: probable oral lethal dose for humans is 5−50 mg/kg; between seven drops and one teaspoonful for 70 kg person (150 lb). Poisonous; may be fatal if inhaled, swallowed, or absorbed through skin. Contact may cause burns to skin and eyes. Symptoms of carbamate poisoning resemble those of parathion. This material is similar to carbaryl; symptoms of carbaryl exposure include nausea, vomiting, abdominal cramps; diarrhea, excessive salivation; sweating, lassitude and weakness. Runny nose and sensation of tightness in chest may occur with inhalation exposures. Blurring or dimness of vision, tearing, eye muscle spasm; loss of muscle coordination; slurring of speech; and twitching of muscles may also occur.

Long-Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. Mexacarbate may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, central nervous system; cardiovascular system, skin, eyes, plasma, and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider CBC. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Store in a cool, dry place or a refrigerator.

Shipping: UN2757 Carbamate pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during clean-up. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen and carbon. This chemical is a combustible solid. *Small fires*: dry chemical, carbon dioxide; water spray; or foam. *Large fires*: water spray, fog, or foam. Dike fire control water for later disposal; do not scatter the material. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform to EPA regulations governing storage, transportation, treatment, and waste disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Mexacarbate, Washington, DC, Chemical Emergency Preparedness Program (Nov. 30, 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Mexacarbate. Trenton, NJ (December 1999).

Mica M:1370

Formula: $Al_6H_4K_2O_{24}Si_6$; $K_2Al_4(Al_2Si_6O_{20})(OH)_4$

Synonyms: Amber mica; Biotite; Fluorophlogopite; Lepidolite; Margarite; Mica silicate; Muscovite; Phlogopite; Roscoelite, suzorite mica; Zimmwaldite

CAS Registry Number: 12001-26-2

HSDB Number: 2539

RTECS Number: VV8760000

UN/NA & ERG Number: Not regulated.

Regulatory Authority and Advisory Information

United States National Primary Drinking Water Regulations: SMCL = 0.05 to 0.2 mg[Al]/L as aluminum.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Description: Mica (muscovite), takes the form of a colorless, odorless solid that separates into flakes or thin sheets of hydrous silicates. Molecular weight = 398.3; specific gravity (H_2O:1) = 2.6−3.2 @ 20°C; freezing/melting point = 1387°C. Insoluble in water.

Potential Exposure: Mica is used as reinforcing filler for plastics, substitute for asbestos; for insulation in electrical equipment; used in the manufacture of roofing shingles, wallpaper and paint.

Incompatibilities: Silicates react with lithium.

Permissible Exposure Limits in Air
NIOSH IDLH = 1500 milligram per cubic meter
OSHA PEL: 20 mppcf, <1% crystalline silica TWA
NIOSH REL: 3 milligram per cubic meter respirable dust; containing <1% quartz TWA
ACGIH TLV[1]: 3 milligram per cubic meter respirable fraction TWA
PAC Ver. 29[138]
PAC-1: 9 milligram per cubic meter
PAC-2: 99 milligram per cubic meter
PAC-3: 590 milligram per cubic meter
Australia: TWA 2.5 milligram per cubic meter, 1993; Belgium: TWA 3 milligram per cubic meter, 1993; Switzerland: MAK-W 3 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 5 milligram per cubic meter (total dust); MAC-TGG 2.5 milligram per cubic meter (respirable dust), 2003; United Kingdom: TWA 10 milligram per cubic meter, total inhalable dust; TWA 0.8 milligram per cubic meter, respirable dust, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 3 milligram per cubic meter, respirable fraction

Determination in Air: Use NIOSH Analytical Method (IV) #0600, Particulates NOR (respiratory)

Routes of Entry: Inhalation, skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Unknown at this time.

Long-Term Exposure: Pneumoconiosis; cough, dyspnea, weakness, weight loss. Repeated heavy exposure can irritate the lungs. After years of high exposure, lung scarring (fibrosis) may result. This causes an abnormal chest X-ray and may cause cough and a shortness of breath.

Points of Attack: Lungs.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful. Lung function tests. Chest X-ray.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately. If a person breathes in large amounts of this chemical, move the exposed person to fresh air at once.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *Up to 15 milligram per cubic meter*: Qm (APF = 25) (any quarter-mask respirator). *Up to 30 milligram per cubic meter*: Any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100; or Sa (APF = 10) (any supplied-air respirator). *Up to 75 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25) (any PAPR with a high-efficiency particulate filter). *Up to 150 milligram per cubic meter*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTHie (APF = 50) (any PAPR with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 1500 milligram per cubic meter*: Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: HieF$^+$(any air-purifying, full facepiece respirator with a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Green: General storage may be used. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Mica silica itself does not burn. Thermal decomposition products may include oxides of metal and harmful and irritating gases. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consider recycling, otherwise, this chemical must be disposed of in compliance with existing federal and local regulations. Landfill.

References

(31); (173); (101); (138); (2).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Silica, Mica, Trenton, NJ (January 1996).

Michlers Ketone M:1380

Formula: $C_{17}H_{20}N_2O$; $(CH_3)_2N\text{-}C_6H_4\text{-}CO\text{-}C_6H_4\text{-}N(CH_3)_2$
Synonyms: Benzophenone, 4,4′-bis(dimethylamino)-; *p*,*p*′-Bis(dimethylamino)benzophenone; 4,4′-Bis(dimethylamino) benzophenone; Bis(4-dimethylaminophenyl) ketone; Bis[*p*-(*N*,*N*-dimethylamino)phenyl] ketone; Cetona de michler (Spanish); Methanone, bis[4-(dimethylamino)phenyl]-; *p*,*p*′-Michler's ketone; NCI-C02006; *N*,*N*,*N*′,*N*′-Tetramethyl-4,4′-diaminobenzophenone; Tetramethyldiaminobenzophenone
CAS Registry Number: 90-94-8
HSDB Number: 2865 as 4,4′-bis(dimethylamino) benzophenone
RTECS Number: DJ0250000
UN/NA & ERG Number: UN3143 (Dyes, solid, toxic, n.o.s. [or] Dye intermediates, solid, toxic, n.o.s.)/151; UN1602 (Dye intermediate, liquid, toxic, n.o.s.)/151; UN2811 (toxic solid, organic, n.o.s.)/154
EC Number: 202-027-5 [*Annex I Index No.*: 606-073-00-0]
Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogenIARC: Animal Sufficient Evidence; Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B; NCI: Carcinogenesis Studies (feed); clear evidence: rat, mouse, 1979.

California Proposition 65 Chemical[102]: Cancer 1/1/1988

Hazard Alert: Poison, Combustible, Suspected of causing genetic defects, Possible risk of forming tumors.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%.

Hazard symbols, risk, & safety statements: Hazard symbol: T; risk phrases: R45; R41; R62; R68; safety phrases: S25; S41; S45; S53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Michler's ketone is a is a blue powder or white to green-colored leaflet material. Molecular weight = 268.39; boiling point ≥360°C (decomposition); freezing/melting point = 179°C; flash point = 220°C; autoignition temperature = 480°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 1, reactivity 0. Insoluble in water.

Potential Exposure: Mutagen. Animal Carcinogen. Michler's ketone is a dye intermediate and derivative of dimethylaniline. It is also used in antifreeze formulations, cosmetics, cleaning compounds; heat transfer fluids; as a chemical intermediate in the synthesis of at least 13 dyes and pigments, especially auramine derivatives.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from aldehydes, alkaline materials, strong acids, strong bases, strong reducing agents such as hydrideds and active metals. Contact with hydrogen peroxide may form heat- and shock-sensitive explosives.

Permissible Exposure Limits in Air

PAC Ver. 29[138]
PAC-1: 30 milligram per cubic meter
PAC-2: 330 milligram per cubic meter
PAC-3: 2000 milligram per cubic meter
DFG MAK: Carcinogen Category 2

Routes of Entry: Inhalation and skin adsorption.

Harmful Effects and Symptoms

Irritates the eyes, skin and mucous membranes. Absorbed through the skin.

Short-Term Exposure: May have a narcotic or anesthetic effect.

Points of Attack: Gastrointestinal or liver cancer

Long-Term Exposure: A potential occupational carcinogen.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure.

First Aid: *Skin Contact*[52]: Flood all areas of body that have contacted the substance with water. Don't wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others. *Eye Contact*: Remove any contact lenses at once. Immediately flush eyes well with copious quantities of water or normal saline for at least 20−30 minutes. Seek medical attention. *Inhalation*: Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion*: If unconscious or convulsing, do not induce vomiting or give anything by mouth. Assure that victim's airway is open and lay him on his side with his head lower than his body and transport at once to a medical facility. If conscious and not convulsing, give a glass of water to dilute the substance, If medical advice is not readily available, do not induce vomiting, and rush the victim to the nearest medical facility.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/ manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See NIOSH Criteria Document 78-173, *Ketones*.

Respirator Selection: *At any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full- facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in a refrigerator or a cool, dry place away from peroxides, aldehydes, strong acids. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN3143 Dyes, solid, toxic, n.o.s. or Dye intermediates, solid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poison Inhalation Hazard. UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN1602 Dyes, liquid, toxic, n.o.s or Dye intermediates, liquid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/ 75 ft (NJ). Isolation Distance, Fire: 800 m/0.5 mi.[70] Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120 (q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Do not discharge into drains or sewers. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. If allowed, Incineration with effluent gas scrubbing is recommended. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(109); (102); (31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Michler's ketone, #1305, Trenton, NJ, (February 2001, revised).

Mineral Oil M:1385

Synonyms: Adepsine oil; Heavy mineral oil mist; Mist of white mineral oil; Cutting oil; Heat-treating oil; Hydraulic oil; Cable oil; Lubricating oil; Paraffin oil; Paroil-70; Slaboil; White mineral oil; White oil

CAS Registry Number: 8042-47-5; 64741-53-3; 64741-88-4; 64742-54-7; 8012-95-1; *(alt.)* 39355-35-6; *(alt.)* 79956-36-8; *(alt.)* 83046-05-3

HSDB Number: 1922

RTECS Number: PY8030000

EC Number: 232-455-8 (mineral oil); 232-384-2 (paraffin oils)

Regulatory Authority and Advisory Information

Carcinogenicity (*For untreated, mildly treated, and poorly refined mineral oils, and used mineral motor oils*): NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen; Mineral oils (untreated and mildly treated); NTP (*untreated and poorly refined*): Known to be a human carcinogen; IARC (*untreated and poorly refined*): Human Sufficient Evidence; Animal Limited Evidence, *carcinogenic to humans*, Group 1; IARC (*highly refined*): Human No Adequate Data, animal No Evidence, *not classifiable as carcinogenic to humans*, Group 3.

Soots, tars, and mineral oils (untreated and mildly treated oils and used engine oils), cancer. 2/27, 1987.

Hazard Alert: Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction), Aspiration hazard.

FDA-When used as a lubricant with incidental food contact, mineral oil levels shall not exceed 10 ppm.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: Xi; risk phrases: R36/37/38; R41; R45; R62; safety phrases: S23; S24/25; S26; S26 (see Appendix 4)

Description: Mineral oil mist is a colorless, oily liquid aerosol dispersed in air with an odor like burned lubricating oil. The odor threshold is 1.0 ppm. Specific gravity (H_2O:1) = 0.865 @ 60°C; 0.83−0.91[138]; boiling point = 250−360°C; vapor pressure =< 0.5 mmHg @ 20°C; flash point = 185−193°C; autoignition temperature = 260−371°C. Hazard identification (based on NFPA-704 M Rating System): Health 0, flammability 1, reactivity 0. Insoluble in water.

Potential Exposure: Mineral oil is used in cosmetics, pharmaceutical bases; food, and fiber production; as carriers and bases; as a lubricating oil and as a solvent for inks in the printing industry. Oil mist would be encountered in quenching of hot metal parts and in metal machining operations.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong acids (especially nitric acid), strong bases.

Permissible Exposure Limits in Air

When used as a lubricant with incidental food contact, mineral oil levels shall not exceed 10 ppm.[FDA]

as oil mist (mineral)

NIOSH IDLH = 2500 milligram per cubic meter

OSHA PEL: 5 milligram per cubic meter TWA

NIOSH REL: 5 milligram per cubic meter TWA; 10 milligram per cubic meter STEL

ACGIH TLV[1]: 5 milligram per cubic meter inhalable fraction from highly refined and pure mineral oil, TWA

includes: *64741-53-3, 64741-88-4, 8042-47-5, 8012-95-1; 64742-54-7*

PAC Ver. 29[138]

PAC-1: 140 milligram per cubic meter

PAC-2: 1500 milligram per cubic meter

PAC-3: 8900 milligram per cubic meter

Australia: TWA 5 milligram per cubic meter; STEL 10 milligram per cubic meter, 1993; Belgium: TWA 5 milligram per cubic meter; STEL 10 milligram per cubic meter, 1993; Finland: TWA 5 milligram per cubic meter, 1999; Hungary: STEL 5 milligram per cubic meter, carcinogen, 1993; Japan: 3 milligram per cubic meter, Group 1 carcinogen, 1999; the Philippines: TWA 5 milligram per cubic meter, 1993; Poland: MAC (TWA) 5 milligram per cubic meter; MAC (STEL) 10 milligram per cubic meter, 1999; Russia: STEL 5 milligram per cubic meter, 1993; the Netherlands: MAC-TGG 5 milligram per cubic meter, 2003; Sweden: NGV 3 milligram per cubic meter; STEL 5 milligram per cubic meter, 1993; Switzerland: MAK-W 5 milligram per cubic meter, 1999; United Kingdom: LTEL 5 milligram per cubic meter; STEL 10 milligram per cubic meter, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 10 milligram per cubic meter. Several states have set guidelines or standards for mineral oil mist in ambient air[60] ranging from 16.7 μ/m^3 (New York); to 25 μ/m^3 (South Carolina); to 50 μ/m^3 (Florida); to 80 μ/m^3 (Virginia); to 100 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #5026, Oil mist, mineral; #5524, Metalworking Fluids

Permissible Concentration in Water: The EEC[35] set a MAC in drinking water of 10 μg/L. Russia set a MAC in surface water for fishery purposes of 6.5 mg/L.

Routes of Entry: Inhalation, skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: *Inhalation*: May irritate nose and throat. If taken into lungs may cause coughing and swelling of lung tissue; may cause pneumonia. Similarity to kerosene indicates that headache, nausea, ringing in the ears, weakness, confusion, drowsiness, coma and death may occur. *Skin*: May cause redness and swelling if not promptly removed. *Eyes*: May cause severe irritation if not promptly removed. *Ingestion*: Will cause burning sensation in mouth, throat, and stomach if swallowed. Vomiting, diarrhea and belching may follow. If liquid gets into lungs it may cause rapid breathing; Blue skin coloration; rapid heartbeat; and fever with rapid onset of chemical pneumonia and possible secondary infection. Death may result from as little as half a liquid ounce in the absence of lung involvement. *Note*: Food grades are highly purified and are of low toxicity.

Long-Term Exposure: Prolonged contact may cause skin irritation; acne-like rash may develop. May cause skin allergy with itching and rash. There is some evidence that some substances referred to as "mineral oils" may be carcinogens. However, this information is unclear at this time and mineral oils (except for food grades) should be treated with caution.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Special tests of the sputum to look for oil droplets. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. *For untreated, mildly treated, and poorly refined mineral oils, and used motor oils*: These chemicals are known or suspected human carcinogens. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *50 milligram per cubic meter*: 100XQ (APF = 10) [Any APR with an N100, R100, or P100 filter (including N100, R100, and P100 filtering facepieces) except quarter-mask respirators]; or Sa (APF = 10) (any supplied-air respirator). *125 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25) (any PAPR with a high-efficiency particulate filter). *250 milligram per cubic meter*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTHie (APF = 50) (any PAPR with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *2500 milligram per cubic meter*: Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or Planned Entry into Unknown Concentrations or IDLH Conditions* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

For untreated, mildly treated, and poorly refined mineral oils, and used motor oils: *At any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA—or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full-facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(109); (31); (173).

New York State Department of Health, *Chemical Fact Sheet*: Mineral Seal Oil, Bureau of Toxic Substance Assessment, (2). Albany, NY (March 1986).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 1, No. 2, 47−48 (1980).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Oil Mist, Mineral, Trenton, NJ (June 2001).

Mirex M:1390

Formula: $C_{10}Cl_{12}$

Synonyms: Bichlorendo; CG-1283; Dechlorane 4070; 1,1a,2,2,3,3a,4,5,5,5a,5b,6-Dodecachlorooctahydro-1,3,4-metheno-1*H*-cyclobuta(c,d)pentalene; Dodecachlorooctahydro-1,3,4-metheno-2*H*-cyclobuta(c,d)pentane; Dodecachloropentacyclodecane; ENT 25,719; Ferriamicide; 1,2,3,4,5,5-Hexachloro-1,3-cyclopentadiene dimer; Hexachlorocyclopentadienedimer; HRS 1276; NCI-C06428; Perchlorodihomocubane; Perchloropentacyclodecane

CAS Registry Number: 2385-85-5

HSDB Number: 1659

RTECS Number: PC8225000

UN/NA & ERG Number: UN2761/151

EC Number: 219-196-6 [*Annex I Index No.*: 602-077-00-1]

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Animal Sufficient Evidence, Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B.

California Proposition 65 Chemical[102]: Cancer 1/188

Hazard Alert: Poison, Combustible, Possible risk of forming tumors, Endocrine disruptor (high), Suspected of causing genetic defects, Suspected reprotoxic hazard, Environmental hazard, Agricultural Chemical.

Banned or Severely Restricted (several countries) (UN)[13]

Persistent Organic Pollutants (UN)

List of Stockholm Convention POPs: Annex A (Elimination)

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xn, N; risk phrases: R45; R21/22; R40; R50/53; R62; R63; R64; safety phrases: S2; S13; S36/37; S41; S46; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)].

Description: Mirex is a snow-white crystalline solid. Molecular weight = 545.50; boiling point = (decomposes) 485°C; vapor pressure = 8×10^{-7} mm @ 20°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 1, reactivity 0. Insoluble in water.

Potential Exposure: A potential danger to those involved in the manufacture, formulation, and application of the insecticide (particularly effective against fire ants). Also used as a fire retardant in plastics. Not produced in the United States but may be found in imported products.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, dichromates.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 6.3 milligram per cubic meter

PAC-2: 69 milligram per cubic meter

PAC-3: 410 milligram per cubic meter

Several states have set guidelines or standards for mirex in ambient air[60] ranging from 0 (Massachusetts) to 0.03 μ/m^3 (New York) to 0.88 μ/m^3 (Pennsylvania) to 4500 μ/m^3 (South Carolina).

Permissible Concentration in Water: 0.001 mg/L for protection of aquatic life (Sax-reference below).

Determination in Water: Fish Tox = 1.98564000 ppb (HIGH).

Routes of Entry: Inhalation, ingestion; skin and/or eye contact. Passes through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: *Inhalation*: Can irritate the respiratory tract. This compound is moderately toxic (the LD_{50} value for rats is 300 mg/kg). *Skin*: Can cause irritation, burning sensation and rash. *Eyes*: Can cause irritation. *Ingestion*: No cases of human toxicity reported. Possible symptoms include nausea, vomiting, restlessness, tremor, weight loss; nervous system and liver abnormalities; skin rash and reproductive failure. Exposure can cause nausea and vomiting, headache, dizziness, muscular weakness; fatigue, convulsions and may cause unconsciousness.

Long-Term Exposure: May damage the developing fetus during lactation. May cause damage to the testes. May damage the liver and cause anemia. High exposure can cause arrhythmia (irregular heartbeat) and may cause death. Mirex has caused cataracts, liver and thyroid cancer and birth defects in both rats and mice. Whether it does so in humans is not known.

Points of Attack: Blood, liver, nervous system, unborn fetus. Reproductive system.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure. CBC, liver function tests; EKG, examination of the nervous system. Pregnant women should avoid contact. Employees should be notified by a physician that this chemical may affect the reproductive system. In addition to comprehensive initial medical and work histories emphasizing reproductive experience and menstrual history, patient should have physical examination and testing of genitourinary tract, sperm count, motility, and morphology. If required, other tests, such as serum testosterone, serum FSH, and serum LH may be indicated.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. *Note to Physician*: Gastric lavage or catharsis may be useful. High urine organic chlorine indicative of exposure, but not severity.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Pesticide respirators may be used to limit exposure. Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in a cool area in closed containers away from oxidizers and dichromates. Always store pesticides in their original containers, complete with labels that list ingredients, directions for use, and first aid steps in case of accidental poisoning. Never store pesticides in cabinets with or near food, animal feed, or medical supplies. Do not store pesticides in places where flooding is possible or in places where they might spill or leak into wells, drains, ground water, or surface water[72]. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2761 Organochlorine pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Use HEPA vacuum; do not use wet method. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Mirex is a noncombustible solid. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. Thermal decomposition products may include hydrogen chloride and oxides of carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: High-temperature incineration is recommended. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(109); (102); (31); (173); (101); (138); (203); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 1, No. 2, 48 (1980) and 7, No. 5, 88–91 (1987).

New York State Department of Health, *Chemical Fact Sheet*: *Mirex*, Bureau of Toxic Substance Assessment, Albany, NY (March 1986).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: *Mirex*, Trenton, NJ (July 1999).

Mitomycin C M:1400

Formula: $C_{15}H_{18}N_4O_5$

Synonyms: Ametycin; 7-Amino-9-α-methoxymitosane; 7-Amino-9-α-methoxymitosane; Azirino (2′,3′: 3,4) pyrrolo (1,2-a) indole-4,7-dione, 6-amino-8-([(aminocarbonyl) oxy] methyl)-1,1a, 2,8,8a,8b-hexahydro-8-α-methoxy-5-methyl-[1aS-(1a-a, 8b, 8a-a, 8ba)]; MIT-C; MITO-C; Mitocin-C; Mitomycin; Mitomycin-C; Mitomycinum; MMC; Mutamycin; Mytomycin; NCI-C04706; NSC 26980

CAS Registry Number: 50-07-7

HSDB Number: 3239

RTECS Number: CN0700000

DOT ID and ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154; UN3249 (medicine, solid, toxic, n.o.s)/151

EC Number: 200-008-6

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Sufficient Evidence; Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B, 1987; NCI: Carcinogenesis Studies (ipr); clear evidence: rat; no evidence: mouse, 1975.

California Proposition 65 Chemical[102]: Cancer 4/1/1988.

Hazard Alert: Poison, Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Drug.

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U010

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg)

Hazard symbols, risk, & safety statements: Hazard symbol: T+, Xn; risk phrases: R45; R22; R25; R26/27/28; R33; R40; R50/53; R62; R63; safety phrases: S22; S28; S36/37/39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Mitomycin is a blue-violet crystalline solid. Molecular weight = 334.37; boiling point = 534°C; freezing/melting point = > 360°C; vapor pressure = 1×10^{-5} mmHg @ 25°C. Soluble in water.

Potential Exposure: This compound is an antitumor antibiotic complex. This drug is usually injected intravenously.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, heat, strong light, calcium salts

Permissible Exposure Limits in Air

PAC Ver. 27, no values found in Ver. 29[138]

PAC-1: 2.1 milligram per cubic meter

PAC-2: 23 milligram per cubic meter

PAC-3: 23 milligram per cubic meter

Routes of Entry: Inhalation. It is not known if this chemical penetrates the unbroken skin.

Harmful Effects and Symptoms

Short-Term Exposure: Contact may irritate and damage the eyes. Toxic doses as low as 750 mg/kg have been reported in humans. The major toxic effect is myelosuppression, characterized by marked leukopenia and thrombocytopenia; this may be delayed and cumulative. Interstitial pneumonia and glomerular damage resulting in kidney failure are unusual but well documented complications. Administration of mitomycin has been recognized as, causing pneumonitis, alveolitis and pulmonary fibrosis. Administration of mitomycin can cause kidney damage. Kidney toxicity was observed in 1%–5% of patients. Depressed immune conditions were noted also. Headaches; blurred vision; confusion, drowsiness, fatigue, diarrhea, and pain have been occasionally noted as symptoms of mitomycin exposure. These do not appear to be dose related by intravenous administration. Fever and anorexia occur in 15% of patients. Hair loss, sloughing of skin; and loss of feeling occur in approximately 4% of patients. Labored breathing; cough and pneumonia occur in some cases. Renal toxicity is sometimes observed.

Long-Term Exposure: Causes mutations. Causes cancer in animals. There is limited evidence that Mitomycin C is a teratogen in animals. Can damage the bone marrow and cause kidney damage.

Points of Attack: Blood, Lungs, kidneys.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure. Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: CBC and platelet count. Kidney function tests.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Based on potential carcinogenicity the following is recommended by NIOSH: *At any detectable concentration*: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full-facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from heat (temperatures over 40°C). If you are required to work in a "sterile" environment you require special training. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN3249 Medicine, solid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft (NJ). Isolation Distance, Fire: 800 m/0.5 mi.[70] Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform to EPA regulations governing storage, transportation, treatment, and waste disposal. It is inappropriate and possibly dangerous to the environment to dispose of expired or waste drugs and pharmaceuticals by flushing them down the toilet or discarding them to the trash. Household quantities of expired or waste pharmaceuticals may be mixed with wet cat litter or coffee grounds, double-bagged in plastic, discard in trash. Larger quantities shall carefully take into consideration applicable DEA, EPA, and FDA regulations. If possible return the pharmaceutical to the manufacturer for proper disposal being careful to properly label and securely package the material. Alternatively, the waste pharmaceutical shall be labeled, securely packaged, and transported by a state licensed medical waste contractor to dispose by burial in a licensed hazardous or toxic waste landfill or incinerator.

References
(102); (31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Mitomycin C, Washington, DC, Chemical Emergency Preparedness Program (Nov. 30, 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Mitomycin C, Trenton, NJ (June 2000).

Molybdenum M:1410

Formula: Mo

Synonyms: Elemental molybdenum; Molybdate; Molybdenum metal

CAS Registry Number: 7439-98-7

HSDB Number: 5032

RTECS Number: QA4680000 (elemental)

UN/NA & ERG Number: UN3089 (powder)/170

EC Number: 231-107-2

Regulatory Authority and Advisory Information

Hazard Alert: Highly flammable solid (powder/dust), Strong reducing agent, Suspected reprotoxic hazard, Suspected of causing genetic defects.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard Symbol (powder): T, F+, Xi, Xn; risk phrases: R12; R36/38; R51/53; R48/20; R62; R63; R65; R67; safety phrases: S9; S16; S21; S26; S36/37/39; S61; S62 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): Nonhazard to water if particle size is >1 mm.

Description: Molybdenum is a silvery-white metal or dark gray or black powder with a metallic luster. Molecular weight = 95.94; specific gravity (H_2O:1) = 10.2; boiling point = 4639°C; freezing/melting point = 2623°C. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 4, reactivity 0. Molybdenite is the only important commercial source. This ore is often associated with copper ore. Molybdenum is insoluble in water and soluble in hot concentrated nitric and sulfuric acid.

Potential Exposure: Most of the molybdenum produced is used in alloys: steel, stainless steel; tool steel; case iron; steel mill rolls; manganese, nickel, chromium, and tungsten. The metal is used in electronic parts (contacts, spark plugs, X-ray tubes, filaments, screens, and grids for radios); induction heating elements; electrodes for glass melting; and metal spraying applications. Molybdenum compounds are utilized as lubricants; as pigments for printing inks; lacquers, paints, for coloring rubber animal fibers, leather, and as a mordant; as catalysts for hydrogenation cracking; alkylation, and reforming in the petroleum industry; in Fischer−Tropsch synthesis; in ammonia production; and in various oxidation-reduction and organic cracking reactions; as a coating for quartz glass; in vitreous enamels to increase adherence to steel; in fertilizers, particularly for legumes; in electroplating to form protective coatings; and in the production of tungsten. Hazardous exposures may occur during high-temperature treatment in the fabrication and production of molybdenum products, spraying applications; or through loss of catalyst. MoO_3 sublimes above 800°C.

Incompatibilities: Metallic Mo is a combustible solid in form of dust or powder and is potentially explosive. Dust or powder may form explosive mixture with air. *Soluble compounds*: alkali metals; sodium, potassium, molten magnesium. *Insoluble compounds*: Violent reaction with oxidizers, nitric acid; sulfuric acid. Forms explosive mixture with potassium nitrate. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

Mo, metal and insoluble compounds

NIOSH IDLH = 5000 mg[Mo]/m^3

OSHA PEL: 15 mg[Mo]/m^3 total dust TWA [*Note*: The PEL also applies to other insoluble molybdenum compounds (as Mo).]

NIOSH: See Appendix D of the *NIOSH Pocket Guide*.

ACGIH TLV[1]: 10 mg[Mo]/m^3 inhalable fraction; 3 mg [Mo]/m^3 respirable fraction. PAC Ver. 29[138]

elemental

PAC-1: 30 milligram per cubic meter

PAC-2: 330 milligram per cubic meter

PAC-3: 2000 milligram per cubic meter

Mo, soluble compounds

NIOSH IDLH = 1000 mg[Mo]/m^3

OSHA PEL: 5 mg[Mo]/m^3 TWA

NIOSH: See Appendix D of the *NIOSH Pocket Guide*.

ACGIH TLV[1]: 0.5 mg[Mo]/m^3 respirable fraction TWA confirmed animal carcinogen with unknown relevance to humans.

DFG MAK: No numerical value established. Data may be available; testing for carcinogenic effects.

Russia[43] established a MAC of 2 milligram per cubic meter for *soluble compounds, aerosol condensates*; 4 milligram per cubic meter for *soluble compounds as dusts*; MAC of 6 milligram per cubic meter for *insoluble compounds*. Several states have set guidelines or standards for molybdenum in ambient air[60] ranging from 100−200 μ/m^3 (Connecticut) to 119 μ/m^3 (Nevada) to 160 μ/m^3 (Virginia).

Determination in Air: Use NIOSH Analytical Method #7300, Elements by ICP (Nitric/perchloric acid ashing); #7301, Elements by ICP (Aqua regia ashing); #7303, Elements by ICP [Hot Block (HCl/HNO_3 Digestion)]; #9102, Elements on wipes; #8310, Metals in urine, #8005, Elements in blood or tissue; OSHA Analytical Methods ID-121 and ID-125G.

Permissible Concentration in Water: Russia[43] has established a molybdenum limit of 0.5 mg/L in bodies used for domestic purposes. EPA[32] has suggested a permissible ambient goal of 70 μg/L based on health effects.

Determination in Water: With atomic-absorption spectrophotometry, a detection limit of 20 μg/L is attainable by direct aspiration into the flame, necessitating concentration for ordinary determinations. When the graphite furnace is used to increase sample atomization the detection limit is lowered to 0.5 μg/L or. Neutron activation may be used at even lower detection limits, according to United States Environmental Protection Agency.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Contact irritates the skin and eyes. Inhalation can irritate the respiratory tract causing coughing and wheezing.

Long-Term Exposure: Can cause headache, fatigue, loss of appetite; muscle and joint pain. Uric acid levels may be elevated which can lead to gout. May damage the liver and kidneys. May cause low blood count (anemia). In animals: irritation of eyes, nose, throat; anorexia, diarrhea, weight loss; listlessness; liver, kidney damage. Soluble compounds e.g., sodium molybdate) and freshly generated molybdenum fumes, are considerably more toxic. Inhalation of high concentrations of molybdenum trioxide dust is very irritating to animals and has caused weight loss; diarrhea, loss of muscular coordination; and a high mortality rate. Molybdenum trioxide dust is more toxic than the fumes. Large oral doses of ammonium molybdate in rabbits caused some fetal deformities.

Points of Attack: *Soluble compounds*: Eyes, respiratory system; kidneys, blood. *Insoluble compounds*: Eyes, respiratory system; liver, kidneys.

Medical Surveillance: NIOSH lists the following tests for molybdenum and compounds: whole blood (chemical/metabolite); biologic tissue/biopsy; urine (chemical/metabolite). Preemployment and periodic physical examinations should evaluate any irritant effects to the eyes or respiratory tract and the general health of the worker. Liver and kidney function tests. CBC. Uric acid level. Molybdenum is considered to be an essential trace element in many species, including humans. However, excessive intake of molybdenum may produce signs of copper deficiency. The normal intake of copper in the diet may be sufficient to combat or prevent systemic toxic effects due to molybdenum poisoning.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear eye protection (chemical goggles and face shield unless full facepiece respiratory protection is worn). Employees should wash immediately with soap when skin is wet or contaminated.

Respirator Selection: *For Insoluble Compounds*: OSHA *Up to 75 milligram per cubic meter*: Qm (APF = 25) (any quarter-mask respirator).+ *Up to 150 milligram per cubic meter*: Any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100; or Sa (APF = 10) (any supplied-air respirator). *Up to 375 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25) (any PAPR with a high-efficiency particulate filter).+ *Up to 750 milligram per cubic meter*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTHie (APF = 50) (any PAPR with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 5000 milligram per cubic meter*: Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp: ASCBA (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).+ If not present as a fume. *For Soluble Compounds*: *25 milligram per cubic meter*: Qm (APF = 25) (any quarter-mask respirator).* *50 milligram per cubic meter*: Any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100;* or Sa (APF = 10) (any supplied-air respirator).* *125 milligram per cubic meter*: Sa: Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode);* or PAPRDM, if not present as a fume (any PAPR with a dust and mist filter).* *250 milligram per cubic meter*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTHie (APF = 50) (any PAPR with a tight-fitting facepiece and a high-efficiency particulate filter);* or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *1000 milligram per cubic meter*: SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA). *Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Powder. Color code—Red Stripe: Flammability Hazard: Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Store flammable solids up to maximum allowable quantity per control area in an approved flammable storage area. Do not store in a basement. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Molybdenum must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from bromine, trifluoride; fluorine, chlorine trifluoride and lead dioxide.

Shipping: UN3089 Metal powders, flammable, n.o.s., Hazard Class: 4.1; Labels: 4.1-Flammable solid.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during clean-up. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of metal. Dust or powdered molybdenum may cause a dust explosion. Use dry chemicals appropriate for extinguishing metal fires, such as dry sand, dolomite or graphite. *Do not use water*. For large fires use extinguishing agents suitable for surrounding fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Recovery is indicated whenever possible. Processes for recovery of Molybdenum from scrap, flue dusts, spent catalysts and other industrial wastes have been developed.

References

(31); (101); (138); (2); (100).

United States Environmental Protection Agency, Molybdenum: A Toxicological Appraisal, Report EPA-600/1-75-004, Research Triangle Park, NC Health Effects Research Laboratory (Nov. 1975).

(173); (101); (138).

United States Environmental Protection Agency, Toxicology of Metals, Vol. II: Molybdenum, Report EPA-600/1-77-022, Research Triangle Park, NC, pp 345−357 (May 1977).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Molybdenum, Trenton, NJ (November 1999).

Molybdenum Trioxide M:1420

Formula: MoO_3

Synonyms: MO 1202T; Molybdena; Molybdenum oxide; Molybdenum(VI) oxide; Molybdenum oxide (MoO_3); Molybdenum(VI) oxide; Molybdenum(VI) trioxide; Molybdic acid anhydride; Molybdic anhydride; Trioxido de molibdeno (Spanish)

CAS Registry Number: 1313-27-5

HSDB Number: 1661

RTECS Number: QA4725000

DOT ID and ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 215-204-7 [*Annex I Index No.*: 042-001-00-9]

Regulatory Authority and Advisory Information
Carcinogenicity: ACGIH: A3, Confirmed animal carcinogen with unknown relevance to humans, as molybdenum, soluble compounds.[195]

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Safe Drinking Water Act (47FR 9352): Priority List (55 FR 1470) as molybdenum

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xi, Xn; risk phrases: R40; R36/37; R40; R41; safety phrases: S2; S22; S25; S26; S36/37; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Molybdenum trioxide is an odorless, white crystalline powder that turns yellow when heated. Molecular weight = 143.94; specific gravity (H_2O:1) = 4.9 @ 20°C; boiling point = 1155; freezing/melting point = 795°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 0, reactivity 0. Slightly soluble in water.

Potential Exposure: Molybdenum trioxide is used in agriculture; manufacture of metallic molybdenum, ceramic glazes; enamels, pigments, and in analytical chemistry.

Incompatibilities: Explodes on contact with molten magnesium. Violent reaction with strong oxidizers, such as chlorine trifluoride; bromine pentafluoride. Not compatible with strong acids; active metals (sodium, potassium, lithium).

Permissible Exposure Limits in Air
NIOSH IDLH = 1000 mg[Mo]/m^3
OSHA PEL: 5 mg[Mo]/m^3 TWA *soluble compounds*
NIOSH: See Appendix D of the *NIOSH Pocket Guide*.
ACGIH TLV[1]: 0.5 mg[Mo]/m^3 TWA *soluble compounds*, confirmed animal carcinogen with unknown relevance to humans.
PAC Ver. 29[138]
PAC-1: 2.3 milligram per cubic meter
PAC-2: 43 milligram per cubic meter
PAC-3: 260 milligram per cubic meter
DFG MAK: Carcinogen Category 3B

Determination in Air: Use NIOSH Analytical Method #7300, Elements by ICP (Nitric/perchloric acid ashing); #7301, Elements by ICP (Aqua regia ashing); #7303, Elements by ICP [Hot block (HCl/HNO_3 Digestion)]; #9102, Elements on wipes; #8310, Metals in urine, #8005, Elements in blood or tissue; OSHA Analytical Methods ID-121 and ID-125G.

Permissible Concentration in Water: No specific values set for MoO_3; see this section in the entry on “Molybdenum and Compounds.”

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms
Short-Term Exposure: Irritation of the skin and eyes. Dust or mist can irritate the respiratory tract causing cough and/or tightness in the chest. Can cause anorexia, weight loss; headache, muscle and joint aches; listlessness, hair loss; lack of muscular coordination; diarrhea, liver and kidney damage.

Long-Term Exposure: Can irritate the lungs; bronchitis may develop. May cause anemia. May affect the liver and kidneys.

Points of Attack: Lungs, blood, liver and kidneys.

Medical Surveillance: This soluble Mo chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure. NIOSH lists the following tests for molybdenum and compounds: whole blood (chemical/metabolite); biologic tissue/biopsy; urine (chemical/metabolite). If symptoms develop or overexposure is suspected, the following may be useful: tests for liver and kidney function, CBC; uric acid level; lung function tests.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *For Soluble Compounds*: *25 milligram per cubic meter*: Qm (APF = 25) (any quarter-mask respirator). * *50 milligram per cubic meter*: Any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100; * or Sa (APF = 10) (any supplied-air respirator).* *125 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode);* or PAPRDM, if not present as a fume (any PAPR with a dust and mist filter).* *250 milligram per cubic meter*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTHie (APF = 50) (any PAPR with a tight-fitting facepiece and a high-efficiency particulate filter);* or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *1000 milligram per cubic meter*: SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA). *Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Molybdenum trioxide must be stored to avoid contact with strong acids (such as hydrochloric, sulfuric and nitric); alkalis, sodium, potassium and molten magnesium, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft (NJ). Isolation Distance, Fire: 800 m/0.5 mi.[70] Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during clean-up. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Molybdenum trioxide itself does not burn. Thermal decomposition products may include oxides of metal. Extinguish fire using an agent suitable for type of surrounding fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (2); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 8, No. 3, 73–78 (1988).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Molybdenum Trioxide, Trenton, NJ (July 1999).

Monocrotophos M:1430

Formula: $C_7H_{14}NO_5P$; $(CH_3O)_2P(O)OC(CH_3) = CHCONHCH_3$

Synonyms: Apadrin; Azodrin; Biloborn; Bilobran; C 1414; Ciba 1414; Crisodin; Crisodrin; Crotonamide, 3-hydroxy-*N*-methyl-, dimethylphosphate, (*E*)-; Crotonamide, 3-Hydroxy-*N*-methyl-, dimethylphosphate, *cis*-; 3-(Dimethoxyphosphinyloxy)-*N*-methyl-*cis*-crotonamide; *O*,*O*-Dimethyl-*O*-(2-*N*-methylcarbamoyl-1-methyl)-vinyl-phosphat (German); *O*,*O*-Dimethyl *O*-(2-*N*-methylcarbamoyl-1-methylvinyl) phosphate; (*E*)-Dimethyl 1-methyl-3-(methylamino)-3-*oxo*-1-propenyl phosphate; Dimethyl 1-methyl-2-(methylcarbamoyl)vinyl phosphate, *cis*-; Dimethyl phosphate ester of 3-hydroxy-*N*-methyl-*cis*-crotonamide; Dimethyl phosphate of 3-hydroxy-*N*-methyl-*cis*-crotonamine; ENT 27,129; Glore Phos 36; 3-Hydroxy-*N*-methyl-*cis*-crotonamide dimethyl phosphate; 3-Hydroxy-*N*-methylcrotonamide dimethyl phosphate; *cis*-1-Methyl-2-methyl carbamoyl vinyl phosphate; Monocron; Monocrotofos (Spanish); Monodrin; Nuvacron; Phosphate de dimethyle et de 2-methylcarbamoyl 1-methyl vinyle (French); Phosphoric acid, dimethyl ester, with *cis*-3-hydroxy-*N*-methylcrotonamide; Pillardin; Plantdrin; SD 9129; Shell SD 9129; Susvin; Ulvair

CAS Registry Number: 6923-22-4

HSDB Number: 1591

RTECS Number: TC4375000

UN/NA & ERG Number: (PIH) UN2783 (organophosphorus pesticides, solid, toxic)/152

EC Number: 230-042-7 [*Annex I Index No.*: 015-072-00-9]

Regulatory Authority and Advisory Information

United States Environmental Protection Agency Gene-Tox Program, Positive: In vitro UDS-human fibroblast; *S. cerevisiae-homozygosis*; Negative: *D. melanogaster* sex-linked lethal; TRP reversion; Inconclusive: *B. subtilis* rec assay; *E. coli polA* without S9; Inconclusive: Histidine reversion-Ames test

Hazard Alert: Poison inhalation hazard, Neurotoxin (cumulative), Combustible, Suspected of causing genetic defects, Suspected reprotoxic hazard, Agricultural chemical, Environmental hazard.

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 10/10,000 lb (4.54/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg)

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

United States DOT 49CFR172.101, Inhalation Hazard Chemical as organophosphates

Rotterdam Convention Annex III (Chemicals Subject to the PIC Procedure)[monocrotophos and dustable powder formulations containing a combination of monocrotophos (solid pesticide and soluble liquid formulations of the substance that exceed 600 g active ingredient/L)].

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292].

Hazard symbols, risk, & safety statements: Hazard symbol: T+, N; risk phrases: R24; R26/28; R33; R50/53; R68; safety phrases: S1/2; S29/35; S36/37; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)].

Description: Monocrotophos is a colorless to reddish-brown solid with a mild ester odor. Molecular weight = 223.19; specific gravity (H_2O:1) = 1.3; boiling point = 125°C; freezing/melting point = 53.9°C (pure); 25−30°C (the reddish brown technical product); vapor pressure = 7×10^{-6} mm @ 20°C; flash point = > 93°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 1, reactivity 0. Soluble in water. Commercially available as a water-miscible solution.

Potential Exposure: The liquid form is a severely hazardous pesticide formulation. A potential danger to those involved in the manufacture, formulation, and application of this insecticide.

Incompatibilities: Alkaline pesticides. Attacks black iron, drum steel; stainless steel; brass.

Permissible Exposure Limits in Air

OSHA PEL: None

NIOSH REL: 0.25 milligram per cubic meter TWA

ACGIH TLV[1]: 0.05 milligram per cubic meter TWA, inhalable fraction and vapor [skin], not classifiable as a human carcinogen; BEI_A releases as Acetylcholinesterase inhibiting pesticides.

PAC Ver. 29[138]

PAC-1: 0.15 milligram per cubic meter

PAC-2: 0.63 milligram per cubic meter

PAC-3: 3.5 milligram per cubic meter

Several states have set guidelines or standards for monocrotophos in ambient air[60] ranging from 2.5 μ/m³ (North Dakota) to 40 μ/m³ (Virginia) to 5.0 μ/m³ (Connecticut) to 6.0 μ/m³ (Nevada). Australia: TWA 0.25 milligram per cubic meter, 1993; Belgium: TWA 0.25 milligram per cubic meter, 1993; Denmark: TWA 0.25 milligram per cubic meter, 1999; France: VME 0.25 milligram per cubic meter 1999; Switzerland: MAK-W 0.25 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 0.25 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen.

Determination in Air: OSHA versatile sampler-2; Toluene/Acetone; Gas chromatography/Flame photometric detection for sulfur, nitrogen, or phosphorus; NIOSH Analytical Method (IV) #5600, Organophosphorus Pesticides; OSHA Analytical Method PV-2045, Monocrotophos.

Determination in Water: Fish Tox = 728.00039000 ppb (VERY LOW)

Routes of Entry: Inhalation, ingestion, skin contact.

Harmful Effects and Symptoms

Monocrotophos is a highly toxic. May be fatal if swallowed or inhaled. It is a direct acting; water-soluble cholinesterase inhibitor which appears to be capable of penetration through the skin. It is excreted rapidly and does not accumulate in the body.

Short-Term Exposure: Acute exposure to monocrotophos may result in the following signs and symptoms: pinpoint pupils; blurred vision; headache, dizziness, muscle spasms; and profound weakness. Vomiting, diarrhea, abdominal pain; seizures, and coma may also occur. The heart rate may decrease following oral exposure or increase following dermal exposure. Hypotension (low blood pressure) may occur, although hypertension (high blood pressure) is not uncommon. Chest pain may be noted. Dyspnea (shortness of breath) may lead to respiratory collapse. Giddiness is common. Monocrotophos acts on the nervous system. Extremely toxic; probable oral lethal dose to humans 5−50 mg/kg or between seven drops and 1 teaspoon for a 70-kg (150 lb) person. Repeated inhalation or skin contact with this material may, without symptoms, progressively increase susceptibility to poisoning. Monocrotophos may cause mutations. Handle with extreme caution. In animals: possible teratogenic effects. Human Tox = 0.35000 ppb (EXTRA HIGH).

Long-Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage. May cause personality changes with depression, anxiety, irritability.

Points of Attack: Eyes, respiratory system; central nervous system; cardiovascular system, blood cholinesterase, reproductive system.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider CBC. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Obtain authorization and/or further instructions from the local hospital for administration of an antidote or performance of other invasive procedures.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid, or wear dust-proof goggles and faceshield when working with powders or dust, unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gal or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN2783 Organophosphorus pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling:

Initial isolation and protective action distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.3/0.4
Night 0.8/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 600/200
Then: Protect persons downwind (mi/km)
Day 1.4/2.3
Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Do not touch spilled material. Do not breathe vapors. Stay upwind; keep out of low areas. Remove all ignition sources. Ventilate area of spill or leak. This material is a combustible liquid. For a spill or leak of a combustible liquid, shut off ignition sources; no flares, smoking or flames in hazard area. Stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid or solid. Thermal decomposition products may include oxides of phosphorus, nitrogen and carbon. Like other organophosphorus pesticides, extinguish with dry chemical, carbon dioxide; water spray, fog, or foam. Move container from fire area if you can do so without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Wear positive pressure breathing apparatus and full protective clothing. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Container may explode in heat of fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Small amounts may be hydrolyzed with water[22]. Incineration in a unit with effluent gas scrubbing is recommended for larger amounts. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (80); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: *Monocrotophos*, Washington, DC, Chemical Emergency Preparedness Program (Nov. 30, 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: *Monocrotophos*, Trenton, NJ (November 1999).

Morpholine M:1440

Formula: C_4H_9NO

Synonyms: Diethyleneimide oxide; Diethylene imidoxide; Diethylene oximide; N,N-Dimethylacetamide; Diethylenimide oxide; *p*-Isoxazine, tetrahydro-; 1-Oxa-4-azacyclohexane; 2H-1,4-Oxazine, tetrahydro-; Tetrahydro-1,4-isoxazine; Tetrahydro-1,4-oxazine; Tetrahydro-2H-1,4-oxazine; Tetrahydro-*p*-oxazine

CAS Registry Number: 110-91-8

HSDB Number: 102

RTECS Number: QD6475000

UN/NA & ERG Number: UN2054/132

EC Number: 203-815-1 [*Annex I Index No.*: 613-028-00-9]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human, No Adequate Data; Animal, Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1999. United States Environmental Protection Agency Gene-Tox Program, Positive: Host-mediated assay.

Hazard Alert: Highly flammable, Possible risk of forming tumors, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction).

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: C; risk phrases: R11; R20/21/22; R34; R62; safety phrases: S1/2; S21; S23; S36; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Morpholine is a colorless liquid with a weak ammonia or fish-like odor. The odor threshold is 0.01 ppm. Molecular weight = 87.14; specific gravity (H_2O:1) = 1.007; boiling point = 128.9°C; freezing/melting point = −5°C; vapor pressure = 6 mmHg @ 20°C; flash point = 37°C. Autoignition temperature: 310°C. Explosive limits: LEL = 1.4%; UEL: 11.2%. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 3, reactivity 0. Soluble in water.

Potential Exposure: Morpholine is used as a separating agent for volatile amines; an intermediate for textile lubricants; in the synthesis of rubber accelerators and pharmaceuticals. It is also used as a solvent; as a boiler water additive; and in the formulation of waxes, polishers and cleaners.

Incompatibilities: Strong acids, strong oxidizers; metals, nitro compounds. Corrosive to metals; attacks copper and its compounds.

Permissible Exposure Limits in Air

NIOSH IDLH = 1400 ppm [LEL]

Conversion factor: 1 ppm = 3.56 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL:20 ppm/70 milligram per cubic meter TWA [skin]

NIOSH REL:20 ppm/70 milligram per cubic meter TWA; 30 ppm/105 milligram per cubic meter STEL [skin]

ACGIH TLV[1] 20 ppm/71 milligram per cubic meter TWA [skin]

DFG MAK: 10 ppm/36 milligram per cubic meter TWA; Peak Limitation Category I(2); [skin]; Pregnancy Risk Group D

PAC Ver. 29[138]

PAC-1: 30 ppm

PAC-2: 1300 ppm

PAC-3: 8000 ppm

Australia: TWA 20 ppm (70 milligram per cubic meter); STEL 30 ppm [skin], 1993; Austria: MAK 20 ppm

(70 milligram per cubic meter) [skin], 1999; Belgium: TWA 20 ppm (71 milligram per cubic meter); STEL 30 ppm [skin] 1999; Denmark: TWA 20 ppm (70 milligram per cubic meter) [skin], 1999; Finland: TWA 20 ppm (70 milligram per cubic meter); STEL 30 ppm (105 milligram per cubic meter) [skin], 1999; France: VME 20 ppm (70 milligram per cubic meter), VLE 30 ppm (105 milligram per cubic meter), 1999; Hungary: STEL 10 milligram per cubic meter [skin], 1993; Norway: TWA 20 ppm (70 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 36 milligram per cubic meter [skin], 2003; the Philippines: TWA 20 ppm (70 milligram per cubic meter) [skin], 1993; Poland: MAC (TWA) 70 milligram per cubic meter; MAC (STEL) 100 milligram per cubic meter, 1999; Russia: TWA 0.5 milligram per cubic meter; STEL 1.5 milligram per cubic meter [skin], 1993; Sweden: NGV 20 ppm (70 milligram per cubic meter), KTV 30 ppm (110 milligram per cubic meter) [skin], 1999; Switzerland: MAK-W 20 ppm (70 milligram per cubic meter), KZG-W 40 ppm (140 milligram per cubic meter) [skin], 1999; United Kingdom: TWA 20 ppm (72 milligram per cubic meter); STEL 30 ppm [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Russia set a MAC for ambient air in residential areas of 0.01 milligram per cubic meter (10 μ/m^3) on a once-daily basis. Several states have set guidelines or standards for morpholine in ambient air[60] ranging from 0.7−1.05 milligram per cubic meter (North Dakota) to 1.15 milligram per cubic meter (Virginia) to 1.4 milligram per cubic meter (Connecticut) to 1.6667 milligram per cubic meter (Nevada).

Determination in Air: Use NIOSH (II-3) Method #S-150.

Permissible Concentration in Water: Russia[35,43] set a MAC for water bodies used for domestic purposes of 0.04 mg/L.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = -0.9$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, skin absorption; ingestion, and skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: The substance is corrosive to the eyes, skin, and the respiratory tract. Contact can cause redness, swelling and burns. Exposure can cause corneal (eye) swelling resulting in blurring vision. Inhalation can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: Morpholine may damage the liver and kidneys. Can cause a skin rash.

Points of Attack: Eyes, skin, respiratory system; liver, kidneys.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater) the following are recommended before beginning work and at regular times after that. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin contact: **8 hours**: butyl rubber gloves, suits, boots; 4H and Silver Shield gloves. Also, polyvinyl alcohol, and Viton are among the recommended protective materials. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *550 ppm*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOv (APF = 25) [any PAPR with organic vapor cartridge(s)]. *1000 ppm*: CcrFOv (APF = 50) [any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s)]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister]; or PaprTOv (APF = 50) [any PAPR with a tight-fitting facepiece and organic vapor cartridge(s)]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *1400 ppm*: SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-, mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA). *Note*: Substance causes eye irritation or damage; eye protection needed.

Storage: (1) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location; keep acids away from bases and red, yellow, and blue-coded chemicals. (2) Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Morpholine must be stored to avoid contact with strong acids; such as nitric acid; and strong oxidizers, such as chlorine, chlorine dioxide; bromine, nitrates, and permanganates, since violent reactions occur.

Shipping: UN2054 Morpholine, Hazard class: 8; Labels: 8-Corrosive material, 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Controlled incineration (incinerator equipped with a scrubber or thermal unit to reduce nitrogen oxides emissions)[22].

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Morpholine, Washington, DC (Nov. 16, 1977).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 1, No. 8, 82−84 (1981).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Morpholine, Trenton, NJ (January 2000).

Muscimol M:1450

Formula: $C_4H_6N_2O_2$

Synonyms: Agarin; 5-Aminomethyl-3-hydroxyisoxazole; 5-(Aminomethyl)-3-isoxazolol; 5-(Aminomethyl)-3-(2H)isoxazolone; 5-Hydroxy-5-aminomethylisoxazole; Muscimol

CAS Registry Number: 2763-96-4

HSDB Number: 6036

RTECS Number: NY3325000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 220-430-4

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Combustible.

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P007

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 302, Extremely Hazardous Substances, TPQ = 500/10,000 lb(227/4550 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1000 lb(455 kg).

Hazard symbols, risk, & safety statements: Hazard symbol: T; risk phrases: R28; R50; safety phrases: S46; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Muscimol is a crystalline solid. Molecular weight = 114.12; freezing/melting point = 175°C (decomposes); vapor pressure = 1×10^{-5} mmHg @ 25°C.

Potential Exposure: Formerly used as a sedative and an antiemetic; and for experimental laboratory purposes.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 1.5 milligram per cubic meter

PAC-2: 17 milligram per cubic meter

PAC-3: 100 milligram per cubic meter

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Muscimol is a potent central nervous system depressant. Initially, drowsiness, stupor, or sleep is followed by mild nausea and vomiting. Muscle spasms in extremities, various emotional changes and distorted perceptions of space and time; but only rarely hallucinations. This compound is a natural constituent of amanita mushrooms and is extremely toxic. It is a potent central nervous system depressant, and is believed to be responsible for most of the nervous system effects that result from eating this mushroom. The lowest toxic dose in humans has been reported @ 109 mg/kg.

Long-Term Exposure: Points of attack: central nervous system.

Medical Surveillance: Examination of the nervous system. Examination for brain effects.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers and reducing agents.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft (NJ). Isolation Distance, Fire: 800 m/0.5 mi.[70] Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: It is inappropriate and possibly dangerous to the environment to dispose of expired or waste drugs and pharmaceuticals by flushing them down the toilet or discarding them to the trash. Household quantities of expired or waste pharmaceuticals may be mixed with wet cat litter or coffee grounds, double-bagged in plastic, discard in trash. Larger quantities shall carefully take into consideration applicable DEA, EPA, and FDA regulations. If possible return the pharmaceutical to the manufacturer for proper disposal being careful to properly label and securely package the material. Alternatively, the waste pharmaceutical shall be labeled, securely packaged, and transported by a state licensed medical waste contractor to dispose by burial in a licensed hazardous or toxic waste landfill or incinerator. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform to EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (173); (101); (138); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*" 2, No. 3, 81 (1982).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Muscimol, Washington, DC, Chemical Emergency Preparedness Program (Nov. 30, 1987).

Mustard Gas (Agents H, HD & HT)

M:1460

Formula: $C_4H_8Cl_2S$; $C_4(H_8)C1_2(S)$; $(ClCH_2CH_2)_2S$

Synonyms: Bis(β-chloroethyl) sulfide; Bis(2-chloroethyl) sulfide; 1-Chloro-2-(β-chloroethylthio)ethane; β,β′-Dichlorodiethyl sulfide; 2,2′-Dichlorodiethyl sulfide; Dichloro diethyl sulfide; β,β′-Dichloroethyl sulfide; 2,2′-Dichloroethyl sulfide; Di-2-chloroethyl sulfide; Distilled mustard (HD); Ethane, 1,1′-thiobis-2-chloro-; Gas mostaza (Spanish); H and HD (military designations); Iprit; Kampstoff lost; Lost (German); Pyro (Agent HD); Senfgas; Sesquimustard; S-Lost (German); Sulfide, bis(2-chloroethyl); Sulfur mustard; Sulfur mustard gas; 1,1′-Thiobis (2-chloroethane); Yellow cross gas; Yellow cross liquid; S-Yperite; Yperite *HT*: mixture of BIS(2-chloroethyl) sulfide and BIS[2-(2-chloroethylthio)ethyl]ether; Mustard-T mixture

CAS Registry Number: 505-60-2; 39472-40-7, 68157-62-0; *(alt.)* 69020-37-7; 6392-89-8 (HT); 3563-36-8 (HD); 5819-08-9 (sulfoxide)

HSDB Number: 336

RTECS Number: WQ090000

UN/NA & ERG Number: (PIH) UN2810 (toxic liquid, organic, n.o.s.)/153

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity: *Theft hazard* CUM 100 g. [*505-60-2; 3563-36-8 (HD)*]

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen; IARC: Human Sufficient Evidence; Animal Limited Evidence, *carcinogenic to humans*, Group 1, 1998; HT (Agent T) should be treated as a suspect carcinogen due to its similarity to Mustard Agent HD. United States Environmental Protection Agency Gene-Tox Program, Positive: *D. melanogaster*-whole sex chrom. loss; Positive: *D. melanogaster*-reciprocal translocation; Positive: L5178Y cells In vitro-TK test; N crassa-reversion; Positive: *D. melanogaster* sex-linked lethal; Positive/dose response: TRP reversion; Positive/limited: Carcinogenicity-mouse/rat.

California Proposition 65 Chemical[102]: Cancer 2/27/1987.

Hazard Alert: Poison inhalation hazard: exposure can be lethal, Blister agent/vesicant, Combustible, Explosive, Corrosive, Water reactive; Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction), Environmental hazard.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500 lb (227 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

United States DOT 49CFR172.101, Inhalation Hazard Chemical

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%.

Hazard symbols, risk, & safety statements: Hazard symbol: T + , E, C, N; risk phrases: R33; R36/37/38; R62; R63; safety phrases: S1; S41; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. (all CAS numbers).

Description: Mustard gas, a chlorinated sulfur compound(s), is an oily, yellow to black liquid (clear when pure). It has a sweet, burnt garlic or horseradish-like odor. The odor threshold for HD is 0.0006 milligram per cubic meter. Molecular weight = 159.08; specific gravity (H_2O = 1) = 1.27 @ 20°C; volatility = 610 milligram per cubic meter @ 20°C; 920 milligram per cubic meter @ 25°C; boiling point = (decomposes) 215−217°C; freezing/melting point = 13−14°C; vapor pressure = 0.072 mmHg @ 20°C; 0.11 mmHg @ 25°C; 0.09 mmHg @ 30°C; vapor density (air = 1) = 5.5; flash point (ignited by large explosive charges) = 104°C. Hazard identification (based on NFPA-704 M Rating System): Health 4, flammability 1, reactivity 1₩. Slightly soluble in water (reaction). Hydrolyzed, forming hydrochloric acid and thiodiglycol. Soluble in acetone, $CH_3(C1)$, tetrachloroethane, ethylbenzoate, and ether. Thickened is essentially the same as HD except for viscosity, which uses HD K125 (acryloid copolymer, 5%) as a thickener. K125 is not known to be hazardous except in a finely divided, powder form. The viscosity of HD is between 1000 and 1200 centistokes @ 25°C.

Mustard gas, sulfoxide: Molecular weight: 175.08. HT is a mixture of 60% HD and 40% Agent HT [(bis-(2-chloroethylthio ethyl)ether], a closely related vesicant with a lower freezing point). Agent HT is essentially the same as Agent HD, but HT is more stable. HT is a clear, yellowish, highly viscous liquid. It has a longer duration of effectiveness, and has a lower garlic-like odor similar to HD. Although volatility is low, vapors can reach hazardous levels in warm weather. Specific gravity (Specific gravity (H_2O:1): = 1.2361 @ 25°C; boiling point: 120°C @ 0.02 Torr; 174°C @ 2.0 Torr; freezing/melting point = 9.6−9.9°C; 13−14°C[77]; volatility (mg/L) = 4.1×10^{-4} @ 25°C; Viscosity (centistoke) = 14.7 @ 25°C; vapor pressure = 0.025 mmHg @ 0°C; 0.090 mmHg @ 30°C. Vapor density (air = 1) = 9.08; Flash point = 100°C. Practically insoluble in water; solubility = 0.8 g/L @ 20°C.

Potential Exposure: Mustard gas is used as an alkylating agent. It has also been used as a chemical warfare agent, causing delayed casualties. It is a vesicant and blister agent in chemical warfare (especially during World War I, military designation H or HD). Mustard gas is used as a model compound in biological studies. Mustard gas has been tested as an antineoplastic agent, but its clinical use as a tumor inhibitor has been minimal.

Incompatibilities: Sulfur mustard is stable at ambient temperatures. Reacts with oxidizers (vigorous), strong acids; acid fumes; strong alkalies; oxygen; water, steam, and other forms of moisture. On contact with acid or acid fumes, it emits highly toxic fumes of oxides of sulfur and chlorine. Rapidly corrosive to brass @ 65°C. Will corrode steel at a rate of 0.0001 in/month @ 65°C. HD reacts with water; will hydrolyze; forming HCI and thiodiglycol. When heated to decomposition (between149°C to 177°C), it emits gaseous hydrogen chloride and oxides of sulfur and chlorine. Contact with metals may evolve flammable hydrogen gas.

Persistence of Chemical Agent: HD: Summer: 3 days to 1 week; Winter: May last for weeks.

Permissible Exposure Limits in Air

Odor Threshold (HD) = 0.0006 milligram per cubic meter.
IDLH: 0.7 milligram per cubic meter
STEL: 0.003 milligram per cubic meter
WPL (Worker population limit): 0.0004 milligram per cubic meter
GPL (General population limit): 0.00002 milligram per cubic meter
AEGL (Acute Exposure Guidelines): 0.06 ppm/0.4 milligram per cubic meter (10 minute); 0.001 ppm/0.008 milligram per cubic meter (8 hours)
PAC* Ver. 29[138]
505-60-2
PAC-1: $\mathbf{0.010}_{\mathbf{A}}$ ppm
PAC-2: $\mathbf{0.020}_{\mathbf{A}}$ ppm
PAC-3: $\mathbf{0.32}_{\mathbf{A}}$ ppm
*AEGLs are marked with a subscript "**A**" and correspond to 60-minute values.
DFG MAK: [skin] Carcinogen Category 1 as bis(β-chloroethyl)sulfide
Finland: carcinogen, 1999; France: carcinogen, 1993; Sweden: carcinogen, 1999; Switzerland: carcinogen, 1999; United Kingdom: carcinogen, 2000
5819-08-9, Mustard gas, sulfoxide Ver. 29[138]
PAC-1: 0.52 ppm
PAC-2: 5.7 ppm
PAC-3: 34 ppm

Determination in Air: Available monitoring equipment for agent HD is the M8/M9 Detector paper, Blue bank tube; M256/M256A1 kits; bubbler. Depot Area Air Monitoring System (DAMMS); automated Continuous Air Monitoring System (ACMS); CAM-M1, Hydrogen Flame Photometric Emission Detector (HYFED); and the Minature Chemical Agent Monitor (MINICAM).

Determination in Water: Ecotoxicology: Octanol−water coefficient: Log K_{ow} (estimated) = 2.41. Unlikely to bioaccumulate in marine organisms. Bulk mustard can persist for decades in soil or water. When exposed to sea water, mustard forms a thick outer "crust" over a core of mustard which allows the mustard to be brought to the surface where it can injure unsuspecting fishermen, who may snare plastic lumps of mustard gas in their nets. Mustard and a number of its hydrolysis products are oxidized (air, oxygen, hypochlorite, hydrogen peroxide; nitric acid; potassium permanganate; and chromic acid) to give the less toxic sulfoxide and sulfone analogs. Mustard and its hydrolysis products do not significantly degrade in sunlight and are stable at less than 49°C.

Routes of Entry: Ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Sulfur mustard causes severe, delayed burns to the eyes, skin, and respiratory tract. Sulfur mustard damages cells within minutes of contact; however, the onset of pain and other health effects is delayed until hours after exposure. Large exposures to sulfur mustard may be fatal[92].

Short-Term Exposure: Contact with the liquid or exposure to high vapor concentrations can cause severe burns and permanent eye damage. There is no pain on contact, but hours later redness, swelling and pain occur. Blindness may result. Inhalation can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. In 1−12 hours there may be coughing, swollen eyelids, reddened skin; and severe itching. There may be swelling and destruction of tissue in the respiratory tract and exposed skin. Ingestion may cause nausea and destruction of tissue in the respiratory tract and exposed skin. Ingestion may cause nausea and vomiting. The median lethal dosage is 1500 mg-minute/m^3 for inhalation and 10,000 mg-minute/m^3 for skin absorption (masked personnel). The median incapacitating dosage is 200 mg-minute/m^3 for eye injury and 2000 mg-minute/m^3 for skin absorption (masked personnel). Wet skin absorbs more material than dry skin. May cause death or permanent injury after very short exposure to small quantities. It is a blistering gas and is highly irritating to eyes, skin, and lungs. Pulmonary lesions are often fatal. HD is a vesicant (causing blisters) and alkylating agent producing cytotoxic action on the hematopoietic (blood-forming) tissues which are especially sensitive. The rate of detoxification of HD in the body is very slow and repeated exposures produce a cumulative effect. Median doses of HD in humans are: LD_{50} (skin) = 100 mg/kg; ICt_{50} (skin) = 2000 mg-min/m^3 @ 21−27°C (humid environment); = 1000 mg-min/m^3 @ 32°C (dry environment); ICt_{50} (eyes) = 200 mg-min/m^3; ICt_{50} (inhalation) = 1500 mg-min/m^3 (Ct unchanged with time) LD_{50} (oral-rat) = 0.7 mg/kg. Maximum safe Ct for skin and eyes are 5 and 2 mg-min/m^3, respectively.

Acute physiological action, local: HD affects both the eyes and the skin. *Skin* damage occurs after percutaneous resorption. Being lipid soluble, HD can be reabsorbed into all organs. Skin penetration is rapid without skin irritation. Swelling (blisters) and reddening (erythema) of the skin occurs after a latency period of 4−24 hours following the exposure, depending on degree of exposure and individual sensitivity. The skin healing process is very slow. Tender skin, mucous membrane and perspiration covered skin are more sensitive to the effects of HD. HD's effect on the skin, however, is less than on the eyes. Local action on the eyes produces severe necrotic damage and loss of eyesight. Exposure of eyes to HD vapor or aerosol produces lacrimation, photophobia; and inflammation of the conjunctiva and cornea.

Acute physiological action, systemic: occur primarily through inhalation and ingestion. The HD vapor or aerosol is less toxic to the skin or eyes than the liquid form. When inhaled, the upper respiratory tract (nose, throat, trachea) is inflamed after a few hours latency period, accompanied by sneezing, coughing, and bronchitis, loss of appetite; diarrhea, fever, and apathy. Exposure to nearly lethal dose of HD can produce injury to bone marrow; lymph nodes; and spleen, as indicated by a drop in WBC count and, therefore, results in increased susceptibilty to local and systemic infections. Ingestion of HD will produce severe stomach pains, vomiting, and bloody stools after a 15−20-minute latency period.

Long-Term Exposure: HD can cause sensitization, chronic bronchitis and lung impairment, (cough, shortness of breath; chest pain); and cancer of the mouth, throat, respiratory tract, skin, and leukemia. It may also cause birth defects. Mustard gas is a carcinogen.

Points of Attack: Lungs, eyes.

Medical Surveillance. This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure. Lung function tests. Examination of the eyes, including slit lamp. Consider chest X-ray following acute overexposure.

First Aid: There is no antidote for sulfur mustard toxicity. If this chemical gets into the eyes instantly flush with water. A delay of seconds can cause permanent damage. *Inhalation*: Remove from the source *immediately*. If breathing has stopped, give artificial respiration. If breathing is difficult, administer oxygen. *Seek medical attention immediately*. *Eye contact*: Speed in decontaminating the eyes is absolutely essential. Remove person from the liquid source, flush the eyes immediately with water by tilting the head to the side, pulling the eyelids apart with the fingers and pouring water slowly into the eyes. Do not cover eyes with bandages but, if necessary, protect eyes by means of dark or opaque goggles. *Transfer the patient to a medical facility immediately. Ingestion*: Do not induce vomiting. Give victim milk to drink. Seek medical attention immediately. *Skin contact*: Don respiratory protective mask and gloves; remove victim from agent source immediately. Flush skin and clothes with solution of sodium hypochlorite or liquid household bleach (see decontamination procedure below) within one minute. Cut and remove contaminated clothing, flush contaminated skin area again with sodium hypochlorite solution, then wash contaminated skin area with soap and water. If shower facilities are available, wash thoroughly and transfer to medical facility. If the skin becomes contaminated with a thickened agent, blot/wipe the material off immediately with an absorbent pad/paper towel prior to using decontaminating solution.

Decontamination: This is very important, and you have to decontaminate as soon as you can. Extra minutes before decontamination might make a big difference. If you don't have the equipment and training don't enter the hot zone to rescue and decontaminate victims. If the victim can't move, decontaminate without touching and without entering the hot zone. Use clean water from any source; if possible, use a hose (spray or fog to prevent injury to the victim) or other system so that you won't have to touch the victim; don't even wait for soap or for the victim to remove clothing, begin washing immediately. Immediately flush the eyes with water for at least 15 minutes. Wash−strip−wash−evacuate up wind and uphill: The approach is to immediately wash with water, then have the victim (not the first responder) remove all the victim's clothing, then wash again (with soap if available); and then move away from the hot zone in an upwind and uphill direction. Wash the victim with warm water and soap. Decontaminate with diluted household bleach (10%, or one part bleach to nine parts water), but don't let any get in the victim's eyes, open wounds, or mouth. Wash off the diluted bleach solution after 15 minutes. Be sure you've decontaminated the victims as much as you can before they leave the area so that they don't spread the agent. Use 5% solution of common bleach (sodium hypochlorite) or calcium hypochlorite solution (48 oz per 5 gal of water) to decontaminate scissors used in clothing removal, clothes and other items.

Personal Protective Methods:

General information: first responders should use a NIOSH-certified CBRN SCBA with a level a protective suit when entering an area with an unknown contaminant or when entering an area where the concentration of the contaminant is unknown. Level a protection should be used until monitoring results confirm the contaminant and the concentration of the contaminant. *Note*: safe use of protective clothing and equipment requires specific skills developed through training and experience.

LEVEL A: (*RED ZONE*): select when the greatest level of skin, respiratory, and eye protection is required. This is the maximum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than the AEGL-2. A NIOSH-certified CBRN full- facepiece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle. A TECP suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, and a hard hat worn under the TECP suit are optional items.

LEVEL B: (RED ZONE): Select when the highest level of respiratory protection is necessary but a lesser level of skin protection is required. This is the minimum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than AEGL-2. It differs from Level A in that it incorporates a nonencapsulating, splash-protective, chemical-resistant splash suit that provides Level A protection against liquids but is not airtight.

A NIOSH-certified CBRN full-facepiece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL C: (YELLOW ZONE): Select when the contaminant and concentration of the contaminant are known and the respiratory protection criteria factors for using APRs or PAPRs are met. This level is appropriate when decontaminating patient/victims. A NIOSH-certified CBRN tight-fitting APR with a canister-type gas mask or CBRN PAPR for air levels greater than AEGL-2. A NIOSH-certified CBRN PAPR with a loose-fitting facepiece, hood, or helmet and a filter or a combination organic vapor, acid gas, and particulate cartridge/filter combination or a continuous flow respirator for air levels greater than AEGL-1. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Escape mask, face shield, coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL D: (GREEN ZONE): Select when the contaminant and concentration of the contaminant are known and the concentration is below the appropriate occupational exposure limit or less than AEGL-1 for the stated duration times. Limited to coveralls or other work clothes, boots, and gloves.

Notes: Take all necessary precautions to prevent any reasonable probability of skin or eye contact. Protective gloves, mandatory: Butyl, toxicological agent, protective gloves (M3, M4, glove set). As a minimum, chemical goggles will be worn. For splash hazards use goggles and face-shield. Full protective clothing will consist of the M3 butyl rubber suit with hood, M2A1 butyl boots; M3 gloves; impregnated underwear; M9 series mask and coveralls (if desired); or the Demilitarization Protective Ensemble (DPE). For general lab work, gloves and lab coat shall be worn with M9 or M17 mask readily available. In addition, when handling contaminated lab animals, a daily clean smock, foot covers; and head covers are required. *Ventilation*: Local Exhaust: Mandatory. Must be filtered or scrubbed. *Special*: Chemical laboratory hoods shall have an average inward face velocity of 100 linear feet per minute (lfpm) plus or minus 10% with the velocity at any point not deviating from the average face velocity by more than 20%. Laboratory hoods shall be located so that cross-drafts do not exceed 20% of the inward face velocity. A visual performance test utilizing smoke-producing devices shall be performed in assessing the ability of the hood to contain agent HD. Other: recirculation of exhaust air from agent areas is prohibited. No connection between agent areas and other areas through ventilation system is permitted. Emergency backup power is necessary. Hoods should be tested semi-annually or after modification or maintenance operations. Operations should be performed with 20 cm inside hoods.

Swatch Test Results for Level A Suits and Chemical Protective Gloves for HD (Mustard gas)

Item	*Breakthrough*
25-mil chemical protective gloves	360 min
Kappler Suit Model 42483	150 min
TYCHEM 10,000 Pkg Style No. 12645	330 min
Trellchem HPS suit	>480 min
Ready 1 Limited Use Suit: Model 91	125 min
First Team XE HazMat suit	385 min
Commander Ultrapro Suit, Style 79102	280 min
Kappler Suit Model 50660	435 min.
TYCHEM Style No. 11645	>480 min
Trellchem TLU suit	>480 min
Chemturion Suit: Model 13	110 min
Chempruf II BETEX Suit	125 min
Commander Brigade: F91	>480 min

Respirator Selection: *When used as a weapon, use SCBA Respirator Certified by NIOSH for CBRN Environments. Do not use chemical cartridge or canister respirators. Less than or equal to 0.003*: Protective mask not required provided that: as an 8-hour TWA (a) Continuous real-time monitoring (with alarm capability is conducted in the work area at the 0.003-milligram per cubic meter level of detection. (b) M9, M17 or M40 mask is available and donned if ceiling concentrations exceed 0.003 milligram per cubic meter. (c) Exposure has been limited to the extent practicable by engineering controls (remote operations, ventilation, and process isolation) or work practices. *If these conditions are not met then the following applies*: full facepiece chemical canister, APRs. (The M9, M17 or M40 series or other certified equivalent masks are acceptable for this purpose in conjunction with the M3 toxicological agent protective (TAP) suit for dermal protection.); *Greater than 0.003 as an 8 hours TWA*: The Demilitarization Protective Ensemble (DPE), 30 mil, may be used with prior approval from the AMC Field Safety Activity. Use time for the 30-mil DPE must be restricted to two hours or less. *Note*: When 30 mil DPE is not available, the M9 or M40 series mask with Level A protective ensemble including impregnated innerwear can be used. However, use time shall be restricted to the extent operationally feasible, and may not exceed 1 hour. As an additional precaution, the cuffs of the sleeves and the legs of the M3 suit shall be taped to the gloves and boots respectively, to reduce aspiration.

At any detectable concentration: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full- facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Stable at ambient temperatures. Thermal decomposition temperature is 149−177°C. Mustard is a persistent agent depending on pH and moisture, and has been known to remain active for Up to three years in soil. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. During handling, the "buddy" (two-man) system will be used. Containers should be periodically inspected for leaks either visually or using a detector kit, and prior to transferring the containers from storage to work areas. Stringent control over all personnel handling HD must be exercised. Chemical showers, eyewash stations; and personal cleanliness facilities must be provided. Each worker will wash their hands before meals and shower thoroughly with special attention given to hair, face, neck, and hands; using plenty of soap before leaving at the end of the work-day. No smoking, eating, or drinking is permitted at the work site. Decontaminating equipment shall be conveniently located. Exits must be designed to permit rapid evacuation. HD should be stored in containers made of glass for Research, Development, Test and Evaluation (RDTE) quantities or one-ton steel containers for large quantities. Agent shall be double-contained in liquid-tight containers when in storage.

Shipping: UN2810 Toxic liquids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling:

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 0.7/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 1000/300
Then: Protect persons downwind (mi/km)
Day 1.1/1.8
Night 2.8/4.5

H, HD, when used as a weapon

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 300/90
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 0.3/0.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. To clean up a spill, cover with Up to 15% calcium hypochloride. Place in container; neutralize after 12 hours if necessary. Keep sparks, flames, and other sources of ignition away. Keep material out of water sources and sewers. Attempt to stop leak if it is without hazard. Use water spray to knock down vapors. Avoid breathing vapors and bodily contact with the material. Keep upwind. Wash away any material which may have contacted the body with copious amounts of soap and water. Downwind evacuation must be considered. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

If spills or leaks of THD (Thickened HD) occur, follow the same procedures as those for HD, but dissolve the THD in acetone prior to introducing any decontaminating solution. Containment of THD is generally not necessary. Spilled THD can be carefully scraped off the contaminated surface and placed in a fully removable head drum with a high density, polyethylene lining. The THD can then be decontaminated, after it has been dissolved in acetone, using the same procedures used for HD. Contaminated surfaces should be treated with acetone, then decontaminated using the same procedures as those used for HD. Handling the THD requires careful observation of the "stringers" (elastic, thread-like attachments) formed when the agents are transferred or dispensed. These stringers must be broken cleanly before moving the contaminating device or dispensing device to another location, or unwanted contamination of a working surface will result.

Recommended field procedures (H, HD): The mustard should be contained using vermiculite, diatomaceous earth, clay, or fine sand, and neutralized as soon as possible using copious amounts of 5.25% sodium hypochlorite solution. Scoop all material and place in an approved DOT container. Cover the contents of the drum with decontaminating solution as above. The exterior of the drum shall be decontaminated and then labeled per IAW, EPA, and DOT regulations. All leaking containers shall be over-packed with vermiculite placed between the interior and exterior containers. Decontaminate and label in accordance with IAW, EPA, and DOT regulations. Dispose of the material used to decontaminate exterior of drum in accordance with IAW, federal, state, and local regulations. Conduct general area monitoring with an approved monitor to confirm that the atmospheric concentrations do not exceed the airborne exposure limit. If 5.25% Sodium Hypochlorite solution is not available then the following decontaminates may be used instead and are listed in the order of preference: Calcium Hypochlorite Decontaminating Solution No. 2 [DS2: (2% NaOH, 70% diethylenetriamine, 28% ethylene glycol monomethyl ether)]; and Super Tropical Bleach Slurry (STB).

Warning: Pure, undiluted calcium hypochlorite (HTH) will burn on contact with liquid blister agent.

Recommended laboratory procedures: A minimum of 65 g of decontamination fluid per gram of HD is allowed to agitate for a minimum of 1 h. Agitation is not necessary following the first hour if a single phase is obtained. At the end of 24 hours, the resulting solution shall be adjusted to a pH between 10 and 11. Test for presence of active chlorine by use of acidic potassium iodide solution to give free iodine color. Place 3 mL of the decontaminate in a test tube. Add several crystals of potassium Iodine and swirl to dissolve. Add 3 mL of 50 wt.% sulfuric acid water and swirl. IMMEDIATE iodine color indicates the presence of active chlorine. If negative, add additional 5.25% sodium hypochlorite solution to the decontamination solution, wait two hours, then test again for active chlorine. Continue procedure until positive chlorine is given by solution. A 10 wt.% calcium hypochlorite (HTH) mixture may be substituted for sodium hypochlorite. Use 65 g of decon/g of HD and continue the test as described for sodium hypochlorite. Scoop up all material and place in approved DOT containers. Cover the contents of the drum with decontaminating solution as above. The exterior of the drum shall be decontaminated and then labeled in accordance with IAW, EPA, and DOT regulations. All leaking containers shall be over-packed with vermiculite placed between the interior and exterior containers. Decontaminate and label in accordance with IAW, EPA, and DOT regulations. Dispose of the material used to decontaminate exterior of drum In accordance with IAW federal, state and local regulations. Conduct general area monitoring with an approved monitor to confirm that the atmospheric concentrations do not exceed the airborne exposure limits. *Note*: Surfaces contaminated with HD and then rinse decontaminated, may evolve sufficient mustard vapor to produce a physiological response.

Recommended field procedures (HT): HT should be contained using vermiculite, diatomaceous earth; clay, or fine sand, and neutralized as soon as possible using copious amounts of alcoholic caustic, carbonate, or Decontaminating Solution No. 2 [DS2: (2% NaOH, 70% diethylenetriamine, 28% ethylene glycol monomethyl ether)]. Caution must be exercised when using these decontaminates since acetylene will be given off. Household bleach can also be used if accompanied by stirring to allow contact. Scoop up all contaminated material and place in approved DOT containers. Cover the contents with additional decontaminant. All leaking containers will be over-packed with vermiculite placed between the interior and exterior containers. Decontaminate the outside of the container and label according to DOT and EPA requirements. Dispose of according to waste procedures below. Dispose of decontaminate according to federal, state, and local laws. Conduct general area monitoring with an approved monitor to confirm that the atmospheric concentrations do not exceed the airborne exposure limit.

Warning: Never use dry High Test Hypochlorite (HTH) or Super Tropical Bleach (STB) since they will react violently with HT and may burst into flames.

Recommended laboratory procedures: A minimum of 65 g of decontamination fluid per gram of HD is allowed to agitate for a minimum of 1 h. Agitation is not necessary following the first hour if a single phase is obtained. At the end of 24 hours, the resulting solution will be adjusted to a pH between 10 and 11. Test for presence of active chlorine by use of acidic potassium iodide solution to give free iodine color. Place 3 mL of the decontaminate in a test tube. Add several crystals of potassium iodine and swirl to dissolve. Add 3 mL of 50 wt.% sulfuric acid: water, and swirl. Immediate iodine color shows the presence of active chlorine. If negative, add additional 5.25% sodium hypochlorite solution to the decontamination solution, wait two hours, then test again for active chlorine. Continue procedure until positive chlorine is given by solution. Scoop up all material and place in approved DOT containers. Cover the contents with additional decontaminate as above. The exterior of the container will be decontaminated and labeled according to EPA and DOT regulations. All leaking containers will be over-packed with vermiculite placed between the interior and exterior containers. Decontaminate and label according to EPA and DOT regulations. Dispose of the material according to waste disposal methods provided below. Dispose of decontaminate according to federal, state and local regulations. Conduct general area monitoring with an approved monitor to confirm that the atmospheric concentrations do not exceed the airborne exposure limits.

A 10 wt.% calcium hypochlorite mixture may be substituted for sodium hypochlorite. Use 65 g decon/g HT and continue the test as described for sodium hypochlorite. *Note*: Surfaces contaminated with HT, then rinse-decontaminated, may evolve sufficient HT vapor to produce a physiological response. HT on laboratory glassware may be oxidized by vigorous reaction with concentrated nitric acid.

Waste disposal method: All neutralized material should be collected, contained and thermally decomposed in EPA approved incinerators that will filter or scrub toxic by-products from effluent air before discharge to the atmosphere. Any contaminated materials or protective clothing should be decontaminated using HTH or bleach, and analyzed to assure it is free of detectable contamination (3X) level. Contaminated clothes and personal belongings should be placed in a sealed double bag and placed inside properly labeled drums and held for shipment back to the DA issue point. *Note*: Several states define decontaminated surety material as a RCRA hazardous waste.

Fire Extinguishing: This chemical may burn but does not easily ignite. HD will hydrolyze, forming HCI and thiodiglycol. Thermal decomposition products may include hydrogen chloride and oxides of sulfur and chlorides. Extinguish with water, foam, dry chemical, or carbon dioxide. Protective clothing and SCBA are required in presence of mustard gas. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Principles and methods for destruction of chemical weapons: “Destruction of chemical weapons” means a process by which chemicals are converted in an essentially irreversible way to a form unsuitable for production of chemical weapons, and which in an irreversible manner renders munitions and other devices unusable as such. Each nation shall determine how it shall destroy chemical weapons, except that the following processes may not be used: dumping in any body of water, land burial or open-pit burning. It shall destroy chemical weapons only at specifically designated and appropriately designed and equipped facilities. Each nation shall ensure that its chemical weapons destruction facilities are constructed and operated in a manner to ensure the destruction of the chemical weapons; and that the destruction process can be verified under the provisions of this Convention [Organization for the Prohibition of Chemical Weapons; Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and Their Destruction]. All decontaminated material should be collected, contained and chemically decontaminated or thermally decomposed in an EPA approved incinerator, which will filter or scrub toxic by-products from effluent air before discharge to the atmosphere. Any contaminated protective clothing should be decontaminated using calcium hypochlorite (HTH) or bleach and analyzed to assure it is free of detectable contamination (3X) level. Contaminated clothes and personal belongings should be placed in a sealed double bag and subsequently placed inside properly labeled drums and held for shipment back to the DA issue point. Decontamination of waste or excess material shall be accomplished in accordance with the procedures outlined above with the following exceptions: (a) HD on laboratory glassware may be oxidized by its vigorous reaction with concentrated nitric acid. (b) Open pit burning or burying of HD or items containing or contaminated with HD in any quantity is prohibited. *Note*: Several states define decontaminated surety material as a RCRA Hazardous Waste.

References

(109); (102); (31); (173); (101); (138); (85); (86); (87); (169); (92); (93); (94); (103); (105); (163); (176); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Mustard Gas, Washington, DC, Chemical Emergency Preparedness Program (Nov. 30, 1987).

USAEHA Technical Guide No. 173, Occupational Health *Guidelines for the Evaluation and Control of Occupational Exposure to Mustard Agents H, HD and HT.*

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Mustard Gas, Trenton, NJ (March 2006).

Myclobutanil M:1470

Formula: $C_{15}H_{17}ClN_4$

Synonyms: α-Butyl-α-(4-chlorophenyl)-1*H*-1,2,4-triazole-1-propanenitrile; Caswell No. 723K; 2-(4-Chlorophenyl)-2-(1*H*-1,2,4-triazole-1-ylmethyl)hexanenitrile; 2-*p*-Chlorophenyl-2-(1*H*-1,2,4-triazole-1-ylmethyl)hexanenitrile; Eagle; Laredo; Nova; Nu-flow; Rally; RH 3866; Systhane technical; 1*H*-1,2,4-Triazole-1-propnenitrile, α-butyl-α-(4-chlorophenyl)

CAS Number: 88671-89-0

HSDB Number: 6708

RTECS Number: XZ5257000

UN/NA & ERG Number: UN2763 (triazine pesticide, solid, poisonous)/151; UN3077 (environmentally hazardous substances, solid, n.o.s.)/171; UN3082 (environmentally hazardous substances, liquid, n.o.s.)/171

EC Number: 410-400-0

Regulatory Authority and Advisory Information

Carcinogenicity[83]: EPA Group E, Evidence of noncarcinogenicity for human.

California Proposition 65 Chemical[102]: Developmental/Reproductive toxin (male)

Hazard Alert: Poison, Suspected reprotoxic hazard, Environmental hazard.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%

Hazardous to aquatic life or environment, with possible long-lasting effects[293]. Toxic to aquatic life with long-lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: Xi, Xn, N; risk phrases: R22; R36; R51/53; R63; safety phrases: S2; S12/35; S26; S36/37; S41; S46; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: White to pale yellow crystalline solid. Molecular weight = 288.78; specific gravity (H_2O:1) = 1.24; boiling point = 391°C; 465°C; freezing/melting point = 65°C; vapor pressure = 10^{-8} mmHg @ 25°C; vapor pressure = 1.57×10^{-6} mmHg @ 0°C; flash point = 235°C. Soluble in water; solubility = 142 mg/L @ 25°C.

Potential Exposure: Myclobutanil is a nitrile compound and a triazole fungicide. It is widely used to control powdery mildew, rust, sclerotina, spot blight, rot, black rot and similar fungi on a variety of food and nonfood crops. Nitriles can be derived from salts of cyanide, but are usually less toxic.

Incompatibilities: Decomposes on exposure to strong light. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. The triazoles are sensitive to heat, friction, and impact. Sensitivity varies with the type substitution to the triazole ring. Metal chelated and halogen substitution of the triazole ring make for a particularly heat sensitive material. Azido and nitro derivatives have been employed as high explosives. No matter the derivative these materials should be treated as explosives[88]. Nitriles may polymerize in the presence of metals and some metal compounds. They are incompatible with acids; mixing nitriles with strong oxidizing acids can lead to extremely violent reactions. Nitriles are generally incompatible with other oxidizing agents such as peroxides and epoxides. The combination of bases and nitriles can produce hydrogen cyanide. Nitriles are hydrolyzed in both aqueous acid and base to give carboxylic acids (or salts of carboxylic acids). These reactions generate heat. Peroxides convert nitriles to amides. Nitriles can react vigorously with reducing agents. Acetonitrile and propionitrile are soluble in water, but nitriles higher than propionitrile have low aqueous solubility. They are also insoluble in aqueous acids[101].

Permissible Exposure Limits in Air:

NIOSH REL: *Nitriles*: 2 ppm, Ceiling Concentration, not to be exceeded in any 15-minute work period.

Permissible Concentration in Water: Because nitriles do not release cyanide ions, they are generally less toxic.

Determination in Water: Method: USGS-NWQL O-2002-01; Procedure: gas chromatography/mass spectrometry; Matrix: filtered natural-water; Detection Limit: 0.0011 μg/L. Octanol−water coefficient: Log $K_{ow} = \sim 3$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Ingestion, inhalation, dermal and eye contact

Harmful Effects and Symptoms

Short-Term Exposure: Corrosive. Can cause irreversible eye damage. Harmful when inhaled, swallowed, or absorbed through skin. Poisonous if swallowed. Contact may irritate skin and cause eye irritation and possible severe injury. Avoid inhalation. LD_{50} (oral, rat) = 1600 mg/kg; (dermal, rat) ≥ 2 g/kg.

Long-Term Exposure: Evidence of reproductive and developmental effects.

Points of Attack: Eyes, skin. May affect this chemical may damage the male reproductive glands.

Medical Surveillance: Comprehensive physical examination with emphasis on the genitourinary tract analysis to include sperm count, motility and morphology. Other tests, such as serum testosterone, serum FSH, and serum LH may be carried out if, in the opinion of a physician, they are indicated. production of effects on the reproductive system

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear positive pressure SCBA (SCBA). Wear chemical protective clothing that is specifically recommended by the manufacturer. DuPont Tychem Suit Fabrics is recommended by one government source[88]. It may provide little or no thermal protection. Structural firefighters' protective clothing provides limited protection in fire situations ONLY; it is not effective in spill situations where direct contact with the substance is possible.

Respirator Selection: Where the neat (undiluted) test chemical is weighed and diluted, wear a NIOSH-approved half face respirator equipped with a combination filter cartridge, i.e., organic vapor/acid gas/HEPA (specific for organic vapors, HCl, acid gas, SO_2 and a high efficiency particulate filter)[88] wherever and whenever workplace conditions warrant respirator use, a respiratory protection program must be followed that meets one or more of the following government standards: OSHA's 29 CFR 1910.134, ANSI Z88.2, or European Standard EN 149.

Storage: Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN2763 Triazine pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required. UN3082 Environmentally hazardous substances, liquid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required

Spill Handling:

Nitriles spill

Initial isolation and protective action distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.3/0.5
Night 0.5/0.8

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: See "Incompatibilities" section. Thermal decomposition products may include Hydrogen chloride and oxides of nitrogen and carbon. As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 m/150 ft for liquids and at least 25 m/75 ft for solids. *Fire involving storage or vehicular tanks*: Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. *On a small fire*: use dry chemical, CO_2, water spray or regular *foam. On a large fire*: use water spray, fog, or regular foam. Do not scatter spilled material with high pressure streams of water. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal. *Fire involving tanks*: From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. Always stay away from tanks engulfed in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Contact a licensed disposal facility about surplus and nonrecyclable solutions. Burn in a chemical incinerator equipped with an afterburner and scrubber. Extra care must be exercised as the material in an organic solvent is highly flammable. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office. Incineration or permanganate oxidation.

References

(92); (102); (31); (173); (101); (138); (100).

United States Environmental Protection Agency, Office of Pesticide Programs, Pesticide Residue Limits, “Myclobutanil,” 40 CFR 180.443, http://www.epa.gov/pesticides/food/viewtols.htm.

N

Nabam N:0050

Formula: $C_4H_6N_2Na_2S_4$
Synonyms: AMA-30; Campbell's Nabam soil fungicide; Carbon D; Carbamodithioic acid, 1,2-ethanediylbis-, disodium salt; Carbamic acid, ethylenebis (dithio-), disodium salt; Chem-Bam; Disodium ethylenebis(dithiocarbamate); Dithane A-40; Dithane A-46; Dithane D-14; DSE; EBDC, disodium salt; EBDC, Sodium salt; 1,2-Ethanediylbis(carbamodithioic acid), disodium salt; Ethylenebis(dithiocarbamic acid), disodium salt; Nabame; Nabasam; Nafun-IPO; Nalco D-62C44; Parzate; Spring-Bak
CAS Number: 142-59-6
HSDB Number: 1170
RTECS Number: FA6825000
UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171; UN2771(solid)/151
EC Number: 205-547-0 [*Annex I Index No.:* 006-014-00-3]
Regulatory Authority and Advisory Information
California Proposition 65 Chemical[102]: Developmental/ Reproductive toxin (3/30/1999)
Hazard Alert: Poison, Possible thyroid effects, Sensitization hazard (skin), Suspected reprotoxic hazard, Environmental hazard
47FR 47669 (10/27/82); 54 FR 50020 (12/04/89); (55 FR 7935 (03) 06/90) [Environmental Protection]
California Chemical List of Lists (February 1997)
EPA Hazardous Waste Number (RCRA No.): U114
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%
United States DOT Regulated marine pollutant (49CFR172. 101, Appendix B)
Hazardous to aquatic life or environment, with possible long lasting effects[291,292].
Hazard symbols, risk, & safety statements: Hazard symbol: Xi, Xn, N; risk phrases: R22; R37; R43; R50/53; safety phrases: S2; S8; S24/26; S29/35; S41; S46; S60; S61 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]
Description: Colorless crystalline solid (when pure). Light amber crystalline solid or 22% wettable powder solution. Slight odor of sulfide. Molecular weight = 256.34; specific gravity (H_2O:1) = 1.14 @ 20°C; boiling point = (decomposes); freezing/melting point = decomposes before melting @ 196°C; vapor pressure = very low; negligible. Hazard identification (based on NFPA-704 M Rating System): Health hazards (blue): 2; flammability (red): 0; reactivity (yellow): 0. Molecular weight = 256.34; boiling point = decomposes; freezing/melting point = decomposes when heated, without melting; specific gravity: 1.14 @ 20°C (solid). Highly soluble in water; solubility = $>2 \times 10^5$ mg/L.
Potential Exposure: Nabam is a broad spectrum dithiocarbamate fungicide/bactericide/algaecide/herbicide/microbiocide used to prevent crop damage by fungi, to protect harvested products from deterioration, and as an industrial microbiocide. As a result of the United States Environmental Protection Agency review of nabam in 1989, all food uses were voluntarily canceled by the manufacturers except for one FDA-regulated food use on sugar mill grinding, crusher, and/or diffuser systems, e.g., processing water systems. All other uses of nabam are for the control of algae, slime-forming bacteria, and fungi in indoor nonfood environments, paper mills, water cooling systems, drilling mud and packer fluids, and secondary oil recovery water system. Registered in the United States only for nonfood application.
Incompatibilities: Combustible material. Dust may form explosive mixture in air, water, acid, oxidizing materials. Heat or contact with moisture or acids causes rapid decomposition and the generation of toxic and flammable hydrogen sulfide and carbon disulfide. Dithiocarbamate esters are combustible. They react violently with powerful oxidizers such as calcium hypochlorite. Poisonous gases are generated by the thermal decomposition of dithiocarbamate compounds, including carbon disulfide, oxides of sulfur, oxides of nitrogen, hydrogen sulfide, ammonia, and methylamine. Thio and dithiocarbamates slowly decompose in aqueous solution to form carbon disulfide and methylamine or other amines. Such decompositions are accelerated by acids. Flammable gases are generated by the combination of dithiocarbamate with aldehydes, nitrides, and hydrides. Dithiocarbamate are incompatible with acids, peroxides, and acid halides. Corrosive to iron, copper, brass, and zinc metals, especially in the presence of moisture. Heat alkalies (lime), moisture can cause decomposition. Decomposes on prolonged storage; by moisture, light, and heat. Degradation produces ethylene thiourea.
Determination in Water: EPA EMSLC Method 630. The Determination of Dithiocarbamate Pesticides in Municipal and Industrial Wastewater by UV−VIS Spectrophotometry. Octanol−water coefficient: Log K_{ow} = negative; dissociates in water −4.24 (est)[83]. Unlikely to bioaccumulate in marine organisms.
Routes of Entry: Poisoning can occur by inhalation, ingestion, and absorption through the skin.
Harmful Effects and Symptoms
Short-Term Exposure: Low levels of toxicity. Concentrated solutions are slightly corrosive to eyes and mucous membranes. Dust inhalation can cause irritation of the respiratory system with sneezing. Eye contact can cause irritation, watering, pain, and inflammation of the eyelids. Dermal contact can cause irritation and minor ulceration. Ingestion can cause nausea, vomiting, fever, muscle twitching, seizure, rapid

Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens.
DOI: http://dx.doi.org/10.1016/B978-0-323-38968-6.00013-2

respiration, slow heartbeat. Severe exposure may result in death. Unlike carbamates the dithiocarbamates are not cholinesterase inhibitors, but some of them may react with recently ingested alcohol or alcohol-containing products including wine, medications, and cold remedies such as cough syrups. Exposure may cause skin sensitization. LD_{50} (oral, rat) = 395 mg/kg[86]; 1400 mg/kg[83].

Long-Term Exposure: Thyroid effects. Evidence of reproductive and developmental effects. May cause skin sensitization.

Points of Attack: Thyroid function (possible goiter). Respiratory system, central nervous system, cardiovascular system, skin, eyes. Repeated or prolonged contact with skin may result in dermatitis (red inflamed skin).

Medical Surveillance: Comprehensive physical examination with emphasis on the genitourinary tract analysis to include sperm count, motility, and morphology. Other tests, such as serum testosterone, serum follicle stimulating hormone (FSH), and serum luteinizing hormone (LH) may be carried out if, in the opinion of a physician, they are indicated production of effects on the reproductive system. Medical observation is recommended for 24−48 hours following breathing overexposure, as pulmonary edema may be delayed. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. Before employment and at regular times after that, the following are recommended: If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider complete blood count (CBC) and chest X-ray following acute overexposure. Evaluation by a qualified allergist, including exposure history and testing, may help diagnose allergy. Thyroid function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious and able to swallow, have victim drink 4−8 ounces of water. Do not induce vomiting. *Note to physician or authorized medical personnel*: Medical observation is recommended for 24−48 hours following breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic might consider administering a drug or other inhalation therapy. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure.

Personal Protective Methods: Reacts with the following absorbent materials: Cellulose-Based; Mineral- and Clay-Based; Dirt/Earth[88]. Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of dermal and/or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. As first aid for pulmonary edema, a doctor or authorized paramedic might consider administering a drug or other inhalation therapy.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved, SCBA, that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with an N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a tightly closed container in a dry, well-ventilated, and secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Where possible, automatically transfer material from other storage containers to process containers. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard Class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: First remove all sources of ignition. Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen, carbon, and sulfur. Decomposes in boiling hot water, releasing poisonous hydrogen sulfide, and flammable carbon disulfide. As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 m/150 ft. for liquids and at least 25 m/75 ft. for solids. *Fire involving storage or vehicular tanks:* Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. *On a small fire:* use dry chemical, CO_2, water spray or regular *foam. On a large fire:* use water spray, fog, or regular foam. Do not scatter spilled material with high pressure streams of water. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal. *Fire involving tanks:* From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. Always stay away from tanks engulfed in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Do not discharge into drains or sewers. Dispose of waste material as hazardous waste using a licensed disposal contractor to an approved landfill. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. A potential candidate for liquid injection incineration at a temperature range of 650−1600°C and a residence time 0.1−2 seconds. Also, a potential candidate for rotary kiln incineration at a temperature range of 820−1600°C and residence times of seconds for liquids and gases, and hours for solids[83].

References

(102); (31); (173); (101); (138); (204); (100).

United States Environmental Protection Agency, *Reregistration Eligibility Decision (RED), Nabam*, Office of Prevention, Pesticides and Toxic Substances, Washington, DC (January 1996). http://www.epa.gov/REDs/0641.pdf

Naled N:0100

Formula: $C_4H_7Br_2Cl_2O_4P$

Synonyms: AI3-24988; Arthodibrom; Bromchlophos; Bromex; BRP; Dibrom; *O*-(1,2-Dibrom-2,2-dichloraethyl)-*O*,*O*-dimethyl-phosphat (German); 1,2-Dibromo-2,2-dichloroethyl dimethyl phosphate; *O*,*O*-Dimethyl *O*-(1,2-dibromo-2,2-dichloroethyl) phosphate; Dimethyl 1,2-dibromo 2,2-dichlorethyl phosphate; *O*,*O*-Dimethyl *O*-2,2-dichloro-1,2-dibromoethyl phosphate; ENT 24,988; Ethanol, 1,2-dibromo-2,2-dichloro-, dimethyl phosphate; Hibrom; OMS 75; Ortho 4355; Orthodibrom; Orthodibromo; Phosphate de *O,O*-dimethyle et de *O*-(1,2-dibromo-2-dichlorethyle) (French); Phosphoric acid, 1,2-dibromo-2,2-dichloroethyl dimethyl ester

CAS Registry Number: 300-76-5; *(alt.)* 53095-31-1

HSDB Number: 1148

RTECS Number: TB9450000

UN/NA & ERG Number: (PIH) UN2811 (toxic solid, organic, n.o.s.)/154; UN3018 (organophosphorus pesticide, liquid, toxic)/152; UN2783 (organophosphorus pesticides, solid, toxic)/152

EC Number: 206-098-3 [*Annex I Index No.:* 015-055-00-6]

Regulatory Authority and Advisory Information

Hazard Alert: Poison inhalation hazard, Neurotoxin (cumulative), Suspected of causing genetic defects, Primary irritant (w/o allergic reaction), Environmental hazard.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

United States DOT 49CFR172.101, Inhalation Hazard Chemical as organophosphates.

Hazardous to aquatic life or environment, with possible long lasting effects.[291] Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xn, N; risk phrases: R21/22; R25; R33; R36/38; R50; R62; safety phrases: S2; S26; S29; S35; S36/37; S41; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Naled is a white crystalline solid (when pure) or light straw-colored liquid (above 26.7°C) with a slightly pungent insecticide odor. Molecular weight = 380.80; specific gravity (H_2O:1) = 1.96 @ 25°C; boiling point = (decomposes) 110°C; freezing/melting point = 26.7°C; vapor pressure = 2×10^{-4} mm @ 20°C. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 0, reactivity 1. Insoluble in water; slowly hydrolyzed.

Potential Exposure: A potential danger to those involved in the manufacture, formulation, and application of this insecticide, fungicide, bactericide, acaricide. Also used in cooling towers, veterinary medicine, pulp and paper mill systems; hospitals, swimming pools; and bathrooms.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine,

bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Hydrolyzed in presence of water. Degraded by sunlight. Decomposes when heated; on contact with acids, acid fumes; bases, producing fumes of hydrogen chloride, hydrogen bromide, phosphorous oxides. Reacts with acids, strong oxidizers in sunlight. Slowly reacts with water; hydrolysis is; corrosive to metals. Attacks some plastics, rubber and coatings.

Permissible Exposure Limits in Air

NIOSH IDLH = 200 milligram per cubic meter

OSHA PEL: 3 milligram per cubic meter TWA

NIOSH REL: 3 milligram per cubic meter TWA [skin]

ACGIH TLV[1]: 0.1 milligram per cubic meter inhalable fraction and vapor [skin, sensitizer]; not classifiable as a human carcinogen; BEIA issued as Acetylcholinesterase inhibiting pesticides

Protective Action Criteria (PAC) not available

DFG MAK: 1 milligram per cubic meter, measured as the, inhalable fraction TWA; Peak Limitation Category II(2); [skin] danger of skin sensitization; Pregnancy Risk Group C

Australia: TWA 3 milligram per cubic meter [skin], 1993; Austria: MAK 3 milligram per cubic meter, 1999; Belgium: TWA 3 milligram per cubic meter [skin], 1993; Finland: TWA 3 milligram per cubic meter; STEL 6 milligram per cubic meter, 1999; France: VME 3 milligram per cubic meter [skin], 1999; Norway: TWA 3 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 3 milligram per cubic meter, 2003; Thailand: TWA 3 milligram per cubic meter, 1993; United Kingdom: TWA 3 milligram per cubic meter; STEL 6 milligram per cubic meter, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Several states have set guidelines or standards for dibrom in ambient air[60] ranging from 30 μ/m^3 (North Dakota) to 50 μ/m^3 (Virginia) to 60 μ/m^3 (Connecticut) to 71 μ/m^3 (Nevada).

Determination in Air: No method available.

Permissible Concentration in Water: Mexico[35] has set maximum permissible concentration values in coastal waters of 3.0 μg/L and 0.03 mg/L (30 μg/L) in estuaries.

Determination in Water: Fish Tox = 10.17349000 ppb (INTERMEDIATE)

Routes of Entry: Inhalation, skin absorption; ingestion, eye and/or skin contact. Absorbed by the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin, and respiratory tract. May affect the nervous system; causing convulsions, respiratory failure. Organic phosphorus insecticides are absorbed by the skin, as well as by the respiratory and gastrointestinal tracts. They are cholinesterase inhibitors. Symptoms of exposure include headache, giddiness; blurred vision; nervousness, weakness, nausea, cramps, diarrhea, and discomfort in the chest. Signs include sweating, tearing, salivation, vomiting, cyanosis, convulsions, coma, loss of reflexes, and loss of sphincter control. High exposure can result in death. Highly toxic; a probable human lethal dose may be between 1 teaspoon and 1 ounce. Human Tox = 14.00000 ppb (INTERMEDIATE).

Long-Term Exposure: May cause skin allergy. Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system; central nervous system; cardiovascular system, skin, eyes, blood cholinesterase.

Medical Surveillance: NIOSH lists the following tests: cholinesterase: blood plasma, red blood cells/count; cholinesterase: blood serum, red blood cells/count; cholinesterase: red blood cells/count. Before employment and at regular times after that, the above tests are recommended. Cholinesterase level tests for the enzyme poisoned by this chemical. If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of “normal.” Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider CBC. Consider chest X-ray following acute overexposure. Evaluation by a qualified allergist. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Effects may be delayed. Medical observation is recommended. *Note to physician:* 1−4 mg atropine; maintenance: 2-mg doses at intervals of 15−60 minutes.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid, unless full facepiece respiratory protection is worn. Wear dust-proof goggles and face shield when working with powders or dust, unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *30 milligram per cubic meter*: 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *75 milligram per cubic meter:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *150 milligram per cubic meter:* 100F (APF = 50) (any air purifying, full facepiece respirator with an N100, R100, or P100 filter); or SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece). *200 milligram per cubic meter:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. It must be stored to avoid contact with strong oxidizers, such as chlorine and chlorine dioxide, since violent reactions occur. Keep away from acids, acid fumes; sunlight, heat, and water.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN2783 Organophosphorus pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN3018 Organophosphorus pesticides, liquid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling:

Initial isolation and protective action distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424−9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548−8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft./m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.3/0.4
Night 0.8/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft./m) 600/200
Then: Protect persons downwind (mi/km)
Day 1.4/2.3
Night 2.8/4.5

Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is noncombustible. Use agents suitable for surrounding fire. Thermal decomposition products may include hydrogen chloride, hydrogen bromide, and oxides of phosphorus, nitrogen, and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: This pesticide is more stable to hydrolysis than dichlorvos (50% hydrolysis at pH 9 @ 37.5°C in 301 minutes). It is unstable in alkaline conditions, in presence of iron; and is degraded by sunlight. About 10% hydrolysis per day is obtained in ambient water. Incineration is recommended for large amounts[22]. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (100).

United States Environmental Protection Agency, *Investigation of Selected Potential Environmental Contaminants: Haloalkyl Phosphates*, Report EPA 560/2/76-007, Washington, DC (August 1976).

(173); (101); (138).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 5, No. 3, 44−47 (1985).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Dimethyl-1,2-Dibromo-2,2-Dichloroethyl Phosphate, Trenton, NJ (December 1998).

Naphtha(s) N:0110

Synonyms: *coal tar naphtha:* Coal tar naphtha; Crude solvent coal tar naphtha; High solvent naphtha; Naphtha
petroleum naphtha: Aliphatic petroleum naphtha; Petroleum naphtha; Petroleum spirit; rubber solvent
VM&P naphtha: Ligroin; Painters naphtha; Petroleum ether; Petroleum spirit; Refined solvent naphtha; Varnish makers' & painters' naphtha

CAS Registry Number: 8002-05-9 (petroleum distillate; petroleum asphalt); 8030-30-6; *(alt.)* 50813-73-5; *(alt.)* 54847-97-1 (naphtha, low boiling point); 121448-83-7 (coal tar naphtha); 8032-32-4 (ligroin or VM&P naphtha); *(alt.)* 8031-06-9; 64475-85-0 (naphtha, petroleum spirits); 64742-89-8 [Naphtha (petroleum) light aliphatic; rubber solvent]

HSDB Number: 2892

RTECS Number: SE7449000 [petroleum distillates (naphtha)]; DE3030000 (coal tar naphtha); OI6180000 (VM&P naphtha)

UN/NA & ERG Number: UN1136 (coal tar distillate)/128; UN1268 (petroleum distillates, n.o.s. or petroleum products, n.o.s.)/128; UN1300 (Mineral spirits, turpentine substitute)/128; UN1993 (flammable liquids, n.o.s.)/128

EC Number: 232-298-5 [*Annex I Index No.:* 649-049-00-5] (crude solvent coal tar naphtha); 232-443-2 [*Annex I Index No.:* 649-262-00-3] (naphtha, low boiling point); 232-453-7 [*Annex I Index No.:* 649-263-00-9] (ligroin or VM&P naphtha)

Regulatory Authority and Advisory Information

Carcinogenicity: IARC (*8002-05-9*): Human, No Adequate Data; Animal, Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3

Hazard Alert: Highly flammable, [*petroleum distillates (naphtha)*]: Primary irritant (w/o allergic reaction), (*coal tar naphtha*) Agricultural chemical, Possible risk of forming tumors, Primary irritant (w/o allergic reaction), *(VM&P naphtha)* Suspected of causing genetic defects, Primary irritant (w/o allergic reaction).

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. VM&P naphtha.

European/International Regulations *(8002-05-9)*: Hazard symbol: T; Risk phrases: R45; safety phrases: S53; S45; (*8030-30-6; Naptha, low boiling point* and *8032-32-4 ligroin or VM&P naphtha*): Hazard symbol: T, F+; risk phrases: R45; R12; R46; R62; R65; safety phrases: S21; S41; S45; S53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water. (*CAS: 8002-05-9*); 1-Low hazard to water. (*CAS: 8030-30-6; 8032-32-4*)

Description: Naphthas derived from both petroleum and coal tar are included in this group. *Petroleum naphthas* are colorless liquids. Gasoline or kerosene-like odor. A mixture of paraffins (C_5−C_{13}) that may contain a small amount of aromatic hydrocarbons, and are termed "close-cut" fractions. "Medium-range" and "wide-range" fractions are made up of 40−80% aliphatic hydrocarbons; 25−50% naphthenic hydrocarbons; 0−10% benzene, and 0−20% other aromatic hydrocarbons. Molecular weight = (approx.) 98 [petroleum distillates (naphtha)]; specific gravity (H_2O:1) = 0.78−0.97 [petroleum distillates (naphtha)]; boiling point = 35−60°C; freezing/melting point = −73°C; vapor pressure = (approx.) 40 mmHg [petroleum distillates (naphtha)]; flash point = − 40 to −66°C [petroleum distillates (naphtha)]; autoignition temperature = 288°C. Explosive Limits: LEL = 1.1%; U-1EL = 5.9%. Hazard identification (based on NFPA-704 M Rating System): Health 1; flammability 4; reactivity 0. Insoluble in water.

Coal tar naphtha is a mixture of aromatic hydrocarbons, principally toluene, xylene, and cumene. Coal tar naphtha is a reddish-brown, mobile liquid with an aromatic odor. Shipped as a molten solid. Benzene is present in appreciable amounts in those coal tar naphthas with low boiling points. molecular weight = (approx.) 110; specific gravity (H_2O:1) = 0.89−0.97; boiling point = 160−220°C; vapor pressure = <5 mmHg @ 20°C; flash point = 38−43°C. Explosive Limits: LEL = 1.0%; UEL—unknown. Hazard identification (based on NFPA-704 M Rating System): (coal tar) Health 2; flammability 2; reactivity 0. Insoluble in water. *VM&P naphtha* is a clear to yellowish liquid. Pleasant, aromatic odor: molecular weight = 111.73; specific gravity (H_2O:1) = 0.64−0.66; boiling point = 100−177°C; vapor pressure = 2−20 mmHg @ 20°C; flash points = −2 to 29°C; autoignition temperature = 232°C. Explosive limits: vary somewhat but typical values are: LEL = 0.9%; UEL: 6.7%. Hazard identification (based on NFPA-704M Rating System): (VM&P) Health 1; flammability 3; reactivity 0. See also Stoddard Solvent. *Mineral spirits, 64475-85-0*: molecular weight = 97.26. *Naphtha (petroleum) light aliphatic; rubber solvent, 64742-89-8*: molecular weight = 97.26; specific gravity (H_2O:1) = 0.6.

Potential Exposure: Naphthas are used as organic solvents for dissolving or softening rubber, oils, greases, bituminous paints, varnishes, and plastics. The less flammable fractions are used in dry cleaning. The heavy naphthas are used as a vehicle for various pesticides. Coal tar naphthas are used as quick-drying paint solvent; in the manufacture of floor coverings; resin solution; varnish; VM&P naphtha is used as a solvent for lacquers and varnishes and as a rapid-dry paint thinner.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

8002-05-9, naphtha, petroleum distillates

NIOSH IDLH = 1100 ppm [LEL]

Conversion factor: 1 ppm = 4.05 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 500 ppm/2000 milligram per cubic meter TWA

NIOSH REL: 350 milligram per cubic meter TWA; 1800 milligram per cubic meter [15-min] Ceiling Concentration

PAC Ver. 29[138]

PAC-1: 1100 milligram per cubic meter

PAC-2: 1800 milligram per cubic meter

PAC-3: 40,000 milligram per cubic meter

121448-83-7, naphtha, coal tar

NIOSH IDLH = 1000 ppm [LEL]

Conversion factor: 1 ppm = 4.50 milligram per cubic meter (approx)@ 25°C & 1 atm

NIOSH REL: 100 ppm/400 milligram per cubic meter TWA

Australia: TWA 480 milligram per cubic meter, 1993; Denmark: TWA 25 ppm (145 milligram per cubic meter), 1999; Hungary: TWA 300 milligram per cubic meter; STEL 800 milligram per cubic meter, 1993; the Phillipines: TWA 100 ppm (400 milligram per cubic meter), 1993; Poland: MAC (TWA) 300 milligram per cubic meter; MAC (STEL) 900 milligram per cubic meter, 1999; Russia: STEL 100 milligram per cubic meter, 1993; Switzerland: MAK-W 300 milligram per cubic meter (1100 milligram per cubic meter), 1999; Turkey: TWA 100 ppm (400 milligram per cubic meter), 1993

8032-32-4, VM&P naphtha, legroin, paint solvent

OSHA PEL: None

NIOSH REL: 350 milligram per cubic meter TWA; 1800 milligram per cubic meter [15-minutes] Ceiling Concentration

ACGIH withdrawn; confirmed animal carcinogen with unknown relevance to humans.

PAC Ver. 28, no values found in Ver. 29[138]

PAC-1: 1100 ppm

PAC-2: 1800 ppm

PAC-3: 40,000 ppm

Poland: TWA 500 milligram per cubic meter; STEL 1500 milligram per cubic meter, 1999. In addition, several states have set guidelines or standards for naphtha in ambient air[60] ranging from zero (Nevada) to 60–27,000 μ/m^3 (Connecticut) to 225 μ/m^3 (Virginia).

PAC Ver. 28, no values found in Ver. 29[138]

64742-89-8 [naphtha (petroleum) light aliphatic; rubber solvent]

PAC-1: 1200 ppm

PAC-2: 6700 ppm

PAC-3: 40,000 ppm

Determination in Air: Use NIOSH Analytical Method (IV) #1550, Naphthas, OSHA Analytical Method 48.

Routes of Entry: Inhalation of vapor, ingestion; skin and/or eye contact. Percutaneous absorption of liquid is important in development of systemic effects if benzene is present.

Harmful Effects and Symptoms

Short-Term Exposure: The naphthas are irritating to the skin conjunctiva; and the mucous membranes of the upper respiratory tract. Skin "chapping" and photosensitivity may develop after repeated contact with the liquid. If confined against skin by clothing, the naphthas may cause skin burn. Exposure can cause dizziness, lightheadedness, and unconsciousness. Petroleum naphtha has a lower order of toxicity than that derived from coal tar, where the major hazard is brought about by the aromatic hydrocarbon content. Sufficient quantities of both naphthas cause central nervous system depression. Symptoms include eye irritation; followed by headache and nausea. In severe cases, dizziness, convulsions, and unconsciousness occasionally result. Symptoms of anorexia and nervousness have been reported to persist for several months following an acute overexposure, but this appears to be rare. One fraction, hexane, has been reported to have been associated with peripheral neuropathy. If benzene is present, coal tar naphthas may produce blood changes, such as leukopenia, aplastic anemia, or leukemia. The kidneys and spleen have also been affected in animal experiments. At vapor concentrations up to 450 ppm, petroleum naphtha inhalations may produce slight throat irritation. At 880 ppm, definite throat irritation is observed. Vapors may also irritate the nose. High concentrations may produce difficulty in breathing; Blue coloration of skin, excitement and dizziness. Inhalation of vapors in the absence of oxygen is immediately life-threatening. A vapor concentration up to 450 ppm mild, temporary irritation is observed; @ 880 ppm more severe irritation may be experienced. Human Tox = 14,00000 ppb (INTERMEDIATE)

Long-Term Exposure: Irritates the eyes and upper respiratory system. Coal tar naphtha may contain benzene, a cancer-causing agent in humans. Exposure may cause nervous system and kidney damage. Some coal tar naphthas contain other substances that can cause blood cell damage. Longer exposure may cause drying and cracking of the skin, and make the skin sunburn more easily. Swallowing the liquid may cause chemical pneumonia.

Points of Attack: Eyes, skin, respiratory system; central nervous system; liver, kidneys.

Medical Surveillance: Preplacement and periodic medical examinations should include the central nervous system. If benzene exposure is present, workers should have a periodic CBC including hematocrits, hemoglobin, white blood cell count and differential count, mean corpuscular volume and platelet count, reticulocyte count, serum bilirubin determination, and urinary phenol in the preplacement examination and @ 3-month intervals. There are no specific diagnostic tests for naphtha exposure but urinary phenols may indicate exposure to benzene and aromatic hydrocarbons. It should be noted that benzene content of vapor may be higher than predicted by content in the liquid.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get immediate medical attention.

Note to physician: Inhalation: Bronchodilators, decongestants, and oxygen may be used if necessary. Corticosteroids are useful for treating pneumonitis.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Nitrile, Neoprene rubber, Silvershield, chlorinated polyethylene; styrene-butadiene rubber, and polyvinyl alcohol are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash or dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Coal tar naphthas: Up to 1000 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); CcrFOv (APF = 50) [any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s)]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA). *Note:* Causes eye irritation or damage; may require eye protection.

Petroleum naphtha: NIOSH: *Up to 850 ppm:* Sa (APF = 10) (any supplied-air respirator). *Up to 1100 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); *SCBAF (APF = 50) (any SCBA with a full facepiece); SaF (APF = 50) (any supplied-air respirator with a full facepiece).

Emergency or planned entry into unknown concentrations or IDLH conditions: SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA). *Substance reported to cause eye irritation or damage; may require eye protection.

VM&P naphtha: 3500 milligram per cubic meter: CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)]; or Sa (APF = 10) (any supplied-air respirator). *8750 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]. *17,500 milligram per cubic meter:* CcrFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or PaprTOv (APF = 50) [any powered, air-purifying respirator with a tight-fitting facepiece and organic vapor cartridge(s)]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece).

Emergency or planned entry into unknown concentrations or IDLH conditions: SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Naphthas must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine), since violent reactions occur. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames are prohibited where naphthas are handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of naphthas should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of naphtha. Wherever naphtha is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1136 Coal tar distillates, flammable, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Theses chemicals are flammable liquids. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Use water for cooling only. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (2); (80); (100).

National institute for Occupational Safety and Health (NIOSH), “Criteria for a Recommended Standard: Occupational. Exposure to Refined Petroleum, NIOSH Document Number 77-192,” Washington, DC (1977).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Benzine*, Trenton, NJ (December 1985).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Coal Tar Naphtha*, Trenton, NJ (March 1986).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: VM&P Naphtha*, Trenton, NJ (August 1998).

New York State Department of Health, *Chemical Fact Sheet: V.M.&P. Naphtha*, Bureau of Toxic Substance Assessment, Albany, NY (May 1986, Version 2).

United States Environmental Protection Agency, *Chemical Hazard Information Profile: Naphtha (Petroleum) Solvents*, Washington, DC, Office of Toxic Substances (September 28, 1984).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Naphtha (Coal Tar)*, Trenton, NJ (January 2001).

Naphthalene N:0120

Formula: $C_{10}H_8$

Synonyms: Agitene 141/super; Albocarbon; Camphor tar; Dezodorator; Mighty 150; Moth balls; Moth flakes; Naftaleno (Spanish); Naphthaline; Napthalene, moletn; Napthalin; Napthaline; Napthene; NCI-C52904; Tar camphor

CAS Registry Number: 91-20-3

HSDB Number: 184

RTECS Number: QJ0525000

UN/NA & ERG Number: UN1334 (crude and refined)/133; UN2304 (molten)/133

EC Number: 202-049-5 [*Annex I Index No.:* 601-052-00-2] (naphthalene, crude or refined)

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; NCI: Carcinogenesis Studies (inhalation); clear evidence: rat; equivocal evidence: mouse; NTP: Carcinogenesis Studies (inhalation); some evidence: mouse; IARC: Animal Sufficient Evidence; Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B, 2002; EPA: Possible Human Carcinogen; Cannot be Determined. United States

Environmental Protection Agency Gene-Tox Program, Negative: Cell transformation-mouse embryo; Negative: Cell transformation-RLV F344 rat embryo; Negative: Histidine reversion-Ames test.

California Proposition 65 Chemical[102]: Cancer 4/19/2002.

Hazard Alert: Flammable solid, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction), Environmental hazard.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR401.15 Section 307 Toxic Pollutants

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U165

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.059; Nonwastewater (mg/kg), 5.6

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8100 (200); 8270 (10)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 100 lb (45.4 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xn, N; risk phrases: R45; R10; R22; R40; R50/53; R62; R63; safety phrases: S2; S29; S36/37; S46; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Naphthalene is a colorless to brown crystalline solid with a characteristic "moth ball" odor. Shipped as a molten solid. Molecular weight = 128.17; specific gravity (H_2O:1) = 1.03 @ 20°C; boiling point = 217.8°C; freezing/melting point = 80.3°C; vapor pressure = 0.08 mmHg @ 20°C; flash point = 78.9°C; autoignition temperature = 540°C. Explosive limits: LEL = 0.9%; UEL: 5.9%. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 2; reactivity 0. Practically insoluble in water; solubility = 0.003%.

Potential Exposure: Naphthalene is used as a chemical intermediate or feedstock for synthesis of phthalic, anthranilic, hydroxyl (naphthols), amino (naphthylamines), and sulfonic compounds; which are used in the manufacture of various dyes and in the preparation of phthalic anhydride, 1-naphthyl-*N*-methyl carbonate; and β-naphthol. Naphthalene is also used in the manufacture of hydronaphthalenes, synthetic resins; lampblack, smokeless powder; and celluloid. Naphthalene has been used as a moth repellent.

Approximately 100 million people worldwide have G6PD deficiency which would make them more susceptible to hemolytic anemia on exposure to naphthalene. At present, more than 80 variants of this enzyme deficiency have been identified. The incidence of this deficiency is 0.1% in American and European Caucasians, but can range as high as 20% in American blacks and greater than 50% in certain Jewish groups. Newborn infants have a similar sensitivity to the hemolytic effects of naphthalene, even without G6PD deficiency.

Incompatibilities: Dust may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Violent reactions with chromium(III) oxide, dinitrogen pentoxide; chromic anhydride.

Permissible Exposure Limits in Air

NIOSH IDLH = 250 ppm

Odor threshold = 0.038 ppm

OSHA PEL: 10 ppm/50 milligram per cubic meter TWA

NIOSH REL: 10 ppm/50 milligram per cubic meter TWA; 15 ppm/75 milligram per cubic meter STEL

ACGIH TLV[1]: 10 ppm/52 milligram per cubic meter TWA; 15 ppm/79 milligram per cubic meter STEL [skin]

DFG MAK: [skin] Carcinogen Category 3B

PAC Ver. 29[138]

PAC-1: 15 ppm

PAC-2: 83 ppm

PAC-3: 500 ppm

Arab Republic of Egypt: TWA 10 ppm (50 milligram per cubic meter), 1993; Austria: MAK 10 ppm (50 milligram per cubic meter), 1999; Belgium: TWA 10 ppm (52 milligram per cubic meter); STEL 15 ppm (79 milligram per cubic meter), 1993; Denmark: TWA 10 ppm (50 milligram per cubic meter), 1999; Finland: TWA 10 ppm (50 milligram per cubic meter); STEL 20 ppm (100 milligram per cubic meter), 1999; France: VME 10 ppm (50 milligram per cubic meter), 1999; Hungary: TWA 40 milligram per cubic meter; STEL 80 milligram per cubic meter [skin], 1993; the Netherlands: MAC-TGG 50 milligram per cubic meter, 2003; Norway: TWA 10 ppm (50 milligram per cubic meter), 1999; the Phillipines: TWA 10 ppm (50 milligram per cubic meter), 1993; Poland: MAC (TWA) 20 milligram per cubic meter; MAC (STEL) 75 milligram per cubic meter, 1999; Russia: STEL 20 milligram per cubic meter, 1993; Switzerland: MAK-W 10 ppm (50 milligram per cubic meter), 1999; United Kingdom: TWA 10 ppm (53 milligram per cubic meter); STEL 15 ppm (80 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 15 ppm [skin]. Russia[43] set a MAC in ambient air in residential areas of 0.003 milligram per cubic meter (3 μ/m^3). Several states have set guidelines or standards for naphthalene in ambient air[60] ranging from 14 μ/m^3 (Massachusetts) to 166.7 μ/m^3 (New York) to 500 μ/m^3 (Florida) to 500–750 μ/m^3 (North Dakota) to 800 μ/m^3 (Virginia) to 1000 μ/m^3 (Connecticut) to 1190 μ/m^3 (Nevada) to 1250 μ/m^3 (South Carolina).

***Determination in Air*:** Use NIOSH Analytical Methods #1501; OSHA Analytical Method 35.

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 100 μg/L; State Drinking Water Standards: New Jersey 300 μg/L; State Drinking Water Guidelines: California 170 μg/L; Connecticut 6.5 μg/L; Florida 100 μg/L; Massachusetts 140 μg/L; Maine 14 μg/L; Minnesota 300 μg/L; Wisconsin 100 μg/L.

Determination in Water: Methylene chloride extraction followed by high pressure liquid chromatography with fluorescence or UV detection; or gas chromatography (EPA Method 610) or gas chromatography plus mass spectrometry (EPA Method 625). Octanol–water coefficient: Log $K_{ow} = 3.3$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation of vapor or dust, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin, and respiratory tract. High levels cause headache, fatigue, confusion, excitement, malaise, nausea, and vomiting. *Inhalation:* Levels above 10 ppm may cause headache, nausea, excessive sweating, and vomiting. *Skin:* May cause irritation. If hypersensitive to naphthalene, severe irritation may occur.

Eyes: Levels above 15 ppm may cause irritation. Direct contact may cause severe irritation, injury to the cornea and a blurring of vision. *Ingestion:* Ingestion of 0.5 g (1/60 ounce) may cause nausea, vomiting, abdominal pain; irritation of the bladder; and brown or black coloration of the urine. The symptoms usually disappear after a few days. Animal studies indicate that the probable lethal dose for an adult is 5–15 g (1/16–0.5 ounce).

Long-Term Exposure: Repeated exposure or ingestion may cause clouding of the eye (cataract). Inhalation of levels above 10 ppm may cause headaches, nausea, vomiting and a feeling of general discomfort. Chronic skin problems are rare, except in cases of hypersensitivity. May cause skin allergy, kidney, and liver damage. May damage the red blood cells, causing anemia.

Points of Attack: Eyes, skin, blood, liver, kidneys, central nervous system.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure. NIOSH lists the following tests: blood plasma, hemoglobin; CBC; liver function tests; red blood cells/count, RBC hemolysis; urine (chemical/metabolite); hemoglobin; urinalysis (routine); white blood cell count/differential. For those with frequent or potentially high exposure (half the TLV or greater, or significant skin contact), the following is recommended before beginning work and at regular times after that: exam of the eyes and vision. If symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function tests, CBC. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Up to 2.5 milligram per cubic meter: Qm (APF = 25) (any quarter-mask respirator). *Up to 5 milligram per cubic meter:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or any supplied-air respirator.* *Up to 12.5 milligram per cubic meter:* Sa:Cf (any supplied-air respirator operated in a continuous-flow mode)*; or PaprHie* (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *Up to 25 milligram per cubic meter:* 100F (APF = 50) (any air purifying, full facepiece respirator with an N100, R Sa:Cf* (any supplied-air respirator operated in a continuous-flow mode) 100, or P100 filter); or any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter*; or any SCBA with a full facepiece; or any supplied-air respirator with a full facepiece. *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—Red Stripe: Flammability Hazard: Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Store flammable solids up to maximum allowable quantity per control area in an approved flammable storage area. Do not store in a basement. Naphthalene must be stored to avoid contact with chromium(III) oxide, dinitrogen pentoxide; and strong oxidizers (such as chlorine, bromine, and fluorine), since violent reactions occur. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames are prohibited where naphthalene is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gallons or more of naphthalene should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Liquid naphthalene must avoid contact with water.

Shipping: UN1334 Naphthalene, crude or Naphthalene, refined, Hazard Class: 4.1; Labels: 4.1-Flammable solid. UN2304 (molten) Hazard Class: 4.1; Labels: 4.1-Flammable solid.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. Keep naphthalene out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid but is not easily ignited. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. Use caution when using water spray or foam directly on molten naphthalene as extensive foaming may occur. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(109); (102); (31); (173); (101); (80); (100).

United States Environmental Protection Agency, *Naphthalene: Ambient Water Quality Criteria*, Washington, DC (1980) (2).

National institute for Occupational Safety and Health (NIOSH), *Profiles on Occupational Hazards for Criteria Document Priorities: Naphthalene, pp 269-273, Report PB-274,073*, Cincinnati, Ohio (1977).

United States Environmental Protection Agency, *Naphthalene, Health and Environmental Effects Profile No. 131*, Washington, DC, Office of Solid Waste (April 30, 1980).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 5, No. 4, 71−74 (1985).

New York State Department of Health, Chemical Fact Sheet: *Naphthalene, Bureau of Toxic Substance Assessment*, Albany, NY (March 1986 & Version 2).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Naphthalene*, Trenton, NJ (October 2004).

1-Naphthaleneacetic Acid N:0128

Formula: $C_{12}H_{10}O_2$

Synonyms: Agronaa; Alco NAA; Alpha-Spra; Amcotone; ANA; APPL-SET; Celmone; Destruxol; Dip'n Grow; Fruitone; Goldengro; Hormex; Klingtite; Liqui-Stik; NAA; NAA 800; Nafusaku; Naphthaleneacetic acid(1-); α-Naphthaleneacetic acid; Naphthalene-1-acetic acid; Naphthylacetic acid; α-Naphthylacetic; α-Naphthylacetic acid; 1-Naphthylacetic acid; α-Naphthyleneacetic acid; Niagara-Stik; Nu-Tone; Parmone; Phymone; Pimacol-Sol; Planofix; Plucker; Primacol; Rhizopon b rooting powder; Rootone (component, with indole-3-butyric acid and 1-naphthaleneacetamide); Stafast; Stik; Stop-Drop; Tekkam; Tipoff; Transplantone (component, with 1-naphthaleneacetamide); Tre-Hold; Vardhak

CAS Number: 86-87-3

HSDB Number: 2038

RTECS Number: QJ0875000

UN/NA & ERG Number: UN1759 (Corrosive solids, n.o.s.)/154

EC Number: 201-705-8

Regulatory Authority and Advisory Information

Hazard Alert: Poison (DOT). Combustible, Corrosive solid, Suspected reprotoxic hazard, Agricultural chemical.

Hazard symbols, risk, & safety statements: Hazard symbol: T, C, Xn, Xi; risk phrases: R22; R34; R36/37/38; R41; R51; R63; R68; safety phrases: S22; S23; S24/25; S26; S27; S36/37/39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: α-Naphthyleneacetic acid is a white crystalline solid, needles, powder, or colorless liquid. Odorless. Molecular weight = 186.21; boiling point = (decomposes) 322°C; 352°C; freezing/melting point = 134°C; vapor pressure = very low; negligible. Soluble in water; aqueous solution is acidic.

Potential Exposure: A carboxylic acid plant growth regulator used for thinning fruit sets in apples, pears, olives, and some citrus. Induces root formation on cuttings and transplants. Inhibits fruit drops. Not currently registered in EU countries (may be pending).

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, chlorates nitrates, ammonia, aliphatic amines, alkanolamines, isocyanates, alkylene oxides, epichlorohydrin. Compounds of the carboxyl group react with all bases, both inorganic and organic (i.e., amines) releasing substantial heat, water and a salt that may be harmful. Incompatible with arsenic compounds (releases hydrogen cyanide gas), diazo compounds, dithiocarbamates, isocyanates, mercaptans, nitrides, and sulfides (releasing heat, toxic, and possibly flammable gases), thiosulfates and dithionites (releasing hydrogen sulfate and oxides of sulfur).

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 2.6$. Unlikely to bioaccumulate in marine organisms. Fish toxicity (threshold)[101]: Very low—4918.96611 ppb, MATC (Maximum Acceptable Toxicant Concentration)

Routes of Entry: Inhalation, ingestion

Harmful Effects and Symptoms

Short-Term Exposure: Dusts may cause skin, and respiratory tract irritation. Eye irritation may be severe. Ingestion may cause upset stomach and affect central nervous system. LD_{50} (oral, rat) = 1000− >1750 mg/kg; (dermal, rat) = >2 g/kg.

Long-Term Exposure: Possible blood toxin; may cause lower blood cell count. May be a developmental and reproductive toxin. Human toxicity (long term)[101]: Very low—350.00 ppb, Health Advisory.

Points of Attack: Blood, central nervous system, eyes.

Medical Surveillance: CBC.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Do not induce vomiting when formulations containing petroleum solvents are ingested.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of dermal and/or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Wherever and whenever workplace conditions warrant respirator use, a respiratory protection program must be followed that meets one or more of the following government standards: OSHA's 29 CFR 1910.134, ANSI Z88.2, or European Standard EN 149.

Storage: (1) Color code—Blue: Health Hazard/Poison. Store in a secure poison location. (2) White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN1759 Corrosive solids, n.o.s., Hazard Class: 8; Labels: 8-Corrosive material, Technical Name Required.

Spill Handling: First remove all sources of ignition. Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Ventilate area of spill or leak. Use water spray to reduce vapor. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol-resistant foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Office of Pesticide Programs, Pesticide Residue Limits, *1-Naphthaleneacetic Acid*, 40 CFR 180.155, http://www.epa.gov/pesticides/food/viewtols.htm.

Pesticide Management Education Program, *1-Naphthaleneacetic Acid (NAA) Herbicide Profile 3/85*, Cornell University, Ithaca, NY (March 1985). http://pmep.cce.cornell.edu/profiles/herb-growthreg/naa-rimsulfuron/naa/herb-prof-naa.html.

Naphthenic Acid N:0130

Formula: Mixture: $R_2C\text{-}CR_2\text{-}CR_2\text{-}CR_2\text{-}CR\text{-}(CH_2)_n\text{-}COOH$ (where $n = 2-6$); $C_nH_{2n}1COOH$; C_7H1O_2

Synonyms: Acido naftalico (Spanish); Agenap; Agenap HMW-H; Cyclopentane carboxylic acid; Naphid; Sunaptic acid B; Sunaptic acid C

CAS Registry Number: 1338-24-5

HSDB Number: 1178

RTECS Number: QK8750000

UN/NA & ERG Number: UN3082 (environmentally hazardous substances, liquid, n.o.s.)/171

EC Number: 215-662-8

Regulatory Authority and Advisory Information

Carcinogenicity: DFG MAK: Carcinogenic: Category 3B, chemical of concern.

Hazard Alert: Combustible, Sensitization hazard (skin), Environmental hazard.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 100 lb (45.4 kg)

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B).

Hazardous to aquatic life or environment, with possible long lasting effects[291]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xi, N; risk phrases: R40; R36/37/38; R43; R50; R51/53; safety phrases: S26; S29/35; S36/37; S45; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [2-Hazard to water. (est.)]

Description: Naphthenic acid is a gold to black, odorless liquid. Molecular weight = (approx.) 200−250 (mixture); specific gravity (H_2O:1) = 0.982 @ 20°C; boiling point = 132−243°C; freezing/melting point = 31°C; flash point = 149°C (oc). Explosive limits: LEL = 0.9−1%; UEL: unknown. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 2; reactivity 0. Slightly soluble in water.

Potential Exposure: Used to make metallic naphthenates for paint dryers and cellulose preservatives. It is also used as a solvent; detergent, rubber reclaiming agent. Used in catalysts, cutting oils; drilling compounds; rust inhibitors; surfactants, emulsions, grease, and wood preservatives.

Incompatibilities: Compounds of the carboxyl group react with all bases, both inorganic and organic (i.e., amines) releasing substantial heat, water, and a salt that may be harmful. Incompatible with arsenic compounds (releases hydrogen cyanide gas), diazo compounds, dithiocarbamates, isocyanates, mercaptans, nitrides, and sulfides (releasing heat, toxic, and possibly flammable gases), thiosulfates and dithionites (releasing hydrogen sulfate and oxides of sulfur). Incompatible with sulfuric acid, caustics, ammonia, aliphatic amines; alkanolamines, isocyanates, alkylene oxides; epichlorohydrin, strong oxidizers. Corrosive to metals.

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices. DFG MAK: Carcinogen Category 3B, chemical of concern.

Harmful Effects and Symptoms

Short-Term Exposure: Vapors irritate the eyes, skin, and respiratory tract. Contact with the skin caused reddening. Principal effect is that of mild primary irritation when encountered in high concentrations. Inhalation of vapor causes coughing. Liquid is moderately irritating to eyes and slightly to moderately irritating to skin; excessive exposure could result in dermatitis[136].

Long-Term Exposure: Repeated or prolonged contact causes dry and cracked skin; and may cause contact dermatitis. May cause liver and central nervous system damage.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure. Evaluation by a dermatologist. Evaluation by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Green: General storage may be used. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from metals and other incompatible materials listed above. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN3082 Environmentally hazardous substances, liquid, n.o.s., Hazard Class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical may burn but does not easily ignite. Thermal decomposition products may include oxides of carbon and may contain other oxides of carbon.

Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (80); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Naphthenic Acid*, Trenton, NJ (June1999).

2-Naphthol N:0140

Formula: $C_{10}H_8O$
Synonyms: β-Hydroxynaphthalene; 2-Naphthalenol; 2-Naphthol; β-Naphthol
CAS Registry Number: 135-19-3
HSDB Number: 6812 as naphtha-2
RTECS Number: QL2975000
UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154; UN3077 (environmentally hazardous substances, solid, n.o.s.)/171
EC Number: 205-182-7 [*Annex I Index No.:* 604-007-00-5]
Regulatory Authority and Advisory Information
Hazard Alert: Poison, Combustible, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction), Environmental hazard.
Canada, WHMIS, Ingredients Disclosure List Concentration 1%.
Hazardous to aquatic life or environment, with possible long lasting effects.[291] Do not allow release to the environment unless proper permits are obtained from the federal government.
Hazard symbols, risk, & safety statements: Hazard symbol: Xn, N; risk phrases: R20/22; R51/53; R60; R62; safety phrases: S2; S24/25; S29/35; S61 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.
Description: 2-Naphthol is a white, crystalline solid. Slight phenolic odor. Darkens in air and on exposure to light. Molecular weight = 144.18; specific gravity (H_2O:1) = 0.58 @ 0°C; boiling point = 286°C; freezing/melting point = 123°C; vapor pressure = 10 mmHg @ 46°C; flash point = 153°C. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 1; reactivity 0; (1-naphthol) Health 3, flammability 1, reactivity 1. Slightly soluble in water.
Potential Exposure: A potential danger to those involved in rubber antioxidant production, synthesis of dyes; leather processing; fungicides, pharmaceuticals, and perfumes. Used as an antioxidant for fats, oils; as an antiseptic; in insecticides.
Incompatibilities: Dust or powder may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, iron salts; 2,3-dimethyl-1-phenyl-3-pyrazolin-5-one (antipyrine); camphor, phenol, menthol, urethane.
Permissible Exposure Limits in Air
PAC Ver. 29[138]
PAC-1: 5.9 milligram per cubic meter
PAC-2: 65 milligram per cubic meter
PAC-3: 390 milligram per cubic meter
Russia: STEL 0.1 milligram per cubic meter, 1993
Russia[43] set a MAC in ambient air in residential areas of 0.006 milligram per cubic meter on a momentary basis and 0.003 milligram per cubic meter on a daily average basis.
Permissible Concentration in Water: Russia[43] set a MAC in water bodies used for domestic purposes of 0.4 mg/L.
Routes of Entry: Inhalation; skin absorption.
Harmful Effects and Symptoms
Short-Term Exposure: Irritates the skin and eyes. Ingestion can cause nephritis, lens opacity, vomiting, diarrhea, abdominal pain; circulatory collapse; convulsion, hemolytic anemia, and death.
Long-Term Exposure: May cause kidney damage, anemia. May cause mutations.
Points of Attack: Eyes, skin, blood, liver, kidneys, central nervous system.
Medical Surveillance: CBC, kidney damage.
First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved

and take precautions to protect themselves. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: SCBA.

Storage: Color code—Blue (1-naphthol): Health Hazard/Poison: Store in a secure poison location. Color code—Green (2-naphthol): General storage may be used. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in a cool, dark place.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard Class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft.(NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include oxides of carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Mix with flammable solvent and atomize into an incinerator.

References

(31); (173); (101); (80); (100).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 2, No. 3, 81−83 (1982) & 3, No. 6, 49−52 (1983) & 8, No. 3, 79−86 (1988).

1,4-Naphthoquinone N:0150

Formula: $C_{10}H_6O_2$

Synonyms: 1,4-Dihydro-1,4-diketonaphthalene; Naftoquinona (Spanish); 1,4-Naphthalenedione; α-Naphthoquinone

CAS Registry Number: 130-15-4

HSDB Number: 2037

RTECS Number: QL7175000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 204-977-6

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Inhalation hazard, Combustible solid, Highly toxic, Corrosive, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Sensitization hazard [skin], Environmental hazard.

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U166

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 5000 lb (2270 kg).

Hazardous to aquatic life or environment, with possible long lasting effects.[291] Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, N, C, Xi; risk phrases: R25; R26; R36/37/38; R43; R50/53; R34; R62; R63; safety phrases: S16; S24; S26; S29/35; S36/37/39; S38; S45; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: 1,4-Naphthoquinone is a yellow to greenish-yellow crystalline solid. Pungent odor like benzoquinone. Molecular weight = 158.15; specific gravity (H_2O:1) = 1.4 @ 20°C; sublimation point = 100°C; freezing/melting point = 129°C; vapor pressure = 0.2 mmHg @ 50°C. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 1, reactivity 0. Slightly soluble in water.

Potential Exposure: 1,4-Naphthoquinone is used as a polymerization regulator for rubber and polyester resins; in the synthesis of dyes and pharmaceuticals; and as a fungicide and algicide.

Incompatibilities: Ketones are incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, nitrated amines, azo, diazo, azido compounds, carbamates, organic cyanates. May react with many acids and bases liberating heat and flammable gases (e.g., hydrogen) generating heat may be sufficient to start a fire in the unreacted portion of the ketone. May react with reducing agents such as hydrides, alkali metals, and nitrides to produce flammable gas (e.g., hydrogen) and heat. Incompatible with isocyanates, aldehydes, cyanides, peroxides, and anhydrides. May react violently with aldehydes[101].

Permissible Exposure Limits in Air

Odor threshold = 0.02 ppm

PAC Ver. 29[138]

PAC-1: 0.57 milligram per cubic meter

PAC-2: 6.3 milligram per cubic meter

PAC-3: 38 milligram per cubic meter

Russia: STEL 0.1 milligram per cubic meter [skin], 1993

Russia[43] set a MAC in ambient air in residential areas of 0.005 milligram per cubic meter both on a momentary and a daily average basis.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Long-Term Exposure: The most consistent findings reported in the literature for health effects of 1,4-naphthoquinone involve hematological changes; irritant and allergenic activity; and inhibition of biochemical oxidation processes. One study found 1,4-naphthoquinone to be oncogenic. Some evidence of inhibition of *in vitro* endocrine function and of nerve activity was reported.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft. (NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (101); (138); (100).

United States Environmental Protection Agency, *1,4-Naphthoquinone, Health and Environmental Effects Profile No. 132*, Washington, DC, Office of Solid Waste (April 30, 1980).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 4, No. 2, 81−83 (1984).

1-Naphthylamine N:0160

Formula: $C_{10}H_9N$; $C_{10}H_7NH_2$

Synonyms: 1-Aminonaphthalene; C.I. azoic diazo component 114; Fast garnet B base; α-Naftilamina (Spanish); 1-Naftilamina (Spanish); 1-Naphthalenamine; Naphthalidine; 1-Naphthylamin (German); α-Naphthylamine; Naphthyla mine; Naphthylamine-a; Napthalidine

CAS Registry Number: 134-32-7

HSDB Number: 1080

RTECS Number: QM1400000

UN/NA & ERG Number: UN2077/53

EC Number: 205-138-7 [*Annex I Index No.:* 612-020-00-2]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human, Inadequate Evidence; Animal, Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1997; OSHA/NIOSH: Potential human carcinogen. United States Environmental Protection Agency Gene-Tox Program, Positive: Cell transformation-SA7/SHE; Host-mediated assay; Positive: *E. coli polA* with S9; Histidine reversion-Ames test; Negative: SHE-clonal assay; Cell transformation-RLV F344 rat embryo; Negative: *E. coli polA* without S9; *In vitro* UDS-human fibroblast; Negative: S *cerevisiae-homozygosis*; Negative/limited: Carcinogenicity-mouse/rat; Inconclusive: Mammalian micronucleus; N crassa-forward mutation; Inconclusive: Sperm morphology-mouse.

California Proposition 65 Chemical[102]: Cancer 10/1/1989.

Hazard Alert: Poison, Combustible, Possible risk of forming tumors, Suspected reprotoxic hazard, Environmental hazard.

OSHA, 29CFR1910 Specifically Regulated Chemicals (see CFR 1910.1004)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U167

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 100 lb (45.4 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), as naphthalene, crude, refined and molten.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: Xn, N; risk phrases: R22; R51/53; safety phrases: S2; S24; S6; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: α-Naphthylamine exists as white needle-like crystals which turn red on exposure to air. Has a weak ammonia-like odor. Molecular weight = 143.19; specific gravity (H_2O:1) = 1.02 @ 20°C; boiling point = 301°C; freezing/melting point = 49°C; vapor pressure = 4.2×10^{-3} mmHg @ 25°C; flash point = 157.2°C; autoignition temperature = ~450°C. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 1; reactivity 0. Practically insoluble in water; solubility = 0.002%; 1 mg/mL at 20°C[193].

Potential Exposure: α-Naphthylamine is used as an intermediate in dye production; for manufacturing herbicides and antioxidants; in the manufacture of condensation colors, rubber, and in the synthesis of many chemicals, such as α-naphthol, sodium naphthionate; *o*-naphthionic acid; Neville and Winther's acid; sulfonated naphthylamines, α-naphthylthiourea (a rodenticide); and *N*-phenyl-α-naphthylamine.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, nitrous acid, organic anhydrides, isocyanates, aldehydes. Oxidizes on contact with air.

Permissible Exposure Limits in Air

OSHA: Cancer Suspect Agent, see 29CFR1910.1003.

NIOSH REL: A potential occupational carcinogen. Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A

ACGIH TLV[1]: Confirmed Human Carcinogen

PAC Ver. 29[138]

PAC-1: 2 milligram per cubic meter

PAC-2: 22 milligram per cubic meter
PAC-3: 130 milligram per cubic meter
Austria: carcinogen, 1999; Poland: MAC (TWA) 0 milligram per cubic meter, MAC (STEL) 0 milligram per cubic meter, 1999; Sweden: carcinogen, 1993. α-Naphthylamine is included in the Federal standard for carcinogens; all contact with it should be avoided[63]. Several states have set guidelines or standards for 1-naphthylamine in ambient air[60] ranging from zero in South Carolina to 0.03 μ/m^3 (New York).

Determination in Air: Use NIOSH Analytical Method #5518, Naphthylamines; OSHA Analytical Method 93

Determination in Water: Octanol−water coefficient: Log K_{ow} = <2.5. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood. Naphthalenes and naphthenic acids are listed as United States DOT marine pollutants and may persist in the environment.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact. Percutaneous absorption.

Harmful Effects and Symptoms

Short-Term Exposure: 1-Naphthylamine can affect you when breathed in and by passing through your skin. 1-Naphthylamine should be handled as a carcinogen with extreme caution. High exposure can cause the skin and lips to turn blue. This reduces the ability of the blood cells to carry oxygen to body organs (methemoglobinemia). Higher levels can cause breathing difficulties, collapse, and possible death.

Long-Term Exposure: Some related chemicals can damage the liver and/or cause skin allergies. It is not known whether 1-naphthylamine has these effects. A report of excess bladder cancer among individuals who worked with this chemical has been published. This may be due to contamination with 2-naphthylamine, a known human carcinogen.

Points of Attack: Bladder, skin. *Cancer site:* bladder cancer.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure. OSHA mandates the following tests or information: *Increased Risk:* reduced immunologic competence; steroid treatment; pregnancy; cigarette smoking.* NIOSH lists the following tests: *increased risk:* reduced immunologic competence; steroid treatment; pregnancy; cigarette smoking; cystoscopy; urinalysis (routine). Before beginning employment and at regular times after that, the following are recommended: urine cytology (a test for abnormal cells in the urine). A urine test for 1-naphthylamine can also be done to determine whether this cancer agent is entering the body. For accuracy, it should be done shortly after exposure. If symptoms develop or overexposure is suspected, the following may be useful: test for methemoglobin (most accurate a few hours after exposure; the blood sample must be promptly tested).**Code of Federal Regulations. 29 CFR Part 1910.1000. Subpart Z. Air Contaminants.* United States Government Printing Office (July 1, 2004).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. *Note to physician:* Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Based on potential carcinogenicity the following is recommended by NIOSH: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from light. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2077 *alpha*-Naphthylamine, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. PGIII.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: 1-Naphthylamine may burn, but does not readily ignite. Use dry chemical, CO_2, water spray; or foam extinguishers; however, water or foam may cause frothing. Thermal decomposition products may include oxides of nitrogen and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Controlled incineration whereby oxides of nitrogen are removed from the effluent gas by scrubber, catalyst, or thermal device. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(102); (31); (173); (101); (138); (2); (100).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 4, No. 3, 79–82 (1984).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* 1-Naphthylamine, Trenton, NJ (April 2004).

2-Naphthylamine N:0170

Formula: $C_{10}H_9N$; $C_{10}H_7NH_2$

Synonyms: 2-Aminonaphthalene; C.I. 37270; Fast scarlet base B; NA; β-Naftilamina (Spanish); 2-Naftilamina (Spanish); 2-Naphthalenamine; β-Naphthamin (German); 2-Naphthylamin (German); 2-Naphthylamine; 6-Naphthylamine; Naphthylamine-b; 2-Naphthylamine mustard

CAS Registry Number: 91-59-8

HSDB Number: 1131

RTECS Number: QM2100000

UN/NA & ERG Number: UN1650/153

EC Number: 202-080-4 [*Annex I Index No.:* 612-022-00-3]

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen; IARC: Human Sufficient Evidence; Animal Sufficient Evidence, *carcinogenic to humans*, Group 1, 1998; Carcinogenicity: NIOSH/OSHA: Potential occupational carcinogen. United States Environmental Protection Agency Gene-Tox Program, Positive: Carcinogenicity-mouse/rat; SHE-clonal assay; Positive: Cell transformation-mouse embryo; Positive: Cell transformation-RLV F344 rat embryo; Positive: Cell transformation-SA7/SHE; Host-mediated assay; Positive: Mammalian micronucleus; N crassa-forward mutation; Positive: *E. coli polA* with S9; Histidine reversion-Ames test; Positive: S *cerevisiae* gene conversion; Negative: Cell transformation-BALB/c-3T3; *E. coli polA* without S9; Negative: Sperm morphology-mouse; S *cerevisiae-homozygosis*; Inconclusive: D *melanogaster* sex-linked lethal; Positive: CHO gene mutation.

California Proposition 65 Chemical[102]: Cancer 2/27/1987.

Hazard Alert: Poison, Possible risk of forming tumors, Suspected reprotoxic hazard, Environmental hazard.

Banned or Severely Restricted (several countries) (UN)[35]

OSHA, 29CFR1910 Specifically Regulated Chemicals (see CFR 1910.1009)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U168

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.52; Nonwastewater (mg/kg), N/A

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

United States DOT Regulated marine pollutant (49CFR172.101, Appendix B) as naphthalenes

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R22; R45; R50/53; safety phrases: S41; S45; S53; S61 (see Appendix 4). PG II.

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to waters

Description: 2-Naphthylamine is a white to red crystals with a faint, aromatic odor. Darkens in air to a reddish-purple color. Molecular weight = 143.20; specific gravity (H_2O:1) = 1.06 @ 97.8°C; boiling point = 294°C; freezing/melting point = 109–110°C; vapor pressure = 1 mmHg @ 104°C; flash point = 157°C. Soluble in hot water.

Potential Exposure: 2-Naphthylamine is presently used only for research purposes. It is present as an impurity in α-naphthylamine. It is as an intermediate in the preparation of other compounds. 2-Naphthylamine was widely used in the manufacture of dyestuffs; as an antioxidant for rubber; and in rubber coated cables.

Incompatibilities: A weak base. Dust may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Incompatible with nitrous acid.

Permissible Exposure Limits in Air

NIOSH IDLH = Not determined. Potential occupational carcinogen.

ACGIH TLV[1]: Exposure by all routes should be carefully controlled to levels as low as possible; Confirmed Human Carcinogen

PAC not available.

DFG MAK: [skin]; Carcinogen Category 1

Australia: carcinogen, 1993; Austria [skin] carcinogen, 1999; Belgium: carcinogen, 1993; Finland: carcinogen, 1999; France: VME 0.001 ppm (0.005 milligram per cubic meter), continuous; carcinogen, 1993; Poland: MAC (TWA) 0 milligram per cubic meter, MAC (STEL) 0 milligram per cubic meter, 1999; Sweden: carcinogen, 1999; Switzerland: [skin] carcinogen, 1999; United Kingdom: carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Confirmed Human Carcinogen. 2-Naphthylamine is included in the federal standard for carcinogens; all contact with it should be avoided. ACGIH states that β-naphthylamine is a human carcinogen without an assigned TLV. Several states have set guidelines of standards for 2-naphthylamine in ambient air[60] ranging from zero (North Dakota, New York, and South Carolina) to 3.0 μ/m^3 (Virginia) to 19.07 μ/m^3 (Pennsylvania).

Determination in Air: Use NIOSH Analytical Method #5518, Naphthylamines; OSHA Analytical Method 93

Permissible Concentration in Water: Octanol–water coefficient: Log K_{ow} = <2.5. Unlikely to bioaccumulate in marine organisms. Naphthalenes and naphthenic acids are listed as United States DOT marine pollutants and may persist in the environment. EPA[32] has suggested an ambient level goal based on health effects of 291 μg/L.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact. Percutaneous absorption.

Harmful Effects and Symptoms

Short-Term Exposure: 2-Naphthylamine is irritating to the eyes and skin; has produced contact dermatitis. High levels can interfere with the blood's ability to carry oxygen (methemoglobinemia). Higher levels can cause breathing difficulties, collapse, and even death.

Long-Term Exposure: 2-Naphthylamine is a known human bladder carcinogen with a latent period of about 16 years. The symptoms are frequent urination, dysuria, and hematuria. Acute poisoning leads to methemoglobinemia or acute hemorrhagic cystitis. 2-Naphthylamine is carcinogenic, producing urinary bladder carcinomas in hamsters, dogs, and nonhuman primates; and hepatomas in mice, after oral administration. Epidemiological studies have shown that occupational exposure to 2-naphthylamine, either alone or when present as an impurity in other compounds, is causally associated with bladder cancer.

Points of Attack: Bladder, skin. *Cancer site:* bladder cancer.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure. OSHA mandates the following tests or information: *increased risk:* reduced immunologic competence; steroid treatment; pregnancy; cigarette smoking.* NIOSH lists the following tests: *increased risk:* reduced immunologic competence; steroid treatment; pregnancy; cigarette smoking; cystoscopy; urinalysis (routine). Preplacement and periodic examinations should include an evaluation of exposure to other carcinogens; use of alcohol, smoking, and medications; and family history. Special attention should be given on a regular basis to urine sediment and cytology. If red cells or positive smears are seen, cystoscopy should be done at once. The general health of exposed persons should also be evaluated in periodic examinations.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable

probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store away from heat and light in a refrigerator or a cool, dry place away from incompatible materials. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045 and 1910.1003.

Shipping: UN1650 β-Naphthylamine, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen spilled material with 60−70% acetone to avoid airborne dust. Transfer to vapor-tight plastic bags for eventual disposal. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include oxides of nitrogen and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Controlled incineration whereby oxides of nitrogen are removed from the effluent gas by scrubber, catalyst, or thermal device[22]. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(109); (102); (31); (173); (101); (138); (2); (100).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 2, No. 2, 56−58 (1982) & 3, No. 6, 52−56 (1983).

Napropamide N:0173

Formula: $C_{17}H_{21}NO_2$

Synonyms: Colzor trio (dimethachlor + napropamide + clomazone); Devrinol; *N,N*-Diethyl-2-(1-naphthalenyloxy) propanamide; 2-(1-Naphthoxy)-*N,N*-diethylpropionamide; [2-(α-Naphthoxy)-*N,N*-diethylpropionamide]; Naproguard; R-7165; Waylay

CAS Number: 15299-99-7

HSDB Number: 6710

RTECS Number: UE3600000

UN/NA & ERG Number: UN3082 (environmentally hazardous substances, liquid, n.o.s.)/171

EC Number: 239-333-3

Regulatory Authority and Advisory Information

Potential Ground water Pollutant [California FAC Section 13145(d)/12811, active]

Hazard symbols, risk, & safety statements: Hazard symbol: N; risk phrases: R51/53; safety phrases: S2; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [2-Hazard to waters (est.)]

Description: Colorless crystalline solid (pure). Technical form is tan to brown solid. Molecular weight = 271.35; specific gravity (H_2O:1) = 1.18; boiling point = 317°C; freezing/melting point = 73.5°C; vapor pressure = 1.72×10^{-7} mm @ 20°C[83]. Soluble in water; solubility = 73 mg/L @ 20°C.

Potential Exposure: A amide/alkanamide general use pesticide and herbicide that is compatible with many other fungicides and herbicides. Used to control broadleaf weeds and annual grasses on a variety of crops including vegetables, fruit trees; fruit bushes, oil seed rape, vines, sunflowers, olives, tobacco, and mint.

Incompatibilities: Slowly hydrolyzes in water, releasing ammonia and forming acetate salt.

Permissible Exposure Limits in Air:

Determination in Air: Filter; none; Gravimetric; NIOSH IV [Particulates NOR; #0500 (total), #0600 (respirable)][18].

Permissible Concentration in Water: Federal Drinking Water Guidelines: 800 ppb[14].

Determination in Water: Octanol−water coefficient: Log $K_{ow} = >3.0$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, dermal, and eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the respiratory tract.

LD_{50} (oral, rat) = >4500 mg/kg; (dermal, rat) = >2 g/kg.

Long-Term Exposure: Possible liver and kidney toxin.

Points of Attack: Liver, kidneys

Medical Surveillance: Preliminary medical exam to detect chronic diseases of central nervous system, liver, heart, kidneys, lung, and skin, as well as endocrinological or immunological disturbances, should protect susceptible individuals. Periodical medical exams of internal organs, skin, and eyes are important to avoid chronic occupational intoxications. They should include lab and patch tests when necessary[83]. Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Do not induce vomiting when formulations containing petroleum solvents are ingested.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of dermal and/or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to amides exists, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison. Store in a secure poison location. Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers; strong acids; strong alkalies. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN3082 Environmentally hazardous substances, liquid, n.o.s., Hazard Class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required

Spill Handling: First remove all sources of ignition. Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Nifluridide decomposes forming toxic and corrosive gases, including oxides of nitrogen and carbon. This chemical is a combustible solid. As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 m/150 ft. for liquids and at least 25 m/75 ft. for solids. *Fire involving storage or vehicular tanks:* Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. *On a small fire:* use dry chemical, CO_2, water spray or regular *foam. On a large fire:* use water spray, fog or regular foam. Do not scatter spilled material with high pressure streams of water. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal. *Fire involving tanks:* From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. Always stay away from tanks engulfed in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Small amounts may be destroyed by alkaline hydrolysis. Admixture with alkali can be followed by soil burial. Larger quantities can be disposed of by incineration in admixture with acetone or xylene and using effluent gas scrubbing.

References

(31); (173); (101); (138); (100).

EXTOXNET, Extension Toxicology Network, *Pesticide Information Profile, Napropamide*, Oregon State University, Corvallis, OR (June 1996). http://extoxnet.orst.edu/pips/napropam.htm.

Neon N:0190

Formula: Ne

Synonyms: Neon, elemental

CAS Registry Number: 7440-01-9

HSDB Number: 7916

RTECS Number: QP4450000

UN/NA & ERG Number: UN1065 (compressed); UN1913 (liquid)

EC Number: 231-110-9

Regulatory Authority and Advisory Bodies

Hazard Alert: Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated.

Hazard symbols, risk, & safety statements: Hazard symbol: Xn; risk phrases: R5; R21; safety phrases: S9; S33; S38; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): Nonhazard to water.

Description: Neon is an inert, colorless, odorless, tasteless gas or liquid. Molecular weight = 20.18; specific gravity (H_2O:1) = 1.2 @ −246°C (BP); boiling point = −246°C; freezing/melting point = −246°C. Slightly soluble in water.

Potential Exposure: Neon is used in photoelectric bulbs and certain light tubes; in the electronic industry; in lasers; in plasma studies; and other research.

Incompatibilities: Compressed neon gas under pressure may explode when heated.

Permissible Exposure Limits in Air

ACGIH TLV[1]: Simple asphyxiant

PAC Ver. 29[138]

PAC-1: 65,000 ppm

PAC-2: 230E + 05 ppm

PAC-3: 400E + 05 ppm

Australia: asphyxiant, 1993; Belgium: asphyxiant, 1993; Hungary: asphyxiant, 1993; Switzerland: asphyxiant, 1999; United Kingdom: asphyxiant, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Simple asphyxiant. Large amounts of neon will decrease the amount of available oxygen. Oxygen content should be tested to ensure that it is at least 19% by volume.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short-Term Exposure: Neon can affect you when breathed in. Exposure can cause you to feel dizzy and lightheaded. Very high levels can cause you to pass out and could cause suffocation from lack of oxygen. Contact with liquefied neon could cause frostbite. Before entering a confined space be certain that sufficient oxygen exists.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid, unless full facepiece respiratory protection is worn. Eye protection is required in laser operations to avoid eye burning. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash (gloves, footwear, headgear) which should be clean, available each day, and put on before work. Where exposure to cold equipment, vapors, or liquid may occur, employees should be provided with special clothing designed to prevent the freezing of body tissues.

Respirator Selection: Exposure to neon is dangerous because it can replace oxygen and lead to suffocation. Only

NIOSH/MSHA or European Standard EN 149-approved SCBA with a full facepiece operated in positive-pressure mode should be used in oxygen deficient environments.

Storage: Check oxygen content prior to entering storage area. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Storage areas should be dry and well ventilated. Protect cylinders of neon from physical damage. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: UN1065 Neon and UN1913 Neon, refrigerated liquid (cryogenic liquid), Hazard Class: 2.2; Labels: 2.2-Nonflammable compressed gas. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: If in a building, evacuate building and confine vapors by closing doors and shutting down HVAC systems. Restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak to disperse the gas. Wear chemical protective suit with SCBA to combat spills. Stay upwind and use water spray to “knock down” vapor; contain runoff. Stop the flow of gas, if it can be done safely from a distance. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place; and repair leak or allow cylinder to empty. Keep this chemical out of confined spaces, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a nonflammable gas, but pressurized containers may explode in fire. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Vapors are heavier than air and will collect in low areas. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Venting to atmosphere.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Neon, Trenton, NJ (September 2001).

Neopentane N:0200

Formula: C_5H_{12}; $CH_3C(CH_3)_2CH_3$

Synonyms: 2,2-Dimethylpropane; Dimethylpropane; Neopentane; *tert*-Pentane; Propane, 2,2-dimethyl-; Tetramethylmethane; 1,1,1-Trimethylethane

CAS Registry Number: 463-82-1

HSDB Number: 110

RTECS Number: TY1190000

UN/NA & ERG Number: UN2044/115

EC Number: 207-343-7 [*Annex I Index No.:* 601-005-00-6]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 ($\geq$1.00% concentration).

Hazard Alert: Extremely flammable gas, Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated, Environmental hazard.

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg)

Hazardous to aquatic life or environment, with possible long lasting effects[293]. Toxic to aquatic life with long lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Canada, WHMIS, Ingredients Disclosure List (neopentane not listed) *n*-pentane Concentration 1%.

Hazard symbols, risk, & safety statements: Hazard symbol: F+, N; risk phrases: R5; R12; R21; R44; R53; safety phrases: S1; S2; S9; S16; S29; S33; S38; S41; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Neopentane is an extremely flammable gas and volatile liquid. Molecular weight = 72.17; specific gravity (H_2O:1) = 0.6 @ 0°C; boiling point = 9.5°C; flash point = (gas) −17°C. Explosive limits: LEL = 1.4%; UEL: 7.5%; Autoignition temperature = 450°C. Hazard identification (based on NFPA-704 M Rating System): Health 0; flammability 4; reactivity 0. Insoluble in water.

Potential Exposure: Neopentane is used as a gasoline blending component; for making butyl rubber. A research chemical. Reacts with strong oxidizers, causing fire and explosion hazard. Attacks some plastics, rubbers, and coatings.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

OSHA give limits for *n-pentane* as do several states, but they do not single out "neopentane." *This is shown for reference only.*

NIOSH IDLH = 1500 ppm [LEL]

OSHA PEL: 1000 ppm/2950 milligram per cubic meter TWA

NIOSH REL: 120 ppm/350 milligram per cubic meter TWA

ACGIH TLV[1]: 600 ppm/1770 TWA

PAC Ver. 29[138]

PAC-1: 3000 ppm

PAC-2: 33,000 ppm

PAC-3: 2.00E + 05 ppm

DFG MAK: 1000 ppm/3000 milligram per cubic meter TWA; Peak Limitation Category II(2); Pregnancy Risk Group C

Austria: MAK 600 ppm (1899 milligram per cubic meter), 1999; Denmark: TWA 500 ppm (1500 milligram per cubic meter), 1999; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 600 ppm.

United Kingdom[33] TWA 600 ppm (1800 milligram per cubic meter); STEL of 750 ppm (2250 milligram per cubic meter) (all isomers of pentane).

Determination in Air: Charcoal tube; CS_2; Gas chromatography/Flame ionization detection; NIOSH Analytical Method (IV) #1500, Hydrocarbons.

Toxic to aquatic life with long lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Determination in Water: Octanol–water coefficient: Log $K_{ow} = >3$. Values above 3.0 are likely to bioaccumulate in aquatic organisms. Toxic to aquatic life with long lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Exposure can cause skin irritation and severe burns with redness, itching. May affect the central nervous systems. Skin contact with the undiluted material for 5 hours causes blisters; for one hour it causes irritation, itching, erythema, pigmentation, swelling, burning and pain. Skin contact can cause frostbite. Inhalation can cause headache, dizziness, and suffocation. The toxicity is via the inhalation route. It is narcotic in high concentrations. Ingesting the liquid may cause chemical pneumonia (aspiration).

Long-Term Exposure: Repeated or prolonged contact with skin may cause dermatitis. See above.

Points of Attack: Eyes, skin, respiratory system; central nervous system.

Medical Surveillance. Lung function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Note to physician: Inhalation: bronchodilators, decongestants, and oxygen may be used if necessary. Corticosteroids are useful for treating pneumonitis.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH (as pentane): *1200 ppm:* Sa (APF = 10) (any supplied-air respirator). *1500 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Check oxygen content prior to entering storage area. Flammable gas. Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers and heat. Sources of ignition, such as smoking and open flames are prohibited where this chemical is handled, used, or stored. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: UN2044 2,2-Dimethylpropane, Hazard Class: 2.1; Labels: 2.1-Flammable gas. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Stop the flow of gas if it can be done safely. If source of leak is a cylinder and the leak cannot be stopped in place, remove leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. Keep this chemical out of confined space, such as a sewer because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable gas. Thermal decomposition products may include oxides of carbon. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Dimethylpropane, Trenton, NJ (February 1999).

Niacinamide N:0210

Formula: $C_6H_6N_2O$

Synonyms: Acidamide; Nicotimanide; Nicotine acid amide; 3-Pyridine carboxamide; 3-Pyridine carboxylic acid amide; VI-Nicotyl; VI-Nictyl; Vitamin B_3; Vitamin Pp

CAS Registry Number: 98-92-0

HSDB Number: 1237

RTECS Number: QS3675000

EC Number: 202-713-4

Regulatory Authority and Advisory Information

Hazard Alert: Combustible solid, Suspected of causing genetic defects.

Hazard symbols, risk, & safety statements: Hazard symbol: Xi; risk phrases: R36/37/38; R41; R60; R61; R62; safety phrases: S16; S26; S27; S36/37/39; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Niacinamide is a white crystalline powder or forms colorless needle-like crystals. Molecular weight = 122.14; specific gravity (H_2O:1) = 1.4 @ 20°C; boiling point = 155°C; freezing/melting point = 129−130°C; vapor pressure = 4.2×10^{-5} mmHg @ 25°C. Hazard identification (based on NFPA-704 M Rating System): Health 1; flammability 0; reactivity 0. Highly soluble in water.

Potential Exposure: Used as a dietary supplement and food additive.

Incompatibilities: Combustible solid; dust may form explosive mixture with air. Amides are incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 5.6 milligram per cubic meter

PAC-2: 62 milligram per cubic meter

PAC-3: 690 milligram per cubic meter

Routes of Entry: Ingestion; deral and eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: These symptoms reported from cases of medical treatment or self-prescribed massive vitamin dosage. The sudden onset of nausea, vomiting, and fatigue have been reported following increased dose from 4−9 g daily. From animal studies, the lethal human dose has been estimated to be about 0.5 pound.

Long-Term Exposure: The recommended dietary supplement is 10−20 mg per day. This level causes no adverse effects. Levels of 4−9 g per day may cause nausea and vomiting, as well as serious changes in liver tissue and enzymes. May cause mutations.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Prior to working with this chemical, personnel should be trained on its proper handling and storage.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include oxides of nitrogen and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (101); (138); (100).

New York State Department of Health, *Chemical Fact Sheet:* Niacinamide, Bureau of Toxic Substance Assessment, Albany, NY (March 1986).

Nickel & Compounds N:0220

Formula: Ni

Synonyms: *metal:* Alloy 725; Alloy 732; Alloy 735; Alloy 762; Alloy 770; C.I. 77775; FM 1208; HCA 1; Metallic Nickel; Ni; Ni 0901S (Harshaw); Ni 233; Ni 270; Ni 4303T; Nickel, Elemental; Nickel 0901S; Nickel 200; Nickel 201; Nickel 203; Nickel 204; Nickel 205; Nickel 211; Nickel 212; Nickel 213; Nickel 222; Nickel 223; Nickel 225; Nickel 229; Nickel 233; Nickel 270; Nickel 4303T; Nickel Sponge; Niklad 794-A; NP 2; Raney Alloy; Raney Nickel; RCH 55/5; Synonyms of other nickel compounds vary depending upon the specific compound.

CAS Registry Number: 7440-02-0

HSDB Number: 1096
RTECS Number: QR5950000 [*Annex I Index No.:* 028-002-00-7]
UN/NA & ERG Number: Metal powder, in bulk, may be pyrophoric: UN3089 (Metal powder, flammable, n.o.s.)/170; UN3077 (environmentally hazardous substances, solid, n.o.s.)/171; UN2881(Nickel catalyst, dry)/135 Nickel catalyst, dry; UN1378
EC Number: 231-111-4 [*Annex I Index No.:* 028-002-00-7]
Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen (Nickel compounds and metallic nickel); IARC (*Ni compounds*) Human Sufficient Evidence; Animal Sufficient Evidence, *carcinogenic to humans*, Group 1; (*elemental*): Animal Sufficient Evidence; Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B, (compounds) *carcinogenic to humans*, Group 1, 1997; NTP (*elemental and Ni compounds, soluble and insoluble*): NIOSH (*elemental and Ni compounds, soluble and insoluble*): Potential occupational carcinogen; United States Environmental Protection Agency Gene-Tox Program, Positive: Carcinogenicity-mouse/rat.

California Proposition 65 Chemical[102]: Cancer 1/1/1989; Nickel (metallic) 10/1/1989; nickel compounds 5/7/2004; Nickel refinery dust from the pyrometallurgical process 10/1/1987.

Hazard Alert: Flammability (powder), Pyrophoric (powder), Catalytic hazard, Strong reducing agent, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Possible sensitization hazard, Environmental hazard.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) as nickel compounds

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as nickel and compounds; Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 3.98; Nonwastewater (mg/L), 5.0 TCLP

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): total dust 6010 (50); 7520 (400)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 100 lb (45.4 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Dropped from listing of Extremely Hazardous Substance (EPCRA) in 1988

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%, as elemental nickel

Nickel compounds:

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as nickel and compounds

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed, as nickel compounds, n.o.s.

EPCRA Section 313: Includes any unique chemical substance that contains nickel as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: 0.1

Canada, WHMIS, Ingredients Disclosure List Concentration (most listed compounds are 0.1%). Nickel, water-insoluble compounds, n.o.s. and Nickel, water-soluble inorganic compounds, n.o.s. are 1%. See list.

Hazardous to aquatic life or environment, with possible long lasting effects: powder[194].

Hazard symbols, risk, & safety statements: Hazard symbol (*powder*): T, F+, N, Xi; risk phrases: R10 (powder); R17; R40; R43; R48/23; R51/53; R62; R63; safety phrases: S2; S29/35; S36/37/39; S41; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to waters (*nickel metal; nickel powder, particle size <0.1 mm*); 1-Low hazard to water. (*nickel, particle size >0.1 mm*).

Description: Nickel metal is a hard, ductile, magnetic metal with a silver-white color. Molecular weight = 58.7; specific gravity (H_2O:1) = 8.9 @ 20°C; boiling point = 2837°C; 29.13°C; freezing/melting point = 1455°C. Hazard identification (based on NFPA-704 M Rating System) (*powder*): Health 2; flammability 4; reactivity 1; (*metal*) Health 1; flammability 0; reactivity 0. Insoluble in water. It occurs free in meteorites and in ores combined with sulfur, antimony, or arsenic. Processing and refining of nickel is accomplished by either the Oxford (sodium sulfide and electrolysis) or the Mond (nickel carbonyl) processes. In the latter, impure nickel powder is reacted with carbon monoxide to form gaseous nickel carbonyl which is then treated to deposit high purity metallic nickel.

Potential Exposure: Nickel is used as an alloy additive in steel manufacture; in the production of coins and other utensils. Nickel forms alloys with copper, manganese, zinc, chromium, iron, molybdenum, etc. Stainless steel is the most widely used nickel alloy. An important nickel−copper alloy is Monel metal, which contains 66% nickel and 32% copper and has excellent corrosion resistance properties. Permanent magnets are alloys chiefly of nickel, cobalt, aluminum, and iron. Elemental nickel is used in electroplating, anodizing aluminum casting operations for machine parts; and in coinage; in the manufacture of acid-resisting and magnetic alloys; magnetic tapes; surgical and dental instruments; nickel−cadmium batteries; nickel soaps in crankcase oil; in ground-coat enamels; colored ceramics; and glass. It is used as a catalyst in the hydrogenation synthesis of acrylic esters for plastics. Exposure to nickel may also occur during mining, smelting, and refining operations. The route by which most people in the general population receive the largest portion of daily nickel intake is through food. Based on the available data from composite diet analysis, between 300 and 600 μg nickel per day are ingested. Fecal nickel analysis, a more accurate measure of dietary nickel intake, suggests about 300 μg per day. The highest level of nickel observed in water was 75 μg/L. Average drinking water levels are about 5 μg/L. A typical consumption of 2 L daily would yield an additional 10 μg of nickel, of which up to 1 μg would be absorbed.

Incompatibilities: Nickel dust is a spontaneously flammable solid and a dangerous fire hazard.

Permissible Exposure Limits in Air

NIOSH IDLH = 10 mg[Ni]/m^3

OSHA PEL (*elemental, soluble & insoluble compounds*): 1 mg[Ni]/m^3 TWA

NIOSH REL (*elemental, soluble & insoluble compounds*): 0.015 mg[Ni]/m^3 TWA; A potential occupational carcinogen. Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV[1] (*elemental*): 1.5 mg[Ni]/m^3 inhalable fraction TWA; not suspected as a human carcinogen; (*inorganic, insoluble compounds*) 0.2 mg[Ni]/m^3 inhalable fraction TWA, confirmed human carcinogen; (*inorganic, soluble compounds*) 0.1 mg[Ni]/m^3 inhalable fraction TWA, confirmed human carcinogen.

PAC Ver. 29[138]

PAC-1: 4.5 milligram per cubic meter

PAC-2: 50 milligram per cubic meter

PAC-3: 99 milligram per cubic meter

DFG MAK (*elemental & nickel compounds*): Inhalable fraction, sensitization of the respiratory tract and skin; Carcinogen Category 1; DFG TRK: *As inhalable dusts/aerosols from nickel metal*: 0.50 μg[Ni]/L in urine, after several shifts; Carcinogen Category 1 DFG TRK: 0.50 μg[Ni]/L in urine, after several shifts; Category 1, human carcinogen, as inhalable dusts/aerosols from nickel metal, nickel carbonate arising in production and processing.

Arab Republic of Egypt: TWA 0.1 milligram per cubic meter, 1993; Australia: TWA 1 milligram per cubic meter, 1993; Austria: carcinogen, 1999; Denmark: TWA 0.5 milligram per cubic meter, 1999; Finland: TWA 0.1 milligram per cubic meter [skin] carcinogen, 1999; France: VME 1 milligram per cubic meter, continuous carcinogen, 1999; Hungary: STEL 0.005 mg[Ni]/m^3, Carcinogen (insoluble compounds), 1993; the Netherlands: MAC-TGG 1 milligram per cubic meter, 2003; the Phillipines: TWA 1 milligram per cubic meter, 1993; Poland: MAC (TWA) 0.25 milligram per cubic meter, 1999; Russia: STEL 0.05 milligram per cubic meter, 1993; Sweden: NGV 0.5 milligram per cubic meter (*dust*), 1999; Switzerland: MAK-W 0.5 milligram per cubic meter, carcinogen, 1999; Thailand: TWA 1 milligram per cubic meter, 1993; United Kingdom: TWA 0.1 milligram per cubic meter, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Confirmed Human Carcinogen. Russia[35][43] set a MAC in ambient air in residential areas of 0.0002 milligram per cubic meter for soluble nickel salts. Various states have set guidelines or standards for nickel in ambient air[60] ranging from 0.002 μ/m^3 (Rhode Island) to 0.002−0.018 μ/m^3 (Massachusetts) to 0.0303 μ/m^3 (Kansas) to 0.13−0.70 μ/m^3 (Montana) to 0.24 μ/m^3 (Pennsylvania) to 0.5 μ/m^3 (North Carolina and South Carolina) to 1.0 μ/m^3 (North Dakota) to 2.0 μ/m^3 (Nevada) to 3.3 μ/m^3 (New York) to 5.0 μ/m^3 (Connecticut) to 10.0 μ/m^3 (Virginia).

Determination in Air: Use NIOSH Analytical Method #7300, Elements by ICP (Nitric/perchloric acid ashing); #7301, Elements by ICP (Aqua regia ashing); #7303, Elements by ICP [Hot block (HCl/HNO_3 Digestion)]; #9102, Elements on wipes; #8310, Metals in urine, #8005, Elements in blood or tissue; OSHA Analytical Methods ID-121 and ID-125G.

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 100 μg[Ni]/L; State Drinking Water Standards: California 100 μg[Ni]/L; Connecticut: 100 μg [Ni]/L; Delaware: 100 μg[Ni]/L; Wisconsin: 100 μg[Ni]/L; State Drinking Water Guidelines: Arizona 150 μg[Ni]/L; Massachusetts: 100 μg[Ni]/L; Maine: 140 μg[Ni]/L; Minnesota: 100 μg[Ni]/L.

Determination in Water: Digestion followed by atomic absorption, or by colorimetric (heptoxime) determination; or by Inductively Coupled Plasma (ICP) Optical Emission Spectrometry. This gives total nickel; dissolved nickel may be determined by the same method preceded by 0.45 μm filtration.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Nickel dusts and fumes can affect you when breathed in. Can cause irritation of the eyes and skin. Skin contact may cause skin allergy, with itching, redness and later, rash. Lung allergy occasionally occurs with asthma-type effects. Fumes from heated nickel can cause pneumonia-like illness with cough and shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours or days. This can cause death.

Long-Term Exposure: May cause skin and respiratory sensitization and allergy. May cause allergic asthma, pneumonitis. Breathing nickel dust and fume can cause a sore or hole in the nasal septum. May damage the kidneys and affect liver function. Nickel is a carcinogen and may damage the developing fetus. Occupational exposure to nickel refinery dust contains nickel subsulfide, and is associated with lung cancer. Handle with extreme caution.

Points of Attack: Nasal cavities, lungs, skin, liver, kidneys. *Cancer site:* lung, throat, and nasal cancer.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure. NIOSH lists the following tests: Blood Gas Analysis; whole blood (chemical/metabolite); blood plasma; end-of-shift; blood serum; biologic tissue/biopsy; chest X-ray, electrocardiogram, pulmonary function tests; pre- & postshift; sputum cytology; urine (chemical/metabolite); end-of-shift; white blood cell count/differential. Before beginning employment and at regular times after that, the following are recommended. Lung function tests. These may be normal if the person is not having an attack at the time of the test. Urine or plasma test for nickel (unexposed persons have urine levels less than 10 μg/L). If symptoms develop or overexposure is suspected, the following may be useful: Daily urine nickel for several days (persons with urine nickel over 100 μg need medical attention). Consider chest X-ray for acute overexposure. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: Inhalation: Bronchodilators, decongestants and oxygen may be used if necessary. Corticosteroids are useful for treating pneumonitis.

Note to physician: For severe poisoning BAL (British Anti-Lewisite), dimercaprol, dithiopropanol ($C_3H_8OS_2$) has been used to treat toxic symptoms of certain heavy metals poisoning—including nickel. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Specific engineering controls are recommended by NIOSH Criteria Document #77-164, *Inorganic Nickel.*

Respirator Selection: *At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with an N100, R100, or P100 filter).

Storage: Pyrophoric (dry nickel powder, Raney nickel, and nickel catalyst) are fire hazards. Prior to working with these chemicals, all handlers should be trained on its proper handling and storage. Finely divided nickel must be stored to avoid contact with strong acids (such as hydrochloric, sulfuric, and nitric), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from acids, fluorine, ammonia, phosphorus, sulfur, selenium, hydrazine, and performic acid. Sources of ignition, such as smoking and open flames, are prohibited where pulverized nickel is handled, used, or stored. Wherever pulverized nickel is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN3089 Metal powders, flammable, n.o.s., Hazard Class: 4.1; Labels: 4.1-Flammable solid. UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard Class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Use dry chemicals, sand, water spray or foam. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. Keep nickel catalyst spills out of confined spaces, such as sewers, because of the possibility of an explosion or fire. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Nickel dust is flammable. Use dry chemical, soda ash; or lime extinguishers. Thermal decomposition products may include metal oxides. Dry nickel catalyst may spontaneously ignite and the fire may restart after it has been extinguished. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Nickel compounds-encapsulation followed by disposal in a chemical waste landfill. However, nickel from various industrial wastes may also be recovered and recycled as described in the literature.

References

(109); (102); (31); (173); (101); (138); (2); (170); (100).

National institute for Occupational Safety and Health (NIOSH), "Criteria for a Recommended Standard: Occupational Exposure to Inorganic Nickel," NIOSH Document Number 77-64, Cincinnati, OH (1977).

National Academy of Sciences, *Report on Medical and Biological Effects of Environmental Pollutants: Nickel*, Washington, DC (1975).

United States Environmental Protection Agency, *Nickel: Ambient Water Quality Criteria*, Washington, DC (1980).

United States Environmental Protection Agency, *Nickel, Health and Environmental Effects Profile No. 133*, Washington, DC, Office of Solid Waste (April 30, 1980).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 1, No. 1, 50−51 (1980) and 3, No. 3, 76−80 (1983).

United States Public Health Service, *Toxicological Profile for Nickel*, Atlanta, Georgia, Agency for Toxic Substances and Disease Registry (October 31, 1987).

United States Environmental Protection Agency, *Chemical Hazard Information Profile:* Nickel, Washington, DC, Chemical Emergency Preparedness Program (October 31, 1985).

New York State Department of Health, *Chemical Fact Sheet:* Nickel Metal and Soluble Nickel Compounds, Bureau of Toxic Substance Assessment, Albany, NY (March 1986 and Version 2).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Nickel, Trenton, NJ (March 2007).

Nickel Ammonium Sulfate N:0230

Formula: $H_{20}N_2NiO_{14}S2$; $NiSO_4 \cdot (NH_4)_2SO_4 \cdot 6H_2O$

Synonyms: Ammonium disulfatonickelate (II); Ammonium nickel sulfate; Nickel ammonium sulfate; Sulfato de niquel y amonio (Spanish); Sulfuric acid, ammonium nickel(2+) salt (2: 2:1); Sulfuric acid, ammonium nickel(II) salt (2: 2:1)

CAS Registry Number: 15699-18-0; 7785-20-8 (hexahydrate)

HSDB Number: 1241

RTECS Number: WS6050000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171; UN3288 (Toxic solid, inorganic, n.o.s.)/151

EC Number: 239-793-5

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen (Nickel compounds and metallic nickel); IARC: (compounds) *carcinogenic to humans,* Group 1, 1997; NIOSH: Potential occupational carcinogen.

California Proposition 65 Chemical[102]: Cancer (as nickel compounds) 5/7/2004

Hazard Alert: Poison, Highly Toxic, Environmental hazard, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Sensitization hazard

United States National Primary Drinking Water Regulations: SMCL = 250 mg[SO_4^{-2}]/L as Sulfate

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) as nickel compounds

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR401.15 Section 307 Toxic Pollutants as nickel and compounds; Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed, as nickel compounds, n.o.s.

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 100 lb (45.4 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, Xi, N; risk phrases: R45; R27/28; R42/43; R50/53; R62; R63; safety phrases: S13; S22; S28; S29/35; S36/37; S45; S53; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Nickel ammonium sulfate is a green, odorless powder. Molecular weight = 286.93; specific gravity (H_2O:1) = 1.9. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0; reactivity 1. Soluble in water; forms an acidic solution.

Potential Exposure: This material is used in electroplating.

Incompatibilities: Forms an acidic solution with water. A weak oxidizer; keep away from combustible materials, reducing agents, including hydrides. Possible violent reaction with strong acids. Incompatible with nickel nitrate, sulfur, selenium, wood, organics, and other combustibles.

Permissible Exposure Limits in Air
NIOSH IDLH = 10 mg[Ni]/m^3
OSHA PEL (*elemental, soluble & insoluble compounds*): 1 mg[Ni]/m^3 TWA
NIOSH REL (*elemental, soluble & insoluble compounds*): 0.015 mg[Ni]/m^3 TWA; A potential occupational carcinogen. Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A.
ACGIH TLV[1] (*inorganic, soluble compounds*) 0.1 mg [Ni]/m^3 inhalable fraction TWA, confirmed human carcinogen.
PAC Ver. 29[138]
15699-18-0
PAC-1: 1.5 milligram per cubic meter
PAC-2: 13 milligram per cubic meter
PAC-3: 79 milligram per cubic meter
DFG MAK (*elemental & nickel compounds*): Inhalable fraction, sensitization of the respiratory tract and skin; Carcinogen Category 1; DFG TRK: *As inhalable dusts/aerosols from nickel metal*: 0.50 μg[Ni]/L in urine, after several shifts; Carcinogen Category 1.

Determination in Air: Use NIOSH Analytical Method #7300, Elements by ICP (Nitric/Perchloric Acid Ashing); #7301, Elements by ICP (Aqua Regia Ashing); #7303, Elements by ICP [Hot Block (HCl/HNO_3 Digestion)]; #9102, Elements on Wipes; #8310, Metals in urine, #8005, Elements in blood or tissue; OSHA Analytical Methods ID-121 and ID-125G.

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 100 μg[Ni]/L; State Drinking Water Standards: California 100 μg[Ni]/L; Connecticut: 100 μg [Ni]/L; Delaware: 100 μg[Ni]/L; Wisconsin: 100 μg[Ni]/L; State Drinking Water Guidelines: Arizona 150 μg[Ni]/L; Massachusetts: 100 μg[Ni]/L; Maine: 140 μg[Ni]/L; Minnesota: 100 μg[Ni]/L.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Nickel ammonium sulfate can affect you when breathed in. Eye and skin contact may cause irritation and burns. Lung damage may result from a single high exposure or lower repeated exposure. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. This is sometimes delayed for 1−2 days after exposure.

Long-Term Exposure: Skin contact may cause skin allergy with itching, redness, and later, rash. Lung allergy occasionally occurs, with asthma-type effects. High or repeated lower exposures may cause scarring of the lungs, and may damage the heart, liver, or kidneys.

Points of Attack: Lungs, kidneys, heart, liver, skin.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure. NIOSH lists the following tests: Blood Gas Analysis; whole blood (chemical/metabolite); blood plasma; blood plasma, end-of-shift; blood serum; biologic tissue/biopsy; chest X-ray, electrocardiogram, pulmonary function tests; pre- & postshift; sputum cytology; urine (chemical/metabolite); end-of-shift; white blood cell count/differential. Before beginning employment and at regular times after that, the following are recommended. Lung function tests. These may be normal if the person is not having an attack at the time of the test. Urine or plasma test for nickel (unexposed persons have urine levels less than 10 μg/L). If symptoms develop or overexposure is suspected, the following may be useful: daily urine nickel for several days (person's urine nickel over 100 μg needs medical attention). Lung function tests. Consider chest X-ray following acute overexposure. Liver and kidney function tests. Evaluation by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility for medical observation up to 2 days and tests for urine nickel. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Note to physician: For severe poisoning BAL (British Anti-Lewisite), dimercaprol, dithiopropanol ($C_3H_8OS_2$) has been used to treat toxic symptoms of certain heavy metals poisoning—including nickel. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when

skin is wet or contaminated. Provide emergency showers and eyewash. See NIOSH Criteria Document #77-164, *Inorganic Nickel*.

Respirator Selection: *At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with an N100, R100, or P100 filter.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Nickel ammonium sulfate must be stored to avoid contact with strong acids (such as hydrochloric, sulfuric, and nitric), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from sulfur.

Shipping: UN3288 Toxic solids, inorganic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard Class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical may burn but does not easily ignite. Thermal decomposition products may include oxides of nitrogen, sulfur, metal and carbon. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(109); (102); (31); (173); (101); (138); (2); (100).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 5, No. 4, 74–76 (1985).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Nickel Ammonium Sulfate, Trenton, NJ (January 1996).

Nickel Carbonyl N:0240

Formula: C_4NiO_4; $Ni(CO)_4$

Synonyms: Nickel carbonyle (French); Nickel tetracarbonyl; Nickel tetracarbonyle (French); Niquel carbonilo (Spanish); Tetracarbonyl nickel

CAS Registry Number: 13463-39-3

HSDB Number: 1663

RTECS Number: QR6300000

UN/NA & ERG Number: (PIH) UN1259/131

EC Number: 236-669-2 [*Annex I Index No.:* 028-001-00-1]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen (Nickel compounds and metallic nickel); IARC:[9] *possibly carcinogenic to humans*, Group B2; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies; NIOSH: Potential occupational carcinogen.

California Proposition 65 Chemical[102]: Cancer 10/1/1987; Developmental/Reproductive toxin 9/1/1996.

Hazard Alert: Poison inhalation hazard: exposure can be lethal, Highly toxic gas, with inadequate warning properties, Highly flammable, Possible risk of forming tumors, Reproductive toxin: Suspected of causing genetic defects, Environmental hazard.

OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 150 lb

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) as nickel compounds; Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 1000 lb (454.0 kg)

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as nickel and compounds

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P073

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

SUPERFUND/EPCRA 302, Extremely Hazardous Substances: TPQ = 1 lb (0.454 kg)

United States DOT Regulated marine pollutant (49CFR172.101, Appendix B)

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazard symbols, risk, & safety statements: Hazard symbol: F, T+, N; risk phrases: R61; R11; R26; R40; R50/53; R62; safety phrases: S1; S21; S45; S53; S41; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)]

Description: Nickel carbonyl is a colorless, highly volatile, flammable liquid with a musty odor. The Odor Threshold is 1.3 ppm. It decomposes above room temperature producing carbon monoxide and finely divided nickel. Molecular weight = 170.73; specific gravity (H_2O:1) = 1.32 @ 17°C; boiling point = 42°C; freezing/melting point = -19°C; vapor pressure = 315 mmHg @ 20°C; 750 mmHg @ 42°C; Flash point < -24°C (cc); Autoignition temperature: 60°C. Explosive limits: LEL = 2%; UEL: 34%. Hazard identification (based on NFPA-704 M Rating System): Health 4; flammability 3; reactivity 3. Insoluble in water.

Potential Exposure: Nickel carbonyl is used as an intermediate product in the refining of nickel. The primary use for nickel carbonyl is in the production of nickel by the Mond process. Impure nickel powder is reacted with carbon monoxide to form gaseous nickel carbonyl which is then treated to deposit high purity metallic nickel and release carbon monoxide. Other uses include gas plating; the production of nickel products; in chemical synthesis as a catalyst, particularly for oxo reactions (addition reaction of hydrogen and carbon monoxide with unsaturated hydrocarbons to form oxygen-function compounds); e.g., synthesis of acrylic esters; and as a reactant.

Incompatibilities: May spontaneously ignite on contact with air. In the presence of air, oxidizes and forms a deposit which becomes peroxidized; this tends to decompose and ignite. May explode when heated above 60°C. Decomposes on contact with acids producing carbon monoxide. Violent reaction with oxidizers; may cause fire and explosions. Vapor may promote the ignition of mixtures of combustible vapors (such as gasoline) and air. Attacks some plastics, rubber and coatings. Store under inert gas blanket.

Permissible Exposure Limits in Air

NIOSH IDLH = 2 ppm

Conversion factor: 1 ppm = 6.98 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 0.0001 ppm/0.007 mg[Ni]/m^3 TWA

NIOSH REL: 0.0001 ppm/0.007 mg[Ni]/m^3 TWA, potential carcinogen, limit occupational exposure to lowest feasible level; See *NIOSH Pocket Guide*, Appendix A

ACGIH TLV[1]: 0.05 ppm/0.12 mg[Ni]/m^3 TWA

PAC* Ver. 29[138]

PAC-1: 0.0033 ppm

PAC-2: **0.036**$_{\mathbf{A}}$ ppm

PAC-3: **0.16**$_{\mathbf{A}}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

DFG MAK: [skin] Carcinogen Category 2

Arab Republic of Egypt: TWA 0.007 ppm (0.001 milligram per cubic meter), 1993; Australia: TWA 0.05 ppm (0.1 milligram per cubic meter), 1993; Austria: carcinogen, 1999; Belgium: carcinogen, 1993; Denmark: TWA 0.001 ppm (0.007 mg[Ni]/m^3 [skin]), 1999; Finland: TWA 0.001 ppm (0.007 milligram per cubic meter); STEL 0.003 ppm, carcinogen, 1999; France: VME 0.05 ppm (0.23 mg[Ni]/m^3), 1999; the Netherlands: MAC-TGG 0.35 milligram per cubic meter, 2003; Japan: 0.001 ppm (0.007 milligram per cubic meter), 1999; Norway: TWA 0.001 ppm (0.007 milligram per cubic meter), 1999; the Phillipines: TWA 0.001 ppm (0.007 milligram per cubic meter), 1993; Russia: TWA 0.001 ppm; STEL 0.0005 milligram per cubic meter, carcinogen, 1993; Sweden: NGV 0.001 ppm (0.007 milligram per cubic meter), carcinogen, 1999; Switzerland: MAK-W 0.05 ppm (0.35 milligram per cubic meter), [skin], carcinogen, 1999; Thailand: TWA 0.001 ppm (0.007 milligram per cubic meter), 1993; Turkey: TWA 0.001 ppm (0.007 milligram per cubic meter), 1993; United Kingdom: STEL 0.1 ppm (0.24 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 0.05 (Ni) ppm. The Czech Republic:[35] TWA 0.01 milligram per cubic meter; ceiling value 0.02 milligram per cubic meter. Several states have set guidelines or standards for nickel carbonyl in ambient air[60] ranging from 1.17 μ/m^3 (New York) to 1.75 μ/m^3 (Connecticut and South Carolina) to 5.0 μ/m^3 (Virginia) to 8.0 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method #6007, Nickel carbonyl. Charcoal tube (low Ni); HNO_3; Graphite furnace atomic absorption spectrometry; NIOSH Analytical Method (IV) #6007.

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 100 μg[Ni]/L; State Drinking Water Standards: California 100 μg[Ni]/L; Connecticut: 100 μg [Ni]/L; Delaware: 100 μg[Ni]/L; Wisconsin: 100 μg[Ni]/L; State Drinking Water Guidelines: Arizona 150 μg[Ni]/L; Massachusetts: 100 μg[Ni]/L; Maine: 140 μg[Ni]/L; Minnesota: 100 μg[Ni]/L.

Routes of Entry: It may be possible for appreciable amounts of the liquid to be absorbed through the skin; also ingestion and eye and skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates and burns the eyes and skin. Irritates the respiratory tract. May affect the central nervous system and the kidneys, causing tissue lesions. Medical observation is advised for 3 days or more; delayed lung effects may occur. Probable oral lethal dose for a human is between 50 and 500 mg/kg, between one teaspoon and one ounce per 150 lb person. Nickel carbonyl has also been estimated to be lethal in humans at atmospheric exposures of 30 ppm for 20 minutes. Autopsies show congestion, collapse, and tissue destruction; as well as hemorrhage in the brain. Dermatitis, recurrent asthmatic attacks; and increased number of white blood cells (eosinophils) in respiratory tract are acute health hazards. Acute exposure to nickel carbonyl may result in dizziness, giddiness, weakness, convulsions, hallucinations, delirium, nausea, vomiting, and diarrhea. Following inhalation, respiration will initially be rapid, accompanied by a nonproductive cough; and followed by pain and tightness in the chest. Pulmonary edema, cerebral edema; and hepatic (liver) degeneration may also occur. Vapor is irritating to the eyes, nose, and throat. Nickel contact dermatitis is the most common reaction to nickel carbonyl. Nickel itch may begin with a burning sensation and itching, often followed by erythema (redness) and nodular eruptions.

Long-Term Exposure: Repeated or prolonged inhalation exposure may cause skin and lung sensitization and asthma. A potential occupational carcinogen. In animals: reproductive, teratogenic effects. Permanent lung damage may occur following a single high exposure or lower repeated exposure. High or repeated exposures may cause damage to the heart muscle, liver, and/or kidney damage.

Points of Attack: Lungs, paranasal sinus, central nervous system; reproductive system; liver, kidney, heart.

Medical Surveillance: NIOSH lists the following tests: Blood Gas Analysis; blood plasma; chest X-ray, electrocardiogram, Expired Air, 2H; pulmonary function tests; Forced Vital Capacity, Forced Expiratory Volume (1 second); sputum cytology; urinalysis (routine); white blood cell count/differential. Before beginning employment and at regular times after that, the following are recommended. Lung function tests. Urine or plasma test for nickel (unexposed persons have urine levels under 10 μg/L). If symptoms develop or overexposure is suspected, the following may be useful: daily urine nickel for several days. Lung function tests. Chest X-ray (persons with urine levels over 100 μg/L need medical observation). Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is advised for 3 days or more; delayed lung effects including pulmonary edema may occur.

Note to physician: For severe poisoning BAL (British Anti-Lewisite), dimercaprol, dithiopropanol ($C_3H_8OS_2$) has been used to treat toxic symptoms of certain heavy metals poisoning—including nickel. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See NIOSH Criteria Document #77-164, *Inorganic Nickel.*

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full facepiece respirator with an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Poison inhalation chemical (PIH); check oxygen content prior to entering storage area. (1) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. (2) Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Nickel carbonyl must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from strong acids (such as hydrochloric, sulfuric, and nitric). Sources of ignition, such as smoking and open flames, are prohibited where nickel carbonyl is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of nickel carbonyl should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of nickel carbonyl. Wherever nickel carbonyl is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1259 Nickel carbonyl, Hazard Class: 6.1; Labels: 6.1-Poisonous materials, 3-Flammable liquid, Inhalation Hazard Zone A. A United States DOT Severe Marine Pollutant.

Spill Handling:

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424−9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548−8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft./m)500/150

Then: Protect persons downwind (mi/km)

Day 0.9/1.5

Night 3.1/4.9

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft./m) 3000/1000

Then: Protect persons downwind (mi/km)

Day 7.0 +/11.0+*

Night 7.0+/11.0+*

*+ means distance can be larger in certain atmospheric conditions.

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition includes oxides of carbon. Use dry chemical, carbon dioxide; or foam extinguishers. Solid streams of water may be ineffective. Material is too dangerous to health to expose fire fighters. A few whiffs of the vapor could cause death. If liquid or vapor penetrates fire fighter's protective gear it will cause fatality. Normal full protective gear available to the average fire department will not provide adequate inhalation or skin protection. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration in admixture with a flammable solvent. Also, nickel carbonyl used in metallizing operations may be recovered and recycled. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(109); (102); (31); (173); (101); (138); (2); (100).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 5, No. 4, 76−82 (1985) and 8, No. 6, 8−16 (1988).

United States Environmental Protection Agency, *Chemical Hazard Information Profile:* Nickel Carbonyl, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

New York State Department of Health, *Chemical Fact Sheet:* Nickel Carbonyl, Bureau of Toxic Substance Assessment, Albany, NY (March 1986, Version 2).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Nickel Carbonyl, Trenton, NJ (February 2001).

Nickel Chloride N:0250

Formula: Cl_2Ni; $NiCl_2$

Synonyms: Cloruro de niquel (Spanish); Nickel(2+) chloride; Nickel(2+) chloride (1:2); Nickel(II) chloride;

Nickel(II) chloride (1:2); Nickel chloride (ous); Nickelous chloride

CAS Registry Number: 7718-54-9; 37211-05-5; 7791-20-0 (hexahydrate)

HSDB Number: 860

RTECS Number: QR6475000

UN/NA & ERG Number: UN3288 (Toxic solid, inorganic, n.o.s.)/151

EC Number: 231-743-0 [*Annex I Index No.:* 028-011-00-6] (*37211-05-5*)

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen (Nickel compounds and metallic nickel); IARC: (compounds) *carcinogenic to humans,* Group 1, 1997; NIOSH: Potential occupational carcinogen.

California Proposition 65 Chemical[102]: (nickel compounds) Cancer 5/7/2004

Hazard Alert: Poison, Sensitization hazard, Suspected of causing genetic defects, Suspected reprotoxic hazard, Environmental hazard

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) as nickel compounds

United States National Primary Drinking Water Regulations: SMCL = 250 mg[Cl^-]/L as Chloride

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR401.15 Section 307 Toxic Pollutants as nickel and compounds; Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed, as nickel compounds, n.o.s.

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 100 lb (45.4 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazardous to aquatic life or environment, with possible long lasting effects[291,292].

Hazard symbols, risk, & safety statements: Hazard symbol: T, N, Xi; risk phrases (*7718-54-9*): R49; R61; R23/25; R38; R42/43; R48/23; R68; R50/53; R62; R63; safety phrases: S29/35; S41; S45; S53; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water. (CAS: 7718-54-9)

Description: Nickel chloride appears as green or brown scales, or sparkling golden-yellow powder. Molecular weight = 129.61; specific gravity (H_2O:1) = 3.5 @ 20°C; sublimation temperature = 973°C; freezing/melting point = 1000°C. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 0; reactivity 0; (*hexahydrate*) Health 3; flammability 0; reactivity 0. Soluble in water.

Potential Exposure: Nickel chloride is used in electroplating and ink manufacturing.

Incompatibilities: Strong acids, potassium, sulfur. Forms an impact-sensitive mixture with potassium.

Permissible Exposure Limits in Air

NIOSH IDLH = 10 mg [Ni]/m^3

OSHA PEL: 1 mg[Ni]/m^3 TWA

NIOSH REL: 0.015 mg[Ni]/m^3 TWA; A potential occupational carcinogen. Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV[1]: 0.1 mg[Ni]/m^3 TWA, inhalable fraction, confirmed human carcinogen

7718-54-9

PAC Ver. 29[138]

PAC-1: 0.66 milligram per cubic meter

PAC-2: 22 milligram per cubic meter

PAC-3: 130 milligram per cubic meter

DFG MAK: Inhalable fraction, sensitization of the respiratory tract and skin; Carcinogen Category 1 Russia set a MAC level of 0.005 milligram per cubic meter for nickel salts and aerosols.

PAC Ver. 29[138]

7791-20-0, hexahydrate

PAC-1: 1.2 milligram per cubic meter

PAC-2: 5.2 milligram per cubic meter

PAC-3: 31 milligram per cubic meter

Determination in Air: Use NIOSH Analytical Method #7300, Elements by ICP (Nitric/Perchloric Acid Ashing); #7301, Elements by ICP (Aqua Regia Ashing); #7303, Elements by ICP [Hot Block (HCl/HNO_3 Digestion)]; #9102, Elements on Wipes; #8310, Metals in urine, #8005, Elements in blood or tissue; OSHA Analytical Methods ID-121 and ID-125G.

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 100 μg[Ni]/L; State Drinking Water Standards: California 100 μg[Ni]/L; Connecticut: 100 μg [Ni]/L; Delaware: 100 μg[Ni]/L; Wisconsin: 100 μg[Ni]/L; State Drinking Water Guidelines: Arizona 150 μg[Ni]/L; Massachusetts: 100 μg[Ni]/L; Maine: 140 μg[Ni]/L; Minnesota: 100 μg[Ni]/L.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Nickel chloride can affect you when breathed in. Exposure can irritate and inflame the air passages and sinuses; causing cough, phlegm, shortness of breath; and ulceration. Contact can irritate and burn the eyes or skin.

Long-Term Exposure: Repeated or prolonged contact with skin may cause dermatitis. Repeated or prolonged contact may cause skin sensitization. Repeated or prolonged inhalation exposure may cause asthma-like allergy. Once allergy develops, even low future exposures can trigger symptoms. Repeated exposure can cause lung scarring and may affect the kidneys. Nickel chloride may cause mutations. Handle with extreme caution.

Points of Attack: Skin, lungs, kidneys.

Medical Surveillance: NIOSH lists the following tests: Blood gas analysis; whole blood (chemical/metabolite);

blood plasma; blood plasma, end-of-shift; blood serum; biologic tissue/biopsy; chest X-ray, electrocardiogram, pulmonary function tests; pre- & postshift; sputum cytology; urine (chemical/metabolite); end-of-shift; white blood cell count/differential. If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Consider lung function tests if lung symptoms are present. Kidney function tests. Chest X-ray. Daily testing for urine nickel for several days. Persons with urine nickel over 100 μg/L require immediate medical attention.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: For severe poisoning BAL (British Anti-Lewisite), dimercaprol, dithiopropanol ($C_3H_8OS_2$) has been used to treat toxic symptoms of certain heavy metals poisoning—including nickel. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid, unless full facepiece respiratory protection is worn. Wear dust-proof goggles and face shield when working with powders or dust, unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See NIOSH Criteria Document #77-164, *Inorganic Nickel*.

Respirator Selection: *At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with an N100, R100, or P100 filter).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Nickel chloride must be stored to avoid contact with strong acids (such as hydrochloric, sulfuric, and nitric), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from potassium and sulfur. Mixtures of nickel chloride and potassium will produce a strong explosion on impact.

Shipping: UN3288 Toxic solids, inorganic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Nickel chloride itself may burn but does not easily ignite. Thermal decomposition products may include hydrogen chloride and oxides of metal and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Recycle or disposal in a chemical waste landfill is recommended[22].

References
(109); (102); (31); (173); (101); (138); (2); (100).
New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Nickel Chloride, Trenton, NJ (June 2002).

Nickel Cyanide N:0260

Formula: C_2N_2Ni; $Ni(CN)_2$
Synonyms: Cianuro de niquel (Spanish); Nickel(2+) cyanide; Nickel(II) cyanide; Nickel cyanide, solid
CAS Registry Number: 557-19-7
HSDB Number: 1185
RTECS Number: QR6495000
UN/NA & ERG Number: UN1653/151
EC Number: 209-160-8 [*Annex I Index No.:* 028-034-00-1]
Regulatory Authority and Advisory Information
Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen (Nickel compounds and metallic nickel); IARC: (compounds) *carcinogenic to humans,* Group 1, 1997; NIOSH: Potential occupational carcinogen.
California Proposition 65 Chemical[102]: (nickel compounds) Cancer 5/7/2004
Hazard Alert: Poison, Sensitization hazard, Environmental hazard,
United States National Primary Drinking Water Regulations: MCLG = 0.2 mg[CN^-]/L; MCL = 0.2 mg [CN^-]/L as cyanide
Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) as nickel compounds
Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as nickel and compounds
United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P074
RCRA, 40CFR261, Appendix 8 Hazardous Constituents
Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 10 lb (4.54 kg)
EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.
United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)
Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.
Hazardous to aquatic life or environment, with possible long lasting effects[291,292].
Hazard symbols, risk, & safety statements: Hazard symbol: T, N, Xi; risk phrases: R49; R32; R42/43; R48/23; R50/53; safety phrases: S41; S45; S53; S60; S61 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)]
Description: Nickel cyanide is a yellowish-brown plates or powder that may change to a green color by absorbing moisture. Odor is a weak almond odor like cyanide. Moledcular weight = 110.75; specific gravity (H_2O:1) = 2.4 @ 20°C; Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 0; reactivity 0. Insoluble in water.
Potential Exposure: Nickel cyanide is used in metallurgy, electroplating and making other chemicals.
Incompatibilities: Nnickel cyanide is thermally unstable and easily oxidized. Weakly basic. Liberates flammable and lethally poisonous hydrogen cyanide gas on contact with acids or acid fumes. Undergoes violent reactions with fluorine, hypochlorites, nitric acid, nitrates, nitrites. Undergoes an explosive reaction if melted with nitrites or chlorates (at about 450°C). Violent reaction with magnesium. Keep away from acids, active metals, heat, or CO_2; contact can cause release of toxic cyanide gas.
Permissible Exposure Limits in Air
NIOSH IDLH = 10 mg[Ni]/m^3
OSHA PEL (*elemental, soluble & insoluble compounds*): 1 mg[Ni]/m^3 TWA
NIOSH REL (*elemental, soluble & insoluble compounds*): 0.015 mg[Ni]/m^3 TWA; A potential occupational carcinogen. Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A.
ACGIH TLV[1] (*inorganic, soluble compounds*) 0.1 mg [Ni]/m^3 inhalable fraction TWA, confirmed human carcinogen.
PAC Ver. 29[138]
PAC-1: 1.1 milligram per cubic meter
PAC-2: 13 milligram per cubic meter
PAC-3: 75 milligram per cubic meter
DFG MAK (*elemental & nickel compounds*): Inhalable fraction, sensitization of the respiratory tract and skin; Carcinogen Category 1; DFG TRK: *As inhalable dusts/aerosols from nickel metal*: 0.50 μg[Ni]/L in urine, after several shifts; Carcinogen Category 1.
Russia set a MAC level of 0.005 milligram per cubic meter for nickel salts and aerosols.
as cyanides
NIOSH recommends a level of 5 milligram per cubic meter not to be exceeded during any 10-minute work period. ACGIH recommends a TWA of 5 milligram per cubic meter.
Determination in Air: Use NIOSH Analytical Method #7300, Elements by ICP (Nitric/Perchloric Acid Ashing); #7301, Elements by ICP (Aqua Regia Ashing); #7303, Elements by ICP [Hot Block (HCl/HNO_3 Digestion)]; #9102, Elements on Wipes; #8310, Metals in urine, #8005, Elements in blood or tissue; OSHA Analytical Methods ID-121 and ID-125G.
Permissible Concentration in Water: Federal Drinking Water Standards: EPA 100 μg[Ni]/L; State Drinking Water Standards: California 100 μg[Ni]/L; Connecticut: 100 μg[Ni]/L; Delaware: 100 μg[Ni]/L; Wisconsin: 100 μg [Ni]/L; State Drinking Water Guidelines: Arizona 150 μg[Ni]/L; Massachusetts: 100 μg[Ni]/L; Maine: 140 μg [Ni]/L; Minnesota: 100 μg[Ni]/L. Federal Drinking Water

Guidelines: EPA 200 μg[CN]/L; State Drinking Water Standards: California 150 μg[CN]/L; State Drinking Water Guidelines: Arizona 220 μg[CN]/L; Maine 140 μg[CN]/L; Minnesota 100 μg[CN]/L. United States Army field drinking-water standards for cyanide: 2 mg[CN]/L assuming a water consumption of 15 L/day and 6 mg[CN]/L assuming a water consumption of 5 L/day. United States Army field drinking-water standards for cyanide, long-term consumption 0.5 mg[CN]/L; Short-term consumption; Raw water constituents (maximum) 20 mg[CN]/L. Consider the restrictions imposed both by nickel and by cyanide. However, the lifetime health advisories developed by EPA[49] are 154 μg/L for cyanide and 150 μg/L for nickel, which are nearly the same.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Nickel cyanide can affect you when breathed in. Eye contact may cause irritation. Skin contact may cause skin allergy, with itching and redness, and later, rash. Fumes can cause pneumonia-like illness, with coughing and/or shortness of breath. Lung damage may result from a single high exposure or lower repeated exposures. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Lung allergy occasionally occurs with asthma-type effect. High or repeated lower exposures may damage the heart, liver, or kidneys.

Long-Term Exposure: Lung allergy occasionally occurs with asthma-type effect. Skin contact can cause allergy. High or repeated lower exposures may damage the lungs, with scarring of the lung tissue; and may cause damage to the heart, liver, or kidneys.

Points of Attack: Lungs, liver, kidneys.

Medical Surveillance: NIOSH lists the following tests: Blood Gas Analysis; whole blood (chemical/metabolite); blood plasma; blood plasma, end-of-shift; blood serum; biologic tissue/biopsy; chest X-ray, electrocardiogram, pulmonary function tests; pre- & postshift; sputum cytology; urine (chemical/metabolite); end-of-shift; white blood cell count/differential. Before beginning employment and at regular times after that, the following are recommended: lung function tests, urine or plasma test for nickel (unexposed persons have urine levels less than 10 μg/L). If symptoms develop or overexposure is suspected, the following may be useful: daily urine nickel for several days (persons with urine nickel over 100 μg need medical attention). Consider chest X-ray after acute overexposure. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Liver and kidney function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility for medical observation, up to 2 days and test for urine nickel. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy. Use amyl nitrate capsules if symptoms develop. All area employees should be trained regularly in emergency measures for cyanide poisoning and in CPR. A cyanide antidote kit should be kept in the immediate work area and must be rapidly available. Kit ingredients should be replaced every 1−2 years to ensure freshness. Persons trained in the use of this kit; oxygen use, and CPR must be quickly available.

Note to physician: For severe poisoning BAL (British Anti-Lewisite), dimercaprol, dithiopropanol ($C_3H_8OS_2$) has been used to treat toxic symptoms of certain heavy metals poisoning—including nickel. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See NIOSH Criteria Document #77-164, *Inorganic Nickel.*

Respirator Selection: *Nickel: At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with an N100, R100, or P100 filter). *Cyanides: Up to 25 milligram per cubic meter:* Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any self-contained breathing apparatus with full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern and having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Nickel cyanide must be stored to avoid contact with magnesium, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from acids since heat and acids can release toxic cyanide.

Shipping: UN1653 Nickel cyanide, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Nickel cyanide itself does not burn. Thermal decomposition products may include hydrogen cyanide and oxides of nitrogen, nickel, and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(109); (102); (31); (173); (101); (138); (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Nickel Cyanide, Trenton, NJ (July 2001).

Nickel Hydroxide N:0270

Formula: H_2NiO_2

Synonyms: Hidroxido niquel (Spanish); Nickel black; Nickel dihydroxide; Nickel(2+) hydroxide; Nickel(II) hydroxide; Nickelic hydroxide; Nickelous hydroxide

CAS Registry Number: 12054-48-7; *(alt.)* 12125-56-3; 11113-74-9

HSDB Number: 1827

RTECS Number: QR7040000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 235-008-5 [*Annex I Index No.:* 028-008-00-X]

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen (Nickel compounds and metallic nickel); IARC: (compounds) *carcinogenic to humans*, Group 1, 1997; NIOSH: Potential occupational carcinogen.

California Proposition 65 Chemical[102]: Cancer 10/1/1989

Hazard Alert: Sensitization hazard (skin, resp.), Environmental hazard, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) as nickel compounds

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR401.15 Section 307 Toxic Pollutants as nickel and compounds; Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed, as nickel compounds, n.o.s.

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazardous to aquatic life or environment, with possible long lasting effects[291,292].

Hazard symbols, risk, & safety statements: Hazard symbol (12054-48-7): T, N, Xi; risk phrases: R49; R61; R20/22; R42/43; R48/23; R68; R50/53; R62; R63; safety phrases: S29/35; S45; S53; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Nickel hydroxide is a light, apple-green powder. Molecular weight = 92.71; specific gravity (H_2O:1) = 4.1 @ 20°C; freezing/melting point = 230°C (decomposes); autoignition temperature = 400°C[136]. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 0; reactivity 0. Insoluble in water.

Potential Exposure: It may be found in the workplace as a dust, liquid, or acid solution. This compound may be used in nickel plating operations.

Incompatibilities: Incompatible with strong acids. Aqueous solution may be acidic.

Permissible Exposure Limits in Air

NIOSH IDLH = 10 mg[Ni]/m^3

OSHA PEL (*elemental, soluble & insoluble compounds*): 1 mg[Ni]/m^3 TWA

NIOSH REL (*elemental, soluble & insoluble compounds*): 0.015 mg[Ni]/m^3 TWA; A potential occupational carcinogen. Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV[1] (*inorganic, insoluble compounds*) 0.2 mg [Ni]/m^3 inhalable fraction TWA, confirmed human carcinogen

12054-48-7

PAC Ver. 29[138]

PAC-1: 0.95 milligram per cubic meter

PAC-2: 8.8 milligram per cubic meter

PAC-3: 53 milligram per cubic meter

DFG MAK (*elemental & nickel compounds*): Inhalable fraction, sensitization of the respiratory tract and skin; Carcinogen Category 1; DFG TRK: *As inhalable dusts/aerosols from nickel metal*: 0.50 μg[Ni]/L in urine, after several shifts; Carcinogen Category 1

Determination in Air: Use NIOSH Analytical Method #7300, Elements by ICP (Nitric/Perchloric Acid Ashing); #7301, Elements by ICP (Aqua Regia Ashing); #7303, Elements by ICP [Hot Block (HCl/HNO_3 Digestion)]; #9102, Elements on Wipes; #8310, Metals in urine, #8005, Elements in blood or tissue; OSHA Analytical Methods ID-121 and ID-125G.

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 100 μg[Ni]/L; State Drinking Water Standards: California 100 μg[Ni]/L; Connecticut: 100 μg [Ni]/L; Delaware: 100 μg[Ni]/L; Wisconsin: 100 μg[Ni]/L; State Drinking Water Guidelines: Arizona 150 μg[Ni]/L; Massachusetts: 100 μg[Ni]/L; Maine: 140 μg[Ni]/L; Minnesota: 100 μg[Ni]/L.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Nickel hydroxide can affect you when breathed in. Irritates and burns the eyes and skin on contact. Irritates the respiratory tract causing phlegm and/or shortness of breath. Lung damage may result from a single high or lower repeated exposures. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: Lung allergy occasionally occurs with asthma-type effects. High or repeated lower exposure may cause lung scarring and may damage the heart, liver, or kidneys. Skin contact may cause skin allergy, with itching, redness, and later rash. Nickel hydroxide is a carcinogen; handle with extreme caution.

Points of Attack: Skin, lungs, kidneys.

Medical Surveillance: NIOSH lists the following tests: Blood Gas Analysis; whole blood (chemical/metabolite); blood plasma; end-of-shift; blood serum; biologic tissue/biopsy; chest X-ray, electrocardiogram, pulmonary function tests; pre- & postshift; sputum cytology; urine (chemical/metabolite), end-of-shift; white blood cell count/differential. Before beginning employment and at regular times after that, the following are recommended. Lung function tests. Urine or plasma test for nickel (unexposed persons have urine levels less than 10 μg/L). If symptoms develop or overexposure is suspected, the following may be useful: daily urine nickel levels for several days (persons with urine nickel over 100 μg need medical attention). Consider chest X-ray after acute overexposure. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and do not induce vomiting. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Note to physician: For severe poisoning BAL (British Anti-Lewisite), dimercaprol, dithiopropanol ($C_3H_8OS_2$) has been used to treat toxic symptoms of certain heavy metals poisoning—including nickel. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with an N100, R100, or P100 filter).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers away from strong acids. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard Class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Nickel hydroxide is combustible but not easy to ignite. Thermal decomposition products may include oxides of nickel. Use dry chemicals, carbon dioxide; water spray; or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Recover and recycle where possible or dispose of in a chemical waste landfill[22].

References

(109); (102); (31); (85); (173); (101); (138); (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Nickel Hydroxide, Trenton, NJ (March 2002).

Nickel Nitrate N:0280

Formula: N_2NiO_6; $Ni(NO_3)_2$

Synonyms: Nickel(2+) nitrate (1:2); Nickel(II) nitrate (1:2); Nickel nitrate hexahydride; Nickel nitrate (ous); Nickelous nitrate; Nitric acid, nickel(2+) salt; Nitric acid, nickel(II) salt

CAS Registry Number: 13138-45-9; 13478-00-7 (hexahydrate); 14216-75-2 (nickel dinitrate)

HSDB Number: 1829

RTECS Number: OR7200000

UN/NA & ERG Number: UN2725/140

EC Number: 236-068-5 [*Annex I Index No.:* 028-012-00-1]; 238-076-4 [*Annex I Index No.:* 028-012-00-1] (nickel dinitrate)

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen (Nickel compounds and metallic nickel); IARC: (compounds) *carcinogenic to humans,* Group 1, 1997; NIOSH: Potential occupational carcinogen.

California Proposition 65 Chemical[102]: (nickel compounds) Cancer 5/7/2004

Hazard Alert: Poison, Strong oxidizer, Environmental hazard, Suspected of causing genetic defects, Suspected reprotoxic hazard.

United States National Primary Drinking Water Regulations: MCLG = 10 mg[N]/L; MCL = 10 mg[N]/L nitrate measured as Nitrogen.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) as nickel compounds

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as nickel and compounds

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed, as nickel compounds, n.o.s.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Hazardous to aquatic life or environment, with possible long lasting effects[291,292].

Hazard symbols, risk, & safety statements: Hazard symbol: O, T, N, Xi; risk phrases: R45; R49; R61; R8; R20/22; R38; R41; R42/43; R48/23; R68; R50/53; safety phrases: S29/35; S53; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

14216-75-2

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) as nickel compounds

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR401.15 Section 307 Toxic Pollutants as nickel and compounds; Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed, as nickel compounds, n.o.s.

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 100 lb (45.4 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazard symbols, risk, & safety statements: Hazard symbol: O, T, N; risk phrases: R8; R49; R61; R8; R20/22; R38; R41; R42/43; R48/23; R68; R50/53; safety phrases: S17; S41; S45; S53; S60; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Nickel nitrate is a green powder. Molecular weight = 182; specific gravity (H_2O:1) = 2.1; boiling point = 137°C; freezing/melting point = 57°C. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 0; reactivity 3 (oxidizer). Highly soluble in water.

Hexahydrate: Molecular weight = 290.9; specific gravity (H_2O:1) = 2.1; boiling point = 137°C; freezing/melting point = 57°C.

Potential Exposure: Nickel nitrate is used in electroplating, in nickel catalyst production for making other chemicals and the manufacture of brown ceramic colors.

Incompatibilities: A strong oxidizer. Incompatible with strong acids; sulfur, combustibles, organics, and other easily oxidizable materials. Noncombustible, but it will accelerate the burning of combustible materials. If large quantities are involved in a fire or the combustible material is finely divided, an explosion may result. Prolonged exposure to fire or heat may result in an explosion[101].

Permissible Exposure Limits in Air

NIOSH IDLH = 10 mg[Ni]/m^3

OSHA PEL (*elemental, soluble & insoluble compounds*): 1 mg[Ni]/m^3 TWA

NIOSH REL (*elemental, soluble & insoluble compounds*): 0.015 mg[Ni]/m^3 TWA; A potential occupational carcinogen. Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV[1] (*inorganic, soluble compounds*) 0.1 mg [Ni]/m^3 inhalable fraction TWA, confirmed human carcinogen.

PAC Ver. 29[138]

13138-45-9

PAC-1: 0.93 milligram per cubic meter

PAC-2: 10 milligram per cubic meter

PAC-3: 61 milligram per cubic meter

13478-00-7, *hexahydrate*

PAC-1: 1.5 milligram per cubic meter

PAC-2: 53 milligram per cubic meter

PAC-3: 320 milligram per cubic meter

DFG MAK (*elemental & nickel compounds*): Inhalable fraction, sensitization of the respiratory tract and skin; Carcinogen Category 1; DFG TRK: *As inhalable dusts/aerosols from nickel metal*: 0.50 μg[Ni]/L in urine, after several shifts; Carcinogen Category 1

Russia set a MAC level of 0.005 milligram per cubic meter for nickel salts and aerosols.

Determination in Air: Use NIOSH Analytical Method #7300, Elements by ICP (Nitric/Perchloric Acid Ashing); #7301, Elements by ICP (Aqua Regia Ashing); #7303, Elements by ICP [Hot Block (HCl/HNO_3 Digestion)]; #9102, Elements on Wipes; #8310, Metals in urine, #8005, Elements in blood or tissue; OSHA Analytical Methods ID-121 and ID-125G.

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 100 μg[Ni]/L; State Drinking Water Standards: California 100 μg[Ni]/L; Connecticut: 100 μg [Ni]/L; Delaware: 100 μg[Ni]/L; Wisconsin: 100 μg[Ni]/L; State Drinking Water Guidelines: Arizona 150 μg[Ni]/L; Massachusetts: 100 μg[Ni]/L; Maine: 140 μg[Ni]/L; Minnesota: 100 μg[Ni]/L. Safe Drinking Water Act (47FR 9352): MCLG = 10 mg[N]/L; MCL = 10 mg[N]/L nitrate measured as nitrogen.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Nickel nitrate can affect you when breathed in. Irritates and burns the eyes and skin. Irritates the respiratory tract causing coughing and phlegm.

Long-Term Exposure: Skin contact may cause skin allergy with itching, redness and rash. Nickel nitrate may cause mutations. There is limited evidence that nickel nitrate may decrease fertility in males. Handle with extreme caution. Exposure may also cause lung allergy (asthma) to nickel. Once allergy asthma develops, even low future exposures can cause symptoms. Infants below the age of six months who drink water containing nitrate in excess of the MCL could become seriously ill and, if untreated, may die.

Symptoms include shortness of breath and blue-baby syndrome.

Points of Attack: Skin, lungs.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. NIOSH lists the following tests: Blood Gas Analysis; whole blood (chemical/metabolite); blood plasma; end-of-shift; blood serum; biologic tissue/biopsy; chest X-ray, electrocardiogram, pulmonary function tests; pre- & postshift; sputum cytology; urine (chemical/metabolite); end-of-shift; white blood cell count/differential. If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Consider lung function tests if lung symptoms are present.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: For severe poisoning BAL (British Anti-Lewisite), dimercaprol, dithiopropanol ($C_3H_8OS_2$) has been used to treat toxic symptoms of certain heavy metals poisoning—including nickel. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See NIOSH Criteria Document #77-164, *Inorganic Nickel.*

Respirator Selection: *At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with an N100, R100, or P100 filter).

Storage: Check oxygen content prior to entering storage area. Color code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially organic materials, flammables and combustibles, and other incompatible materials. Oxidizers, including oxidizing gases, should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong acids; sulfur, combustibles, organics, or other readily oxidizable materials. Avoid storage on wood floors. Store in a cool, well-ventilated area away from incompatible materials listed above. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage.

Shipping: UN2725 Nickel Nitrate, Hazard Class: 5.1; Labels: 5.1-Oxidizer.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen and metal. Nickel nitrate is an oxidizer. It increases the flammability of combustible or organic substances. Extinguish fire using an agent suitable for type of surrounding fire. Nickel nitrate itself does not burn. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(109); (102); (31); (173); (101); (138); (2); (100).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 5, No. 6, 64−67 (1985).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Nickel Nitrate, Trenton, NJ (July 2001).

Nickel Sulfate N:0290

Formula: $NiSO_4$

Synonyms: NCI-C60344; Nickelous sulfate; Nickel(2+) sulfate(1:1); Nickel(II) sulfate; Nickel sulfate; Sulfato de niquel (Spanish); Sulfuric acid, nickel(2+) salt; Sulfuric acid, nickel(II) salt

CAS Registry Number: 7786-81-4; 10101-97-0 (hexahydrate); 10101-98-2 (heptahydrate)

HSDB Number: 1114

RTECS Number: QR9350000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171; UN3288 (Toxic solid, inorganic, n.o.s.)/151

EC Number: 232-104-9 [*Annex I Index No.:* 028-009-00-5]

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen (Nickel compounds and metallic nickel); IARC: (compounds) *carcinogenic to humans*, Group 1, 1997; NIOSH: Potential occupational carcinogen. United States Environmental Protection Agency Gene-Tox Program, Positive: Cell transformation-SA7/SHE; Inconclusive: Carcinogenicity-mouse/rat.

California Proposition 65 Chemical[102]: (nickel compounds) Cancer 5/7/2004.

Hazard Alert: Poison, Possible risk of forming tumors, Sensitization hazard (skin, resp.), Suspected of causing genetic defects, Primary irritant (w/o allergic reaction), Organometallic, Strong reducing agent, Environmental hazard.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) as nickel compounds

United States National Primary Drinking Water Regulations: SMCL = 250 mg[SO_4^{-2}]/L as Sulfate

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR401.15 Section 307 Toxic Pollutants as nickel and compounds; Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed, as nickel compounds, n.o.s.

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 100 lb (45.4 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%, CAS 7786-81-4

Hazardous to aquatic life or environment, with possible long lasting effects[191,192].

Hazard symbols, risk, & safety statements: Hazard symbol: T, N, Xn, Xi; risk phrases: R45; R22; R36/37/38; R40; R42/43; R50/53; R62; R63; safety phrases: S16; S22; S23; S26; S29/35; S36/37; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Nickel sulfate is a blue to blue-green crystalline solid. It has a sweet taste (do not test). Molecular weight = 154.76; specific gravity (H_2O:1) = 4.01; boiling point = 103°C; freezing/melting point = (decomposes) 848°C. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 0; reactivity 0; (hexahysrate) Health 3, flammability 0; reactivity 0. Soluble in water.

Hexahydrate: Molecular weight = 262.9; specific gravity (H_2O:1) = 2.03.

Potential Exposure: Nickel sulfate is used in plating baths, and as an intermediate in the production of nickel ammonium sulfate; as a mordant in dyeing, and printing textiles; coatings, and ceramics.

Incompatibilities: A strong reducing agent. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. The aqueous solution is a weak acid. Sulfates may react violently with aluminum, magnesium.

Permissible Exposure Limits in Air

NIOSH IDLH = 10 mg[Ni]/m^3

OSHA PEL (*elemental, soluble & insoluble compounds*): 1 mg[Ni]/m^3 TWA

NIOSH REL (*elemental, soluble & insoluble compounds*): 0.015 mg[Ni]/m^3 TWA; A potential occupational carcinogen. Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV[1] (*inorganic, soluble compounds*) 0.1 mg $[Ni]/m^3$ inhalable fraction TWA, confirmed human carcinogen. PAC Ver. 29[138]

7786-81-4

PAC-1: 0.79 milligram per cubic meter

PAC-2: 8.6 milligram per cubic meter

PAC-3: 51 milligram per cubic meter

10101-97-0 hexahydrate

PAC-1: 1.3 milligram per cubic meter

PAC-2: 8.7 milligram per cubic meter

PAC-3: 52 milligram per cubic meter

DFG MAK (*elemental & nickel compounds*): Inhalable fraction, sensitization of the respiratory tract and skin; Carcinogen Category 1; DFG TRK: *As inhalable dusts/aerosols from nickel metal*: 0.50 μg[Ni]/L in urine, after several shifts; Carcinogen Category 1

Arab Republic of Egypt: TWA 0.1 $mg[Ni]/m^3$, 1993; Australia: TWA 1 $mg[Ni]/m^3$, 1993; Belgium: TWA 1 mg $[Ni]/m^3$ (insoluble compounds), 1993; Denmark: TWA 0.1 $mg[Ni]/m^3$, 1999; Finland: TWA 0.1 $mg[Ni]/m^3$ [skin], carcinogen, 1999; France: VME 1 $mg[Ni]/m^3$, 1999; Hungary: STEL 0.005 $mg[Ni]/m^3$, Carcinogen (insoluble compounds), 1993; the Phillipines: TWA 1 $mg[Ni]/m^3$, 1993; Poland: MAC (TWA) 0.25 $mg[Ni]/m^3$, 1999; Russia: STEL 0.05 $mg[Ni]/m^3$, 1993; Sweden: NGV 0.1 $mg[Ni]/m^3$, carcinogen, 1999; Switzerland: MAK-W 0.5 $mg[Ni]/m^3$ (insoluble compounds), 1999; Switzerland: MAK-W 0.5 $mg[Ni]/m^3$, carcinogen, 1999; Thailand: TWA 1 mg $[Ni]/m^3$, 1993; United Kingdom: TWA 0.1 $mg[Ni]/m^3$, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 0.1 $mg[Ni]/m^3$.

Determination in Air: Use NIOSH Analytical Method #7300, Elements by ICP (Nitric/Perchloric Acid Ashing); #7301, Elements by ICP (Aqua Regia Ashing); #7303, Elements by ICP [Hot Block (HCl/HNO_3 Digestion)]; #9102, Elements on Wipes; #8310, Metals in urine, #8005, Elements in blood or tissue; OSHA Analytical Methods ID-121 and ID-125G.

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 100 μg[Ni]/L; State Drinking Water Standards: California 100 μg[Ni]/L; Connecticut: 100 μg [Ni]/L; Delaware: 100 μg[Ni]/L; Wisconsin: 100 μg[Ni]/L; State Drinking Water Guidelines: Arizona 150 μg[Ni]/L; Massachusetts: 100 μg[Ni]/L; Maine: 140 μg[Ni]/L; Minnesota: 100 μg[Ni]/L.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Nickel sulfate can affect you when breathed in. It may also cause infertility in males. High or repeated exposures can scar the lungs. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: Repeated or prolonged contact may cause skin sensitization and allergy, with itching, redness, and later rash. Repeated or prolonged inhalation exposure may cause asthma-like lung allergy. Lungs may be scarred by repeated or prolonged exposure to the aerosol. Nickel sulfate may cause mutations. Handle with extreme caution. Carcinogenic to humans. Animal tests show that this substance possibly causes toxic effects upon human reproduction. May cause kidney damage.

Points of Attack: Skin, lungs, kidneys.

Medical Surveillance: NIOSH lists the following tests: Blood Gas Analysis; whole blood (chemical/metabolite); blood plasma; end-of-shift; blood serum; biologic tissue/biopsy; chest X-ray, electrocardiogram, pulmonary function tests; pre- & postshift; sputum cytology; urine (chemical/metabolite); end-of-shift; white blood cell count/differential. Before beginning employment and at regular times after that, the following are recommended: lung function test. Urine or plasma test for nickel (unexposed persons have urine levels less than 10 μg/L). If symptoms develop or overexposure is suspected, the following may be useful: daily urine nickel for several days (persons with urine nickel over 100 μg/L need medical attention). Lung function tests. Consider chest X-ray after acute overexposure. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Note to physician: For severe poisoning BAL (British Anti-Lewisite), dimercaprol, dithiopropanol ($C_3H_8OS_2$) has been used to treat toxic symptoms of certain heavy metals poisoning—including nickel. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See NIOSH Criteria Document #77-164, *Inorganic Nickel*.

Respirator Selection: *At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with an N100, R100, or P100 filter).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Nickel sulfate must be stored to avoid contact with strong acids (such as hydrochloric, sulfuric, and nitric); wood, and other combustibles, since violent reactions occur. A regulated, marked area should be established where nickel sulfate is handled, used or stored.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard Class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required. UN3288 Toxic solids, inorganic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Nickel sulfate is not flammable. Thermal decomposition products may include oxides of sulfur and metal. Use agent suitable for surrounding fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(109); (102); (31); (173); (101); (138); (2); (100).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 5, No. 6, 68−71 (1985).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Nickel Sulfate, Trenton, NJ (April 2003).

Nicosulfuron N:0295

Formula: $C_{15}H_{18}N_6O_6S$

Synonyms: Accent; Basis; Celebrity; Challenger; Dasul; 2-[((((4,6-Dimethoxy-2-pyrimidinyl)amino) carbonyl)amino) sulfonyl]-*N,N*-dimethyl-3-pyridinecarboxamide; DPX 79406 Herbicide (with rimsulfuron); DPX-V9636; GHIBLI; Lama; Matrix herbicide (with rimsulfuron); Milagro; Mistral; Motivel; Nisshin; 3-Pyridinecarboxamide, 2-[((((4,6-dimethoxy-2-pyrimidinyl)amino)carbonyl)amino) sulfonyl]-*N,N*-dimethyl-; Samson; Steadfast, (nicosulfuron + rimsulfuron)

CAS Number: 111991-09-4

HSDB Number: 7950

RTECS Number: US4615000

UN/NA & ERG Number: UN3082 (environmentally hazardous substances, liquid, n.o.s.)/171

Regulatory Authority and Advisory Information

Carcinogenicity[83]: EPA Group E, Evidence of noncarcinogenicity for humans.

Description: White crystalline solid or powder. Phenolic odor. Molecular weight = 410.41; specific gravity (H_2O:1) = 1.45 @20°C; boiling point = (decomposes) 165°C; freezing/melting point = 141-144°C; 172°C; Henry's Law constant = 4.13 × 10^{-18} atm-m^3/mol @ 25°C[83,USDA]. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 0; reactivity 0. Highly soluble in water; solubility = 0.25 g/L @ 25°C; 1.2 × 10^4 mg/L @ 25°C[83,USDA].

Potential Exposure: Nicosulfuron is a sulfonylurea post-emergence herbicide used to control a variety of weeds on field corn and popcorn crops. Some formulations may be registered as United States Restricted Use Pesticides (RUP)

Incompatibilities: Slowly hydrolyzes in water, releasing ammonia and forming acetate salts. Decomposed >165°C.

Permissible Exposure Limits in Air: No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = <1.0$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, dermal contact, ingestion

Harmful Effects and Symptoms

Human health effects from the sulfonylurea herbicides at low environmental doses or at biomonitored levels from low environmental exposures are unknown. The sulfonylurea herbicides are generally of low toxicity in mammalian studies. Animal studies showed low acute toxicity and little chronic, reproductive, or developmental toxicity or teratogenic effects. Developmental or teratogenic effects tended only to occur at high or maternally toxic doses. At high sublethal, chronic oral doses, such nonspecific effects as weight loss and anemia were observed. Some chemical-specific effects were noted at high doses in animals[96].

Short-Term Exposure: May cause skin, eye and respiratory tract irritation. Moderately poisonous if ingested or inhaled. LD_{50} (oral, rat) = >5 g/kg; LD_{50} (dermal, rat) = >2 g/kg.

Medical Surveillance: Urinary levels of the sulfonylurea herbicides reflect recent exposure. There is very limited information on the biomonitoring of sulfonylurea herbicides or their metabolites. Detection of the metabolites may reflect exposure to more than one particular sulfonylurea herbicide or from exposure to environmental degradation products. The urinary metabolites dimethoxypyrimidine and dimethylpyrimidine can be used as nonspecific markers of exposure to the pyrimidinylsulfonylureas, a group that includes bensulfuron-methyl, halosulfuron, primisulfuron-methyl, and sulfosulfon. The urinary metabolite methoxymethyl triazine can be used as a nonspecific marker of exposure to the triazinylsulfonylureas, a group that includes chlorosulfuron, prosulfuron, and triasulfuron[96].

Harmful Effects and Symptoms

Human health effects from the sulfonylurea herbicides at low environmental doses or at biomonitored levels from low environmental exposures are unknown. The sulfonylurea herbicides are generally of low toxicity in mammalian studies. Animal studies showed low acute toxicity and little chronic, reproductive, or developmental toxicity or teratogenic effects. Developmental or teratogenic effects tended only to occur at high or maternally toxic doses. At high sublethal, chronic oral doses, such nonspecific effects as weight loss and anemia were observed. Some chemical-specific effects were noted at high doses in animals[96].

Short-Term Exposure: May cause skin and eye irritation. Moderately poisonous if ingested or inhaled. LD_{50} (oral, rat) = >5 g/kg; (dermal, rat) = >2 g/kg.

Long-Term Exposure: Prolonged or repeated contact can cause chronic injury. See below:

Medical Surveillance: Preliminary medical exam to detect chronic diseases of central nervous system, liver, heart, kidneys, lung, and skin, as well as endocrinological or immunological disturbances, should protect susceptible individuals. Periodical medical exams of internal organs, skin, and eyes are important to avoid chronic occupational intoxications. They should include lab and patch tests when necessary[83]. Urinary levels of the sulfonylurea herbicides reflect recent exposure. There is very limited information on the biomonitoring of sulfonylurea herbicides or their metabolites. Detection of the metabolites may reflect exposure to more than one particular sulfonylurea herbicide or from exposure to environmental degradation products. The urinary metabolites dimethoxypyrimidine and dimethylpyrimidine can be used as nonspecific markers of exposure to the pyrimidinylsulfonylureas, a group that includes bensulfuron-methyl, halosulfuron, primisulfuron-methyl, and sulfosulfon. The urinary metabolite methoxymethyl triazine can be used as a nonspecific marker of exposure to the triazinylsulfonylureas, a group that includes chlorosulfuron, prosulfuron, and triasulfuron[96].

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Do not induce vomiting when formulations containing petroleum solvents are ingested.

Personal Protective Methods: Applicators and other handlers must wear: Coveralls worn over long-sleeved shirt and long pants; Chemical-resistant gloves such as DuPont Tychem suit fabrics, barrier laminate, or Viton; Chemical-resistant footwear plus socks; Protective eye wear; Chemical-resistant headgear for overhead exposure; Chemical-resistant apron when cleaning equipment, mixing, or loading[83]. Agricultural Use/Engineering Controls: When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the Worker Protection Standard (WPS) for agricultural pesticides, 40 CFR 170.240(d)(4-6), the handler PPE requirements may be reduced or modified as specified in the Worker Protection Standard. Firefighters should wear NIOSH approved SCBA and full protective clothing.

Respirator Selection: Wherever and whenever workplace conditions warrant respirator use, a respiratory protection program must be followed that meets one or more of the following government standards: OSHA's 29 CFR 1910.134, ANSI Z88.2, or European Standard EN 149.

Storage: Color code—Blue: Health Hazard/Poison. Store in a secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN3077 or UN3082 Environmentally hazardous substances, liquid or solid, n.o.s., Hazard Class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: First remove all sources of ignition. Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Ventilate area of spill or leak. Use water spray to reduce vapor. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include fluorine and nitrogen oxides. As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 m/150 ft. for liquids and at least 25 m/75 ft. for solids. *Fire involving storage or vehicular tanks:* Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. *On a small fire:* use dry chemical, CO_2, water spray or regular *foam. On a large fire:* use water spray, fog or regular foam. Do not scatter spilled material with high pressure streams of water. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal. *Fire involving tanks:* From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. Always stay away from tanks engulfed in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: It is the responsibility of chemical waste generators to determine the toxicity and physical properties and of a discarded chemical and to properly identify its classification and certification as a hazardous waste and to determine the disposal method. United States Environmental Protection Agency guidelines for the classification determination are listed in 40 CFR Parts 261.3. Additionally, waste generators must consult and follow all regional, national, state and local hazardous waste laws to ensure complete and accurate classification and disposal methods.

References

(31); (173); (101); (138).

United States Environmental Protection Agency, Office of Pesticide Programs, Pesticide Residue Limits, *Nicosulfuron*, 40 CFR 180.454, http://www.epa.gov/pesticides/food/viewtols.htm.

EXTOXNET, Extension Toxicology Network, *Pesticide Information Profile, Nicosulfuron*, Oregon State University, Corvallis, OR (May 1995). http://extoxnet.orst.edu/pips/nicosulf.htm.

Nicotine N:0300

Formula: $C_{10}H_{14}N_2$

Synonyms: Black leaf; Campbell's nico-soap; Destruxol orchard spray; Di-tetrahydronicotyrine; Emo-Nib; ENT 3,424; Flux MAAG; Fumeto-Bac; Mach-Nic; 1-Methyl-2-(3-pyridyl) pyrrolidine; 3-(*N*-Methylpyrrolidino)pyridine; (s)-3-(1-Methyl-2-pyrrolidinyl)pyridine; 3-(1-Methyl-2-pyrrolidinyl)pyridine; (-)-3-(1-Methyl-2-pyrrolidyl)pyridine; 1-3-(1-Methyl-2-pyrrolidyl) pyridine; 3-(1-Methyl-2-pyrrolidyl) pyridine; Niagra P.A. dust; Nicocide; Nicodust; Nicofume; Nicotina (Spanish); 1-Nicotine; Nicotine alkaloid; Nikotin (German); Orthon-4 dust; Orthon-5 dust; Pyridine, 3-(1-methyl-2-pyrrolidinyl)-; Pyridine, (s)-3-(1-methyl-2-pyrrolidinyl)- and salts; Pyridine, 3-(tetrahydro-1-methylpyrrol-2-yl); β-Pyridyl-α-*N*-methylpyrrolidine; Tendust; Xl all insecticide

CAS Registry Number: 54-11-5; *(alt.)* 6912-85-2; *(alt.)* 16760-37-5

HSDB Number: 1107

RTECS Number: QS5250000

UN/NA & ERG Number: UN1654/151

EC Number: 200-193-3 [*Annex I Index No.:* 614-001-00-4]

Regulatory Authority and Advisory Information

United States Environmental Protection Agency Gene-Tox Program, Negative: *N crassa-aneuploidy*; Histidine reversion-Ames test

California Proposition 65 Developmental/Reproductive toxin 4/1/90

Hazard Alert: Exposure can be lethal, Systemic agent, Combustible, Reproductive toxin: possible risk of gene damage/impaired fertilty; Suspected reprotoxic hazard.

Banned or Severely Restricted (in agriculture) (Germany, Hungary) (UN)[13]

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): No. P075

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

SUPERFUND/EPCRA 302, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 100 lb (45.4 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, N; risk phrases: R25; R27; R50/53; R62; R63; safety phrases: S1/2; S36/37; S41; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Nicotine is a pale yellow to dark brown, oily liquid. Slight, fishy or pyridine-like odor when warm. It is also available as a powder. Molecular weight = 162.23; specific gravity (H_2O:1) = 1.01; boiling point = 250°C; freezing/melting point = −78.9°C; vapor pressure = 0.08 mmHg @ 20°C; flash point = 95°C (cc); autoignition temperature = 240°C. Explosive limits: LEL = 0.7%; UEL: 4.0%. Hazard identification (based on NFPA-704 M Rating System): Health 4; flammability 1; reactivity 0. Slightly soluble in water.

Potential Exposure: An alkaloid produced from tobacco. Nicotine is used in some drugs; and in tanning. At one time, nicotine was used in the United States as an insecticide and fumigant; however, it is no longer produced or used in the United States for this purpose.

Incompatibilities: Incompatible with strong oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Incompatible with strong acids. Attacks some forms of plastics, rubber, and coatings.

Permissible Exposure Limits in Air

NIOSH IDLH = 5 milligram per cubic meter

OSHA PEL: 0.5 milligram per cubic meter TWA [skin]

NIOSH REL: 0.5 milligram per cubic meter TWA [skin]

ACGIH TLV[1]: 0.5 milligram per cubic meter TWA [skin]

PAC Ver. 29[138]

PAC-1: 1.5 milligram per cubic meter

PAC-2: 3.5 milligram per cubic meter

PAC-3: 35 milligram per cubic meter

DFG MAK: [skin]

Arab Republic of Egypt: TWA 0.5 milligram per cubic meter [skin], 1993; Australia: TWA 0.5 milligram per cubic meter [skin], 1993; Austria: MAK 0.07 ppm, 1999; Belgium: TWA 0.5 milligram per cubic meter [skin], 1993; Denmark: TWA 0.5 milligram per cubic meter [skin], 1999; Finland: TWA 0.5 milligram per cubic meter; STEL 1.5 milligram per cubic meter [skin], 1999; France: VME 0.5 milligram per cubic meter [skin], 1999; the Netherlands: MAC-TGG 0.5 milligram per cubic meter [skin], 2003; Norway: TWA 0.5 milligram per cubic meter, 1999; the Phillipines: TWA 0.5 milligram per cubic meter [skin], 1993; Poland: MAC (TWA) 0.5 milligram per cubic meter; MAC (STEL) 1.5 milligram per cubic meter, 1999; Switzerland: MAK-W 0.07 ppm (0.5 milligram per cubic meter), KZG-W 0.14 ppm [skin], 1999; Thailand: TWA 0.5 milligram per cubic meter, 1993; Turkey: TWA 0.5 milligram per cubic meter [skin], 1993; United Kingdom: TWA 0.5 milligram per cubic meter; STEL 1.5 milligram per cubic meter [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 0.5 milligram per cubic meter [skin]. Several states have set guidelines or standards for nicotine in ambient air[60] ranging from 8.0 μ/m^3 (Virginia) to 10.0 μ/m^3 (Connecticut) to 12.0 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #2544, #2551.

Determination in Water: Hazardous to the aquatic environment. Octanol−water coefficient: Log K_{ow} = 1.2. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Nicotine affects the nervous system and the heart. Exposure to relatively small amounts can rapidly be fatal [77].

Short-Term Exposure: Irritates the eyes and skin. Even small exposures can cause increased heart rate; increased blood fat levels; and change vital hormone levels. May affect the cardiovascular system and central nervous system; resulting in convulsions and respiratory failure. Nicotine is classified as super toxic. Probable oral lethal dose in humans is less than 5 mg/kg or a taste (less than 7 drops) for a 70 kg (150 lb) person. It may be assumed that ingestion of 40−60 mg of nicotine is lethal to humans. There is a fundamental difference between acute toxicity from use of nicotine as an insecticide instead of from ingestion; and chronic toxicity that may be caused by prolonged exposure to small doses as occurs in smoking. Maternal smoking during pregnancy is associated with increased risk of spontaneous abortion, low birth weight and still-birth. Acute exposure to nicotine may result in headache, dizziness, confusion, agitation, restlessness, lethargy, seizures, and coma. Victims may experience hypertension (high blood pressure), tachycardia (rapid heart rate), and tachypnea (rapid respirations), followed by hypotension (low blood pressure), bradycardia (slow heart rate), and respiratory depression. Cardiac arrhythmias may also occur. Gastrointestinal effects include nausea, vomiting, abdominal pain or burning sensation; and diarrhea. Increased salivation, lacrimation (tearing), and sweating may be noted. High levels, far above the OEL, may result in death.

Determination in Water: Octanol−water coefficient: Log K_{ow} = <1.2. Unlikely to bioaccumulate in marine organisms.

Long-Term Exposure: Animal tests show that this substance possibly causes toxic effects upon human reproduction. Nicotine was found as a cocarcinogen in animals.

Points of Attack: Central nervous system; cardiovascular system; lungs, GI tract; reproduction system. Has been shown to be a teratogen in animals; may be a teratogen in humans. Causes fat deposits in the arteries (reducing blood supply to many body organs). This increases the risk of heart attack, stroke, and many other poor circulation problems. Chronic high blood pressure can also result.

Medical Surveillance: NIOSH lists the following tests: blood plasma, during exposure; pre- and postshift; urine (chemical/metabolite). Before beginning employment and at regular times after that, the following is recommended: blood test for nicotine (only accurate shortly after exposure); consider test to evaluate typical exposures as well as for suspected overexposure or if symptoms are present. Even those who have smoked for a long time can reduce the risk of developing health problems by stopping.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods:

General information: first responders should use a NIOSH-certified chemical, biological, radiological, nuclear (CBRN) SCBA with a level a protective suit when entering an area with an unknown contaminant or when entering an area where the concentration of the contaminant is unknown. Level a protection should be used until monitoring results confirm the contaminant and the concentration of the contaminant. *Note:* safe use of protective clothing and equipment requires specific skills developed through training and experience.

LEVEL A: (*RED ZONE*): select when the greatest level of skin, respiratory, and eye protection is required. This is the maximum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than the AEGL-2. A NIOSH-certified CBRN full facepiece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle. A totally encapsulating chemical protective (TECP) suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, and a hard hat worn under the TECP suit are optional items.

LEVEL B: (RED ZONE): Select when the highest level of respiratory protection is necessary but a lesser level of skin protection is required. This is the minimum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than AEGL-2. It differs from Level A in that it incorporates a nonencapsulating, splash-protective, chemical-resistant splash suit that provides Level A protection against liquids but is not airtight. A NIOSH-certified CBRN full facepiece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL C: (YELLOW ZONE): Select when the contaminant and concentration of the contaminant are known and the respiratory protection criteria factors for using Air Purifying Respirators (APR) or Powered Air Purifying Respirators (PAPR) are met. This level is appropriate when decontaminating patient/victims. A NIOSH-certified CBRN tight-fitting APR with a canister-type gas mask or CBRN PAPR for air levels greater than AEGL-2. A NIOSH-certified CBRN PAPR with a loose-fitting face-piece, hood, or helmet and a filter or a combination organic vapor, acid gas, and particulate cartridge/filter combination or a continuous flow respirator for air levels greater than AEGL-1. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Escape mask, face shield, coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL D: (GREEN ZONE): Select when the contaminant and concentration of the contaminant are known and the concentration is below the appropriate occupational exposure limit or less than AEGL-1 for the stated duration times. Limited to coveralls or other work clothes, boots, and gloves.

Notes: Take all necessary precautions to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

possibility of skin contact. Wear eye protection to prevent any possibility of eye contact. Employees should wash immediately when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *5 milligram per cubic meter:* Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister]; or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Nicotine must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine), strong acids (such as hydrochloric, sulfuric, and nitric), since violent reactions occur. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1654 Nicotine, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Nicotine is a combustible liquid. Extinguish with foam, dry chemical, or carbon dioxide extinguishers. Thermal decomposition products may include oxides of nitrogen and carbon. Water may cause frothing if it gets below surface of liquid and turns to steam. However, water fog gently applied to surface will cause frothing which will extinguish the fire. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed[22]. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (173); (101); (138); (2); (100).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 1, No. 8, 84−85 (1981) and 5, No. 4, 82−85 (1985).

United States Environmental Protection Agency, *Chemical Hazard Information Profile:* Nicotine, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Nicotine, Trenton, NJ (March 2000).

Nicotine Sulfate N:0310

Formula: $C_{10}H_{18}N_2O_8S_2$; $C_{10}H_{14}N_2 \cdot 2H_2SO_4$
Synonyms: ENT 2,435; 1-1-Methyl-2-(3-pyridyl)-pyrrolidine sulfate; (S)-3-(1-Methyl-2-pyrrolidinyl)pyridine sulfate (2:1); 1-3-(1-Methyl-2-pyrrolidinyl)pyridine sulfate; Nico tine sulfate (2:1); Nicotine sulfate; Nikotinsulfat (German); Pyridine, 3-(1-methyl-2-pyrrolidinyl)-, (S)-, sulfate (2:1); Pyrrolidine, 1-methyl-2-(3-pyridyl)-, sulfate; Sulfate de nicotine (French); Sulfato de nicotina (Spanish)
CAS Registry Number: 65-30-5
HSDB Number: 805
RTECS Number: QS9625000
UN/NA & ERG Number: UN1658/151
EC Number: 200-606-7 [*Annex I Index No.:* 614-002-00-X]
Regulatory Authority and Advisory Information
Hazard Alert Extremely toxic, Combustible, Suspected of causing genetic defects, Environmental hazard.
Banned or Severely Restricted (in agriculture) (East Germany, New Zealand, former USSR) (UN)[13]
United States National Primary Drinking Water Regulations: SMCL = 250 mg[SO_4^{-2}]/L as Sulfate
SUPERFUND/EPCRA 302, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg)
Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 100 lb (45.4 kg)
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
Hazardous to aquatic life or environment, with possible long lasting effects[293]. Toxic to aquatic life with long lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.
Hazard symbols, risk, & safety statements: Hazard symbol: T+, N; risk phrases: R26/27/28; R34; R36/37/38; R50/53; R61; R62; safety phrases: S1/2; S13; S16; S26; S28; S29; S36/37/39; S45; S61 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]
Description: Nicotine sulfate is a white crystalline solid. Molecular weight = 420.58; autoignition temperature = 244°C. Hazard identification (based on NFPA-704 M Rating System): Health 4; flammability 1; reactivity 0. Soluble in water.
Potential Exposure: Nicotine sulfate is used as an insecticide and in veterinary medicine as an anthelmintic and external parasiticide. An alkaloid produced from tobacco.
Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.
Permissible Exposure Limits in Air
PAC Ver. 29[138]
PAC-1: 0.82 milligram per cubic meter
PAC-2: 9 milligram per cubic meter
PAC-3: 18 milligram per cubic meter
Russia set a MAC in ambient air in residential areas of 0.005 milligram per cubic meter on a once-daily basis and 0.001 milligram per cubic meter on a daily average basis.
Routes of Entry: Inhalation, ingestion; skin and/or eye contact.
Harmful Effects and Symptoms
Short-Term Exposure: The liquid irritates the eyes and skin. Inhalation irritates nose and throat. May affect the central nervous system; causing convulsions and respiratory failure. Exposure at high concentrations may result in death. Onset of acute poisoning is rapid. Symptoms include nausea, salivation, abdominal pain; vomiting, diarrhea, cold sweat; headache, dizziness, disturbed hearing and vision; mental confusion; marked weakness; faintness and prostration, lowered blood pressure; difficult breathing; and weak, rapid and irregular pulse. It is classified as super toxic. Probable oral lethal dose in humans is less than 5 mg/kg (less than 7 drops) for a 70 kg (150 lb) person. Death is possible from respiratory failure caused by paralysis of the respiratory muscles.
Long-Term Exposure: Animal tests show that this substance possibly causes toxic effects upon human reproduction.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.
Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1658 Nicotine sulfate solution, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: *Solid:* Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Solution: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. To clean up, do not touch spilled material; stop leak if possible. Use water spray to reduce vapors. *Small spills*: Take up with sand or other noncombustible absorbent material and place into containers for disposal. Small dry spills with clean shovel place material into clean, dry container, and cover; move containers from spill area. *Large spills*: Dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen, sulfur, and carbon. As for nicotine, extinguish with alcohol foam, dry chemical, or carbon dioxide. Large fires can be extinguished with water spray, fog, or foam. Wear positive pressure breathing apparatus and special protective clothing. Dike fire control water; do not scatter the material. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (100).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 5, No. 4, 88–90 (1985).

United States Environmental Protection Agency, *Chemical Hazard Information Profile:* Nicotine Sulfate, Washington, DC, Chemical Preparedness Program (November 30, 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Nicotine Sulfate, Trenton, NJ (April 2002).

Nitric Acid N:0340

Formula: HNO_3

Synonyms: Acide nitrique (French); Acido nitrico (Spanish); Aluminum etch 16-1-1-2; Aluminum etch 82-3-15-0; Aluminum etch II; Aluminum etch III; Aqua fortis; Aqua regia; Azotic acid; Chrome etch KTI; Copper, brass brite dip 1127; Copper, brass brite dip 127; Copperlite RD-25; C-P 8 solution; Doped poly etch; Freckle etch; Hydrogen nitrate; Kovar bright dip (412X); Kovar bright dip (RDX-555); KTI aluminum etch I; KTI chrome etch; MAE etchants; Mixed acid etch (5-2-2); Mixed acid etch (6-1-1); NF solder stripper 3114-B; Nital; Nitraline; Nitric acid, red fuming; Nitric acid, white fuming; Nitrous fumes; Nitryl hydroxide; Passivation solution; Patclin 958; Poly etch 95%; Red fuming nitric acid; RFNA; RT-2 stripping solution; Salpetersaure (German); Silicon etch solution; Solder strip NP-A; Stress relief etch; Wet K-etch; WFNA; White fuming nitric acid

CAS Registry Number: 7697-37-2

HSDB Number: 1665

RTECS Number: QU5775000

UN/NA & ERG Number: (PIH) UN2031 (other than red fuming, with >70% nitric acid)/157; UN2032 (fuming)/157

EC Number: 231-714-2 [*Annex I Index No.:* 007-004-00-1]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 15,000 (≥80.00% concentration); *Theft hazard* 400 (≥68.00% concentration).

United States Environmental Protection Agency Gene-Tox Program, Negative: Cell transformation-SA7/SHE.

Hazard Alert: Poison inhalation hazard, Corrosive, Strong oxidizer, Water reactive, Known catalytic activity, Suspected reprotoxic hazard, Suspected of causing genetic defects.

OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 500 lb (227 kg) (≥94.5%)

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

SUPERFUND/EPCRA 302, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 1000 lb (454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, O, C; risk phrases: R8; R35; R62; safety phrases: S1/2; S17; S23; S26; S36; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Nitric acid is a colorless to light brown fuming liquid with an acrid, suffocating odor. Fuming nitric acid is a reddish fuming liquid. Fumes in moist air. Often used in an aqueous solution. Fuming nitric acid is concentrated nitric acid that contains dissolved nitrogen dioxide. Nitric acid is a solution of nitrogen dioxide, NO_2, in water and so-called fuming nitric acid contains an excess of NO_2 and is yellow to brownish-red in color. Molecular weight = 63.02; specific gravity (H_2O:1) = 1.50 @ 25°C; boiling point = 82.8°C; freezing/melting point = −42°C (monohydrate); −19°C (trihydrate); vapor pressure = 48 mmHg. Soluble in water.

Potential Exposure: Nitric acid is the second most important industrial acid and its production represents the sixth largest chemical industry in the United States. Nitric acid is used in chemicals, explosives, fertilizers, steel pickling; metal cleaning. The largest use of nitric acid is in the production of fertilizers. Almost 15% of the production goes into the manufacture of explosives, with the remaining 10% distributed among a variety of uses, such as etching, bright-dipping; electroplating, photoengraving, production of rocket fuel; and pesticide manufacture.

Incompatibilities: A strong oxidizer and strong acid. Reacts violently with combustible and reducing agents; carbides, hydrogen sulfide, turpentine, charcoal, alcohol, powdered metals; strong bases. Heat causes decomposition producing nitrogen oxides. Attacks some plastics. Corrosive to metals.

Permissible Exposure Limits in Air

NIOSH IDLH = 25 ppm

Conversion factor: 1 ppm = 2.58 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 2 ppm/5 milligram per cubic meter TWA

NIOSH REL: 2 ppm/5 milligram per cubic meter TWA; 4 ppm/10 milligram per cubic meter STEL

ACGIH TLV[1]: 2 ppm/5.2 milligram per cubic meter TWA; 4 ppm/10 milligram per cubic meter STEL

PAC* Ver. 29[138]

PAC-1: $\mathbf{0.16}_{\mathbf{A}}$ ppm

PAC-2: $\mathbf{24}_{\mathbf{A}}$ ppm

PAC-3: $\mathbf{92}_{\mathbf{A}}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values. DFG MAK: 2 ppm/5.2 milligram per cubic meter TWA; Peak Limitation Category I(1); Pregnancy Risk Group D

Arab Republic of Egypt: TWA 2 ppm (5 milligram per cubic meter), 1993; Australia: TWA 2 ppm (5 milligram per cubic meter); STEL 4 ppm, 1993; Austria: MAK 2 ppm (5 milligram per cubic meter), 1999; Belgium: TWA 2 ppm (5.2 milligram per cubic meter); STEL 4 ppm (10 milligram per cubic meter), 1993; Denmark: TWA 2 ppm (5 milligram per cubic meter), 1999; Finland: TWA 2 ppm (5 milligram per cubic meter); STEL 5 ppm (13 milligram per cubic meter) [skin], 1999; France: VME 2 ppm (5 milligram per cubic meter), VLE 5 ppm (10 milligram per cubic meter), 1999; Hungary: STEL 5 milligram per cubic meter, 1993; Japan: 2 ppm (5.2 milligram per cubic meter), 1999; Norway: TWA 2 ppm (5 milligram per cubic meter), 1999; the Phillipines: TWA 2 ppm (5 milligram per cubic meter), 1993; Poland: MAC (TWA) 5 milligram per cubic meter; MAC (STEL) 10 milligram per cubic meter, 1999; Russia: TWA 2 ppm; STEL 2 milligram per cubic meter [skin], 1993; Sweden: NGV 2 ppm (5 milligram per cubic meter), KTV 5 ppm (13 milligram per cubic meter), 1999; Thailand: TWA 2 ppm (5 milligram per cubic meter), 1993; Turkey: TWA 2 ppm (5 milligram per cubic meter), 1993; United Kingdom: LTEL 2 ppm (5 milligram per cubic meter); STEL 4 ppm (10 milligram per cubic meter), 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 4 ppm. Russia set a MAC for nitric acid in ambient air in residential areas of 0.4 milligram per cubic meter on a once-daily basis and 0.15 milligram per cubic meter on a daily average basis. Several states have set guidelines or standards for nitric acid in ambient air[60] ranging from 50−100 μ/m^3 (North Dakota) to 80 μ/m^3 (Virginia) to 100 μ/m^3 (Connecticut, Florida, New York, and South Dakota) to 119 μ/m^3 (Nevada) to 125 μ/m^3 (South Carolina) to 1000 μ/m^3 (North Carolina).

Determination in Air: Use NIOSH Analytical Method #7903, acids, inorganic; OSHA Analytical Methods ID-127 and ID-165SG.

Permissible Concentration in Water: The EEC set a MAC in drinking water of 50 mg NO_3/liter and a guideline level of 25 mg NO_3/liter[35]. Russia[43] set a MAC of 0.4 mg/L in water bodies used for domestic purposes.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Corrosive to the eyes, skin, and respiratory tract. Corrosive if ingested. Inhalation can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. This compound is a Primary irritant (w/o allergic reaction), and causes burns and ulceration of all tissues and membranes that it contacts. This includes burns to the eyes and skin by contact; burns to the mouth, throat, esophagus, and stomach by ingestion; and the entire respiratory tract by inhalation. Circulatory collapse and shock is often the immediate cause of death. The approximate minimum lethal dose is 5 ml for a 150 lb person. Persons with skin, eye, or cardiopulmonary disorders are at a greater risk. Signs and symptoms of acute ingestion of nitric acid may be severe and include increased salivation; intense thirst; difficulty in swallowing; chills, pain, and shock. Oral, esophageal, and stomach burns are common. Vomitus generally has a coffee-ground appearance. The potential for circulatory collapse is high following ingestion of nitric acid. Acute inhalation exposure may result in sneezing, hoarseness, choking, laryngitis, dyspnea (shortness of breath), respiratory tact irritation; and chest pain. Bleeding of nose and gums, ulceration of the nasal and oral mucosa; chronic bronchitis; and pneumonia may also occur. If the eyes have come in contact with nitric acid, irritation, pain, swelling, corneal erosion; and blindness may occur. Dermal exposure may result in severe burns, pain, and dermatitis (red, inflamed skin).

Long-Term Exposure: The mists or vapors may cause erosion of the teeth. May affect the lungs.

Points of Attack: Eyes, skin, respiratory system; teeth.

Medical Surveillance: NIOSH recommends that workers subject to nitric acid exposure have comprehensive preplacement and annual medical examinations including a 14″ × 17″ posterior-anterior chest X-ray, pulmonary function tests: forced vital capacity, forced expiratory volume (1 second); and a visual examination of the teeth for evidence of dental erosion.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious, administer water, or milk. Do not induce vomiting. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pneumonitis or pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Nitric acid: Neoprene (up to 30%); Natural rubber or polyvinyl chloride (up to 70%); Neoprene/natural rubber or Saranex (more than 70%). For fuming nitric acid the following are recommended: Viton, nitrile, Neoprene, natural rubber, chlorobutyl, or Neoprene/natural rubber. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. possibility of skin contact with liquids of pH < 2.5 or repeated or prolonged contact with liquids of pH > 2.5. Wear eye protection to prevent any possibility of eye contact. Employees should wash immediately when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash if liquids of pH < 2.5 are involved.

Respirator Selection: *25 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); orCcrFS (APF = 50) [any chemical cartridge respirator with a full facepiece and cartridge(s) providing protection against the compound of concern]; or GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp:SCBA (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern]; or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection. Only nonoxidizable sorbents are allowed (not charcoal).

Storage: Store nitric acid separately from acetic acid. Storage in another isolated location and/or in the shipping container, usually Styrofoam, is preferred.

(1) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. (2) Color code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Oxidizers should be isolated from acids, metals, organic materials, and ammonium nitrate. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Nitric acid must be stored to avoid contact with metallic powders, carbides, hydrogen sulfide; turpentine, or strong bases because violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Heat may cause containers to burst and result in an escape of poisonous gases. Fuming nitric acid should be avoided.

Shipping: UN2031 Nitric acid other than red fuming, with >70% nitric acid or Nitric acid other than red fuming, with at least 65%, but not >70% nitric acid, Hazard Class: 8; Labels: 8-Corrosive material, 5.1-Oxidizer. UN2032 Nitric acid, red fuming, Hazard Class: 8; Labels: 8-Corrosive material, 5.1-Oxidizer, 6.1-Poisonous material. Inhalation, Hazard Zone B. UN2031 Nitric acid other than red fuming, with >20% and <65% nitric acid or Nitric acid other than red fuming, with not >20% nitric acid, Hazard Class: 8; Labels: 8-Corrosive material.

Spill Handling:

UN2032 Nitric acid, red fuming

Initial isolation and protective action distances (UN2032 fuming nitric acid)

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424−9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548−8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

Nitric acid, fuming and red fuming

First: Isolate in all directions (ft./m)100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.2/0.3

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft./m) 500/150
Then: Protect persons downwind (mi/km)
Day 0.4/0.6
Night 0.7/1.2

Keep unnecessary people away. Do not touch spilled material; stop leak if you can do so without risk. Isolate the hazard area and deny entry. Stay upwind and keep out of low areas. Ventilate closed spaces before entering them. Ventilate area of spill or leak. Remove all ignition sources. Keep combustibles (wood, paper, oil, etc.) away from spilled material. Use water spray to reduce vapors; do not get water inside container. *Small spills*: flush area with flooding amounts of water. *Large spills*: dike far ahead of spill for later disposal. Flush with copious quantities of water and neutralize with alkaline material (such as soda ash, lime, etc.). Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Firefighting gear (including SCBA) may not provide adequate protection. If exposure occurs, remove and isolate gear immediately and thoroughly decontaminate personnel. Nitric acid is noncombustible. However, it can increase the flammability of combustible, organic, and readily oxidizable materials, or even cause ignition of some of these with water. Thermal decomposition products may include nitrogen oxides. Use water spray. *Small fires:* water, dry chemical, or soda ash. *Large fires:* flood fire area with water. Move container from fire area if you can do so without risk. For massive fire in cargo area, use unmanned hose holder or monitor nozzles; if this is impossible, withdraw from area and let fire burn. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Soda ash-slaked lime is added to form the neutral solution of nitrate of sodium and calcium. This solution can be discharged after dilution with water[22]. Also, nitric acid can be recovered and reused in some cases as with acrylic fiber spin solutions. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with

EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); National institute for Occupational Safety and Health (NIOSH), "Criteria for a Recommended Standard:(100). Occupational(2). Exposure to Nitric Acid," NIOSH Document Number 76-141, Cincinnati OH (1976).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 1, No. 5, 71–72 (1981) and 5, No. 3, 64–67 (1985).

United States Environmental Protection Agency, *Chemical Hazard Information Profile:* Nitric Acid, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

New York State Department of Health, *Chemical Fact Sheet:* Nitric Acid, NY, Bureau of Toxic Substance Assessment (March 1986, Version 2).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Nitric Acid, Trenton, NJ (May 2001).

Nitric Oxide N:0350

Formula: NO

Synonyms: Bioxyde d'azote (French); Monoxido de nitrogeno (Spanish); Nitric oxide; Nitrogen monoxide; NO (military designation); Oxido nitrico (Spanish); Oxyde nitrique (French); Stickmonoxyd (German)

CAS Registry Number: 10102-43-9; *(alt.)* 51005-21-1; *(alt.)* 90452-29-2; *(alt.)* 90880-94-7

HSDB Number: 1246

RTECS Number: QX0525000

UN/NA & ERG Number: UN1660/124

EC Number: 233-271-0

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 ($\geq$1.00% concentration). *Theft hazard* 15 ($\geq$3.83% concentration).

Hazard Alert: Poison inhalation hazard (gas), Explosive, Strong oxidizer, Corrosive, Water reactive, Air reactive, Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated, Suspected of causing genetic defects.

OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 250 lb

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P076

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

SUPERFUND/EPCRA 302, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 10 lb (4.54 kg)

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, O, Xi; risk phrases: R5; R8; R21; R23; R38; R41; R44; R62; safety phrases: S1; S9; S17; S23; S25; S26; S33; S36/37/39; S38; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Nitric oxide is a colorless gas with a sharp, sweet odor; brown at high concentration in air. Shipped as a nonliquefied compressed gas. Molecular weight = 30.01; specific gravity (H_2O:1) = 1.22 @ 20°C; boiling point = −151.7°C; freezing/melting point = −163.3°C; Relative vapor density (air = 1) = 1.04; vapor pressure = 750 mmHg @ −152°C. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 0; reactivity 0 ₩, oxidizer. Slightly soluble in water; solubility = 5%. The liquid is very sensitive to detonation in the presence of water[101].

Potential Exposure: Nitric oxide is used in the manufacture of nitric acid; it is also used in the bleaching of rayon; it is a raw material for nitrosyl halide preparation.

Incompatibilities: A strong oxidizer but may also act as a reducing agent[101]. Explosive reaction with nitrogen trichloride, ozone, carbon disulfide; pentacarbonyl iron; chlorine monoxide. Incompatible with halogens, combustibles, metals, oil, alcohols, chlorinated hydrocarbons (e.g., trichloroethylene), reducing agents (such as NH_3), oxygen, fluorine, metals. Reacts with water to form nitric acid. Rapidly converted in air to nitrogen dioxide. Combines very rapidly with oxygen in the air to form nitrogen dioxide. Nitrogen dioxide reacts with water to form nitric acid and nitric oxide, reacts with alkalis to form nitrates and nitrites[206,136].

Permissible Exposure Limits in Air

NIOSH IDLH = 100 ppm

Conversion factor: 1 ppm = 1.88 milligram per cubic meter @ 25°C & 1 atm

Odor threshold = 0.3–1.0 ppm.

OSHA PEL: 25 ppm/30 milligram per cubic meter TWA

NIOSH REL: 25 ppm/30 milligram per cubic meter TWA

ACGIH TLV[1]: 25 ppm/31 milligram per cubic meter TWA; BEIM issued for Methemoglobin inducers.

PAC* Ver. 29[138]

PAC-1: 0.5 ppm

PAC-2: 12 ppm

PAC-3: 20 ppm

DFG MAK: 0.5 ppm/0.63 milligram per cubic meter TWA; Peak Limitation Category II(2); Pregnancy Risk Group D.

Austria: MAK 25 ppm (30 milligram per cubic meter), 1999; Denmark: TWA 25 ppm (30 milligram per cubic meter), 1999; France: VME 25 ppm (30 milligram per cubic meter), 1999; Norway: TWA 25 ppm (30 milligram per cubic meter), 1999;

Poland: MAC (TWA) 5 milligram per cubic meter; MAC (STEL) 10 milligram per cubic meter, 1999; Sweden: NGV 25 ppm (30 milligram per cubic meter), KTV 50 ppm (60 milligram per cubic meter), 1999; Thailand: TWA 25 ppm (30 milligram per cubic meter), 1993; the Netherlands: MAC-TGG 30 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 25 ppm. Several states have set guidelines or standards for nitric oxide in ambient air[60] ranging from 0.3 milligram per cubic meter (North Dakota) to 0.5 milligram per cubic meter (Virginia) to 0.6 milligram per cubic meter (Connecticut) to 0.714 milligram per cubic meter (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #6014, Nitric oxide and nitrogen dioxide, 6014; OSHA Analytical Method #ID-109.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin. Strong respiratory tract irritant. High levels can interfere with the blood's ability to carry oxygen (methemoglobinemia). Nitric oxide forms acids in the respiratory system which are irritating and can cause congestion in the lungs or pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Nitric oxide can cause death or permanent injury after a very short exposure to small quantities. Can cause unconsciousness. Concentrations of 60-150 ppm cause immediate irritation of the nose and throat with coughing and burning in the throat and chest 6−24 hours after exposure; labored breathing and unconsciousness may result. Concentrations of 100−150 ppm are dangerous for a short exposure of 30−60 minutes. Concentrations of 200−700 ppm may be fatal after very short exposure. Nitric oxide can cause death due to blockage of gas exchange in lungs. Initially, symptoms include slight coughing, fatigue and nausea at high concentrations; coughing, choking, headache, nausea, abdominal pain; and shortness of breath are seen. Latent symptoms are uneasiness, restlessness, rapid and shallow breathing; bluing of skin, lips and fingernail beds; anxiety, mental confusion; and finally loss of consciousness.

Long-Term Exposure: Can irritate the lungs; bronchitis may develop. Can cause headache, nausea, vomiting, fatigue, mental confusion; unconsciousness, and death. Increased blood methemoglobin levels.

Points of Attack: Eyes, skin, respiratory system; blood, central nervous system.

Medical Surveillance: NIOSH lists the following tests: chest X-ray, electrocardiogram, on workers over 40 years, expired air, pulmonary function tests: forced vital capacity, forced expiratory volume (1 second). Consider the points of attack in preplacement and periodic physical examinations. Blood methemoglobin levels.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Effects may be delayed; keep victim under observation. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Note to Physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear nonvented, impact resistant, gas-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. pressure, pressure-demand, full facepiece SCBA (SCBA) or pressure-demand supplied air respirator with escape SCBA and a fully-encapsulating, chemical resistant suit.

Respirator Selection: NIOSH/OSH: *1000* ppm*:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or CcrFS (APF = 50) (any chemical cartridge respirator with a full facepiece and cartridge(s) providing protection against the compound of concern); or PaprS (APF = 25) (any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern); or GmFS (APF = 50) (any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern); or Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:*

GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern]; or SCBAE (any appropriate escape-type, SCBA). *Note:* Only nonoxidizable sorbents are allowed (not charcoal).

Storage: Check oxygen content prior to entering storage area. Poison gas. (1) Color code—Blue: Health Hazard/ Poison: Store in a secure poison location. This gas is highly toxic. Even slight exposure to these gasses can cause death. Store outdoors in a secure, restricted area that containing warning signs. This area must be roofed and shaded with the cylinders stored off the ground and separated from all other products assigned to other hazard categories and radiant heat sources on nonwooden floors. If indoors, store in a well-ventilated areas in temperatures not to exceed 50°C. (2) Color code—Yellow Stripe: Reactivity Hazard; Store separately in a area isolated from flammables, combustibles, or other yellow coded materials. Oxidizers, including oxidizing gases, should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. (3) Prior to working with this chemical, personnel should be trained on its proper handling and storage. (3) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location; keep acids away from bases and red, yellow, and blue-coded chemicals. High concentrations cause a deficiency of oxygen with the risk of unconsciousness or death. Check that oxygen content is at least 19% before entering storage or spill area. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: UN1660/124 Nitric oxide, compressed, Hazard Class: 2.3; Labels: 2.3-Poisonous gas, 5.1-Oxidizer, 8-Corrosive material, Inhalation Hazard Zone A. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling:

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424−9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548−8730 (24-hour response line).

Un1660 nitric oxide or nitric oxide, compressed

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft./m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.4/0.6

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft./m) 300/90
Then: Protect persons downwind (mi/km)
Day 0.4/0.6
Night 1.5/2.4

If in a building, evacuate building and confine vapors by closing doors and shutting down HVAC systems. Restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak to disperse the gas. Wear chemical protective suit with SCBA to combat spills. Stay upwind and use water spray to "knock down" vapor; contain runoff. Stop the flow of gas, if it can be done safely from a distance. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place; and repair leak or allow cylinder to empty. Keep this chemical out of confined spaces, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Nitric oxide itself does not burn. It will react with water or steam to produce heat and corrosive fumes. Thermal decomposition products may include nitrogen oxides. This gas is under pressure; containers may rupture and explode when heated. May ignite other combustible materials (wood, paper, oil, etc.). Mixture with fuels may explode. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapor explosion and poison hazard indoors, outdoors or in sewers. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Incineration with added hydrocarbon fuel, controlled so as to produce elemental nitrogen, CO_2, and water. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥ 100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (173); (101); (138); (2); (100).

National institute for Occupational Safety and Health (NIOSH), "Criteria for a Recommended Standard: Occupational Exposure to Oxides of Nitrogen," NIOSH Document Number 76-149, Washington, DC (1976).

World Health Organization, *Oxides of Nitrogen, Environmental Health Criteria No. 4*, Geneva, Switzerland (1977).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 1, No. 5, 73−74 (1981).

United States Environmental Protection Agency, *Chemical Hazard Information Profile:* Nitric Oxide, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Nitric Oxide, Trenton, NJ (August, 1999).

Nitrilotriacetic Acid N:0360

Formula: $C_6H_9NO_6$; $N(CH_2COOH)_3$

Synonyms: Acetic acid, nitrilotri-; Acido nitrilotriacetico (Spanish); Aminotriacetic acid; *N,N*-Bis(carboxymethyl) glycine; Chel 300; Complexon I; Glycine, *N,N*-Bis(carboxymethyl)-; Hampshire NTA acid; Komplexon I; NCI-C02766; Nitrilo-2,2′,2″-triacetic acid; NTA; Titriplex I; Tri (carboxymethyl)amine; Triglycine; Triglycollamic acid; Trilon A; α,α',α''-Trimethylaminetricarboxylic acid; Versene NTA acid

CAS Registry Number: 139-13-9; *(alt.)* 26627-44-1; *(alt.)* 26627-45-2; *(alt.)* 80751-51-5

HSDB Number: 2853

RTECS Number: AJ0175000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 205-355-7

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Animal Sufficient Evidence; Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B, 1999; NCI: Carcinogenesis Bioassay (feed); clear evidence: mouse, rat. United States Environmental Protection Agency Gene-Tox Program, Positive: Carcinogenicity-mouse/rat; Negative: D *melanogaster* sex-linked lethal.

California Proposition 65 Chemical[102]: Cancer 1/1/1988.

Hazard Alert: Poison, Combustible, Possible risk of forming tumors, Suspected reprotoxic hazard.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%.

Hazard symbols, risk; & safety statements: Hazard symbol: T, Xn; risk phrases: R45; R20/21/22; R36/37/38; R34; R40; R63; safety phrases: S22; S26; S36/37/39; S45; S53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Nitrilotriacetic acid is a crystalline compound. Molecular weight = 191.16; boiling point = 167°C; freezing/melting point = 242°C (decomposition). Hazard identification (based on NFPA-704 M Rating System): Health 1; flammability 1; reactivity 0. Slightly soluble in water.

Potential Exposure: Nitrilotriacetic acid (NTA) was used as a phosphate replacement in laundry detergents in the late 1960s. In 1971, the use of NTA was discontinued. The possibility of resumed use arose in 1980. NTA is now used in laundry detergents in states where phosphates are banned. NTA is also used as a boiler feed-water additive at a maximum use level of 5 ppm of trisodium salt. Currently, the remaining nondetergent uses of NTA are for water treatment, textile treatment; metal plating and cleaning; and pulp and paper processing.

Incompatibilities: Dust may form explosive mixture with air. Compounds of the carboxyl group react with all bases, both inorganic and organic (i.e., amines) releasing substantial heat, water and a salt that may be harmful. Incompatible with arsenic compounds (releases hydrogen cyanide gas), diazo compounds, dithiocarbamates, isocyanates, mercaptans, nitrides, and sulfides (releasing heat, toxic and possibly flammable gases), thiosulfates and dithionites (releasing hydrogen sulfate and oxides of sulfur). Attacks aluminum, copper, copper alloy and nickel.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 4.4 milligram per cubic meter

PAC-2: 49 milligram per cubic meter

PAC-3: 290 milligram per cubic meter

DFG MAK: avoid simultaneous exposure to Iron (Fe) compounds.

Permissible Concentration in Water: No criteria set for drinking water; NTA addition to boiler feed-water is limited to 5 ppm by FDA. NTA levels in the United States drinking water prior to NTA's discontinued use in detergents was estimated by EPA to have ranged from 0.20−24.5 μg/L. NTA is rapidly degraded under aerobic conditions at temperatures above 5°C, and biodegradation does not lead to the formation of persistent intermediates.

Determination in Water: Octanol-water coefficient: Log $K_{ow} = < -3$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes and skin. This material is moderately toxic; harmful when ingested. The LD_{50}-oral-rat is 1470 mg/kg.

Long-Term Exposure: Possibly carcinogenic. Possible kidney damage.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Kidney function tests.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Based on potential carcinogenicity the following is recommended by NIOSH: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full facepiece respirator with an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in a refrigerator or in a cool, dry place. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft.(NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen spilled material with toluene to avoid dust. Or, use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include oxides of nitrogen and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(109); (102); (31); (173); (101); (138); (100).

5-Nitroacenaphthene N:0370

Formula: $C_{12}H_9O_2$

Synonyms: 1-Amino-2-methoxy-5-nitrobenzene; 2-Amino-1-methoxy-4-nitrobenzene; 3-Amino-4-methoxynitrobenzene; 2-Amino-4-nitroanisole; *o*-Anisidine nitrate; *o*-Anisidine, 5-nitro-; Azoamine scarlet; Azoamine scarlet K; Azogene Ecarlate R; Azoic diazo component 13 base; Benzenamine, C.I. 37130; Benzenamine, 2-methoxy-5-nitro-; C.I. 37130; C.I. Azoic diazo component 13; Fast scarlet R; 1-Methoxy-2-amino-4-nitrobenzene; 2-Methoxy-5-nitro-; 2-Methoxy-5-nitroaniline; 2-Methoxy-5-nitrobenzenamine; NCI-C01934; 3-Nitro-6-methoxyaniline; 5-Nitro-2-methoxyaniline

CAS Registry Number: 602-87-9

HSDB Number: 4092

RTECS Number: AB1060000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 210-025-0 [*Annex I Index No.:* 609-037-00-2]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Sufficient Evidence; Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B, 1987. NCI: Carcinogenesis Bioassay (feed); clear evidence: mouse, rat, 1987.

California Proposition 65 Chemical[102]: Cancer 4/1/1988.

Hazard Alert: Poison, Combustible, Possible risk of forming tumors, Suspected of causing genetic defects.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xi; risk phrases: R45; R50; R62; safety phrases: S1; S41; S45; S53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: 5-Nitroacenaphthene is a yellow crystalline solid. Molecular weight = 199.22; freezing/melting point = 103-104°C. Hazard identification (based on NFPA-704 M Rating System): Health 1; flammability 1; reactivity 0.

Potential Exposure: Used in organic synthesis.

Incompatibilities: 5-Nitroacenaphthene is an aromatic hydrocarbon (nitro compound). It may be flammable or explosive. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides; alkalis may increases the thermal sensitivity of this chemical.

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

DFG MAK: Carcinogen Category 2

Determination in Water: Octanol-water coefficient: Log $K_{ow} = >3$. Values above 3.0 are likely to bioaccumulate in aquatic organisms.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: May reduce the blood's ability to carry oxygen (methhemoglobinemia) with cyanosis, fatigue, dizziness, headache. May affect the central nervous system.

Long-Term Exposure: Little is known aside from the fact that it is a carcinogen. May cause liver and kidney damage. Poisoning may cause anemia, cyanosis, fatigue, insomnia, weight loss.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure.

First Aid: *Skin Contact:* Flood all areas of body that have contacted the substance with water. Don't wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others[52]. *Eye Contact:* Remove any contact lenses at once. Flush eyes well with copious quantities of water or normal saline for at least 20−30 minutes. Seek medical attention. *Inhalation:* Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion:* If convulsions are not present, give a glass or two of water or milk to dilute the substance. Assure that the person's airway is unobstructed and contact a hospital or poison center immediately for advice on whether or not to induce vomiting.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Teflon, Silvershield, Viton, Viton/chlorobutyl rubber, chlorinated polyethylene; and polyvinyl alcohol are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA-or European Standard EN 149-approved SCBA that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in a refrigerator or a cool, dry place. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/ 75 ft.(NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen spilled material with acetone. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include oxides of nitrogen and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Careful incineration in an incinerator equipped with afterburner and scrubbers[22].

References

(102); (31); (173); (101); (138); (100).

p-Nitroaniline N:0380

Formula: $C_6H_6N_2O_2$: $H_2NC_6H_4NO_2$

Synonyms: *p*-Aminonitrobenzene; 1-Amino-4-nitrobenzene; Aniline, *p*-nitro-; Aniline, 4-nitro-; Azoamine red ZH; Azofix red GG salt; Azoic diazo component 37; Benzenamine, 4-nitro-; C.I. 37035; C.I. azoic diazo component 37; C.I. Developer 17; Developer P; Devol red GG; Diazo fast red GG; Fast red 2 G base; Fast red 2 G salt; Fast red base; Fast red base 2 J; Fast red base GG; Fast red GG base; Fast red GG salt; Fast red MP base; Fast red P base; Fast red P salt; Fast red salt 2 J; Fast red salt GG; Naphtoelan red GG base; NCI-C60786; Nitoraniline-*p*; 4-Nitranbine; *p*-Nitraniline; Nitrazol CF extra; *p*-Nitroanilina (Spanish); *p*-Nitroaniline; 4-Nitroaniline; 4-Nitrobenzenamine; *p*-Nitrophenylamine; PNA; Red 2 G base; Shinnippon fast red GG base

CAS Registry Number: 100-01-6

HSDB Number: 1156

RTECS Number: BY7000000

UN/NA & ERG Number: UN1661/153

EC Number: 202-810-1 [*Annex I Index No.:* 612-012-00-9]

Regulatory Authority and Advisory Information

Carcinogenicity: NCI: Carcinogenesis Studies (gavage); equivocal evidence: rat. United States Environmental Protection Agency Gene-Tox Program, Negative: Sperm morphology-mouse.

Hazard Alert: Poison, Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard.

OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 5000 lb (2270 kg)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P077

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.028; Nonwastewater (mg/kg), 28

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 5000 lb (2270 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

European/International Regulations (*all isomers*): Hazard symbol: T, N; risk phrases: R23/24/25; R33; R51/53; R61; R62; R63; safety phrases: S1/2; S28; S36/37; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: *p*-Nitroaniline consists of yellow crystals with a pungent, faint ammonia-like odor. Molecular weight = 138.12; specific gravity (H_2O:1) = 1.42 @ 20°C; boiling point = 332°C; freezing/elting point = 148°C; vapor pressure = 0.000002 mmHg @ 20°C; Flash point = 198.9°C; Autoignition temperature = 510°C. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 1; reactivity 0. Slightly soluble in water.

Potential Exposure: *p*-Nitroaniline is used as an intermediate in the manufacture of dyes; antioxidants, pharmaceuticals, and pesticides.

Incompatibilities: A combustible liquid. A strong oxidizer. Incompatible with strong acids; sulfur, combustibles, organics, and other easily oxidizable materials. Will accelerate the burning of combustible materials. If large quantities are involved in a fire or the combustible material is finely divided, an explosion may result. Prolonged exposure to fire or heat may result in an explosion[101].

Permissible Exposure Limits in Air

NIOSH IDLH = 300 milligram per cubic meter

OSHA PEL: 1 ppm/6 milligram per cubic meter TWA [skin]

NIOSH REL: 3 milligram per cubic meter TWA [skin]

ACGIH TLV[1]: 3 milligram per cubic meter TWA [skin]; not classifiable as a human carcinogen; BEIM issued for Methemoglobin inducers.

DFG MAK: [skin]; Carcinogen Category 3A

PAC Ver. 29[138]

PAC-1: 9 milligram per cubic meter

PAC-2: 71 milligram per cubic meter

PAC-3: 300 milligram per cubic meter

Arab Republic of Egypt: TWA 1 ppm (6 milligram per cubic meter) [skin], 1993; Australia: TWA 3 milligram per cubic meter [skin], 1993; Austria: MAK 1 ppm (6 milligram per cubic meter) [skin], 1999; Belgium: TWA 3 milligram per cubic meter [skin], 1993; Denmark: TWA 0.5 ppm (3 milligram per cubic meter) [skin], 1999; Finland: TWA 1 ppm (6 milligram per cubic meter); STEL 3 ppm (18 milligram per cubic meter) [skin], 1993; France: VME 3 milligram per cubic meter [skin], 1999; the Netherlands: MAC-TGG 6 milligram per cubic meter, [skin], 2003; Japan: 3 milligram per cubic meter [skin], 1999; Norway: TWA 1 milligram per cubic meter, 1999; the Phillipines: TWA 1 ppm (6 milligram per cubic meter) [skin], 1993; Poland: MAC (TWA) 3 milligram per cubic meter; MAC (STEL) 10 milligram per cubic meter, 1999; Russia: STEL 0.1 milligram per cubic meter [skin], 1993; Switzerland: MAK-W 0.5 ppm (3 milligram per cubic meter) [skin], 1999; Turkey: TWA 1 ppm (6 milligram per cubic meter) [skin], 1993; United Kingdom: TWA 6 milligram per cubic meter, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Several states have set guidelines or standards for *p*-nitroaniline in ambient air[60] ranging from zero (Connecticut) to 6.0 μ/m^3 (New York) to 7.143 μ/m^3 (Kansas) to 15 μ/m^3 (South Carolina) to 30 μ/m^3 (Florida and North Dakota) to 50 μ/m^3 (Virginia) to 71 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #5033.

Determination in Water: Octanol-water coefficient: Log K_{ow} = 2.7. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: *p*-Nitroaniline can affect you when breathed in and by passing through your skin. Exposure by skin contact or breathing can interfere with the ability of the blood to carry oxygen (metheglobinemia) and kidney impairment. This can cause headaches, dizziness, cyanosis (a Blue color to the skin and lips), trouble breathing and even collapse and death.

Long-Term Exposure: Because this is a potential mutagen, handle it as a possible cancer-causing substance-with extreme caution. May affect the blood, causing the forming of methemoglobin, low blood count (anemia), kidney and liver damage. People with "G-6-P-D Deficiency" may be at higher risk for developing health problems following exposure.

Points of Attack: Respiratory system, blood, heart, liver, kidneys.

Medical Surveillance: NIOSH lists the following tests: whole blood (chemical/metabolite), Methhemoglobin; CBC; liver function tests. Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following is recommended: kidney function tests. Also, tests for the condition called "G-6-P-D Deficiency."

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to Physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *Up to 30 milligram per cubic meter:* Sa (APF = 10) (any supplied-air respirator).* *Up to 75 milligram per cubic meter:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode).* *Up to 150 milligram per cubic meter:* SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 300 milligram per cubic meter:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp; ASCBA (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus). *Escape:* GmFOv100 [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA). *Note:* *Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. *p*-Nitroaniline must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates and nitrates); reducers and strong acids (such as hydrochloric, sulfuric, and nitric), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area. Protect storage containers from physical damage. Wherever *p*-nitroaniline is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1661 Nitroanilines (*m-, o-, p-*), Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include sulfur dioxide and nitrogen oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration (982°C, 2.0 seconds minimum) with scrubbing for nitrogen oxides abatement. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (173); (101); (138). (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: p*-Nitroaniline, Trenton, NJ (April 2004).

5-Nitro-*o*-anisidine N:0390

Formula: $C_7H_8N_2O_3$; $C_6H_3(OCH_3)(NH_2)(NO_2)$

Synonyms: 1-Amino-2-methoxy-5-nitrobenzene; 2-Amino-1-methoxy-4-nitrobenzene; 3-Amino-4-methoxynitrobenzene; 2-Amino-4-nitroanisole; *o*-Anisidine nitrate; *o*-Anisidine, 5-nitro-; Azoamine scarlet; Azoamine scarlet K; Azogene Ecarlate R; Azoic diazo component 13 base; Benzenamine, C.I. 37130; Benzenamine, 2-methoxy-5-nitro-; C.I. 37130; C.I. azoic diazo component 13; Fast scarlet R; 1-Methoxy-2-amino-4-nitrobenzene; 2-Methoxy-5-nitro-; 2-Methoxy-5-nitroaniline; 2-Methoxy-5-nitrobenzenamine; NCI-C01934; 3-Nitro-6-methoxyaniline; 5-Nitro-2-methoxyaniline

CAS Registry Number: 99-59-2

HSDB Number: 4104

RTECS Number: BZ7175000

UN/NA & ERG Number: UN3143 (Dyes, solid, toxic, n.o.s.)/151

EC Number: 202-770-5

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Limited Evidence; Human No Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1987; NCI: Carcinogenesis Bioassay (feed); clear evidence: mouse, rat, 1978. 5-Nitro-*o*-anisidine was removed from the NTP 6th Report on Carcinogens as a substance "reasonably anticipated to be a human carcinogen" in 1991, when NTP concluded there was insufficient evidence of carcinogenicity. California Proposition 65 Chemical[102]: Cancer delisted 12/8/2006

Hazard Alert: Poison, Combustible, Possible risk of forming tumors, Suspected of causing genetic defects,

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xi; risk phrases: R20/21/22; R27/28; R36/37/38; R46; R51; R62; safety phrases: S13; S22; S36/37/39; S45; S53; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: 5-Nitro-*o*-anisidine is an orange-red crystalline compound. Molecular weight = 168.17; freezing/melting point = 118°C. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 1; reactivity 0.

Potential Exposure: 5-Nitro-*o*-anisidine is a chemical intermediate in the production of C.I. Pigment red 23, which is used as a colorant for commodities, such as printing inks, interior latex paints; lacquers, rubber, plastics, floor coverings; paper coating; and textiles. It is also used with other C.I. coupling components to produce various hues of red, brown, yellow, and violet on cotton, silk, acetate and nylon.

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, acid chlorides; acid anhydrides; chloroformates.

Permissible Exposure Limits in Air No OELs have been established, but this chemical can be absorbed through the skin. Several states have set guidelines or standards for 5-nitro-*o*-ansidine in ambient air[60] ranging from zero (North Dakota) to 0.08 μ/m^3 (Rhode Island).

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: High levels can interfere with the blood's ability to carry oxygen (methemoglobinemia) causing dizziness, cyanosis. Higher levels can cause trouble breathing; collapse, and even death.

Long-Term Exposure: This compound is a proved carcinogen in experimental animals. Related chemicals can cause allergic skin rash, and irritate the nose, throat, and lungs. It is not known whether this substance can cause these effects.

Points of Attack: Blood. *Cancer site:* bladder.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Blood hemoglobin level, CBC.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong acids; acid chlorides; acid anhydrides; and chloroformates. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN3143 Dyes, solid, toxic, n.o.s. or Dye intermediates, solid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration (982°C, 2.0 seconds minimum) with scrubbing for nitrogen oxides abatement.

References

(102); (31); (173); (101); (138); (100).

United States Environmental Protection Agency, *Chemical Hazard Information Profile:* 5-Nitro-*o*-Anisidine, Washington, DC (1979).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* 5-Nitro-*o*-anisidine, Trenton, NJ (September 2004).

o-Nitroanisole N:0395

Formula: $C_7H_7NO_3$

Synonyms: Anisole, *o*-nitro-; Benzene, 1-methoxy-2-nitro-; 2-Methoxynitrobenzene; 1-Methoxy-2-nitrobenzene; NCI-C60388; 2-Nitroanisol (German); 2-Nitroanisole; *o*-Nitrobenzene methyl ether; 2-Nitromethyoxybenzene; o-Nitrophenyl methyl ether

CAS Registry Number: 91-23-6; 35973-13-8; 555-03-3 (*m*-Nitroanisole); 100-17-4 (*p*-Nitroanisole)

HSDB Number: 5186

RTECS Number: BZ8790000 (*o*-); BZ8800000 (*p*-)

UN/NA & ERG Number: UN2730 (Nitroanisoles, liquid)/152; UN3458 (Nitroanisoles, solid)/152

EC Number: 202-052-1 [609-047-00-7]

Regulatory Authority and Advisory Information

Carcinogenicity: (91-23-6) NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Animal Sufficient Evidence; Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B. California Proposition 65 Chemical[102]: Cancer, 10/1/1990

Hazard Alert: Poison, (91-23-6): Poison, Combustible, Strong oxidizer; Possible risk of forming tumors, Suspected of causing genetic defects.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

European/International Regulations (91-23-6): Hazard symbol: T, O; risk phrases: R45; R8; R22; R45; R50/53; R62; safety phrases: S17; S41; S45; S53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: 2-Nitroanisole is a yellowish or light-red to amber liquid. May be transported in molten form. Molecular weight = 153.15; specific gravity (H_2O:1) = 1.254 @ 20°C; boiling point = 271°C @ 760 mmHg; freezing/melting point = 9.4-10.5°C; vapor pressure = 4×10^{-3} mmHg @ 25°C; Henry's Law constant = 4.29×10^{-7} atm-m^3/mol @ 25°C (est)[72]; flash point = >110°C; 142°C; autoignition temperature = 464°C. Practically insoluble in water; solubility = <1 mg/mL @ 24°C.

Potential Exposure: A dye intermediate and for synthesis of other chemicals. NFPA has reported an explosion on during reduction with a nickel catalyst. Occupational exposure to 2-nitroanisole may occur through inhalation and dermal contact with this compound at workplaces where the chemical is produced or used.

Incompatibilities: A strong oxidizer. Incompatible with strong acids; sulfur, combustibles, organics, and other easily oxidizable materials. Will accelerate the burning of combustible materials. If large quantities are involved in a fire or the combustible material is finely divided, an explosion may result. Prolonged exposure to fire or heat may result in an explosion[101]. Explodes at temperatures >110°C. Combustible-liquid or fine powder may form explosive mixture with air. Nitroanisole reacts explosively with (sodium hydroxide + zinc). It reacts vigorously with hydrogen + catalyst (@ 250°C & 25,500 mmHg)[193].

Permissible Exposure Limits in Air: No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Determination in Water: Octanol-water coefficient: Log K_{ow} = <2. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation skin contact, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Highly toxic, may be fatal if inhaled, swallowed or absorbed through skin. Contact with molten substance may cause severe burns to skin and eyes. Avoid any skin contact. Effects of contact or inhalation may be delayed[DOT, ERG 152]. LD_{50} = (oral-rat) <800 mg/kg.

Long-Term Exposure: May cause cancer. Possible risk of forming tumors. May be mutagenic

Points of Attack: Not found.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure.

First Aid: *Eyes*: First check the victim for contact lenses and remove if present. Flush victim's eyes with water or normal saline solution for 20−30 minutes while simultaneously calling a hospital or poison control center. Do not put any ointments, oils, or medication in the victim's eyes without specific instructions from a physician. *Immediately* transport the victim after flushing eyes to a hospital even if no symptoms (such as redness or irritation) develop. *Skin: immediately* flood affected skin with water while removing and isolating all contaminated clothing. Gently wash all affected skin areas thoroughly with soap and water. If symptoms such as redness or irritation develop, *immediately* call a physician and be prepared to transport the victim to a hospital for treatment. *Inhalation: immediately* leave the contaminated area; take deep breaths of fresh air. If symptoms (such as wheezing, coughing, shortness of breath, or burning in the mouth, throat, or chest) develop, call a physician and be prepared to transport the victim to a hospital. Provide proper respiratory protection to rescuers entering an unknown atmosphere. Whenever possible, SCBA should be used; if not available, use a level of protection greater than or equal to that advised under Protective Clothing. *Ingestion: do not induce vomiting*. If the victim is conscious and not convulsing, give 1 or 2 glasses of water to dilute the chemical and *immediately* call a hospital or poison control center. Be prepared to transport the victim to a hospital if advised by a physician. If the victim is convulsing or unconscious, do not give anything by mouth, ensure that the victim's airway is open and lay the victim on his/her side with the head lower than the body. *Do not induce vomiting. Immediately* transport the victim to a hospital.

Personal Protective Methods: Reacts—do *not* use—with cellulose-based absorbents and expanded polymeric absorbents. Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA-or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with an N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong acids; acid chlorides; acid anhydrides; and chloroformates. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2730 Nitroanisoles, liquid, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN3458 Nitroanisoles, solid, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Eliminate all ignition sources (no smoking, flares, sparks or flames in immediate area). Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Stop leak if you can do it without risk. Prevent entry into waterways, sewers, basements or confined areas. Cover with plastic sheet to prevent spreading. Absorb or cover with dry earth, sand or other noncombustible material and transfer to containers. *Do not get water inside containers.*

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen and carbon. If tank, rail car or tank truck is involved in a fire, *isolate* for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. *Small fire:* dry chemical, CO_2 or water spray. Large fire: water spray, fog or regular foam. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal; do not scatter the material. Use water spray or fog; do not use straight streams. *Fire involving tanks or car/trailer loads:* fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Do not get water inside containers. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. Always stay away from tanks engulfed in fire. *For massive fire*, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn.

Disposal Method Suggested: Use a licensed professional waste disposal service to dispose of this material. Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(109); (102); (31); (173); (101); (138). (100).

Nitrobenzene N:0400

Formula: $C_6H_5NO_2$

Synonyms: Benzene, nitro-; Essence of mirbane; Essence of myrbane; Mirbane oil; NCI-C60082; Nitrobenceno (Spanish); Nitrobenzol; Nitrobenzol, L; Nitro, liquid; Oil of mirbane; Oil of myrbane

CAS Registry Number: 98-95-3

HSDB Number: 104

RTECS Number: DA6475000

UN/NA & ERG Number: UN1662/152

EC Number: 202-716-0 [*Annex I Index No.:* 609-003-00-7]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Explosive hazard*; *Theft hazard* 100 (ACG concentration).

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Animal Sufficient Evidence; Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B, 1996; EPA: Likely to produce cancer in humans.

California Proposition 65 Chemical[102]: Cancer 8/26/97; Developmental/Reproductive toxin (male) 3/30/2010U.S.

Hazard Alert: Poison, Flammable, Possible risk of forming tumors, Reproductive toxin: possible risk of gene damage/impaired fertilty; Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction). Listed for Tier 1 screening as an endocrine disruptor[88].

EPA TSCA Section 8(e) Risk Notification, 8EHQ-0293-8703; 8EHQ-0293-8723; 8EHQ-0293-8724; 8EHQ-0892-9102; 8EHQ-0892-9103

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR401.15 Section 307 Toxic Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U169

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.068; Nonwastewater (mg/kg), 14

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8090 (40); 8270 (10)

SUPERFUND/EPCRA 302, Extremely Hazardous Substances: TPQ = 10,000 lb (4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 1000 lb (454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, F, N; risk phrases: R10; R23/24/25; R40; R48/23/24; R51/53; R62; R63; safety phrases: S1/2; S28; S36/37; S41; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Nitrobenzene is a pale yellow to dark brown oily liquid whose odor resembles bitter almonds (or black paste shoe polish). Molecular weight = 123.11; specific gravity (H_2O:1) = 1.2 @ 20°C; boiling point = 211°C; freezing/melting point = 5.7°C; vapor pressure = 0.3 mmHg @ 25°C; Flash point = 88°C (cc); Autoignition temperature = 480°C. Explosive limits: LEL = 1.8% @ 93°C; 2000 ppm[138]; UEL: 40%. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 2; reactivity 1. Practically insoluble in water; solubility = 0.2%.

Potential Exposure: Nitrobenzene is used in the manufacture of explosives and aniline dyes and as solvent and intermediate. It is also used in floor polishes; leather dressings and polished; and paint solvents, and to mask other unpleasant odors. Substitution reactions with nitrobenzene are used to form *m*-derivatives. Pregnant women may be especially at risk with respect to nitrobenzene as with many other chemical compounds, due to transplacental passage of the agent. Individuals with glucose-6-phosphate dehydrogenase deficiency may also be special risk groups. Additionally, because alcohol ingestion or chronic alcoholism can lower the lethal or toxic dose of nitrobenzene, individuals consuming alcoholic beverages may be at risk.

Incompatibilities: Concentrated nitric acid, nitrogen tetroxide; caustics; phosphorus pentachloride; chemically-active metals, such as tin or zinc. Violent reaction with strong oxidizers and reducing agents. Attacks many plastics. Forms thermally unstable compounds with many organic and inorganic compounds.

Permissible Exposure Limits in Air

NIOSH IDLH = 200 ppm

Conversion factor: 1 ppm = 5.04 milligram per cubic meter @ 25°C & 1 atm

Odor Threshold = 0.044; 0.02 ppm (NJ)

OSHA PEL: 1 ppm/5 milligram per cubic meter TWA [skin]

NIOSH REL: 1 ppm/5 milligram per cubic meter TWA [skin]

ACGIH TLV[1]: 1 ppm TWA [skin]; BEI: 5 mg[total *p*-nitrophenol]/g creatinine in urine/end-of-shift at end of work-week; 1.5% methemoglobin in blood, end-of-shift. confirmed animal carcinogen with unknown relevance to humans.

PAC Ver. 29[138]

PAC-1: 3 ppm

PAC-2: 20 ppm

PAC-3: 200 ppm

DFG MAK: [skin] Carcinogen Category 3B; BAT: 100 μg [Aniline, released from aniline-hemoglobin conjugate]/L in blood, for long-term exposure, after several shifts (sampling time) [skin]

Arab Republic of Egypt: TWA 1 ppm (5 milligram per cubic meter) [skin], 1993; Australia: TWA 1 ppm (5 milligram per cubic meter) [skin], 1993; Austria: MAK 1 ppm (5 milligram per cubic meter) [skin], 1999; Belgium: TWA 1 ppm (5 milligram per cubic meter) [skin], 1993; Denmark: TWA 1 ppm (5 milligram per cubic meter) [skin], 1999; Finland: TWA 1 ppm (5 milligram per cubic meter); STEL 3 ppm (15 milligram per cubic meter) [skin], 1999; France: VME 1 ppm (5 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 5 milligram per cubic meter, [skin], 2003; Japan: 1 ppm (5 milligram per cubic meter) [skin], 1999; Norway: TWA 1 ppm (5 milligram per cubic meter), 1999; Poland: MAC (TWA) 3 milligram per cubic meter; MAC (STEL) 10 milligram per cubic meter, 1999; Russia: TWA 1 ppm; STEL 3 milligram per cubic meter [skin], 1993; Sweden: NGV 1 ppm (5 milligram per cubic meter), KTV 2 ppm (10 milligram per cubic meter) [skin], 1999; Switzerland: MAK-W 1 ppm (5 milligram per cubic meter), KZG-W 2 ppm (10 milligram per cubic meter) [skin], 1999; Turkey: TWA 1 ppm (5 milligram per cubic meter) [skin], 1993; United Kingdom: TWA 1 ppm (5.1 milligram per cubic meter); STEL 2 ppm (10 milligram per cubic meter), [skin], 2000; New Zealand, Singapore, Vietnam: ACGIH TLV: confirmed animal carcinogen with unknown relevance to humans. The Czech Republic: TWA 1 ppm (5 milligram per cubic meter)[35]. Russia[43] has set 0.008 milligram per cubic meter (8 μ/m^3) as an MAC for ambient air in residential areas. Several states have set guidelines or standards for nitrobenzene in ambient air[60] ranging from 6.8 μ/m^3 (Massachusetts) to 16.7 μ/m^3 (New York) to 25 μ/m^3 (North Carolina and South Carolina) to 50 μ/m^3 (North Dakota) to 80 μ/m^3 (Virginia) to 100 μ/m^3 (Connecticut) to 119 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #2017. See also Method #2005.

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA Two approaches were used to derive criterion levels for nitrobenzene. Based on available toxicity data, to protect public health the derived level is 19.8 mg/L. Using available organoleptic data, to control undesirable taste and odor qualities of ambient water the estimated level is 30 μg/L. Organoleptic data have limitations as a basis for establishing water criterion, and have no demonstrated relationship to potential adverse human health effects. State Drinking Water Guidelines: Arizona 3.5 μg/L; Florida 9.5 μg/L; Maine 3.5 μg/L.

Determination in Water: Methylene chloride extraction followed by exchange to toluene, gas chromatography with flame ionization detection (EPA Method 609) or gas chromatography plus mass spectrometry (EPA Method 625). Octanol-water coefficient: Log $K_{ow} = 1.86$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact. Penetrates the skin.

Harmful Effects and Symptoms

Short-Term Exposure: *Inhalation:* Has caused headache and nausea @ 3-6 ppm. 40 ppm may cause intoxication. Symptoms due to decreased ability of blood to carry oxygen may include Blue coloration of lips, fingernails and earlobes; headache, dizziness, loss of coordination; labored breathing; rapid heartbeat; vomiting, coma, and death. Symptoms may be delayed Up to 4 hours. *Skin:* Easily absorbed through the skin and contributes significantly to symptoms listed under inhalation. May also cause irritation and allergic sensitization. Death has been reported from skin absorption. *Eyes:* May cause irritation and damage to the cornea. *Ingestion:* May cause symptoms listed under inhalation and include burning of throat, abdominal pain; bloody diarrhea; and enlarged spleen and liver. Death has resulted from as little as 0.4 ml (0.05 liq. oz), about 8 drops. High levels of exposure can interfere with the blood's ability to carry oxygen (methemoglobinemia). Signs and symptoms of acute exposure to nitrobenzene may be severe and include cyanosis (blue tint to the skin and mucous membranes), tachycardia (rapid hearth rate), Hypotension (low blood pressure), and cardiac arrhythmias. Respiratory depression and respiratory failure may also occur. Headache, lethargy, weakness, vertigo (dizziness), severe depression; and coma may be noted. Gastrointestinal symptoms include nausea and vomiting. Urine and vomitus may have the odor of bitter almonds.

Long-Term Exposure: Occupational exposure to 40 ppm for 6 months has caused intoxication and anemia. Can cause skin allergy. Can cause jaundice, liver and spleen damage; fatigue, bladder distress; nerve damage. May affect the blood forming organs, causing anemia. Exposure may affect vision (acuity and contraction of fields).

Points of Attack: Blood, liver, kidneys, cardiovascular system, skin.

Medical Surveillance: NIOSH lists the following tests: whole blood (chemical/metabolite); whole blood (chemical/metabolite), carboxyhemoglobin; whole blood (chemical/metabolite), methhemoglobin; whole blood (chemical/metabolite), methhemoglobin, end-of-shift; CBC; urine (chemical/metabolite); urine (chemical/metabolite), end-of-shift at end-of-work-week; urine (chemical/metabolite), end-of-work-week. Preemployment and periodic examinations should be concerned particularly with a history of dyscrasias, reactions to medications; alcohol intake; eye disease; skin, and cardiovascular status. Liver and renal functions should be evaluated periodically, as well as blood and general health. Follow methemoglobin levels until normal in all cases of suspected cyanosis. The metabolites in urine, *p*-nitro-and *p*-aminophenol, can be used as evidence of exposure. Liver function tests. *Note:* Alcohol ingestion increases the toxic effects of nitrobenzene. Persons with blood, heart, liver or lung diseases should not work with this substance.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to Physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Chlorinated polyethylene, polyvinyl alcohol, teflon, Viton/chlorobutyl, and Silvershield are recommended. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *10 ppm:* CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)]; Sa (APF = 10) (any supplied-air respirator). *25 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]. *50 ppm:* CcrFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-, mounted organic vapor canister]; or PaprTOv (APF = 50) [any powered, air-purifying respirator with a tight-fitting facepiece and organic vapor cartridge(s)]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *200 ppm:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode).

Emergency or planned entry into unknown concentrations or IDLH conditions: SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Nitrobenzene must be stored to avoid contact with strong acids (such as hydrochloric, sulfuric, and nitric) and chemically active metals (such as potassium, sodium, magnesium and zinc) caustic nitrogen tetroxide or silver perchlorate, since violent reactions occur. Sources of ignition, such as smoking and open flames are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1662 Nitrobenzene, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration (982°C, 2.0 seconds minimum) with scrubbing for nitrogen oxides abatement[22]. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(109); (102); (31); (173); (101); (138). (2); (100).

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(173); (101); (138).

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United States Environmental Protection Agency, *Nitrobenzene, Health and Environmental Effects Profile No. 134*, Washington, DC, Office of Solid Waste (April 30, 1980).

United States Environmental Protection Agency, *Chemical Hazard Information Profile:* Nitrobenzene, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 5, No. 6, 77−81 (1985).

New York State Department of Health, *Chemical Fact Sheet:* Nitrobenzene, Bureau of Toxic Substance Assessment, Albany, NY (March 1986).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Nitrobenzene, Trenton, NJ (April 2004).

4-Nitrobiphenyl N:0410

Formula: $C_{12}H_9NO_2$: $C_6H_5C_6H_4NO_2$

Synonyms: BA 2794; 1,1'-Biphenyl, 4-nitro-; Biphenyl, 4-nitro-; *p*-Nitrobiphenyl; *p*-Nitrodiphenyl; 4-Nitrodiphenyl; *p*-Nitrofenol (Spanish); 4-Nitrofenol (Spanish); 1-Nitro-4-phenylbenzene; *p*-Phenylnitrobenzene; 4-Phenylnitrobenzene; PNB

CAS Registry Number: 92-93-3

HSDB Number: 2632

RTECS Number: DV5600000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 202-204-7 [*Annex I Index No.:* 609-039-00-3]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Inadequate Evidence; Human No Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1987; NIOSH: Potential occupational carcinogen. United States Environmental Protection Agency Gene-Tox Program, Positive: SHE-clonal assay; Cell transformation-SA7/SHE; Positive: Host-mediated assay; *E. coli polA* without S9; Positive: Histidine reversion-Ames test; Positive/limited: Carcinogenicity-mouse/rat; Negative: *N crassa-aneuploidy*; S *cerevisiae-homozygosis.*

California Proposition 65 Chemical[102]: Cancer 4/1/1988.

Hazard Alert: Poison, Combustible, Possible risk of forming tumors, Suspected reprotoxic hazard, Environmental hazard. OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR 1910.1003)

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 1 lb (0.454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazardous to aquatic life or environment, with possible long lasting effects[293]. Toxic to aquatic life with long lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R 45; R50-45; R63; safety phrases: S41; S45; S53; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: 4-Nitrobiphenyl exists as yellow plates or needles. Molecular weight = 199.21; boiling point = 340°C; freezing/melting point = 113.9°C; Flash point = 143.3°C. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 1; reactivity 0. Insoluble in water.

Potential Exposure: 4-Nitrobiphenyl was formerly used in the synthesis of 4-aminodiphenyl. It is presently used only for research purposes; there are no commercial uses.

Incompatibilities: Incompatible with strong reducing agents such as hydrides, oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

NIOSH IDLH = Not determined, potential occupational carcinogen

OSHA: Cancer Suspect Agent [skin], see Code of Federal Regulations 29CFR1910.1003.

NIOSH REL: A potential occupational carcinogen. [skin]; Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV[1]: [skin] Suspected Human Carcinogen *as 4-nitrodiphenyl*

PAC Ver. 29[138]

PAC-1: 6.7 milligram per cubic meter

PAC-2: 74 milligram per cubic meter

PAC-3: 440 milligram per cubic meter

DFG MAK: [skin] Carcinogen Category 2

Australia: carcinogen, 1993; Austria: [skin], carcinogen, 1999; Belgium: carcinogen, 1993; Finland: carcinogen, 1999; Norway: TWA 0.01 milligram per cubic meter, 1999; Sweden: carcinogen, 1999; Switzerland: [skin], carcinogen, 1999; United Kingdom: carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Suspected Human Carcinogen. Several states have set guidelines or standards for nitrobiphenyl in ambient air[60] ranging from zero (New York, North Dakota, South Carolina, Virginia) to 2.77 μ/m^3 (Pennsylvania).

Determination in Air: Collection on a glass fiber filter in series with silica gel, elution with 2-propanol, analysis by gas chromatography/flame ionization detection; NIOSH (II-4) P&CAM Method #273; OSHA Analytical Method PV-2082.

Permissible Concentration in Water: No criteria set, but EPA[32] has suggested a permissible ambient goal of 890 μg/L based on health effects.

Determination in Water: Octanol-water coefficient: Log $K_{ow} = >3.5$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact. Percutaneous absorption.

Harmful Effects and Symptoms

Short-Term Exposure: 4-Nitrobiphenyl can affect you when breathed in and by passing through your skin. Other health effects are not well known at this time, but contact with biphenyls can cause irritation of the skin and eyes; and may cause liver nerve damage; disturbed sleep; headache, lethargy (drowsiness or indifference), dizziness; dyspnea (breathing difficulty); ataxia, weakness, methemoglobinemia, urinary burning; acute hemorrhagic cystitis.

Long-Term Exposure: 4-Nitrobiphenyl is a potential occupational carcinogen. Handle with extreme caution. May cause liver damage. Related compounds have caused damage to the nerves of the arms and legs.

Points of Attack: Bladder, blood, liver. Cancer site in animals: bladder tumors.

Medical Surveillance: OSHA mandates tests and information on the following: *Increased Risk;* reduced immunologic competence; steroid treatment; pregnancy; cigarette smoking. NIOSH lists the following tests: *increased risk*; reduced immunologic competence; steroid treatment; pregnancy; cigarette smoking; urine (chemical/metabolite) placement and periodic examinations should include an evaluation of exposure to other carcinogens, as well as an evaluation of smoking; or use of alcohol and medications; and of family history. Special attention should be given on a regular basis to urine sediment and cytology. If red cells or positive smears are seen, cystoscopy should be done at once. The general health of exposed persons should also be evaluated in periodic examinations. Liver function tests, CBC. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045 and 1910.1003.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Note to Physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).
Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from heat and flame. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.
Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.
Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft.(NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.
Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include oxides of nitrogen and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.
Disposal Method Suggested: Incineration @ 982°C/2.0 seconds (minimum) with scrubbing for nitrogen oxides abatement.

References

(102); (31); (173); (101); (138). (100).
New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* 4-Nitrobiphenyl, Trenton, NJ (February 2000).

Nitrocellulose N:0420

Formula: $C_{12}H_{16}(ONO_2)_4O_6$
Synonyms: Box toe gum; Celloidin; Cellulose nitrate solution; Collodion cotton; Gun cotton; Nitrocellulose; Nitrocellulose gum; Nitrocellulose solution; Nitrocellulose, with plasticizer; Nitrocotton; Nitron; Nixon N/C; NT; Pyroxylin solution; Synpor; Tsapolak 964; Xyloidin
CAS Registry Number: 9004-70-0
HSDB Number: 1973
RTECS Number: QW0970000
UN/NA & ERG Number: UN2059 [nitrocellulose, solution, flammable with not >12.6% nitrogen, by mass, and not > 55% nitrocellulose]/127; UN2555 [nitrocellulose with water with not <25% water, by mass]/113; UN2556 [nitrocellulose with alcohol with not <25% alcohol by mass, and with not >12.6% nitrogen, by dry mass]/113; UN2557 [nitrocellulose, with not >12.6% nitrogen, by dry mass, or nitrocellulose mixture with pigment or nitrocellulose mixture with plasticizer or nitrocellulose mixture with pigment and plasticizer]/133; UN0340 [Nitrocellulose, dry or wetted with <25% water (or alcohol), by mass]/112; UN0341 [nitrocellulose, unmodified or plasticized with <18% plasticizing substance, by mass]/112; UN0343 [nitrocellulose, plasticized with not <18% plasticizing substance, by mass]/112; UN0342 [nitrocellulose, wetted with not <25% alcohol, by mass]/112; 3270 (Nitrocellulose membrane filters)/133.
Regulatory Authority and Advisory Information
Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard: explosives* 5000 (commercial grade); *Theft hazard* 400 (commercial grade).
Hazard Alert: Explosive, Highly flammable solid.
Hazard symbols, risk, & safety statements: Hazard symbol: E, F+, T, Xi, Xn; risk phrases: R1 (containing more than 12,6% nitrogen); R3; R11; R12; R16; R17; R22; R36/38; R61; R66; R67; safety phrases: S1; S1; S7; S9; S16; S21; S23; S29; S33; S35; S36/37/39; S45; S53; S41 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.
Description: Nitrocellulose is a pulpy, cotton-like solid, or a colorless liquid solution. Molecular weight = 504.3; specific gravity (H_2O:1) = 1.66; boiling point = about 34°C; Flash point = 12–27°C (wet with alcohol); Autoignition

temperature = 160°C. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 3; reactivity 3 (oxidizer). Insoluble in water.

Potential Exposure: It is used in making explosives, rocket propellants and celluloid.

Incompatibilities: Dust and powder form explosive mixture with air. Keep wet; do not allow to become dry. Dry material is a shock-sensitive explosive. Desensitize using water or alcohol. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

PAC Ver. 27

PAC-1: 15 milligram per cubic meter

PAC-2: 170 milligram per cubic meter

PAC-3: 990 milligram per cubic meter

Harmful Effects and Symptoms

Short-Term Exposure: Only those associated with the flammable and explosive nature of this flammable and reactive material. However, it may be wetted with alcohol, ether, or other dangerous liquid material that can be irritating to the eyes, nose, and throat. If inhaled will cause dizziness, difficult breathing; or loss of consciousness.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Wear splash-proof chemical goggles when working with liquid, unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Engineering controls must be effective to ensure that exposure to nitrocellulose does not occur. See respirator for solvent used as a wetting agent.

Storage: Color code—Red: Flammability Hazard: Store in a flammable materials storage area. Color code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Oxidizers, including oxidizing gases, should have a boundary separation of 8–10 m or a 1-hour fire wall from flammable or reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Nitrocellulose must be stored to avoid contact with oxidizers, strong acids (such as hydrochloric, sulfuric, and nitric) and alkaline materials (such as sodium hydroxide and potassium hydroxide), since violent reactions occur. Store nitrocellulose away from high temperatures and direct sunlight. Do not allow material to become dry. Sources of ignition, such as smoking and open flames, are prohibited where nitrocellulose is handled, used, or stored. Wherever nitrocellulose is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN2555, UN2556 and UN2557 requires a shipping label of "FLAMMABLE SOLID." They fall in DOT Hazard Class 4.1. UN0342 and UN0343 requires a shipping label of "EXPLOSIVE." They fall in DOT Hazard Class 1.3C.

Spill Handling: Restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Immediately flood spill area with water, collect material and deposit in sealed containers. Keep nitrocellulose out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing:[17] Presents an unusually severe fire hazard; when dry, ignites readily and burns explosively. Should never be kept for any appreciable time in any dry fibrous state. Unstabilized product decomposes gradually at relatively low temperature, with evolution of copious volumes of toxic and flammable gases, and rapid heat generation. In prolonged storage and aging of nitrocellulose plastics, camphor is lost with deterioration and the decomposition temperature may be lowered to 40°C. The resulting flameless decomposition is self-sustaining and accelerative, presenting the added hazard of dangerous pressures in building structures.

Use extreme caution in approaching fires involving this material as it may explode. No attempt should be made to fight advanced fires, except for remote activation of installed fire extinguishing equipment and/or with unmanned fixed turrets and hose nozzles. The surrounding areas should be evacuated. Fires should be approached from upwind and SCBA used. Since cellulose nitrate supplies its own oxygen, prompt cooling with a large quantity of water is essential; water applied through spray nozzles is effective if fused quickly and in sufficient volume, in a manner to wet the entire exposed surface. Thermal decomposition products may include oxides of nitrogen (and possibly hydrogen cyanide, and carbon monoxide). If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Nitrocellulose, Trenton, NJ (April 2001).

p-Nitrochlorobenzene N:0430

Formula: $C_6H_4ClNO_2$*:* *p*-$ClC_6H_4NO_2$

Synonyms: Benzene, 1-chloro-4-nitro-; 1-Chlor-4-nitrobenzol (German); *p*-Chloronitrobenzene; 1-Chloro-4-nitrobenzene; 4-Chloro-1-nitrobenzene; 4-Chloronitrobenzene; *p*-Nitrochlorobenzol (German); *p*-Nitroclorobenzene; PNCB

CAS Registry Number: 100-00-5

HSDB Number: 1666

RTECS Number: CZ1050000

UN/NA & ERG Number: UN1578/152

EC Number: 202-809-6 [*Annex I Index No.:* 610-005-00-5]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Inadequate Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1996; NIOSH: Potential occupational carcinogen.

California Proposition 65 Chemical[102]: Cancer 10/29/1999.

Hazard Alert: Poison, Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R23/24/25; R40; R48/20/21/22; R62; R63; R68; R51/53; safety phrases: S1/2; S28; S36/37; S41; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: *p*-Nitrochlorobenzene is a yellow crystalline solid with a sweet odor. Molecular weight = 157.56; specific gravity (H_2O:1) = 1.52; 1.3 @ 90°C; boiling point = 242°C; freezing/melting point = 82°C; vapor pressure = 0.2 mmHg @ 20°C; Flash point = 127.2°C (cc). Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 1; reactivity 3. Shock and heat sensitive. Insoluble in water.

Potential Exposure: *p*-Nitrochlorobenzene (PNCB) is used as an intermediate in pesticide (parathion) manufacture, drug (phenacetin and acetaminophen) manufacture; and in dye making; rubber and antioxidant manufacture.

Incompatibilities: A strong oxidizer. Reacts violently with oxidizers, combustibles, alkalis, sodium methoxide; and reducing materials

Permissible Exposure Limits in Air

NIOSH IDLH = 100 milligram per cubic meter, potential occupational carcinogen.

OSHA PEL: 1 milligram per cubic meter TWA [skin]

NIOSH REL: A potential occupational carcinogen. [skin]; Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A.BEIM issued for Methemoglobin inducers.

ACGIH TLV[1]: 0.1 ppm/0.64 milligram per cubic meter TWA [skin]; confirmed animal carcinogen with unknown relevance to humans.

PAC Ver. 29[138]

PAC-1: 1.9 milligram per cubic meter

PAC-2: 170 milligram per cubic meter

PAC-3: 1000 milligram per cubic meter

DFG MAK: [skin] Carcinogen Category 3B

Australia: TWA 0.1 ppm (0.6 milligram per cubic meter) [skin], 1993; Austria Suspected: carcinogen, 1999; Belgium: TWA 0.1 ppm (0.64 milligram per cubic meter) [skin], 1993; Denmark: TWA 0.1 ppm (0.64 milligram per cubic meter) [skin], 1999; Finland: TWA 1 milligram per cubic meter; STEL 3 milligram per cubic meter [skin], 1999; Hungary: TWA 1 milligram per cubic meter; STEL 2 milligram per cubic meter [skin], 1993; Japan: 0.1 ppm (0.64 milligram per cubic meter) [skin], 1999; the Netherlands: MAC-TGG 1 milligram per cubic meter, [skin], 2003; Norway: TWA 1 milligram per cubic meter, 1999; the Phillipines: TWA 1 milligram per cubic meter [skin], 1993; Poland: MAC (TWA) 1 milligram per cubic meter; MAC (STEL) 3 milligram per cubic meter, 1999; Russia: TWA 0.1 ppm; STEL 1 milligram per cubic meter [skin], 1993; Switzerland: MAK-W 1 milligram per cubic meter, KZG-W 2 milligram per cubic meter [skin], 1999; United Kingdom: TWA 1 milligram per cubic meter; STEL 2 milligram per cubic meter, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: confirmed animal carcinogen with unknown relevance to humans. Russia[43] set a MAC in ambient air of residential areas of 0.004 milligram per cubic meter both on a momentary and a daily average basis. Several states have set guidelines or standards for 4-chloronitrobenzene in ambient air[60] ranging from 3.3 μ/m^3 (New York) to 5 μ/m^3 (South Carolina) to 10 μ/m^3 (Florida) to 20 μ/m^3 (Connecticut) to 24 μ/m^3 (Nevada) to 30 μ/m^3 (North Dakota) to 50 μ/m^3 (Virginia) to 83.33 μ/m^3 (Kansas).

Determination in Air: Use NIOSH Analytical Method (IV) #2005,[18] Nitrobenzene.

Determination in Water: Octanol-water coefficient: Log $K_{ow} = 2.4$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes and skin on contact. Inhalation can cause irritation of the respiratory tract with coughing and wheezing. High levels can interfere with the body's ability to carry oxygen (methemoglobinemia) causing cyanosis, headache, dizziness, fatigue. Can also cause nausea, vomiting, dyspnea. Higher levels can cause trouble breathing; collapse, and death.

Long-Term Exposure: Repeated or prolonged contact may cause skin sensitization and allergy. Can affect the nervous system. May damage the liver and kidneys. May cause methemoglobinemia, hemoglobinuria, anemia, spleen, bone marrow changes; reproductive effects. Potential occupational carcinogen. In animals: hematuria (blood in the urine)

Points of Attack: Blood, liver, kidneys, cardiovascular system; spleen, bone marrow; reproductive system. Cancer site in animals: vascular and liver tumors.

Medical Surveillance: NIOSH lists the following tests: whole blood (chemical/metabolite), Methhemoglobin; CBC. Consider the points of attack in preplacement and periodic physical examinations. Evaluation by a qualified allergist. Liver and kidney function tests. Alcohol consumption may increase liver damage caused by PNCB.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to Physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in a refrigerator and protect from shock, heat sources, light, oxidizers, reducing agents; alkalis, and sodium methoxide. Sources of ignition, such as smoking and open flames are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN1578 Chloronitrobenzenes, solid or liquid, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. It does not readily ignite. Use dry chemical, carbon dioxide; water spray; alcohol foam or polymer foam extinguishers. Thermal decomposition products may include nitrogen oxides and hydrogen chloride. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration (816°C, 0.5 second for primary combustion; 1204°C, 1.0 second for secondary combustion). The formation of elemental chlorine can be prevented through injection of steam or methane into the combustion process. nitrogen oxides may be abated through the use of thermal or catalytic devices.

References

(102); (31); (100).

United States Environmental Protection Agency, *Chemical Hazard Information Profile Draft Report: 4-Chloronitrobenzene, (2)*, Washington, DC (June 13, 1983).

(173); (101); (138).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: p*-Nitrochlorobenzene, Trenton, NJ (July 1999).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Chloronitrobenzenes (mixed isomers), Trenton, NJ (January 2007).

Nitrocyclohexane N:0440

Formula: $C_6H_{11}NO_2$

Synonyms: Cyclohexane, nitro-; Hexahydronitrobenzene

CAS Registry Number: 1122-60-7

HSDB Number: 6414

RTECS Number: GV6600000

UN/NA & ERG Number: UN3382/151

EC Number: 214-354-0

Regulatory Authority and Advisory Information

Hazard Alert: Highly flammable, Strong oxidizer.

SUPERFUND/EPCRA 302, Extremely Hazardous Substances: TPQ = 500 lb (227 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 500 lb (227 kg).

Hazard symbols, risk, & safety statements: Hazard symbol: T, F; risk phrases: R11; R23/24/25; R36/37/38; R50/53; safety phrases: S13; S26; S36/37/39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Nitrocyclohexane is a highly flammable, colorless liquid. Molecular weight = 129.18; specific gravity (H_2O:1) = 1.06 @ 20°C; boiling point = (decomposes) 206°C; freezing/melting point = −34°C; Flash point = 88°C; vapor pressure = 0.35 mmHg @ 25°C;. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 2; reactivity 2 (oxidizer). Insoluble in water.

Potential Exposure: Used in organic synthesis.

Incompatibilities: A nitro compound; a fire and explosive hazard. May form explosive mixture with air. Nitrocyclohexane, a nitroalkane, is a strong oxidizing agents. If mixed with reducing agents, including hydrides, sulfides and nitrides, they may begin a vigorous reaction that culminates in a detonation. Nitroalkanes are milder oxidizing agents, but still react violently with reducing agents at higher temperature and pressures. Nitroalkanes react with inorganic bases to form explosive salts. The presence of metal oxides increases the thermal sensitivity of nitroalkanes. Nitroalkanes with more than one nitro group are generally explosive. Incompatible with alkalis, and metal oxides. This chemical is highly reactive and may be heat-and shock-sensitive.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 0.14 milligram per cubic meter

PAC-2: 1.5 milligram per cubic meter

PAC-3: 9 milligram per cubic meter

Russia[43] set a MAC in work-place air of 1.0 milligram per cubic meter.

Permissible Concentration in Water: Russia[43] set a MAC in water bodies used for domestic purposes of 0.1 mg/L.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

The LD_{50} = (oral-mouse) 250 mg/kg (moderately toxic).

Short-Term Exposure: Insufficient data is available on the effect of this substance on human health, therefore utmost care must be taken. May be absorbed through the skin. May be an irritant to the eyes, skin and respiratory system. Similar chemical can cause cyanosis due to formation of methemoglobin.

Long-Term Exposure: Similar chemicals can cause kidney and liver damage.

Points of Attack: Most of the above information is based on similar nitro compounds of aromatic hydrocarbons. May cause blood, liver and kidney effects.

Medical Surveillance: There is no special test for this chemical. However, if illness occurs or overexposure is suspected, medical attention is recommended. The following might be considered: blood methemoglobin level, CBC, liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek

medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Note to Physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. pressure, pressure-demand, full facepiece SCBA (SCBA) or pressure-demand supplied air respirator with escape SCBA and a fully-encapsulating, chemical resistant suit.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Poison inhalation chemical (PIH); check oxygen content prior to entering storage area. Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, alkalis, metal oxides. Where possible, automatically pump liquid from drums or other storage containers to process containers Sources of ignition, such as smoking and open flames are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN3382 Toxic by inhalation liquid, n.o.s. with an LC_{50} lower than or equal to 1000 ml/m3 and saturated vapor concentration ≥ 10 LC_{50}, Hazard Class: 6.1; Labels: 6.1 Technical Name Required, Inhalation Hazard Zone B.

Spill Handling:

Toxic/Poisonous by inhalation liquid, n.o.s. (Inhalation Hazard Zone B)

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424−9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548−8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft./m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft./m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.3/0.5
Night 0.5/0.8

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Do not touch spilled material; stop leak if you can do so without risk. *Large fires:* water spray, fog, or foam. Move container from fire area if you can do it without risk. Stay upwind; keep out of low areas. Wear positive pressure breathing apparatus and special protective clothing. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of nitrogen and carbon. *Small fires:* dry chemical, carbon dioxide; water spray; or foam. *Large fires:* water spray, fog, or foam. Move container from fire area if you can do it without risk. Stay upwind; keep out of low areas. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (100).

United States Environmental Protection Agency, *Chemical Hazard Information Profile:* Nitrocyclohexane, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

(173); (101); (138).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Nitrocyclohexane, Trenton, NJ (April 2002).

Nitroethane N:0450

Formula: $C_2H_5NO_2$: $CH_3CH_2NO_2$

Synonyms: Ethane, nitro-; Nitroetano (Spanish)

CAS Registry Number: 79-24-3

HSDB Number: 105

RTECS Number: KI5600000

UN/NA & ERG Number: UN2842/129

EC Number: 201-188-9 [*Annex I Index No.:* 609-035-00-1]

Regulatory Authority and Advisory Information

United States Environmental Protection Agency Gene-Tox Program, Inconclusive: Mammalian micronucleus.

Hazard Alert: Highly flammable, Suspected reprotoxic hazard.

List 1, DEA chemical code 6724 (Title 21 CFR1310.02)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xn; risk phrases: R11; R20/22; R63; safety phrases: S2; S9; S21; S25; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Nitroethane is a colorless, oily liquid with a mild, fruity odor. The Odor Threshold is 163 ppm[41]. Molecular weight = 75.08; specific gravity (H_2O:1) = 1.05; boiling point = 113.9°C; freezing/melting point = −90°C; vapor pressure = 21 mmHg @ 25°C; 15.6 mmHg @ 20°C; Flash point = 28°C. Begins to decompose @ 300°C; Autoignition temperature = 414°C. Explosive limits: LEL = 3.4%; UEL: Unknown. Hazard identification (based on NFPA-704 M Rating System): Health 1; flammability 3; reactivity 3. Slightly soluble in water; solubility = 5%.

Potential Exposure: Nitroethane is used as solvent for polymers, cellulose esters; vinyl, waxes, fats, dyestuffs, and alkyd resins; as a stabilizer. It has been used as a rocket propellant. It is used as an intermediate in pharmaceutical manufacture and in pesticide manufacture.

Incompatibilities: A nitroparaffin, nitroethane forms explosive mixture with air. Explodes when heated or when shocked; in confined area, with elevated temperatures. A strong reducing agent. Violent reaction with oxidizers, hydrocarbons, other combustibles; amines, metal oxides. Forms shock-sensitive compounds with strong acids; strong alkalis. Attacks some plastics and coatings.

Permissible Exposure Limits in Air

NIOSH IDLH = 1000 ppm

OSHA PEL: 100 ppm/310 milligram per cubic meter TWA

NIOSH REL: 100 ppm/310 milligram per cubic meter TWA

ACGIH TLV[1]: 100 ppm/307 milligram per cubic meter TWA

PAC Ver. 29[138]

PAC-1: 60 ppm

PAC-2: 170 ppm

PAC-3: 1000 ppm

DFG MAK: 100 ppm/310 milligram per cubic meter TWA; Peak Limitation Category II(4); Pregnancy Risk Group D

Australia: TWA 100 ppm (310 milligram per cubic meter), 1993; Austria: MAK 100 ppm (310 milligram per cubic meter), 1999; Belgium: TWA 100 ppm (307 milligram per cubic meter), 1993; Denmark: TWA 100 ppm (310 milligram per cubic meter), 1999; Finland: TWA 100 ppm (310 milligram per cubic meter); STEL 150 ppm (465 milligram per cubic meter), 1999; France: VME 100 ppm (310 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 60 milligram per cubic meter, 2003; the Phillipines: TWA 100 ppm (310 milligram per cubic meter), 1993; Poland: MAC (TWA) 30 milligram per cubic meter, MAC (STEL) 240 milligram per cubic meter, 1999; Russia: STEL 30 milligram per cubic meter, 1993; Sweden: TWA 20 ppm (60 milligram per cubic meter); STEL 50 ppm (150 milligram per cubic meter), 1999; Switzerland: MAK-W 100 ppm (310 milligram per cubic meter), 1999; Turkey: TWA 100 ppm (310 milligram per cubic meter), 1993; United Kingdom: TWA 100 ppm

(312 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 100 ppm. Several states hve set limits in ambient air ranging from 3.1 milligram per cubic meter (North Dakota) to 5.2 milligram per cubic meter (Virginia) to 6.2 milligram per cubic meter (Connecticut) to 7.38 milligram per cubic meter (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #2526.

Permissible Concentration in Water: Russia[43] set a MAC in water bodies used for domestic purposes of 1.0 mg/L.

Determination in Water: Octanol-water coefficient: Log $K_{ow} = 0.18$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin, and respiratory tract. Inhalation can cause coughing and wheezing. High exposure could cause headache, dizziness and unconsciousness. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. LD_{50} = (oral-rat) 250 mg/kg (moderately toxic).

Long-Term Exposure: May cause liver and kidney damage. Can cause dermatitis, drying and cracking skin. Can cause lung irritation; bronchitis may develop.

Points of Attack: Skin, respiratory system; central nervous system; kidneys, liver.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Liver and kidney function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. butyl rubber and polyvinyl alcohol are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *1000 ppm:* SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or Sa: Pd,Pp (APF = 1000): ASCBA (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* SCBAE (any appropriate escape-type, SCBA).

Storage: (1) Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. (2) Color code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in a area isolated from flammables, combustibles, or other yellow coded materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in an explosion-proof refrigerator away from oxidizers, strong acids; amines, alkalis, hydrocarbons, combustibles, metal oxides; strong bases; and reducing agents. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN2842 Nitroethane, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of nitrogen and carbon. Do not use dry chemical powder. Use carbon dioxide, or alcohol; or polymer foam extinguishers. Water may be ineffective. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration: large quantities of material may require nitrogen oxide removal by catalytic or scrubbing processes[22].

References

(31); (173); (101); (138). (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Nitroethane, Trenton, NJ (June 1999).

Nitrofen N:0460

Formula: $C_{12}H_7Cl_2NO_3$; $O_2NC_6H_4OC_6H_3Cl_3$

Synonyms: Benzenamine, 4-Ethoxy-*N*-(5-nitro-2-furanyl) methylene-; Benzene, 2,4-dichloro-1-(4-nitrophenoxy)-; 2′,4′-Dichloro-4′-nitrodiphenyl ether; 2,4-Dichloro-1-(4-nitrophenoxy)benzene; 4-(2,4-Dichlorophenoxy) nitrobenzene; 2,4-Dichlorophenyl-4-nirtophenylaether (German); 2,4-Dichlorophenyl *p*-nitrophenyl ether; 2,4-Dichlorophenyl 4-nitrophenyl ether; Ether, 2,4-dichlorophenyl *p*-nitrophenyl; FW 925; Mezotox; NCI-C00420; Niclofen; NIP; Nitrochlor; 4′-Nitro-2,4-dichlorodiphenyl ether; 4-Nitro-2′,4′-dichlorodiphenyl ether; Nitrofene (French); Nitrophen; Nitrophene; Preparation 125; TOK; TOK-2; TOK E; TOK E 25; TOK E 40; Tokkom; Tokkorn; TOK WP-50; Trizilin

CAS Registry Number: 1836-75-5; *(alt.)* 51274-07-8

HSDB Number: 1578

RTECS Number: KN8400000

UN/NA & ERG Number: UN3345/153; UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 217-406-0 [*Annex I Index No.:* 609-040-00-9]

Regulatory Authority and Advisory Information

Carcinogenicity: NTP (*technical grade*)13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC (*technical grade*): Animal Sufficient Evidence; Human No Adequate Data, *possibly carcinogenic to humans*, Group 2B, 1987; NCI: Carcinogenesis Bioassay (feed); clear evidence: mouse, rat, 1978; (feed); clear evidence: mouse, 1979; (feed); no evidence: rat, 1979. United States Environmental Protection Agency Gene-Tox Program, Positive: Carcinogenicity-mouse/rat; Inconclusive: Mammalian micronucleus.

California Proposition 65 Chemical[102]: Cancer 1/1/1988.

Hazard Alert: Poison, High acute toxicity, Highly flammable, Endocrine disruptors (medium), Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Environmental hazard.

Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Hazard symbols, risk, & safety statements: Hazard symbol: T+, F, N; risk phrases: R11; R45; R20/22; R23/25; R33; R50/53; R61; R62; R63; safety phrases: S20/21; S28; S45; S53; S60; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Nitrofen is a crystalline solid. Molecular weight = 284.10; freezing/melting point = 70−71°C; vapor pressure = 1.2×10^{-7} mm @ 20°C. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 3; reactivity 0. Very slightly soluble in water.

Potential Exposure: Nitrofen is a contact herbicide used for pre-and post-emergency control of annual grasses and broadleaf weeds on a variety of food and ornamental crops. Occupational exposure to nitrofen, primarily through inhalation and dermal contact may occur among workers at production facilities. Field handlers of the herbicide are subject to inhalation exposure during application procedures.

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Finland: carcinogen, 1999; Russia: STEL 1 milligram per cubic meter, 1993; United Kingdom: carcinogen, TWA 1 ppm (7.1 milligram per cubic meter), 2000. Russia set a MAC in ambient air in residential areas of 0.02 milligram per cubic meter on a once-daily basis and 0.01 milligram per cubic meter on an average daily basis. Pennsylvania has set a guideline for nitrofen in ambient air[60] of 0.75 μ/m^3.

Permissible Concentration in Water: Nitrofen presumably falls under the EPA Priority Toxic Pollutant category of haloethers[6] but specific limits have not been set. Russia has set a limit in surface water of 4.0 mg/L.

Determination in water: Hazardous to the aquatic environment. Fish Tox = 92.54948000 ppb (INTERMEDIATE). Octanol-water coefficient: Log K_{ow} = >4.5. Values above 3.0 are likely to bioaccumulate in aquatic organisms.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Toxic by ingestion. Severe eye irritant. Causes skin irritation on contact. Inhalation can cause irritation to the respiratory tract. May cause difficult breathing; fatigue, and loss of appetite.

Long-Term Exposure: May cause cancer. Long-term exposure may cause damage to the blood cells, causing low white cell (leukocyte) count, reduced hemoglobin; and reduced serum cholinesterase and erythrocyte catalase activities. May cause liver damage. May affect the nervous system.

Points of Attack: Blood, liver, kidneys, nervous system.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure, CBC. Liver function tests. Examination of the nervous system and interview for brain effects.

First Aid: *Skin Contact*: Flood all areas of body that have contacted the substance with water. Don't wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others[52]. *Eye Contact:* Remove any contact lenses at once. Immediately flush eyes well with copious quantities of water or normal saline for at least 20−30 minutes. Seek medical attention.

Inhalation: Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion:* Contact a physician, hospital or poison center at once. If the victim is unconscious or convulsing, do not induce vomiting or give anything by mouth. Assure that the patient's airway is open and lay him on his side with his head lower that his body and transport immediately to a medical facility. If conscious and not convulsing, give a glass of water to dilute the substance. Vomiting should not be induced without a physician's advice.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with an N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in a refrigerator or a cool, dry place. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN3345 Phenoxyacetic acid derivative pesticide, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard Class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all sources of ignition and dampen spilled material with 60−70% acetone to avoid airborne dust. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid, but does not readily ignite. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. Thermal decomposition products may include hydrogen chloride and oxides of nitrogen. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Small quantities may be landfilled but large quantities should be incinerated[22]. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(102); (31); (173); (101); (138). (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Nitrofen, Trenton, NJ (September 2001).

Nitrogen N:0470

Formula: N_2

Synonyms: Liquid nitrogen; Nitrogen, compressed; Nitrogen, cryogenic liquid; Nitrogen gas; Nitrogen, refrigerated liquid

CAS Registry Number: 7727-37-9

HSDB Number: 5060

RTECS Number: QW9700000

UN/NA & ERG Number: UN1066 (compressed)/121; UN1977 (refrigerated liquid)/120

EC Number: 231-783-9

Regulatory Authority and Advisory Information

Hazard Alert: Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated.

Hazard symbols, risk, & safety statements: risk phrases: R5, R21; safety phrases: S9; S33; S38 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): Non hazard to water.

Description: Nitrogen is a nonflammable, stable, odorless, cryogenic liquid or a compressed gas. Molecular weight = 28.02; specific gravity (H_2O:1) = 0.81 @ −196°C; boiling point = −196°C; freezing/melting point = −210°C. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 0; reactivity 0. Slightly soluble in water.

Potential Exposure: Nitrogen is present in the air we breathe. Health effects may occur at concentrations above 80%. It has many medical and industrial uses including the quick freezing of food. The gas is used for purging, heat treating; food freezing; annealing, cooling, oil recovery; in the inert blanketing of sensitive materials and as a reactant in chemical synthesis of ammonia.

Incompatibilities: Containers may explode when heated. Liquid nitrogen is very unreactive, nonflammable, noncombustible and nontoxic. Contact with water may result in vigorous or violent boiling and extremely rapid vaporization. If the water is hot, there is the possibility that a liquid "superheat" explosion may occur. Pressures may build to dangerous levels if the liquid contacts water in a closed container[136].

Permissible Exposure Limits in Air Before entering an enclosed space where nitrogen may be present, oxygen content should be tested to ensure that it is at least 19% by volume.

Determination in Air:

OSHA PEL: Simple asphyxiant-inert gases and vapors

NIOSH REL: Simple asphyxiant-inert gases and vapors

ACGIH TLV[1]: Simple asphyxiant

PAC Ver. 29[138]

PAC-1: 796,000 (7.96E + 05) ppm

PAC-2: 832,000 (8.32E + 05) ppm

PAC-3: 869,000 (8.69E + 05) ppm

United Kingdom: asphyxiant, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Simple asphyxiant: nitrogen is a simple asphyxiant inert gas or vapor; *oxygen* content should be at least 19%.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short-Term Exposure: *Inhalation:* No significant toxic effects except as an asphyxiant; that is, it may threaten life if levels are so high as to reduce oxygen levels below 19%. Since nitrogen is odorless, colorless and tasteless, there may not be adequate warning of high levels. Symptoms of lack of oxygen may include nausea, drowsiness, Blue coloration of skin and lips; unconsciousness, and death. *Skin:* Liquid may cause frostbite and freezing burns. *Eyes:* Liquid may cause frostbite and freezing burns. *Ingestion:* Liquid may cause frostbite and cryogenic burns.

Long-Term Exposure: No information is known at this time.

First Aid: *Inhalation:* Move person to fresh air. Give oxygen or artificial respiration as necessary. *Skin:* Remove liquid-soaked clothing after allowing to thaw. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water. Seek medical attention. *Eyes:* Seek immediate medical attention if contact with liquid occurs. *Ingestion:* Seek medical attention as necessary.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming

frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. If vapors, or liquid may occur, employees should be provided with special clothing designed to prevent the freezing of body tissues. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work.

Respirator Selection: Exposure to nitrogen is dangerous because it can replace oxygen and lead to suffocation. Only NIOSH/MSHA or European Standard EN 149-approved SCBA with a full facepiece operated in positive-pressure mode should be used in oxygen deficient environments.

Storage: Check oxygen content prior to entering storage area. Prior to working with this chemical, personnel should be trained on its proper handling and storage. A regulated, marked area should be established where nitrogen is handled, used, or stored. Store liquid containers and cylinders in cool, well-ventilated areas. Use only in well-ventilated areas. Cylinders must be secured and protected against damage. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: UN1066 Nitrogen, compressed, Hazard Class:, Hazard Class: 2.2; Labels: 2.2-Nonflammable compressed gas; UN1977 Nitrogen, refrigerated liquid cryogenic liquid, Hazard Class:, Hazard Class: 2.2; Labels: 2.2-Nonflammable compressed gas. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: If liquid nitrogen is spilled or leaked, take the following steps: Restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Ventilate the area of spill or leak. Stop the leak or move the container to a safe area and allow the liquid to evaporate. If nitrogen gas is leaked, take the following steps: Restrict persons not wearing protective equipment from area of leak until cleanup is complete. Stop flow of gas. If source of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Nitrogen itself does not burn. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Vent to atmosphere.

References

(31); (173); (101); (138). (100).

New York State Department of Health, *Chemical Fact Sheet:* Nitrogen, Bureau of Toxic Substance Assessment, Albany, NY (March 1986).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Nitrogen, Trenton, NJ (September 2004).

Nitrogen Dioxide N:0480

Formula: NO_2; N_2O_4 (nitrogen tetroxide)

Synonyms: Dinitrogen dioxide; Dinitrogen dioxide, di-; Dinitrogen tetroxide (N_2O_4); Dioxido de nitrogeno (Spanish); Nitrogen peroxide; Nitrogen tetroxide

CAS Registry Number: 10102-44-0; 10544-72-6 (nitrogen tetroxide)

HSDB Number: 718

RTECS Number: QW9800000

UN/NA & ERG Number: (PIH) UN1067/124; UN1975 (nitrogen oxide & dinitrogen tetroxide mixture)/124

EC Number: 233-272-6 [*Annex I Index No.:* 007-002-00-0]; 234-126-4 [*Annex I Index No.:* 007-002-00-0] (dinitrogen tetraoxide)

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Theft hazard* 15 (≥3.80% concentration) (*dinitrogen tetraoxide*).

Hazard Alert: Poison inhalation hazard, High acute toxicity (N_2O_4), Strong oxidizer, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard.

OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 250 lb

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P078

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

SUPERFUND/EPCRA 302, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 10 lb (4.54 kg)

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. European/International Regulations (*nitrogen dioxide*; *nitrogen tetraoxide*): Hazard symbol: T+, N; risk phrases: R8; R26; R34; R62; R63; safety phrases: S1/2; S9; S26; S28; S36/37/39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water. (*nitrogen dioxide*; *nitrogen tetraoxide*)

Description: Nitrogen dioxide (and nitrogen tetroxide, the solid dimer) is a dark brown gas (above 21°C) or a yellow, fuming liquid or colorless solid with a pungent, acrid odor. The solid form is colorless below about −11°C; it is found structurally as N_2O_4. Molecular weight = 46.01; 92 (tetroxide); specific gravity (H_2O:1) = 1.44 @ 20°C; 1.5 @ 20°C (tetroxide); boiling point = 21°C (dioxide & tetroxide); freezing/melting point = −9.3°C; −11.2°C (tetroxide); vapor pressure = 908 mmHg @ 25°C. Decomposes @ 160°C. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 0; reactivity ₩ (oxidizer). Decomposes (reacts) with water.

Potential Exposure: Nitrogen dioxide is found in automotive and diesel emissions. Nitrogen dioxide is an industrial chemical used as an intermediate in nitric and sulfuric acid manufacture; it is used in the nitration of organic compounds; it is used as an oxidizer in liquid propellant rocket fuel combinations. It is also used in firefighting, welding and brazing.

Incompatibilities: A strong oxidizer. Reacts violently with combustible matter, chlorinated hydrocarbons; ammonia, carbon disulfide; reducing materials. Reacts with water, forming nitric acid and nitric oxide. Attacks steel in the presence of moisture.

Permissible Exposure Limits in Air

NIOSH IDLH = 20 ppm

Conversion factor: 1 ppm = 1.88 milligram per cubic meter @ 25°C & 1 atm

Odor Threshold = 5 ppm

OSHA PEL: 5 ppm/9 milligram per cubic meter Ceiling Concentration

NIOSH REL: 1 ppm/1.8 milligram per cubic meter STEL

ACGIH TLV[1]: 3 ppm/5.6 milligram per cubic meter TWA; 5 ppm/9.4 milligram per cubic meter STEL, not classifiable as a human carcinogen

10102-44-0

PAC* Ver. 29[138]

PAC-1: **0.50**$_{\mathbf{A}}$ ppm

PAC-2: **12**$_{\mathbf{A}}$ ppm

PAC-3: **20**$_{\mathbf{A}}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

DFG MAK: 0.5 ppm/0.95 milligram per cubic meter TWA; Peak Limitation Category I(1); Pregnancy Risk Group D; Carcinogen Category 3B

Arab Republic of Egypt: TWA 3 ppm (6 milligram per cubic meter), 1993; Austria: MAK 3 ppm (6 milligram per cubic meter), 1999; Denmark: TWA 3 99 m (5.6 milligram per cubic meter), 1999; Finland: TWA 3 ppm (6 milligram per cubic meter); STEL 6 ppm (12 milligram per cubic meter), 1999; France: VLE 3 ppm (6 milligram per cubic meter), 1999; Japan: pending, 1999; the Netherlands: MAC-TGG 4 milligram per cubic meter, 2003; the Phillipines: TWA 5 ppm (9 milligram per cubic meter), 1993; Poland: MAC (TWA) 5 milligram per cubic meter; MAC (STEL) 10 milligram per cubic meter, 1999; Sweden: NGV 2 ppm (4 milligram per cubic meter), TGV 5 ppm (13 milligram per cubic meter), 1999; Switzerland: MAK-W 3 ppm (6 milligram per cubic meter), KZG-W 6 ppm (12 milligram per cubic meter), 1999; Thailand: TWA 5 ppm (9 milligram per cubic meter), 1993; Turkey: TWA 5 ppm (9 milligram per cubic meter), 1993; United Kingdom: TWA 3 ppm (5.7 milligram per cubic meter); STEL 5 ppm (9.6 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 5 ppm. Russia[43] set a MAC for ambient air in residential areas of 0.085 milligram per cubic meter (85 μ/m^3). Several states have set guidelines or standards for nitrogen dioxide in ambient air[60] ranging from 100 μ/m^3 (Arizona and Connecticut) to 143 μ/m^3 (Nevada).

PAC* Ver. 29[138]

10544-72-6, nitrogen tetroxide

NIOSH IDLH = 20 ppm

PAC-1: **0.25**$_{\mathbf{A}}$ ppm

PAC-2: **6.2**$_{\mathbf{A}}$ ppm

PAC-3: **10**$_{\mathbf{A}}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

Determination in Air: Use NIOSH Analytical Method (IV) #6014, Nitric oxide and nitrogen dioxide; OSHA Analytical Methods ID-109 and ID-182.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Nitrogen dioxide and its vapors irritate the eyes, skin, and respiratory tract. Inhalation exposure can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Acute exposure to nitrogen dioxide may be severe and result in a weak, rapid pulse; cyanosis (blue tint to the skin and mucous membranes); and circulatory collapse. Cough, dyspnea (shortness of breath), bronchitis, pneumonitis, and pulmonary edema may occur following inhalation exposure. Gastrointestinal symptoms include nausea and abdominal pain. Fatigue, lethargy, restlessness, fever, anxiety, headache, mental confusion; and loss of consciousness may also occur. Contact with the skin and mucous membranes may result in severe irritation and burns. When liquid nitrogen dioxide contacts the skin, frostbite will result. *Inhalation:* 10–20 ppm can cause mild irritation of the nose and throat. 25–50 ppm can cause an inflammation of the lungs, such as bronchitis or pneumonia. Levels above 100 ppm can cause death. Only highly concentrated fumes cause immediate symptoms, such as coughing, choking, headache, nausea and stomach or chest pain. However, exposures to less concentrated fumes may produce these symptoms after 5–72 hours. Rapid and shallow breathing; bluish coloration in skin and unconsciousness may develop along with lung irritation or congestion. *Skin:* Can cause severe irritation and burns. *Eyes:* Levels of 10–20 ppm can cause irritation. Higher vapor concentration can cause eye injury. Contact with liquid can cause severe chemical burns. *Ingestion:* Can cause burns in mouth, throat and stomach.

Long-Term Exposure: Can cause headache, weakness, loss of sleep and appetite; sores in nose and mouth; nausea and erosion of teeth. Exposure to 0.4–2.7 ppm for 4–6 years has been associated with emphysema and bronchitis. Genetic changes have been shown in experimental animals; possibly causes toxic effects on human reproduction. Nitrogen dioxide may affect the immune system and lungs, resulting in a decreased resistance to infection.

Points of Attack: Respiratory system, lungs, cardiovascular system.

Medical Surveillance: NIOSH lists the following tests: Electrocardiogram, expired air, pulmonary function tests: forced vital capacity, forced expiratory volume (1 second); sputum cytology; white blood cell count/differential. Preplacement and periodic examinations should be concerned particularly with the skin, eyes, and with significant pulmonary and heart diseases. Smoking history should be known. Methemoglobin studies may be of interest if exposure to nitric oxide is present. In the case of nitric acid vapor mist exposure, dental effects may be present.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and do not induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24–48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Note to Physician: Inhalation: bronchodilators, decongestants and oxygen may be used if necessary. Corticosteroids are useful for treating pneumonitis. Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Individuals should be equipped with supplied air respirators with full facepiece or chemical goggles, and enclosed areas should be properly ventilated before entering. An observer equipped with appropriate respiratory protection should be outside the area and standing by to supply any aid needed. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash, where nitrogen oxides may accumulate (e.g., silos).

Respirator Selection: NIOSH: *20 ppm:* Sa:Cf (APF = 25)* (any supplied-air respirator operated in a continuous-flow mode); SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS* [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister protection against the compound of concern]; or SCBAE (any appropriate escape-type, SCBA). *Note:* *Only nonoxidizable sorbents are allowed (NOT charcoal).

Storage: Poison inhalation chemical (PIH); check oxygen content prior to entering storage area. Poison gas. (1) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. This gas is highly toxic. Even slight exposure to these gasses can cause death. Store outdoors in a secure, restricted area that containing warning signs. This area must be roofed and shaded with the cylinders stored off the ground and separated from all other products assigned to other hazard categories and radiant heat sources on non-wooden floors. If indoors, store in a well-ventilated areas in temperatures not to exceed 50°C. (2) Color code—Yellow Stripe: Reactivity Hazard; Store separately in a area isolated from flammables, combustibles, or other yellow coded materials. Oxidizers, including oxidizing gases, should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. (3) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location; keep acids away from bases and red, yellow, and blue-coded chemicals. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Protect containers from physical damage. Store separately from combustible, organic and readily oxidizable materials. Transfer facilities should be outdoors.

Shipping: UN1067/124 Dinitrogen tetroxide, Hazard Class: 2.3; Labels: 2.3-Poisonous gas, 5.1-Oxidizer, 8-Corrosive material, Inhalation Hazard Zone A. UN1975 Nitric oxide and dinitrogen tetroxide mixtures or Nitric oxide and nitrogen dioxide mixtures, Hazard Class: 2.3; Labels: 2.3-Poisonous gas, 5.1-Oxidizer, 8-Corrosive material, Inhalation Hazard Zone A. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling:

Nitric oxide and dinitrogen tetroxide mixtures or Nitric oxide and nitrogen dioxide mixtures, Inhalation Hazard Zone A

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424−9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548−8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package) dinitrogen tetroxide, nitrogen dioxide, Dinitrogen tetroxide and Nitric oxide mixture; Nitric oxide and Dinitrogen tetroxide mixture; Nitric oxide and Nitrogen dioxide mixture; Nitric oxide and Nitrogen tetroxide mixture; Nitrogen dioxide and Nitric oxide mixture; Nitrogen tetroxide and Nitric oxide mixture

First: Isolate in all directions (ft./m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.2/0.3

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft./m) 1000/400
Then: Protect persons downwind (mi/km)
Day 0.7/1.1
Night 1.8/2.8

Dinitrogen tetroxide and nitric oxide mixture; nitric oxide and dinitrogen tetroxide mixture; nitric oxide and nitrogen dioxide mixture; nitric oxide and nitrogen tetroxide mixture; nitrogen dioxide and nitric oxide mixture; nitrogen tetroxide and nitric oxide mixture

First: Isolate in all directions (ft./m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.4/0.6

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft./m) 300/100
Then: Protect persons downwind (mi/km)
Day 0.4/0.6
Night 1.4/2.3

Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Evacuate area endangered by gas. For water spills, neutralize with agricultural lime (slaked lime), crushed limestone, or sodium bicarbonate. For an air spill, apply water spray or mist to knock down vapors. Vapor knockdown water is corrosive or toxic and should be diked for containment. Keep combustibles (wood, paper, oil, etc.) away from spilled material. Stop leak if you can do so without risk. Use water spray to reduce vapor but do not put water on leak or spill area. Isolate area until gas has dispersed. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: NO_2 is nonflammable but supports combustion. Wearing proper equipment, shut off flow of gas. Use water spray to keep containers cool and to also direct escaping gas away from personnel attempting to shut off leak. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Destroy by incineration with the addition of hydrocarbon fuel, controlled in such a way that combustion products are elemental nitrogen, CO_2, and water. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥ 100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (173); (101); (138); (2); (100).

National institute for Occupational Safety and Health (NIOSH), "Criteria for a Recommended Standard: Occupational Exposure to Oxides of Nitrogen," NIOSH Document Number 76-149, Cincinnati OH (1976).

World Health Organization, Oxides of Nitrogen, Environmental Health Criteria No. 4, Geneva, Switzerland (1977).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 1, No. 5, 74−76 (1981) and 5, No. 6, 81−83 (1985).

United States Environmental Protection Agency, *Chemical Hazard Information Profile:* Nitrogen Dioxide, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

New York State Department of Health, *Chemical Fact Sheet:* Nitrogen Dioxide, Bureau of Toxic Substance Assessment, Albany, NY (March 1986).

Nitrogen Mustard Hydrochloride N:0485

Formula: $C_5H_{11}Cl_2N \cdot ClH$; $C_5H_{11}Cl_2N \cdot HCl$

Synonyms: Antimit; Azotoyperite; *N,N*-Bis(2-chloraethyl) methylamin-hydrochlorid; Bis(2-chloroethyl)methylamine hydrochloride; *N,N*-Bis(2-chloroethyl)methylamine hydrochloride; C 6866; Caryolysine; Chloramin; Chlormethine hydrochloride; Chlormethinum; 2-Chloro-*N*-(2-chloroethyl)-*N*-methylethanamine hydrochlroide; Dichloren; β,β'-Dichlorodiethyl-*N*-methylamine hydrochloride; Di(2-chloroethyl) methylamine hydrochloride; 1,5-Dichloro-3-methyl-3-azapentane hydrochloride; 2,2′-Dichloro-*N*-methyldiethylamine hydrochloride; Diethylamine, 2,2′-dichloro-N-methyl, hydrochloride; Dimitan; Embichin HCl; Erasol; Ethanamine, 2-chloro-*N*-(2-chloroethyl)-*N*-methyl-, hydrochloride; HN2 hydrochloride; *N*-Lost; Kloramin; MBA hydrochloride; Mechlorethamine hydrochloride; *N*-Methyl-bis-beta-chlorethylamine hydrochloride; *N*-Methylbis(2-chloroethyl) amine hydrochloride; *N*-Methyl-2,2'-dichlorodiethylamine hydrochloride; *N*-Methyl-di-2-chloroethylamine hydrochloride; Methyldi(beta-chloroethyl)amine hydrochloride; Methyldi(2-chloroethyl)amine hydrochloride; *N*-Mustard; Mustargen hydrochloride; Mustine hydrochloride; NCI-C56382; Nitrogranulogen; NSC-762 hydrochloride; Pliva; Stickstofflost; Zagreb

CAS Registry Number: 55-86-7

HSDB Number: 7176

RTECS Number: IA2100000

UN/NA & ERG Number: UN2928 (Toxic solids, corrosive, organic, n.o.s.)/154; UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 200-246-0

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen

California Proposition 65 Chemical[102]: Cancer 4/1/1988; developmental 7/1/1990

Hazard Alert: Exposure can be lethal, Corrosive, Possible risk of forming tumors, Drug, Suspected of causing genetic defects, Suspected reprotoxic hazard, Drug (antineoplastic agent).

Hazard symbols, risk, & safety statements: Hazard symbol: T+, C; risk phrases: R14; R21/22/23; R26/27/28; R31; R34; R35; R42/43; R45; R46; R61; R62; R63; safety phrases: S36/37/39; S41; S45; S53; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)]

Description: Highly toxic white to yellowish crystalline solid or powder. May be available as an unstable aqueous solution. Fish-like odor. Molecular weight = 192.515; freezing/melting point = ~110°C. Hazard identification (based on NFPA-704 M Rating System): Health 4; flammability 0; reactivity 0. Water soluble. Physical and toxicological properties may be affected by the carrier solvents used in commercial formulations.

Potential Exposure:

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong acids, bases. Dry crystals are stable at temperatures up to 40°C. *Note:* Chlorinating agents destroy nitrogen mustards. Dry chlorinated lime and chloramines with a high content of active chlorine vigorously chlorinate nitrogen mustards to the carbon chain, giving low toxicity products. In the presence of water this interaction proceeds less actively. They are rapidly oxidized by peracids in aqueous solution at weakly alkaline pH. In acid solution the oxidation is much slower.

Permissible Exposure Limits in Air:
PAC* Ver. 29[138]
PAC-1: 0.013 milligram per cubic meter
PAC-2: 0.14 milligram per cubic meter
PAC-3: 0.83 milligram per cubic meter
DFG MAK: [skin] danger of skin sensitization; Carcinogen Category 2A; Germ Cell Mutation Category 2

Routes of Entry: Inhalation, ingestion, dermal contact.

Harmful Effects and Symptoms

Short-Term Exposure: This compound is highly toxic and may be fatal if inhaled, swallowed or absorbed through the skin. It is a powerful vesicant. A severe irritant of the mucous membranes and a powerful vesicant, high concentrations are extremely destructive to tissues of the skin, eyes, mucous membranes and upper respiratory tract. Symptoms of exposure to this compound may include irritation of the mucous membranes, vesication, burning sensation, destruction of tissues of the skin, eyes (possible necrotizing uveitis), mucous membranes and upper respiratory tract, shortness of breath and headache, weakness, nausea, vomiting, diarrhea, and anorexia. Thrombophlebitis, thrombosis and necrosis have occured following extravascular injections. LD_{50} = (oral-rat) 10 mg/kg.

Long-Term Exposure: Exposure can lead to hemolytic anemia, chromosomal abnormalities, agranulocytosis, thrombocytopenia, depression of the hematopoietic system, persistent pancytopenia, oligomenorrhea, temporary or permanent amenorrhea. In males it may cause impaired spermatogenesis, azoospermia and total germinal aplasia. Problems of bone marrow function, kidney function, gastrointestinal symptoms, hemorrhagic complications, maculopapular skin eruptions, herpes zoster.

Points of Attack: Eyes, skin, kidneys, blood, gastrointestinal tract, male sperm, women's reproductive system, hematopoietic system, bone marrow.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure.

First Aid Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Individuals should be equipped with supplied air respirators with full facepiece or chemical goggles, and enclosed areas should be properly ventilated before entering.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA-or European Standard EN 149-approved SCBA that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA)

Storage: (1) Color code—Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. (2) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location; keep acids away from bases and red, yellow, and blue-coded chemicals. In order to maintain stability, keep dry crystals at temperatures below 40°C. Store in tightly closed containers in a well-ventilated area away from oxidizing agents; chemically active metals; strong bases; moisture. Prior to working with this chemical you should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2928 Toxic solids, corrosive, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, 8-Corrosive material, Technical Name Required. UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft.(NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. Keep ethylene glycol diethyl ether out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include toxic fumes of hydrogen chloride gas and oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include oxides of nitrogen and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: It is not appropriate to dispose of expired or waste product such as lab chemicals by flushing them down the toilet or discarding them to the trash. Larger quantities shall carefully take into consideration applicable EPA, and FDA regulations. If possible return the lab chemicals to the manufacturer for proper disposal being careful to properly label and securely package the material. Alternatively, the waste lab chemicals shall be labeled, securely packaged and transported by a state licensed medical waste contractor to dispose by burial in a licensed hazardous or toxic waste landfill or incinerator.

References

(109); (102); (31); (173); (101); (138). (100).

Nitrogen Oxides (NOx) N:0490

Formula: NO (nitric oxide); NO_2 (nitrogen dioxide); N_2O_3 (nitrogen trioxide); N_2O_4 (dinitrogen tetraoxide); N_2O_5 (nitrogen pentoxide)

Synonyms: Amidogen, OXO-; Mononitrogen monoxide; Monoxyde d'azote (French); Monoxyde d'azote, comprimé (French); Nitric oxide (NO); Nitric oxide trimer; Nitric oxide, compressed; Nitrogen monooxide; Nitrogen monoxide; Nitrogen(II) oxide; Nitrosyl radical; Oxido nítrico (Spanish); Oxido nítrico, comprimido (Spanish); Oxyde nitrique (French); Oxyde nitrique, comprimé (French)

CAS Registry Number: 10102-43-9 (nitric oxide, nitric monoxide); 10544-73-7 (nitrogen trioxide); 10102-03-1 (dinitrogen pentoxide); 10024-97-2 (nitrous oxide)

UN/NA & ERG Number: (PIH) UN1660 (nitric oxide)/124; UN2201(Nitrous oxide, refrigerated liquid)/122; UN2421(Nitrogen trioxide)/124; UN1067 (dinitrogen tetroxide)/124; UN2421 (dinitrogen tetroxide)/124

EC Number: 233-032-0 (nitrous oxide); 233-271-0 9 (nitrogen monoxide); 234-128-5 (dinitrogen trioxide); 233-264-2 (dinitrogen pentaoxide)

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (*commercial grade, nitrogen trioxide*)

Hazard Alert: Poison inhalation hazard: exposure can be lethal, High acute toxicity *(nitrogen trioxide*) See entries for specific compound

United States DOT 49CFR172.101, Inhalation Hazardous Chemical (nitrogen dioxide, nitric oxide, nitrogen tetroxide; nitrogen trioxide).

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%, nitrous oxide 10024-97-2

Hazard symbols, risk, & safety statements: Hazard symbol: T+; risk phrases: R27/28; R50/53; safety phrases: S1; S13; S28; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water (for above CAS number except dinitrogen pentoxide; no hazard value assigned).

Description: Nitrogen oxides are colorless (NO, N_2O) to brick red (NO_2) gases. Little or no odor, or an irritating odor (NO_2). When frozen they appear to be white to bluish-white snow. Molecular weight = 30 (*nitric oxide*); 76.01(*nitrogen trioxide*); specific gravity (H_2O:1) = (nitric oxide) 1.23 @ 20°C; (nitrogen tetroxide) 1.04 @ 2°C; boiling point = −152°C (*nitric oxide*); 21°C (*nitrogen dioxide*); 47°C (*nitrogen pentoxide*); freezing/melting point = −163°C (*nitric oxide*); −9°C (*nitrogen dioxide*); 30°C (*nitrogen pentoxide*); −101°C (*Nitrogen tetroxide*); vapor pressure = (nitric oxide) 750 mmHg @ −151°C;. Hazard identification (based on NFPA-704 M Rating System) (*nitric oxide*): Health 4; flammability 0; reactivity 1; (*nitrogen dioxide*) Health 2, flammability 0; reactivity 0. They decompose in water.

Potential Exposure: See entries for specific compound

Incompatibilities: Stability and reactivity is variable depending on specific compound. All are strong oxidizers that enhance the combustion of easily oxidizer materials, reducing agents; combustibles, organics.

Permissible Exposure Limits in Air
PAC Ver. 29[138]
nitric oxide; nitrogen dioxide; nitrogen tetroxide
10102-43-9 (nitric oxide, nitric monoxide)
PAC-1: $\mathbf{0.5_A}$ ppm
PAC-2: $\mathbf{12_A}$ ppm
PAC-3: $\mathbf{20_A}$ ppm
*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.
10024-97-2, nitrous oxide
PAC-1: 910 ppm
PAC-2: 10,000 ppm
PAC-3: 20,000 ppm
10544-73-7, *nitrogen trioxide*
PAC-1: 0.82 ppm
PAC-2: 20 ppm
PAC-3: 33 ppm
See entries for specific compound. The United States Environmental Protection Agency has set national ambient air quality standards for nitrogen oxides of 0.05 ppm (100 μ/m^3) as an annual arithmetic mean value.

Harmful Effects and Symptoms

Short-Term Exposure: Serious health hazards. Corrosive to the eyes and skin. Harmful if inhaled. See "Nitric oxide," "Nitrogen dioxide," etc.

First Aid: If any of these chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Poison inhalation chemical (PIH); check oxygen content prior to entering storage area. Poison gas. (1) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. This gas is highly toxic. Even slight exposure to these gasses can cause death. Store outdoors in a secure, restricted area that containing warning signs. This area must be roofed and shaded with the cylinders stored off the ground and separated from all other products assigned to other hazard categories and radiant heat sources on nonwooden floors. If indoors, store in a well-ventilated areas in temperatures not to exceed 50°C. (2) Color code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Oxidizers should be isolated from acids, metals, organic materials, and ammonium nitrate. (3) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location; keep acids away from bases and red, yellow, and blue-coded chemicals. Prior to working with nitrogen oxides all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizable materials. Outside or detached storage is preferred. Do not put on wooden floors. See NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers.*

Shipping: UN1660 Nitric oxide, compressed, Hazard Class: 2.3; Labels: 2.3-Poison Gas, 8-Corrosive material, 5.1-Oxidizer, Inhalation Hazard Zone A. UN2201 Nitrous oxide, refrigerated liquid, Hazard Class: 2.2; Labels: 2.2-Nonflammable compressed gas, 5.1-Oxidizer. UN2421 Nitrogen trioxide, Nitrogen trioxide, Hazard Class: 2.3; Labels: 2.3-Poison Gas, 5.1-Oxidizer, 8-Corrosive material, Inhalation Hazard Zone A. UN1067 Dinitrogen tetroxide, Hazard Class: 2.3; Labels: 2.3-Poison Gas, 5.1-Oxidizer, 8-Corrosive material, Inhalation Hazard Zone A. UN2421 Nitrogen trioxide, Hazard Class: 2.3; Labels: 2.3-Poison Gas, 5.1-Oxidizer, 8-Corrosive material, Inhalation Hazard Zone A.

Spill Handling:
Initial isolation and protective action distances
Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424−9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548−8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)
First: Isolate in all directions (ft./m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.4/0.6
Large spills (From a large package or from many small packages)
First: Isolate in all directions (ft./m) 300/90
Then: Protect persons downwind (mi/km)
Day 0.4/0.6
Night 1.5/2.4

Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources and dampen spilled material with toluene to avoid airborne dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Runoff of less volatile nitrogen oxides may contain nitric acid.

Fire Extinguishing: Nitrogen oxides enhance the activity of an existing fire. This gas is under pressure; containers may rupture and explode when heated. Wearing proper equipment, shut off flow of gas. Use water spray to keep containers cool and to also direct escaping gas away from personnel attempting to shut off leak. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References
(31); (173); (101); (138); (100).

National Academy of Sciences, *Medical and Biologic Effects of Environmental Pollutants: Nitrogen Oxides*, Washington, DC (1977).

United States Environmental Protection Agency, *Air Quality Criteria for Oxides of Nitrogen*, Research Triangle Park, NC, Criteria and Assessment Office.

Nitrogen Trifluoride N:0500

Formula: F_3N; NF_3
Synonyms: Nitrogen fluoride; Nitrogen trifluoride, compressed; Perfluoroammonia; Trifluoramine; Trifluorammonia; Trifluoroamine; Trifluoroammonia; Trifluorure d'azote (French); Trifluorure d'azote, comprimé (French); Trifluoruro de nitrógeno (Spanish); Trifluoruro de nitrógeno, comprimido (Spanish) Trifluoramine; Trifluorammonia
CAS Registry Number: 7783-54-2
HSDB Number: 1113
RTECS Number: QX1925000
UN/NA & ERG Number: (PIH) UN2451/122
EC Number: 232-007-1
Regulatory Authority and Advisory Information

Hazard Alert: Poison inhalation hazard, Explosive, Oxidizer (gas), Corrosive (contact with moisture), Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated.

OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 5000 lb (2270 kg)

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

United States National Primary Drinking Water Regulations: MCLG = 4 mg[F]/L; MCL = 4 mg[F]/L; SMCL = 2.0 mg [F]/L, as Fluoride.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: O; risk phrases: R5; R8; R20; R21; R23/24; safety phrases: S7/8; S9; S17; S23; S33; S38; S41; S45(see Appendix 4).

WGK[100] (German Aquatic Hazard Class): Not hazardous to water (Lit.).

Description: Nitrogen trifluoride is a colorless gas. Moldy odor. Shipped as a nonliquefied compressed gas. Molecular weight = 71.01; specific gravity (H_2O:1) = 1.5 @ −129°C; boiling point = −129°C; freezing/melting point = −209°C; Relative vapor density (air = 1) 2.46 @ 20°C; vapor pressure = >1 atm. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 0; reactivity ₩. Practically insoluble in water (reactive).

Potential Exposure: This material has been used in chemical synthesis and as an oxidizer for high-energy fuels (as an oxidizer in rocket propellant combinations).

Incompatibilities: The gas is a powerful oxidizer. Presents dangerous fire hazard in the presence of reducing agents.

Etches glass in the presence of moisture[101]. Reacts with oil, grease, reducing agents and other oxidizable materials; combustibles, organics, ammonia, carbon monoxide; methane, hydrogen, hydrogen sulfide; activated charcoal; diborane, water. Can react violently with hydrogen, ammonia, carbon monoxide, diborane, hydrogen sulfide, methane, tetrafluorohydrazine, charcoal[101]. Nitrogen trifluoride will increase intensity of an existing fire.

Permissible Exposure Limits in Air

NIOSH IDLH = 1000 ppm

Conversion factor: 1 ppm = 2.90 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 10 ppm/29 milligram per cubic meter TWA

NIOSH REL: 10 ppm/29 milligram per cubic meter TWA

ACGIH TLV[1]: 10 ppm/29 milligram per cubic meter TWA; BEIM issued for Methemoglobin inducers.

PAC* Ver. 29[138]

PAC-1: $\mathbf{200}_{\mathbf{A}}$ ppm

PAC-2: $\mathbf{530}_{\mathbf{A}}$ ppm

PAC-3: $\mathbf{860}_{\mathbf{A}}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values. United Kingdom: TWA 10 ppm (30 milligram per cubic meter); STEL 15 ppm (44 milligram per cubic meter), 2000; United Kingdom: TWA 2.5 mg[F]/m^3, 2000; the Netherlands: MAC-TGG 29 milligram per cubic meter, 2003. Several states have set guidelines or standards for NF3 in ambient air[60] ranging from 0.3 milligram per cubic meter (North Dakota) to 0.5 milligram per cubic meter (Virginia) to 0.58 milligram per cubic meter (Connecticut) to 0.714 milligram per cubic meter (Nevada).

Determination in Air: No NIOSH Analytical Method available.

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guidelines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg[F]/L. SafeDrinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg [F]/L; SMCL = 2 mg/F/L, as Fluoride.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short-Term Exposure: Insufficient data are available on the effect of this substance on human health, therefore utmost care must be taken. May be corrosive to eyes, skin and respiratory tract. In animals: anoxia, cyanosis, methemoglobinemia; weakness, dizziness, headache, liver, kidney injury. (NIOSH).

Long-Term Exposure: However, a Japanese source[24] states that NF3 is corrosive to tissue and that teeth and bones are affected on long inhalation. See also, "Fluoride," above.

Points of Attack: Blood, liver, kidneys.

Medical Surveillance: NIOSH lists the following tests: whole blood (chemical/metabolite), methhemoglobin; CBC. Liver and kidney function tests. Urine fluoride test (levels above 3−4 mg/L at the end of exposure represent increased exposure).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If frostbite has occurred, seek medical attention immediately; do NOT rub the affected areas or flush them with water. In order to prevent further tissue damage, do NOT attempt to remove frozen clothing from frostbitten areas. If frostbite has NOT occurred, immediately and thoroughly wash contaminated skin with soap and water.

Note to Physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. No protective devices other than respirators are indicated by NIOSH. rubber gloves, face shield and overalls are suggested by others, however[22]. Specific engineering controls are recommended in NIOSH Criteria Document #76-103: *Inorganic fluorides*.

Respirator Selection: *Up to 100 ppm:* CcrS (APF = 10) [any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern]; or Sa (APF = 10) (any supplied-air respirator). *Up to 250 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprS (APF = 25) [any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern]. *Up to 500 ppm:* CcrFS (APF = 50) [any chemical cartridge respirator with a full facepiece and cartridge(s) providing protection against the compound of concern]; or GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern]; or PaprTS (APF = 50) [any powered, air-purifying respirator with a tight-fitting facepiece and cartridge(s) providing protection against the compound of concern];* or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode);* or SCBAF (APF = 50) (any SCBA with a full facepiece); or SAF(any supplied-air respirator with a full facepiece). *Up to 1000 ppm:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-, mounted canister providing protection against the compound of concern]; or SCBAE (any appropriate escape-type, SCBA). *Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Check oxygen content prior to entering storage area. Color code—Yellow Stripe: Reactivity Hazard; Store separately in a area isolated from flammables, combustibles, or other yellow coded materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. High concentrations cause a deficiency of oxygen with the risk of unconsciousness or death. Check that oxygen content is at least 19% before entering storage or spill area. Store in a cool, well-ventilated area away from incompatible materials listed above. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage.

Shipping: UN2451 Nitrogen trifluoride, Hazard Class: 2.2; Labels: 2.2-Nonflammable compressed gas; 5.1-Oxidizer. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: If in a building, evacuate building and confine vapors by closing doors and shutting down HVAC systems. Restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak to disperse the gas. Wear chemical protective suit with SCBA to combat spills. Stay upwind and use water spray to "knock down" vapor; contain runoff. Stop the flow of gas, if it can be done safely from a distance. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place; and repair leak or allow cylinder to empty. Keep this chemical out of confined spaces, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material is a nonflammable gas. Thermal decomposition products may include hydrogen fluoride and oxides of nitrogen. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Vent into large volume of concentrated reducing agent (bisulfites, ferrous salts or hypo) solution, then neutralize and flush to sewer with large volumes of water.

References

(31); (101); (138); (122); (100).

National institute for Occupational Safety and Health (NIOSH), "Criteria for a Recommended Standard: Occupational Exposure to Inorganic Fluorides," NIOSH Document Number 75-103, Washington, DC (1975).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Nitrogen Dioxide*, Trenton, NJ (April 2000).

Nitroglycerin N:0510

Formula: $C_3H_5N_3O_9$; $C_3H_5(NO_3)_3$

Synonyms: Angibid; Anginine; Angiolingual; Angorin; Blasting gelatin; Blasting oil; Cardmist; Glonoin; Glucor nitro; Glycerol nitric acid triester; Glycerol (trinitrate de) (French); Glycerol trinitrate; Glyceryl nitrate; Glyceryl trinitrate; GTN; Klavi kordal; Lenitral; Myocon; Myoglycerin; NG; Niglycon; Niong; Nitora; Nitric acid triester of glycerol; Nitrin; Nitrine; Nitrine-TDC; Nitro-dur; Nitroglicerina (Spanish); Nitroglycerine; Nitroglycerol; Nitroglyn; Nitrol; Nitrolan; Nitrolent; Nitroletten; Nitrolingual; Nitrolowe; Nitronet; Nitrong; Nitrorectal; Nitro-Span; Nitrostabilin; Nitrostat; Nitrozell retard; NK-843; NTG; Perglottal; 1,2,3-

Propanetriyl nitrate; 1,2,3-Propanetrol, trinitrate; Pyro-glycerine; SK-106N; SNG; Soup; Spirit of glonoin; Spirit of glyceryl trinitrate; Spirit of trinitroglycerin; Temponitrin; TNG; Trinitrin; Trinitroglycerin; Trinitroglycerol

CAS Registry Number: 55-63-0

HSDB Number: 30

RTECS Number: QX2100000

UN/NA & ERG Number: UN1204 (solution in alcohol with not >1% nitroglycerin)/127; UN3064 (solution in alcohol, with >1% but not >5% nitroglycerin)/127; UN0144 (solution in alcohol, with >1% but not >10% nitrogylcerin)/112; UN0143 (desensitized with not <40% nonvolatile, water-insoluble phlegmatizer, by mass)/112; UN3319 (nitroglycerin mixture with more than 2% but not >10% Nitroglycerin, desensitized)/113; UN3343 (Nitroglycerin mixture, desensitized, liquid, flammable, n.o.s., with not >30% Nitroglycerin)/113; UN3357 (Nitroglycerin mixture, desensitized, liquid, n.o.s., with not >30% Nitroglycerin)/113

EC Number: 200-240-8 [*Annex I Index No.:* 603-034-00-X]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 5000 (commercial grade); *Theft hazard* 400 (commercial grade).

Hazard Alert: Explosive (unstable), Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction); FDA-proprietary drug. Listed for Tier 1 screening as an endocrine disruptor[88].

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P081

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Hazardous to aquatic life or environment, with possible long lasting effects[293]. Toxic to aquatic life with long lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: E, T+, N; risk phrases: R3; R26/27/28; R33; R51/53; R62; R63; safety phrases: S1/2; S28; S33; S35; S36/37; S41; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [2-Hazard to waters (est.)]

Description: Nitroglycerin is a pale yellow liquid or crystalline solid (below 13°C). Molecular weight = 227.09; specific gravity (H_2O:1) = 1.6 @ 20°C; boiling point = begins to decompose @ 50−60°C; explodes @ 261°C; freezing/melting point = 13.5°C; vapor pressure = 0.0003 mmHg @ 20°C; Flash point = explodes; Autoignition temperature = 261°C. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 2; reactivity 4. Practically insoluble in water.

Potential Exposure: An explosive ingredient in dynamite (20−40%) with ethylene glycol dinitrate (80−60%). It is also used in making other explosives, rocket propellants; and medicine (vasodilator).

Incompatibilities: Heat, ozone, shock, acids. An OSHA Class A Explosive (1910.109). Heating may cause violent combustion or explosion. May explosively decompose on shock, friction, or concussion. Reacts with ozone causing explosion hazard.

Permissible Exposure Limits in Air

NIOSH IDLH = 75 milligram per cubic meter

Conversion factor: 1 ppm = 9.29 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 0.2 ppm/2 milligram per cubic meter Ceiling Concentration [skin]

NIOSH REL: 0.1 milligram per cubic meter STEL [skin]

ACGIH TLV[1]: 0.05 ppm/0.46 milligram per cubic meter [skin]

PAC Ver. 29[138]

PAC-1: 0.1 ppm

PAC-2: 2 ppm

PAC-3: 75 ppm

DFG MAK: [skin] Carcinogen Category 3B; Pregnancy Risk Group C.

Arab Republic of Egypt: TWA 0.02 ppm (0.2 milligram per cubic meter) [skin], 1993; Australia: TWA 0.05 ppm (0.5 milligram per cubic meter) [skin], 1993; Austria: MAK 0.05 ppm (0.5 milligram per cubic meter) [skin], 1999; Belgium: TWA 0.05 ppm (0.46 milligram per cubic meter) [skin], 1993; Denmark: TWA 0.02 ppm (0.2 milligram per cubic meter) [skin], 1999; Finland: TWA 0.1 ppm (0.9 milligram per cubic meter); STEL 0.3 ppm (3 milligram per cubic meter) [skin], 1999; France: VME 0.1 ppm (1 milligram per cubic meter) [skin], 1999; the Netherlands: MAC-TGG 0.5 milligram per cubic meter, [skin], 2003; Japan: STEL 0.05 ppm (0.46 milligram per cubic meter) [skin], 1999; Norway: TWA 0.03 ppm (0.27 milligram per cubic meter), 1999; the Phillipines: TWA 0.2 ppm (2 milligram per cubic meter) [skin], 1993; Poland: MAC (TWA) 0.5 milligram per cubic meter; MAC (STEL) 1 milligram per cubic meter, 1999; Russia: STEL 0.5 ppm, 1993; Sweden: NGV 0.03 ppm (0.3 milligram per cubic meter), KTV 0.1 ppm (0.9 milligram per cubic meter) [skin], 1999; Switzerland: MAK-W 0.05 ppm (0.5 milligram per cubic meter), KZG-W 0.1 ppm (1 milligram per cubic meter) [skin], 1999; Thailand: TWA 0.2 ppm (2 milligram per cubic meter), 1993; Turkey: TWA 0.2 ppm (2 milligram per cubic meter) [skin], 1993; United Kingdom: TWA 0.2 ppm (1.9 milligram per cubic meter); STEL 0.2 ppm, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 0.05 ppm [skin]. Several states have set guidelines or standards for nitroglycerin in ambient air[60] ranging from 1.67 μ/m^3 (Nevada) to 5.0 μ/m^3 (Florida, North Dakota and South Carolina) to 8.0 μ/m^3 (Virginia) to 10.0 μ/m^3 (Connecticut) to 12.0 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #2507. See also OSHA Analytical Method #43.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Nitroglycerin can affect you when breathed and by passing through skin. Irritates the eyes. May affect the cardiovascular system and blood, causing lowered blood pressure; circulatory collapse; and interfere with the blood's ability to carry oxygen resulting in cyanosis, the formation of methemoglobin; trouble breathing and even death. Exposure can cause headaches, nausea, and lightheadedness.

Long-Term Exposure: After repeated exposure to nitroglycerin, a marked tolerance develops. Returning to work after a short absence from exposure can cause headaches and other symptoms, and may lead to sudden death. Angina (chest pain) and heart attacks can occur when exposure stops suddenly. Repeated or prolonged contact may cause skin sensitization and allergy.

Points of Attack: Cardiovascular system, blood, skin, central nervous system.

Medical Surveillance: NIOSH lists the following tests: whole blood (chemical/metabolite); Blood Plasm; CBC, electrocardiogram, EKG (immediately, if any chest discomfort is felt). Blood methemoglobin level.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to Physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid, unless full facepiece respiratory protection is worn. Wear dust-proof goggles and face shield when working with powders or dust, unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. See NIOSH Criteria Document #78-187 *Occupational Exposure to Nitroglycerin and Ethylene Glycol Dinitrate.*

Respirator Selection: NIOSH: *Up to 1 milligram per cubic meter:* Sa (APF = 10) (any supplied-air respirator).* *Up to 2.5 milligram per cubic meter:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode).* *Up to 5 milligram per cubic meter:* SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); * or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 75 milligram per cubic meter:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA). *Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Explosive. Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Nitroglycerin must be stored to avoid contact with heat, flames, mechanical shock or ozone, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from strong acids (such as hydrochloric, sulfuric, and nitric). Sources of ignition, such as smoking and open flames are prohibited where nitroglycerin is handled, used, or stored. Nitroglycerin has a special shipping regulation by DOT and therefore requires specific handling procedures. Metal containers involving the transfer of 5 gallons or more of nitroglycerin should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of nitroglycerin. Wherever nitroglycerin is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Nitroglycerin is often found mixed with ethylene glycol dinitrate. Also consult the entry on "Ethylene glycol dinitrate."

Shipping: UN1204 Nitroglycerin solution in alcohol with not >1% nitroglycerin, Hazard Class: 3; Labels: 3-Flammable liquid. UN3064 Nitroglycerin, solution in alcohol with >1% but not >5% nitroglycerin, Hazard Class: 3; Labels: 3-Flammable liquid. UN0143 Nitroglycerin, desensitized with not <40% nonvolatile, water-insoluble phlegmatizer, by mass. It falls in Hazard Class 1.1D (subsidiary hazard: 6.1).

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak

until cleanup is complete. Do not touch or disturb spilled material. Consult an expert trained for this kind of emergency. Do NOT wash away into sewer (extra personal protection: complete protective clothing including SCBA). It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is an explosive and flammable liquid. In case of fire, evacuate area. Combustion in an enclosed space can result in explosion. Isolate area around fire and call for expert help. Consider letting fire burn. Thermal decomposition products may include oxides of nitrogen and carbon. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Do not wash into sewer. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (173); (101); (138); (2); (100).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 1, No. 4, 89−90 (1981).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Nitroglycerin, Trenton, NJ (July 2001).

Nitromethane N:0520

Formula: CH_3NO_2
Synonyms: Methan, nitro-; Nitrocarbol
CAS Registry Number: 75-52-5
HSDB Number: 106
RTECS Number: PA9800000
UN/NA & ERG Number: UN1261/129
EC Number: 200-876-6 [*Annex I Index No.:* 609-036-00-7]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Theft hazard* 400 (commercial grade).

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Animal Sufficient Evidence; Human No Adequate Data, *possibly carcinogenic to humans*, Group 2B, 2000; NCI: Carcinogenesis Studies (inhalation); clear evidence: mouse, rat.

California Proposition 65 Chemical[102]: Cancer 5/1/1997.

Hazard Alert: Highly flammable, Possible risk of forming tumors,

OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 2500 lb (1135 kg)

Carcinogenicity: (New Jersey)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: Xn; risk phrases: R5; R11; R22; safety phrases: S1; S2; S21; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Nitromethane is a highly flammable and explosive colorless liquid with a strong, disagreeable odor. Molecular weight = 61.05; specific gravity (H_2O:1) = 1.13 @ 20°C; boiling point = 101°C; freezing/melting point = −29°C; vapor pressure = 28 mmHg @ 20°C; Flash point = 35°C (cc); Autoignition temperature = 417°C. Explosive limits: LEL = 7.3%; UEL: 63%. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 3; reactivity 4 (Possible detonation). Slightly soluble in water.

Potential Exposure: Nitromethane is used in the production of the fumigant, chloropicrin. It is best known as racing car fuel. It is also used as a solvent and as an intermediate in the pharmaceutical industry.

Incompatibilities: May explode from heat, shock, friction, or concussion. Reacts with alkalis, strong acids; metallic oxides. Detonates or reacts violently with strong oxidizers, strong reducing agents such as hydrides; formaldehyde, copper, copper alloys; lead, lead alloys; hydrocarbons and other combustibles, causing fire and explosion hazard. Forms shock sensitive mixture when contaminated with acids, amines, bases, metal oxides; hydrocarbons, and other combustible materials.

Permissible Exposure Limits in Air

NIOSH IDLH = 750 ppm

Conversion factor: 1 ppm = 2.50 milligram per cubic meter @ 25°C & 1 atm

Odor threshold = <200 ppm

OSHA PEL: 100 ppm/250 milligram per cubic meter TWA

NIOSH REL: see *NIOSH Pocket Guide*, Appendix D.

ACGIH TLV[1]: 20 ppm/ 50 milligram per cubic meter TWA, confirmed animal carcinogen with unknown relevance to humans.

PAC Ver. 29[138]

PAC-1: 60 ppm
PAC-2: 210 ppm
PAC-3: 1000 ppm
DFG MAK: [skin] Carcinogen Category 3B

Austria: MAK 100 ppm (250 milligram per cubic meter), 1999; Denmark: TWA 100 ppm (250 milligram per cubic meter), 1999; Finland: TWA 100 ppm (250 milligram per cubic meter); STEL 150 ppm (375 milligram per cubic meter), 1999; France: VME 100 ppm (250 milligram per cubic meter), 1999; Norway: TWA 50 ppm (125 milligram per cubic meter), 1999; the Phillipines: TWA 100 ppm (250 milligram per cubic meter), 1993; the Netherlands: MAC-TGG 50 milligram per cubic meter, 2003; Sweden: NGV 20 ppm (50 milligram per cubic meter), KTV 50 ppm (125 milligram per cubic meter), 1999; Switzerland: MAK-W 100 ppm (250 milligram per cubic meter), 1999; Turkey: TWA 100 ppm (250 milligram per cubic meter), 1993; United Kingdom: TWA 100 ppm (254 milligram per cubic meter); STEL 150 ppm, 2000; New Zealand, Singapore, Vietnam: ACGIH TLV: confirmed animal carcinogen with unknown relevance to humans. Several states have set guidelines or standards for nitromethane in ambient air[60] ranging from 2.5 milligram per cubic meter (North Dakota) to 4.0 milligram per cubic meter (Virginia) to 5.0 milligram per cubic meter (Connecticut) to 5.952 milligram per cubic meter (Nevada).

Determination in Air: Use NIOSH Analytical Method(IV) #2527, Nitromethane.

Permissible Concentration in Water: Russia[43] set a MAC in water bodies used for domestic purposes of 0.005 mg/L.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the skin and eyes on contact. Inhaling nitromethane irritates the nose and throat causing mild pulmonary irritation with coughing and wheezing. May affect the central nervous system; causing CNS depression, weakness, muscular incoordination; convulsions.

Long-Term Exposure: Repeated or prolonged contact may cause dry and cracked skin. May affect or damage the peripheral nervous system. May cause kidney and liver damage. May cause anorexia, nausea, vomiting and diarrhea.

Points of Attack: Eyes, skin, central nervous system; kidneys, liver.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. butyl rubber; Neoprene, polyethylene are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: OSHA: *750* ppm*:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* SCBAE (any appropriate escape-type, SCBA). Note: Substance causes eye irritation or damage; eye protection needed.

Storage: (1) Color code—Red Stripe: Flammability Hazard: Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. (2) Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in an explosion-proof refrigerator and protect from heat, oxidizers, strong acids; strong bases; formaldehyde, amines, hydrocarbons, combustibles. metallic oxides, reducing agents; copper and its alloys; lead and its alloys, light. Sources of ignition, such as smoking and open flames are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN1261 Nitromethane, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Follow by washing surfaces well first with alcohol, then with soap and water. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Water may be ineffective. Alcohol foam is recommended[17].

Disposal Method Suggested: Incineration: large quantities of material may require nitrogen oxide removal by catalytic or scrubbing processes[22].

References

(109); (102); (31); (173); (101); (138); (2); (100).

National institute for Occupational Safety and Health (NIOSH), Information Profiles on Potential Occupational Hazards: Classes of Chemicals: Nitroparaffins, NIOSH Pub. No. TR-78-518, Rockville, MD, pp 199-210 (April 1978)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Nitromethane, Trenton, NJ (August 1999).

Nitrophenols N:0530

Formula: $C_6H_5NO_3$; $NO_2C_6H_4OH$

Synonyms: *(2-nitrophenol; o-isomer):* 2-Hydroxynitrobenzene; *o*-Nitrofenol (Spanish); *o*-Nitrophenol; Orthonitrophenol; Phenol, *o*-nitro-; Phenol, 2-nitro-

(3-nitrophenol; m-isomer): *m*-Hydroxynitrobenzene; 3-Hydroxynitrobenzene; *m*-Nitrofenol (Spanish); 3-Nitrophenol; Phenol, 3-nitro-

(4-nitrophenol; p-isomer): Degradation product of parathion; 4-Hydroxynitrobenzene; NCI-C55992; Niphen; *p*-Nitrofenol (Spanish); 4-Nitrofenol (Spanish); 4-Nitrophenol; Paranitrophenol (French, German); Phenol, *p*-nitro; Phenol, 4-nitro-; PNP

CAS Registry Number: 88-75-5 (*o*-isomer); 554-84-7 (*m*-isomer); 100-02-7 (*p*-isomer); 25154-55-6 (mixed isomers)

HSDB Number: 1133 (*o*-isomer); 1337 (*m*-isomer); 1157 (*p*-isomer); 6296 (mixed isomers)

RTECS Number: SM2100000 (2-nitrophenol; *o*-isomer); SM1925000 (3-nitrophenol; *m*-isomer); SM2275000 (4-nitrophenol; *p*-isomer)

UN/NA & ERG Number: UN1663 (nitrophenols)/153

EC Number: 201-857-5 (2-nitrophenol); 209-073-5 (3-nitrophenol); 202-811-7 [*Annex I Index No.:* 609-015-00-2] (4-nitrophenol)

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Combustible, Strong oxidizers.

Hazard symbols, risk, & safety statements: Hazard symbol: T, F, Xn; risk phrases: R11; R20/21/22; R23/24/25; R33; R36/37/38; R39; R50/53; safety phrases: S7; S16; S28; S36;/37; S45; S61 (see Appendix 4)

m-isomer*:*

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as nitrophenols

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 100 lb (45.4 kg)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%, nitrophenols (*o-; m-; p-*).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to waters *(m*-isomer*)*

o-isomer:

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as nitrophenols

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 100 lb (45.4 kg)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%, nitrophenols (*o-; m-; p-*)

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as nitrophenols; Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

Hazardous to aquatic life or environment, with possible long lasting effects[194]. Harmful to aquatic life with long lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements:.

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water (*o*-isomer)

p-isomer*:*

Carcinogenicity: NCI: Carcinogenesis Studies (derm); no evidence: mouse. United States Environmental Protection Agency Gene-Tox Program, Positive: S *cerevisiae* gene conversion; Negative: Histidine reversion-Ames test; Inconclusive: Host-mediated assay

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as nitrophenols; Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U170

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.12; Nonwastewater (mg/kg), 29

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8040 (10); 8270 (50)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 100 lb (45.4 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

European/International Regulations *(p-isomer)*: Hazard symbol: Xn; risk phrases: R20/21/22; R33; R51; safety phrases: S2; S28; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to waters *(p-isomer)*

mixed isomers:

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR401.15 Section 307 Toxic Pollutants as nitrophenols

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 100 lb (45.4 kg)

Hazard symbols, risk, & safety statements:

Description: There are three isomers of nitrophenol. The isomer of greatest concern, and the subject of *ATSDR Toxicology Profile*, is the *p*-isomer (4-nitrophenol). The meta-form is produced from *m*-nitroaniline, and the *o*-and *p*-isomers are produced by nitration of phenol. They are colorless to slightly yellowish crystals with an aromatic to sweetish odor. Molecular weight = (*o-, m-, & p*-isomers) 139.11; specific gravity (H_2O:1) = (*o*-, *m*-& *p*-isomers) 1.5 @ 20°C; boiling point = (*o*-isomer) 215°C; (*m*-isomer) 194°C; (*p*-isomer) 279°C (decomposes); freezing/melting point = (*o*-isomer) 45°C; 97°C (*m*-isomer); (*p*-isomers) 114°C (sublimes); vapor pressure = (*o*-isomer) 1 mmHg @ 49°C; (*m*-isomer) 0.1 mmHg @ 25°C; Flash point = (*o-& m*-isomers) 102°C; (*p*-isomer) 169°C; Autoignition temperature = (*p*-isomer) 283°C. Explosive limits (*m*-isomer) LEL = 73,000 ppm; UEL: unknown. NFPA 704 M Hazard identification (*m*-, *o*-, *p*-): Health 3; flammability 1; reactivity 2. Not soluble in water.

Potential Exposure: (*p*-isomer): Possible risk of forming tumors, Suspected reprotoxic hazard. Nitrophenols are used as intermediates in production of dyes; photochemicals, pesticides, and pharmaceuticals; in leather tanning.

Incompatibilities: Nitrophenols are strong oxidizers. Reacts violently with combustible and reducing agents. Contact with potassium hydroxide forms an explosive mixture. May explode on heating.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

88-75-5, o-isomer

PAC-1: 2.1 milligram per cubic meter

PAC-2: 23 milligram per cubic meter

PAC-3: 140 milligram per cubic meter

554-84-7 *m-isomer*

PAC-1: 2.8 milligram per cubic meter

PAC-2: 31 milligram per cubic meter

PAC-3: 180 milligram per cubic meter

100-02-7 *p-isomer 100-02-7 & mixed isomers*

PAC-1: 0.69 milligram per cubic meter

PAC-2: 7.6 milligram per cubic meter

PAC-3: 46 milligram per cubic meter

Russia set a MAC for 4-nitrophenols in ambient air in residential areas of 0.003 milligram per cubic meter on a once-daily basis. Guidelines for *p*-nitrophenol in ambient air[60] have been set by South Carolina at zero and by New York at 0.03 μ/m^3.

Permissible Concentration in Water: Federal Drinking Water Guidelines (*4-Nitrophenol*): EPA 60 μg/L. State Drinking Water Guidelines (*2-Nitrophenol*): Florida 20 μg/L.

Determination in Water: Methylene chloride extraction followed by gas chromatography with flame ionization or electron capture detection (EPA Method 604) or gas chromatography plus mass spectrometry (EPA Method 625).

Routes of Entry: Inhalation, ingestion; skin and/or eye contact. Percutaneous absorption of liquid.

Harmful Effects and Symptoms

Short-Term Exposure: Nitrophenols can affect you when breathed in and by passing through your skin. Nitrophenols can irritate and burn the skin and eyes with possible eye damage. Vapors can cause irritation of the respiratory tract with coughing and/or shortness of breath. High levels of vapors may cause metabolism increase and rapid heart beat. High levels can lower the ability of the blood to carry oxygen (methemoglobinemia), leading to cyanosis (a bluish color to the skin and lips), headaches, dizziness and collapse. Higher levels can cause death. Exposure can cause headache, upset stomach; dizziness, weakness, confusion, fever, breathing trouble; a slow pulse; fall in blood pressure; convulsions (fits) and death.

Long-Term Exposure: Nitrophenols may damage the kidney and liver. Nitrophenols can irritate the lungs; bronchitis may develop. High or repeated exposure may affect the nervous system.

Points of Attack: Liver, kidneys, blood.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: A blood test for methemoglobin level, liver function tests; kidney function tests; nervous system tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to Physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Butyl rubber is recommended by a manufacturer and other authorities as a protective material. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposure to nitrophenols, use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece respirator with a high efficiency particulate filter. Greater protection is provided by a powered-air purifying respirator. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Nitrophenols must be stored to avoid contact with reducing agents; oxidizers, combustibles, organic materials; and strong bases, since violent reactions occur. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1663 Nitrophenols (*o-; m-; p-*), Hazard Class: 6.1; Labels: 6.1-Poisonous materials

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include oxides of nitrogen and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Controlled incineration-care must be taken to maintain complete combustion at all times. Incineration of large quantities may require scrubbers to control the emission of nitrogen oxides. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (173); (101); (138); (80); (100).

National institute for Occupational Safety and Health (NIOSH), *Information Profiles on Potential Occupational Hazards: Nitrophenols*, Report No. PB-276, 678, Rockville, MD, pp 212−226 (October 1977).

United States Environmental Protection Agency, *Nitrophenols: Ambient Water Quality Criteria*, Washington, DC (1980).

United States Environmental Protection Agency, *4-Nitrophenol, Health and Environmental Effects Profile No. 135*, Washington, DC, Office of Solid Waste (April 30, 1980).

United States Environmental Protection Agency, *Nitrophenols, Health and Environmental Effects Profile No. 136*, Washington, DC, Office of Solid Waste (April 30, 1980).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 5, No. 3, 67−70 (1985) (2-Nitrophenol) and 1, No. 6, 89−90 (1981) and 6, No. 3, 63−66 (3-Niitrophenol) and 3, No. 3, 82−85 (1983) (4-Nitrophenol).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* 2-Nitrophenol, Trenton, NJ (February 2000).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* 3-Nitrophenol, Trenton, NJ (February 2000).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* 4-Nitrophenol, Trenton, NJ (September 2004).

1-Nitropropane N:0540

Formula: $C_3H_7NO_2$: $CH_3CH_2CH_2NO_2$
Synonyms: α-Nitropropane; Nitropropane; 1-Nitropropano (Spanish); 1-NP; Propane, 1-nitro-; Propane, nitro-
CAS Registry Number: 108-03-2
HSDB Number: 2526
RTECS Number: TZ5075000
UN/NA & ERG Number: UN2608/129
EC Number: 203-544-9 [*Annex I Index No.:* 609-001-00-6]

Regulatory Authority and Advisory Information

Hazard Alert: Highly flammable, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction).

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xn; risk phrases: R11; R20/21/22; R36/37/38; R62; safety phrases: S2; S9; S21; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: 1-Nitropropane is a colorless liquid with a mild, fruity odor. Molecular weight = 89.1; specific gravity (H_2O:1) = 1.01; boiling point = 131°C; freezing/melting point = −108°C; vapor pressure = 7.5 mmHg @ 20°C; Flash point = 35.6°C (cc); Autoignition temperature = 421°C. Explosive limits: LEL = 2.2%; UEL-unknown. Hazard identification (based on NFPA-704 M Rating System): Health 1; flammability 3; reactivity 2. Slightly soluble in water; solubility = 1%. *Note:* Technical products measurably contaminated with 2-Nitropropane.

Potential Exposure: 1-Nitropropane is used as a solvent for polymers, as a stabilizer; and in organic synthesis. *Note:* Technical products measurably contaminated with 2-Nitropropane, see also 2-Nitropropane (N: 0550)

Incompatibilities: 1-Nitropropane, a nitroparaffinin, forms exposive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, reducing agents; nitrates, amines, hydrocarbons, and other combustible materials; metal oxides. May explode on heating.

Permissible Exposure Limits in Air

NIOSH IDLH = 1000 ppm [LEL]
Odor threshold = 140 ppm.
OSHA PEL: 25 ppm/90 milligram per cubic meter TWA
NIOSH REL: 25 ppm/90 milligram per cubic meter TWA
ACGIH TLV[1]: 25 ppm/91 milligram per cubic meter TWA, not classifiable as a human carcinogen.
PAC Ver. 29[138]
PAC-1: 75 ppm
PAC-2: 380 ppm
PAC-3: 2300 ppm
DFG MAK: 25 ppm/1992 milligram per cubic meter TWA; Peak Limitation Category I(4); Pregnancy Risk Group D

Austria: MAK 25 ppm (90 milligram per cubic meter), 1999; Denmark: TWA 5 ppm (18 milligram per cubic meter), 1999; Finland: TWA 25 ppm (90 milligram per cubic meter); STEL 40 ppm (150 milligram per cubic meter), 1999; France: VME 25 ppm (90 milligram per cubic meter), 1999; Norway: TWA 20 ppm (70 milligram per cubic meter), 1999; the Phillipines: TWA 25 ppm (90 milligram per cubic meter), 1993; the Netherlands: MAC-TGG 90 milligram per cubic meter, 2003; Switzerland: MAK-W 5 ppm (18 milligram per cubic meter), carcinogen, 1999; Turkey: TWA 25 ppm (90 milligram per cubic meter), 1993; United Kingdom: TWA 25 ppm (93 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Several states have set guidelines or standards for 1-nitropropane in ambient air[60] ranging from 0.3 milligram per cubic meter (New York) to 0.9 milligram per cubic meter (Florida and North Dakota) to 1.5 milligram per cubic meter (Virginia) to 1.8 milligram per cubic meter (Connecticut) to 2.143 milligram per cubic meter (Nevada) to 2.25 milligram per cubic meter (South Carolina).

Determination in Air: Use OSHA Analytical Method 46.

Permissible Concentration in Water: Russia[43] set a MAC in water bodies used for domestic purposes of 1.0 mg/L.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin, and respiratory tract. Inhalation can cause coughing, wheezing, and/or shortness of breath. High levels can interfere with the ability of the blood to carry oxygen (methemoglobinemia), causing cyanosis, headaches, fatigue, dizziness nausea, vomiting, diarrhea. Higher levels can cause collapse and death.

Long-Term Exposure: In animals: liver, kidney damage.

Points of Attack: Eyes, central nervous system; liver, kidneys.

Medical Surveillance: Liver and kidney function tests. Blood methemoglobin level.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to Physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. butyl rubber; Teflon, and Silvershield are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 250 ppm:* Sa (APF = 10) (any supplied-air respirator).* *Up to 625 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). **Up to 1000 ppm:* SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied air respirator with a full facepiece).

Emergency or planned entry into unknown concentrations or IDLH conditions: SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* SCBAE (any appropriate escape-type, SCBA). *Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist.

Shipping: UN2608 Nitropropanes, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; alcohol foam; or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* 1-Nitropropane, Trenton, NJ (September 1999).

2-Nitropropane N:0550

Formula: $C_3H_7NO_2$: $CH_3CH(NO_2)CH_3$
Synonyms: Dimethylnitromethane; Isonitropropane; Nipar S-20; Nipars-20 solvent; Nipar S-30 solvent; Nitroisopropane; β-Nitropropane; *sec*-Nitropropane; 2-Nitropropano (Spanish); 2-NP; Propane, 2-nitro-
CAS Registry Number: 79-46-9
HSDB Number: 1134
RTECS Number: TZ5250000
UN/NA & ERG Number: UN2608/129
EC Number: 201-209-1 [*Annex I Index No.:* 609-002-00-1]

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Animal Sufficient Evidence; Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B, 1999; NIOSH: Potential occupational carcinogen. United States Environmental Protection Agency Gene-Tox Program, Positive: Carcinogenicity-mouse/rat; Inconclusive: Mammalian micronucleus.

California Proposition 65 Chemical[102]: Cancer 1/1/1988.

Hazard Alert: Highly flammable, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U171

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazardous to aquatic life or environment, with possible long lasting effects[194]. Harmful to aquatic life with long lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: F, T; risk phrases: R45; R11, R45; R10; R20/22; R62; R63; safety phrases: S21; S41; S45; S53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: 2-Nitropropane is a colorless liquid. Molecular weight = 89.1; specific gravity (H_2O:1) = 0.99; boiling point = 120°C; freezing/melting point = −91°C; vapor pressure = 13 mmHg @ 20°C; 7.5 mmHg @ 10.7°C; Flash point = 23.9°C; Autoignition temperature = 428°C. Explosive limits: LEL = 2.6%; UEL: 11.0%. Hazard identification (based on NFPA-704 M Rating System): Health 1; flammability 3; reactivity 2. Slightly soluble in water; solubility = 2%.

Potential Exposure: 2-Nitropropane is used as a solvent for polymers, organic compounds; cellulose, esters; gums, vinyl resins; waxes, epoxy resins, fats, dyes, and chlorinated rubber; as a stabilizer. Its combustion properties have made it useful as a rocket propellant and as a gasoline and diesel fuel additive. 2-Nitropropane also has limited use as a paint and varnish remover. It serves as an intermediate in organic synthesis of some pharmaceuticals; dyes, insecticides, and textile chemicals.

Incompatibilities: 1-Nitropropane, a nitroparaffin compound, forms explosive mixture with air. Contact with heavy metal oxides may cause decomposition. Mixtures with hydrocarbons are extremely flammable. Attacks some plastics, rubber and coatings. May explode on heating. Violent reaction with strong bases; strong acids and metal oxides. Shock-sensitive compounds are formed with acids, amines, inorganic bases and heavy metal oxides. Incompatible with strong oxidizers, combustible materials. 2-Nitropropane reacts with activated carbon causing decomposition. *This reaction may occur in activated carbon respirator filters.*

Permissible Exposure Limits in Air

NIOSH IDLH = 100 ppm
Odor Threshold = 300 ppm.
OSHA PEL: 25 ppm/90 milligram per cubic meter TWA
NIOSH REL:A potential occupational carcinogen. [skin]; Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A.
ACGIH TLV[1]: 10 ppm/36 ppm TWA, confirmed animal carcinogen with unknown relevance to humans.
PAC Ver. 29[138]
PAC-1: 30 ppm
PAC-2: 380 ppm
PAC-3: 2300 ppm
DFG MAK: [skin] Carcinogen Category 2

Austria carcinogen, 1999; Denmark: TWA 5 ppm (18 milligram per cubic meter), 1999; France: carcinogen, 1993; Norway: TWA 10 ppm (35 milligram per cubic meter), 1999; the Phillipines: TWA 25 ppm (90 milligram per cubic meter), 1993; Sweden: NGV 5 ppm (18 milligram per cubic meter), TGV 10 ppm (35 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 0.036 milligram per cubic meter, 2003; Turkey: TWA 25 ppm (90 milligram per cubic meter), 1993; United Kingdom: TWA 5 ppm (19 milligram per cubic meter), carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: confirmed animal carcinogen with unknown relevance to humans. Brazil [35] has set a TWA of 20 ppm (70 milligram per cubic meter). Several states have set guidelines or standards for 2-nitropropane in ambient air[60] ranging from zero in North Dakota to 0.2 μ/m^3 (Rhode Island) to 21.67 μ/m^3 (Pennsylvania) to 350 μ/m^3 (Virginia) to 360 μ/m^3 (Connecticut) to 2143 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #2528; OSHA Analytical Method 46 (which supercedes Method 15).

Permissible Concentration in Water: Russia[43] set a MAC in water bodies used for domestic purposes of 1.0 mg/L.

Determination in Water: Octanol-water coefficient: Log $K_{ow} = 0.9$.Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: The vapor irritates the eyes and respiratory tract. 2-Nitropropane can affect you when breathed in. 2-Nitropropane may cause mutations. Handle with extreme caution. Exposure can cause headaches, dizziness, nausea, vomiting, and diarrhea. At levels, causing these symptoms, severe liver damage can occur that can cause death. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Exposure may also damage the kidneys, heart, and may interfere with the ability of the blood to carry oxygen (methemoglobinemia); this can cause weakness, trouble breathing and cyanosis, a bluish color to the skin and lips. Exposure to high levels may cause liver damage. Exposure to very high levels may result in death.

Long-Term Exposure: May affect the liver, kidneys, heart, and nervous system. Based on animal tests, this chemical is a potential occupational carcinogen. Animal tests show that this substance may cause mutations and affect human reproduction.

Points of Attack: Eyes, skin, respiratory system; central nervous system; kidneys, liver, heart. Cancer site in animals: liver tumors.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: Liver function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Kidney function tests. Blood methemoglobin level.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to Physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. butyl rubber; and polyvinyl chloride are recommended. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. 2-Nitropropane must be stored to avoid contact with strong bases and strong acids (such as hydrochloric, sulfuric, and nitric) and metal oxides; since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area. Protect storage containers from physical damage. Sources of ignition, such as smoking and open flames are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of 2-nitropropane. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2608 Nitropropanes, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration: large quantities of material may require nitrogen oxide removal by catalytic or scrubbing processes[22]. Dilute with pure kerosene and burn with care as it is potentially explosive. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(109); (102); (31); (173); (100).

United States Environmental Protection Agency, *Chemical Hazard Information Profile:* 2-Nitropropane, Washington, DC(2). (September 27, 1977).

(173); (101); (138).

National institute for Occupational Safety and Health (NIOSH), *Information Profiles on Potential Occupational Hazards: Classes of Chemicals: Nitroparaffins*, NIOSH Pub. No. RT 78-518, Rockville, MD, pp 199-210 (April 1978).

National Institute for Occupational Safety and Health 2-Nitropropane, *Current Intelligence Bulletin No. 17*, Rockville, MD (April 25, 1977).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 2, No. 2, 58−59 (1982) and 4, No. 1, 92−94 (1984).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* 2-Nitropropane, Trenton, NJ (July 2001).

N-Nitrosodi-*n*-butylamine N:0560

Formula: $C_8H_{18}N_{20}$

Synonyms: 1-Butanamine, *n*-butyl-*N*-nitroso-; Butylamine, *N*-nitrosodi-; *n*-Butyl-*N*-nitroso-1-butamine; DBN; DBNA; Dibutylamine, *N*-nitroso-; Di-*n*-butylnitrosamin (German); *N*,*N*-Di-*n*-butylnitrosamine; Di-*n*-butylnitrosamine; Dibutylnitrosamine; *N*,*N*-Dibutylnitrosoamine; NDBA; *N*-Nitrosodi-*n*-butylamine; Nitrosodibutylamine

CAS Registry Number: 924-16-3

HSDB Number: 5107

RTECS Number: EJ4025000

UN/NA & ERG Number: UN2810 (toxic liquid, organic, n.o.s.)/153; UN3082 (environmentally hazardous substances, liquid, n.o.s.)/171

EC Number: 213-101-1

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Animal Sufficient Evidence; Human Insufficient Evidence, *possibly carcinogenic to humans*, Group 2B, 1978; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies.

California Proposition 65 Chemical[102]: Cancer 10/1/1987

Hazard Alert: Poison, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard.

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U172

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.40; Nonwastewater (mg/kg), 17

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10)

Clean Water Act: Section 307(a)(1)Toxic Pollutants subject to effluent limitations as nitrosamines

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xn; risk phrases: R45; R22; R23/24/25; R36/37/38; R34;

R40; R46; R50/53; R62; R63; safety phrases: S22; S23; S24/25; S26; S36/37/39; S45; S53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: *N*-Nitrosodi-*n*-butylamine is a yellow, oily liquid. Molecular weight = 158.28; boiling point = 235°C; 116°C @ 14 mm. Hazard identification (based on NFPA-704 M Rating System): Health 1; flammability 0; reactivity 0. Slightly soluble in water.

Potential Exposure: *N*-Nitrosodi-*n*-butylamine is a carcinogenic nitrosamine. It is found or used in various manufacturing industries, including chemical, rubber, metal, etc., and in research.

Incompatibilities: *N*-Nitrosodi-*n*-butylamine is light sensitive. Nitrosamines can be strong oxidizers; contact with these materials may cause fires or explosions. Keep away from combustible materials, alkaline materials, strong acids, strong bases. Nitrated organics range from slight to strong oxidizing agents. If mixed with reducing agents, including hydrides, sulfides and nitrides, they may begin a vigorous reaction. Amines are a chemical base: will neutralize acids to form salts plus water with an exothermic reaction. May be incompatible with isocyanates, halogenated organics, peroxides, phenols (acidic), epoxides, anhydrides, and acid halides. Flammable gaseous hydrogen is generated by amines in combination with strong reducing agents such as hydrides, nitrides, alkali metals, and sulfides.

Permissible Exposure Limits in Air

DFG MAK: [skin] Carcinogen Category 2

There is no established numerical OELs. However, this chemical is a carcinogen and exposure should be reduced to the lowest possible level.

Determination in Air: Use NIOSH Analytical Method (IV) #2522, Nitrosamines; OSHA Analytical Method 38.

Determination in Water: Octanol-water coefficient: Log K_{ow} = 2.6. Values above 3.0 are likely to bioaccumulate in aquatic organisms.

Routes of Entry: Inhalation; dermal contact, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: *N*-Nitrosodi-*n*-butylamine irritates the skin and respiratory tract. Nitrosamines can cause headaches, abdominal cramps; weakness and dizziness. It is unknown if this chemical causes all of these same symptoms.

Long-Term Exposure: May be a human carcinogen; causes urinary bladder, esophagus, and liver cancer in animals. This chemical is toxic to the fetus and causes fetal death in animals. Repeated exposure may cause liver damage.

Points of Attack: Liver, bladder.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA-or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with an N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2810 Toxic liquids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN3082 Environmentally hazardous substances, liquid, n.o.s., Hazard Class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Under 40 CFR 261.5 small quantity generators of this waste may qualify for partial exclusion from hazardous waste regulations.

References

(109); (102); (31); (173); (101); (138); (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: N*-nitrosodi-*N*-butylamine, Trenton, NJ (January 2007).

N-Nitrosodiethylamine N:0570

Formula: $C_4H_{10}N_2O$

Synonyms: DANA; DEN; DENA; Diaethylnitrosamin (German); Diethylamine, *N*-nitroso-; Diethylnitrosamide; Die thylnitrosamine; *N*,*N*-Diethylnitrosoamine; Diethylnitrosoamine; Ethanamine, *n*-ethyl-*N*-nitroso-; *n*-Ethyl-*N*-nitrosoethanamine; NDEA; *N*-Nitrosodiaethylamin (German); *N*-Nitroso-*N*,*N*-diethylamine; Nitrosodiethylamine; *N*-Nitrosodietilamina (Spanish)

CAS Registry Number: 55-18-5

HSDB Number: 4001

RTECS Number: IA3500000

UN/NA & ERG Number: UN2810 (toxic liquid, organic, n.o.s.)/153; UN3082 (environmentally hazardous substances, liquid, n.o.s.)/171

EC Number: 200-226-1

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Animal Sufficient Evidence; Human Insufficient Evidence, Group 2A, 1998; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies; NCI: Carcinogenesis Studies (ipr); clear evidence: mouse, rat 1975.

California Proposition 65 Chemical[102]: Cancer 10/1/1987

Hazard Alert: Poison, Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U174

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.40; Nonwastewater (mg/kg), 28

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 1 lb (0.454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazard symbols, risk, & safety statements: Hazard symbol: T; risk phrases: R45; R20/22; R23/24/25; R36/37/38; R39/23/24/25; R50; R62; R63; safety phrases: S7; S16; S26; S36/37/39; S41; S45; S53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: *N*-Nitrosodiethylamine is a yellow liquid. Molecular weight = 102.16; boiling point = 175−177°C. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 1; reactivity 0. Soluble in water.

Potential Exposure: An additive in gasoline and lubricants; an antioxidant and stabilizer in plastics. Used in research.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Contact with reducing agents may form hydrazine; hydrogen bromide. Light sensitive; rapidly decomposes.

Permissible Exposure Limits in Air

PAC not available. There is no established numerical OELs. However, this chemical is a carcinogen and exposure should be reduced to the lowest possible level.

DFG MAK: [skin] Carcinogen Category 2

Determination in Air: Use NIOSH Analytical Method (IV) #2522, Nitrosamines; OSHA Analytical Method 38.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Contact can irritate the skin and eyes. The vapors cause respiratory tract irritation. Some related nitrosamines can cause headaches, abdominal cramps; weakness and dizziness. It is unknown if this chemical causes all of these same symptoms.

Long-Term Exposure: Potential human carcinogen.

Prolonged or repeated exposure may cause liver damage. May damage the developing fetus.

Points of Attack: Liver.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Plastic, latex, or Neoprene gloves, may be effective protection. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full facepiece respirator with an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Green: General storage may be used. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, dark, well-ventilated area away from light, oxidizers, reducing agents; hydrogen bromide. Where possible, automatically pump liquid from drums or other storage containers to process containers Sources of ignition, such as smoking and open flames are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2810 Toxic liquids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN3082 Environmentally hazardous substances, liquid, n.o.s., Hazard Class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources.

Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120 (q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; alcohol foam; or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(109); (102); (31); (173); (101); (138); (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: N*-Nitrosodiethylamine, Trenton, NJ (August 1999).

N-Nitrosodimethylamine N:0580

Formula: $C_2H_6N_2O$; $(CH_3)_2NN = O$

Synonyms: Dimethylamine, *N*-nitroso-; Dimethylnitrosamin (German); Dimethylnitrosamine; *N,N*-Dimethylnitrosoamine; DMN; DMNA; Methanamine, *n*-methyl-*N*-nitroso-; *n*-Methyl-*N*-nitrosomethan amine; NDMA; *N*-Nitroso-*N*,*N*-dimethylamine; Nitrosodimethylamine; *N*-Nitrosodimetilamina (Spanish)

CAS Registry Number: 62-75-9

HSDB Number: 1667

RTECS Number: IQ0525000

UN/NA & ERG Number: UN2810 (toxic liquid, organic, n.o.s.)/153

EC Number: 200-549-8 [*Annex I Index No.:* 612-077-00-3]

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Animal Sufficient Evidence; Human No Adequate Data, Group 2A, 1987; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies; OSHA/NIOSH: Potential human carcinogen. United States Environmental Protection Agency Gene-Tox Program, Positive: Carcinogenicity-mouse/rat; Positive: D *melanogaster*-reciprocal translocation; Positive: Host-mediated assay; L5178Y cells *In vitro*-TK test; Positive: Mammalian micronucleus; N crassa-forward mutation; Positive: N crassa-reversion; *E. coli polA* with S9; Positive: Histidine reversion-Ames test; Positive: D *melanogaster* sex-linked lethal; Positive: *In vitro* UDS in rat liver; V79 cell culture-gene mutation; Positive: TRP reversion; S *cerevisiae* gene conversion; Positive: S cerevisiae-forward mutation; S *cerevisiae-homozygosis*; Positive: *S pombe*-forward mutation; Positive/dose response: *In vitro* cytogenetics-nonhuman; Positive/dose response: *In vitro* SCE-nonhuman; *In vivo* SCE-nonhuman; Positive/dose response: *In vitro* UDS-human fibroblast; Negative: Cytogenetics-male germ cell; Sperm morphology-mouse; Negative: UDS in mouse germ cells; Inconclusive: SHE-clonal assay; Cell transformation-RLV F344 rat embryo; Inconclusive: Rodent dominant lethal; Mouse spot test; Inconclusive: *E. coli polA* without S9; Positive: CHO gene mutation.

California Proposition 65 Chemical[102]: Cancer 10/1/1987.

Hazard Alert: Poison, Flammable liquid, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard. Listed for Tier 1 screening as an endocrine disruptor[88].

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR 1910.1016)

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Clean Water Act: Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P082

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.40; Nonwastewater (mg/kg), 2.3

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10)

SUPERFUND/EPCRA 302, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%.

Hazardous to aquatic life or environment, with possible long lasting effects[293]. Toxic to aquatic life with long lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, N; risk phrases: R25; R26; R45; R48/25; R50/53; R62; R63; safety phrases: S45; S48/25; S51/53; S53; S41; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: *N*-Nitrosodimethylamine is a yellow oily liquid. Faint, characteristic odor. Molecular weight = 74.08; specific gravity (H_2O:1) = 1.01 @ 20°C; boiling point = 152°C; vapor pressure = 7.5 mmHg @ 37°C; Flash point = 61°C. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 1; reactivity 1. Soluble in water.

Potential Exposure: Nitrosodimethylamine was formerly used in the production of rocket fuels. Presently used as an antioxidant; as an additive for lubricants and as a softener of copolymers. It is used as an intermediate for 1,1-dimethylhydrazine.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong acids, especially peracids strong bases. Sensitive to UV light. Should be stored in dark bottles.

Permissible Exposure Limits in Air

IDLH = Not determined, Potential occupational carcinogen.

OSHA PEL: Cancer suspect agent. Exposure of workers to this chemical is to be controlled through the required use of engineering controls, work practice; and personal protective equipment, including respirators. See 29CFR1910.1003.

NIOSH REL: A potential occupational carcinogen. Limit exposure to lowest feasible concentration

ACGIH TLV[1]: Exposures by all routes should be carefully controlled to levels as low as possible. [skin] confirmed animal carcinogen with unknown relevance to humans.

PAC Ver. 29[138]

PAC-1: 0.082 milligram per cubic meter

PAC-2: 0.9 milligram per cubic meter

PAC-3: 10 milligram per cubic meter

DFG MAK: [skin] Carcinogen Category 2

Austria: carcinogen, 1999; France: carcinogen, 1993; Switzerland: MAK-W 0.001 milligram per cubic meter, carcinogen, 1999; United Kingdom: carcinogen, 2000; the Netherlands: MAC-TGG 0.001 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: confirmed animal carcinogen with unknown relevance to humans.

Determination in Air: Use NIOSH Analytical Method (IV) #2522, Nitrosamines; OSHA Analytical Method 38.

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA: The levels for *N*-nitrosodimethylamine through ingestion of contaminated water and contaminated aquatic organisms which may result in incremental increase of cancer risk over the lifetime are estimated at 1×10^{-5}, 1×10^{-6}, and 1×10^{-7}. The corresponding criteria are 14 ng/L, 1.4 ng/L, and 0.14 ng/L, respectively. For consumption of aquatic organisms only, excluding consumption of water, the levels are 160,000 ng/L, 16,000 ng/L, and 1600 ng/L, respectively. State Drinking Water Guidelines: California 0.01 μg/L; Florida 7.5 μg/L; Massachusetts 0.01 μg/L.

Determination in Water: Methylene chloride extraction followed by gas chromatography with nitrogen-phosphorus or reductive Hall detectors (EPA Method 607); or gas chromatography plus mass spectrometry (EPA Method 625). Octanol-water coefficient: Log K_{ow} = – negative. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin, and respiratory tract. Symptoms of exposure include nausea, vomiting and malaise. Extremely high toxicity. The lowest lethal oral dose in humans has been reported @ 10 mg/kg/80 week intermittent exposure.

Long-Term Exposure: Chronic exposure may cause liver disease with jaundice and swelling with low platelet count; cirrhosis. The effects may be delayed. Based on animal tests, this substance may be a potential carcinogen in humans.

Points of Attack: Liver.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. OSHA mandates the following tests: increased risk: reduced immunologic competence; steroid treatment; pregnancy; cigarette smoking. NIOSH lists the tests: *increased risk*: reduced immunologic competence; steroid treatment; pregnancy; cigarette smoking; liver function tests; pulmonary function tests. Based on human experience and on animal studies, preplacement and periodic examinations should include a history of exposure to other carcinogens, alcohol and smoking habits; medications, and family history. Special attention should be given to liver size and function, and to any changes in lung symptoms or X-rays. Renal function should be followed. Sputum and urine cytology may be useful.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for because the symptoms of jaundice may be delayed. Keep victim quiet and maintain normal body temperature.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full facepiece respirator with an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA). See also Appendix E *NIOSH Pocket Guide*.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in a refrigerator in brown bottles, and protect from oxidizers and prolonged exposure to light. Where possible, automatically pump liquid from drums or other storage containers to process containers Sources of ignition, such as smoking and open flames are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2810 Toxic liquids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. PG I.

Spill Handling:

UN2810 Toxic liquids, organic, n.o.s.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424−9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548−8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft./m) 100/30

Then: Protect persons downwind (mi/km)

Day 0.2/0.3

Night 0.7/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft./m) 1000/300

Then: Protect persons downwind (mi/km)

Day 1.1/1.8

Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in celite, vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Pour over soda ash, neutralize with HCl, then flush to drain with large volumes of water. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(109); (102); (31); (173); (101); (138); (2); (100).

United States Environmental Protection Agency, *Chemical Hazard Information Profile: N*-Nitroso Compounds, Washington, DC (1979).

United States Environmental Protection Agency, *Nitrosamines: Ambient Water Quality Criteria*, Washington, DC (1980).

United States Environmental Protection Agency, *Dimethylnitrosamine, Health and Environmental Effects Profile No. 86*, Washington, DC, Office of Solid Waste (April 30, 1980).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 1, No. 2, 50−51 (1980) and 2, No. 6, 65−69 (1982).

United States Public Health Service, *Toxicological Profile for N-Nitrosodimethylamine*, Atlanta, GA, Agency for Toxic Substances and Disease Registry (December 1988).

United States Environmental Protection Agency, *Chemical Hazard Information Profile: N*-Nitrosodimethylamine, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

N-Nitrosodiphenylamine N:0590

Formula: $C_{12}H_{10}N_2O$; $C_6H_5N(NO)C_6H_5$

Synonyms: Benzenamine, *N*-nitroso-*N*-phenyl-; Curetard A; Delac J; Diphenylamine, *N*-nitrosoamine; Diphenylnitrosamin (German); *N,N*-Diphenylnitrosamine; Diphenylnitrosamine; *N,N*-Diphenyl-*N*-nitrosoamine; NCI-C02880; NDPA; NDPHA; *N*-Nitrosodifenilamina (Spanish); *N*-Nitroso-*N*-diphenylamine; Nitrosodiphenylamine; *N*-Nitroso-*N*-phenylaniline; Nitrous diphenylamide; Redax; Retarder J; TJB; Valcatard; Vulcalent A; Vulcatard A; Vultrol

CAS Registry Number: 86-30-6

HSDB Number: 2875

RTECS Number: JJ9800000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 201-663-0

Regulatory Authority and Advisory Information

Carcinogenicity: NCI: Carcinogenesis Bioassay (feed); clear evidence: rat; no evidence: mouse; IARC: Animal Limited Evidence; Human No Adequate Data, *not classifiable as carcinogenic to humans*, Group 3, 1987; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies.

United States Environmental Protection Agency Gene-Tox Program, Positive: SHE-clonal assay; Cell transformation-RLV F344 rat embryo; Positive/limited: Carcinogenicity-mouse/rat; Negative: Cell transformation-BALB/c-3T3; Host-mediated assay; Negative: *E. coli polA* with S9; Histidine reversion-Ames test; Negative: Sperm morphology-mouse; *In vitro* UDS-human fibroblast; Negative: *In vitro* UDS in rat liver; V79 cell culture-gene mutation; Negative: S *cerevisiae-homozygosis*; Inconclusive: L5178Y cells *In vitro*-TK test; Mammalian micronucleus; Inconclusive: *E. coli polA* without S9; *In vitro* SCE-nonhuman; Inconclusive: D *melanogaster* sex-linked lethal.

California Proposition 65 Chemical[102]: Cancer 4/1/1988.

Hazard Alert: Poison, Combustible Possible risk of forming tumors, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction).

Clean Water Act: Section 313 Water Priority Chemicals (57FR41331, 9/9/1992) RCRA Land Ban Waste

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.92; Nonwastewater (mg/kg), 13

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 100 lb (45.4 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%.

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as nitrosamines

RCRA, 40CFR261, Appendix 8 Hazardous Constituents as nitrosamines

Hazard symbols, risk, & safety statements: Hazard symbol: T, F, Xn; risk phrases: R10; R22; R23/24/25; R39; R51; R62; safety phrases: S7; S16; S22; S36; S45; S53; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: *N*-Nitrosodiphenylamine is a yellow to orange-brown crystalline solid. Molecular weight = 198.24; specific gravity (H_2O:1) = 1.23 @ 20°C; boiling point = 268°C (estimated); freezing/melting point = 67°C. Hazard identification (based on NFPA-704 M Rating System): Health 1; flammability 2; reactivity 0. Slightly soluble in water.

Potential Exposure: *N*-Nitrosodiphenylamine is not a naturally occurring substance; it is a man-made chemical that is no longer produced in the United States. It was used in the manufacture of plastics, resins, rubber and synthetic textiles; to help control processes involved in making rubber products, such as tires and mechanical goods; however, in the early 1980s, the United States manufacturers stopped producing *N*-nitrosodiphenylamine because new and more efficient chemicals were found to replace its uses. In addition, the use of *N*-nitrosodiphenylamine had several undesirable side effects which do not occur with the replacement chemicals.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 5.5 milligram per cubic meter

PAC-2: 60 milligram per cubic meter

PAC-3: 360 milligram per cubic meter

DFG MAK: Carcinogen Category 3 B

There is no established numerical OELs. However, this chemical is a carcinogen and exposure should be reduced to the lowest possible level.

Determination in Air: Use NIOSH Analytical Method (IV) #2522, Nitrosamines; OSHA Analytical Method 23 or 38.

Permissible Concentration in Water:State Drinking Water Guidelines: Kansas 71.0 μg/L, and Minnesota 71.1 μg/L. Russia set a MAC in surface water of 0.1 mg/L.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Information is not available regarding effects of brief exposures to *N*-nitrosodiphenylamine on human health. Very little is known about the health effects of brief exposures to *N*-nitrosodiphenylamine in experimental animals, other than that relatively high doses by ingestion are required to produce death. It is not known if exposure to *N*-nitrosodiphenylamine by breathing or skin contact can affect the health of humans or animals, but, because ingestion of *N*-nitrosodiphenylamine has been shown to have adverse health effects in animals. Exposure of humans to *N*-nitrosodiphenylamine should be minimized.

Long-Term Exposure: Long-term exposure of experimental animals to *N*-nitrosodiphenylamine by ingestion produced inflammation and cancer of the bladder. It is not known whether these effects or birth defects would occur in humans if they were exposed to *N*-nitrosodiphenylamine.

Points of Attack: Cancer site in animals: bladder.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Although the presence of the chemical in blood and urine can be detected by chemical analysis, this analysis has not been used as a test for human exposure or to predict potential health effects.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA-or European Standard EN 149-approved SCBA that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA)

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in a refrigerator under an inert atmosphere for prolonged storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Where possible, automatically transfer from drums or other storage containers to process containers Sources of ignition, such as smoking and open flames are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft.(NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep:[52] remove all sources of ignition and dampen spilled material with 60−70% acetone to avoid airborne dust, then transfer material to a suitable container. Ventilate the spill area and use absorbent paper dampened with 60−70% acetone to pick up remaining material. Wash surfaces well with soap and water. Seal all wastes in vapor-tight plastic bags for eventual disposal. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include oxides of nitrogen and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Burn in admixture with flammable solvent in furnace equipped with afterburner and scrubber[22].

References

(102); (31); (173); (101); (138); (2); (100).

United States Public Health Service, *Toxicological Profile for Nitrosodiphenylamine*, Atlanta, GA, Agency for Toxic Substances & Disease Registry (October 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* N-Nitrosodiphenylamine, Trenton, NJ (February 2000).

p-Nitrosodiphenylamine N:0600

Formula: $C_{12}H_{10}N_2O$

Synonyms: Benzenamine, 4-nitroso-*N*-phenyl-; Diphenylamine, 4-nitroso-; Naugard TKB; NCI-C02244; *p*-Nitrosodifen ilamina (Spanish); 4-Nitrosodiphenylamine; *p*-Nitroso-*N*-phenylaniline; 4-Nitroso-*N*-phenylaniline; *p*-Phenylamino-nitrosobenzene; *N*-Phenyl-*p*-nitrosoaniline; TKB

CAS Registry Number: 156-10-5

HSDB Number: 2876

RTECS Number: JK0175000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171; UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 205-848-7

Regulatory Authority and Advisory Information

Carcinogenicity: NTP: 4-Nitrosodiphenylamine: *delisted* as reasonably anticipated to be a human carcinogen. IARC: Animal Insufficient Evidence; Human No Adequate Data, *not classifiable as carcinogenic to humans*, Group 3, 1982, 1998

California Proposition 65 Chemical[102]: Cancer 1/1/1988.

Hazard Alert: Poison, Possible risk of forming tumors, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction).

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as nitrosamines

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xn; risk phrases: R45; R22; R36/37/38; R50/53; R62; safety phrases: S16; S26; S36/37; S41; S45; R53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: TKB is a black powder or a green plate-like material with a bluish luster. Molecular weight = 198.2; freezing/melting point = 145°C. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 0; reactivity 0. Slightly soluble in water.

Potential Exposure: Used as a chemical intermediate for dyes and pharmaceuticals; in making monomers; and vulcanizing rubber.

Incompatibilities: Nitrated organics range from slight to strong oxidizing agents. If mixed with reducing agents, including hydrides, sulfides and nitrides, they may begin a vigorous reaction. Reaction with aliphatic amines can release carcinogenic nitrosamines. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. 4-nitrosodiphenylamine neutralizes acids in exothermic reactions to form salts plus water. May be incompatible with isocyanates, halogenated organics, peroxides, phenols (acidic), epoxides, anhydrides, and acid halides. May generate hydrogen, a flammable gas, in combination with strong reducing agents such as hydrideds and active metals. May react with strong oxidizing agents[101].

Permissible Exposure Limits in Air

This chemical is a potential occupational carcinogen and all exposure should be reduced to the lowest possible level.

PAC Ver. 29[138]

PAC-1: 0.58 milligram per cubic meter

PAC-2: 6.4 milligram per cubic meter

PAC-3: 39 milligram per cubic meter

Determination in Air: Use NIOSH IV; Method #2522; OSHA Analytical Method 38.

Permissible Concentration in Water: Russia set a MAC in surface water of 0.1 mg/L. Two states have set guidelines for nitrosodiphenylamine in drinking water[60]. They are Kansas @ 71.0 μg/L, and Minnesota @ 71.1 μg/L.

Routes of Entry: Inhalation, ingestion; skin and/or eyes. Absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Contact can cause eye irritation.

Long-Term Exposure: There is limited evidence that this chemical causes bladder cancer in animals.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA-or European Standard EN 149-approved SCBA that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Where possible, automatically transfer material from drums or other storage containers to process containers Sources of ignition, such as smoking and open flames are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard Class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft.(NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(102); (31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: p*-Nitrosodiphenylamine, Trenton, NJ (January 2000).

DHHS/National Toxicology Program; *Eleventh Report on Carcinogens*: *4-Nitrosodiphenylamine (156-10-5)* (January 2005).

N-Nitrosodipropylamine N:0610

Formula: $C_6H_{14}N_2O$; $C_3H_7N(NO)C_3H_7$

Synonyms: Dipropylamine, *N*-nitroso-; Di-*N*-propylnitrosamine; Dipropylnitrosamine; DPN; DPNA; NDPA; *N*-Nitroso-*N*-dipropylamine; *N*-Nitrosodipropylamine; Nitrosodipropylamine; *N*-Nitroso-*N*-propylpropanamine; 1-Propanamine, *N*-nitroso-*N*-propyl-

CAS Registry Number: 621-64-7

HSDB Number: 5108

RTECS Number: JL9700000

UN/NA & ERG Number: UN3082 (environmentally hazardous substances, liquid, n.o.s.)/171

EC Number: 210-698-0 [*Annex I Index No.:* 612-098-00-8]

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Animal Sufficient Evidence; Human Insufficient Evidence, *possibly carcinogenic to humans*, Group 2B; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies; NCI: Carcinogenesis Bioassay (feed); clear evidence: rat; no evidence: mouse. United States Environmental Protection Agency Gene-Tox Program, Positive: SHE-clonal assay; Cell transformation-RLV F344 rat embryo; Positive/limited: Carcinogenicity-mouse/rat; Negative: Cell transformation-BALB/c-3T3; Host-mediated assay; Negative: *E. coli polA* with S9; Histidine reversion-Ames test; Negative: Sperm morphology-mouse; *In vitro* UDS-human fibroblast; Negative: *In vitro* UDS in rat liver; V79 cell culture-gene mutation; Negative: S *cerevisiae-homozygosis*; Inconclusive: L5178Y cells *In vitro*-TK test; Mammalian micronucleus; Inconclusive: *E. coli polA* without S9; *In vitro* SCE-nonhuman; Inconclusive: D *melanogaster* sex-linked lethal.

California Proposition 65 Chemical[102]: Cancer 1/1/1988.

Hazard Alert: Possible risk of forming tumors, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction).

Clean Water Act: Section 313 Water Priority Chemicals (57FR41331, 9/9/1992).

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U111

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.40; Nonwastewater (mg/kg), 14

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%.

As nitrosamines:

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as nitrosamines

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R45; R22; R50/53; R62; safety phrases: S53; S41; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: *N*-nitrosodi-*N*-propylamine is a yellow liquid. Molecular weight = 130.22; boiling point = 206°C; freezing/melting point = 144°C. Explosive limits: LEL = 22,000 ppm; UEL: unknown. Slightly soluble in water.

Potential Exposure: *N*-nitrosodi-*N*-propylamine is used in the manufacture of plastics, resins, rubber, and synthetic textiles. There is no evidence that *N*-nitrosodi-*N*-propylamine exists naturally in soil, air, food, or water. Small quantities of *N*-nitrosodi-*N*-propylamine are inadvertently produced during some manufacturing processes; as an impurity in some commercially available dinitroaniline based weed killers, and during the manufacture of some rubber products. However, according to Sax, some similar *N*-nitroso compounds are formed in the environment and absorbed from precursors in food, water, or air; from tobacco; and from naturally occurring compounds.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Sensitive to UV light.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 5.6 milligram per cubic meter

PAC-2: 62 milligram per cubic meter

PAC-3: 95 milligram per cubic meter

DFG MAK: [skin] Carcinogen Category 2

There is no established numerical OELs. However, this chemical is a carcinogen and exposure should be reduced to the lowest possible level.

Determination in Air: Use NIOSH Analytical Method (IV) #2522, Nitrosamines; OSHA Analytical Method 38.

Routes of Entry: *N*-nitrosodi-*N*-propylamine can enter the body by breathing air that contains *N*-nitrosodi-*N*-propylamine or by eating food or drinking water contaminated with *N*-nitrosodi-*N*-propylamine. *N*-Nitrosodi-*N*-propylamine is not likely to get into your body unless you eat certain foods or drink alcoholic beverages, or are exposed to it at a waste disposal site by breathing *N*-nitrosodi-*N*-propylamine vapors. It is not known whether *N*-nitrosodi-*N*-propylamine can enter the body by direct skin contact with wastes, pesticides, or soil containing *N*-nitrosodi-*N*-propylamine. Experiments with animals suggest that if *N*-nitrosodi-*N*-propylamine enters the body, it will be broken down into other compounds and will leave the body in the urine.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes and skin. The effects of brief or long-term exposures to *N*-nitrosodi-*N*-propylamine on human health have not been studied in depth. Little is known about the health effects of brief exposures to *N*-nitrosodi-*N*-propylamine in experimental animals except that eating or drinking certain amounts of this chemical can cause liver disease and death.

Long-Term Exposure: Long-term exposure of experimental animals to *N*-nitrosodi-*N*-propylamine in food or drinking water produces cancer of the liver, esophagus, and nasal cavities. Although human studies are not available, the animal evidence indicates that it is reasonable to expect that exposure to *N*-nitrosodi-*N*-propylamine by eating or drinking could cause liver disease and cancer in humans. It is not known whether other effects, such as birth defects, occur in animals or could occur in humans if they were exposed to *N*-nitrosodi-*N*-propylamine by eating or drinking.

Points of Attack: Liver.

Medical Surveillance: The presence of *N*-nitrosodi-*N*-propylamine in blood and urine can be detected by chemical analysis, but this analysis is not routinely available and has not been used as a test for human exposure or to predict potential health effects. Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Green: General storage may be used. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Sources of ignition, such as smoking and open flames are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN3082 Environmentally hazardous substances, liquid, n.o.s., Hazard Class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: *N*-Nitrosodi-*N*-propylamine may be destroyed by high temperature incineration in an incinerator equipped with an nitrogen oxide scrubber. Chemical treatment methods may also be used to destroy *N*-nitrosodi-*N*-propylamine. These methods involve (a) denitrosation by reaction with 3% hydrobromic acid in glacial acetic acid; (b) oxidation by reaction with potassium permanganate-sulfuric acid; or (c) extraction of the nitrosamine from the waste using dichloromethane and subsequent reaction with triethyloxonium tetrafluoroborate (TOEF). Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(109); (102); (31); (173); (101); (138); (2); (100).

United States Environmental Protection Agency, *Chemical Hazard Information Profile:* *N*-Nitroso Compounds, Washington, DC (1979).

United States Environmental Protection Agency, *Nitrosamines: Ambient Water Quality Criteria*, Washington, DC (1980).

United States Environmental Protection Agency, *Dimethylnitrosamine, Health and Environmental Effects Profile No. 86*, Washington, DC, Office of Solid Waste (April 30, 1980).

United States Public Health Service, *Toxicological Profile for N-nitroso-di-N-Propylamine*, Atlanta, GA, Agency for Toxic Substances & Disease Registry (December 1988).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* *N*-Nitrosodi-*N*-phenylamine, Trenton, NJ (December 2006).

N-Nitroso-*N*-ethyl urea N:0620

Formula: $C_3H_7N_3O_2$

Synonyms: AENH (German); Aethylnitroso-harnstoff (German); ENU; *N*-Ethyl-*N*-nitrosocarbamide; *N*-Ethyl-*N*-nitrosourea; 1-Ethyl-1-nitrosourea; Ethyl-1-nitrosourea; Ethylnitrosourea; NEU; Nitrosoethylurea; NSC 45403; Urea, *N*-ethyl-*N*-nitroso-; Urea, 1-ethyl-1-nitroso-

CAS Registry Number: 759-73-9

HSDB Number: 5111

RTECS Number: YT3150000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154; UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 212-072-2

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Animal Sufficient Evidence; Human Limited Evidence, Group 2A, 1998

California Proposition 65 Chemical[102]: Cancer 1/1/87.

Hazard Alert: Poison, Water reactive, Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as nitrosamines

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U176

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 1 lb (0.454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xn; risk phrases: R45; R15; R20/21/22; R27/28; R46; R50/53; R61; R62; R63; safety phrases: S13; S22; S36/37/39; S41; S45; S53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: *N*-Nitroso-*N*-ethyl urea is a pale yellow, crystalline powder; freezing/melting point = 103−104°C (decomposes). Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 1; reactivity 0₩. Soluble in water; hydrolysis produces explosive gas.

Potential Exposure: Used as a chemical intermediate for dyes and pharmaceuticals; a polymerization inhibitor during the manufacture of vinyl monomers such as styrene; a precursor of diazoethane; accelerator for rubber vulcanization. Used

Incompatibilities: *N*-nitroso-*N*-ethylurea is highly reactive. Sensitive to moisture and light. Its stability in aqueous solutions is pH-dependent. Incompatible with water and nucleophilic reagents. Alkaline hydrolysis produces a highly explosive gas[NTP, 1992]. This compound is extremely unstable at high pH. It will decompose to extremely unstable decomposition products if acidic conditions are not maintained[101]. Nitrated organics range from slight to strong oxidizing agents. If mixed with reducing agents, including hydrides, sulfides and nitrides, they may begin a vigorous reaction. Reaction with aliphatic amines can release carcinogenic nitrosamines.

Determination in Air:

No OELs have been established. However this chemical is a carcinogen and exposure should be reduced to the lowest possible level.

DFG MAK: [skin]

Determination in Water: Octanol-water coefficient: Log $K_{ow} = <1.5$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Contact can cause irritation of the eyes and skin. Inhalation can cause respiratory tract irritation. Higher exposure can cause headache, drowsiness, fatigue, weakness, and loss of appetite.

Long-Term Exposure: A potential occupational carcinogen. This chemical has been shown to be a teratogen in animals. High or repeated exposure may cause liver damage. Animal studies involving high or repeated exposures have found effects on the liver, lungs, kidneys and heart.

Points of Attack: Liver. Depending on exposure history, possibly the lungs, heart, and kidneys.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Liver function tests. Possibly tests on lungs, heart, and kidneys.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. A Class I, Type B, biological safety hood should be used for handling and mixing in a laboratory environment. Specific engineering controls are required for drug manufacture by the Food and Drug Administration. See 21CFR210.

Respirator Selection: Specific respirator(s) have not been recommended by NIOSH. However, based on potential carcinogenicity the following might be considered: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full facepiece respirator with an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Where possible, automatically transfer this material from storage containers to process containers Sources of ignition, such as smoking and open flames are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard Class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen and carbon; products may be explosive[101]. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(109); (102); (31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: N*-Nitroso-*N*-ethylurea, Trenton, NJ (April 2002).

N-Nitrosomethylvinylamine N:0630

Formula: $C_3H_6N_2O$

Synonyms: Ethenamine, *N*-methyl-*N*-nitroso-; Ethylene, *N*-methyl-*N*-nitroso-; *N*-Methyl-*N*-nitrosovinylamine; Methylvinylnitrosamine; Methylvinylnitrosamine (German); MVNA; *N*-nitroso-*N*-methylvinyl amine; NMVA; Vinylamine, *N*-methyl-*N*-nitroso-

CAS Registry Number: 4549-40-0

HSDB Number: 5110

RTECS Number: YZ0875000

UN/NA & ERG Number: UN3082 (environmentally hazardous substances, liquid, n.o.s.)/171

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Animal Sufficient Evidence; Human Limited Evidence, *possibly carcinogenic to humans*, Group 2B, 1987

California Proposition 65 Chemical[102]: Cancer 1/1/1988

Hazard Alert: Combustible, Water reactive, Possible risk of forming tumors, Suspected of causing genetic defects,

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as nitrosamines

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P084

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 10 lb (4.54 kg).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazard symbols, risk, & safety statements: Hazard symbol: T; risk phrases: R45; R20/21/22; R27/28; R46; R50/53; R62; safety phrases: S13; S22; S36/37/39; S41; S45; S53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: *N*-Nitrosomethylvinylamine is a yellow liquid. Molecular weight = 86.11. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 1; reactivity 0. Decomposes in water.

Potential Exposure: This chemical is not manufactured but occurs as a chemical reaction byproduct found in the dye, automotive, rubber, and leather industries.

Incompatibilities: Light sensitive. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. A nitrated amine. Amines are combustible. Azo, diazo, azido compounds can detonate. This applies in particular to organic azides that have been sensitized by the addition of metal salts or strong acids. Toxic gases are formed by mixing materials of this class with acids, aldehydes, amides, carbamates, cyanides, inorganic fluorides, halogenated organics, isocyanates, ketones, metals, nitrides, peroxides, phenols, epoxides, acyl halides, and strong oxidizing or reducing agents. Flammable gases are formed by mixing materials in this group with alkali metals. Explosive combination can occur with strong oxidizing agents, metal salts, peroxides, and sulfides[101].

Permissible Exposure Limits in Air

PAC not available. There is no established numerical OELs. However, this chemical is a carcinogen and exposure should be reduced to the lowest possible level.

DFG MAK: [skin]

Determination in Air: NIOSH Analytical Method (IV) #2522, Nitrosamines; OSHA Analytical Method 38.

Routes of Entry: Inhalation, eye and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes and skins. Some related nitrosamines can cause headaches, abdominal cramps; weakness and dizziness. It is unknown if this chemical causes all of these same symptoms.

Long-Term Exposure: A potential occupational carcinogen. Has been shown to be a teratogen in animals. May cause liver and kidney damage.

Points of Attack: Liver and kidneys.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Based on potential carcinogenicity the following is recommended by NIOSH: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA-or European Standard EN 149-approved SCBA that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. However, storage is not likely. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, light. Sources of ignition, such as smoking and open flames are prohibited where this chemical is handled, used, or stored. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN3082 Environmentally hazardous substances, liquid, n.o.s., Hazard Class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(109); (102); (31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: N*-Nitrosomethylvinylamine, Trenton, NJ (March 2006).

***N*-Nitrosopiperidine N:0640**

Formula: $C_5H_{10}N_2O$

Synonyms: Hexahydro-*N*-nitrosopyridine; Nitrosopiperidin (German); 1-Nitrosopiperidine; N.N-PIP; No-PIP; NPIP; Piperidine, 1-nitroso

CAS Registry Number: 100-75-4

HSDB Number: 5115

RTECS Number: TN2100000

UN/NA & ERG Number: UN2810 (toxic liquid, organic, n.o.s.)/153; UN3082 (environmentally hazardous substances, liquid, n.o.s.)/171

EC Number: 202-886-6

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Animal Sufficient Evidence; Human Limited Evidence, *possibly carcinogenic to humans*, Group 2B, 1987.

California Proposition 65 Chemical[102]: Cancer 1/1/1988.

Hazard Alert: Poison, Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard,

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U179

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.013; Nonwastewater (mg/kg), 35

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%.

Hazard symbols, risk, & safety statements: Hazard symbol: T; risk phrases: R45; R20/22; R23/24/25; R36/37/38; R39/23/24/25; R50/53; R62; R63; safety phrases: S7; S16; S26; S36/37/39; S41; S45; S53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: *N*-Nitrosopiperidine is a clear, yellow, oily liquid. Molecular weight = 114.17; boiling point = 217°C; Flash point = 93°C. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 1; reactivity 0. Soluble in water.

Potential Exposure: *N*-Nitrosopiperidine is found in some foods and tobacco smoke. Used as a research chemical.

Incompatibilities: Nitrated organics range from slight to strong oxidizing agents. If mixed with reducing agents, including hydrides, sulfides and nitrides, they may begin a vigorous reaction. Reaction with aliphatic amines can release carcinogenic nitrosamines. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Light and UV may cause decomposition.

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

DFG MAK: [skin] Carcinogen Category 2

There is no established numerical OELs. However, this chemical is a carcinogen and exposure should be reduced to the lowest possible level.

Determination in Air: Use NIOSH IV; Method #2522; OSHA Analytical Method 38.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Can irritate and may cause permanent damage to the eyes; inflammation in the pigmented area and damage to the cornea with clouded patches of vision.

Long-Term Exposure: A potential carcinogen. Prolonged exposure may cause liver damage.

Points of Attack: Eyes, liver.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Examination of the eyes. Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Based on potential carcinogenicity, and where the potential exists for exposure, the following might be considered: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full facepiece respirator with an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers Sources of ignition, such as smoking and open flames are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2810 Toxic liquids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN3082 Environmentally hazardous substances, liquid, n.o.s., Hazard Class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Under 40 CFR 261.5 small quantity generators of this waste may qualify for partial exclusion from hazardous waste regulations.

References

(109); (102); (31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: N*-Nitrosopiperidine, Trenton, NJ (March 2006).

N-Nitrosopyrrolidine N:0650

Formula: $C_4H_8N_2O$

Synonyms: *N*-Nitrosopyrrolidin (German); 1-Nitrosopyrrolidine; N-N-PYR; No-PYR; NPYR; Tetrahydro-*N*-nitrosop yrrole

CAS Registry Number: 930-55-2

HSDB Number: 5116

RTECS Number: UY1575000

UN/NA & ERG Number: UN3082 (environmentally hazardous substances, liquid, n.o.s.)/171; UN2810 (toxic liquid, organic, n.o.s.)/153

EC Number: 213-218-8

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Animal Sufficient Evidence; Human Limited Evidence, *possibly carcinogenic to humans*, Group 2B, 1987; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies.

California Proposition 65 Chemical[102]: Cancer 10/1/1987.

Hazard Alert: Poison, Flammable,

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U180

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.013; Nonwastewater (mg/kg), 35

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 1 lb (0.454 kg)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, F, Xn; risk phrases: R45; R10; R20/21/22; R27/28; R40; R46; R50/53; R61; safety phrases: S13; S22; S36/37/39; S41; S45; S53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: *N*-Nitrosopyrrolidine is a yellow liquid. Molecular weight = 100.14; boiling point = 105°C @ 20 mm; Flash point = 83°C. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 2; reactivity 0. Soluble in water.

Potential Exposure: *N*-Nitrosopyrrolidine is a cyclic nitrosamine and a research chemical. Not commercially produced in the U.S.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

PAC not available. There is no established numerical OELs. However, this chemical is a carcinogen and exposure should be reduced to the lowest possible level.

DFG MAK: [skin] Carcinogen Category 2

Determination in Air: Use NIOSH IV; Method #2522; OSHA Analytical Method 38.

Determination in Water: Octanol-water coefficient: Log $K_{ow} = <1$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Contact can irritate the skin and eyes. Harmful if swallowed.

Long-Term Exposure: A potential occupational carcinogen. May cause damage to the liver and kidneys. Implicated in human colon cancer

Points of Attack: Liver, kidneys, colon.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical

facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Specific respirator(s) have not been recommended by NIOSH. However, based on potential carcinogenicity, and where the potential exists for exposure, the following might be considered:

At any detectable concentration: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full facepiece respirator with an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers Sources of ignition, such as smoking and open flames are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2810 Toxic liquids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN3082 Environmentally hazardous substances, liquid, n.o.s., Hazard Class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; alcohol foam; or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Under 40 CFR 261.5 small quantity generators of this waste may qualify for partial exclusion from hazardous waste regulations. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(109); (102); (31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: N*-Nitrosopyrrolidine, Trenton, NJ (July 1999).

Nitrosyl Chloride N:0655

Formula: ClNO; NOCl

Synonyms: Chlorine nitride oxide; Cloruro de nitrosilo (Spanish); Nitrogen chloride oxide; Nitrogen oxide chloride; Nitrogen oxychloride; Nitrosochloride; Nitrosonium chloride

CAS Registry Number: 2696-92-6

HSDB Number: 849

RTECS Number: OZ7783000

UN/NA & ERG Number: UN1069/125

EC Number: 220-273-1

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Theft hazard*: Minimum concentration = 17%; *Theft hazard* 15 pounds. Weapon of mass effect (WME).

Hazard Alert: Poison inhalation hazard (gas), Corrosive, Strong oxidizer, Water reactive, Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated.

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

DOT Appendix B, §172.101—marine pollutant. Harmful to aquatic life in very low concentrations. May be dangerous if it enters nearby water intakes; notify operators. Notify local health and wildlife officials.

United States National Primary Drinking Water Regulations: SMCL = 250 mg$[Cl^-]$/L as Chloride

Hazard symbols, risk, & safety statements: Hazard symbol: T+, C, N; risk phrases: R5; R14; R21/22/23; R26/27/28; R31; R34; R35; R46; safety phrases: S1; S9; S30; S33; S36/37/39; S38; S41; S45; S53; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)]

Description: Yellow to reddish liquid or yellow/red gas. Choking odor. Liquefies at −5.5°C. Molecular weight = 65.46[136]; specific gravity (water = 1): 1.1571 @ 20°C; 1.36 @ −5.7°C[136]; 1.350 @ 30°C[138]; boiling point @ 1 atm = − 5.8°C[136]; −6.4°C[138]; freezing/melting point = −58.9°C[136]; Critical temperature: (estimate) 899.2 °F/481.8°C/754.9 °K; Critical pressure: (estimate) 611.8 psia = 41.6 atm = 4.22 MN/m^2; Liquid surface tension: 39.07 dynes/cm = 0.03907 N/m @ 40°C; Liquid water interfacial tension: 34.9 dynes/cm = 0.0349 N/m @ 40°C. Relative vapor density (air = 1) = 4.73; Ratio of specific heats of vapor (gas): (GAS): (estimate) $>$ 1; Latent heat of vaporization: (estimate) at boiling point-155.3 Btu/lb = 86.3 cal/g = 3.61×10^5 J/kg; Heat of combustion: (estimate) −11232 Btu/lb = −6240 cal/g = -261.1×10^5 J/kg; vapor pressure: 0.12 mmHg; Flash point: 106°C (cc). Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 0; reactivity 1. Special Notice (White): OXY; ₩ Liquid sinks and mixes with water; reacts, forming a poisonous visible vapro cloud of hydrochloric acid and toxic red oxides of nitrogen.

Potential Exposure: A nitrocompound used as a reagent, catalyst, bleaching agent, and intermediate for making other chemicals.

Incompatibilities: Dissolves into and reacts with moisture in the air or with water forming hydrochloric acid and toxic red oxides of nitrogen. Nitrosyl chloride is a strong oxidizer. Violent reaction with strong acids, alkalis (e.g., sodium hydroxide), ammonia, amines, reducing agents, other strong oxidizers. Elevated temperature may cause explosive decomposition. Dissociates into nitric oxide and chlorine on heating. Corrosive to most metals. Attacks some plastics, rubber, and coatings.

Permissible Exposure Limits in Air:

PAC Ver. 29[138]

PAC-1: 0.014 ppm

PAC-2:0.15 ppm

PAC-0.9 ppm

Routes of Entry: Inhalation, dermal contact

Harmful Effects and Symptoms

Short-Term Exposure: Gas is highly poisonous and intensely irritating and corrosive. Breathing the vapor can kill you. Skin or eye contact causes severe burns, impaired vision, and possible blindness. Inhalation causes severe irritation of respiratory tract and damage to mucous membranes. Labored breathing, sore throat. Delayed effects, which include severe pulmonary edema and possible hemorrhage, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. DOE description: Eye irritant, severe; Respiratory toxin, acute effects other than severe or moderate irritation; Respiratory irritant, acute, severe, or moderate but not mild irritant effects; Skin irritant, severe.

Long-Term Exposure: repeated or prolonged contact may cause skin, eye, or respiratory problems.

Points of Attack: Lungs, skin, eyes.

Medical Surveillance: Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following If symptoms develop or overexposure is suspected, chest X-ray must be considered.

First Aid: First Aid: Move victim to fresh air. Call 911 or emergency medical service. *Inhalation*: remove victim to fresh air; call a doctor; enforce complete rest until doctor arrives; observe at least 24 hours for delayed effects. *Skin or eyes*: flush with water for at least 15 minutes. Immediately call a physician and be prepared to transport the victim to a hospital even if no symptoms (such as wheezing, coughing, shortness of breath, or burning in the mouth, throat, or chest) develop. Give artificial respiration if victim is not breathing. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with liquefied gas, thaw frosted parts with lukewarm water. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. Keep victim warm and quiet. Keep victim under observation. Effects of contact or inhalation may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves.

Personal Protective Methods: Fully encapsulating, vapor protective clothing should be worn for spills and leaks with no fire. SCBA (approved mask may be used for short exposures only); rubberized clothing; gloves; shoes; chemical goggles.

Respirator Selection: *20 ppm:* SA* (any supplied-air respirator). *50 ppm:* SA:CF* (any supplied-air respirator operated in a continuous-flow mode). *100 ppm:* SAT:CF* (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or SCBAF (any SCBA with a full facepiece); or SAF (any supplied-air respirator with a full facepiece). *200 ppm:* SAF: PD,PP (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *EMERGENCY OR PLANNED ENTRY INTO UNKNOWN CONCENTRATIONS OR IDLH CONDITIONS:* SCBAF: PD,PP (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SAF: PD,PP:ASCBA (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *ESCAPE:* GMFOVHiE [any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having a high-efficiency particulate filter]; or SCBAE (any appropriate escape-type, SCBA). **Note*: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Check oxygen content prior to entering storage area. Poison gas. (1) Color code—Blue: Health Hazard/ Poison: Store in a secure poison location. This gas is highly toxic. Even slight exposure to these gasses can cause death. Store outdoors in a secure, restricted area that containing warning signs. This area must be roofed and shaded with the cylinders stored off the ground and separated from all other products assigned to other hazard categories and radiant heat sources on nonwooden floors. If indoors, store in a well-ventilated areas in temperatures not to exceed 50°C. (2) Color code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Oxidizers should be isolated from acids, metals, organic materials, and ammonium nitrate. Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location; keep acids away from bases and red, yellow, and blue-coded chemicals. Prior to working with nitrogen oxides all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizable materials. Outside or detached storage is preferred. Do not put on wooden floors. Store in a cool, well-ventilated area away from incompatible materials listed above. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage.

Shipping: UN1069 Nitrosyl chloride, Hazard Class: 2.3; Labels 2.3-Poisonous gas, 8-Corrosive material; Inhalation Hazard Zone C

Spill Handling:

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424−9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548−8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft./m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 0.7/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft./m) 2000/600
Then: Protect persons downwind (mi/km)
Day 2.3/3.7
Night 5.9/9.5

Fully encapsulating, vapor protective clothing should be worn for spills and leaks with no fire. Do not touch or walk through spilled material. Stop leak if you can do it without risk. If possible, turn leaking containers so that gas escapes rather than liquid. Prevent entry into waterways, sewers, basements or confined areas. Do not direct water at spill or source of leak. Notify local health and wildlife officials. Use water spray to reduce vapors or divert vapor cloud drift. Avoid allowing water runoff to contact spilled material. Isolate area until gas has dispersed. Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources and dampen spilled material with toluene to avoid airborne dust. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Harmful to aquatic life in very low concentrations. May be dangerous if it enters nearby water intakes; notify operators.

Fire Extinguishing: Thermal decomposition products may include toxic nitric oxide and chlorine; hydrogen chloride and nitrogen oxides. Strong oxidizer which may react spontaneously with low flash point organics or reducing agents. Heat forms oxygen that will increase the activity of an existing fire. May cause fire or explosion on contact with combustibles (wood, paper, oil, clothing, etc.). Containers may BLEVE when exposed to fire. Do not put yourself in danger by entering a contaminated area to rescue a victim. Wearing proper equipment, shut off flow of gas. Use water spray to keep containers cool and to also direct escaping gas away from personnel attempting to shut off leak. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Use a licensed professional waste disposal service to dispose of this material. Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(9); (31); (173); (101); (138). (100).

Nitrotoluenes N:0660

Formula: $C_7H_7NO_2$: $CH_3C_6H_4NO_2$

Synonyms: *m-isomer:* Benzene, 1-methyl-3-nitro-; *m*-Nitrotoluene; *m*-Methylnitrobenzene; 3-Methylnitrobenzene; MNT; 3-Nitrotoluene; Nitrotoluene, 3-; *m*-Nitrotolueno (Spanish); 3-Nitrotoluol

mixed isomers: Mixo-nitrotoluene

ortho-isomer: Benzene, 1-methyl-2-nitro-; *o*-Methylnitrobenzene; 2-Methylnitrobenzene; 2-Nitrotoluene; Nitrotoluene, 2-; *o*-Nitrotolueno (Spanish); *o*-Nitrotoluol; ONT; Orthonitrotoluene

para-isomer: Benzene, 1-methyl-4-nitro-; *p*-Methylnitrobe nzene; 4-Methylnitrobenzene; NCI-C60537; 4-Nitrotoluene; Nitrotoluene, 4-; *p*-Nitrotolueno (Spanish); *p*-Nitrotoluol; 4-Nitrotoluol; *p*-Nitrotoluene; PNT

CAS Registry Number: 99-08-1 (*m*-isomer); 88-72-2 (*o*-isomer); *(alt.)* 57158-05-1; 99-99-0 (*p*-isomer); 1321-12-6 (mixed isomers)

HSDB Number: 2937 (*m*-isomer)*;* 2189 (*o*-isomer);1158 (*p*-isomer)

RTECS Number: XT3150000 (*o*-isomer); XT2975000 (*m*-isomer); XT3325000 (*p*-isomer)

UN/NA & ERG Number: UN1664/152

EC Number: 201-853-3 [*Annex I Index No.*: 609-065-00-5]

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen(*o*-isomer)

California Proposition 65 Chemical[102]: Cancer 5/15/1998

(*m*-isomer) IARC: Animal Inadequate Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1996; NTP; NCI: Carcinogenesis Studies (feed); clear evidence: mouse, rat; NTP: Carcinogenesis studies; on test (2-year studies), October 2000; (*p*-isomer) IARC: Animal Inadequate Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1996; NCI: Carcinogenesis Studies (feed); equivocal evidence: rat; test completed (peer review), October 2000.

Hazard Alert: Poison, (*all* isomer) Poison, Combustible, Endocrine disruptors (low), Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Environmental hazard

all isomers:

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 1000 lb (454 kg)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. all isomers.

Hazardous to aquatic life or environment, with possible long lasting effects[293]. Toxic to aquatic life with long lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R45; R46; R22; R62; R50/53; R61; R62; R63; safety phrases: S29/35; S51/53 S41; S45; S53; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water. (all isomers)

Description: Nitrotoluene is formed in 3 isomeric forms. The *o*-and *m*-forms are yellow liquids or solids. The *p*-form is a pale yellow crystalline solid. All have weak aromatic odors. The Odor Thresholds are: 0.05 mg/L (*o*-isomer); 1.74 ppm (*m*-isomer). Molecular weight = 137.15 (all isomers); specific gravity (H_2O:1) = 1.16 @ 15°C (*m-& o*-isomers); 1.14 @ 75°C (*p*-isomer) noiling point = 222°C (*o*-isomer); 232°C (*m*-isomer); 238° (*p*-isomer); freezing/melting point = −10°C (*o*-isomer); 16°C (*m*-isomer); 52°C (*p*-isomer); vapor pressure = 1 mmHg @50°C (*o*-isomer); 0.27 mmHg @ 25°C (*m*-isomer); 0.164 mmHg @ 25°C (*p*-isomer); Flash point = 101-106°C (all isomers). Explosive limits: LEL = 2.2; UEL-unknown. Hazard identification (based on NFPA-704 M Rating System): (*all*-isomers) Health 3; flammability 1; reactivity 1. Insoluble in water.

Potential Exposure: The nitrotoluenes are used in the production of toluidines and other dye intermediates. All isomers are used in manufacture of agriculture and rubber chemicals and in various dyes.

Incompatibilities: Decomposes on contact with strong oxidizers; strong acids; reducing agents; strong bases; ammonia, amines producing toxic fumes, causing fire and explosion hazard. Heat above 190°C may cause explosive decomposition. Attacks some plastics, rubbers, and coatings.

Permissible Exposure Limits in Air

NIOSH IDLH = 200 ppm

Conversion factor: 1 ppm = 5.61 milligram per cubic meter (all isomers)@ 25°C & 1 atm.

99-08-1, m-isomer

OSHA PEL: 5 ppm/30 milligram per cubic meter TWA [skin]

NIOSH REL: 2 ppm/11 milligram per cubic meter TWA [skin]

ACGIH TLV[1]: 2 ppm/11 milligram per cubic meter TWA [skin]; BEIM issued for Methemoglobin inducers

PAC Ver. 29[138]

PAC-1: 6 ppm

PAC-2: 14 ppm

PAC-3: 200 ppm

DFG MAK: [skin] Carcinogen Category 3B

Australia: TWA 2 ppm (11 milligram per cubic meter) [skin], 1993; Austria: MAK 2 ppm (11 milligram per cubic meter) [skin], 1999; Belgium: TWA 2 ppm (11 milligram per cubic meter) [skin], 1993; Denmark: TWA 2 ppm (12 milligram per cubic meter), 1999; France: VME 2 ppm (11 milligram per cubic meter) [skin], 1999; Norway: TWA 1 ppm (5.5 milligram per cubic meter), 1999; Poland: MAC (TWA) 3 milligram per cubic meter; MAC (STEL) 9 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 6 milligram per cubic meter, [skin], 2003; Switzerland: MAK-W 2 ppm (11 milligram per cubic meter), KZG-W 4 ppm (22 milligram per cubic meter) [skin], 1999; United Kingdom: TWA 5 ppm (29 milligram per cubic meter); STEL 10 ppm, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 2 ppm [skin]

88-72-2, o-isomer

NIOSH IDLH = 200 ppm

OSHA PEL: 5 ppm/30 milligram per cubic meter TWA [skin]

NIOSH REL: 2 ppm/11 milligram per cubic meter TWA [skin]

ACGIH TLV[1]: 2 ppm/11 milligram per cubic meter TWA [skin]; BEIM issued for Methemoglobin inducers

DFG MAK: [skin] Carcinogen Category 3B

PAC Ver. 29[138]

PAC-1: 6 ppm

PAC-2: 33 ppm

PAC-3: 200 ppm

Australia: TWA 2 ppm (11 milligram per cubic meter) [skin], 1993; Austria: MAK 2 ppm (11 milligram per cubic meter) [skin], 1999; Belgium: TWA 2 ppm (11 milligram per cubic meter) [skin], 1993; Denmark: TWA 2 ppm (12 milligram per cubic meter), 1999; Norway: TWA 1 ppm (5.5 milligram per cubic meter), 1999; Sweden: NGV 1 ppm (6 milligram per cubic meter), KTV 2 ppm (11 milligram per cubic meter) [skin], 1999; Switzerland: [skin], carcinogen, 1999; United Kingdom: TWA 5 ppm (29 milligram per cubic meter); STEL 10 ppm, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 2 ppm [skin]

99-99-0, p-isomer

NIOSH IDLH = 200 ppm

OSHA PEL: 5 ppm/30 milligram per cubic meter TWA [skin]

NIOSH REL: 2 ppm/11 milligram per cubic meter TWA [skin]

ACGIH TLV[1]: 2 ppm/11 milligram per cubic meter TWA [skin]; BEIM issued for Methemoglobin inducers

DFG MAK: [skin] Carcinogen Category 3B

PAC Ver. 29[138]

PAC-1: 6 ppm

PAC-2: 33 ppm

PAC-3: 200 ppm

Australia: TWA 2 ppm (11 milligram per cubic meter) [skin], 1993; Austria: MAK 2 ppm (11 milligram per cubic meter) [skin], 1999; Belgium: TWA 2 ppm (11 milligram per cubic meter) [skin], 1993; Denmark: TWA 2 ppm (12 milligram per cubic meter), 1999; Norway: TWA 1 ppm (5.5 milligram per cubic meter), 1999; Poland: MAC (TWA) 3 mg/m^4; MAC (STEL) 9 milligram per cubic meter, 1999; Sweden: NGV 1 ppm (6 milligram per cubic meter), KTV 2 ppm (11 milligram per cubic meter) [skin], 1999; Switzerland: MAK-W 2 ppm (11 milligram per cubic meter), KZG-W 4 ppm (22 milligram per cubic meter) [skin], 1999; United

Kingdom: TWA 5 ppm (29 milligram per cubic meter); STEL 10 ppm, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 2 ppm [skin]. In addition, Several states have set guidelines or standards for *p*-nitrotoluene in ambient air[60] ranging from 5.5 μ/m^3 (South Carolina) to 36.7 μ/m^3 (New York) to 110.0 μ/m^3 (Florida). Further, several states have set guidelines or standards for *m*-nitrotoluene in ambient air[60] ranging from 37.0 μ/m^3 (New York) to 110.0 μ/m^3 (North Dakota) to 220.0 μ/m^3 (Connecticut) to 262.0 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #2005, Nitrobenzenes.

Permissible Concentration in Water: No criteria set, but EPA[32] has suggested a permissible ambient goal of 414 μg/L based on health effects.

Determination in Water: Octanol-water coefficient: Log $K_{ow} = 2.3-2.5$ (all isomers). Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin, and respiratory tract. Inhalation can cause coughing and wheezing. Exposure can cause headache, flushing of the skin; rapid heartbeat; nausea, vomiting, weakness, irritability, convulsions, coma and death. High levels may affect the blood, causing formation of methemoglobinemia. Symptoms include anoxia, cyanosis, headache, weakness, dizziness, ataxia, dyspnea (breathing difficulty), tachycardia, vomiting.

Long-Term Exposure: May damage the liver, kidneys, and blood; anemia may develop. May cause damage to the testes.

Points of Attack: Blood, skin, gastrointestinal tract; cardiovascular system; central nervous system; liver, kidneys.

Medical Surveillance: NIOSH lists the following tests (all isomers): whole blood (chemical/metabolite), Methhem oglobin; CBC; urinalysis (chemical/metabolite). Consider the points of attack in preplacement and periodic physical examinations. Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to Physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. For *p*-nitrotoluene, Butyl rubber and polycarbonate are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *20 ppm:* Sa (APF = 10) (any supplied-air respirator); or SCBA (any SCBA). *50 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *100 ppm:* SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *200* ppm*:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from combustibles, reducing agents; strong oxidants, strong bases; strong acids. Where possible, automatically transfer materials from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1664 Nitrotoluenes, (o-; m-; p-), Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: *Solid:* Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. With the solid (*p*-isomer) isomer, dampen spilled material with alcohol to avoid dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Liquid: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: These chemicals aor combustible solids. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are self-contained breathing apparatuses that have full facepieces and are operated in a pressure-demand or other positive-pressure mode. *Liquid:* This chemical is a combustible liquid. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Controlled incineration-care must be taken to maintain complete combustion at all times. Incineration of large quantities may require scrubbers to control the emission of nitrogen oxides.

References

(109); (102); (31); (173); (101); (138); (2); (100).

National institute for Occupational Safety and Health (NIOSH), *Information Profiles on Potential Occupational Hazards: Nitrotoluenes*, Report PB-276-678, Rockville, MD pp 227−240 (October 1977).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 3, No. 3, 85−88 (1983) (*p*-Nitrotoluene).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Nitrotoluenes, Trenton, NJ (August 1999).

(173); *NTP: Toxicity studies, Nitrotoluenes (all isomers) Report No: TOX-23, October 2000; (o-isomer) Report No: TOX-44*, Bethesda MD, October 2000.

5-Nitro-*o*-toluidine N:0670

Formula: $C_7H_8N_2O_2$

Synonyms: AI3-01557; Amarthol fast scarlet G base; Amarthol fast scarlet G salt; 1-Amino-2-methyl-5-nitrobenzene; 2-Amino-4-nitrotoluene; Azoene fast scarlet GC base; Azoene fast scarlet GC salt; Azofix scarlet G salt; Azogene fast scarlet G; Azoic diazo component 12; Benzenamine, 2-methyl-5-nitro-; C.I. 37105; C.I. azoic diazo component 12; Dainichi fast scarlet G base; Daito scarlet base G; Devol scarlet B; Devol scarlet G salt; Diabase scarlet G; Diazo fast scarlet G; Fast red SG base; Fast scarlet base G; Fast scarlet base J; Fast scarlet G; Fast scarlet G base; Fast scarlet GC base; Fast scarlet G salt; Fast scarlet J salt; Fast scarlet M 4NT base; Fast scarlet T base; Hiltonil fast scarlet G base; Hiltonil fast scarlet GC base; Hiltonil fast scarlet G salt; Kayaku scarlet G base; Lake scarlet G base; Lithosol orange R base; 2-Methyl-5-nitroaniline; 6-Methyl-3-nitroaniline; 2-Methyl-5-nitrobenzenamine; 2-Methyl-5-nitro-benzeneamine; Mitsui scarlet G base; Naphthanil scarlet G base; Naphtoelan fast scarlet G base; Naphtoelan fast scarlet G salt; NCI-C01843; 4-Nitro-2-aminotoluene; 3-Nitro-6-methylaniline; 5-Nitro-2-methylaniline; *p*-Nitro-*o*-toluidina (Spanish); *p*-Nitro-*o*-

toluidine; 5-Nitro-2-toluidine; NSC 8947; PNOT; scarlet base Ciba II; scarlet base IRGA II; scarlet base NSP; scarlet G base; Sugai fast scarlet G base; Symulon scarlet G base; *o*-Toluidine, 5-nitro-

CAS Registry Number: 99-55-8

HSDB Number: 4144

RTECS Number: XU8225000

UN/NA & ERG Number: UN2660/153

EC Number: 202-765-8 [*Annex I Index No.:* 612-210-00-5]

Regulatory Authority and Advisory Information

IARC: Animal Inadequate Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3; ACGIH A3 Confirmed animal carcinogen with unknown relevance to humans; DFG MAK: Carcinogen Category 2, Substances which are considered to be carcinogenic for man because adequate results of long-term animal studies or evidence from animal and epidemiological studies indicate that they can make a significant contribution to cancer risk. Inadequate data from animal studies can be supported by information about the mechanism of action and by results of in vitro tests and short-term animal studies.

Hazard Alert: Poison, Possible risk of forming tumors, Suspected of causing genetic defects, Environmental hazard.

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U181

RCRA, 40CFR261, Appendix 8 Hazardous Constituents.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.32; Nonwastewater (mg/kg), 28

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 100 lb (45.4 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Hazardous to aquatic life or environment, with possible long lasting effects[194]. Harmful to aquatic life with long lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R40; R23/24/25;52/53; safety phrases: S1/2; S28; S29/35; S36/37; S41; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: 5-Nitro-*o*-toluidine is a yellow, crystalline solid. Molecular weight = 152.17; freezing/melting point = 107°C; vapor pressure = 1.3×10^{-6} mmHg @ 20°C. Explosive limits: LEL = 16,000 ppm; UEL: unknown.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, acid chlorides; acid anhydrides; chloroformates.

Permissible Exposure Limits in Air

ACGIH TLV[1]: 1 milligram per cubic meter inhalable fraction TWA; confirmed animal carcinogen with unknown relevance to humans.

PAC Ver. 29[138]

PAC-1: 3 milligram per cubic meter

PAC-2: 19 milligram per cubic meter

PAC-3: 110 milligram per cubic meter

DFG MAK: Carcinogen Category 2

Determination in Air: Use NIOSH Analytical Method (IV) #2005, Nitrobenzenes.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Contact may irritate the skin and eyes. High levels of exposure may interfere with the blood's ability to carry oxygen (methemoglobinemia) causing headache, fatigue, dizziness, and cyanosis (a Blue color to the skin and lips). Higher levels can cause trouble breathing; collapse, and death.

Long-Term Exposure: There is limited evidence that this chemical causes liver cancer in animals.

Points of Attack: Liver, blood.

Medical Surveillance: Blood methemoglobin levels, CBC. Liver function disease. Based on animal studies, this chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. *Note to Physician:* Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full

facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Based on potential carcinogenicity the following is recommended by NIOSH: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA-or European Standard EN 149-approved SCBA that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, strong acids; acid chlorides; acid anhydrides; chloroformates.

Shipping: UN2660 Nitrotoluidines (mono), Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical may burn but does not easily ignite. Use dry chemical, carbon dioxide; water spray; alcohol foam or polymer foam extinguishers. Thermal decomposition products may include oxides of nitrogen and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥ 100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (173); (101); (138); (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* 5-Nitro-*o*-toluidine, Trenton, NJ (August 1999).

Nitrous Oxide N:0680

Formula: N_2O

Synonyms: Dinitrogen monoxide; Factitious air; Hyponitrous acid anhydride; Laughing gas; Nitrogen Oxide

CAS Registry Number: 10024-97-2

HSDB Number: 504

RTECS Number: QX1350000

UN/NA & ERG Number: UN1070 (compressed)/122; UN2201 (refrigerated liquid)/122

EC Number: 233-032-0

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Inadequate Evidence, Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1987. United States Environmental Protection Agency Gene-Tox Program, Positive: V79 cell culture-gene mutation; Negative: Sperm morphology-mouse; Inconclusive: Carcinogenicity-mouse/rat.

California Proposition 65 Developmental/Reproductive toxin 8/1/2008.

Hazard Alert: Poison, Oxidizing gas, Asphyxiation hazard, Possible risk of forming tumors, Reproductive toxin: possible risk of gene damage/impaired fertilty; Suspected reprotoxic hazard.

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, O, Xn; risk phrases: R8, R62; R63; safety phrases: S17; S38 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Nitrous oxide is a colorless gas. Slightly sweet odor. Shipped as a liquefied compressed gas. Molecular weight = 44.01; specific gravity (H_2O:1) = 1.8 @ 20°C; boiling point = −89°C; freezing/melting point = −91°C; Relative density of the vapor/air-mixture (air = 1) = 1.53 @ 20°C; vapor pressure = 750 mmHg @ −89°C; Slightly soluble in water; solubility = 0.1% @ 25°C. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 0; reactivity 0.

Potential Exposure: Used as an anesthetic in dentistry and surgery; used as a gas in food aerosols, such as whipped cream; used in manufacture of nitrites; used in rocket fuels; in firefighting; diesel emissions. Large amounts of nitrous oxide will decrease the amount of available oxygen.

Oxygen should be routinely tested to ensure that it is at least 19% by volume.

Incompatibilities: Nitrous oxide is a weak oxidizer. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Violent reactions with organic peroxides, hydrazine, hydrogen, hydrogen sulfide; lithium, boron, lithium hydride, sodium, aluminum, phosphine. This chemical is a strong oxidizer @ >300°C and self-explodes at high temperature. May form explosive mixtures with ammonia, carbon monoxide; hydrogen sulfide; oil, grease and fuels.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 1.80 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: none

NIOSH REL: 25 ppm/46 milligram per cubic meter TWA over the time exposed; [*Note:* REL for exposure to waste anesthetic gas]

ACGIH TLV[1]: 50 ppm TWA; not classifiable as a human carcinogen

PAC Ver. 29[138]

10024-97-2, nitrous oxide

PAC-1: 910 ppm

PAC-2: 10,000 ppm

PAC-3: 20,000 ppm

DFG MAK: 100 ppm/180 milligram per cubic meter TWA; Peak Limitation Category II(2); Pregnancy Risk Group C

Denmark: TWA 50 ppm (90 milligram per cubic meter), 1999; Finland: TWA 100 ppm, 1999; Norway: TWA 100 ppm (180 milligram per cubic meter), 1999; Sweden: NGV 100 ppm (180 milligram per cubic meter), KTV 500 ppm (900 milligram per cubic meter), 1999; Switzerland: MAK-W 100 ppm (200 milligram per cubic meter), KZG-W 200 ppm (400 milligram per cubic meter), 1999; United Kingdom: TWA 100 ppm (183 milligram per cubic meter), 2000; the Netherlands: MAC-TGG 152 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen. The recommended ACGIH TLV is 50 ppm. Connecticut[60] has set a guideline for nitrous oxide in ambient air of 1.34 milligram per cubic meter.

Determination in Air: Use NIOSH Analytical Method (IV) #6600, Nitrous oxide; OSHA Analytical Methods ID-166

Routes of Entry: Inhalation, skin and/or eye contact (liquid).

Harmful Effects and Symptoms

Short-Term Exposure: *Inhalation:* May cause dizziness and difficult breathing. Excessive exposure may cause headaches, nausea, fatigue and irritability. Loss of consciousness may result from exposure to concentrations of 400,000−800,000 ppm. Anesthetic grades are composed of 80% nitrous oxide with 20% oxygen. High concentrations may cause a deficiency of oxygen in the air. *Skin:* Liquid may cause frostbite and freezing burns. *Eyes:* Liquid may cause frostbite and freezing burns. Vapors are nonirritating. *Ingestion:* Liquid may cause frostbite and freezing burns of the mouth and throat.

Long-Term Exposure: Increased incidence of liver and kidney disease; neurological disease; and spontaneous abortion have been reported. Nitrous oxide has been shown to cause birth defects in rats. Repeated exposure can damage the nervous system, causing numbness and weakness in the arms and legs. May damage the bone marrow and affect blood cell production. May be a teratogen in humans.

Points of Attack: Respiratory system; central nervous system; blood, reproductive system.

Medical Surveillance: Before beginning employment and a regular times after that, for those with frequent or potentially high exposures, the following is recommended: exam of the nervous system. If symptoms develop or overexposure is suspected, the following may be useful: consider nerve conduction studies; CBC; examination of the nervous system. Check the work-place air to make certain the oxygen level is at least 19%.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If frostbite has occurred, seek medical attention immediately; do NOT rub the affected areas or flush them with water. In order to prevent further tissue damage, do NOT attempt to remove frozen clothing from frostbitten areas. If frostbite has NOT occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof goggles, unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Exposure to nitrous oxide is dangerous because it can replace oxygen and lead to suffocation. Where there is potential exists for exposure *over 25 ppm*; Use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Oxidizers, including oxidizing gases, should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Check oxygen level before entering area. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Nitrous oxide must be stored to avoid contact with organic peroxides, ammonia, carbon monoxide; hydrogen, hydrogen sulfide and phosphine, since violent reactions occur. Cylinders of nitrous oxide should be stored in a cool, preferably fire resistant area, away from heat sources.

Shipping: UN1070 Nitrous oxide, compressed, Hazard Class: 2.2; Labels: 2.2-Nonflammable compressed gas; 5.1-Oxidizer; UN2201 Nitrous oxide, refrigerated liquid, Hazard Class: 2.2; Labels: 2.2-Nonflammable compressed gas; 5.1-Oxidizer. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: If in a building, evacuate building and confine vapors by closing doors and shutting down HVAC systems. Restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak to disperse the gas. Wear chemical protective suit with SCBA to combat spills. Stay upwind and use water spray to "knock down" vapor; contain runoff. Stop the flow of gas, if it can be done safely from a distance. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place; and repair leak or allow cylinder to empty. If flow cannot be stopped, allow it to flow into a mixture of caustic soda and slaked lime and dispose of the resulting material in a hood. Keep this chemical out of confined spaces, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Nitrous oxide is an oxidizer and will increase the intensity of any fire. Nitrous oxide self-explodes at high temperature. Extinguish fire using an agent suitable for type of surrounding fire. Nitrous oxide itself does not burn. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Disperse in atmosphere or spray on dry soda ash/lime with great care; then flush to sewer.

References

(31); (173); (101); (138); (2); (100).

Sax, N. I., Ed., *Dangerous Properties of Industrial Materials Report*, 1, No. 7, 66−67 (1981).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Nitrous Oxide, Trenton, NJ (September 2004).

New York State Department of Health, *Chemical Fact Sheet:* Nitrous Oxide, Bureau of Toxic Substance Assessment, Albany, NY (May 1986).

Nonane N:0685

Formula: C_9H_{20}; $CH_3(CH_2)_7CH_3$

Synonyms: *N*.Nonane; Nonyl hydride; Shellsol 140

CAS Registry Number: 111-84-2

HSDB Number: 107

RTECS Number: RA6115000

UN/NA & ERG Number: UN1920/128

EC Number: 203-913-4

Regulatory Authority and Advisory Information

Hazard Alert: Highly flammable, Aspiration hazard, Primary irritant (w/o allergic reaction).

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: Xn; risk phrases: R11; R20; R22; R36/37/38; R65; R67; safety phrases: S16; S21; S23/24/25; S26; S36/37; S45; S62; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [1-Low hazard to water. (est.)]

Description: Nonane is a colorless liquid. Molecular weight = 128.26; specific gravity (H_2O:1) = 0.72 @ 20°C;

boiling point = 151°C; freezing/melting point = −54°C; vapor pressure = 3 mmHg @ 20°C; 7.5 mmHg @ 34°C; Flash point = 31°C; Autoignition temperature = 205°C. Explosive limits: LEL = 0.8%; 21,000 ppm; UEL: 2.9%. Hazard identification (based on NFPA-704 M Rating System): Health 0; flammability 3; reactivity 0. Insoluble in water.

Potential Exposure: Nonane is used in the synthesis of biodegradable detergents as a distillation chaser; an ingredient in Stoddard solvent and gasoline.

Incompatibilities: Nonane forms explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 5.25 milligram per cubic meter @ 25°C & 1 atm

Odor threshold = 47 ppm.

OSHA PEL: None

NIOSH REL: 200 ppm/1050 milligram per cubic meter TWA

ACGIH TLV[1]: 200 ppm TWA

PAC Ver. 29[138]

PAC-1: 600 ppm

PAC-2: 830 ppm

PAC-3: 5000 ppm

Denmark: TWA 200 ppm (1050 milligram per cubic meter), 1999; Finland: TWA 200 ppm (1050 milligram per cubic meter); STEL 250 ppm (1315 milligram per cubic meter), 1999; France: VME 200 ppm (1050 milligram per cubic meter), 1999; Japan: 200 ppm (1050 milligram per cubic meter), 1999; Norway: TWA 100 ppm (525 milligram per cubic meter), 1999; Sweden: NGV 150 ppm (800 milligram per cubic meter), KTV 200 ppm (1100 milligram per cubic meter), 1999; Switzerland: MAK-W 200 ppm (1050 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 1050 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 200 ppm. Several states have set guidelines or standards for nonane in ambient air[60] ranging from 10.5−13.0 milligram per cubic meter (North Dakota) to 17.5 milligram per cubic meter (Virginia) to 21.0 milligram per cubic meter (Connecticut) to 25.0 milligram per cubic meter (Nevada).

Determination in Air: No NIOSH Analytical Method available.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Nonane can affect you when breathed in. Aspiration hazard, Inhalaing or swallowing the liquid may cause chemical pneumonitis. Narcotic at high concentrations; may affect the central nervous system. Exposure to high levels can cause headache, drowsiness, dizziness, confusion, nausea, tremor, lack of coordination; and unconsciousness. Irritates the eyes, skin, respiratory tract. Effects may include severe pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death.

Long-Term Exposure: Prolonged contact can cause drying and cracking of the skin. Repeated exposure can affect the liver.

Points of Attack: Eyes, skin, respiratory system; central nervous system; liver.

Medical Surveillance: Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. If symptoms develop or overexposure is suspected, the following may be useful: liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to Physician: Inhalation: bronchodilators, decongestants and oxygen may be used if necessary. Corticosteroids are useful for treating pneumonitis.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Wear solvent-resistant gloves and clothing. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work.

Respirator Selection: Where there is potential exists for exposures *over 200 ppm*; Use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece respirator with an organic vapor cartridge/canister. Greater protection is provided by a powered-air purifying respirator. Where there is potential for high exposure exists, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure demand or other positive-pressure mode.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames are prohibited where nonane is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of nonane should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Wherever nonane is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Use only nonsparking tools and equipment, especially when opening and closing containers of nonane.

Shipping: UN1920 Nonanes, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (100).

National institute for Occupational Safety and Health (NIOSH), “Criteria for a Recommended Standard: Occupational Exposure to Alkanes,” NIOSH Document Number 77-151, Cincinnati, OH (1977).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Nonane, Trenton, NJ (February 2000).

Nonyl Trichlorosilane N:0690

Formula: $C_9H_{19}Cl_3Si$; $C_9H_{19}SiCl_3$

Synonyms: Silane, nonyltrichloro-; Silane, trichlorononyl-; Trichlorononylsilane

CAS Registry Number: 5283-67-0

HSDB Number: 1999

RTECS Number: VV4660000

UN/NA & ERG Number: UN1799/156

EC Number: 226-113-7

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade).

Carcinogenicity: IARC: Animal Inadequate Evidence, Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3 (see Appendix 4)

Hazard Alert: Combustible, Corrosive, Violently reactive with water.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, C, Xi, Xn; risk phrases: R14/15; R29; R34; R36/37/38; R34; R40; R45; R51; safety phrases: S1; S22; S26; S36/37/39; S45; S53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Nonyl trichlorosilane is a clear fuming liquid. Irritating odor. Molecular weight = 261.72; specific gravity (H_2O:1) = 1.07 @ 20°C. Explosive limits: LEL = 8000 ppm, UEL: unknown. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 1; reactivity 2₩. Reacts violently with water, rapidly releasing heat and corrosive hydrogen chloride gas.

Potential Exposure: Used in silicone (polysiloxane) manufacture.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Chlorosilanes react vigorously with bases and both organic and inorganic acids generating toxic and/or flammable gases. Chlorosilanes react with water, moist air, or steam to produce heat and toxic, corrosive fumes of hydrogen chloride. They may also produce flammable gaseous hydrogen. Attacks metals in the presence of moisture.

Permissible Exposure Limits in Air:

PAC* Ver. 29[138]

PAC-1: $\mathbf{0.60_A}$ ppm

PAC-2: $\mathbf{7.3_A}$ ppm

PAC-3: $\mathbf{33_A}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Nonyl trichlorosilane can affect you when breathed in. Nonyl trichlorosilane is a corrosive chemical, and can cause severe eye burns leading to permanent damage. Contact can cause severe skin burns. Exposure can irritate the eyes, nose and throat. Exposure can irritate the lungs, causing coughing and/or shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: May cause lung irritation; bronchitis may develop.

Points of Attack: Lungs.

Medical Surveillance: For those with frequent or potentially high exposure the following are recommended before beginning work and at regular times after that. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water, or milk. Do not induce vomiting. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposure to nonyl trichlorosilane, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from combustible materials, such as wood, paper or oil.

Shipping: UN1799 Nonyltrichlorosilane, Hazard Class: 8; Labels: 8-Corrosive material.

Spill Handling:

Nonyltrichlorosilane when spilled in water.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424−9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548−8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft./m) 100/30

Then: Protect persons downwind (mi/km)

Day 0.1/0.2

Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft./m) 200/60

Then: Protect persons downwind (mi/km)

Day 0.3/0.5
Night 1.0/1.5
Stay upwind and uphill. Isolate the area of release or fire and deny entry. Remove all ignition sources. Stop the release if it can be done safely from a distance. All equipment used to handle this material must be grounded. Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. *Small spill*: Cover with *dry* earth, *dry* sand, or other noncombustible material followed with plastic sheet to minimize spreading or contact with water or rain. Use clean nonsparking tools to collect material and place material into loosely covered plastic containers for later disposal. Prevent material and runoff from entering sewers and waterways if it can be done safely well ahead of the release. Use vapor suppressing foam to disperse vapors-contain runoff. Water spray may reduce vapor, but may not prevent ignition in enclosed spaces. Ventilate confined area if it can be done without placing personnel at risk. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Nonyl trichlorosilane may burn, but does not readily ignite. Thermal decomposition products may include gaseous hydrogen chloride, chlorine and phosgene and oxides of metal and carbon. *For chlorosilanes do not use water. Use afff alcohol-resistant, medium expansion foam. Small fire*: use *dry* chemical, CO_2, *dry* sand, or alcohol-resistant foam. May react with foams releasing corrosive/toxic gases. *Large fire*: use water spray or alcohol-resistant foam if it is available in sufficient amounts. Under favorable conditions, experienced crews can use coordinated fog streams to sweep the flames off the surface of the burning liquid. Combustible material: may burn but does not ignite readily. Most vapors are heavier than air. They will spread along ground and collect in low or confined areas (sewers, basements, tanks). Vapors may travel to source of ignition and flash back. Containers may explode when heated or if contaminated with water. Keep exposures cool long after fire is out to protect against reignition. Do not direct straight streams into the liquid. Cool exposed containers with large quantities of water from unattended equipment or remove intact containers if it can be done safely. *Do not get water on spilled substance or inside containers*. If cooling streams are ineffective (*venting sound increases in volume and pitch, tank discolors or shows signs of deforming*), withdraw immediately to a secure location. Always stay away from ends of tanks, especially when engulfed in flames. If material or contaminated runoff from fire control enters waterways, notify downstream users of potentially contaminated water. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References
(31); (173); (101); (138); (100).
New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Nonyl Trichlorosilane, Trenton, NJ (February 2000).

Norbormide N:0700

Formula: $C_{33}H_{25}N_3O_3$
Synonyms: Compound S-6,999; ENT 51,762; 5(α-Hydroxy-α-2-pyridylbenzyl)-7-(α-2-pyridylbenzylidene)-5-norborene-2,3-dicarboxide; MCN 1025; Norbormida (Spanish); Raticate; Raticide; S-6,999; Shoxin
CAS Registry Number: 991-42-4
HSDB Number: 1743
RTECS Number: RB8750000
UN/NA & ERG Number: UN2588 (Pesticides, solid, toxic, n.o.s.)/151
EC Number: 213-589-6 [*Annex I Index No.:* 650-004-00-7]
Regulatory Authority and Advisory Information
SUPERFUND/EPCRA 302, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg)
Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 100 lb (45.4 kg).
Hazard symbols, risk, & safety statements: Hazard symbol: Xn; risk phrases: R22; safety phrases: S2; S41 (see Appendix 4).

Description: Norbormide is a white crystalline powder. Molecular weight = 511.61; freezing/melting point = 190−198°C. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 0; reactivity 0. Insoluble in water.

Potential Exposure: This material is used as a selective, fast acting rat poison.

Incompatibilities: Compounds of the carboxyl group react with all bases, both inorganic and organic (i.e., amines) releasing substantial heat, water and a salt that may be harmful. Incompatible with arsenic compounds (releases hydrogen cyanide gas), diazo compounds, dithiocarbamates, isocyanates, mercaptans, nitrides, and sulfides (releasing heat, toxic and possibly flammable gases), thiosulfates and dithionites (releasing hydrogen sulfate and oxides of sulfur).

Permissible Exposure Limits in Air
PAC Ver. 29[138]
PAC-1: 0.35 milligram per cubic meter
PAC-2: 3.8 milligram per cubic meter
PAC-3: 190 milligram per cubic meter

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Harmful if inhaled or swallowed. Moderately to highly toxic to humans. Probable human lethal dose is 50–500 mg/kg, or 1 teaspoon to 1 pint for a 150 lb person. Exposure may cause a transient decrease in temperature and blood pressure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage.

Shipping: UN2588 Pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. *Small wet spills:* Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. *Small dry spills:* with clean shovel place material into clean, dry container and cover; move containers from spill area. *Large spills*: dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include oxides of nitrogen and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Small amounts may be treated with alkali, then landfilled. Large amounts should be incinerated[22]. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138).

United States Environmental Protection Agency, *Chemical Hazard Information Profile:* Norbormide, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

Norflurazon N:0710

Formula: $C_{12}H_9ClF_3N_3O$

Synonyms: Caswell No. 195AA; 4-Chloro-5-(methylamino)-2-[3-(trifluoromethyl)phenyl]-3(2H)-pyridazinone; 4-Chloro-5-methylamino-2-(3-trifluoromethylphenyl)pyridazin-3-one; 4-Chloro-5-(methylamino)-2-(α,α,α-trifluoro-m-tolyl)-3(2H)-pyridazinone; 4-Chloro-5-methylamino-2-(α,α,α-trifluoro-*m*-tolyl)pyridazinone-3(2H)-one; 4-Chloro-5-(methylamino)-2-[3-(trifluoromethyl)phenyl]-3

(2H)-pyridazinone; Dodecylbenzenesulfonic acid, triethanolamine salt; Evita L; H 9789; Monomethflurazone; Norflurazon pyridazine herbicide; 3(2H)-Pyridazinone, 4-chloro-5-(methylamino)-2-[3-(trifluoromethyl)phenyl]-; 3(2H)-Pyridazinone, 4-chlor o-5-(methylamino)-2-(α,α,α-trifluoro-*m*-tolyl)-; SAN 9789H; SAN 97895; Solicam; Telok; Triethanolamine dbs; Triethanolamine dodecylbenzenesulfonate; Zorial

CAS Number: 27314-13-2

HSDB Number: 6845

RTECS Number: UR6150000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 248-397-1

Regulatory Authority and Advisory Information

Hazard Alert: Environmental hazard, Agricultural chemical.

Potential Ground water Pollutant (California FAC Section 13149)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%

Hazardous to aquatic life or environment, with possible long lasting effects[291].

Hazard symbols, risk, & safety statements: Hazard symbol: N; risk phrases: R50; safety phrases: S29/35; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: White to gray-brown crystalline solid or powder. Odorless. Molecular weight = 303.67; specific gravity (H_2O:1) = 1.45; freezing/melting point = 184°C; vapor pressure = 2.3×10^{-8} mm @ 20°C. Slightly soluble in water; solubility = 30 mg/L.

Potential Exposure: Norflurazon is a pyridazinone selective pre-emergent herbicide used to control germinating annual grasses, sedges, rushes and broadleaf weeds in fruits (cranberries, citrus, cherries, nectarines, apricots), grape vines, vegetables, nuts, cotton, peanuts, soybeans, and various nonagricultural and industrial areas. Forbidden for use in the EU after 7/25/2003. Manufactured in the United States by Clariant Corporation, North Carolina.

Incompatibilities: rapidly degraded by strong light; UV. Incompatible with oxidizers, chlorates nitrates, peroxides.

Permissible Concentration in Water: Federal Drinking Water Guidelines: 10 ppb[14]. State Drinking Water Guidelines: Florida 280 μg/L; Maine 10.5 μg/L. *Fluoride ion*: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guidelines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg[F]/L. SafeDrinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg[F]/L; SMCL = 2 mg/F/L, as Fluoride.

Determination in Water: Octanol-water coefficient: Log K_{ow} = <2.5. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Ingestion, dermal and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Contact may irritate skin and cause eye irritation and possible severe injury. Inhalation should be avoided; use NIOSH-or CEN (UK)-approved air purifying respirators for pesticides. Poisonous if swallowed. LD_{50} (oral, rat) = >5 g/kg; (dermal, rat) = >7.5 g/kg.

Long-Term Exposure: May cause liver cancer. Fluorides may cause bone disease (pain and tenderness of the bones); mottled teeth in children.

Points of Attack: Liver, ovary, uterus, thyroid; central nervous system, bones.

Medical Surveillance: Preliminary medical exam to detect chronic diseases of central nervous system, liver, heart, kidneys, lung and skin, as well as endocrinological or immunological disturbances, should protect susceptible individuals. Periodical medical exams of internal organs, skin and eyes are important to avoid chronic occupational intoxications. They should include lab and patch tests when necessary[83]. This chemical is a suspected or known human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and advice for medical monitoring. Liver function tests. See medical help if poisoning is suspected or if redness, itching, burning of skin or eyes develop.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Applicators and other handlers must wear: Coveralls worn over long-sleeved shirt and long pants; Chemical-resistant gloves such as DuPont Tychem suit fabrics, barrier laminate, or Viton; Chemical-resistant footwear plus socks; Protective eye wear; Chemical-resistant headgear for overhead exposure; Chemical-resistant apron when cleaning equipment, mixing, or loading[83]. Agricultural Use/Engineering Controls: When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the Worker Protection Standard (WPS) for agricultural pesticides, 40 CFR 170.240(d)(4-6), the handler PPE requirements may be reduced or modified as specified in the Worker Protection Standard. Firefighters should wear NIOSH approved SCBA and full protective clothing.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with an N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Possible Human Carcinogen: Store in a tightly closed container in a dry, well-ventilated and secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Where possible, automatically transfer material from other storage containers to process containers. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard Class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Careful, a possible carcinogen. For solids, *small spill*, isolate spill or leak area in all directions for at least 25 m/75 ft. Increase, in the downwind direction, as necessary. For a *large spill* evacuate downwind at least 100 m/330 ft. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Stop leak if you can do it without risk. Keep combustibles (wood, paper, oil, etc.) away from spilled material. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Stop leak if you can do it without risk. Do not allow water to get inside containers. *Small dry spill*: With clean shovel place material into clean, dry container and cover loosely; move containers from spill area. *Large spill*: Dike far ahead of liquid spill for later disposal. Following product recovery, flush area with water. Prevent entry into waterways, sewers, basements or confined areas. Cover with plastic sheet to prevent spreading. Absorb or cover with dry earth, sand or other noncombustible material and transfer to containers. Do not allow water to get inside containers. Prevent entry into waterways, sewers, basements or confined areas. Cover with plastic sheet to prevent spreading. Absorb or cover with dry earth, sand or other noncombustible material and transfer to containers.

Fire Extinguishing: Thermal decomposition products may include toxic gases, including oxides of nitrogen, carbon, hydrogen fluoride and hydrogen chloride gases. As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 m/150 ft. for liquids and at least 25 m/75 ft. for solids. *Fire involving storage or vehicular tanks:* Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. *On a small fire:* use dry chemical, CO_2, water spray or regular *foam. On a large fire:* use water spray, fog or regular foam. Do not scatter spilled material with high pressure streams of water. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal. *Fire involving tanks:* From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. Always stay away from tanks engulfed in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: It is the responsibility of chemical waste generators to determine the toxicity and physical properties and of a discarded chemical and to properly identify its classification and certification as a hazardous waste and to determine the disposal method. United States Environmental Protection Agency guidelines for the classification determination are listed in 40 CFR Parts 261.3. Additionally, waste generators must consult and follow all regional, national, state and local hazardous waste laws to ensure complete and accurate classification and disposal methods. Follow recommendations for the disposal of pesticides and pesticide containers. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (122); (100).

United States Environmental Protection Agency, Office of Pesticide Programs, Pesticide Residue Limits, *Norflurazon*, 40 CFR 180.356, http://www.epa.gov/pesticides/food/viewtols.htm.

United States Environmental Protection Agency, *Reregistration Eligibility Decision (RED), Norflurazon*, Office of Prevention, Pesticides and Toxic Substances, Washington, DC.

Pesticide Management Education Program, *Norflurazon (Zorial, Solicam) Herbicide profile 12/84*, Cornell University, Ithaca, NY (December 1984). http://pmep.cce.cornell.edu/profiles/herb-growthreg/naa-rimsulfuron/norflurazon/herb-prof-norflurazon.html.

O

Ochratoxin A O:0050

Formula: $C_{20}H_{18}ClNO_6$
Synonyms: Alanine,*N*-[(5-chloro-8-hydroxy-3-methyl-1-*oxo*-7-isochromanyl)carbonyl]-3-; Alanine,*N*-[(5-chloro-8-hydroxy-3-methyl-1-*oxo*-7-isochromanyl)carbonyl]-3-phenyl-,(-)-; *N*-[((3R)-5-Chloro-8-hydroxy-3-methyl-1-*oxo*-7-isochromanyl)carbonyl]-3-phenyl-L-alanine; (-)-*N*-[(5-Chloro-8-hydroxy-3-methyl-1-*oxo*-7-isochromanyl)carbonyl]-3-phenylalanine; NCI-C56586; OTA; Phenyl-l-alanine; Phenylalanine-ochratoxin A; PHE-OTA
CAS Registry Number: 303-47-9
HSDB Number: 4305
RTECS Number: AY4375000
UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154; UN3462/153
EC Number: 206-143-7
Regulatory Authority and Advisory Information
Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen
California Proposition 65 Chemical[102]: cancer, 7/1/1990
Hazard Alert: Poison, Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Environmental hazard.
Hazardous to aquatic life or environment, with possible long-lasting effects[194]. May cause long-lasting harmful effects to aquatic life
Hazard symbols, risk, & safety statements: Hazard symbol: T+, N, Xn; risk phrases: R45; R20/21/22; R26/27/28; R36/38; R46; R48/23/24/25; R61; R62; R63; R65; safety phrases: S16; S22; S26; S28; S39/35; S36; S36/37/39; S45; S53; S62 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]
Description: White crystalline solid or powder. Molecular weight = 403.81; Boiling point = ~632.42°C at 760 mmHg (est.)[Santa Cruz, Biotechnology]; freezing/melting point = 169°C. Practically insoluble in water; solubility = $<$1 mg/mL @ 19°C; 0.4246 mg/L @ 25°C (est)[72].
Potential Exposure: Ochratoxin A, a carboxylic acid derivative and a naturally occurring toxic mold (strain of *Aspergillus ochraceus*), occasionally in storage grains such as wheat and on field crops such as corn and oilseed (i.e., cottonseed), in ancient tombs, and decayed vegetation. Used as a laboratory chemical for research. Not currently produced in the United States.
Incompatibilities: Ochratoxin A is Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fire. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides. Compounds of the carboxyl group R·COOH Compounds of the carboxyl group react with all bases, both inorganic and organic (i.e., amines) releasing substantial heat, water, and a salt that may be harmful. Incompatible with arsenic compounds (releases hydrogen cyanide gas), diazo compounds, dithiocarbamates, isocyanates, mercaptans, nitrides, and sulfides (releasing heat, toxic, and possibly flammable gases), thiosulfates and dithionites (releasing hydrogen sulfate and oxides of sulfur).
Permissible Exposure Limits in Air: No standards or Protective Action Criteria (PAC) available. This substance may still be harmful or dangerous; follow safe work and usage practices.
Determination in Water: Octanol–water coefficient: Log $K_{ow} = <5$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.
Routes of Entry: Ingestion
Harmful Effects and Symptoms
Short-Term Exposure: Strain of *Aspergillus ochraceus*. Fatal if ingested. LD_{50} = (oral-rat) $<$20 mg/kg
Long-Term Exposure: May cause cancer and tumors. A possible mutagen and reproductive effector.
Points of Attack: Kidneys, liver.
Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure.
First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth methods if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device?* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In the case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24–48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.
Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA-or European Standard EN 149-approved self-contained breathing

Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens.
DOI: http://dx.doi.org/10.1016/B978-0-323-38968-6.00014-4

apparatus (SCBA) that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100 F (APF = 50) (any air purifying, full-face-piece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health hazard/toxics/poisons: Store in a secure poison location.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN3462 Toxins, extracted from living sources, solid, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft. (NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. Keep ethylene glycol diethyl ether out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: May burn but does not easily ignite. Thermal decomposition products may include hydrogen chloride and oxides of carbon and nitrogen. *Small fires:* dry chemical, carbon dioxide; water spray; or foam. Extinguishers. *Large fires:* water spray, fog, or foam. Move container from fire area, if you can do it without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Contact with easily oxidized organic materials may cause fires and explosions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(109); (102); (31); (88); (173); (101); (138); (100).

Octafluorocyclobutane O:0100

Formula: C_4F_8

Synonyms: Cyclobutane, cyclooctafluorobutane; Freon C-318; Octafluoro-; Perfluorocyclobutane; PFC-318

CAS Registry Number: 115-25-3

HSDB Number: 147

RTECS Number: GU1779500

UN/NA & ERG Number: UN1976/126

EC Number:204-075-2

Regulatory Authority and Advisory Information

Hazard Alert: Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated. Suspected of causing genetic defects.

Global Warming potential (100 years time horizon): 10,300 (40 CFR 98, Subpart A)

Hazard symbols, risk, & safety statements: Hazard symbol: Xn; risk phrases: R22; R36/37/38; R62; safety phrases: S16; S26; S36/37; S41; S45 (see Appendix 4)

Description: Octafluorocyclobutane is a colorless gas. Molecular weight = 200.03; boiling point = −6°C; freezing/melting point = −4.140E + 01°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 0, reactivity 0. Slightly soluble (slight hydrolysis).

Potential Exposure: This material is used as a refrigerant.

Incompatibilities: Octafluorocyclobutane is chemically inert in many situations, but can react violently with strong reducing agents such as hydrides and the active metals and especially the very active metals. They suffer oxidation with strong oxidizing agents and under extremes of temperature[101].

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 400 ppm

PAC-2: 4400 ppm

PAC-3: 27,000 ppm

Routes of Entry: Inhalation, skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Octafluorocyclobutane can affect you when inhaled. Inhalation can irritate the lungs, causing coughing and shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. High levels can cause you to feel dizzy, lightheaded and to pass out. Very high levels could cause death.

Long-Term Exposure: Similar chemicals can cause irregular heartbeat, which could lead to death. Very irritating chemicals may affect the lungs; may cause bronchitis and lung damage.

Points of Attack: Lungs, heart.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: special 24 hours EKG (Holter Monitor) to look for irregular heart beat. Consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask), if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24—48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof goggles, unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where, there is potential for exposures to octafluorocyclobutane exists, use NIOSH/MSHA or European Standard EN 149-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with the full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Check oxygen content prior to entering storage area. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from potential high heat sources. Protect cylinders from physical damage. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: UN1976 octafluorocyclobutane, or refrigerant gas RC-318, Hazard class: 2.2; Labels: 2.2-Nonflammable compressed gas. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: If in a building, evacuate building and confine vapors by closing doors and shutting down HVAC systems. Restrict persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Ventilate area of spill or leak to disperse the gas. Wear chemical protective suit with SCBA to combat spills. Stay upwind and use water spray to “knock down” vapor; contain runoff. Stop the flow of gas, if it can be done safely from a distance. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place; and repair leak or allow cylinder to empty. Keep this chemical out of confined spaces, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Octafluorocyclobutane itself does not burn. Thermal decomposition products may include carbonyl fluorine, hydrogen fluoride, and oxides of carbon. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters water ways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Nonrefillable cylinders should be disposed of in accordance with local, state and federal regulations. Allow remaining gas to vent slowly into atmosphere in an unconfined area or exhaust hood. Refillable-type cylinders should be returned to original supplier with any valve caps and outlet plugs secured and valve protection caps in place.

References

(31); (173); (101); (138).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Octafluorocyclobutane, Trenton, NJ (February 2000).

Octamethyl Diphosphoramide O:0110

Formula: $C_8H_{24}N_4O_3P2$; $C_8H_{24}N_4P_2O_3$

Synonyms: Bis (bisdimethylamino) phosphonousanhydride; Bis (bisdimethylaminophosphonous) anhydride; Bis-bisdimethylaminophosphonous anhydride; Bis (bisdimethylamino) phosphoric anhydride; Bis-*N*,*N*,*N*′,*N*′-tetramethylphosphorodiamidic anhydride; Diphosphoramide, octamethyl-; ENT 17,291; Letha laire G-59; Octamethyldiphosphorsaeure-tetramid (German); Octamethylpyrophosphoramide; Octamethyl pyrophosphortetramide; Octamethyl tetramido pyrophosphate; Octametilpirofosforamida (Spanish); OMPA; Ompacide; Ompatox; Ompax; Pestox; Pestox 3; Pestox III; Pyrophosphoric acid octamethylteraamide; Pyrophosphorytetrakisdimethylamide; Schradan; Schradane (French); Systam; Systophos; Sytam; Tetrakisdimethylaminophosphonous anhydride; Tetrakisdimethylaminophosphoric anhydride

CAS Registry Number: 152-16-9

HSDB Number: 1744 as Schradan

RTECS Number: UX5950000

UN/NA & ERG Number: UN3018 (organophosphorus pesticide, liquid, toxic)/152

EC Number: 205-801-0 [*Annex I Index No.:* 015-026-00-8]

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Neurotoxin (cumulative), Combustible, Agricultural chemical.

Banned or Severely Restricted (in agriculture) (Russia, USA) (UN)[13]

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P085

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

SUPERFUND/EPCRA 302, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 100 lb (45.4 kg).

Hazard symbols, risk, & safety statements: Hazard symbol: T+; risk phrases: R27/28; R33; R50; safety phrases: S1/2; S36/37; S38; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: OMPA is a colorless liquid in crude form; otherwise, it is a dark brown viscous liquid. Molecular weight = 286.29; boiling point = 120−125°C @ 0.5 mmHg; freezing/melting point = 14−19°C; vapor pressure = 1.3×10^{-3} mmHg @ 25°C. Hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 1; reactivity 0. Soluble in water.

Potential Exposure: Material is used as a systemic insecticide for plants and as an acaricide. Not registered as a pesticide in the United States.

Incompatibilities: Organophosphates are susceptible to formation of highly toxic and flammable phosphine gas in the presence of strong reducing agents such as hydrides and active metals. Partial oxidation by oxidizing agents may result in the release of toxic phosphorus oxides[101]. Acids.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 0.073 milligram per cubic meter

PAC-2: 0.8 milligram per cubic meter

PAC-3: 4.9 milligram per cubic meter

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Acute exposure to OMPA may produce the following signs and symptoms: Pinpoint pupils; blurred vision; headache, dizziness, muscle spasms; and profound weakness. Vomiting, diarrhea, abdominal pain; seizures, and coma may also occur. The heart rate may decrease following oral exposure or increase following dermal exposure. Hypotension (low blood pressure) and chest pain may be noted. Hypertension (high blood pressure) is not uncommon. Respiratory symptoms include dyspnea, respiratory depression, and respiratory paralysis. Psychosis may occur. This material is extremely toxic; probable oral lethal dose in humans is 5−50 mg/kg, between seven drops and one teaspoonful for a 150 lb person. It is highly toxic when inhaled. Material is a cholinesterase inhibitor. It is similar in action to other organophosphorus pesticides in its toxicity. It is slightly less toxic than parathion. Gastrointestinal, neurologic, and respiratory symptoms may accompany poisoning with this material. High doses may cause a toxic psychosis similar to acute alcoholism. *Note:* Persons taking the following drugs may be at greater risk: Phenobarbital and phenaglycodol together; glutethimide, chlorpromazine hydrochloride; or mepromabate. These drugs appear to enhance the toxicity of the material markedly.

Long-Term Exposure: A cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, and central nervous system; cardiovascular system, skin, eyes, plasma, and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: Plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Obtain authorization and/or further instructions from the local hospital for administration of an antidote or performance of other invasive procedures.

Note to Physician: 1,1′-trimethylenebis (4-formylpyridinium bromide) dioxime (a.k.a TMB-4 dibromide and TMV-4) has been used as an antidote for organophosphate poisoning.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash; pressure, pressure-demand, full-face-piece SCBA or pressure-demand supplied air respirator with escape SCBA and a fully-encapsulating, chemical resistant suit.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health hazard/poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from acids. Where possible, automatically transfer from drums or other storage containers to process containers.

Shipping: UN3018 Organophosphorus pesticides, liquid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling:

Initial isolation and protective action distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (from a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.3/0.4
Night 0.8/1.2

Large spills (from a large package or from many small packages)

First: Isolate in all directions (ft/m) 600/200
Then: Protect persons downwind (mi/km)
Day 1.4/2.3
Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Do not touch spilled material. Do not breathe vapors. Stay upwind; keep out of low areas. Remove all ignition sources. Ventilate area of spill or leak. This material is a combustible liquid. For a spill or leak of a combustible liquid, shut off ignition sources; no flares, smoking or flames in hazard area. Stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: Absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: Dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible liquid. Thermal decomposition products may include phosphineand oxides of phosphorus, nitrogen and carbon. Do not extinguish fire unless flow can be stopped. Use water in flooding quantities as fog. Solid streams of water may be ineffective. Cool all affected containers with flooding quantities of water. Apply water from as far a distance as possible. Use alcohol foam, carbon dioxide; or dry chemical. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Octamethyl Phosphoramide, Washington, DC, Chemical Emergency Preparedness Program (Nov. 30, 1987)

Octane O:0120

Formula: C_8H_{18}

Synonyms: Isobutyltrimethylmethane; Isooctane; Isooctano (Spanish);*n*-Octane; *normal*-Octane; Octanes; Octano (Spanish); 2,2,4-Trimethylpentane; 2,4,4-Trimethylpentane

CAS Registry Number: 111-65-9 (*n*-); 540-84-1 (*iso*-)

HSDB Number: 108 (*n*-); 5682 (*iso*-)

RTECS Number: RG8400000

UN/NA & ERG Number: UN1262/128

EC Number: (*n*-) 203-892-1 [*Annex I Index No.*:601-009-00-8]; (*iso*-) 208-759-1 [*Annex I Index No.:* 601-009-00-8]

Regulatory Authority and Advisory Information

Carcinogenicity: EPA (*isooctane; oral*): Inadequate information to assess carcinogenic potential.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard Alert: Highly flammable, Environmental hazard.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

European/International Regulations (*n*- and *iso*-): Hazard symbol: F, Xn, N; risk phrases: R11; R38; R65; R67; R50/53; safety phrases: S2; S9; S16; S21; S29; S33; S60; S61; S62; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to waters (*octane and isomers*)

Description: Octane is a colorless liquid with a gasoline-like odor. The odor threshold is 4 ppm[41] and 48 ppm (New Jersey Fact Sheet). Molecular weight = 114.26 (*both isomers*); specific gravity (H2O:1) = 0.70 @ 20°C (*both isomers*); boiling point = 126°C (*n*-); 99 C (*iso*-); freezing/melting point = −56.7 (*n*-); −108°C (*iso*-); vapor pressure = 10 mmHg @ 19°C (*n*-); 41 mmHg @ 21°C (*iso*-); flash point = 13°C (cc); autoignition temperature = 206°C. Explosive limits: LEL = 1.0%; UEL: 6.5%. Hazard identification (based on NFPA-704 M Rating System): Health 0; flammability 3; reactivity 0. Practically insoluble in water; solubility = 7×10^{-5}.

Potential Exposure: Octane is used as a solvent; as a fuel; as an intermediate in organic synthesis; and in azeotropicdistillations.

Incompatibilities: Reacts with strong oxidizers, causing fire and explosion hazard. Attacks some forms of plastics, rubber and coatings.

Permissible Exposure Limits in Air

NIOSH IDLH = 1000 ppm [LEL]

Conversion factor: 1 ppm = 4.67 milligram per cubic meter @ 25°C & 1 atm

Odor Threshold = 4 ppm[41]; 48 ppm[70]

OSHA PEL (*n-octane only*): 500 ppm/2350 milligram per cubic meter TWA; *Construction Industry*: 400 ppm/1900 milligram per cubic meter TWA

NIOSH REL (*n-octane only*): 75 ppm/350 milligram per cubic meter TWA; 385 ppm/1800 milligram per cubic meter [15-minute] Ceiling Concentration

ACGIHTLV[1] (*all isomers*): 300 ppm/1401 milligram per cubic meter TWA

PAC Ver. 29[138]

m- & *iso*-isomers

PAC-1: 230 ppm

PAC-2: 385 ppm

PAC-3: 5000 ppm

DFGMAK (*n-isomer*): 500 ppm/2400 milligram per cubic meter TWA; Peak Limitation Category II(2); Pregnancy Risk Group D

Australia: TWA 300 ppm (1450 milligram per cubic meter); STEL 375 ppm, 1993; Austria: MAK 300 ppm (1400 milligram per cubic meter), 1999; Belgium: TWA 300 ppm (1400 milligram per cubic meter); STEL 375 ppm

(1750 milligram per cubic meter), 1993; Denmark: TWA 200 ppm (935 milligram per cubic meter), 1999; Finland: TWA 300 ppm (1400 milligram per cubic meter); STEL 375 ppm (1750 milligram per cubic meter), 1999; France: VME 300 ppm (1450 milligram per cubic meter), 1999; Japan: 300 ppm (1400 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 1450 milligram per cubic meter, 2003; Norway: TWA 150 ppm (725 milligram per cubic meter), 1999; the Phillipines: TWA 500 ppm (2350 milligram per cubic meter), 1993; Poland: MAC (TWA) 1000 milligram per cubic meter; MAC (STEL) 1800 milligram per cubic meter, 1999; Russia: TWA 300 ppm, 1993; Sweden: NGV 200 ppm (900 milligram per cubic meter), KTV 300 ppm (1400 milligram per cubic meter), 1999; Switzerland: MAK-W 300 ppm (1400 milligram per cubic meter), KZG-W 600 ppm (2800 milligram per cubic meter), 1999; Turkey: TWA 400 ppm (1900 milligram per cubic meter), 1993; United Kingdom: LTEL 300 ppm (1450 milligram per cubic meter); STEL 375 ppm, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 300 ppm. Several states have set guidelines or standards for octane in ambient air [60] ranging from 7.0 milligram per cubic meter (Connecticut) to 14.5−18.0 milligram per cubic meter (North Dakota) to 24.0 milligram per cubic meter (Virginia) to 34.524 milligram per cubic meter (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #1500, for hydrocarbons, BP 36−126°C; #2549, volatileorganic compounds; OSHA Analytical Method 7.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 4.5$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Octane can affect you when breathed in. Irritates the eyes, skin, and respiratory tract. Skin contact can cause rash and a burning sensation. Swallowing the liquid may cause aspiration into the lungs and chemical pneumonitis. Exposure to high concentrations of vapor can cause lightheadedness, dizziness, confusion, and may cause you to pass out.

Long-Term Exposure: Repeated or prolonged contact can result in dry, cracked skin.

Points of Attack: Eyes, skin, and respiratory system; central nervous system.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Do not induce vomiting. Give victim nothing to drink.

Note to Physician: Inhalation: Bronchodilators, decongestants, and oxygen may be used if necessary. Corticosteroids are useful for treating pneumonitis.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation Neoprene, Nitrile/PVC, and Nitrile are recommended. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *Up to 750 ppm*: Sa (APF = 10) (any supplied-air respirator).* *Up to 1000 ppm*: Sa: Cf (APF = 25) (any supplied -air respirator operated in a continuous-flow mode);* or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister] or SCBAE (any appropriate escape-type, SCBA). *Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—Red: Flammability hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Octane must be stored to avoid contact with strong oxidizers (such as chlorine and bromine) because violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where octane is used, handled, or stored. Metal containers used in the transfer of 5 gallons or more of octane should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of octane.

Shipping: UN1262 Octanes, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition includes oxides of carbon. Use dry chemical, carbon dioxide; or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an after burner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (100).

National institute for Occupational Safety and Health (NIOSH), "Criteria for a Recommended Standard: Occupational (2). Exposure to Alkanes," NIOSH Document Number 77-151, Cincinnati OH (1977).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Octane, Trenton, NJ (January 2000).

Octhilinone O:0124

Formula: $C_{11}H_{19}NOS$

Synonyms: Acticide, Thor; Busan; Cytox; Isothiazolone, 2-octyl-; Kathon 4200; Kathon 893; Kathon LM; Kathon LP; Microbicide 8; Micro-Chek 11; Micro-Chek Skane; Micropel; 2-octyl-3(2*h*)-isothiazolone; 2-octyl-4-isothiazolin-3-one; Pancil; Pancil T; Rh 893; Skane 8; Skane HQ; Skane M8; Slimicide; Ultrafresh DM25; Vinylzene IT

CAS Number: 26530-20-1

RTECS Number: NX8156900

UN/NA & ERG Number: UN2922/154

EC Number: 247-761-7 [*Annex I Index No.:* 613-112-00-5]

Regulatory Authority and Advisory Information

Hazard Alert: Poison (EPA Toxicity Class I, Danger, Highly toxic), Combustible, Corrosive, Sensitization hazard, Primary irritant (w/o allergic reaction), Environmental hazard.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292].

Hazard symbols, risk, & safety statements: Hazard symbol: T+, Xn, Xi, N; risk phrases: R22; R23/24/25; R34; R36/37/38; R43; R50/53; safety phrases: S1/2; S26; S29/35; S36/37/38; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to waters

Description: Yellow solid or clear dark amber liquid. Molecular weight = 213.35; Specific gravity (H_2O:1) = 1.04 @ 20°C; boiling point = 119.5°C; vapor pressure = 3 mmHg @ 25°C; flash point = > 100°C. Low solubility in water; solubility = < 1 mg/mL @ 25°C.

Potential Exposure: Isothiazolone/isothiocyanate/heteroaramatic fungicide and microbiocide used on textiles, in metalworking fluids, and some water thinned paints. Its use as a fungicide on cotton was canceled in the United States and the tolerances were revoked in 1998.

Incompatibilities: Oxidizers. Contact with hydrogen peroxide may form explosive material. Isothiocyanates are incompatible with many classes of compounds, reacting exothermically to release toxic gases. Reactions with amines, aldehydes, alcohols, alkali metals, ketones, mercaptans, strong oxidizers, hydrides, phenols, and peroxides can cause vigorous releases of heat. Ketones behave a weak acid. Forms water soluble alkali metal salts. Ketones are reactive with many acids and bases liberating heat and flammable gases. The amount of heat may be sufficient to start a fire in the unreacted portion of the ketone. Ketones react with reducing agents such as hydrides, alkali metals, and nitrides to produce flammable hydrogen gas and heat. Ketones are incompatible with isocyanates, aldehydes, cyanides, peroxides, and anhydrides. They react violently with aldehydes, nitric acid, and perchloric acid[101].

Permissible Exposure Limits in Air:

Determination in Air: Charcoal adsorption followed by CS_2 treatment and gas chromatographic analysis. See NIOSH Method 1300 [Ketones] [18]

Permissible Concentration in Water: No criteria set. Runoff from spills or fire control may cause water pollution.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 2.5. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Ingestion, inhalation, dermal, and eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Highly toxic by all routes. Contact can irritate the skin. Exposure can irritate the eyes and respiratory tract. Exposure to high concentrations may cause dizziness, lightheadedness, and unconsciousness. LD_{50} (oral, rat) = 550 mg/kg; (dermal, rat) = 4 mg/kg; (inhalation, rat) = < 1 mg/kg.

Long-Term Exposure: Repeated skin exposure can cause dryness and skin cracking. This chemical has not been adequately evaluated to determine whether brain or nerve damage could occur with repeated exposure. However, many solvents and other petroleum-based chemicals have been shown to cause such damage. Effects may include reduced memory and concentration, personality changes (withdrawal, irritability), and fatigue, sleep disturbances, reduced coordination, and/or effects on the nerves to the arms and legs causing weakness and "pins and needles."

Points of Attack: Respiratory system, skin.

Medical Surveillance: Preplacement examinations should evaluate skin and respiratory conditions. Acetone can be detected in the blood, urine, and expired air, and can be used as an index of exposure. Evaluation for brain effects such as changes in memory, concentration, sleeping patterns, and mood, as well as headaches and fatigue. Consider evaluations of the cerebellar, autonomic, and peripheral nervous systems. Positive and borderline individuals should be referred for neuropsychological testing

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth methods if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device?* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In the case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Applicators and other handlers must wear: Coveralls worn over long-sleeved shirt and longpants; chemical-resistant gloves such as DuPont Tychem suit fabrics, barrier laminate, or Viton; chemical-resistant foot wear plus socks; Protective eye wear; chemical-resistant headgear for overhead exposure; chemical-resistant apron when cleaning equipment, mixing, or loading[72]. Agricultural Use/Engineering Controls: When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the Worker Protection Standard (WPS) for agricultural pesticides, 40 CFR 170.240(d)(4-6), the handler PPE requirements may be reduced or modified as specified in the WPS. Firefighters should wear NIOSH approved SCBA and full protective clothing.

Respirator Selection: Wherever and whenever workplace conditions warrant respirator use, a respiratory protection program must be followed that meets one or more of the following requirements: OSHA's 29 CFR 1910.134, ANSIZ88.2, or European Standard EN 149.

Storage: (**1**) Color code—White: Corrosive or contact hazard; store separately in a corrosion resistant location. (2) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from acids. Where possible, automatically transfer from drums or other storage containers to process containers.

Shipping: UN2922 Corrosive liquids, toxic, n.o.s., Hazard class: 8; Labels: 8-Corrosive material, 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: May burn but does not easily ignite. Thermal decomposition products may include oxides of nitrogen, sulfur, and carbon. *Small fires:* Dry chemical, carbon dioxide; water spray; or foam. extinguishers. *Large fires:* Water spray, fog, or foam. Move container from fire area if you can do it without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Contact with easily oxidized organic materials may cause fires and explosions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (101); (138); (204); (100).

tert-Octyl Mercaptan O:0128

Formula: $C_8H_{18}S$

Synonyms: 2-Methyl-2-heptanethiol; *tert*-Octanethiol; Octyl mercaptan-t; *t*-Octyl mercaptan; 1,1,3,3-Tetramethyl-1-butylsulfhydrate; 2,4,4-Trimethyl-2-pentanethiol

CAS Registry Number: 141-59-3

HSDB Number: 6319

RTECS Number: SA3260000

UN/NA & ERG Number: (PIH) UN3023/131

EC Number: 205-490-1

Regulatory Authority and Advisory Information

Hazard Alert: Poison inhalation hazard, Neurotoxin, Flammable liquid.

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Hazard symbols, risk, & safety statements: Hazard symbol: T+, F, Xn; risk phrases: R11; R20/22; R23/24/25; R36/37/38; R39; R41; R50/53; safety phrases: S7; S16; S26; S36/37/39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: 2,4,4-Trimethyl-2-pentanethiol is a clear, colorless liquid. Molecular weight = 146.29; specific gravity (H_2O:1) = 0.85 @ 16°C; boiling point = 155.48°C; freezing/melting point = 45.8°C; vapor pressure = 5.198 mmHg @ 25°C; flash point = 41°C. Henry's Law constant = 1.9×10^{-2} atm-m^3/mol @ 25°C (est)[72]. Hazard identification (based on NFPA-704 M Rating System): Health 2; flammability 2; reactivity 0[88], HSDB. Soluble in water; solubility = 31 mg/L @ 25°C.

Potential Exposure: A mercaptan, sulfhydral, thioalcohol, and organic sulfide. Used as a lubricant additive and in polymer modification[193].

Incompatibilities: Highly flammable; easily ignited by heat, sparks, or flames. Vapors may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides. Attacks many metals and rubber.

Permissible Exposure Limits in Air:

PAC* Ver. 29[138]

PAC-1: 0.055 ppm

PAC-2: $\mathbf{0.60_A}$ ppm

PAC-3: $\mathbf{1.8_A}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

Determination in Water: Octanol−water coefficient: Log K_{ow} = ~4.0. Values above 3.0 are likely to bioaccumulate in aquatic organisms. Runoff from fire control or dilution water may cause pollution.

Routes of Entry: Inhalation, ingestion, and dermal contact.

Harmful Effects and Symptoms

Short-Term Exposure: 2,4,4-Trimethyl-2-pentanethiol is highly toxic. It may be fatal if inhaled, ingested or absorbed through skin. Inhalation or contact will irritate or burn skin and eyes and cause dizziness, headache, nausea, vomiting, and unconsciousness. May attack the central nervous system, causing convulsions, lowering of consciousness, and respiratory depression. Exposure may result in death.

Long-Term Exposure: May be neurotoxic with cumulative effects.

Points of Attack: Brain. Central nervous system.

Medical Surveillance: Examination of the nervous system.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth methods if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device?* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In the case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. Wash skin with soap and water. In the case of burns, immediately cool affected skin for as long as possible with cold water. Do not remove clothing if adhering to skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves.

Personal Protective Methods: Fully encapsulating, vapor protective clothing should be worn for spills and leaks with no fire.

Respirator Selection: Wherever and whenever workplace conditions warrant respirator use, a respiratory protection program must be followed that meets one or more of the following requirements: OSHA's 29 CFR 1910.134, ANSI Z88.2, or European Standard EN 149.

Storage: Poison inhalation chemical (PIH); check oxygen content prior to entering storage area. Color code—Blue: Health hazard/poison: Store in a secure poison location. Color code—Red: Flammability hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. This chemical must be stored to avoid contact with strong oxidizers (such as chlorine and bromine) because violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where octane is used, handled, or stored. Metal containers used in the transfer of 5 gallons or more of octane should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers.

Shipping: UN3023 2-Methyl-2-heptanethiol, Hazard Class: 6.1; Labels: 6.1-Poison Inhalation Hazard; 3-Flammable liquid; Inhalation Hazard Zone B

Spill Handling:

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.2/03

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.3/0.5
Night 0.5/0.8

Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Fully encapsulating, vapor protective clothing should be worn for spills and leaks with no fire. *Eliminate* all ignition sources (no smoking, flares, sparks, or flames in immediate area). All equipment used when handling the product must be grounded. Do not touch or walk through spilled material. Stop leak if you can do it without risk. Prevent entry into waterways, sewers, basements, or confined areas. A vapor suppressing foam may be used to reduce vapors. *Small spill*: Absorb with earth, sand, or other noncombustible material and transfer to containers for later disposal. Use clean nonsparking tools to collect absorbed material. *Large spill:* Dike far ahead of liquid spill for later disposal. Water spray may reduce vapor; but may not prevent ignition in closed spaces. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include hydrogen sulfide and and oxides of sulfur and carbon. Vapors may cause dizziness or suffocation. Vapors may travel to source of ignition and flash back. Most vapors are heavier than air. They will spread along ground and collect in low or confined areas (sewers, basements, and tanks). Vapor explosion and poison hazard indoors, outdoors, or in sewers. Runoff from fire control or dilution water may cause pollution. Runoff to sewer may create fire or explosion hazard. Containers may explode when heated.

Disposal Method Suggested: Use a licensed professional waste disposal service to dispose of this material. Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (100).

Octyl Phenol O:0130

Formula: $C_{14}H_{22}O$; $C_8H_{17}C_6H_4OH$

Synonyms: Diisobutyl phenol; 4-(Di-*iso*-butyl) phenol; 4-*tert*-Octylphenol; *p*-tert-Octylphenol; *p-t*-Octyl phenol; 4-(1,1,3,3-Tetramethylbutyl)phenol; *p*-(1,1,3,3-Tetramethylbutyl)phenol; *p*-(1,1,3,3-Tetramethyl-*N*-butyl) phenol; Timtec-BB

CAS Registry Number: 27193-28-8; 1322-69-6

HSDB Number: 5857

RTECS Number: SM5775000

EC Number: 248-310-7

Regulatory Authority and Advisory Information

FDA: 21CFR§175.105

Hazard symbols, risk, & safety statements: Hazard symbol: Xn; risk phrases: R21; R22; R38; R41; R51; safety phrases: S16; S26; S36; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [2-Hazard to water. (est.)]

Description: Octyl phenol is a white to pink crystalline solid. Molecular weight = 206.36; boiling point = 280−302°C; freezing/melting point = 72−74°C; flash point = ~149°C. Insoluble in water.

Potential Exposure: As a fuel oil stabilizer; as an intermediate for resins; in fungicides, bactericides, dyestuffs, adhesives, antioxidants, nonionic surfactants; plasticizers and rubber; in adhesives; and food packaging.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides.

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Routes of Entry: Inhalation, ingestion; skin, and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: *Inhalation*: May cause irritation to lungs and throat. *Skin*: May cause irritation. *Eyes*: May cause severe irritation. *Ingestion*: Moderately toxic; may cause digestive upset. LD_{50} = (ip-mouse) 25 mg/kg.

Long-Term Exposure: May cause liver and/or kidney damage. May be a mutagenic.

Points of Attack: Liver, kidneys.

Medical Surveillance: Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)- approved respirator such as a supplied-air respirator with a full-face-piece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health hazard/poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Will ignite at about 149°C. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an after burner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (100).

New York State Department of Health, *Chemical Fact Sheet:* Octyl Phenol, Bureau of Toxic Substance Assessment, Albany, NY (April 1986).

Oryzalin O:0138

Formula: $C_{12}H_{18}N_4O_6S$

Synonyms: Agvalue; Benzene sulfonamide, 4-(dipropylamino)-3,5-dinitro-; Caswell No. 623A; Compound 67019; 3,5-Dinitro-N^4,N^4-dipropyl sulfanilamide; 3,5-Dinitro-N^4,N^4-dipropylsulfanilamide; 3,5-Dinitro-N^4,N^4-dipropyl sulphanilamide; 4-(Dipropylamino)-3,5-dinitrobenzene sulfonamide; Dirimal; EL-119; Excel-S-Plus; Expedite; Flexlan; Nations

AGII; Oryza; Pro-Teck; Rout; Rycelan; Ryzelan; Snapshot; Sulfanilamide, 3,5-dinitro-N^4,N^4-dipropyl-; Surflan; Turf Fertilizer; XL 2G

CAS Number: 19044-88-3

HSDB Number:6858

RTECS Number: WO9350000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171; UN1596 (Dinitroanilines)/153

EC Number: 242-777-0

Regulatory Authority and Advisory Information

United States Environmental Protection Agency Carcinogens: Likely a human carcinogen

California Proposition 65 Chemical[102]: Cancer, 9/12/2008

Hazard Alert: Poison, Sensitization hazard, Suspected reprotoxic hazard, Agricultural chemical.

Potential Ground water Pollutant [California FAC Section 13145(d)/12811, active]

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%

Regulations: Hazard symbol: Xn, N; risk phrases: R45; R40; R43; R50/53, Xi; safety phrases: S2; S50/53; R60 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Yellow−orange crystalline solid or powder. Odorless. Molecular weight = 346.36; specific gravity (H_2O:1) = 1.2; boiling point = (decomposes); freezing/melting point = 138°C; vapor pressure = 1.2×10^{-8} mm @ 20°C. Low solubility in water; solubility = 2.49 mg/L.

Potential Exposure: Oryzalin is a 2,6-dinitroaniline herbicide used to control annual grasses, herbaceous plants, woody shrubs, vines, and broad leaf weeds on fruit and nut trees, soya beans, peas, sweet potatoes, berries, vine and crops, cotton, Christmas tree plantations, commercial/industrial and recreation area lawns, golf course turf, residential lawns and turf, ornamental, and/or shade trees, nonagricultural rights-of-way, nonagricultural uncultivated and industrial areas, power stations, paths/patios, and paved areas.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides. Slowly hydrolyzes in water, releasing ammonia, and forming acetate salts. Decomposes at 265°C releasing toxic oxides of nitrogen, sulfur, and carbon. Decomposed by strong ultraviolet light.

Permissible Concentration in Water: Runoff from spills or fire control may cause water pollution. State Drinking Water Guidelines: Florida 350 μg/L.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = > 3.5$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Harmful Effects and Symptoms

Short-Term Exposure: Slight irritant to skin, eyes, and mucous membranes. Dermatitis may develop. Potential liver, kidney, and spleen toxin. LD_{50} (oral, rat) = > 7 g/kg; (dermal, rat) = >2 g/kg.

Long-Term Exposure: May cause skin sensitization. This chemical can bioaccumulate. A potential human carcinogen.

Points of Attack: Liver, kidney, spleen, and skin.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure. Preliminary medical exam to detect chronic diseases of central nervous system, liver, heart, kidneys, lung, and skin, as well as endocrinological or immunological disturbances, should protect susceptible individuals. Periodical medical exams of internal organs, skin, and eyes are important to avoid chronic occupational intoxications. They should include lab and patch tests when necessary[83]. Kidney, spleen, and liver function tests. Evaluation by a qualified allergist, including exposure history and testing, may help diagnose allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Dinitroanilines react with cellulose-based and expanded polymeric absorbents[88]. Reacts with the following absorbent materials: Cellulose-based; mineral-and clay-based; expanded polymeric[88]. Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of dermal and/or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration*: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA

(APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-face-piece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: (1) Color code—Blue: Health hazard/poison. Store in a secure poison location. (2) Color code—Yellow Stripe: Reactivity hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, strong acids; strong bases and other incompatible materials listed above. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. If this material contains a flammable carrier, sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneoushazardous material, Technical Name Required. UN1596 Dinotoanilines, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: First remove all sources of ignition. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Decomposes above 250°C. Thermal decomposition products may include toxic oxides of nitrogen, sulfur, and carbon. As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 m/150 ft for liquids and at least 25 m/75 ft for solids. *Fire involving storage or vehicular tanks:* Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. *On a small fire:* use dry chemical, CO_2, water spray, or regular *foam. On a large fire:* use water spray, fog or regular foam. Do not scatter spilled material with high pressure streams of water. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal. *Fire involving tanks:* From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. Always stay away from tanks engulfed in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Do not discharge into drains or sewers. Dispose of waste material as hazardous waste using a licensed disposal contractor to an approved landfill. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Incineration with effluent gas scrubbing is recommended. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(102); (31); (173); (101); (138); (100).

United States Environmental Protection Agency, "Reregistration Eligibility Decision (RED), Oryzalin," Office of Prevention, Pesticides and Toxic Substances, Washington, DC (September 1994). http://www.epa.gov/REDs/0186.pdf

United States Environmental Protection Agency, Office of Pesticide Programs, Pesticide Residue Limits, "Oryzalin," 40 CFR 180.304, http://www.epa.gov/pesticides/food/viewtols.htm

EXTOXNET, Extension Toxicology Network, "Pesticide Information Profile, Oryzalin," Oregon State University, Corvallis, OR (June 1996). http://extoxnet.orst.edu/pips/oryzalin.htm

Osmium & Osmium Tetroxide O:0140

Formula: Os; O_4Os

Synonyms: Milas' reagent; Osmic acid anhydride; Osmium oxide (OsO_4); Osmium (IV) oxide; Tetroxido de osmio (Spanish)

CAS Registry Number: 7440-04-2 (elemental); 20816-12-0 (tetroxide)
HSDB Number: 7329 (elemental); 719 (tetroxide)
RTECS Number: RN1100000 (elemental); RN1140000 (tetroxide)
UN/NA & ERG Number: (PIH) UN2471 (tetroxide)/154
EC Number: 231-114-0; 244-058-7 [*Annex I Index No.:* 076-001-00-5] (tetroxide)
Regulatory Authority and Advisory Information
United States Environmental Protection Agency Gene-Tox Program (*tetroxide*), Positive: B *subtilis* rec assay; Inconclusive: D *melanogaster* sex-linked lethal
Hazard Alert (osmium tetroxide): Extremely toxic gas, Strong oxidizer, Suspected of causing genetic defects, Suspected reprotoxic hazard.
OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 100 lb (45 kg)
Superfund/EPCRA 302, Extremely Hazardous Substances: *Dropped From Listing In 1988*
United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P087
RCRA, 40CFR261, Appendix 8 Hazardous Constituents
Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1000 lb (454 kg)
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%. as osmium tetroxide.
European/International Regulations (*tetroxide*): Hazard symbol: T+, N; Risk phrases: R26/27/28; R34; R62; R63; safety phrases: S1/2; S7/9; S26; S41; S45 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): Nonhazardous to water. (metal, <1 mm.)
Description: Osmium is a blue−white metal. It is found in platinum ores and in the naturally occurring alloy osmiridium. Osmium when heated in air or when the finely divided form is exposed to air at room temperature, oxidizes to form the tetroxide (OsO_4), osmic acid. Osmium tetraoxide is a colorless, crystalline solid or pale-yellow mass. Unpleasant, acrid, chlorine-like odor. A liquid above 41°C. Molecular weight = 190.2 (Os); 254.23 (OsO_4); specific gravity (H_2O:1) = 22.6 (Os); 5.1 (OsO_4); boiling point = 5012°C (Os); 131°C (sublimes well below the BP, OsO_4); freezing/melting point = 41°C (OsO_4); vapor pressure = 7 mmHg @ 20°C (OsO_4). Slightly soluble in water; solubility = 6% @ 25°C (OsO_4). Hazard identification (based on NFPA-704 M Rating System): Health 4, flammability 0, reactivity 3 (oxidizer).
Potential Exposure: Osmium may be alloyed with platinum metals, iron, cobalt, and nickel; and it forms compounds withtin and zinc. The alloy with iridium is used in the manufacture of fountain pen points, engraving tool; record player needles; electrical contacts; compass needles; fine machine bearings; and parts for watch and lock mechanisms. The metal is a catalyst in the synthesis of ammonia; and in the dehydrogenation of organic compounds. It is also used as a stain for histological examination of tissues. Osmium tetroxide is used as an oxidizing agent, catalyst, and as a fixative for tissues in electron microscopy. Other osmium compounds find use in photography. Osmium no longer is used in incandescent lights or in fingerprinting.
Incompatibilities: Osmium tetroxide is a strong oxidizer. Reacts with combustibles and reducing materials. Reacts with hydrochloric acid to form toxic chlorine gas. Forms unstable compounds with alkalis.
Permissible Exposure Limits in Air
NIOSH IDLH = 1 mg[OsO_4]/m^3
Conversion factor: 1 ppm = 10.40 milligram per cubic meter (tetroxide) @ 25°C & 1 atm
OSHA PEL: 0.002 mg[Os]/m^3 TWA
NIOSH REL: 0.0002 ppm/0.002 mg[Os]/m^3 TWA; 0.006 mg[Os]/m^3/0.0006 ppm STEL
ACGIH TLV[1]: 0.0002 ppm/0.0016 mg[Os]/m^3 TWA; 0.0047 mg[Os]/m^3/0.0006 ppm STEL
PAC* Ver. 29[138]
7440-04-2, elemental
PAC-1: 0.28 milligram per cubic meter
PAC-2: 3.1 milligram per cubic meter
PAC-3: 19 milligram per cubic meter
20816-12-0, tetroxide
NIOSH IDLH = 1 mg[OsO_4]/m^3
Odor threshold = 0.0019 ppm
PAC-1: 0.0006 ppm (6.00E-4)
PAC-2: **0.0084**$_{\mathbf{A}}$ ppm
PAC-3: **4.0**$_{\mathbf{A}}$ ppm
*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.
Arab Republic of Egypt: TWA 0.0002 ppm (0.002 mg [Os]/m^3), 1993; Australia: TWA 0.0002 ppm (0.002 mg [Os]/m^3); STEL 0.0006 ppm, 1993; Austria: MAK 0.0002 ppm (0.002 mg[Os]/m^3), 1999; Belgium: TWA 0.0002 ppm (0.0016 mg[Os]/m^3); STEL 0.0006 ppm, 1993; Denmark: TWA 0.0002 ppm (0.002 mg[Os]/m^3), 1999; Finland: TWA 0.0002 mg[Os]/m^3; STEL 0.002 mg[Os]/m^3, 1999; France: VME 0.0002 ppm (0.002 mg[Os]/m^3), 1999; the Netherlands: MAC-TGG 0.002 mg[Os]/m^3, 2003; Norway: TWA 0.0002 ppm (0.002 mg[Os]/m^3), 1999; the Philippines: TWA 0.002 mg[Os]/m^3, 1993; Switzerland: MAK-W 0.0002 ppm (0.002 mg[Os]/m^3), KZG-W 0.0004 ppm, 1999; United Kingdom: TWA 0.0002 ppm (0.002 mg [Os]/m^3); STEL 0.0006 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 0.0006 (Os)ppm. There is presently no PEL for elemental, metallic osmium. Several states have set guidelines or standards for osmium tetroxide in ambient air[60] ranging from zero in North Dakota to 0.04 μ/m^3 (Connecticut) to 1.0 μ/m^3 (Nevada) to 3000 μ/m^3 (Virginia).
Determination in Air: No NIOSH Analytical Method available.
Determination in Water: Osmium tetraoxide may be hazardous to the environment; crustacea, in particular, may be at risk.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Osmium metal is innocuous, but persons engaged in the production of the metal may be exposed to acids and chlorine vapors. By contrast, osmium tetroxide vapors are poisonous and extremely irritating to the eyes; even in low concentrations they may cause weeping and persistent conjunctivitis. Longer exposure can cause redness, swelling of the eye tissue; blurred vision; and may result in damage to the cornea and permanent loss of vision. Contact with skin may cause discoloration (green or black) dermatitis and ulceration. *Inhalation*: Fumes are extremely irritating to the respiratory system, causing tracheitis, bronchitis, bronchial spasm; and difficulty in breathing which may last several hours. Longer exposures can cause serious inflammatory lesions of the lungs (bronchopneumonia with suppuration and gangrene). Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Exposure to high concentrations may result in death. Slight kidney damage was seen in rabbits inhaling lethal concentrations of vapor for 30 minutes. Some fatty degeneration of renal tubules was seen in one fatal human case along with bronchopneumonia following an accidental overexposure.

Long-Term Exposure: Repeated or prolonged contact with skin may cause dermatitis. The substance may cause kidney damage. Repeated exposure may cause lung irritation; bronchitis may develop. There is limited evidence that osmium tetroxide may cause mutations.

Points of Attack: Eyes, respiratory system; lungs, skin, and kidneys.

Medical Surveillance: Consider the skin, eyes, respiratory tract, and renal function in preplacement or periodic examinations. Lung function tests. Complete eye exam. Urinalysis. Chest X-ray.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth methods if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device?* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In the case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Avoid all contact. Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eye wash.

Respirator Selection: *Up to 0.1 milligram per cubic meter*: CcrFS100 (APF = 50) [Any air-purifying full-face-piece respirator equipped with cartridge(s) providing protection against the compound of concern in combination with an N100, R100, or P100 filter]; or GmFS100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front-or back- mounted canister providing protection against the compound of concern and having an N100, R100, or P100 filter]; or SCBAF (APF = 50) (any SCBA with a full facepiece); SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 1 milligram per cubic meter*: SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd, Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front-or back-mounted canister providing protection against the compound of concern and having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Check oxygen content prior to entering storage area. Color code—Blue: Health hazard/poison (*osmium tetroxide*): Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store refrigerated in tightly closed containers away from hydrochloric acid, reducing agents and easily oxidized materials. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Store in a cool, well-ventilated area away from incompatible materials listed above. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage.

Shipping: UN2471 Osmium tetroxide, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Osmium tetraoxide may burn but does not easily ignite. Thermal decomposition products may include oxides of osmium. *Small fires:* dry chemical, carbon dioxide; water spray; or foam. extinguishers. *Large fires:* water spray, fog, or foam. Move container from fire area if you can do it without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Contact with easily oxidized organic materials may cause fires and explosions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Osmium Tetroxide, Washington, DC, Chemical Emergency Preparedness Program (Oct. 31, 1985)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Osmium Tetroxide, Trenton NJ (August 2002)

Oxadiazon O:0154

Formula: $C_{15}H_{18}Cl_2N_2O_3$

Synonyms: 2-*tert*-Butyl-4-(2,4-dichloro-5-isopropoxyphenyl)-δ(sup2)-1,3,4-oxadiazoline-5-one; 5-*tert*-Butyl-3-(2,4-dichloro-5-isopropoxyphenyl)-1,3,4-oxadiazol-2(3*H*)-one; 2-*tert*-Butyl-4-(2,4-dichloro-5-isopropoxyphenyl)-δ(*sup2*)-1,3,4-oxadiazolin-5- one; 2-*tert*-Butyl-4-(2,4-dichloro-5-isopropyloxyphenyl)-1,3,4-oxadiazolin-5-one; Carpetmaker; Caswell No. 624A; Chip Shot; 3-(2,4-Dichloro-5-isopropyloxy-phenyl)-δ(sup4)4-5-(*tert*-butyl)-1,3,4-oxadiaz oline-2-one; 3-(2,4-Dichloro-5-(1-methylethoxy)phenyl)-5-(1,1-dimethylethyl)-1,3,4-oxadiazol-2(3*H*)-one; Gold-Kist; δ(sup2) 2-1,3,4-Oxadiazolin-5-one, 2-*tert*-butyl-4-(2,4-dichloro-5-isopropyloxyphenyl)-; 1,3,4-Oxadiazol-2(3*H*)-one, 3-(2,4-dichloro-5-(1-methylethoxy)phenyl)-5-(1,1-dimethylethyl)-; Oxadiazone; 1,3,4-Oxazol-2(3*H*)-one, 3-[2,4-dichloro-5-(1-methylethoxy)phenyl]-5-(1,1-dimethylethyl)-; Par EX; Pro-Grow; Regal O-O; Regalstar; Ronstar; RP-17623; Turfic; Vertagreen; Wilbro

CAS Number: 19666-30-9

HSDB Number: 6936

RTECS Number: RO0874000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 243-215-7 [*Annex I Index No.:* 606-045-00-8]

Regulatory Authority and Advisory Information

Carcinogenicity[83]: EPA Group C, Possible human carcinogen

California Proposition 65 Chemical[102]: Carcinogen (7/1/1991) and developmental toxin (5/15/1998)

Hazard Alert: Poison, Suspected reprotoxic hazard, Environmental hazard.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: N; risk phrases: R45; R50/53; R60; R61; R63; safety phrases: S2; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Colorless crystalline solid. Odorless. Molecular weight = 345.22; boiling point = 281.5°C; freezing/melting point = 89°C; vapor pressure = 1.15×10^{-7} mm @ 20°C[83,USDA]. Low solubility in water; solubility = 0.7 mg/L @ 20°C.

Potential Exposure: An oxadiazolinone/oxidiazole preemergence and early postemergence herbicide used to control annual grasses, sedges, and broadleaf weeds. Originally registered for use on turf and ornamentals; has wide use on golf courses.

Incompatibilities: Dust may form explosive mixture in air. Diazo compounds can detonate. This applies in particular to organic azides that have been sensitized by the addition of metal salts or strong acids. Toxic gases are formed by mixing materials of this class with acids, aldehydes, amides, carbamates, cyanides, inorganic fluorides, halogenated organics, isocyanates, ketones, metals, nitrides, peroxides, phenols, epoxides, acyl halides, and strong oxidizing or reducing agents. Flammable gases are formed by mixing materials in this group with alkali metals. Explosive combination can occur with strong oxidizing agents, metal salts, peroxides, and sulfides. This chemical is sensitive to prolonged exposure to heat. This chemical is incompatible with strong oxidizing agents[101].

Determination in Air: Filter; none; Gravimetric; NIOSH IV [Particulates NOR; #0500 (total), #0600 (respirable)][18].

Determination in Water: Octanol−water coefficient: Log $K_{ow} = > 4.5$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, dermal and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: May irritate the eyes and skin. LD_{50} (oral, rat) = > 3 g/kg[83]; (dermal, rat) = > 2 g/kg.

Long-Term Exposure: Frequent or prolonged exposure may cause cancer. Fluorides may cause bone disease (pain and tenderness of the bones); mottled teeth in children. May cause liver problems. Repeated exposure may cause weight loss and reduced red blood cell count. May be mutagenic.

Points of Attack: Liver, blood, and bones; may affect fetus.

Medical Surveillance: Preliminary medical exam to detect chronic diseases of central nervous system, liver, heart, kidneys, lung, and skin, as well as endocrinological or immunological disturbances, should protect susceptible individuals. Periodical medical exams of internal organs, skin, and eyes are important to avoid chronic occupational intoxications. They should include lab and patch tests when necessary[83]. This chemical is a suspected or known human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and advice for medical monitoring. Test for anemia, liver function tests. In addition to comprehensive initial medical and work histories emphasizing reproductive experience and menstrual history, patient should have physical examination and testing of genito-urinary tract, sperm count, motility, and morphology. If required, other tests, such as serum testosterone, serum follicle stimulating hormone (FSH), and serum lutenizing hormone (LH) may be indicated.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Do not induce vomiting when formulations containing petroleum solvents are ingested

Personal Protective Methods: Applicators and other handlers must wear: Coveralls worn over long-sleeved shirt and long pants; Chemical-resistant gloves such as DuPontTychem suit fabrics, barrier laminate, or Viton; Chemical-resistant foot wear plus socks; Protective eye wear; Chemical-resistant headgear for overhead exposure; Chemical-resistant apron when cleaning equipment, mixing, or loading[83]. Agricultural Use/Engineering Controls: When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the WPS for agricultural pesticides, 40 CFR 170.240 (d) (4-6), the handler PPE requirements may be reduced or modified as specified in the WPS. Firefighters should wear NIOSH approved SCBA and full protective clothing.

Respirator Selection: *At any detectable concentration*: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-face-piece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health hazard/possible human carcinogen: Store in a tightly closed container in a dry, well-ventilated and secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Where possible, automatically transfer material from other storage containers to process containers. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Careful, a possible carcinogen. For solids, *small spill*, isolate spill or leak area in all directions for at least 25 m/75 ft. Increase, in the downwind direction, as necessary. For a *large spill* evacuate downwind at least 100 m/330 ft. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Stop leak if you can do it without risk. Keep combustibles (wood, paper, oil, etc.) away from spilled material. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Stop leak if you can do it without risk. Do not allow water to get inside containers. *Small dry spill*: With clean shovel place material into clean, dry container and cover loosely; move containers from spill area. *Large spill*: Dike far ahead of liquid spill for later disposal. Following product recovery, flush area with water. Prevent entry into waterways, sewers, basements, or confined areas. Cover with plastic sheet to prevent spreading. Absorb or cover with dry earth, sand or other noncombustible material and transfer to containers. Do not allow water to get inside containers. Prevent entry into waterways, sewers, basements, or confined areas. Cover with plastic sheet to prevent spreading. Absorb or cover with dry earth, sand or other noncombustible material and transfer to containers.

Fire Extinguishing: Thermal decomposition products may include hydrogen chloride and oxides of nitrogen and carbon. As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 m/150 ft for liquids and at least 25 m/75 ft for solids. *Fire involving storage or vehicular tanks:* Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. *On a small fire:* use dry chemical, CO_2, water spray or regular *foam. On a large fire:* use water spray, fog or regular foam. Do not scatter spilled material with high pressure streams of water. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal. *Fire involving tanks:* From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. Always stay away from tanks engulfed in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: It is the responsibility of chemical waste generators to determine the toxicity and physical properties and of a discarded chemical and to properly identify its classification and certification as a hazardous waste, and to determine the disposal method. United States Environmental Protection Agency guidelines for the classification determination are listed in 40 CFR Parts 261.3. Additionally, waste generators must consult and follow all regional, national, state, and local hazardous waste laws to ensure complete and accurate classification and disposal methods. Follow recommendations for the disposal of pesticides and pesticide containers. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

Disposal Method Suggested: Do not discharge into drains or sewers. Dispose of waste material as hazardous waste using a licensed disposal contractor to an approved landfill. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. If allowed, incineration with effluent gas scrubbing is recommended. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(102); (31); (173); (101); (138); (100).

Pesticide Management Education Program, “Oxadiazon (Ronstar) Herbicide Profile 2/85,” Cornell University, Ithaca, NY (February 1985). http://pmep.cce.cornell.edu/profiles/herb-growthreg/naa-rimsulfuron/oxadiazon/herb-Prof-oxadiazon.html

Ouabain O:0150

Formula: $C_{29}H_{44}O_{12}$

Synonyms: Acocantherin; Astrobain; Gratibain; Gratus strophanthin; G-Strophanthin; Ouabagenin-l-rhamnosid (German); Ouabaine; Oubain; Purostrophan; Quabain; Quabagenin-l-rhamnoside; Strophanthin G; Strophoperm

CAS Registry Number: 630-60-4; 11018-89-6 (octahydrate)

HSDB Number: 3519

RTECS Number: RN3675000

UN/NA & ERG Number: UN1544 (Alkaloids, solid, n.o.s.)/151

EC Number: 211-139-3 [*Annex I Index No.:*614-025-00-5]

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Suspected of causing genetic defects.

SUPERFUND/EPCRA 302, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)

Canada: WHMIS, Class D1A; Not on DSL or NDSL lists.

European/International Regulations (630-60-4): Hazard symbol: T; risk phrases: R23/25; R33; R50; R62; safety phrases: S1/2; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Ouabain is a white crystalline solid. Molecular weight = 584.73; freezing/melting point = (decomposes) 190°C. Slightly soluble in water.

Routes of Entry: Inhalation, ingestion.

Potential Exposure: Ouabain, similar to digitoxin, is used to produce rapid digitalization in acute congestive heart failure. Also recommended in treatment of atrial or nodal paroxysmal tachycardia and atrial flutter; enzyme inhibitor.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.).

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 0.75 milligram per cubic meter

PAC-2: 8.3 milligram per cubic meter

PAC-3: 50 milligram per cubic meter

Determination in Water: Log $K_{ow} = < -1$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Upon exposure to ouabain, symptoms of heart failure occur, with marked increase in serum potassium. Signs may include confusion, vomiting, coma, convulsions, and respiratory failure. It is classified as extremely toxic. Probable oral lethal dose in humans is less than 5 mg/kg or a taste (less than 7 drops) for 70 kg (150 lb) person. Exposure may result in respiratory and cardiac failure; and/or hyperalkemia. $LD_{50} =$ (oral-mouse) $\geq$ 500 mg/kg *Note:* Patients with frequent premature ventricular heart beat or who have received any preparation of digitalis during preceding 3 weeks are prone to toxicity.

Points of Attack: Heart, other organs.

Medical Surveillance: EKG, tests of Lungs, liver, kidneys.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: For emergency situations, wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. pressure, pressure-demand, full-face-piece SCBA or pressure-demand supplied air respirator with escape SCBA and a fully-encapsulating, chemical resistant suit.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health hazard/poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage.

Shipping: UN1544 Alkaloids, solid, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Keep combustibles (wood, paper, oil, etc.) away from spilled material. Do not touch spilled material. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills*: with clean shovel place material into clean, dry container and cover; move container from spill area. *Large spills*: dike far ahead of spill for later disposal. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of carbon. For small fires, use dry chemical, carbon dioxide; water spray; or foam. For large fires, use water spray, fog, or foam. Cool containers that are exposed to flames with water from the side until well after fire is out. For massive fires use unmanned hose holder or monitor nozzles; if this is impossible, withdraw and let fire burn. Wear self-contained (positive pressure if available) breathing apparatus and full protective clothing. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Ouabain, Washington, DC, Chemical Emergency Preparedness Program (Nov. 30, 1987).

Oxalic Acid O:0160

Formula: $C_2H_2O_4$; $C_2H_6O_6$; $HOOCCOOH \cdot 2H_2O$

Synonyms: Acide oxalique (French); Aktisal; Aquisal; Ethanedioic acid; Ethanedioic acid; NCI-C55209; Oxalic aciddihydrate; Oxalsaeure (German)

CAS Registry Number: 144-62-7

HSDB Number: 1100

RTECS Number: RO2450000

UN/NA & ERG Number: UN3261/154

EC Number: 205-634-3 [*Annex I Index No.:* 607-006-00-8]

Regulatory Authority and Advisory Information

Hazard Alert: Combustible, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction).

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazard symbols, risk, & safety statements: Hazard symbol: Xn; risk phrases: R21/22; R60; R61; R62; safety phrases: S2; S24/25 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Oxalic acid is a colorless, odorless powder, or granular solid. The anhydrous form $(COOH)_2$ is an odorless, white solid; the solution is a colorless liquid. Molecular weight = 90.04; specific gravity (H_2O:1) = 1.9 @ 17°C; sublimation point = 150−157°C; freezing/melting point (decomposes): 101.7°C; 190°C (anhydrous); vapor pressure = 0.54 mmHg @ 105°C;. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 1, reactivity 0. Moderately soluble in water.

Potential Exposure: Oxalic acid is used in textile finishing, paint stripping; metal and equipment cleaning; as an intermediate; as an analytic reagent and in the manufacture of dyes, inks, bleaches, and paint removers; varnishes, wood, and metal cleansers; dextrin, cream of tartar, celluloid, oxalates, tartaric acid, purified methyl alcohol, glycerol, and stable hydrogen cyanide. It is also used in the photographic, ceramic, metallurgic, rubber, leather, engraving, pharmaceutical, paper, and lithographic industries.

Incompatibilities: The aqueous solution is a medium-strong acid. Compounds of the carboxyl group react with all bases, both inorganic and organic (i.e., amines) releasing substantial heat, water and a salt that may be harmful. Incompatible with arsenic compounds (releases hydrogen cyanide gas), diazo compounds, dithiocarbamates, isocyanates, mercaptans, nitrides, and sulfides (releasing heat, toxic, and possibly flammable gases), thiosulfates and dithionites (releasing hydrogen sulfate and oxides of sulfur). Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from silver compounds; strong alkalis; chlorites. Contact with some silver compounds forms explosive materials.

Permissible Exposure Limits in Air

NIOSH IDLH = 500 milligram per cubic meter

OSHA PEL: 1 milligram per cubic meter TWA

NIOSH REL: 1 milligram per cubic meter TWA; 2 milligram per cubic meter STEL

ACGIH TLV[1]: 1 milligram per cubic meter TWA; 2 milligram per cubic meter STEL

PAC Ver. 29[138]

PAC-1: 2 milligram per cubic meter

PAC-2: 20 milligram per cubic meter

PAC-3: 500 milligram per cubic meter

Arab Republic of Egypt: TWA 1 milligram per cubic meter, 1993; Australia: TWA 1 milligram per cubic meter; STEL 2 milligram per cubic meter, 1993; Austria: MAK 1 milligram per cubic meter, 1999; Denmark: TWA 1 milligram per cubic meter, 1999; Finland: TWA 1 milligram per cubic meter; STEL 3 milligram per cubic meter, 1999; France: VME 1 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 1 milligram per cubic meter, 2003; Poland: MAC (TWA) 1 milligram per cubic meter; MAC (STEL) 2 milligram per cubic meter, 1999; Sweden: NGV 1 milligram per cubic meter, KTV 2 milligram per cubic meter, 1999; Switzerland: MAK-W 1 milligram per cubic meter, 1999; United Kingdom: TWA 1 milligram per cubic meter; STEL 0.2 milligram per cubic meter, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 2 milligram per cubic meter. Several states have set guidelines or standards for oxalic acid in ambient air[60] ranging from 3.3 μ/m^3 (New York) to 10.0 μ/m^3 (Florida and South Carolina) to 10−20 μ/m^3 (North Dakota) to 16.0 μ/m^3 (Virginia) to 20.0 μ/m^3 (Connecticut) to 24.0 μ/m^3 (Nevada).

Determination in Air: No NIOSH Analytical Method available.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = < -1$ (estimated). Unlikely to bioaccumulate in marineorganisms.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Corrosive to the eyes, skin, and respiratory tract. Corrosive on ingestion. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Also, very high exposure (far above the OEL) can cause death. *Inhalation:* Contact with dust or mist can cause irritation, burns and sores of the nose and throat. *Skin:* Contact with solid or solution may cause severe burns. *Eyes:* Contact with solid or solution may cause severe burns and eye damage. *Ingestion:* Onset of symptoms is usually rapid and includes burning and erosion of mouth, throat, and stomach tissue; nausea; vomiting, including vomiting blood; abdominal pain; diarrhea and bloody stools; numbness of fingers and toes; shock; collapse and convulsions; and kidney damage. Ingestion of 5 g (1/6 ounce) can be fatal.

Long-Term Exposure: Prolonged skin contact can cause irritation and slowly healing sores, pain, and discoloration (blue color) in fingers and localized tissue damage; gangrene may develop. Contact with dust or mist may cause inflammation and irritation of the nose and throat. May affect the kidneys and urinary stone formation. Repeated exposure may cause irritability, headache, and weakness.

Points of Attack: Eyes, skin, and respiratory system; kidneys.

Medical Surveillance: NIOSH lists the following tests: Urine (chemical/metabolite). If symptoms develop or overexposure is suspected, the following may be useful: Kidney function tests. Exam of the blood vessels in exposed areas. For an acute overexposure, consider testing serum calcium level.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth methods if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device?* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In the case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24–48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Natural rubber, Neoprene, nitrile/PVC, nitrile, and polyethylene are recommended. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid, unless full-face-piece respiratory protection is worn. Wear dust-proof goggles and face shield when working with powders or dust, unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: 25 *milligram per cubic meter*: Sa: Cf (APF = 25)* (any supplied-air respirator operated in a continuous-flow mode); or PAPRDM* (any powered, air-purifying respirator with a dust and mist filter). *50 milligram per cubic meter:* 100F (APF = 50) (any air purifying, full-face-piece respirator with and N100, R100, or P100 filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *500 milligram per cubic meter:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-face-piece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

*Substance causes eye irritation or damage; eye protection needed.

Storage: Color code—White: Corrosive or contact hazard; Store separately in a corrosion resistant location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Oxalic acid must be stored to avoid contact with silver or strong oxidizers (such as chlorine and bromine) because violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames are prohibited where oxalic acid is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN3261 Corrosive solid, acidic, organic, n.o.s., Hazard class: 8; Labels: 8-Corrosive material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Wearing proper protective clothing and equipment, cover with soda ash or sodium bicarbonate. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include formic acid and oxides of carbon. This chemical is a combustible solid. Use dry chemical, carbon dioxide; or water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Pretreatment involves chemical reaction with limestone or calcium oxide forming calcium oxalate. This may then be incinerated utilizing particulate collection equipment to collect calcium oxide for recycling.

References

(31); (173); (100).

National institute for Occupational Safety and Health (NIOSH), Information Profiles on Potential Hazards: Oxalic Acid, Report PB-276,678, Rockville, MD, pp 42–46 (Oct. 1977).

(173); (101); (138).

New York State Department of Health, *Chemical Fact Sheet:* Oxalic Acid, Bureau of Toxic Substance Assessment, Albany, NY (March 1986 and Version 2).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Oxalic Acid, Trenton, NJ (February 2000).

Oxamyl O:0170

Formula: $C_7H_{13}N_3O_3S$; $(CH_3)_2NCOC(SCH_3){=}NOCONHCH_3$

Synonyms: D-1410; 2-(Dimethylamino)-N([(methylamino) carbonyl]oxy)2-oxoethanimidothioic acid methyl ester; 2-Dimethylamino-1-(methylamino)glyoxal-*O*-methylcarbamoyl monoxime; *N*,*N*-Dimethyl-α-methylcarbamoyloxyimino-α-(methylthio) acetamide; *N*,*N*-Dimethyl-*N*-[(methylcarbamoyl)oxy]-1-thiooxamimidic acid methyl ester; DPX 1410; Insecticide-nemacide 1410; Methyl 2-(dimethylamino)-*N*-[((methylamino)carbonyl)oxy]-2-oxoethanimidothioate; *S*-Methyl 1-(dimethylcarbamoyl)-*N*-[(methylcarbamoyl)oxy] thioformimidate; Methyl 1-(dimethylcarbamoyl)-*N*-(methylcarbamoyloxy)thioformimidate; Methyl *N*,*N*'-dimethyl-*N*-[(methylcarbamoyl)oxy]-1-thiooxamimidate; Oxamyl carbamate insecticide; Thioxamyl; Vydate; Vydate 10G; Vydate insecticide/nematicide; Vydate L; Vydate Oxamyl insecticide/nematocide

CAS Registry Number: 23135-22-0

HSDB Number: 6453

RTECS Number: RP2300000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/153; UN2991 (Carbamate pesticides, toxic, flammable liquid)/131

EC Number: 245-445-3 [*Annex I Index No.:* 006-059-00-9]

Regulatory Authority and Advisory Information

Hazard Alert: Extremely toxic, Possible neurotoxic effects (methyl carbamate), Combustible, Poisonous (inhalation, ingestion), Suspected reprotoxic hazard, Agricultural chemical.

United States National Primary Drinking Water Regulations: MCLG = 0.02 mg/L; MCL = 0.02 mg/L.

EPA Acceptable Daily Intake (ADI): EPA/OPP oral reference dose (RfD) = 0.025 mg/kg/day (UF: 100, MF: 1)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P194

Superfund/EPCRA [40CFR 302 and 355, F R: 8/16/06, Vol 71, No. 158] RQ: 100 lb (45.4 kg)

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Waste water (mg/L), 0.056; Nonwaste water (mg/kg), 0.28

SUPERFUND/EPCRA 302, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg).

Hazard symbols, risk, & safety statements: Hazard symbol: T+, Xn, N; risk phrases: R21; R26/28; R33; R50/53; R63; safety phrases: S1/2; S36/37; S41; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Oxamyl is a white crystalline solid. Sulfur or garlic-like odor. Molecular weight = 219.3. Melting/freezing point = 100°−102°C. Vapor pressure = 2.4×10^{-4} mmHg @ 20°C. Hazard identification (based on NFPA-704 M Rating System): Health 4, flammability 1, reactivity 0. Slightly soluble in water; solubility = 280 g/L @ 25°C. Carrier solvents used in commercial formulations may change physical and toxicological properties.

Incompatibilities: Compounds of the carboxyl group react with all bases, both inorganic and organic (i.e., amines) releasing substantial heat, water and a salt that may be harmful. Incompatible with arsenic compounds (releases hydrogen cyanide gas), diazo compounds, dithiocarbamates, isocyanates, mercaptans, nitrides, and sulfides (releasing heat, toxic, and possibly flammable gases), thiosulfates and dithionites (releasing hydrogen sulfate and oxides of sulfur).

Potential Exposure: A carbamic acid, carbamate/organonitrogen pesticide. Used as an insecticide, nematicide, and acaricide on many field crops, vegetables, fruits, and ornamentals.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 0.15 milligram per cubic meter

PAC-2: 1.7 milligram per cubic meter

PAC-3: 4.7 milligram per cubic meter

Determination in Air: Organonitrogen pesticides. OSHA versatile sampler-2; Reagent; High-pressure liquid chromatography/Ultraviolet detection; NIOSH Analytical Method (IV) #5601.

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 200 μg/L; State Drinking Water Standards: California 50 μg/L; State Drinking Water Guidelines: Arizona 180 μg/L; Maine 175 μg/L; Massachusetts 50 μg/L.

Determination in Water: Fish Tox = 707.10678000 ppb MATC (VERY LOW). Octanol−water coefficient: Log $K_{ow} = < -0.5$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Contact can cause skin and eye irritation. Acute exposure to oxamyl usually leads to a cholinergic crisis. Signs and symptoms may include increased salivation; lacrimation (tearing), perspiration, spontaneous defecation; and spontaneous urination. Pinpoint pupils; blurred vision; tremor, muscle twitching; mental confusion; convulsions, and coma may occur. Gastrointestinal symptoms include abdominal pain; diarrhea, nausea, and vomiting. Bradycardia (slow heart rate) is common. Dyspnea (shortness of breath) and pulmonary edema may also occur. Classified by the World Health Organization as highly hazardous. Has also been rated as extremely-to super-toxic. Acute oral exposure (ingestion) to oxamyl has caused death. Oxamyl is a potent cholinesterase inhibitor. LD_{50} = 5 mg/kg[77].

Long-Term Exposure: Can cause slight nervous system effects. Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system causing numbness and/or weakness in the hands and feet. Repeated exposure may cause personality changes with depression, anxiety, and irritability. May cause liver damage. Human Tox = 200.00000 ppb MCL (VERY LOW).

Points of Attack: Respiratory system, lungs, and central nervous system; cardiovascular system, skin, eyes, liver, plasma, and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: Plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider complete blood count. Consider chest X-ray following acute overexposure. Consider liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Obtain authorization and/or further instructions from the local hospital for administration of an antidote or performance of other invasive procedures. Transport to the health care facility.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)- approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health hazard/poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from heat and light. Where possible, automatically transfer material from drums or other storage containers to process containers.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN2991 Carbamate pesticides, liquid, toxic, flammable, flash point <23°C, Hazard Class: 6.1; Labels: 6.1-Poisonous material, 3-Flammable liquid.

Spill Handling: UN2811: Isolation distance, spill: 25m/75 ft. (NJ). Isolation distance, Fire: 800 m/0.5mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen, sulfur and carbon. Extinguish fire using agent suitable for type of surrounding fire, as the material itself does not burn or burns with difficulty. Use water in flooding quantities as a fog. Use alcohol foam, carbon dioxide or dry chemical. Move container from fire area. Fight fire from maximum distance. Dike fire control water for later disposal does not scatter the material. Wear positive pressure breathing apparatus and special protective clothing. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Small quantities may be treated with alkali and buried in a landfill[22]. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Oxamyl, Washington, DC, Chemical Emergency Preparedness Program (Nov. 30, 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Oxamyl, Trenton, NJ (July 1999).

NIOSH Manual of Analytical Methods, 4th Edition, Issue 1, *Organonitrogen pesticides*, page 7of 21, Cincinnati, OH, 1/15/1998.

Oxycarboxin O:0175

Formula: $C_{12}H_{13}NO_4S$

Synonyms: Carboject; Carboxin sulfone; DCMOD; 2,3-Dihydro-5-carboxanilido-6-methyl-1,4-oxathiin-4,4-dioxide; 5,6-5,6-Dihydro-2-methyl-1,4-oxathiin-3-carboxanilide 4,4-dioxide; 5,6-Dihydro-2-methyl-*N*-phenyl-1,4-oxathiin-3-carboxamide-4,4-dioxide; Dynam; F461; Fungisol; 1,4-Oxathiin-3-carboxanilide, 5,6-dihydro-2-methyl-, 4,4-dioxide; 1,4-Oxathiin-3-carboxamide, 5,6-dihydro-2-methyl-*N*-phenyl-, 4, 4-dioxide; Oxycarboxine; Plantvax; Plant Wax; Vitavex

CAS Number: 5259-88-1

HSDB Number: 1747

RTECS Number: RP4900000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 226-006-2 [*Annex I Index No.:* 006-060-00-4]

Regulatory Authority and Advisory Information

Hazard Alert: Exposure can be lethal, Combustible, Suspected reprotoxic hazard[TRI], Environmental hazard.

Hazardous to aquatic life or environment, with possible long-lasting effects[194]. Harmful to aquatic life with long-lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, Xn, N; risk phrases: R22; R52/53; R63; safety phrases: S2; S61 (see Appendix 4)

Description: Oxydisulfoton is a white corrosive solid. Molecular weight = 290.42; 267.30; specific gravity (H_2O:1) = 1.40 @ 20°C; boiling point = 528°C; freezing/melting point = 121°C; vapor pressure = 3.2×10^{-11} mmHg @ 25°C; flash point = 220°C. Hazard Identification (based on NFPA-704M Rating System): Health 4, flammability 1, reactivity 0. Slightly soluble in water; solubility = 0.3 g/L @ 25°C.

Potential Exposure: A carboxamide fungicide used as a foliar systemic fungicide for use against rust on carnations and greenhouse geranium.

Incompatibilities: May react with strong oxidizers such as chlorates, peroxides, and nitrates. Can become unstable in acidic and alkaline media. Combustible; dust may form explosive mixture with air. Corrosive, may attack some metals, rubbers, and plastics.

Determination in Water: Octanol–water coefficient: Log $K_{ow} = < 1$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion dermal and/or eye contact. May penetrate unbroken skin.

Harmful Effects and Symptoms

Short-Term Exposure: Corrosive. Harmful if ingested. May cause skin, eye, and respiratory tract irritation. LD_{50} (oral, rat) = > 2 g/kg; (dermal, rat) = > 5 g/kg[83].

Long-Term Exposure: May affect reproduction, DNA.

Points of Attack: Skin, eyes, reproductive system.

Medical Surveillance: Comprehensive preplacement or initial medical and work histories with emphasis on reproductive experience and menstrual history. Comprehensive physical examination with emphasis on the genito-urinary tract analysis to include sperm count, motility and morphology. Other tests, such as serum testosterone, serum FSH, and serum LH may be carried out if, in the opinion of the responsible physician, they are indicated. Employees shall be counseled by a health officer or physician to ensure that each employee is aware that this chemical may affect the reproductive system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Do not induce vomiting when formulations containing petroleum solvents are ingested

Personal Protective Methods: Wear-protective eye protection, gloves and clothing to prevent any reasonable probability of dermal and/or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure- demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode).

Storage: Color code—White: Corrosive or contact hazard; store separately in a corrosion resistant location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Prior to working with oxycarboxin all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneoushazardous material, Technical Name Required.

Spill Handling: First remove all sources of ignition. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen, sulfur and carbon. Use dry chemical, carbon dioxide; water spray; or alcohol-resistant foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Do not discharge into drains or sewers. Dispose of waste material as hazardous waste using alicensed disposal contractor to an approved landfill. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. If allowed, Incineration with effluent gas scrubbing is recommended. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138).

Pesticide Management Education Program, "Oxycarboxin (Plantvax) Chemical Profile 2/85," Cornell University, Ithaca, NY (February 1985). http://pmep.cce.cornell.edu/profiles/fung-nemat/febuconazole-sulfur/oxycarboxin/fung-Prof-oxycarboxin.html

4,4′-Oxydianiline O:0180

Formula: $C_{12}H_{12}N_2O$; $H_2NC_6H_4OC_6H_4NH_2$

Synonyms: *p*-Aminophenyl ether; 4-Aminophenyl ether; Aniline, 4,4′-oxydi-; Benzenamine, 4,4′-oxybis-; Bis(*p*-aminophenyl) ether; Bis(4-aminophenyl) ether; 4,4-Diaminodiphenyl ether; Diaminodiphenyl ether; 4,4′-Diaminofenol ether (Spanish); 4,4′-Diaminophenyl ether; NCI-C50146; Oxybis(4-aminobenzene); *p,p*′-Oxybis(aniline); 4,4′-Oxybis(aniline); *p,p*′-Oxydianiline; 4,4′-Oxydianiline; 4,4′-Oxydiphenylamine; Oxydi-*p*-phenylenediamine

***CAS Registry Number*:** 101-80-4

HSDB Number: 1316

RTECS Number: BY7900000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171; UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 202-977-0 [*Annex I Index No.:*612-199-00-7]

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Animal Sufficient Evidence; Human Limited Evidence, *possibly carcinogenic to humans*, Group 2B, 1987; NCI: Carcinogenesis Studies (feed); clear evidence: mouse, rat California Proposition 65 Chemical[102]: Cancer, 1/1/1988.

Hazard Alert: Poison, Sensitization hazard (skin), Polymerization hazard, Possible risk of forming tumors, Suspected of causing genetic defects, Environmental hazard.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Hazardous to aquatic life or environment, with possible long-lasting effects[293]. Toxic to aquatic life with long-lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R45; R19; R23/24/25; R43; R46; R50/53; R62; safety phrases: S29; S41; S45; S53; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to waters

Description: 4,4′-Oxydianiline is a white crystalline solid, or a beige powder. Molecular weight = 200.26; boiling point ≥ 300°C (sublimes); freezing/melting point = 187°C; flash point = 219°C; vapor pressure = 3×10^{-7} mmHg @ 25°C. Very slightly soluble in water.

Potential Exposure: Intermediate in the manufacture of high-temperature-resistant, straight polyimide and poly (esterimide) resins capable of withstanding temperatures of Up to 480°C for short periods or 260°C for prolonged periods of time. Some *p*-phenylenediamine compounds have been used as rubber components, and DFG warns of danger of skin sensitization.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 2.2 milligram per cubic meter

PAC-2: 24 milligram per cubic meter

PAC-3: 140 milligram per cubic meter

DFG MAK: Danger os skin sensitization; Carcinogen Category 2

Russia set a MAC in work-place air of 5.0 milligram per cubic meter.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritation of the skin and/or eyes. Poisonous. LD_{50} = (oral-rat) 725 mg/kg.

Long-Term Exposure: It has caused liver disease and retinopathy in rats. A potential occupational carcinogen.

Points of Attack: Liver.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure. If skin sensitization is suspected, consider evaluation by a qualified allergist, including exposure history and testing, may help diagnose allergy. Liver tests.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth methods if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device?* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In the case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/ manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Based on potential carcinogenicity the following is recommended by NIOSH: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA-or European Standard EN 149-approved SCBA that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-face-piece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health hazard/poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in a refrigerator under an inert atmosphere. Protect from exposure to light and oxidizing agents. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Thermal decomposition products may include oxides of nitrogen and carbon. UN2811: Isolation Distance, Spill: 25 m/75 ft. (NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Remove all sources of ignition and dampen spilled material with 60%−70% acetone to avoid airborne dust and collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include oxides of nitrogen and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration with provision for nitrogen oxides removal from flue gases.

References

(109); (102); (31); (173); (101); (138); (100).

9,10-Oxydiphenoxarsine O:0190

Formula: $C_{24}H_{16}As_2O_3$

Synonyms: Bis(10-phenoxarsinl) oxide; Bis(phenoxarsin-10-yl) ether; Bis(10-phenoxarsyl) oxide; 10,10′-Bis(phenoxyarsinyl) oxide; Bis(10-phenoxyarsinyl) oxide; DID 47; Diphenoxarsin-10-yl oxide; OBPA; 10-10′-Oxidiphenoxarsine; 10-10′-Oxybisphenoxyarsine; Phenoxaksine oxide; PXO; SA 546; Vinadine; Vinyzene; Vinyzene BP 5; Vinyzene BP 5-2; Vinyzene (Pesticide); Vinyzene SB 1

CASRegistry Number: 58-36-6

HSDB Number: 6375 as phenoxaksine oxide

RTECS Number: SP6800000

UN/NA & ERG Number: UN1760 (corrosive liquids, n.o.s.)/154; UN3465 (organoarsenic compound, solid, n.o.s.)/151

EC Number: 200-377-3

Regulatory Authority and Advisory Information

Hazard Alert: Highly flammable, Corrosive, Primary irritant (w/o allergic reaction), Environmental hazard.

SUPERFUND/EPCRA 302, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 500 lb (227 kg)

As arsenic compound:

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, and Section 112) as arsenic compounds

Clean Water Act: Toxic Pollutant (Section 401.15) as arsenic and compounds

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, D004 (arsenic compounds)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg)

EPCRA (Section 313): Includes any unique chemical substance that contains arsenic as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: organics 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, appendix B) as arsenates, liquid, n.o.s.; arsenates, solid, n.o.s.; arsenical pesticides liquid, toxic, flammable, n.o.s

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. As arsenic, water-soluble compounds, n.o.s.

Canada: Priority Substance List & Restricted Substances/Ocean Dumping FORBIDDEN (CEPA), National Pollutant Release Inventory (NPRI) (arsenic compounds).

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292].

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xi, N; risk phrases: R45; R23/25; R36/37/38; R50/53; safety phrases: S29/35; S41; S45; S53; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)]

Description: 10-10′-Oxidiphenoxarsine is a colorless crystalline, organometallic solid or a dense yellow liquid. Odorless. Molecular weight = 502.24; specific gravity (H_2O:1) = 1.3 @ 20°C; boiling point = 233°C; freezing/melting point = 185°C; vapor pressure = 1×10^{-5} mmHg @ 25°C. Thermal decomposition temperature = 380°C. Flash point = < 32°C. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 0, reactivity 1. Practically insoluble in water.

Incompatibilities: A reducing agent; reacts violently with strong oxidizers. Keep away from strong acids and strong bases.

Potential Exposure: This material is used primarily for fungicidal and bactericidal protection of plastics. It is an organoarsenic and a heavy metal compound.

Permissible Exposure Limits in Air

arsenic, organic compounds

OSHA PEL: 0.5 mg[As]/m^3 TWA

NIOSH REL: Not established. See NIOSH Pocket Guide, Appendix A

ACGIH TLV[1]: 0.01 mg[As]/m^3 TWA; Confirmed Human Carcinogen; BEI established.

PAC Ver. 29[138]

PAC-1: 5 milligram per cubic meter

PAC-2: 14 milligram per cubic meter

PAC-3: 84 milligram per cubic meter

Determination in Air: NIOSH Analytical Methods (inorganic arsenic): #7300, #7301,#7303, #7900, #9102; OSHA Analytical Methods ID-105. The American Conference of Government Industrial Hygienists (ACGIH) Method 803 measures total particulate arsenic in air.

Permissible Concentration in Water: EPA[6] recommends a zero concentration of arsenic for human health reasons. Federal Drinking Water Guidelines: EPA 10 μg/L; State Drinking Water Guidelines: Arizona 10 μg/L; Connecticut 10 μg/L. Toxic pollutant designated pursuant to section 307 (a) (1) of the Clean Water Act and is subject to effluent limitations (arsenic and inorganic and organic arsenic) [40 CFR 401.15 (7/1/1987)]. Canadian Drinking Water Standards: IMAC 0.025 [As] mg/L. Runoff from spills or fire control may cause water pollution.

Determination in Water: See OSHA Analytical Method ID-105 for arsenic. The atomic absorption graphite furnace technique is often used for measurement of total arsenic in water. It also has been standardized by EPA. Total arsenic may be determined by digestion followed by silver diethyldithiocarbamate; an alternative is atomic absorption; another is inductively coupled plasma (ICP) optical emission spectrometry.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes and skin. Contact with eyes may be severe. Ingestion causes nausea, vomiting, and diarrhea. Arsenic compounds are acutely poisonous by ingestion. In severe cases, there may be bloody vomitus and stools and the victim may suffer collapse and shock with weak, rapid pulse; cold sweats; coma, and death. LD_{50} = (oral-rat) 40 mg/kg.

Long-Term Exposure: Arsenic compounds are recognized carcinogens of the skin, lungs, and liver. Ingestion or inhalation may result in chronic poisoning. Symptoms may include disturbances of the digestive system; loss of appetite; cramps, nausea, constipation, and diarrhea. May cause liver damage, resulting in jaundice. May cause disturbances of the blood, kidneys, and nervous system. May cause skin abnormalities including itching, pigmentation, and even cancerous changes.

Points of Attack: Blood, kidneys, skin, and nervous system.

Medical Surveillance: Test for urine arsenic. Levels should not be greater than 100 μg/g of creatinine in the urine. Examine the skin for abnormal growths. Liver and kidney function tests. Examination of the nervous system.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth methods if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device?* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In the case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy. *Note to physician:* For severe poisoning, BAL (British anti-Lewisite), dimercaprol, dithiopropanol (C3H8OS2) have been used to treat toxic symptoms of certain heavy metals poisoning—including arsenic. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5). For milder poisoning *penicillamine (not penicillin)* has been used, both with mixed success. Side effects occur with such treatment and it is never a substitute for controlling exposure. It can only be done under strict medical care.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any concentrations above the NIOSH REL, or where there is no REL, At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFAg100 (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front-or back-mounted acid gas canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: (1) Color code—Corrosive or contact hazard; store separately in a corrosion-resistant location; keep acids away from bases and red, yellow, and blue-coded chemicals. (2) Color code—Blue: Health hazard/poison. Store in a secure poison location. (2) Color code—Blue (*carcinogen*): Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Where possible, automatically transfer material from drums or other storage containers to process containers sources of ignition, such as smoking and open flames are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN1760 Corrosive liquids, n.o.s., Hazard class: 8; Labels: 8-Corrosive material, Technical Name Required. UN3465 Organoarsenic compound, solid, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling:

Organoarsenic compound, solid or liquid

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.5/0.8

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 500/60
Then: Protect persons downwind (mi/km)
Day 1.1/1.8
Night 2.8/4.5

Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources and dampen spilled material with toluene to avoid airborne dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include arsenic and carbon oxides. *Small fires*: Dry chemical, carbon dioxide; water spray; or foam. *Large fires:* Water spray, fog, or foam. Move container from fire area if you can do so without risk. Stay upwind; keep out of low areas. Wear self-contained (positive pressure if available) breathing apparatus and full protective clothing. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: 10,10-Oxydiphenoxarsine, Washington, DC, Chemical Emergency Preparedness Program (Nov. 30, 1987).

Oxydisulfoton O:0200

Formula: $C_8H_{19}OsPS_3$

Synonyms: BAY 23323; *O*,*O*-Diethyl *S*- [2-(ethylsulfinyl) ethyl] phosphorodithioate; *O*,*O*-Diethyl*S*-[(ethylsulfinyl) ethyl]phosphorodithioate; Disulfoton disulfide; Disulfoton sulfoxide; Disyston sulfoxide; Ethylthiomelton sulfoxide

CAS Registry Number: 2497-07-6

HSDB Number: 6425

RTECS Number: TD8600000

UN/NA & ERG Number: UN3018 (organophosphorus pesticide, liquid, toxic)/152

EC Number: 219-679-1 [*Annex I Index No.:* 015-096-00-X]

Regulatory Authority and Advisory Information

Hazard Alert: Exposure can be lethal, Neurotoxin (cumulative), Combustible, Agricultural chemical.

SUPERFUND/EPCRA 302, Extremely Hazardous Substances: TPQ = 500 lb (227 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 500 lb (227 kg).

Hazard symbols, risk, & safety statements: Hazard symbol: T+, N; risk phrases: R24; R28; R33; R50/53; safety phrases: S1/2; S28; S36/37; S41; S45; 60; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)]

Description: Oxydisulfoton is a combustible liquid. Molecular weight = 290.42; specific gravity (H_2O:1) = 1.22 @ 20°C; boiling point = 330°C; vapor pressure = 3.5×10^{-3} mmHg @ 25°C. Hazard identification (based on NFPA-704M Rating System): Health 4, flammability 1, reactivity 0. Highly soluble in water.

Potential Exposure: This material is an agricultural insecticide.

Incompatibilities: ***Vapor may form explosive mixture with air***. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides. Strong oxidizers may cause release of toxic phosphorus oxides. Organophosphates, in the presence of strong reducing agents such as hydrides, may form highly toxic and flammable phosphine gas. Keep away from alkaline materials.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 0.32 milligram per cubic meter

PAC-2: 3.5 milligram per cubic meter

PAC-3: 21 milligram per cubic meter

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Organic phosphorus insecticides are absorbed by the skin, as well as by the respiratory and gastrointestinal tracts. They are cholinesterase inhibitors. Symptoms include the following: *Mild exposure:* Headache, loss of appetite; nausea, dizziness; *moderate exposure:* Abdominal cramps; diarrhea, salivation, and excessive tearing; muscular cramps; *severe exposure:* Fever, blue lips; lack of sphincter control; coma, heart shock; difficult breathing.

Long-Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, central nervous system; cardiovascular system, skin, eyes, plasma, and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: Plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)- approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health hazard/poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage.

Shipping: UN3018 Organophosphorus pesticides, liquid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling:

Initial isolation and protective action distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information

from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (from a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30

Then: Protect persons downwind (mi/km)

Day 0.3/0.4

Night 0.8/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 600/200

Then: Protect persons downwind (mi/km)

Day 1.4/2.3

Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Do not touch spilled material. Do not breathe vapors. Stay upwind; keep out of low areas. Remove all ignition sources. Ventilate area of spill or leak. This material is a combustible liquid. For a spill or leak of a combustible liquid, shut off ignition sources; no flares, smoking, or flames in hazard area. Stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: Absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: Dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish with dry chemical, carbon dioxide; water spray, fog, or foam. Thermal decomposition products may include oxides of phosphorus, sulfur, nitrogen, and carbon. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Poisonous gases may be generated from the fire or runoff water. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR 165 recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Oxydisulfoton, Washington, DC, Chemical Emergency Preparedness Program (Nov. 30, 1987).

Oxyfluorfen O:0205

Formula: $C_{15}H_{11}ClF_3NO_4$

Synonyms: Benzene, 2-chloro-1-(3-ethoxy-4-nitrophenoxy)-4-(trifluoromethyl)-; Caswell No. 188AAA; 2-Chloro-1-(3-ethoxy-4-nitrophenoxy)-4-(trifluoromethyl)benzene; 2-Chloro-4-trifluoromethyl-3′-ethoxy-4′-nitrodiphenyl ether; 2-Chloro-α,α,α-trifluoro-*p*-tolyl-3-ethoxy- 4-nitrophenyl ether; Edger; Ether, 2-chloro-α,α,α-trifluoro-*p*-tolyl-3-ethoxy-4-nitro phenyl; Fire Power (glyphosate + oxyfluorfen); Galigan; Goal; Hadaf; Kleenup; Koltar; Mon-78095®; Oxyfluorfene; Oxyfluorofen; RH-915; RH-2915; Rout (with oryzalin); Triox

CAS Number: 42874-03-3

HSDB Number: 7507

RTECS Number: DV4725000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171; UN3082 (environmentally hazardous substances, liquid, n.o.s.)/171

EC Number: 255-983-0

Regulatory Authority and Advisory Information

Carcinogenicity[83]: EPA Group C, possible human carcinogen

Hazard Alert: Suspected of causing genetic defects, Environmental hazard. Listed for Tier 1 screening as an endocrine disruptor[88].

California EPA AB2588-Air Toxics "Hot Spots" Chemicals (CAL) as chlorophenoxy pesticides

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xn, N; risk phrases: R45; R11, R22; R36/37/38; R50/53; safety phrases: S16; S26; S29/35; S45; S60; S61; S62 (see Appendix 4)

Description: Orange to deep red−brown crystalline solid or powder. Smoke-like odor. Molecular weight = 361.70;

specific gravity (H_2O:1) = 1.49; boiling point = (decomposes) 330°C; freezing/melting point = 85°C; vapor pressure = 2.1×10^{-7} mm @ 20°C. Henry's Law constant = 1.2×10^{-6} atm-m^3/mol @ 25°C (est)[83]. Slightly soluble in water; solubility = 0.098 ppm.

Potential Exposure: Oxyfluorfen, a diphenyl ether herbicide, is used for broad spectrum preemergence and postemergent control of annual broadleaf and grassy weeds in a variety of tree fruit, nut, vine, and field crops. The largest agricultural markets are wine grapes and almonds. Also used on ornamental and forestry sites. Oxyfluorfen is also used for weed control in landscapes, patios, driveways, and similar noncrop areas in residential, highway, and rights-of-way sites.

Incompatibilities: Decomposes >330°C releasing toxic hydrogen fluoride, hydrogen chloride, and nitrogen oxides.

Permissible Exposure Limits in Air: No standards or PAC available.

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guidelines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg[F]/L. Safe Drinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg[F]/L; SMCL = 2 mg/F/L, as Fluoride.

Determination in Water: Octanol–water coefficient: Log K_{ow} = >4.5. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, ingestion, absorbed through the skin

Harmful Effects and Symptoms

Short-Term Exposure: Poisonous; may be fatal if inhaled, swallowed, or absorbed through skin. Severely irritates eyes, skin, and respiratory tract, with burning sensation, pain, redness, and swelling. Metabolic stimulant. If inhaled, causes coughing, dilated pupils, headache, profuse persperation, intense thirst, extreme fatigue, rapid pulse, high fever, clammy, flushed skin, rapid breathing, nausea, vomiting, cyanosis (bluish tint to skin and lips), anxiety and confusion, convulsions, and risk of lung edema. If swallowed, face, and lips turn bluish. Liver injury with associated jaundice, kidney failure, and cardiac arrhythmias are commonly noted. Nerve damage, which may be delayed, may include swelling of legs and feet, muscle twitch and stupor. Severe exposure can cause death from heart failure. Dust or liquid left in contact with the skin for several hours may be absorbed. This may result in severe delayed symptoms as listed above. These symptoms may last for months or years. LD_{50} (oral, rat) = >5 g/kg.; LD_{50} (dermal, rat) = >10 g/kg.

Long-Term Exposure: Fluorides may cause bone disease (pain and tenderness of the bones); mottled teeth in children. Workers exposed to chlorophenoxy compounds over a 5–10 years period at levels above 10 milligram per cubic meter complained of weakness, rapid fatigue, headache, and vertigo. Liver damage, low blood pressure, and slowed heartbeat were also found. Based on animal tests, may affects human reproduction

Points of Attack: Eyes, skin, respiratory system, central nervous system, cardiovascular system, liver, spleen, kidney, and reproduction system.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure. Preliminary medical exam to detect chronic diseases of central nervous system, liver, heart, kidneys, lung, and skin, as well as endocrinological or immunological disturbances, should protect susceptible individuals. Periodical medical exams of internal organs, skin, and eyes are important to avoid chronic occupational intoxications. They should include lab and patch tests when necessary[83]. This chemical is a suspected or known human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and advice for medical monitoring. If symptoms develop or overexposure is suspected, the following may be useful: Liver and kidney function tests. Exam of the nervous system

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. *Do not induce vomiting when formulations containing petroleum solvents are ingested.* Otherwise, give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Diphenyl ether derivatives may react with the following absorbent materials: Cellulose-based; Expanded Polymeric[88]. Applicators and other handlers must wear: Coveralls worn over long-sleeved shirt and long pants; Chemical-resistant gloves such as DuPontTychem suit fabrics, barrier laminate, or Viton; Chemical-resistant footwear plus socks; Protective eye wear; Chemical-resistant headgear for overhead exposure; Chemical-resistant apron when cleaning equipment, mixing, or loading[83]. Agricultural Use/Engineering Controls: When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the WPS for agricultural pesticides, 40 CFR 170.240 (d) (4-6), the handler PPE requirements may be reduced or modified as specified in the WPS. Firefighters should wear NIOSH approved SCBA and full protective clothing.

Respirator Selection: *At any detectable concentration*: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100 F (APF = 50) (any air purifying, full-face-piece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health hazard/poison: Store in a secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Store in a refrigerator or a cool, dry place. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN3082 Environmentally hazardous substances, liquid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required. UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: First remove all sources of ignition. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all sources of ignition and dampen spilled material with 60%−70% acetone to avoid airborne dust. Use HEPA vacuum or wet method to reduce dust during clean-up. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition may include hydrogen fluoride, hydrogen chloride, fluorine and oxides of nitrogen, and carbon. This chemical is a combustible solid, but does not readily ignite. As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 m/150 ft for liquids and at least 25 m/75 ft for solids. *Fire involving storage or vehicular tanks:* Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. *On a small fire:* Use dry chemical, CO_2, water spray, or regular *foam. On a large fire:* Use water spray, fog or regular foam. Do not scatter spilled material with high pressure streams of water. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal. *Fire involving tanks:* From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. Always stay away from tanks engulfed in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Small quantities may be land filled but large quantities should be incinerated. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (122).

United States Environmental Protection Agency, “Reregistration Eligibility Decision (RED) Fact Sheet: Oxyfluorfen,” Office of Prevention, Pesticides and Toxic Substances, Washington, DC (October 2002). http://www.epa.gov/REDs/factsheets/oxyfluorfen_red_fs.htm

EXTOXNET, Extension Toxicology Network, “Pesticide Information Profile, Oxyfluorfen,” Oregon State University, Corvallis, OR (June 1996). http://extoxnet.orst.edu/pips/oxyfluor.htm

Oxygen O:0210

Formula: O_2

Synonyms: Liquid oxygen; LOX; Oxygen, liquid

CAS Registry Number: 7782-44-7

HSDB Number: 5054

RTECS Number: RS2060000

UN/NA & ERG Number: UN1072 (compressed)/122; UN1073 (refrigerated liquid)/122

EC Number: 231-956-9 [*Annex I Index No.:* 008-001-00-8]

Regulatory Authority and Advisory Information

United States Environmental Protection Agency Gene-Tox Program, Positive: V79 cell culture-gene mutation.

Hazard Alert: Strong oxidizing gas, Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated, Suspected reprotoxic hazard, Suspected of causing genetic defects.

Hazard symbols, risk, & safety statements: Hazard symbol: O; risk phrases: R5; R8; R21; R62; R63; safety phrases: S2; S9; S17; S33; S38; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): Nonhazardous to water.

Description: Oxygen is a colorless odorless gas or a bluish cryogenic liquid. Molecular weight = 32.00; boiling point = −183°C; freezing/melting point = −219°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 0. Oxidizer. Slightly soluble in water. Liquid sinks and boils in water.

Potential Exposure: Compressed oxygen is used in various oxidation processes, for feedstock; and enrichment purposes; as a medicinal gas; a chemical intermediate; in oxy-acetylene welding; in metallurgy. Liquid oxygen is used as a rocket fuel. Oxygen is naturally present at a concentration of 21% in breathing air.

Incompatibilities: A strong oxidizer. Reacts violently with nearly every element, combustibles, organics, and reducing materials.

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices. Minimum acceptable breathing air contains 19% oxygen.

Determination in Air: Use NIOSH Analytical Method #6601, Oxygen.

Routes of Entry: Inhalation, skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: *Note*: Increased pressure speeds up the toxic effects of oxygen. Drugs and chemical can also effects toxicity either positively or negatively. *Inhalation:* The air we breathe contains 21% oxygen. Normal activity requires a minimum of 19% oxygen. Breathing Up to 50% oxygen at normal pressure produced no symptoms. Breathing 100% oxygen at normal pressure produced no symptoms after 12 hours, but after 24 hours has caused weakness, dizziness, and burning in the nose and throat; fatigue, pain in joints and muscles; numbness and tingling in the arms and legs; palpitations, headache, cough, and nasal congestion; ear disturbances; nausea, vomiting, and loss of appetite; sore throat, fever, and swelling of the mucous membranes. Pressure levels greater than three times normal may cause convulsions and coma. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. *Skin:* Contact with liquid oxygen may cause freezing burns and tissue damage. *Eyes:* Liquid oxygen may cause freezing burns and tissue damage. *Ingestion:* Liquid oxygen may cause freezing burns in the mouth and throat.

Long-Term Exposure: Breathing of 50%−100% oxygen at normal pressure even intermittently, over a prolonged period can cause lung damage.

Points of Attack: Lungs.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures to pure oxygen, the following are recommended. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: Consider chest X-ray after acute overexposure to pure oxygen.

First Aid: *Eye Contact*: With liquid oxygen -Immediately remove any contact lenses and flush with large amounts of water for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. *Skin Contact*: With liquid oxygen-I. If frostbite has occurred, seek medical attention immediately; do not rub the affected areas or flush them with water. In order to prevent further tissue damage, do not attempt to remove frozen clothing from frostbitten areas. If frostbite has not occurred, immediately and thoroughly wash contaminated skin with soap and water. Seek medical attention. *Breathing Pure Oxygen or Gases >40%* O_2; Remove the person from exposure. Begin (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquefied oxygen. Wear gas-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Specific engineering controls are required by OSHA. See OSHA Standard 1910.104.

Respirator Selection: Entering into oxygen enriched atmospheres (greater than 21% oxygen) is highly dangerous. Consult *NFPA Code 53M.*

Storage: Check oxygen content prior to entering storage area. Color code—Yellow: Reactive hazard; Store in a location separate from other materials, especially flammables and combustibles. Oxidizers, including oxidizing gases, should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Liquid oxygen must be stored to avoid contact with organic and combustible materials (such as oil, grease, and coal dust), since violent reactions occur. Open storage is preferred. Oxygen gas evaporating from liquid or from oxygen enriched environments is easily absorbed into clothing and any source of ignition (such as a static spark) can cause flash burning. Compressed oxygen cylinders must be securely stored separately from fuel cylinders. Liquid oxygen tanks should be stored outdoors. Sources of ignition, such as smoking and open flames are prohibited where oxygen is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Store in a cool, well-ventilated area away from incompatible materials listed above. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage.

Shipping: UN1072 Oxygen, compressed & UN1073 Oxygen, refrigerated liquid (cryogenic liquid), Hazard Class: 2.2; Labels: 2.2-Nonflammable compressed gas; 5.1-Oxidizer. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. *Liquid:* Do not absorb liquid in saw-dust or similar combustible absorbents. This is an oxidizer and a dangerous fire and explosion risk. Use water only. Do not use chemical or carbon dioxide extinguishers. NEVER direct water jet on liquid. Allow liquid oxygen spills to evaporate. A *Gas:* Ventilate area of leak to disperse the gas. Stop flow of gas. If source of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. If liquid oxygen is spilled or leaked, take the following steps: Keep combustibles (wood, paper, oil, etc.) away from spill. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Oxygen is not flammable but supports combustion and greatly increases the intensity of any fire. Mixtures of liquid oxygen and any fuel are highly explosive. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. For a large fire; evacuate danger area and consult an expert. For small fire, extinguish using an agent suitable for type of surrounding fire. Oxygen itself does not burn. Do not use chemical or carbon dioxide on *liquid* oxygen. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Vent to atmosphere.

References

(31); (173); (101); (138); (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Oxygen, Trenton, NJ (April 2004).

New York State Department of Health, *Chemical Fact Sheet:* Oxygen (compressed or liquefied), Bureau of Toxic Substance Assessment, Albany, NY (Feb. 1986).

Oxygen Difluoride O:0220

Formula: F_2O; OF_2

Synonyms: Difluorine monoxide; Fluorine monoxide; Fluorine oxide; Oxygen fluoride

CAS Registry Number: 7783-41-7

HSDB Number: 2525 as fluorine monoxide

RTECS Number: RS2100000

UN/NA & ERG Number: (PIH) UN2190/124

EC Number: 231-996-7

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Theft hazard* 15 ($\geq$0.09% concentration).

Hazard Alert: Poison inhalation hazard: exposure can be lethal, Explosive, Air reactive, Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated, High acute toxicity-gas, Lacrimator, Strong oxidizing gas, Corrosive, Suspected of causing genetic defects, Violently water reactive.

OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 100 lb (45 kg).

United States National Primary Drinking Water Regulations: MCLG = 4 mg[F]/L; MCL = 4 mg[F]/L; SMCL = 2.0 mg [F]/L, as Fluoride.

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, E, O, C; risk phrases: R5; R8, R9, R14; R20/22; R21; R23/24/25; R34; R48/23; R61; R62; safety phrases: S1; S8; S9; S16; S17; S23; S26; S28; S33; 36/37/39; S38; S43; S41; S45 (see Appendix 4)

Description: Oxygen difluoride is a colorless gas. Foul, peculiar odor. Shipped as a nonliquefied compressed gas. Molecular weight = 54.0; specific gravity (H_2O:1) = 1.9 @ −224°C; boiling point = −145°C; freezing/melting point = − 224°C; vapor pressure = 760 @ −145°C; relative vapor density (air = 1) = 1.88. Hazard identification (based on NFPA-704 M Rating System): Health 4, flammability 0, reactivity 3₩. Slightly soluble in water (slowly and dangerously reactive; may explode); solubility = 0.02%.

Potential Exposure: Oxygen difluoride is used as an oxidizer in missile propellant systems.

Incompatibilities: A strong oxidizer. Explodes on contact with steam. Violent reaction with reducing agents; combustible materials; chlorine, bromine, iodine, platinum, metal oxides; moist air; hydrogen sulfide (explosive in ambient air); hydrocarbons, water. Attacks mercury. Reacts, possibly violently, with many materials including porous materials (i.e., alumina, charcoal, and silica), mercury, and phosphorus.

Permissible Exposure Limits in Air

NIOSH IDLH = 0.5 ppm

Conversion factor: 1 ppm = 2.21 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 0.05 ppm/0.1 milligram per cubic meter TWA

NIOSH REL: 0.05 ppm/0.1 milligram per cubic meter Ceiling Concentration

ACGIH TLV[1]: 0.05 ppm/0.11 milligram per cubic meter Ceiling Concentration

PAC* Ver. 29[138]

PAC-1: 0.0075 ppm

PAC-2: **0.083**$_{\mathbf{A}}$ ppm

PAC-3: **0.25**$_{\mathbf{A}}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values. Arab Republic of Egypt: TWA 0.05 ppm (0.1 milligram per cubic meter), 1993; Austria: MAK 2.5 mg[F]/m^3, 1999; Denmark: TWA 0.05 ppm (0.1 milligram per cubic meter), 1999; Finland: STEL 0.05 ppm (0.1 milligram per cubic meter), 1999; Norway: TWA 0.05 ppm (0.1 milligram per cubic meter), 1999; the Phillipines: TWA 0.05 ppm (0.1 milligram per cubic meter), 1993; Poland: MAC (TWA) 1 mg[HF]/m^3; MAC (STEL) 3 mg[HF]/m^3, 1999; the Netherlands: MAC 0.1 milligram per cubic meter, 2003; United Kingdom: TWA 2.5 mg[F]/m^3, 2000; New Zealand, Singapore, Vietnam: ACGIH TLV: Ceiling Concentration 0.05 ppm. Several states have set guidelines or standards for oxygen difluoride in ambient air[60] ranging from 1.0 μ/m^3 (North Dakota) to 2.0 μ/m^3 (Connecticut and Nevada) to 80,000 μ/m^3 (Virginia).

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guidelines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg[F]/L. Safe Drinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg[F]/L; SMCL = 2 mg/F/L, as Fluoride.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Highly poisonous if inhaled. Corrosive to skin and eyes. Skin or eye contact may cause frostbite. Gas under pressure is corrosive to eyes, skin, and respiratory tract; causes burns. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Exposure at low levels may result in severe, intractable headaches. LD_{50} (rat, inhalation) = < 3 ppm.

Points of Attack: Lungs, eyes, and skin.

Medical Surveillance: Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. NIOSH lists the following tests: chest X-ray, electrocardiogram, pulmonary function tests: forced vital capacity, forced expiratory volume (1 sec); sputum cytology; white blood cell count/differential.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy. If frostbite has occurred, seek medical attention immediately; do not rub the affected areas or flush them with water. In order to prevent further tissue damage, do not attempt to remove frozen clothing from frostbitten areas. If frostbite has not occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear-protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/ manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 0.5 ppm:* Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive- pressure mode). *Escape:* GmFS (APF = 50) Only nonoxidizable sorbents are allowed (not charcoal), [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front-or back-, mounted canister providing protection against the compound of concern]; or SCBAE (any appropriate escape-type, SCBA). *Note*: Only nonoxidizable sorbents are allowed (not charcoal).

Storage: Check oxygen content prior to entering storage area. Poison gas. (1) Color code—Blue: Health hazard/poison: Store in a secure poison location. This gas is highly toxic. Even slight exposure to these gasses can cause death. Store outdoors in a secure, restricted area that containing warning signs. This area must be roofed and shaded with the cylinders stored off the ground and separated from all other products assigned to other hazard categories and radiant heat sources on nonwooden floors. If indoors, store in a well-ventilated areas in temperatures not to exceed 50°C. (2) Color code—Yellow Stripe: Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Oxidizers, including oxidizing gases, should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. (3) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location; keep acids away from bases and red, yellow, and blue-coded chemicals. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Protect cylinder containers against physical damage. Do not use wood pallets. Preferably handle behind body shield, in outdoor, or open protective fences. Wear long rubber gloves, goggles, protective clothing, and SCBA. Store in a cool, well-ventilated area away from incompatible materials listed above. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage.

Shipping: Oxygen difluoride, compressed Hazard Class: 2.3; Labels: 2.3-Poisonous gas, 5.1-Oxidizer, 8-Corrosive material, Inhalation Hazard Zone A. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling:

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (from a small package or a small leak from a large package)

Oxygen difluoride, oxygen difluoride, compressed

First: Isolate in all directions (ft/m) 600/180
Then: Protect persons downwind (mi/km)
Day 0.3/0.4
Night 3.3/5.3

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 3000/1000
Then: Protect persons downwind (mi/km)
Day 1.4/2.3
Night 5.4/8.7

If in a building, evacuate building and confine vapors by closing doors and shutting down HVAC systems. Restrict persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Ventilate area of spill or leak to disperse the gas. Wear chemical protective suit with SCBA to combat spills. Stay upwind and use water spray to "knock down" vapor; contain runoff. Stop the flow of gas, if it can be done safely from a distance. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place; and repair leak or allow cylinder to empty. Keep this chemical out of confined spaces, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This is a nonflammable gas, but a strong oxidizer that can increase the intensity of a fire. Thermal decomposition products may include harmful and irritating fumes. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool expos ures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Spray or sift on a thick layer of a (1:1) mixture of dry soda ash and slaked lime behind ashield. After mixing, spray water from an atomizer with great precaution. Transfer slowly into a large amount of water. Neutralize and drain into the sewer with sufficient water.

References

(31); (173); (101); (138).

Oxymetholone O:0225

Formula: $C_{21}H_{32}O_3$

Synonyms: Adroidin; Anadrol; Anadroyd; Anapolon; Anasteron; Anasteronal; Anasterone; Androstan-3-one, 17-hydroxy-2-(hydroxymethylene)-17-methyl-, (5-α,17-β)-; 5-α,17-β-Androstan-3-one, 17-hydroxy-2-(hydroxymethylene)-17-methyl-; 5-α-Androstan-3-one, 17-β-hydroxy-2-(hydroxymethylene)-17-methyl-; Androstano(2,3-c)(1,2,5) oxadiazol-17-ol, 17-methyl-, (5-α,17-β)-; Becorel; CI-406; 4,5-Dihydro-2-hydroxymethylene-17-α-methyltestosterone; Dynasten; HMD; 17-Hydroxy-2-(hydroxymethylene)-17-methyl-5-α-17-β-androst-3-one; 17-β-Hydroxy-2-hydroxymethylene-17-α-methyl-3-androstanone; 17-β-Hydroxy-2-(hydroxymethylene)-17-α-methyl-5-α-androstan-3-one; 17-β-Hydroxy-2-(hydroxymethylene)-17-methyl-5-α-androstan-3-one; 2-Hydroxymethylene-17-α-methyl-5-α-androstan-17-β-ol-3-one; 2-Hydroxymethylene-17-α-methyl-dihydrotestosterone; 2-(Hydroxymethylene)-17-α-methyldihydrotestosterone; 2-Hydroxymethylene-17-α-methyl-17-β-hydroxy-3-androstanone; Methabol; 17-α-Methyl-2-hydroxymethylene-17-hydroxy-5-α-androstan-3-one; Nastenon; NSC-26,198; Oximetholonum; Oximetolona; Oxitosona-50; Oxymethalone; Oxymethenolone; Pavisoid; Plenastril; Protanabol; Roboral; Synasteron-50; Zenalosyn

CAS Registry Number: 434-07-1

HSDB Number: 3374

RTECS Number: BV8060000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 207-098-6

Regulatory Authority and Advisory Information

Carcinogenicty: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen

California Proposition 65 Chemical[102]: Cancer, 1/1/1988.

Hazard Alert: Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Hormone[77]. A controlled substance [Section 202 of the Controlled Substances Act (21 U.S.C. 812)].

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xn; risk phrases: R45; R21; R22; R25; R50; R62; R63; safety phrases: S1/2; S22; S23; S26; S36/37/39; S45; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Oxymetholone is a white to pale yellow crystalline solid or powder. Odorless. Molecular weight = 332.51; freezing/melting point = 178 to 180°C; vapor pressure = 5.1×10^{-11} mmHg @ 25°C (est)[72]. Henry's Law constant = 1.5×10^{-9} atm-m^3/mol @ 25°C (est)[72] Practically insoluble in water; solubility = < 1 mg/mL @ 23°C; 5.2 mg/L @ 25°C (est)[72].

Potential Exposure: Oxymetholone is a controlled substance (US), hormone and a systemic anabolic steroid.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides. May be combustible and light-sensitive.

Permissible Exposure Limits in Air: No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 3.6 (est)[72]. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Ingestion, dermal contact.

Harmful Effects and Symptoms

Symptoms of exposure to Oxymetholone may include cholestatic jaundice, hepatocellular neoplasms and peliosis hepatitis. Prepubertal exposure may cause phallic enlargement and increased frequency of erection. Postpubertal exposure may cause inhibition of testicular function, testicular atrophy, oligospermia, impotence, chronic priapism, epididymitis, bladder irritability, clitoral enlargement, menstrual irregularities, increased or decreased libido, excitation, insomnia, nausea, vomiting, diarrhea, leukemia, gynecomastia, deepening of the voice in women, hirsutism and male-pattern baldness in women, acne, edema, retention of serum electrolytes, and decreased glucose tolerance. It may also cause higher risk of developing liver cell tumors. Other symptoms include abnormal liver function tests, salt and water retention, and masculinization, particularly of the female fetus[101].

Short-Term Exposure: See above.

Long-Term Exposure: Oxymetholone may cause liver damage, tumors. Jaundice. Based on animal studies, it may be mutagenic and harm the unborn fetus.

Points of Attack: Liver (tumors).

Medical Surveillance: Oxymetholone is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure.

First Aid: *Eyes*: first check the victim for contact lenses and remove if present. Flush victim's eyes with water or normal saline solution for 20−30 minutes while simultaneously calling a hospital or poison control center. Do not put any ointments, oils, or medication in the victim's eyes without specific instructions from a physician. Immediately transport the victim after flushing eyes to a hospital even if no symptoms (such as redness or irritation) develop. *Skin*: Immediately flood affected skin with water while removing and isolating all contaminated clothing. Gently wash all affected skin areas thoroughly with soap and water. If symptoms such as redness or irritation develop, immediately call a physician and be prepared to transport the victim to a hospital for treatment. *Inhalation*: Immediately leave the contaminated area; take deep breaths of fresh air. Immediately call a physician and be prepared to transport the victim to a hospital even if no symptoms (such as wheezing, coughing, shortness of breath, or burning in the mouth, throat, or chest) develop. Provide proper respiratory protection to rescuers entering an unknown atmosphere. Whenever possible, SCBA should be used; if not available, use a level of protection greater than or equal to that advised under protective clothing. *Ingestion*: *Do not induce vomiting*. If the victim is conscious and not convulsing, give 1 or 2 glasses of water to dilute the chemical and immediately call a hospital or poison control center. Be prepared to transport the victim to a hospital if advised by a physician. If the victim is convulsing or unconscious, do not give anything by mouth, ensure that the victim's airway is open and lay the victim on his/her side with the head lower than the body. Do not induce vomiting. Immediately transport the victim to a hospital.

Personal Protective Methods:

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA-or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-face-piece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA)

Storage: Color code—Blue: Health hazard/toxics/poisons: Store in a secure poison location.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: First remove all sources of ignition. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition product includes oxides of carbon (carbon monoxide, CO2). Fires involving Oxymetholone can be controlled with a dry chemical, carbon dioxide or Halon extinguisher.

Disposal Method Suggested: It is inappropriate and possibly dangerous to the environment to dispose of expired or waste pharmaceuticals by flushing them down the toilet or discarding them to the trash. Household quantities of expired or waste pharmaceuticals may be mixed with wet cat litter or coffee grounds, double-bagged in plastic, discard in trash. Larger quantities shall carefully take into consideration applicable DEA, EPA, and FDA regulations. If possible return the pharmaceutical to the manufacturer for proper disposal being careful to properly label and securely package the material. Alternatively, the waste pharmaceutical shall be labeled, securely packaged and transported by a state licensed medical waste contractor to dispose by burial in a licensed hazardous or toxic waste landfill or incinerator.

References

(109); (102); (31); (173); (101); (138); (122); (100).

Ozone O:0230

Formula: O_3
Synonyms: Oxygen mol (O_3); Ozono (Spanish); Triatomic oxygen
CAS Registry Number: 10028-15-6
HSDB Number: 717
RTECS Number: RS8225000
UN/NA & ERG Number: UN1955/123
EC Number: 233-069-2
Regulatory Authority and Advisory Information
Carcinogenicity: DFG: Carcinogen Category 3B, chemicals of concern. NCI: Carcinogenesis Studies (inhalation); equivocal evidence: mouse; no evidence: rat; NTP: Carcinogenesis Studies (inhalation); some evidence: mouse. United States Environmental Protection Agency Gene-Tox Program, Negative: *In vivo* cytogenetics-nonhuman bone marrow; Negative: *In vivo* SCE-nonhuman; Inconclusive: *In vivo* cytogenetics-nonhuman lymphocyte; Inconclusive: *In vitro* cytogenetics-human lymphocyte; Inconclusive: *In vivo* cytogenetics-human lymphocyte; Inconclusive: Cytogenetics-male germ cell.
Hazard Alert: High acute toxicity-gas; Oxidizing gas, Highly explosive/unstable, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction).
OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 100 lb (45 kg)
SUPERFUND/EPCRA 302, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg)
Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
SARA Hazard Classes: Sudden Release of pressure hazard; Fire Hazard; Acute Health Hazard; Chronic Health Hazard.
Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.; Category DIA, C. D2B.
Hazard symbols, risk, & safety statements: Hazard symbol: T+, O, Xn, Xi; risk phrases: R36/37/38; R40; R62; R63; safety phrases: S41 (see Appendix 4)

Description: Ozone is a colorless to blue gas. Very pungent characteristic, sulfur-like odor, associated with electrical sparks. Condenses to a blue−black liquid or crystalline solid. Molecular weight = 48.00; specific gravity (H_2O:1) = 1.96 @ 20°C; boiling point = −111.4°C; freezing/melting point = −193°C; vapor pressure = > 1 atm @ 20°C; 750 mmHg @ −112°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 0, reactivity 3. Slightly soluble in water; solubility = 0.001% @ 0°C.

Potential Exposure: Ozone is found naturally in the atmosphere as a result of the action of solar radiation and electrical storms. It is also formed around electrical sources, such as X-ray or ultraviolet generators, electric arcs; mercury vapor lamps; linear accelerators; and electrical discharges. Ozone is used as an oxidizing agent in the organic chemical industry (e.g., production of azelaic acid); as a disinfectant for air, mold and bacteria inhibitor for food in cold storage rooms, and for water (e.g., public water supplies; swimming pools; and sewage treatment); for bleaching textiles; waxes, flour, mineral oils, and their derivatives; paper pulp; starch, and sugar; for aging liquor and wood; for processing certain perfumes; vanillin, and camphor; in treating industrial wastes; in the rapid drying of varnishes and printing inks; and in the deodorizing of feathers.

Incompatibilities: A powerful oxidizer. A severe explosion hazard when exposed to shock or heat, especially solid or liquid form. Spontaneously decomposes to oxygen under ordinary conditions; heating increases oxygen production. Reacts with all reducing agents; combustibles, organic, and inorganic oxidizable materials; and can form products that are highly explosive. Incompatible with alkenes, aniline, benzene, bromine, ether, ethylene, and hydrogen bromide; nitric oxide; stibine. Attacks metals except gold and platinum.

Permissible Exposure Limits in Air
The United States Environmental Protection Agency has set a national ambient air quality standard for ozone of 0.12 ppm (240 μ/m^3) on a 1-hour average basis and a standard for total photochemical oxidants (expressed as ozone) of 0.08 ppm (160 μ/m^3) on a 1-hour average basis (to be exceeded not more than once a year). The Czech Republic[35] has set a TWA in work-place air of 0.1 milligram per cubic meter with a ceiling of 0.2 milligram per cubic meter. Russia set a MAC for ambient air in residential areas of 0.16 milligram per cubic meter on a once-daily basis and 0.03 milligram per cubic meter on an average daily basis. State limits for ozone in ambient air[60] range from 0.005 milligram per cubic meter in Nevada to 0.235 milligram per cubic meter for Connecticut.
NIOSH IDLH = 5 ppm
OSHA PEL: 0.1 ppm/0.2 milligram per cubic meter TWA
Odor Threshold = 0.045 ppm
NIOSH REL: 0.1 ppm/0.2 milligram per cubic meter Ceiling Concentration
ACGIH TLV[1]: (*heavy work*) 0.05 ppm/0.1 milligram per cubic meter TWA; (*moderate work*) 0.08 ppm/0.16 milligram per cubic meter TWA; (*light work*) 0.01 ppm/0.2 milligram per cubic meter TWA; (*light, moderate, or heavy workload* $\leq$*2 hrs.*) 0.2 ppm/0.4 milligram per cubic meter TWA; not classifiable as a human carcinogen.
PAC Ver. 29[138]
PAC-1: 0.24 ppm
PAC-2: 1 ppm
PAC-3: 10 ppm
DFG MAK: Carcinogen Category 3B, Substances which cause concern that they could be carcinogenic for man but which cannot be assessed conclusively because of lack of data.
Arab Republic of Egypt: TWA 0.1 ppm (0.02 milligram per cubic meter), 1993; Australia: TWA 0.1 ppm

(0.2 milligram per cubic meter); STEL 0.3 ppm, 1993; Austria: MAK 0.1 ppm (0.2 milligram per cubic meter), 1999; Belgium: STEL 0.1 ppm (0.2 milligram per cubic meter), 1993; Denmark: TWA 0.1 ppm (0.2 milligram per cubic meter), 1999; Finland: TWA 0.1 ppm (0.2 milligram per cubic meter); STEL 0.3 ppm (0.6 milligram per cubic meter), 1999; France: VME 0.1 ppm (0.2 milligram per cubic meter), VLE 0.2 ppm (0.4 milligram per cubic meter), 1999; Hungary: TWA 0.2 milligram per cubic meter; STEL 0.4 milligram per cubic meter, 1993; Japan: 0.1 ppm (0.2 milligram per cubic meter), 1999; Norway: TWA 0.1 ppm (0.2 milligram per cubic meter), 1999; the Phillipines: TWA 0.1 ppm (0.2 milligram per cubic meter), 1993; Poland: MAC (TWA) 0.1 milligram per cubic meter; MAC (STEL) 0.6 milligram per cubic meter, 1999; Russia: TWA 0.1 ppm; STEL 0.1 milligram per cubic meter, 1993; Sweden: NGV 0.1 ppm (0.2 milligram per cubic meter), TGV 0.3 ppm (0.6 milligram per cubic meter), 1999; Switzerland: MAK-W 0.1 ppm (0.2 milligram per cubic meter), KZG-W 0.2 ppm (0.4 milligram per cubic meter), 1999; Turkey: TWA 0.1 ppm (0.2 milligram per cubic meter), 1993; United Kingdom: STEL 0.2 ppm (0.4 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen

Determination in Air: Use OSHA Analytical Method ID-214.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: May be fatal if inhaled. Irritates the eyes and respiratory tract. Eye exposure may result in conjunctivitis (red, inflamed eyes). Inhalation of the gas can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Inhalation of the gas may cause asthma-like reactions. The liquid may cause frostbite. May affect the central nervous system; causing headache and impaired concentration and performance. Signs and symptoms of acute exposure to ozone may be severe and include irritation and burns of the skin, eyes, and mucous membranes. An increased respiratory rate, shallow breathing; cough, dyspnea (shortness of breath), bronchitis, and pulmonary edema; and pulmonary hemorrhage may occur. Tachycardia (rapid heart rate) and hypotension (low blood pressure) may be observed. Neurologic effects include fatigue, dizziness, drowsiness, headache, exhilaration, and depression. Nausea, vomiting, and anorexia may occur. A level of 0.2 ppm for 3 hours did not produce symptoms. Levels of 0.3 ppm may cause tightness in chest and throat, dry throat; and irritation of throat and lungs within 30 minutes. Levels of 0.5 ppm and above produce a sulfur-like odor and may cause headache, drowsiness, loss of coordination; and accumulation of fluid in the lungs. Levels near 10 ppm may result in immediate, severe irritation of throat and lungs, excessive sweating; continual coughing; decreased blood pressure; weak and rapid pulse; and severe chemical pneumonia. Death may occur from prolonged exposures @ 2 ppm or short exposures @ 10 ppm. *Note:* There may be a delay in onset of breathing difficulties for up to 6 hours. Ozone is highly toxic via inhalation or by contact of liquid to skin, eyes, or mucous membranes. It is capable of causing acute to chronic lung damage, burns, and death or permanent injury. Ozone can be toxic at a concentration of 100 ppm for 1 minute. Ozone is capable of causing death from pulmonary edema. It increases sensitivity of the lungs to bronchoconstrictors and allergens; increases susceptibility to and severity of lung bacterial and viral infections.

Long-Term Exposure: Repeated or prolonged exposure may cause lung damage and/or chronic respiratory disease. Ozone may damage the developing fetus.

Points of Attack: Eyes, respiratory system; lungs.

Medical Surveillance: NIOSH lists the following tests: Chest X-ray, electrocardiogram, pulmonary function tests: Forced vital capacity, forced expiratory volume (1 sec); sputum cytology; white blood cell count/differential. Preemployment and periodic physical examinations should be concerned especially with significant respiratory diseases. Eye irritation may also be important. This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. Administer 100% O_2. Medical observation is recommended for 24–48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: In areas of excessive concentration, gas masks with proper canister and full facepiece or goggles or the use of supplied air respirators is recommended. Wear-protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, and headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof chemical goggles and face shield unless full-face-piece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 1 ppm*: CcrS (APF = 10) [any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern]; or Sa (APF = 10) (any supplied-air respirator). *Up to 2.5 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprS (APF = 25) [any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern]. *Up to 5 ppm:* CcrFS (APF = 50) [any chemical cartridge respirator with a full facepiece and cartridge(s) providing protection against the compound of concern]; or GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front-or back-mounted canister providing protection against the compound of concern]; or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece.) *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS (APF = 50) [any air-purifying, full-face-piece respirator (gas mask) with a chin-style, front-or back-, mounted canister providing protection against the compound of concern]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Check oxygen content prior to entering storage area. Poison gas. (1) Color code—Blue: Health hazard/poison: Store in a secure poison location. This gas is highly toxic. Even slight exposure to these gasses can cause death. Store outdoors in a secure, restricted area that containing warning signs. This area must be roofed and shaded with the cylinders stored off the ground and separated from all other products assigned to other hazard categories and radiant heat sources on nonwooden floors. If indoors, store in a well-ventilated areas in temperatures not to exceed 50°C. (2) Color code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially organic materials, flammables and combustibles, and other incompatible materials. Oxidizers should be isolated from acids, metals, organic materials, and ammonium nitrate. Oxidizers, including oxidizing gases, should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in a cool, dry, well-ventilated place. Detached storage preferred, away from combustible material and reducing agents. Store in a cool, well-ventilated area away from incompatible materials listed above. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage.

Shipping: UN1955 Compressed gas, toxic, n.o.s, Inhalation Hazard Zone A, Hazard Class: 2.3; Labels: 2.3-Poisonousgas, 5.1-Oxidizer, Technical name required, Inhalation Hazard Zone A. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling:

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 300/90
Then: Protect persons downwind (mi/km)
Day 0.3/0.3
Night 0.4/0.6

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 2000/600
Then: Protect persons downwind (m/km)
Day 2.2/3.6
Night 5.9/9.5

If in a building, evacuate building and confine vapors by closing doors and shutting down HVAC systems. Restrict persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Ventilate area of spill or leak to disperse the gas. Wear chemical protective suit with SCBA to combat spills. Stay upwind and use water spray to "knock down" vapor, contain runoff. Stop the flow of gas, if it can be done safely from a distance. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place; and repair leak or allow cylinder to empty. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. Keep this chemical out of confined spaces, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Not flammable; however, ozone can increase the intensity of an existing fire and may react with any combustible substance to cause fire or explosion. Use dry chemical. carbon dioxide, water spray; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Vent to atmosphere. Use a licensed professional waste disposal service to dispose of this material. All federal, state, and local environmental regulations must be observed. Return refillable compressed gas cylinders to supplier.

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CHEMISTRY/TOXICOLOGY

Sittig's Handbook of
Toxic and Hazardous Chemicals and Carcinogens
Volume 2: E – O
SEVENTH EDITION

The definitive reference on hazardous chemical substances.
Comprehensive and convenient, *Sittig's Handbook* focuses on the most important hazardous chemicals in commercial use.

- The chemicals are presented alphabetically and classified as a carcinogen, hazardous substance, hazardous waste, or toxic pollutant.
- Find the chemical you are looking for quickly and reliably: entries have a full range of synonyms for each chemical, including trade names and CAS index.
- Relevant data for the United States and EU included throughout, along with the essential chemical hazard information applicable worldwide.
- The seventh edition includes more than 100 new chemical records.
- The trusted source of reliable information depended on by first-line responders (emergency services), industry, logistics companies, scientists, and environmental protection organizations.

For over 30 years, *Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens* has proven to be a reliable, accessible must-have reference work on hazardous materials. This updated and revised 7th edition is the most quickly accessible and comprehensive listing of the hazardous chemicals that are commonly used, transported, and regulated for use in the environment and the workplace. Information is the most vital resource anyone can have when dealing with potential hazardous substance accidents, spillages, fires, or acts of terror. It is also essential for the safe day-to-day operation of chemical processes and environmental protection. Sittig's handbook provides extensive data for over 2200 chemicals in a uniform format, enabling fast and accurate decisions in almost any situation. This new edition contains expanded and reviewed information for each chemical listed (including chemicals classified as WMDs) and has been updated to keep pace with world events, standards, and regulations.

Richard P. Pohanish is the author or co-author of 25 books and database product in the fields of hazardous material, environmental health, chemical safety, and engineering. Active in the publishing and information business for more than half a century, Mr. Pohanish, now retired, formerly held various executive positions with Van Nostrand Reinhold, including President, Information Division. His numerous published works include *Sittig's Handbook of Pesticides and Agricultural Chemicals*, 2nd Edition.

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SEVENTH EDITION

Sittig's Handbook of
Toxic and Hazardous Chemicals and Carcinogens

Richard P. Pohanish

Volume 3: P – Z

SITTIG'S HANDBOOK OF TOXIC AND HAZARDOUS CHEMICALS AND CARCINOGENS

Seventh Edition

Volume 3: P−Z

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As information may not be available for some chemicals, an absence of data does not necessarily mean that a substance is not hazardous. For major incidents, it will be necessary to obtain additional detailed information from other resources as well as more expertise from those with extensive training. Neither the Publisher nor the Editors assume any liability or responsibility for completeness or accuracy of the information presented or any damages of any kind alleged to result in connection with, or arising from, the use of this work.

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Contents

Preface

For more than 35 years *Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens* has continued to serve an ever-widening audience of users. It has been proven to be among the most easy-to-use and essential reference works on hazardous materials. The 7th edition has been updated and expanded, once again, to keep pace with world events and to respond to the ever-expanding need for reliable information on chemicals used in the workplace and the tool shed.

Most users of this work understand the potential dangers of chemicals. Hazardous and toxic substances pose a wide range of health hazards, including irritation, sensitization, and carcinogenicity. Chemicals can possess physical properties of flammability, explosion and corrosion. Many chemicals can harm the environment by poisoning aquatic and plant life.

The chemical industry and its many component businesses are forced to strike a delicate balance because the same properties that make a chemical substance highly useful can also make it extremely harmful. We are told by some industrialists that toxic chemicals are present in nature and that industrial contributions are just the price we have to pay for progress. There is little argument about the chemical industry's critical place in the nation's economy. The United States is the number one chemical producer in the world, generating more than $550 billion a year and employing more than 5 million people. So, somewhere in between lies the truth—or at least an area in which we can function. Information is vital in a world where virtually every aspect of our lives is touched by chemical hazards.

Each year, in the United States, over 2 billion tons of hazardous and toxic chemicals are manufactured. Including imports, more than 3 billion tons are transported employing 800,000 shipments each day. It is estimated that 1.3 billion tons are moved by truck and hundreds of billions of pounds of these hazardous materials are transported through populated areas. The average American household generates approximately 15 pounds of hazardous waste per year. Nearly five million poisonings occur in the United States annually, resulting in thousands of deaths. Based on 2004 TRI data (publically released April 2006), over 4 billion pounds of toxic chemicals are released into the nation's environment each year, including 72 million pounds of recognized carcinogens from nearly 24,000 industrial facilities.

Chemical accidents and spills can range from small to large and can occur anywhere chemicals are manufactured, transported, stored or used. Today's media headlines constantly point out both the information gaps and the need for constantly updated information. On January 9, 2014, for example, an estimated 10,000 gallons[CDC,NTP] of chemicals used to process coal spilled from a damaged 45,000 gallon storage tank into the Elk River in the US state of West Virginia. As the news of the spill developed, it became clear to the public (and many experts) that federal and state officials had sparse data about the health risks of the two potentially toxic organic solvents involved in the spill: primarily crude 4-methylcyclohexanemethanol and a minor component of mixed glycol ethers consisting of glycol phenyl ether and dipropylene glycol phenyl ether. The latter mixture of chemicals was not reported by the manufacturer to the public until 12 days after the initial spill. The unfortunate truth is that the Elk River is a municipal water source that serves approximately 300,000 people in and around Charleston, the state capitol. For weeks following the spill, residents were instructed not to drink or bathe with local tap water.

The problem of toxic chemicals in the United States; and, indeed, in all the world frightens many people. Over the years, these fears are heightened by news stories such as the huge accidental plant fire in Saudi Arabia that killed at least 12 people and injured another dozen (April 2016); the huge explosion at a vinyl chloride plant in Coatzacoalcos, Mexico—A few days later (also April 2016) that killed 24 workers and injured 136; the worst environmental disaster in Vietnam history caused by a chemical spill of cyanide, phenols and iron hydroxide which poisoned tons of marine life and killed people along 120 miles of coastline and stretching some 20 nautical miles out to sea (June 2016); the chemical plant explosion and subsequent spill of highly flammable liquids in Guizhou Province, China (February 2012) that killed more than 20 people and forced the evacuation of almost 30,000. Whether the chemical involves an aluminum dust explosion (Huntington, IN, 2003), a fertilizer explosion in West Texas (April 2013) leads in the water supply (Flint, MI, 2016), the massive Deepwater Horizon oil spill (Gulf of Mexico, 2010), or older problems—Bhopal, India, Love Canal, New York, the disastrous Valley of the (100,000) Drums (Kentucky), the Valley of Death in Brazil, and the like−these incidents generate emotional responses, often from people uninformed about science or technology and confirm the charge of critics that chemicals are "accidents waiting to happen."

In 2001, the 4th Edition of *Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens* was published shortly before the tragic events of the morning of September 11. The decade that followed brought many changes to life in the civilized world. The United States government, for example, established the Department of Homeland Security and enacted laws such as the *Chemical Facilities Security Act of 2003.* These actions were prompted by concerns involving infrastructure protection and the anticipation of another attack, possibly on the nation's chemical and energy facilities or by using trucks

or tank cars that transport highly dangerous and possibly lethal chemicals. "These facilities are found around the country in industrial parks, in seaports, and near the major population centers. Dangerous chemicals routinely travel along our highways, inland waterways, and on railcars that pass through the heart of major cities including Washington, D.C., just a short distance from Capitol Hill. Terrorist attacks on the US chemical industry have the potential to kill tens of thousands of Americans and seriously injure many more. In many instances, these attacks hold the potential for having a cascading effect across other infrastructures, particularly in the energy and transportation sectors. This is both because of the damage that can be caused by the attack, and the enormous expense and effort associated with the clean-up to an affected area in its aftermath."[83] To put it more simply, using the same low tech/ high concept approach that turned passenger planes into missiles, terrorists do not need to produce or amass chemical weapons or smuggle them into the United States in order to produce great damage.

"Commercial chemical incidents occur tens of thousands of times each year, often with devastating and exorbitantly expensive consequences. They are indiscriminate in their effects. Workers, companies, the public, emergency response organizations, and all levels of government pay the figurative and literal price. Yet, until now and with few exceptions, chemical incidents have been invisible. Perhaps it is due to their pervasiveness, or to the common tendency to overlook what is taken for granted."[84] This quote is from the highly publicized *600K Report* prepared by the Chemical Safety and Hazard Investigation Board (CSB), an independent, nonpartisan, quasi-legislative US government agency. The CSB described our nation's lack of definitive knowledge of the "big picture" surrounding chemical incidents as "… the industrial equivalent of two 737 airplanes "crashing" year after year, killing all passengers (256 people) without anyone seeming to notice."[84]

Almost 40 years ago, the United States Government Accounting Office (GAO) estimated that 62,000 chemicals were in commercial use. Today, that number has grown to beyond 82,000.

Given the reality of problems inherent to chemical hazards, including accidents and spills, the advent of new threats to our way of life, and the challenges of communicating complex data, it is the goal of this work to provide data so that responsible decisions can be made by all who may have contact with chemicals covered in this reference work. With this in mind the work can be used by those in the following chemical fields and related professions:

Applied research and product development
Attorneys
Campus safety and health
Certified chemical hygiene officer (CCHO)
Chemical engineering
Chemical health and safety
Chemical informatics and information management
Chemicals manufacturers and distributors
Chemical technology
Certified hazardous materials manager (CHMM)
Certified health physicist (CHP)
Certified industrial hygienist (CIH)
Certified safety professional (CSP)
Dyes, pigments and inks
Emergency response personnel
Environmental protection and management
Forensic chemistry
Formulation chemistry
Hazardous waste management
Industrial management
Laboratory management
Loss control management
Pesticide distributors
Process chemistry
Process safety
Project management
Public information and outreach
Public health
Quality control and assurance
Regulatory affairs
Researchers
Science policy
Technical communications
Technical support
Toxicology
Water chemistry

The chemicals chosen for inclusion are officially recognized substances, many identified as carcinogens, as belonging to some designated category of hazardous or toxic materials; with numerically defined safe limits in air in the workplace, ambient air, water; in waste effluents. For the most part these are materials of commerce that can be heavily used and may be transported in bulk.

The 7th edition contains more chemicals and data for each material. In keeping with the broad changes initiated with the fourth edition, contents of the 7th edition are focused on the concept of "regulated chemicals." The carcinogen potential of each chemical was compared to listings and reports from eminent authorities as the International Agency for Research on Cancer (IARC), the US National Toxicology Program (NTP) and the US Environmental Protection Agency.

The "Regulatory Authority and Advisory Bodies" section contains new items including, where available, EPA Gene-Tox Program findings, and many of the individual listings now contain useful advice sought after by the regulated community. As a result, the new volume should be even

more practical for those users of specific chemicals, and to those concerned with both adherence to, and enforcement of, regulations.

Data is furnished, to the extent currently available, in a uniform multisection uniform format to make it easy for users who must find information quickly and/or compare the data contained within records, in any or all of these important categories:

Chemical Name and Record Number
Chemical Formula
Synonyms (including trade names)
Code Numbers (including CAS Registry, HSDB, RTECS, UN/NA & ERG, EC)
Regulatory Authority and Advisory Information (summary)
Description (including physical properties, explosion and fire data and water reaction and solubility)
Potential Exposure
Incompatibilities
Permissible Exposure Limits in Air
Determination in Air
Permissible Concentration in Water
Determination in Water
Routes of Entry
Short-Term Exposure
Long-Term Exposure
Points of Attack
Medical Surveillance
First Aid
Decontamination (selected records)
Personal Protective Methods
Respirator Selection
Storage
Shipping
Spill Handling
Fire Extinguishing
Disposal Method Suggested
References

A Brief history of this work

Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens was first published more than 35 years ago. This work continues to provide first responders and occupational and environmental health and safety professionals with an accessible and portable reference source. Based on a count of CAS numbers, the seventh edition of this handbook contains data on almost 2600 toxic and hazardous chemicals (up from nearly 600 in the first edition, nearly 800 in the second edition, nearly 1300 in the third edition, and nearly 1500 in the fourth edition, and 2200 in the sixth edition).

According to the United State Library of Congress, the history of the project is as follows: 1st edition published in 1981; 2nd edition published in 1985; 3rd edition published in 1991; 4th edition published in 2001; 5th edition November 2007; 6th edition 2012, 7th edition: 2017.

Acknowledgments

The compilation of this 7th edition could not have been realized without the contributions of many of the researchers, scientists, contract employees and institutions that developed the excellent documents and databases that provided so much of the essential data that appear in this work. A full list of these contributors is impossible to compile. Nevertheless, In no particular order, I wish to acknowledge the those associated with US Environmental Protection Agency (EPA); United States Department of Labor; Occupational Safety and Health Administration (OSHA); Department of Health and Human Services; National Institute for Occupational Safety and Health (NIOSH); US Department of Energy (DOE); Agency for Toxic Substances and Disease Registry (ATSDR); American Conference of Governmental Industrial Hygienists (ACGIH); Deutsche Forschungsgemeinschaft (DFG); Centers for Disease Control and Prevention (CDC); NOAA; United States National Library of Medicine (NLM) National Institutes of Health (NIH); Hazardous Substance Data Bank (HSDB) and (TOXNET); US Department of Health and Human Services, Public Health Service, National Toxicology Program (NTP); Federal Emergency Management Agency (FEMA); US Department of Transportation (DOT); US Coast Guard (USCG); National Fire Protection Association (NFPA); International Agency for Research on Cancer; (IARC); New Jersey Department of Health and Senior Services; Chemical Safety and Hazard Investigation Board (CSB); United Nations Environment Programme; the states of New York and New Jersey, and many other government organizations, organizations and companies. It is nearly impossible to express the extent of my gratitude to all of them for their contributions to my research.

Although every effort has been made to produce an accurate and highly useful handbook, the editors and Publisher appreciates the need-for constant improvement. Any comments, corrections, or advice from users of this book are welcomed by the author who asks that all correspondence be submitted in writing and mailed directly to the publisher who will maintain a file for reprints and future editions.

How to Use This Book

Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens focuses on critical data for more than 2600 commercially important, regulated and hazardous, to one degree or another, substances. A large number of these chemicals are known or suspected potentially dangerous carcinogens. Many are found in the workplace and fewer are found in the medical and research fields. Some are found in home basements and worksheds. For the most part, importance is defined by inclusion in official, regulatory, and advisory listings. Much of this information, found in US government sources, has been supplemented by a careful search of many publications and databases.

This handbook is becoming more encyclopedic in nature. When one looks at many, if not most published works in this field, the user simply expects to find numerical data. Here, we have tried, wherever possible, to provide useful descriptive material and references which hopefully opens the door to additional of published materials.

Nevertheless, this is not a seminal research work and it is recommended that this book be used as a guide. This work is not meant to be a substitute for workplace hazard communication programs required by regulatory bodies such as OSHA, and/or any other United States or international government agencies. If data are required for legal purposes, the original source documents [such as Code of Federal Regulations (CFR)], appropriate Federal and State agencies, which are often referenced, should be consulted.

In the pages which follow, the following categories of information will be presented, for each chemical record, discussed with reference to scope, sources, nomenclature employed, and the like. Omission of a category generally indicates a lack of available information.

Chemical name: Each record is arranged alphabetically by a chemical name. These are names used by regulatory and advisory bodies. In very few cases the name may be a popularly-used product name or trade name. The chemical name section of each chemical record is backed-up with the "Synonyms" section and Appendix 5, "Synonym and Trade Name-Cross Index."

Formula: Generally, this has been limited to a commonly used one-line empirical or atomic formula. In the *Molecular Formula* field, the Hill system has been used showing number of carbons (if present), number of hydrogens (if present), followed by alphabetically listed element (s). Multiple carbon−carbon (double and triple) bonds have been displayed where appropriate.

Synonyms: This section contains scientific, product, trade, and other synonym names that are commonly used for each hazardous substance. Some of these names are registered trade names. Some are provided in other major languages other than English, including Spanish, French, and German. In some cases, "trivial" and nicknames (such as MEK for methyl ethyl ketone) have been included because they are commonly used in general communications, especially in the workplace. This section is important because the various "regulatory" lists published by federal, state, international agencies and advisory bodies do not always use the same name for a given hazardous substance. Every attempt has been made to ensure the accuracy of the synonyms and trade names found in this work, but errors of highly complex names are inevitable in compilations of this magnitude. Please note that this work may not include the names of all products currently found in commerce, particularly mixtures that may contain ingredients that are regulated chemicals.

The synonym index contains all synonym names listed in alphabetical order. It should be noted that organic chemical prefixes and interpolations such as (α-) alpha-, (β-) beta-, (γ-) gamma-, (δ-) delta-, (o-) ortho-, (m-) meta-; (p-) para-; sec- (secondary-), trans-, cis-, (n-) normal-, and numbers (1-; 1,2-), etc. are not used when searching for a chemical name. In other words, these prefixes are not treated as part of the chemical name for the purposes of alphabetization. Users should use the substance name without the prefix. For example, to locate *n*-butane, search for butane; to locate 3,3′-dichlorobenzidine; search for dichlorobenzidine; and to locate *α*-cyanotoluene or *alpha*-cyanotoluene, search for cyanotoluene. *Note*: All product names, company names, trademarks, and brands are the registered property of their respective owners. All company, product and service names used in this work are for identification purposes only. Use of these names, logos, and brands does not imply endorsement by the Author, Editors or the Publisher.

CAS Registry Number: The Chemical Abstracts Service (CAS) number is a unique identifier assigned to each chemical registered with the CAS of the American Chemical Society. This number is used to identify chemicals on the basis of their molecular structure. CAS numbers, in the format "nnn-nn-n" [two or more numeric characters (dash) two numeric characters (dash) followed by a single numeric check digit]. CAS numbers should always be used in conjunction with substance names to insure positive identification and to avoid confusion with like-sounding names, i.e., benzene (71-43-2) and benzine (8032-32-4). This 7th edition contains some alternate CAS numbers that may now be considered related, retired, obsolete and/or widely and incorrectly used in the literature. In this section, the first CAS number(s), before the abbreviation "alt." for the word "alternate," is considered (based on several sources) to be the correct CAS number(s). Ultimately, it is the responsibility of the user to find and use the correct number. *Note*: CAS Registry Number is a Registered Trademark of the American Chemical Society.

HSDB Number: HSDB is a toxicology data file on the National Library of Medicine's (NLM's) Toxicology Data Network (TOXNET). HSDB is organized into individual chemical records, and contains over 5000 such records. HSDB is a database focused primarily on the toxicology of potentially hazardous chemicals. The information in HSDB has been assessed by a Scientific Review Panel. Using your computer browser and entering a search such as "HSDB (followed by the Number)" should take you to the exact record you are seeking.

RTECS Number: RTECS (Registry of Toxic Effects of Chemical Substances) is a compendium of data extracted from the open scientific literature. The data are recorded in the format developed by the RTECS staff at NIOSH and arranged in alphabetical order by prime chemical name.[NIOSH] The RTECS numbers are unique identifiers assigned NIOSH. The RTECS number in the format "AAnnnnnnn" (two alphabetic characters followed by seven numeric characters) may be useful for online searching for additional toxicologic information on specific substances. It can, for example, be used to provide access to the MEDLARS computerized literature retrieval services of the NLM in Washington, DC. The RTECS number and the CAS number can serve to narrow down online searches. The RTECS Database is currently available from a growing list of "value-added" vendors that are listed on the Internet from NIOSH or CDC. In the US 1-800-232-4636; Outside the US 1-513-533-8328 or by Email: cdcinfo@cdc.gov.

UN/NA & ERG Number: United Nations-North America numbers are four-digit numbers that identify an individual chemical or group of hazardous substances, chemicals or articles (such as explosives, corrosive substances, pesticides, grenades, etc.) with similar characteristics. These four-digit numbers are normally preceded by UN or NA (e.g., UN1759-NA1759). UN/NA numbers are required to appear on shipping documents, and are often displayed on warning labels, the exterior of packages, and on specified containers such as truck or railway placards. These ID (identification) numbers may also be called NA (North American) numbers or DOT (Department of Transportation) numbers.[cameo] UN numbers are assigned by the United Nations Committee of Experts on the Transport of Dangerous Goods. Identification numbers containing a UN prefix (United Nations numbers) are authorized for use with all international shipments of hazardous materials. NA numbers are assigned by the United States DOT and usually correspond closely, but not always precisely, to the UN listing. The "NA" prefix is used for shipments between Canada and the United States *only*, and may *not* be used for other international shipments. Some chemicals without an assigned UN number may have an NA number. These latter NA numbers are usually in the format and range of NA8000−NA9999. Use of these ID numbers for hazardous materials will (1) serve to verify descriptions of chemicals; (2) provide for rapid identification of materials when it might be inappropriate or confusing to require the display of lengthy chemical names on vehicles; (3) aid in speeding communication of information on materials from accident scenes and in the receipt of more accurate emergency response information; and (4) provide a means for quick access to immediate emergency response information in the *North American Emergency Response Guidebook* (ERG) and also in the international publication, *Recommendations on the Transport of Dangerous Goods*, also known as the *Orange Book*.

EC Number: The European Commission number is a seven digit identification code used in countries of the European Union (EU) for commercially available chemical substances within the EU. This number is an identification number (ID) from *European Inventory of Existing Commercial Chemical Substances*, published by the European Environment Agency, Copenhagen, Denmark. The EC number supercedes the outmoded EINECS, ELINCS and NLP numbers. This section also includes "Annex I, Index Number" for the Export and Import of Dangerous Chemicals found in Annex I of Regulation (EC) No. 689/2008.

Regulatory Authority and Advisory Bodies:

This section contains a listing of major regulatory and advisories for the chemical of concern, including, but not limited to, Homeland Security, OSHA, US EPA, DFG (Germany), US DOT, ACGIH, IARC, NTP, WHMIS (Canada) and the EC, etc. Many law or regulatory references in this work have been abbreviated. For example, Title 40 of the CFR, Part 261, subpart 32 has been abbreviated as 40CFR261.32. The symbol "§" may be used as well to designate a "section" or "part."

- United States Department of Homeland Security. Includes "chemicals of interest" from The Chemical Facility Anti-Terrorism Standards (CFATS Act of 2014) program and the *Federal Register*, Appendix A, including all provisions of 6 CFR Part 27, including § 27.210(a)(1)(i). In developing the list, the DHS looked to existing expert sources of information including other federal regulations related to chemicals, including the following: chemicals covered under the United States Environmental Protection Agency's Risk Management Program. Chemicals included in the Chemical Weapons Convention. Hazardous materials, such as gases that are poisonous by inhalation. Explosives regulated by the DOT. The Department of Homeland Security has identified three security issues related to chemicals: *Release*—Toxic, flammable, or explosive chemicals or materials that, if released from a facility, have the potential for significant adverse consequences for human life or health. *Theft or Diversion*—Chemicals or materials that, if stolen or diverted, have the potential to be misused as weapons or easily converted into weapons using chemical

manipulation and techniques and related equipment with the intent of creating significant adverse consequences for human life or health. *Sabotage or Contamination*—Chemicals or materials that, if mixed with other and possibly readily available materials, have the potential to create significant adverse consequences for human life or health. Also considered were these security issues as well as to determine their potential future inclusion in the final version of Appendix A, and/or coverage under *Chemical Facility Anti-Terrorism Standards: Critical to Government Mission*—Chemicals or facilities the loss of which could create significant adverse consequences for national security or the ability of the government to deliver essential services, and *Critical to National Economy*—Chemicals or facilities the loss of which could create significant adverse consequences for the national or regional economy.

- Carcinogenicity: lists known and suspected human carcinogens, the agency making such a determination, the nature of the carcinogenicity. The following lists and agencies were consulted: *US Department of Health and Human Services 13th Report on Carcinogens (10/2/2014)*. United States Environmental Protection Agency: US EPA's general categories recognized by the 2005 guidelines are as follows: *Group A*: Carcinogenic to Humans: Agents with adequate human data to demonstrate the causal association of the agent with human cancer (typically epidemiologic data). *Group B*: Probably Carcinogenic to Humans: Agents with sufficient evidence (i.e., indicative of a causal relationship) from animal bioassay data, but either limited human evidence (i.e., indicative of a possible causal relationship, but not exclusive of alternative explanations; Group B1), or with little or no human data (Group B2). *Group C*: Possibly Carcinogenic to Humans: Agents with limited animal evidence and little or no human data. *Group D*: Not Classifiable as to Human Carcinogenicity: Agents without adequate data either to support or refute human carcinogenicity. *Group E*: Evidence of Noncarcinogenicity for Humans: Agents that show no evidence for carcinogenicity in at least two adequate animal tests in different species or in both adequate epidemiologic and animal studies.[USEPA] US Department of Health and Human Services *13th Report on Carcinogens (RoC)*, (2014), a science-based document prepared by the National Toxicology Program (NTP) that identifies chemical, biological, and physical agents that are considered cancer hazards for people living in the United States. IARC (International Agency for Research on Cancer),[12] are classified as to their carcinogenic risk to humans by IARC as follows: Group 1: Human Carcinogen; Group 2A: Probable Human Carcinogen; Group 2B: Possible Human Carcinogen.
- Chemicals on California's Proposition 65 List, revised as of September 30, 2016. Officially known as the Safe Drinking Water and Toxic Enforcement Act of 1986. The proposition requires that the Governor protect the state's drinking water sources from being contaminated with chemicals known to cause cancer, birth defects or other reproductive harm, and to revise and republish at least once per year a list of such chemicals. It also requires businesses to inform Californians about exposures to chemicals on the revised list[OEHHA].
- This 7th edition contains a brief summary labeled "Hazard Alert". The purpose of this section is to quickly notify users of specific dangers related to each chemicals of interest. Following is a *sample* of warnings appearing in this section: Asphyxiation hazard • Combustible liquid • Contains gas under pressure • may explode if heated • Endocrine disruptors (high/medium/low, where available) • Dangerous nerve agent • Extremely flammable gas • Flammable liquid • Frostbite/Cryogenic burn hazard • Poison inhalation hazard: exposure can be lethal • Polymerization hazard (high) • Polymerization hazard $>$ 30°C • Possible risk of forming tumors • Primary irritant (w/o allergic reaction) • Sensitization hazard (skin, respiratory) • Suspected of causing genetic defects • Suspected reprotoxic hazard • Environmental hazard, etc. *Warning*: This section is merely a guide and does not purport to be complete for every chemical covered in this work.
- A banned or severely restricted product as designated by the United Nations[13] or by the US EPA Office of Pesticide Programs under FIFRA (Federal Insecticide, Fungicide and Rodenticide Act).[14]
- A substance with an air pollutant standard set or recommended by OSHA and/or NIOSH,[58] ACGIH,[1] DFG.[3] The OSHA limits are the enforceable pre-1989 PELs. The transitional limits that were vacated by court order have not been included. However, the vacated limits are used and enforced by some states. Some airborne limits, for example, such as those from NIOSH and ACGIH are recommendations that do not carry the force of law.
- A substance whose allowable concentrations in workplace air are adopted or proposed by the American Conference of Government Industrial Hygienists

(ACGIH),[1] DFG [Deutsche Forschungsgemeinschaft (German Research Society)].[3] Substances whose allowable concentrations in air and other safety considerations have been considered by OSHA and NIOSH.[2] Substances which have limits set in workplace air, in residential air, in water for domestic purposes or in water for fishery purposes as set forth by the former USSRUNEP/IRPTC Project.[43]

- Substances that are specifically regulated by OSHA under 29CFR1910.1001 to 29CFR1910.1050
- Highly hazardous chemicals, toxics, and reactives regulated by OSHA's "*Process Safety Management of Highly Hazardous Chemicals*" under 29CFR1910.119, Appendix A. Substances that are Hazardous Air Pollutants (Title I, Part A, § 112) as amended under 42USC7412. This list provided for regulating at least 189 specific substances using technology-based standards that employ Maximum Achievable Control Technology (MACT) standards; and, possibly health-based standards if required at a later time. § 112 of the Clean Air Act (CAA) requires emission control by the EPA on a source-by-source basis. Therefore, the emission of substances on this list does not necessarily mean that a firm is subject to regulation.
- Regulated Toxic Substances and Threshold Quantities for Accidental Release Prevention. These appear as Accidental Release Prevention/Flammable Substances, Clean Air Act (CAA) §112(r), Table 3, TQ (threshold quantity) in pounds and kilograms under 40 CFR68.130. The accidental release prevention regulations applies to stationary sources that have present more than a threshold quantity of a CAA § 112(r) regulated substance.
- Clean Air Act (CAA) Public Law 101−549, Title VI, *Protection of Stratospheric Ozone*, Subpart A, Appendix A, class I and Appendix B, Class II, Controlled Substances, (CFCs) Ozone depleting substances under 40CFR82.
- Clean Water Act (CWA) Priority toxic water pollutants defined by the US Environmental Protection Agency for 65 pollutants and classes of pollutants which yielded 129 specific substances.[6]
- Chemicals designated by EPA as "Hazardous Substances"[4] under the Clean Water Act (CWA) 40CFR116.4, Table 116.4A.
- Clean Water Act (CWA) § 311 Hazardous Materials Discharge Reportable Quantities (RQs). This regulation establishes reportable quantities for substances designated as hazardous (see §116.4, above) and sets forth requirements for notification in the event of discharges into navigable waters. Source: 40 CFR117.3, amended at 60FR30937.
- Clean Water Act (CWA) § 307 List of Toxic Pollutants. Source: 40CFR401.15.
- Clean Water Act (CWA) § 307 Priority Pollutant List. This list was developed from the List of Toxic Pollutants classes discussed above and includes substances with known toxic effects on human and aquatic life, and those known to be, or suspected of being, carcinogens, mutagens, or teratogens. Source: 40CFR423, Appendix A.
- Clean Water Act, § 313 Water Priority Chemicals. Source: 57FR41331.
- RCRA Maximum Concentration of Contaminants for the Toxicity Characteristic with Regulatory levels in mg/L. Source: 40CFR261.24.
- RCRA Hazardous Constituents. Source: 40CFR261, Appendix VIII. Substances listed have been shown, in scientific studies, to have carcinogenic, mutagenic, teratogenic or toxic effects on humans and other life forms. This list also contains RCRA waste codes. The words, "waste number not listed" appears when a RCRA number is NOT provided in Appendix VIII.

Characteristic Hazardous Wastes

Ignitability	A nonaqueous solution containing less than 24% alcohol by volume and having a closed cup flash point below 60°C/140°F using Pensky−Martens tester or equivalent An ignitable compressed gas A nonliquid capable of burning vigorously when ignited or causes fire by friction, moisture absorption, spontaneous chemical changes at standard pressure and temperature An oxidizer. See §261.21
Corrosivity	Liquids with a pH equal to or less than 2 or equal to or more than 12.5 or which corrode steel at a rate greater than 6.35 mm (0.25 in.) per year @ 55°C/130°F. See §261.22
Reactivity	Unstable substances that undergo violent changes without detonating Reacts violently with water or other substances to create toxic gases Forms potentially explosive mixtures with air. See §261.23
Toxicity	A waste that leaches specified amounts of metals, pesticides, or organic chemicals using Toxicity Characteristic Leaching Procedure (TCLP). See §261, Appendix II, and §268, Appendix I. **Listed Hazardous Wastes**

"F" wastes	Hazardous wastes from nonspecific sources §261.31
"K" Wastes	Hazardous wastes from specific sources §261.32
"U" Wastes	Hazardous wastes from discarded commercial products, off-specification species, container residues §261.34. Covers some 455 compounds and their salts and some isomers of these compounds
"P" Wastes	Acutely hazardous wastes from discarded commercial products, off-specification species, container residues §261.33. Covers some 203 compounds and their salts plus soluble cyanide salts

Note: If a waste is not found on any of these lists, it may be found on state hazardous waste lists.

RCRA Maximum Concentration of Contaminants for the Toxicity Characteristic. Source: 40CFR261.24, Table I. These are listed with regulatory level in mg/L and "D" waste numbers representing the broad waste classes of ignitability, corrosivity, and reactivity.

EPA Hazardous Waste code(s), or RCRA number, appears in its own field. Acute hazardous wastes from commercial chemical products are identified with the prefix "P." Nonacutely hazardous wastes from commercial chemical products are identified with the prefix "U."

RCRA Universal Treatment Standards. Lists hazardous wastes that are banned from land disposal unless treated to meet standards established by the regulations. Treatment standard levels for wastewater (reported in mg/L) and nonwastewater [reported in mg/kg or mg/L TCLP (Toxicity Characteristic Leachability Procedure)] have been provided. Source: 40CFR268.48 and revision, 61FR15654.

RCRA Ground Water Monitoring List. Sets standards for owners and operators of hazardous waste treatment, storage, and disposal facilities, and contains test methods suggested by the EPA (see Report SW-846) followed by the Practical Quantitation Limit (PQL) shown in parentheses. The regulation applies only to the listed chemical; and, although both the test methods and PQL are provided, they are *advisory only*. Source: 40CFR264, Appendix IX.

Safe Drinking Water Act (SDWA) Maximum Contaminant Level Goals (MCLG) for Organic Contaminants. Source: 40CFR141 and 40CFR141.50, amended 57FR31776.

- Maximum Contaminant Levels (MCL) for Organic Contaminants. Source: 40CFR141.61.
- Maximum Contaminant Level Goals (MCLG) for Inorganic Contaminants. Source: 40CFR141.51.
- MCL for Inorganic Contaminants. Source: 40CFR141.62.
- MCL for Inorganic Chemicals. The MCL for arsenic applies only to community water systems. Compliance with the MCL for arsenic is calculated pursuant to §141.23. Source: 40CFR141.11.
- Secondary Maximum Contaminant Levels (SMCL). Federal advisory standards for the states concerning substances that effect physical characteristics (i.e., smell, taste, color, etc.) of public drinking water systems. Source: 40CFR143.3.
- CERCLA Hazardous Substances ("RQ" Chemicals). From Consolidated List of Chemicals Subject to the Emergency Planning and Community Right-to-Know Act (EPCRA) and § 112(r) of the Clean Air Act, as Amended. Source: EPA 550-B-98-017 *Title III List of Lists*.
- Releases of CERCLA hazardous substances in quantities equal to or greater than their reportable quantity (RQ), are subject to reporting to the National response Center under CERCLA. Such releases are also subject to state and local reporting under §304 of SARA Title III (EPCRA). CERCLA hazardous substances, and their reportable quantities, are listed in 40CFR302, Table 302.4. RQs are shown in pounds and kilograms for chemicals that are CERCLA hazardous substances. For metals listed under CERCLA (antimony, arsenic, beryllium, cadmium, chromium, copper, lead, nickel, selenium, silver, thallium, and zinc), no reporting of releases of the solid is required if the diameter of the pieces of solid metal released is 100 μm (0.004 in.) or greater. The RQs shown apply to smaller particles.
- EPCRA §302 Extremely Hazardous Substances (EHS). From Consolidated List of Chemicals Subject to the Emergency Planning and Community Right-to-Know Act (EPCRA) and § 112(r) of the Clean Air Act, as Amended. Source: EPA 550-B-98-017 *Title III List of Lists*. The presence of Extremely Hazardous Substances in quantities in excess of the Threshold Planning Quantity (TPQ), requires certain emergency planning activities to be conducted. The Extremely Hazardous Substances and their TPQs are listed in 40CFR355, Appendices A and B. For chemicals that are solids, there may be two TPQs given (e.g., 500/10,000). In these cases, the lower quantity applies for solids in powder form with particle size less than 100 μm; or, if the substance is in solution or in molten form. Otherwise, the higher quantity (10,000 pounds in the example) TPQ applies.
- EPCRA §304 Reportable Quantities (RQ). In the event of a release or spill exceeding the reportable quantity, facilities are required to notify State Emergency Response Commissions (SERCs) and Local Emergency Planning Committees (LEPCs). From Consolidated List of Chemicals Subject to the

Emergency Planning and Community Right-to-Know Act (EPCRA) and § 112(r) of the Clean Air Act, as Amended. Source: EPA 550-B-98-017 *Title III List of Lists*.

- EPCRA § 313 Toxic Chemicals. From Consolidated List of Chemicals Subject to the Emergency Planning and Community Right-to-Know Act (EPCRA) and § 112(r) of the Clean Air Act, as Amended. Source: EPA 550-B-98-017 *Title III List of Lists*. Chemicals on this list are reportable under §313 and §6607 of the Pollution Prevention Act. Some chemicals are reportable by category under §313. Category codes needed for reporting are provided for the EPCRA§313 categories. Information and Federal Register references have been provided where a chemical is subject to an administrative stay, and not reportable until further notice.
- From "*Toxic Chemical Release Inventory Reporting Form R and Instructions, Revised 2005 Version*," EPA document 260-B-06-001 was used for *de minimis* concentrations, toxic chemical categories.
- Chemicals which EPA has made the subject of Chemical Hazard Information Profiles or "CHIPS" review documents.
- Chemicals which NIOSH has made the subject of "Information Profile" review documents on "Current Intelligence Bulletins."
- Carcinogens identified by the National Toxicology Program of the US Department of Health and Human Services at Research Triangle Park, NC.[10]
- Substances regulated by EPA[7] under the major environmental laws: Clean Air Act, Clean Water Act, Safe Drinking Water Act, RCRA, CERCLA, EPCRA, etc. A more detailed list appears above. Substances with environmental standards set by some international bodies including those in Europe and Canada.[43]
- Hazard Symbols, Risk Phrases, and Safety Phrases. Explanation of these symbols and phrases can be found in Appendix 4. In the year 2018 it is expected that the Globally Harmonized System of Classification and Labeling of Chemicals (GHS) will be phased in by many countries. Hazard statements are an essential element under the GHS, and will eventually replace the risk phrases (R-phrases) described earlier in the paragraph. In addition to hazard statements, containers and Material Safety Data Sheets (MSDS) will often contain, where necessary, one or multiple pictograms, a signal word such as "Warning" or "Danger," and precautionary statements. The precautionary statements will indicate proper handling procedures aimed at protecting the user and other people who might come in contact with the substance during an accident or in the environment. The container and MSDS will also contain the name of the supplier, manufacturer, or importer. Each hazard statement contains a four-digit code, starting with the letter H (in the format Hxxx). Statements appear under various headings grouped together by code number. The purpose of the four-digit code is for reference only; however, following the code is exact *phrase* as it should appear on labels and MSDS. The collection of Risk and Safety phrases in this work my go beyond those found in some, more generalized Material Safety Data Sheets. It is also possible that some of the warnings are based on animal rather than human studies. These statements are usually preceded by the word "suspected" or "potential".
- Water hazard classifications from the German Federal Water Management Act on Water Hazard Classification, *Verwaltungsvorschrift Wassergefährdende Stoffe* (VwVwS). This law requires all chemical substances be evaluated for their detrimental impact on the physical, chemical, or biological characteristics of water. Substances can be classified as nonhazardous to water (*nwg, nicht wassergefährdende*) or assigned to one of three numeric water hazard classes, WGK-1: low hazard to waters (low polluting to water), WGK-2: hazard to waters (water pollutant), or WGK: 3 severe hazard to waters (severe pollutant). The English acronym for WGK is WHC (water hazard class). This work uses the German initial-acronym "WGK" so there is no confusion as to its source. Material Safety Data Sheets (MSDS) that use these water hazards also use the German acronym. If a value was not assigned or not found in the German database, an estimated has been provided using the format, "*WGK (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]*." These estimates are based on other sources, for example, the US DOT *List of Marine Pollutants (§172.101—Appendix B)*. *Warning*: These estimates are to be used only as a guide. In the case of limited information, it is the responsibility of the users of this work to recognize and address those limitations and to engage in additional research, including direct contact with chemical suppliers and all forms of supplier communications such as the legally required Material Safety Data Sheets (MSDSs), Technical Bulletins, etc.

Description: This section contains a quick summary of properties of the substance including physical state (solid, liquid or gas), color, odor description, molecular weight, density, boiling point, freezing/melting point, vapor

pressure, flash point, autoignition temperature, explosion limits in air, Hazard Identification (based on NFPA-704 M Rating System) in the format: Health (ranked 1 to 4), Flammability (ranked 1 to 4), Reactivity (ranked 1 to 4) (see also below for a detailed explanation of the System and Fire Diamond), and solubility or miscibility in water. This section may also contain special and relevant comments about the substance. Terms in this section are also defined in the glossary.

Odor threshold: This is the lowest concentration in air that most humans can detect by smell. Some value ranges are reported. The value cannot be relied on to prevent overexposure, because human sensitivity to odors varies over wide limits, some chemicals cannot be smelled at toxic concentrations, odors can be masked by other odors, and some compounds rapidly deaden the sense of smell.

Molecular weight: The MW as calculated from the molecular formula using standard elemental molecular weights (e.g. carbon = 12.1).

Boiling point at 1 atm: The value is the temperature of a liquid when its vapor pressure is 1 atm. For example, when water is heated to 100°C/212°F its vapor pressure rises to 1 atm and the liquid boils. The boiling point at 1 atm indicates whether a liquid will boil and become a gas at any particular temperature and sea-level atmospheric pressure.

Melting/Freezing point: The melting/freezing point is the temperature at which a solid changes to liquid or a liquid changes to a solid. For example, liquid water changes to solid ice at 0°C/32°F. Some liquids solidify very slowly even when cooled below their melting/freezing point. When liquids are not pure (e.g., salt water) their melting/freezing points are lowered slightly.

Flash point: This is defined as the lowest temperature at which vapors above a volatile combustible substance will ignite in air when exposed to a flame. Depending on the test method used, the values given may be either Tag Closed Cup (cc) (ASTM D56) or Cleveland Open Cup (oc) (ASTM D93). The values, along with those in *Flammable Limits in Air* and *Autoignition temperature* below, give an indication of the relative flammability of the chemical. In general, the open cup value is slightly higher (perhaps 10 to 15°F higher) than the closed cup value. The flash points of flammable gases are often far below 0° (F or C) and these values are of little practical value, so the term "flammable gas" is often used instead of the flash point value.

Autoignition Temperature: This is the minimum temperature at which the material will ignite without a spark or flame being present. Values given are only approximate and may change substantially with changes in geometry, gas, or vapor concentrations, presence of catalysts, or other factors.

Flammable Limits in Air: The percent concentration in air (by volume) is given for the LEL (lower explosive-flammable limit in air, % by volume) and UEL (upper explosive flammable limit in air, % by volume), at room temperature, unless other specified. The values, along with those in "Flash point" and "Autoignition temperature" give an indication of the relative flammability of the chemical.

NFPA Hazard Classifications: The NFPA 704 Hazard Ratings (Classifications) are based on those found in "*Fire Protection Guide to Hazardous Materials*," 2001 edition, National Fire Protection Association, Quincy, MA, ©1994. The classifications are defined in Table 1.

Table 1. *Explanation of NFPA Hazard Classifications*

Classification	*Definition*
HEALTH HAZARD (blue)	
4	Materials which on very short exposure could cause death or major residual injury (even though prompt medical treatment was given), including those that are too dangerous to be approached without specialized protective equipment
3	Materials which on short exposure could cause serious temporary or residual injury (even though prompt medical treatment was given), including those requiring protection from all bodily contact
2	Materials that, on intense or continued (but not chronic) exposure, could cause temporary incapacitation or possible residual injury, including those requiring the use of protective clothing that has an independent air supply
1	Materials which on exposure would cause irritation but only minor residual injury, including those requiring the use of an approved air-purifying respirator
0	Materials that, on exposure under fire conditions offer no hazard beyond that of ordinary combustible material
FLAMMABILITY (red)	
Classification number and Definition	
4	This degree includes flammable gases, pyrophoric liquids, and Class IA flammable liquids. Materials which will rapidly or completely vaporize at atmospheric pressure and normal ambient temperature, or which are readily dispersed in air and which will burn readily
3	Includes Class IB and IC flammable liquids and materials that can be easily ignited under almost all normal temperature conditions
2	Materials that must be moderately heated before ignition will occur and includes Class II and Class IIIA combustible liquids and solids and semisolids that readily give off ignitable vapors
1	Materials that must be preheated before ignition will occur, such as Class IIIB combustible liquids, and solids and semisolids whose flash point exceeds 200°F/93.4°C, as well as most ordinary combustible materials
0	Materials that will not burn

REACTIVITY (yellow)

4 Materials that, in themselves, are readily capable of detonation, explosive decomposition or explosive reaction at normal temperatures and pressures

3 Materials that, in themselves, are capable of detonation, or explosive reaction, but require a strong initiating source or heating under confinement. This includes materials that are sensitive to thermal and mechanical shock at elevated temperatures and pressures and materials that react explosively with water

2 Materials that are normally unstable and readily undergo violent chemical change, but are not capable of detonation. This includes materials that can undergo chemical change with rapid release of energy at normal temperatures and pressures. This also includes materials that may react violently with water or that may form potentially explosive mixtures in water

1 Materials that are normally stable, but that may become unstable at elevated temperatures and pressures and materials that will react with water with some release of energy, but not violently

0 Materials that are normally stable, even under fire exposure conditions, and that do not react with water

OTHER (white)

₩ Materials which react so violently with water that a possible hazard results when they come in contact with water, as in a fire situation. Similar to Reactivity Classification 2. Oxy—Oxidizing material; any solid or liquid that readily yields oxygen or other oxidizing gas, or that readily reacts to oxidize combustible materials

It should be noted that OSHA and DOT have differing definitions for the term "flammable liquid" and "combustible liquid." DOT defines a flammable liquid as one which, under specified procedures, has a flash point of 140°F/60°C or less. A combustible liquid is defined as "having a flash point above 140°F/60°C and below 200°F/93°C." OSHA defines a combustible liquid as having a flash point above 100°F/37.7°C.

Detection: Only those materials having specific or specialized testing materials have this section. For example, the chemical Abrin or Ricin can be detected using BTA (BioThreat Alert) test strips.

History of the material: This section is reserved for those materials having a useful and interesting background. Some of these materials may be, for example, invasive botanicals that may be found in populated areas Dangerous to both people and pets, these invasive plants may have to be professionally removed to prevent both spreading and accidental poisonings.

Potential Exposure: A brief indication is given of the nature of exposure to each compound in the industrial environment. Where pertinent, some indications are given of background concentration and occurrence from other than industrial discharges such as water purification plants. Obviously in a work of this magnitude, this coverage must be very brief. It is of course recognized that nonoccupational exposures may be important as well.

Incompatibilities: Important, potentially hazardous incompatibilities of each substance are listed where available. Where a hazard with water exists, it is described. Reactivity with other materials are described including structural materials such as metal, wood, plastics, cement, and glass. The nature of the hazard, such as severe corrosion formation of a flammable gas, is described. This list is by no means complete or all inclusive. In some cases a very small quantity of material can act as a catalyst and produce violent reactions such as polymerization, disassociation and condensation. Some chemicals can undergo rapid polymerization to form sticky, resinous materials, with the liberation of much heat. The containers may explode. For these chemicals the conditions under which the reaction can occur are given.

Permissible Exposure Limits in Air: The permissible exposure limit (PEL), has been cited as the federal standard where one exists. Inasmuch as OSHA has made the decision to enforce only pre-1989 PELs, we decided to use these values rather than the transitional limits that were vacated by court order. Except where otherwise noted, the PELs are 8-hour work-shift time-weighted average (TWA) levels. Ceiling limits, Short-Term Exposure Limits (STEL), and TWAs that are averaged over other than full work-shifts are noted.

The Short-Term Exposure Limit (STEL) values are derived from NIOSH,[58] ACGIH,[1] and HSE[33] publications. This value is the maximal concentration to which workers can be exposed for a period up to 15 minutes continuously without suffering from: irritation; chronic or irreversible tissue change; or narcosis of sufficient degree to increase accident proneness, impair self-rescue, or materially reduce work efficiency, provided that no more than four excursions per day are permitted, with at least 60 minutes between exposure periods, and provided that the daily TWA also is not exceeded. The "Immediately Dangerous to Life or Health" (IDLH) concentration represents a maximum level from which one could escape within 30 minutes without any impairing symptoms or any irreversible health effects. However, the 30-minute period is meant to represent a MARGIN OF SAFETY and is NOT meant to imply that any person should stay in the work environments any longer than necessary. In fact, every effort should be made to exit immediately. The concentrations are reported in either parts per million (ppm) or milligrams per cubic meter (mg/m^3).

Most US specifications on permissible exposure limits in air have come from ACGIH[1] or NIOSH.[2] In the In

Germany the DFG has established Maximum Concentrations in the workplace.[3] This section also contains numerical values for allowable limits of various materials in ambient air[60] as assembled by the US EPA. Where available, this field contains legally enforceable airborne Permissible Exposure Limits (PELs) from OSHA. It also contains recommended airborne exposure limits from NIOSH, ACGIH, and international sources and special warnings when a chemical substance is a Special Health Hazard Substance. Each are described below. TLVs have not been developed as legal standards and the ACGIH does not advocate their use as such. The TLV is defined as the time-weighted average (TWA) concentration for a normal 8-hour work-day and a 40-hour work-week, to which nearly all workers may be repeatedly exposed, day after day, without adverse effects. A ceiling value (TLV-C) is the concentration that should not be exceeded during any part of the working exposure. If instantaneous monitoring is not feasible, then the TLV-C can be assessed by sampling over a 15-minute period except for those substances that may cause immediate irritation when exposures are short. As some people become ill after exposure to concentrations lower than the exposure limits, this value cannot be used to define exactly what is a "safe" or "dangerous" concentration. ACGIH threshold limit values (TLVs) are reprinted with permission of the American Conference of Governmental Industrial Hygienists, Inc., from the booklet entitled, *Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices*. This booklet is revised on an annual basis. No entry appears when the chemical is a mixture; it is possible to calculate the TLV for a mixture only when the TLV for each component of the mixture is known and the composition of the mixture by weight is also known. According to ACGIH, "Documentation of the Threshold Limit Values and Biological Exposure Indices, 7th Edition" is necessary to fully interpret and implement the TLVs.

OSHA Permissible Exposure Limits (PELs), are found in Tables Z-1, Z-2, and Z-3 of OSHA, "General Industry Air Contaminants Standard (29CFR1910.1000)" that were effective on July 1, 2001 and which are currently enforced by OSHA.

Unless otherwise noted, PELs are the Time-Weighted Average (TWA) concentrations that must not be exceeded during any 8-hour shift of a 40-hour work-week. An OSHA ceiling concentration must not be exceeded during any part of the work-day; if instantaneous monitoring is not feasible, the ceiling must be assessed as a 15-minute TWA exposure. In addition there are a number of substances from Table Z-2 that have PEL ceiling values that must not be exceeded except for a maximum peak over a specified period (e.g., a 5- minute maximum peak in any 2 hours).

NIOSH Recommended Exposure Limits (RELs) are Time-Weighted Average (TWA) concentrations for up to a 10-hour work day during a 40-hour work week. A ceiling REL should not be exceeded at any time. Exposure limits are usually expressed in units of parts per million (ppm), i.e., the parts of vapor (gas) per million parts of contaminated air by volume at 25°C/77°F and one atmosphere pressure. For a chemical that forms a fine mist or dust, the concentration is given in milligrams per cubic meter (mg/m^3).

Protective Action Criteria (PAC) is emergency exposure limits developed by the US Department of Energy (DOE) for more than 3400 chemicals in revision 29, published May 2016. These exposure limits can be used to estimate the consequences of the uncontrolled release of hazardous materials and to plan for emergency response. These PACs have been added to the 7th edition of Sittig because other well established exposure limits in air are available for an only a limited number of chemicals from other governmental and advisory sources. PAC values are given in parts per million (ppm) for volatile liquids and gases; in milligrams per cubic meter (mg/m^3) for solids, particulates, solids, and nonvolatile liquids. Chemicals for which Acute Emergency Guideline Levels (AEGLs) and Emergency Response Planning Guidelines (ERPGs) have their values displayed in *bolded* font.

PAC Definitions[SCAPA]:

There are subtle difference in the definitions of AEGLs, ERPGs, and TEELs and major differences in how they are developed and issued. Differences in their definitions include:

AEGLs pertain to the "general population, including susceptible individuals," but ERPGs and TEELs pertain to "nearly all individuals."

AEGLs are defined as the level "above which" certain health effects are expected, while ERPGs and TEELs are defined as the level "below which" certain health effects are *not* expected.

Acute Emergency Guideline Levels (AEGLs) are defined as follows:

- *AEGL-1*: the airborne concentration (expressed as ppm or mg/m^3) of a substance above which it is predicted that the general population, including susceptible individuals, could experience notable discomfort, irritation, or certain asymptomatic, nonsensory effects. However, these effects are not disabling and are transient and reversible upon cessation of exposure.
- *AEGL-2*: the airborne concentration (expressed as ppm or mg/m^3) of a substance above which it is predicted that the general population, including susceptible individuals, could experience irreversible or other serious, long-lasting, adverse health effects or an impaired ability to escape.
- *AEGL-3*: the airborne concentration (expressed as ppm or mg/m^3) of a substance above which it is predicted that the general population, including susceptible individuals, could experience life-threatening adverse health effects or death.

Emergency Response Planning Guidelines (ERPGs) are defined as follows:

- *ERPG-1*: the maximum concentration in air below which it is believed nearly all individuals could be exposed for up to one hour without experiencing other than mild transient adverse health effects or perceiving a clearly defined objectionable odor.
- *ERPG-2*: the maximum concentration in air below which it is believed nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action.
- *ERPG-3*: the maximum concentration in air below which it is believed nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects.

Additional information on PAC values and links to other sources of information can be found on the webpage for the *Subcommittee for Consequence Assessment and Protective Action (SCAPA)*: http://orise.orau.gov/emi/scapa/teels.htm

The German MAK (DFG MAK) values are conceived and applied as 8-hour time-weighted average (TWA) values.[3]

Short-Term Exposure Limits (15-minute TWA): This field contains Short-Term Exposure Limits (STELs) from ACGIH, NIOSH and OSHA. The parts of vapor (gas per million parts of contaminated air) by volume at 25°C/77°F and one atmosphere pressure is given. The limits are given in milligrams per cubic meter (mg/m^3) for chemicals that can form a fine mist or dust. Unless otherwise specified, the STEL is a 15-minute TWA exposure that should not be exceeded at any time during the work-day.

Determination in Air: The citations to analytical methods are drawn from various sources, such as the *NIOSH Manual of Analytical Methods*.[18] In addition, methods have been cited in the latest US Department of Health and Human Services publications including the *"NIOSH Pocket Guide to Chemical Hazards"* August, 2006.

Permissible Concentrations in Water: The permissible concentrations in water are drawn from various sources also, including: The National Academy of Sciences/National Research Council, Safe Drinking Water Committee Board on Toxicology and Environmental Health Hazards, *Drinking Water and Health*, 1980.[16]

The priority toxic pollutant criteria published by US EPA 1980.[6]

The multimedia environmental goals for environmental assessment study conducted by EPA.[32] Values are cited from this source when not available from other sources.

The US EPA has come forth with a variety of allowable concentration levels:

For allowable concentrations in "California List" wastes.[38] The California List consists of liquid hazardous wastes containing certain metals, free cyanides, polychlorinated biphenyls (PCBs), corrosives with a pH of less than or equal to 2.0, and liquid and nonliquid hazardous wastes containing halogenated organic compounds (HOCs).

For regulatory levels in leachates from landfills.[37]

For concentrations of various materials in effluents from the organic chemicals and plastics and synthetic fiber industries.[51]

For contaminants in drinking water.[36]

For National Primary and Secondary Drinking Water Regulations.[62]

In the form of health advisories for 16 pesticides,[47] 25 organics,[48] and 7 inorganics.[49]

For primary drinking water standards starting with a priority list of 8 Volatile Organic Chemicals.[40]

State drinking water standards and guidelines [61] as assembled by the US EPA.

Determination in Water: The sources of information in this field have been primarily US EPA publications including the test procedures for priority pollutant analysis[25] and later modifications.[42]

Routes of Entry: The toxicologically important routes of entry of each substance are listed. In other words, the way in which the people or experimental animals were exposed to the chemical is listed, e.g. eye contact, skin contact, inhalation, intraperitoneal, intravenous. Many of these are taken from the *NIOSH Pocket Guide*,[2] but are drawn from other sources as well.

Harmful Effects and Symptoms: These are primarily drawn from NIOSH, EPA publications, and New Jersey and New York State fact sheets on individual chemicals, and are supplemented from information from the draft criteria documents for priority toxic pollutants[26] and from other sources. The other sources include the following:

EPA Chemical Hazard Information Profiles (CHIPS) cited under individual entries.

NIOSH Information Profiles cited under individual entries.

EPA Health and Environmental Effect Profiles cited under individual entries.

Particular attention has been paid to cancer as a "harmful effect" and special effort has been expended to include the latest data on carcinogenicity. See also "Regulatory Authority and Advisory Bodies" section.

Short-Term Exposure: These are brief descriptions of the effects observed in humans when the vapor (gas) is inhaled, when the liquid or solid is ingested (swallowed), and when the liquid or solid comes in contact with the eyes or skin. The term LD50 signifies that about 50% of the animals given the specified dose by mouth will die. Thus, for a Grade 4 chemical (below 50 mg/kg) the toxic dose for 50% of animals weighing 70 kg (150 lb) is $70 \times 50 = 3500$ mg = 3.5 g, or less than 1 teaspoonful; it might be as little as a few drops. For a Grade 1 chemical (5−15 g/kg), the LD50 would be between a pint and a quart for a 150-lb man. All LD50 values have been obtained using small laboratory animals such as rodents,

cats, and dogs. The substantial risks taken in using these values for estimating human toxicity are the same as those taken when new drugs are administered to humans for the first time.

Long-Term Exposure: Where there is evidence that the chemical can cause cancer, mutagenic effects, teratogenic effects, or a delayed injury to vital organs such as the liver or kidney, a description of the effect is given.

Points of Attack: This category is based, in part, on the "Target Organs" in the *NIOSH Pocket Guide*[2] but the title has been changed as many of the points of attack are not organs (blood, for example). This is human data unless otherwise noted.

Medical Surveillance: For each chemical, this information is drawn from many and various government publications and sources including, for example, CDC, NIOSH publications,[27] *New Jersey* or *New york State Fact Sheets*,[70] HSDB/Toxnet, etc. In many cases, statements may refer to known and suspected carcinogen, known or suspected mutagens, reproductive affecters, skin and/or respiratory sensitizers, etc.

First Aid: Guides and guidance to first aid found in this work should not be construed as authorization to emergency personnel to perform the procedures or activities indicated or implied. Care of persons exposed to toxic chemicals must be directed by a physician or other recognized professional or authority. Simple first aid procedures are listed for response to eye contact, skin contact, inhalation, and ingestion of the toxic substance as drawn to a large extent from the *NIOSH Pocket Guide*[2] but supplemented by information from recent commercially available volumes in the United States,[29] in the United Kingdom, and in Japan[24] as well as from state fact sheets. They deal with exposure to the vapor (gas), liquid, or solid and include inhalation, ingestion (swallowing) and contact with eyes or skin. The instruction "Do NOT induce vomiting" is given if an unusual hazard is associated with the chemical being sucked into the lungs (aspiration) while the patient is vomiting. "*Seek medical attention*" or "*Call a doctor*" is recommended in those cases where only competent medical personnel can treat the injury properly. In all cases of human exposure, seek medical assistance as soon as possible. In many cases, medical advice has been included for guidance only. Dosage information has been avoided because dosage recommendations constantly change. Emergency personnel are urged to check all manufacturers' information particularly before administering any drug with which they are not familiar or have not used for some period of time. Also, medications suggested to be administered by qualified medical personnel presume no immediate prior administration of the same, similar or complicating medications.

Personal Protective Methods: This information is drawn heavily from NIOSH publications[2][77] and supplemented by information from the United States,[29] the United Kingdom, and Japan.[24] There are indeed other "personal protective methods" which space limitations prohibit describing here in full. One of these involves limiting the quantities of carcinogens to which a worker is exposed in the laboratory. The items listed are those recommended by (1) NIOSH and/or OSHA, (2) manufacturers, either in technical bulletins or in material safety data sheets (MSDS), (3) the Chemical Manufacturers Association (CMA), or (4) the National Safety Council (NSC), for use by personnel while responding to fire or accidental discharge of the chemical. They are intended to protect the lungs, eyes, and skin.

Respirator Selection: The 7th edition, like its predecessors, presents respirator selection with a full text description. For each line a maximum use concentration (in ppm, mg/m^3, μg/m^3, fibers/m^3, or mppcf) condition (e.g., escape) followed by the NIOSH code and full text related to respirator recommendations. All recommended respirators of a given class, can be utilized at any concentration equal to or less than the class's listed maximum use concentration. Respirator selection should follow recommendations that provide the greatest degree of protection. Respirator codes found in the *NIOSH Pocket Guide* have been included to ease updating.

All respirators selected must be approved by NIOSH under the provisions of 42CFR84. The current listing of NIOSH/MSHA certified respirators can be found in the *NIOSH Certified Equipment List*, which is available on www.cdc.gov/niosh/npptl/topics/respirators/cel. This is the NIOSH Web site.

For firefighting, only self-contained breathing apparatuses with full facepieces operated in pressure-demand or other positive pressure modes are recommended for all chemicals in the *NIOSH Pocket Guide*. In the case of chemical warfare agents, use only SCBA Respirator certified by NIOSH For CBRN environments. CBRN stands for "Chemical, Biological, Radiological, and Nuclear."

Pesticides are not identified as such in the respirator selection tables. For those substances that are pesticides, the recommended air-purifying respirator must be specifically approved by NIOSH/MSHA. Specific information on choosing the appropriate respirator will be provided on pesticide labels. Approved respirators will carry a "TC" number prefix, which signifies they have been tested and certified for a specific level of protection. New respirators may carry a "TC-84A" prefix in compliance with 42 CFR 84 for testing and certifying nonpowered, air-purifying, particulate-filter respirators. The new Part 84 respirators have passed a more demanding certification test than the old respirators (e.g., dust and mist [DM], dust, fume and mist [DFM], spray paint, pesticide, etc.) certified under 30 CFR 11.

Additionally, a complete respirator protection program should be implemented including all requirements in 29CFR1910.134 and 42CFR84. At a minimum, a respirator protection program should include regular training, fit-testing, periodic environmental monitoring, maintenance inspection, and cleaning. The selection of the actual respirator to be used within the classes

of recommended respirators depends on the particular use situation, and should only be made by a knowledgeable person. Remember, air-purifying respirators will not protect from oxygen-deficient atmospheres. For firefighting, only self-contained breathing apparatuses with full facepieces operated in pressure-demand or other positive pressure modes are recommended for all chemicals in the *NIOSH Pocket Guide*.

Storage: The 7th edition now provides, as general guidance, a color-coded classification system similar to those often found in commerce and laboratories. It is the objective of any chemical storage classification system to prevent accidental combination of two or more incompatible materials that might be stored in the same space. To prevent an unwanted and possibly dangerous reaction, chemicals must be separated by space and/or physical barriers. Chemical storage areas should be appropriately labeled. Users must be careful to check the MSDS for both additional and specific information. Some chemical entries contain multiple storage codes because the chemical profile fits more than a single category.

Code	***Hazard***
Red	Flammables (Flash point $<100°F$)
Blue	Health hazards/toxics/poisons
Yellow	Reactives/oxidizers
White	Contact hazards
Green[a]	General storage

[a]For general storage, the colors gray and orange may also be used by some companies.

- Chemical containers that are not color coded should contain hazard information on the label.
- Check the MSDS to learn what personal protective equipment is required when using the substance
- *Red*: Flammability hazard: Store in a flammable (liquid or materials) storage area or approved cabinet away from ignition sources and corrosive and reactive materials.
- *Blue*: Health hazard/toxics/poisons: Store in a secure poison location.
- *Yellow*: Reactive hazard; store in a location separate from other materials, especially flammables and combustibles.
- *White*: Corrosive or contact hazard; store separately in a corrosion-resistant location.
- *Green (or gray or orange)*: General storage may be used. Generally, for flammability, health, and corrosivity with an NFPA rating of no higher than "2."
- Chemicals with labels that are colored and diagonally striped may react with other chemicals in the same hazard class. See MSDS for more information.
- *Red Stripe*: Flammability hazard: store separately from all other flammable materials. Example: sodium metal.
- *Yellow Stripe*: Reactivity hazard; store separately in an area isolated from flammables, combustibles, or other yellow coded materials. *Example*: reducing agents.
- *White stripe*: Contact hazard; not compatible with materials in solid white category. Store separately. *Exampl*e: Bases.

Other data in this field is drawn from, or based on, various resources, including the NFPA,[17] from Japanese sources[24] and from publications such as the *Hazardous Substance Fact Sheets* published by the New Jersey Department of Health and Senior Services.[70]

Shipping: The shipping guidance offered herein does not replace the training requirements of the DOT and in no way guarantees that you will be in full compliance with the DOT Regulations. *Labeling*: This section refers to the type label or placard required by regulation on any container or packaging of the subject compound being shipped. In some cases a material may require more than one hazardous materials label. *Quantity limitation*: This section lists quantities of material that may be shipped on passenger aircraft, rail, and cargo aircraft. Materials in certain hazard classes may be shipped under the small quantities exception (see 49 CFR 173.4) with specific approval from the Associate Administrator for Hazardous Materials Safety, DOT. *Hazard class or division*: This number refers to the division number or hazard class that must appear on shipping papers. This information is drawn from DOT publications[19] as well as UN publications[20] and also NFPA publications.[17] The US DOT[19] has published listings of chemical substances which give a hazard classification and required labels. The US DOT listing now corresponds with the UN listing[20] and specifies first a hazard class of chemicals as defined in the following table, and then a packing group (I, II, or III) within each of the classes. These groups are variously defined depending on the hazard class but in general define materials presenting: I—a very severe risk (great danger); II—a serious risk (medium danger); and III—a relatively low risk (minor danger).

Hazard Classification System

The hazard class of dangerous goods is indicated either by its class (or division) number or name. For a placard corresponding to the primary hazard class of a material, the hazard class or division number must be displayed in the lower corner of the placard. However, no hazard class or division number may be displayed on a placard representing the subsidiary hazard of a material. For other than Class 7 or the OXYGEN placard, text indicating a hazard (for example, "CORROSIVE") is not required. Text is shown only in the United States. The hazard class or division number must appear on the shipping document after each shipping name.

Class 1—Explosives
Division 1.1: Explosives with a mass explosion hazard
Division 1.2: Explosives with a projection hazard
Division 1.3: Explosives with predominantly a fire hazard
Division 1.4: Explosives with no significant blast hazard
Division 1.5: Very insensitive explosives with a mass explosion hazard
Division 1.6: Extremely insensitive articles
Class 2—Gases
Division 2.1: Flammable gases
Division 2.2: Nonflammable, nontoxic* gases
Division 2.3: Toxic* gases
Class 3—Flammable liquids [and combustible liquids (United States)]
Class 4—Flammable solids; spontaneously combustible materials; and dangerous when wet materials/Water-reactive substances
Division 4.1: Flammable solids
Division 4.2: Spontaneously combustible materials
Division 4.3: Water-reactive substances/dangerous when wet materials
Class 5—Oxidizing substances and organic peroxides
Division 5.1: Oxidizing substances
Division 5.2: Organic peroxides
Class 6—Toxic* substances and infectious substances
Division 6.1: Toxic* substances
Division 6.2: Infectious substances
Class 7—Radioactive materials
Class 8—Corrosive substances
Class 9—Miscellaneous hazardous materials/Products, Substances or Organisms

**Note*: The words "poison" or "poisonous" are synonymous with the word "toxic."

Spill Handling: Spill or leak information provided is intended to be used only as a guide. The term *Issue warning* is used when the chemical is a poison, has a high flammability, is a water contaminant, is an air contaminant (so as to be hazardous to life), is an oxidizing material, or is corrosive. *Restrict access* is used for those chemicals that are unusually and immediately hazardous to personnel unless they are protected properly by appropriate protective clothing, eye protection, and respiratory protection equipment, etc. *Evacuate area* is used primarily for unusually poisonous chemicals or these that ignite easily. *Mechanical containment* is used for water-insoluble chemicals that float and do not evaporate readily. *Should be removed* is used for chemicals that cannot be allowed to disperse because of potentially harmful effects on humans or on the ecological system in general. The term is not used unless there is a reasonable chance of preventing dispersal, after a discharge or leak, by chemical and physical treatment. *Chemical and physical treatment* is recommended for chemicals that can be removed by skimming, pumping, dredging, burning, neutralization, absorption, coagulation, or precipitation. The corrective response may also include the use of dispersing agents, sinking agents, and biological treatment. *Disperse and flush* is used for chemicals that can be made nonhazardous to humans by simple dilution with water. In a few cases the response is indicated even when the compound reacts with water because, when proper care is taken, dilution is still the most effective way of removing the primary hazard. This material safety data sheet information is drawn from a variety of sources including New Jersey Department of Health and Senior Services *Hazardous Substance Fact Sheets*[70] and EPA *Profiles on Extremely Hazardous Substances.*[82]

Fire Extinguishing: Fire information provided is intended to be used only as a guide. Certain extinguishing agents should not to be used because the listed agents react with the chemical and have the potential to create an additional hazard. In some cases they are listed because they are ineffective in putting out the fire. Many chemicals decompose or burn to give off toxic and irritating gases. Such gases may also be given off by chemicals that vaporize in the heat of a fire without either decomposing or burning. If no entry appears, the combustion products are thought to be similar to those formed by the burning of oil, gasoline, or alcohol; they include carbon monoxide (poisonous), carbon dioxide, and water vapor. The specific combustion products are usually not well known over the wide variety of conditions existing in fires; some may be hazardous. This information is drawn from NFPA publications,[17] FEMA,[78] and other sources. Any characteristic behavior that might increase significantly the hazard involved in a fire is described. The formation of flammable vapor clouds or dense smoke, the possibility of polymerization, and explosions is stated in this section and/or the incompatibility section. Unusual difficulty in extinguishing the fire is noted.

Disposal Method Suggested: The disposal methods for various chemical substances have been drawn from various sources, including government documents and a UN publication.[22,79]

References: The general bibliography for this volume follows immediately. It includes both general reference sources and references dealing with analytical methods. The references at the end of individual chemical records are generally restricted to: references dealing only with that particular compound; and references which, in turn, contain bibliographies giving references to the original literature on toxicological and other behavior of the substance in question.

Key to Abbreviations and Acronyms

α	the Greek letter *alpha*; used as a prefix to denote the carbon atom in a straight chain compound to which the principal group is attached.
***as*-**	prefix for asymmetric
ACGIH	American Conference of Governmental Industrial Hygienists
AEGL	Acute Emergency Guideline Level, developed by the EPA
AIHA	American Industrial Hygeine Association
approx	approximately
***asym*-**	prefix for asymmetric
@	at
atm.	atmosphere
ATSDR	Agency for Toxic Substances and Disease Registry
β	the Greek letter *beta*
BEI	Biological Exposure Indices (ACGIH in the USA; South Africa; New Zealand)
BLV	Biological Limit Values
BP	boiling point.
°C	degrees Centigrade
CAA	Clean Air Act
CAAA	Clean Air Act Amendments of 1990
CAMEO	Computer-Aided Management of Emergency Operations (NOAA)
carc.	carcinogen
CAS	Chemical Abstract Service
cc	cubic centimeter
cc	closed cup (Flash point)
CDC	U.S. Center for Disease Control
CEPA	Canadian Environmental Protection Act
CERCLA	Comprehensive Environmental Response, Compensation, And Liability Act
CFCs	chlorofluorocarbons
CFR	*Code of Federal Regulations*
***cis*-**	(Latin: on this side). Indicating one of two geometrical isomers in which certain atoms or groups are on the same side of a plane
CMA	Chemical Manufacturers Association
CPR	Cardiopulmonary Resuscitation
CWA	Clean Water Act
***cyclo*-**	(Greek, circle). Cyclic, ring structure; as cyclohexane
Δ or δ	Greek letter *delta*
DFG	Deutsche Forschungs-gemeinschaft
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
DOT ID	Department of Transportation Identification Numbers
EEC or EC	European Economic Community
EEGL	Emergency Exposure Guidance Level
EHS	Extremely Hazardous Substances
EINECS	European Inventory of Existing Commercial Chemical Substances
ε	Greek letter epsilon
EPA (US)	Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
ESLI	End of Service Life Indicator
est.	estimate
EU	European Union
°F	degrees Fahrenheit
FDA	Food and Drug Administration
FEMA	Federal Emergency Management Agency
FR	*Federal Register* (United States)
γ	Greek letter *gamma*
GHS	Globally Harmonized System of Classification and Labeling of Chemicals
h	hour(s)
HCFC	hydrochlorofluorocarbons
HCS	Hazard Communication Standard
HSDB	Hazardous Substances Data Bank
IARC	International Agency for Research on Cancer
IATA	International Air Transport Association
IDLH	Immediately Dangerous to Life or Health
ILO	International Labor Office
IRIS	Integrated Risk Information System (EPA)
***iso*-**	(Greek, equal, alike). Usually denoting an isomer of a compound.
kg	kilogram(s)
l	liter(s)
lb	pound(s)
$\mathbf{LC_{50}}$	The concentration of a substance in air that kills 50% of the test population.
$\mathbf{LC_{Lo}}$	The lowest concentration of a substance in air that has been shown to cause death in a test population.
$\mathbf{LD_{50}}$	The dose of a substance administered by any route (other than inhalation) that causes death to 50% of the test population.
$\mathbf{LD_{LO}}$	The lowest dose of a substance administered by any route (other than inhalation)that has been shown to cause death in a test population.

LEL	Lower explosive (flammable) limit in air, % by volume at room temperature or other temperature as noted
LEPC	Local Emergency Planning Committees
LTEL	Long Term Exposure Limit (UK)
m-	an abbreviation for "*meta-*," a prefix used to distinguish between isomers or nearly related compounds
m^3	cubic meter
MACT	Maximum Achievable Control Technology (CAA)
MAK	airborne exposure limit "Maximale Arbeitsplatz-Konzentration" (maximum workplace concentration) from the Deutsche Forschungsgemeinschaft (DFG), German Research Foundation.
MCL	Maximum Contaminant Level (SDWA)
MCLG	Maximum Contaminant Level Goal (SDWA)
mg	milligram(s)
μ	micro
μg	microgram(s)
min	minute(s)
mmHg	millimeters of mercury (non-SI symbol for pressure) Also known as "torr."
mppcf	million particles per cubic foot
MSDS	Material Safety Data Sheets
n-	abbreviation for "normal," referring to the arrangement of carbon atoms in a chemical molecule prefix for normal
N-	Symbol used in some chemical names, indicating that the next section of the name refers to a chemical group attached to a nitrogen atom. The bond to the nitrogen atom
NCI	National Cancer Institute (USA)
NFPA	National Fire Protection Association (USA)
NIOSH	National Institute for Occupational Safety and Health (USA)
NLM	National Library of Medicine (USA)
NOAA	National Oceanic and Atmospheric Administration (USA)
NOAEL	No Observed Adverse Effect Level
NOS	not otherwise specified
NPRI	National Pollutant Release Inventory (Canada)
NTIS	National Technical Information Service (USA)
NTP	National Toxicology Program (USA)
o-	*ortho-*, a prefix used to distinguish between isomers or nearly related compounds.
OEL	Occupational Exposure Limit
ω	Greek letter *omega*
oc	open cup
OSHA	Occupational Safety and Health Administration (USA)
Oxy	Oxidizer or oxidizing agent
p-	an abbreviation for "*para-*," a prefix used to distinguish between isomers or nearly related compounds
PAC	Protective Action Criterion (U.S. DOE)
PBB	polybrominated biphenyl
PCB	polychlorinated biphenyl
PE	polyethylene
PEL	Permissible Exposure Limit (USA, Japan, Mexico)
PNOS	Particulates Not Otherwise Specified
POTW	Publicly Owned Treatments Works
PP	polypropylene
ppb	parts per billion
PPE	Personal Protective Equipment
ppm	parts per million
PQL	Practical Quantitation Limit (RCRA)
prim-	prefix for primary
REL	Recommended Exposure Limits (NIOSH)
RQ	Reportable Quantity
RTECS	Registry of Toxic Effects of Chemical Substances
RTK	Right-to-Know
SARA	Superfund Amendments and Reauthorization Act
s. carc	Suspected Carcinogen
SCAPA	Subcommittee on Consequence Assessment and Protective Actions (DOE)
SCBA	Self-Contained Breathing Apparatus
SDWA	Safe Drinking Water Act
sec-	prefix for secondary
SERC	State emergency response commissions
SMCL	Secondary Maximum Contaminant Levels (SDWA)
STEL	Short-Term Exposure Limit
sym-	abbreviation for "symmetrical," referring to a particular arrangement of elements within a chemical molecule
t-	prefix for tertiary
TC_{Lo}	The lowest concentration of a substance in air that has been shown to produce toxic effects in a test population.
TD_{Lo}	The lowest dose of a substance that has been shown to produce toxic effects in a test population
TEEL	Temporary Emergency Exposure Limit
TRK	Technical Guiding Concentrations (DFG) for workplace control of carcinogens

tert-	abbreviation for “tertiary,” referring to a particular arrangement of elements within a chemical molecule
TLV	Threshold Limit Value (ACGIH)
TQ	Threshold Quantity
trans-	(Latin: across). Indicating that one of two geometrical isomers in which certain atoms or groups are on opposite sides of a plane
TRI	Toxic Release Inventory
TSCA	Toxic Substances Control Act
TWA	Time-Weighted Average. Often shown as TWA - 8h (8 hours)
UEL	Upper Explosive (flammable) Limit in air, % by volume at room temperature or other temperature as noted
UN	United Nations
unsym-	prefix for asymmetric
USDA	United States Department of Agriculture
USCG	United States Coast Guard
VOCs	Volatile Organic Compounds
WEEL	Workplace Environmental Exposure Level (AIHA)
WHMIS	Workplace Hazardous Materials Information System (Canada)
>	symbol for “greater than”
<	symbol for “less than”
≤	symbol for “less than or equal to”
≥	symbol for “greater than or equal to”
°	degrees of temperature
%	percent

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P

Pancreatin P:0050

Synonyms: Beef viokase; Diastase vera; Donnazyme; Entozyme; Ilozyme; Intrazyme; Pancreatic extract; Pancrex-V; Pankreon; Pankrotanon; Panteric; Stamyl; Viobin; Viokase; Zypanar

CAS Registry Number: 8049-47-6; 8057-43-0; 9002-16-8; 9046-39-3

HSDB Number: 1976

RTECS Number: RT9033000

Regulatory Authority and Advisory Information

Hazard Alert: Combustible, Primary irritant (w/o allergic reaction), Sensitization hazard (skin, respiratory).

Hazard Symbols, Risk & Safety statements: Hazard Symbol: Xn; Risk phrases: R22; R36/37/38; R42/43; R50/53; Safety phrases: S16; S22; S24; S26; S36/39; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Pancreatin is a yellowish to cream-colored, amorphous powder with a strong odor. Slightly soluble in water. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 0. Sparingly soluble in water.

Potential Exposure: It is an enzyme found in the pancreas and is used in medicines and in treating leather and textiles.

Incompatibilities: Dust may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, alcohols.

Permissible Exposure Limits in Air:

No standards or Protective Action Criteria (PAC) available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Pancreatin can affect you when breathed in. Exposure can cause an asthma-like lung reaction, with rapidly occurring symptoms of wheezing and shortness of breath. A second type of lung reaction, with fatigue, shortness of breath and possibly fever can occur hours after exposure. This can lead to scars in the lungs. Once allergy develops, even low exposures can trigger symptoms. Other proteolytic enzymes similar to pancreatin can cause severe eye irritation and irritate the tongue, mouth, and cause nose bleeds and skin sores.

Long-Term Exposure: Repeated breathing exposure may cause changes in lung function, even without symptoms. May cause skin allergy, with rash and itching. May cause asthma-like allergy. Can cause severe allergic lung reaction with chills, fever, chest tightness; cough and/or shortness of breath. Repeated attacks may lead to permanent lung scarring. Once allergy develops, even low exposures can trigger symptoms.

Points of Attack: Lungs.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended. Lung function tests. These may be normal if the person is not having an attack at the time of the test. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation for Up to 8 hours after breathing exposure is recommended, as symptoms may be delayed.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposure to pancreatin, use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece respirator with a high efficiency particulate filter. Greater protection is provided by a powered-air purifying respirator. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US)

Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens.
DOI: http://dx.doi.org/10.1016/B978-0-323-38968-6.00015-6

or EN149 (Europe)-approved self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Store under nitrogen blanket. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from alcohol and acids.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid but may not easily ignite. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include oxides of carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Pancreatin, Trenton, NJ (February 1987)

Paraformaldehyde P:0120

Formula: $(CH_2O)_x$; $C_3H_6O_4$

Synonyms: Aldacide; Flo-more; Formagene; Formaldehyde polymer; Granuform; Paraform; Paraform 3; Paraformaldehido (Spanish); Polyformaldehyde; Polymerized formaldehyde; Polyoxymethylene; Polyoxymethylene glycol; Triformol; Trioxymethylene

CAS Registry Number: 30525-89-4; 110-88-3 (1,3,5-trioxane)

HSDB Number: 4070

RTECS Number: RV0540000 (paraformaldehyde); YM1400000 (trioxane)

UN/NA & ERG Number: UN2213/133

EC Number: 203-812-5 [*Annex I Index No.:* 605-002-00-0] (1,3,5-trioxane)

Regulatory Authority and Advisory Information

Carcinogenicity: DFG Carcinogen Category 4, probably not carcinogenic to humans.

Hazard Alert: Highly flammable solid, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction), Sensitization hazard (skin, resp.).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 1000 lb (454 kg)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

European/International Regulations (*110-88-3*): Hazard Symbol: F, Xi; Xn; Risk phrases: R11, R36/37/38; R43; R62; Safety phrases: S2; S21; S36/37; S41; S46; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Paraformaldehyde is a white crystalline solid. Irritating odor. The term “trioxane” applies specifically to this trimer $(CH_2O)_3$ but paraformaldehyde is applied both to trioxane and other low polymers or oligomers of formaldehyde. Specific gravity (H_2O:1) = 1.5 @ 15°C; Boiling point = 115°C (trioxane); Freezing/Melting point = 155°C [120−180°C (decomposition/paraformaldehyde)]; 64°C (trioxane); Flash points = 45°C (trioxane); 70°C (paraformaldehyde); Autoignition temperature = 300°C. Explosive limits: LEL = 3.6%; UEL: 28.7% (trioxane); LEL = 7.0%; UEL: 73.0% (paraformaldehyde). Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 3, Reactivity 1. Slightly soluble in water.

Potential Exposure: Paraformaldehyde is used in polyacetal resin manufacture; as a food additive; and as an odorless fuel.

Incompatibilities: Paraformaldehyde dust forms an explosive mixture with air. Decomposes on contact with oxidizers, strong acids; acid fumes; and bases; with elevated temperatures, forming formaldehyde. May explode when heated. May explode on impact if peroxide contamination develops. Mixtures with hydrogen peroxide or liquid oxygen are explosives sensitive to heat, shock, or contact with lead.

Permissible Exposure Limits in Air:

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 2 milligram per cubic meter

PAC-2: 23 milligram per cubic meter

PAC-3: 47 milligram per cubic meter

No Protective Action Criteria (PAC) available for *trioxane*

The Netherlands: 2 ppm/3 milligram per cubic meter ceiling value[57]; Japan: 5 ppm TWA

DFG MAK: 0.37 milligram per cubic meter [skin]; Peak limitation: Excursion factor 2, 15 min, mean; 4 times per shift; interval 1 hour; Category I: substances for which local irritant effects determine the exposure limit value, also respiratory allergens; Carcinogenic: Category 4; Pregnancy: Group C.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Exposure can irritate the eyes, nose, throat, and skin. Exposure can irritate the lungs, causing coughing and/or shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. See also "Formaldehyde"; this chemical forms formaldehyde when heated.

Long-Term Exposure: Repeated or prolonged contact may cause skin and lung sensitization, resulting in allergies. Paraformaldehyde may cause mutations. Handle with extreme caution. May cause kidney damage. Testing has not been completed to determine the carcinogenicity of paraformaldehyde. However, the limited studies to date indicate that these substances have chemical reactivity and mutagenicity similar to acetaldehyde and malonaldehyde. Therefore, NIOSH recommends that careful consideration should be given to reducing exposures to this aldehyde. Further information can be found in the *NIOSH Current Intelligence Bulletin 55: Carcinogenicity of Acetaldehyde and Malonaldehyde, and Mutagenicity of Related Low-Molecular-Weight Aldehydes* [DHHS (NIOSH), Publication No. 91-112].

Points of Attack: Lungs, kidneys, skin.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended. Lung function tests. These may be normal if person is not having an attack at the time. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin or respiratory allergy. Kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposure to this chemical, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Red Stripe: Flammability Hazard: Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 meters or a 1-hour fire wall from flammable or reactive materials. Store flammable solids up to maximum allowable quantity per control area in an approved flammable storage area. Do not store in a basement. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration is not a danger. Paraformaldehyde must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates); strong acids (such as hydrochloric, sulfuric, and nitric) and alkaline materials (such as potassium or sodium hydroxide), since violent reactions occur. Sources of ignition, such as smoking and open flames, are prohibited where paraformaldehyde is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Protect containers from physical damage. Store in tightly closed containers in a cool, well-ventilated area away from areas of high humidity.

Shipping: UN2213 Paraformaldehyde, Hazard Class: 4.1; Labels: 4.1-Flammable solid.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. Keep paraformaldehyde out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of carbon and may include formaldehyde. This chemical is a flammable solid. Dust can form an explosive mixture with air. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBASCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 3, No. 3, 90–92 (1983)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Paraformaldehyde, Trenton, NJ (February 2000)

Paraldehyde P:0130

Formula: $C_6H_{12}O_3$; $(CH_3CHO)_3$

Synonyms: A13-03115; *p*-Acetaldehyde; Acetaldehyde, trimer; DEANo. 2585; Elaldehyde; NSC9799; Paraacetaldehyde; Paracetaldehyde; Paral; Paraldehido (Spanish); Paraldehyd (German); Paraldehyde draught; Paraldehyde enema; PCHO; Poral; Triacetaldehyde (French); 2,4,6-Trimethyl-1,3,5-trioxacyclohexane; 1,3,5-Trimethyl-2,4,6-trioxane; 2,4,6-Trimethyl-*s*-trioxane; 2,4,6-Trimethyl-1,3,5-trioxane; *s*-Trimethyltrioxymethylene; *S*-Trioxane, 2,4,6-trimethyl

CAS Registry Number: 123-63-7

HSDB Number: 3375

RTECS Number: YK0525000

UN/NA & ERG Number: UN1264/129

EC Number: 204-639-8 [*Annex I Index No.:* 605-004-00-1]

Regulatory Authority and Advisory Information

Hazard Alert: Highly flammable liquid, Primary irritant (w/o allergic reaction).

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U182

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 1000 lb (454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: F, Xi; Risk phrases: R11; R18; R36/37/38; Safety phrases: S2; S21; S29 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Paraldehyde is a colorless liquid. Pleasant, sweet odor. Molecular weight = 132.16; Specific gravity (H_2O:1) = 0.99 @ 20°C; Boiling point = 124°C; Freezing/Melting point = 13°C; Flash point = 36°C; Vapor pressure = 7.5 mmHg @ 17°C; Autoignition temperature = 237°C. Explosive Limits: LEL = 1.3%; UEL-unknown. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 1. Slightly soluble in water.

Potential Exposure: Paraldehyde is used primarily in medicine. It is used as a hypnotic agent, in delirium tremens; and in treatment of psychiatric states characterized by excitement when drugs must be given over a long period of time. It also is administered for intractable pain which does not respond to opiates and for basal and obstetrical anesthesia. It is effective against experimentally induced convulsions and has been used in emergency therapy of tetanus, eclampsia, status epilepticus; and poisoning by convulsant drugs. Since it is used primarily in medicine, the chance of accidental human exposure or environmental contamination is low. However, paraldehyde decomposes to acetaldehyde and acetic acid; these compounds have been found to be toxic. In this case, occupational exposure or environmental contamination is possible. Since paraldehyde is prepared from acetaldehyde by polymerization in the presence of an acid catalyst, there exists a potential for adverse effects, although none have been reported in the available literature. It is also used in the manufacture of organic compounds.

Incompatibilities: Vapor or liquid may form explosive mixture with air. Incompatible with strong oxidants, strong acids; alkalis, ammonia, amines, iodides, hydrocyanic acid. Violent reaction with liquid oxygen. Contact with acids form acetaldehyde. Attacks rubber and plastics.

Permissible Exposure Limits in Air:

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 14 milligram per cubic meter

PAC-2: 150 milligram per cubic meter
PAC-3: 930 milligram per cubic meter
Russia[43] MAC, workplace air: 5.0 milligram per cubic meter.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Paraldehyde can affect you when breathed in and by passing through your skin. Contact can cause severe eye irritation or burns with possible permanent damage, and irritates the skin. Overexposure can cause poor coordination and make you sleepy. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: High or repeated exposure can damage the liver and kidneys. Can irritate the lungs; bronchitis may develop. Repeated exposure may cause fatigue, tremors, changes in speech; personality changes; and/or poor memory.

Points of Attack: Liver, kidneys, lungs, brain.

Medical Surveillance: Liver and kidney function tests. Examine for brain effects. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24–48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures to paraldehyde, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code -Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration is not a danger. Paraldehyde must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates); liquid oxygen; alkalis and nitric acid, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where paraldehyde is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of paraldehyde should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of paraldehyde.

Shipping: UN1264 Paraldehyde, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; alcohol foam; or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire.

Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration in added solvent. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Paraldehyde, Health and Environmental Effects Profile No. 140, Washington, DC, Office of Solid Waste (April 30, 1980)

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 5, No. 6, 87−90 (1985) and 8, No. 6, 74−79 (1988)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Paraldehyde, Trenton, NJ (January 2000)

Paraoxon P:0140

Formula: $C_{10}H_{14}NO_6P$

Synonyms: Chinorta; Diaethyl-*p*-nitrophenylphosphorsaeureester (German); *O,O′*-Diethyl-*p*-nitrophenylphosphat (German); *O,O*-Diethyl *O,p*-nitrophenyl phosphate; *O,O*-Diethyl *p*-nitrophenyl phosphate; Diethyl-*p*-nitrophenyl phosphate; Diethyl paraoxon; *O,O*-Diethylphosphoric acid *O,p*-nitrophenyl ester; E 600; ENT16,087; Ester 25; Ethyl-*p*-nitrophenyl ethylphosphate; Ethyl paraoxon; Eticol; Fosfakol; HC2072; Mintaco; Mintacol; Miotisal; Miotisal A; *O,p*-Nitrofenilfosfato de *O,O*-dietilo (Spanish); *p*-Nitrophenyl dietyhylphosphate; Oxyparathion; Paraoxone; Paroxan; Pestox 101; Phosphacol; Phosphoric acid, diethyl *p*-nitrophenyl ester; Phosphoric acid, diethyl 4-nitrophenyl ester; Soluglacit; TS219

CAS Registry Number: 311-45-5

HSDB Number: 6044

RTECS Number: TC2275000

UN/NA & ERG Number: (PIH) UN3018 (organophosphorus pesticide, solid toxic)/152

EC Number: 206-221-0

Regulatory Authority and Advisory Information

Hazard Alert: Poison inhalation hazard, Neurotoxin (cumulative), Suspected of causing genetic defects, Combustible, Environmental hazard, Agricultural Chemical, Drug.

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P041

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 100 lb (45.4 kg)

United States DOT Regulated Marine Pollutant (49CFR172.101, appendix B)

United States DOT 49CFR172.101, Inhalation Hazard Chemical as organophosphates.

Hazardous to aquatic life or environment, with possible long lasting effects[291]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T+, N; Risk phrases: R23/24/25; R27/28; R33; R51/53, R62; Safety phrases: S1/2; S28; S29/35; S36/37; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Paraoxon is an odorless, reddish-yellow oil. Fruity odor. Molecular weight = 275.22; Boiling point = 170°C @ 1 mmHg; Freezing/Melting point = 189°C; Vapor pressure = 9×10^{-5} mmHg @ 25°C. Slightly soluble in water; solubility = 3640 mg/L @ 20°C.

Potential Exposure: An organophosphate insecticide. Has been used as a medication.

Incompatibilities: Keep away from alkaline materials and strong oxidizers. Contact with oxidizers can cause the release of toxic oxides of phosphorus. May react violently with antimony(V) pentafluoride. Incompatible with lead diacetate, magnesium, silver nitrate. In the presence of strong reducing agents such as hydrides, organophosphates form highly toxic and flammable phosphine gas.

Permissible Exposure Limits in Air:

No standards or Protective Action Criteria (PAC) available. This substance may still be harmful or dangerous; follow safe work and usage practices. This chemical can be absorbed through the skin, thereby increasing exposure.

Determination in Air: Use NIOSH Analytical Method (IV) Method #5600, Organophosphorus Pesticides.

Determination in Water: Octanol-water coefficient: Log $K_{ow} = < 2.0$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Can cause rapid organophosphate poisoning. Organic phosphorus insecticides are absorbed by the skin, as well as by the respiratory and gastrointestinal tracts. They are cholinesterase inhibitors. Symptoms of exposure include headache, giddiness; blurred vision; nervousness, weakness, nausea, cramps, diarrhea, and discomfort in the chest. Signs include sweating, tearing, salivation, vomiting, cyanosis, convulsions, coma, loss of reflexes and loss of sphincter control. LD_{50} = (oral-rat) 1.8 mg/kg.

Long-Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. Repeated exposure may cause personality changes, including depression, anxiety, irritability. May cause liver damage.

Points of Attack: Respiratory system, lungs, central nervous system (CNS); cardiovascular system, skin, eyes, plasma and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also consider complete blood count (CBC). Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates. Refer to the NIOSH Criteria Documents #78-174 and #76-147 on manufacturing, formulating, and working safely with pesticides.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN3018 Organophosphorus pesticides, liquid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling:

Initial isolation and protective action distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.3/0.4
Night 0.8/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 600/200
Then: Protect persons downwind (miles/kilometers)
Day 1.4/2.3
Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Do not touch spilled material. Do not breathe vapors. Stay upwind; keep out of low areas. Remove all ignition sources. Ventilate area of spill or leak. This material is a combustible liquid. For a spill or leak of a combustible liquid, shut off ignition sources; no flares, smoking or flames in hazard area. Stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*:

absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid, but does not readily ignite. Thermal decomposition products may include oxides of phosphorus, nitrogen and carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBA that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Paraoxon, Trenton, NJ (May 2000)

Paraquat (Paraquat Dichloride)

P:0150

Formula: $C_{12}H_{14}Cl_2N_2$; $C_{12}H_{14}N_2Cl_2$

Synonyms: AH 501; AI3-61943; 4,4′-Bipyridinium, 1,1′-dimethyl-, dichloride; Bipyridinium, 1,1′-dimethyl-4,4′-, dichloride; Cekuquat; *para*-COL; Crisquat; Dextrone; Dextrone-X; *N,N′*-Dimethyl-4,4′-bipyridinium dichloride; 1,1′-Dimethyl-4, 4′-bipyridinium dichloride; *N,N′*-Dimethyl-4,4′-bipyridylium dichloride; 1,1′-Dimethyl-4,4′-bipyridynium dichloride; 1,1-Dimethyl-4,4-dipyridilium dichloride; 4,4′-Dimethyldipyridyl dichloride; 1,1′-Dimethyl-4,4′-dipyridylium chloride; *N,N′*-Dimethyl-4,4′-dipyridylium dichloride; 1,1′-Dimethyl-4,4′-dipyridylium dichloride; Dimethyl violgen chloride; Dimethyl viologen chloride; Esgram; Gamixel; Goldquat 276; Gramoxone; Gramoxone D; Gramoxone dichloride; Gramoxone S; Gramoxone W; Herboxone; Methyl viologen; Methyl viologen (reduced); Methyl viologen chloride; Methyl viologen dichloride; NSC263500; NSC 88126; OK622; Paraquat chloride; *ortho*-Paraquat Cl; Paraquat Cl; Paraquat dichloride; Paraquat dichloride bipyridylnium herbicide; Pathclear; Pillarquat; Pillarxone; PP 148; Sweep; Terraklene; Toxer total; Viologen, methyl-; Weedol *Note:* Paraquat is a cation ($C_{12}H_{14}N_2$++; 1,1-Dimethyl-4,4-bipyridinium ion); the commercial product is the dichloride salt of paraquat[77].

CAS Registry Number: 4685-14-7 (cation); 1910-42-5 (dichloride); *(alt.)* 3765-78-4; *(alt.)* 57593-74-5; *(alt.)* 65982-50-5; *(alt.)* 136338-65-3; *(alt.)* 205105-68-6; *(alt.)* 247050-57-3; 4032-26-2 (diiodide); 2074-50-2 (dimethylsulfate; methosulfat)

HSDB Number: 1668

RTECS Number: DW1960000 (cation); DW2275000 (dichloride); DW2280000 (diiodide); DW2010000 (dimethylsulfate)

UN/NA & ERG Number: UN2781/151

EC Number: 225-141-7; 217-615-7 [*Annex I Index No.:* 613-090-00-7]; 223-714-6 [*Annex I Index No.:* 613-089-00-1] (diquat dichloride); 218-196-3 [*Annex I Index No.:* 613-090-00-7] (paraquat-dimethylsulfate)

Regulatory Authority and Advisory Information

Carcinogenicity: EPA (*dichloride*): Possible Human Carcinogen. United States Environmental Protection Agency Gene-Tox Program, Positive: S *cerevisiae* gene conversion.

Hazard Alert: Exposure can be lethal, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction), Environmental hazard.

Banned or Severely Restricted (several countries) (UN)[13]

SUPERFUND/EPCRA 302, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg) (dichloride)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 10 lb (4.54 kg) (dichloride)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

European/International Regulations (*dichloride*): Hazard Symbol: T+, N; Risk phrases: R24/25; R26; R36/37/38; R48/25; R50/53; R62; R63; Safety phrases: S1/2; S22; S28; S36/37/39; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)]

Description: Paraquat is a yellow solid with a faint, ammonia-like odor. Molecular weight = 186.26; Specific gravity (H_2O:1) = 1.25; Boiling point = decomposes; Freezing/Melting point = 298°C (decomposes). Hazard Identification (based on NFPA-704 M Rating System): (paraquat) Health 4, Flammability 0, Reactivity 0. Soluble in water. Paraquat dichloride is a quaternary ion which usually is used as the dichloride salt. Molecular weight = 257.18. Highly soluble in water.

Potential Exposure: Those engaged in manufacture, formulation and application of this herbicide. Classified for restricted use: limited to use by a certified applicator, or those under applicator's direct supervision.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides (hydrolysis), alkylarylsulfonate wetting agents. Corrosive to metals. Decomposes in presence of ultraviolet (UV) light. Decomposes in heat (see physical properties, above) and in the presence of UV light, producing nitrogen oxides, hydrogen chloride.

Permissible Exposure Limits in Air:

NIOSH IDLH = 1.0 milligram per cubic meter

OSHA PEL: 0.5 milligram per cubic meter TWA, respirable dust [Skin]; vacated 1989 OSHA PEL 0.1 milligram per cubic meter TWA, [Skin] is still enforced in some states (dichloride)

NIOSH REL: 0.1 milligram per cubic meter TWA, respirable fraction [Skin] (dichloride)

ACGIH TLV: 0.5 milligram per cubic meter TWA, respirable fraction [Skin]. Excursion Limit Recommendation: Excursions in worker exposure levels may exceed 3 times the TLV-TWA for no more than a total of 30 minutes during a workday, and under no circumstances should they exceed 5 times the TLV-TWA, provided that the TLV-TWA is not exceeded.

Protective Action Criteria (PAC) Ver. 29[138]

4685-14-7

PAC-1: 0.3 milligram per cubic meter
PAC-2: 4.4 milligram per cubic meter
PAC-3: 26 milligram per cubic meter

1910-42-5 (dichloride salt)

PAC-1: 0.15 milligram per cubic meter
PAC-2: 1.6 milligram per cubic meter
PAC-3: 9.6 milligram per cubic meter

2074-50-2 (methosulfate)

PAC-1: 0.014 milligram per cubic meter
PAC-2: 0.15 milligram per cubic meter
PAC-3: 20 milligram per cubic meter

Austria: MAK 0.1 milligram per cubic meter, [skin], 1999; Denmark: TWA 0.1 milligram per cubic meter, [skin], 1999; Switzerland: MAK-W 0.1 milligram per cubic meter, KZG-W 0.2 milligram per cubic meter, [skin], 1999; United Kingdom: TWA 0.08 milligram per cubic meter, respirable dust, 2000; the Netherlands: MAC-TGG 0.1 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 0.5 milligram per cubic meter

Several states have set guidelines or standards for paraquat in ambient air[60] ranging from 0.33 μ/m^3 (New York) to 0.50 μ/m^3 (South Carolina) to 1.0 μ/m^3 (Florida) to 1.6 μ/m^3 (Virginia) to 2.0 μ/m^3 (Connecticut and Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #5003, Paraquat.

Permissible Concentration in Water: A lifetime health advisory of 3.0 μg/L has been derived by EPA (See "References" (31); Below). In addition, the state of Maine[61] has set a guideline for paraquat in drinking water of 17.0 μg/L (100).

Determination in Water: Fish Tox = 2115.13304000 ppb (VERY LOW); Octanol-water coefficient: Log $K_{ow} = -4.2$.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin, and respiratory tract. Inhalation can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Effects occur in two stages, immediate and delayed. Caution is advised. Exposure to paraquat may be fatal; there is no effective antidote. Signs and symptoms of acute exposure to paraquat may be severe and include nausea, vomiting, diarrhea, and abdominal pain. A burning sensation of the mouth and esophagus with possible ulceration may occur following ingestion. Eye exposure may result in corneal opacification (cloudiness). Dermatitis and nail atrophy may occur following dermal contact. Delayed effects include transient reversible liver injury, acute renal failure and progressive pulmonary fibrosis with associated dyspnea (shortness of breath) and pulmonary edema. Absorbed through the skin and can lead to symptoms as listed in the following paragraph. In addition, can cause fingernail discoloration and damage (which returns to normal when exposure stops), irritation, redness, swelling and burning. Exposure through ingestion may cause burning of the mouth and throat, nausea, vomiting, abdominal pain; diarrhea and damage to the kidneys, heart and liver. Lung damage, leading to death, may occur. One half ounce of a 20% solution has caused death. Ingestion can also cause lung hemorrhage and fibrosis. The substance may cause effects on the lungs, kidneys, liver, cardiovascular system and gastro intestinal tract, resulting in impaired functions, tissue lesions.

Long-Term Exposure: Repeated or prolonged contact with skin may cause damage and possible loss of the fingernails, and can lead to dry and cracking skin with blistering. Repeated or prolonged exposure to the aerosol can cause lung irritation, lung damage; bronchitis may develop. Can cause scarring of the lungs leading to breathlessness. Can damage the liver, kidneys and affect the heart. Human Tox = 3.15000 ppb Health Advisory (HIGH)

Points of Attack: Eyes, skin, respiratory system; heart, liver, kidneys, gastrointestinal tract.

Medical Surveillance: NIOSH lists the following tests: chest X-ray; Liver Function tests; pulmonary function tests: forced vital capacity, forced expiratory volume (1 sec); urine (chemical/metabolite); urinalysis (routine). Consider the points of attack in preplacement and periodic physical examinations. Kidney function tests. EKG. Chemical users should be cautioned about the use of alcohol which can increase liver damage.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water, or bentonite clay in water, or activated charcoal in water; and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24–48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy. Obtain authorization and/or further instructions from the local hospital for performance of other invasive procedures. Rush to a health care facility.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *Up to 1 milligram per cubic meter:* CcrOv95 (APF = 10) [Any air-purifying half-mask respirator with organic vapor cartridge(s) in combination with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100];* or PaprOvHie (APF = 25) (any powered air-purifying respirator with an organic vapor cartridge in combination with a high-efficiency particulate filter);* or Sa (APF = 10) (any supplied-air respirator);* or SCBAF (APF = 50) (any SCBA with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA). *Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. This chemical is inactivated by inert clays and anionic surfactants. Store in tightly closed containers in a cool, well ventilated area away from oxidizers; alkylaryl-sulfonate wetting agents; light. Where possible, automatically pump material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN2781 Bipyridilium pesticide, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Thermal decomposition products may include oxides of nitrogen and carbon. Remove all ignition sources. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Remove and isolate contaminated clothing at the site. If water pollution occurs, notify appropriate authorities. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills:* absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills:* with clean shovel place material into clean, dry container and cover; move containers from spill area. *Large spills:* dike far ahead of spill for later disposal. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include hydrogen chloride and oxides of nitrogen and carbon. This chemical is a combustible solid. Procedures for bipyridilium pesticides are as follows. *Small fires:* dry chemical, carbon dioxide; water spray; or foam. *Large fires:* water spray, fog, or foam. Move container from fire area if you can do so without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Paraquat is rapidly inactivated in soil. It is also inactivated by anionic surfactants. Therefore an effective and environmentally safe disposal method would be to mix the product with ordinary household detergent and bury the mixture in clay soil. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (173); (101); (138); (80).

Pasi, A., The Toxicology of Paraquat, Diquat and Morfamquat, Bern, Switzerland, H. Huber (1978)

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United States Environmental Protection Agency, Alert: Paraquat, Washington, DC, Office of Drinking Water (August 1987)

New York State Department of Health, *Chemical Fact Sheet:* Paraquat, Bureau of Toxic Substance Assessment, Albany, NY (Version 2, February 1986 and Version 3)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Paraquat, Trenton, NJ (September 1999)

Parathion P:0170

Formula: $C_{10}H_{14}NO_5PS$

Synonyms: AAT; AATP; ACC 3422; Alkron; Alleron; American cyanamid 3422; Aphamite; Aralo; B 404; BAY E-605; Bayer E-605; Bladan F; Compound 3422; Corothion; Corthion; Corthione; Danthion; *O,O*-Diethyl *O*-(*p*-nitrophenyl) phosphorothioate; *O,O*-Diethyl *O*-(4-nitrophenyl) phosphorothioate; *O,O*-Diethyl *O,p*-nitrophenyl phosphorothioate; Diethyl *p*-nitrophenyl phosphorothionate; Diethyl 4-nitrophenyl phosphorothionate; Diethyl *p*-nitrophenyl thionophosphate; *O,O*-Diethyl *O,p*-nitrophenyl thiophosphate; Diethyl parathion; DNTP; DPP; Drexel parathion 8E; E 605; E 605F; Ecatox; Ekatin WF & WF ULV; Ekatox; ENT15,108; Ethlon; Ethyl parathion; Etilon; Folidol; Folidol E; Folidol E-605; Folidol E&E 605; Folidol oil; Fosfermo; Fosferno; Fosfex; Fosfive; Fosova; Fostern; Fostox; Gearphos; Genithion; Kalphos; Kypthion; Lethalaire G-54; Lirothion; Murfos; Murphos; NCI-C00226; Niran; Niran E-4; Nitrostigmin (German); Nitrostigmine; NIUIF 100; Nourithion; Oleofos 20; Oleoparathene; Oleoparathion; OMS 19; Orthophos; PAC; Pacol; Panthion; Paradust; Paramar; Paramar 50; Paraphos; Parathene; Parathion-ethyl; Parathion thiophos; Parationa (Spanish); Parawet; Penncap E; Pestox plus; Pethion; Phoskil; Phosphorothioic acid, *O,O*-diethyl *O*-(*p*-nitrophenyl) ester; Phosphorothioic acid, *O,O*-diethyl *O*-(4-nitrophenyl) ester; Phosphostigmine; Pleoparaphene; RB; Rhodiasol; Rhodiatox; Rhodiatrox; Selephos; SNP; Soprathion; Stathion; STCC4921469; Sulphos; Super rodiatox; T-47; Thiomex; Thiophos; Thiophos 3422; Tiofos; TOX 47; Toxol (3); Vapophos; Vitrex

CAS Registry Number: 56-38-2; *(alt.)* 8057-70-3; *(alt.)* 11111-91-4; *(alt.)* 110616-89-2

HSDB Number: 197

RTECS Number: TF4550000

UN/NA & ERG Number: (PIH) UN3278 (organophosphorus compound, liquid, toxic n.o.s.)/151; UN2783 (Methyl parathion, solid)/152; UN3018 (organophosphorus pesticide, liquid, toxic)/152; UN1967 (Parathion and compressed gas mixture)/123

EC Number: 200-271-7 [*Annex I Index No.:* 015-034-00-1]

Regulatory Authority and Advisory Information

Carcinogenicity: EPA: Possible Human Carcinogen; IARC: Animal Inadequate Evidence; Human No Adequate Data, *not classifiable as carcinogenic to humans*, Group 3, 1987; NCI: Carcinogenesis Bioassay (feed); clear evidence: rat; no evidence: mouse. United States Environmental Protection Agency Gene-Tox Program, Negative: *In vitro* UDS-human fibroblast; TRP reversion; Negative: S *cerevisiae-homozygosis*; Inconclusive: B *subtilis* rec assay; *E coli polA* without S9; Inconclusive: Histidine reversion-Ames test; Inconclusive: D *melanogaster* sex-linked lethal

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

Hazard Alert: Poison inhalation hazard: exposure can be lethal, Neurotoxin (cumulative), Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard Agricultural Chemical, Environmental hazard.

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P089

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.014; Nonwastewater (mg/kg), 4.6

RCRA 40CFR264, appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10)

Safe Drinking Water Act (47FR 9352): Priority List (55 FR 1470) as parathion degradation

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, appendix B), severe pollutant

United States DOT 49CFR172.101, Inhalation Hazard Chemical as organophosphates

Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)] [parathion (all formulations)—aerosols, dustable powder (DP), emulsifiable concentrate (EC), granules (GR) and wettable powders (WP)—of this substance are included, *except* capsule suspensions (CS)].

Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T+, N; Risk phrases: R24; R27/28; R33; R48/25; R50/53; Safety phrases: S1/2; S28; S36/37; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Parathion is a clear liquid when fresh; pale yellow to dark brown liquid with a garlic-like odor. Commercial formulations use carrier solvents that may change the physical properties shown. Molecular weight = 291.28; Specific gravity (H_2O:1) = 1.27; Boiling point = 375°C; 157−162°C @ 6 mmHg (for CW agent); Freezing/Melting point = 6.1°C; also listed @ 2.9°C for chemical warfare (CW) agent; Flash point = 195°C (oc). Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 0, Reactivity 0. Slightly soluble in water; solubility = 24 mg/L.

Potential Exposure: A severely hazardous pesticide formulation. Those exposed include those engaged in manufacture, formulation and application of this broad spectrum insecticide. This material has also been used as a chemical warfare agent.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Strong oxidizers may cause release of toxic phosphorus oxides. Organophosphates, in the presence of strong reducing agents such as hydrides, may form highly toxic and flammable phosphine gas. Keep away from alkaline materials. Attacks some plastics, rubbers, and coatings. Rapidly hydrolyzed by alkalis.

Permissible Exposure Limits in Air:

NIOSH IDLH = 10 milligram per cubic meter

OSHA PEL: 0.1 milligram per cubic meter TWA [skin]

NIOSH REL: 0.05 milligram per cubic meter TWA [skin]

ACGIH TLV[1]: 0.05 milligram per cubic meter TWA, inhalable fraction and vapor [skin]; not classifiable as a human carcinogen; BEI; 0.05 mg[creatinine]/g in urine, end-of-shift.

Protective Action Criteria (PAC)* Ver. 29[138]

PAC-1: 0.15 milligram per cubic meter

PAC-2: **1.5**$_{\mathbf{A}}$ milligram per cubic meter

PAC-3: **2.0**$_{\mathbf{A}}$ milligram per cubic meter

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

DFG MAK: 0.1 milligram per cubic meter measured as the, inhalable fraction TWA; Peak Limitation Category II(8) [skin]; Pregnancy Risk Group D; BAT: 100 μg[*p*-nitrophenol]/L in urine after several shifts (sampling time)

Arab Republic of Egypt: TWA 0.1 milligram per cubic meter, [skin], 1993; Australia: TWA 0.1 milligram per cubic meter, [skin], 1993; Austria: MAK 0.1 milligram per cubic meter, [skin], 1999; Belgium: TWA 0.1 milligram per cubic meter, [skin], 1993; Denmark: TWA 0.1 milligram per cubic meter, [skin], 1999; Finland: TWA 0.1 milligram per cubic meter, short-term exposure limit 0.3 milligram per cubic meter, [skin], 1999; France: VME 0.1 milligram per cubic meter, [skin], 1999; the Netherlands: MAC-TGG 0.1 milligram per cubic meter, [skin], 2003; Japan: 0.1 milligram per cubic meter, [skin], 1999; Norway: TWA 0.05 milligram per cubic meter, 1999; the Phillipines: TWA 0.1 milligram per cubic meter, [skin], 1993; Russia: STEL 0.05 milligram per cubic meter, 1993; Thailand: TWA 0.11 milligram per cubic meter, 1993; Turkey: TWA 0.1 milligram per cubic meter, [skin], 1993; United Kingdom: TWA 0.1 milligram per cubic meter, short-term exposure limit 0.3 milligram per cubic meter, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Several states have set guidelines or standards for parathion in ambient air [60] ranging from 0.238 μ/m^3 (Kansas) to 0.33 μ/m^3 (New York) to 0.5 μ/m^3 (South Carolina) to 1.0 μ/m^3 (North Dakota) to 1.6 μ/m^3 (Virginia) to 1.87 μ/m^3 (Pennsylvania) to 2.0 μ/m^3 (Connecticut and Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #5600, Organophosphorus pesticides; OSHA Analytical Method ID-62.

Permissible Concentration in Water: Russia set a MAC[35] in surface water of 3.0 μg/L and Mexico has set maximum permissible concentrations of 1.0 μg/L in coastal waters and 10.0 μg/L in estuaries. Several states have set guidelines for parathion in drinking water[61] ranging from 8.6 μg/L in Maine to 30.0 μg/L in California and Kansas.

Determination in Water: Fish Tox = 0.26514000 ppb MATC (EXTRA HIGH); Octanol -water coefficient: Log K_{ow} = > 3.2. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Parathion irritates the eyes, skin, and respiratory tract. A cholinesterase inhibitor. Acute exposure to parathion may produce the following signs and symptoms: pinpoint pupils; blurred vision; headache, dizziness, muscle spasms; and profound weakness. Vomiting, diarrhea, abdominal pain; seizures, and coma may also occur. The heart rate may decrease following oral exposure or increase following dermal exposure. Hypotension (low blood pressure) is not uncommon. Respiratory symptoms include dyspnea (shortness of breath), respiratory depression; and respiratory paralysis. Psychosis may occur. This material is extremely toxic; the probable oral lethal dose is 5−50 mg/kg, or between 7 drops and 1 teaspoonful for a 150 lb person. As little as 1 drop can endanger life if splashed in the eye. Toxicity is highest by inhalation. People at special risk are those with a history of glaucoma, cardiovascular disease; hepatic disease; renal disease; or CNS abnormalities. Some additional details on short-term exposure to parathion are as follows: *Inhalation:* Occasional human exposures at concentrations of 0.1−0.8 milligram per cubic meter did not give rise to any symptoms. Occasional human exposure @ 1.5−2.0 milligram per cubic meter resulted in nausea and vomiting. Higher exposures can give rise to dizziness; blurred vision; wheezing, excessive salivation; and muscle and abdominal cramps. An estimated 10−20 mg (1/1500 ounce) may cause death. *Skin:* However, many human poisonings have occurred through extensive skin contact at unspecified levels. This is the greatest hazard for some workers. Symptoms of poisoning include nausea, vomiting, weakness, blurring of vision and muscle cramps. NIOSH lists the following symptoms of exposure: irritation of the eyes, skin, respiratory system; miosis; rhinorrhea (discharge of thin nasal mucous); headache; chest tightness; wheezing, laryngeal spasm; salivation, cyanosis, anorexia, nausea, vomiting, abdominal cramps; diarrhea; sweating; muscle fasiculation; weakness, paralysis; giddiness, confusion, ataxia; convulsions, coma; low blood pressure; cardiac irregular/irregularities.

Long-Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage. Human Tox = 0.23100 ppb Health Advisory (EXTRA HIGH).

Points of Attack: Respiratory system; CNS; cardiovascular system, eyes, skin, blood cholinesterase.

Medical Surveillance: NIOSH lists the following tests: blood serum; cholinesterase: whole blood (chemical/metabolite); cholinesterase: blood plasma; cholinesterase: blood plasma, red blood cells/count; urine (chemical/metabolite); urine (chemical/metabolite), end-of-shift; urine (chemical/metabolite), end-of-workweek. NIOSH recommends that medical surveillance, including preemployment and periodic examinations, shall be made available to workers who may be occupationally exposed to parathion. Biologic monitoring is also recommended as an additional safety measure. Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates. When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All

protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use SCBA >0.14 milligram per cubic meter. NIOSH: *0.5 milligram per cubic meter:* CcrOv95 (APF = 10) [any air-purifying half-mask respirator with organic vapor cartridge(s) in combination with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *1.25 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOvHie (APF = 25) (any powered air-purifying respirator with an organic vapor cartridge in combination with a high-efficiency particulate filter). *2.5 milligram per cubic meter:* CcrFOv100 (APF = 50) [Any air-purifying full facepiece respirator equipped with organic vapor cartridge(s) in combination with an N100, R100, or P100 filter]; or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTOvHie (APF = 50) [any powered, air-purifying respirator with a tight-fitting facepiece and organic vapor cartridge(s) in combination with a high-efficiency particulate filter]; or SCBAF (APF = 50) (any SCBA with full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *10 milligram per cubic meter:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister having an N100, R100, or P100 filter]or SCBAE (an y appropriate escape-type, SCBA).

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store where possible leakage from containers will not endanger the worker. Maintain regular inspection of containers for leakage. Store in tightly closed containers in a cool, well ventilated area away from oxidizers and alkaline material. Where possible, automatically pump liquid from drums or other storage containers to process containers Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN3278 Organophosphorus compound, liquid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required, Potential Inhalation Hazard (Special Provision 5).UN2783 Organophosphorus pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN3018 Organophosphorus pesticides, liquid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling:

Initial isolation and protective action distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.3/0.4
Night 0.8/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 600/200
Then: Protect persons downwind (miles/kilometers)
Day 1.4/2.3
Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Do not touch spilled material. Do not breathe vapors. Stay upwind; keep out of low areas. Remove all ignition sources. Ventilate area of spill or leak. This material is a combustible liquid. For a spill or leak of a combustible liquid, shut off ignition sources; no flares, smoking or flames in hazard area. Stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is not very combustible unless dissolved in a hydrocarbon carrier such as xylene or toluene. Thermal decomposition products may include oxides of phosphorus, sulfur, nitrogen and carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office. One manufacturer recommends the use of a detergent in a 5% trisodium phosphate solution for parathion disposal and cleanup problems. For parathion disposal in general, however, the recommended method is incineration (816°C, 0.5 second minimum for primary combustion; 1204°C, 1.0 second for secondary combustion) with adequate scrubbing and ash disposal facilities[22].

References

(31); National institute for Occupational Safety and Health (NIOSH), "Criteria for a Recommended Standard:(100). Occupational(2). Exposure to Parathion," NIOSH Document Number 76-190, Cincinnati OH (1976)

(173); (101); (138); (80).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 3, No. 3, 92−97 (1983)

United States Environmental Protection Agency, Chemical Hazard Information Profile: Parathion, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

New York State Department of Health, *Chemical Fact Sheet:* Parathion, Bureau of Toxic Substance Assessment, Albany, NY (Version 2-March 1986 and Version 3)

Paris Green P:0180

Formula: $C_4H_6As_6Cu_4O_{16}$

Synonyms: Acetoarsenite de cuivre (French); Acetoarsenito de cobre (Spanish); Basle green; C.I. 77410; C.I. Pigment green 21; Copper acetoarsenite; Cupric acetoarsenite; Emerald green; ENT884; French green; Imperial green; King's green; Meadow green; Mineral green; Mitis green; Moss green; Mountain green; Neuwied green; New green; Paris green; Parrot green; Patent green; O-P-G bait; Powder green; Schweinfurtergruen (German); Schweinfurt green; Sowbug & cutworm bait; Swedish green; Vienna green

CAS Registry Number: 12002-03-8; 12310-22-4 [copper(II) arsenite acetate]

HSDB Number: 1824

RTECS Number: GL6475000

UN/NA & ERG Number: UN1585/151; UN3465 (organoarsenic compound, solid, n.o.s.)/151

EC Number: [*Annex I Index No.:* 033-002-00-5]

Regulatory Authority and Advisory Information

Carcinogenicity: EPA Classification A, human carcinogen. IARC: Human Sufficient Evidence, 1980; Animal Limited Evidence*, carcinogenic to humans*, Group 1, 1987

California Proposition 65 Chemical[102]: Cancer 2/27/1987

Hazard Alert: Poison, Combustible, Environmental hazard, Agricultural chemical.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); List of high risk pollutants (Section 63.74) as arsenic compounds

Clean Water Act: Section 311 Hazardous Substances/RQ 1 lb (0.454 kg); Toxic Pollutant (Section 401.15) as copper and compounds; Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

Safe Drinking Water Act 47FR9352 Regulated chemical: MCL, 0.05 mg/L (Section 141.11) applies only to community water systems (arsenic)

RCRA 40CFR264, appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 6010 (60); 7210 (200)

Note: All species in the ground water that contain copper are included

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 500 lb (227 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, appendix B) as arsenates, liquid, n.o.s.; arsenates, solid, n.o.s.; arsenical pesticides liquid, toxic, flammable, n.o.s.

Canada: Priority Substance List & Restricted Substances/Ocean Dumping FORBIDDEN (CEPA), National Pollutant Release Inventory (NPRI) (arsenic compounds)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. arsenic, water soluble compounds.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T, N; Risk phrases: R45; R23/25; R50/53; Safety phrases: S29/35; S45; S53; S60; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Paris green (copper acetoarsenite) is an odorless emerald green crystalline powder which decomposes upon heating. Molecular weight = 1013.78. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Insoluble in water.

Potential Exposure: This material, and organoarsenic compound, is used primarily as an insecticide; it may be used as a wood preservative and a pigment, particularly for ships and submarines; and also finds use as an anthelmintic.

Incompatibilities: Can react vigorously with oxidizers. Emits highly toxic arsenic fumes on contact with acid or acid fumes; and in elevated temperatures.

Permissible Exposure Limits in Air:

arsenic, organic compounds

OSHA PEL: 0.5 mg[As]/m^3 TWA

NIOSH REL: Not established. See NIOSH Pocket Guide, Appendix A

ACGIH TLV[1]: 0.01 mg[As]/m^3 TWA; Confirmed Human Carcinogen; BEI established.

Protective Action Criteria (PAC) Ver. 29[138]

paris green; cupric acetoarsenite

PAC-1: 3.4 milligram per cubic meter

PAC-2: 22 milligram per cubic meter

PAC-3: 130 milligram per cubic meter

Arab Republic of Egypt: TWA 0.2 milligram per cubic meter, 1993; Australia: TWA 0.05 milligram per cubic meter, carcinogen, 1993; Belgium: TWA 0.2 milligram per cubic meter, 1993; Denmark: TWA 0.05 milligram per cubic meter, 1999; Finland: carcinogen, 1993; France: VME 0.2 milligram per cubic meter, 1993; Hungary: STEL 0.5 milligram per cubic meter, carcinogen, 1993; India: TWA 0.2 milligram per cubic meter, 1993; Norway: TWA 0.02 milligram per cubic meter, 1999; the Phillipines: TWA 0.5 milligram per cubic meter, 1993; Poland: MAC (TWA) 0.01 milligram per cubic meter, 1999; Sweden: NGV 0.03 milligram per cubic meter, carcinogen, 1999; Switzerland: TWA 0.1 milligram per cubic meter, carcinogen, 1999; Thailand: TWA 0.5 milligram per cubic meter, 1993; Turkey: TWA 0.5 mg(As)/m^3; TWA 0.5 milligram per cubic meter, 1993; United Kingdom: TWA 0.1 milligram per cubic meter, carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH: TLV: Confirmed Human Carcinogen. Russia[43] set a MAC of 0.003 milligram per cubic meter on an average daily basis for residential areas. Several states have set guidelines or standards for arsenic in ambient air:[60] 0.06 milligram per cubic meter (California Prop. 65), 0.0002 μ/m^3 (Rhode Island), 0.00023 μ/m^3 (North Carolina), 0.024 μ/m^3 (Pennsylvania), 0.05 μ/m^3 (Connecticut), 0.07−0.39 μ/m^3 (Montana), 0.67 μ/m^3 (New York), 1.0 μ/m^3 (South Carolina), 2.0 μ/m^3 (North Dakota), 3.3 μ/m^3 (Virginia), 5 μ/m^3 (Nevada).

Determination in Air: Filter; Reagent: Ion chromatography/hydride atomic absorption: NIOSH IV [#5022, Arsenic, organo-](18).

Permissible Concentration in Water: EPA[6] recommends a zero concentration of arsenic for human health reasons. Federal Drinking Water Guidelines: EPA 10 μg/L; State Drinking Water Guidelines: Arizona 10 μg/L; Connecticut 10 μg/L. Toxic pollutant designated pursuant to section 307 (a) (1) of the Clean Water Act and is subject to effluent limitations (arsenic and inorganic and organic arsenic) [40 CFR 401.15 (7/1/1987)]. Canadian Drinking Water Standards: IMAC 0.025 [As] mg/L. Runoff from spills or fire control may cause water pollution.

Determination in Water: *for arsenic:* The atomic absorption graphite furnace technique is often used for measurement of total arsenic in water. It also has been standardized by EPA. Total arsenic may be determined by digestion followed by silver diethyldithiocarbamate; an alternative is atomic absorption; another is inductively coupled plasma (ICP) optical emission spectrometry. See OSHA Analytical Method #ID-105 for arsenic.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: It may cause eye and respiratory tract irritation. Industrial exposure may cause dermatitis. This material is extremely toxic; the probable oral lethal dose for humans is 5−50 mg/kg, or between 7 drops and 1 teaspoonful for a 150 lb person. Some absorption may occur through the skin and by inhalation, but most poisonings result from ingestion. Symptoms usually appear ½ to 1 hour after ingestion, but may be delayed. Causes gastric disturbance, tremors, muscular cramps; and nervous collapse; which may lead to death. Symptoms of exposure also include a sweetish, metallic taste and garlicky odor; difficulty in swallowing; abdominal pain; vomiting and diarrhea; dehydration; rapid heart beat; dizziness and headache; and eventually coma; sometimes convulsions; and death.

Long-Term Exposure: May cause liver damage. Arsenic compounds may cause blood, kidneys, and nervous system damage, and skin abnormalities may develop. See also entries for "Arsenic" and "Copper."

Points of Attack: Liver, kidneys, blood, skin.

Medical Surveillance: Test for urine arsenic. Levels should not be greater than 100 micrograms per gram of creatinine in the urine. Examine the skin for abnormal growths. Liver and kidney function tests. Blood tests including CBC.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the

skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: For severe poisoning BAL (British Anti-Lewisite), Dimercaprol, dithiopropanol ($C_3H_8OS_2$) has been used to treat toxic symptoms of certain heavy metals poisoning—including arsenic. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5). For milder poisoning *penicillamine (not penicillin)* has been used, both with mixed success. Side effects occur with such treatment and it is never a substitute for controlling exposure. It can only be done under strict medical care.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Specific engineering controls are required under OSHA 1910.1018*, Inorganic Arsenic.* See also NIOSH Criteria Document #75-149, *"Inorganic Arsenic."*

Respirator Selection: *Copper dusts and mists: 5 milligram per cubic meter*: Qm (APF = 25) (any quarter-mask respirator). *10 milligram per cubic meter:* Any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100; or Sa (APF = 10) (any supplied-air respirator). *25 milligram per cubic meter:* Sa: Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *50 milligram per cubic meter*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *100 milligram per cubic meter:* SaF: Pd, Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Arsenic: At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration: Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFAg100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted acid gas canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with copper acetoarsenite all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area, away from strong bases; strong acids; and moisture.

Shipping: UN1585 Copper acetoarsenite, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. STN: 49 232 20. UN3465 Organoarsenic compound, solid, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required

Spill Handling:

Organoarsenic compound, solid or liquid

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.5/0.8

Large spills (From a large package or from many small packages)
First: Isolate in all directions (feet/meters) 500/60
Then: Protect persons downwind (miles/kilometers)
Day 1.1/1.8
Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Stay upwind; keep out of low areas. Wear self-contained (positive pressure if available) breathing apparatus and full protective clothing. Do not touch spilled material; stop leak if you can do it without risk. *Small liquid spills:* take up with sand or other noncombustible absorbent material into clean, dry container and cover; move containers from spill area. *Large spills:* dike far ahead of spill for later disposal. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical may burn but does not easily ignite. Thermal decomposition products may include Poisonous fumes are produced in fire, including arsenichydride and oxides of arsenic, copper and carbon. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(102); (31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* “Copper Acetoarsenite,”Trenton, NJ (January 1999)

(173); (101); (138).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Paris Green, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

Pebulate P:0182

Formula: $C_{10}H_{21}NOS$

Synonyms: Butylethylthiocarbamic acid *S*-propyl ester; PEBC; *S*-Propyl-*N*-aethyl-*N*-butyl-thiocarbamat (German); *S*-Propyl butylethylthiocarbamate; *S*-Propyl-*N*-butyl-*N*-ethylthiolcarbamate; Propylethylbutylthiocarbamate; Propylethylbutylthiocarbamate; Propyl-ethyl-*N*-butylthiocarbamate; Propyl-*N*-ethyl-*N*-butylthiocarbamate; *N*-propyl-*N*-ethyl-*N*-(*N*-butyl)thio carbamate; *S*-(*N*-Propyl)-*N*-ethyl-*N*-(*N*-butyl) thiocarbamate

CAS Number: 1114-71-2

HSDB Number: 856

RTECS Number: EZ0400000

UN/NA & ERG Number: UN3082 (environmentally hazardous substances, liquid, n.o.s.)/171

EC Number: 214-215-4 [*Annex I Index No.*: 006-034-00-2]

Regulatory Authority and Advisory Information

Carcinogenicity: EPA Not likely to be a human carcinogen

Hazard Alert: Poison (Category 4), Possible risk of forming tumors, Suspected reprotoxic hazard, Environmental hazard.

EPA Hazardous Waste Number (RCRA No.): U391

RCRA Section 261 Hazardous Constituents

RCRA Universal Treatment Standards: Wastewater (mg/L), 0.003; Nonwastewater (mg/kg), 1.4

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%

Hazardous to aquatic life or environment, with possible long lasting effects[194]. Harmful to aquatic life with long lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: Xn, N; Risk phrases: R22; R51/53; R63; Safety phrases: S16; S26; S29/35; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to waters.

Description: Colorless to yellowish, flammable liquid. Aromatic odor. Molecular weight = 203.36; Specific gravity (H_2O:1) = 0.955 @ 30/4°C; Boiling point = 142°C @ 21 mmHg; Vapor pressure = 8.85×10^{-2} mm @ 20°C[161]; Flash point = 124°C (oc). Sparingly soluble in water; solubility = 92 mg/L @ 21°C.

Potential Exposure: Pebulate is a thiocarbamate herbicide used for pre-emergence control of germinating seeds of broadleaf and grassy weeds in sugar beets, tobacco, and tomatoes. There are no registered residential uses of pebulate

Incompatibilities: Thiocarbamate esters are combustible. They react violently with powerful oxidizers such as calcium hypochlorite. Poisonous gases are generated by the thermal decomposition of thiocarbamate compounds, including carbon disulfide, oxides of sulfur, oxides of nitrogen, hydrogen sulfide, ammonia, and methylamine.Thio and dithiocarbamates slowly decompose in aqueous solution to form carbon disulfide and methylamine or other amines. Such decompositions are accelerated by acids. Flammable gases are generated by the combination of thiocarbamates with aldehydes, nitrides, and hydrides. Thiocarbamates are incompatible with acids, peroxides, and acid halides.

Permissible Concentration in Water: Hazardous to aquatic organisms with long lasting effects. Runoff from spills or fire control may cause water pollution.

Determination in Water: Octanol-water coefficient: Log $K_{ow} = > 3.5$.Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Poisoning can occur by inhalation, ingestion and absorption through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Unlike carbamates the thiocarbamates are not cholinesterase inhibitors, but some of them may react with recently ingested alcohol or alcohol-containing products including wine, medications, and cold remedies such as cough-syrups. Low toxicity. Concentrated solutions are slightly corrosive to eyes and mucous membranes. Dust inhalation can cause irritation of the respiratory system with sneezing. Eye contact can cause irritation, watering, pain, and inflammation of the eyelids. Dermal contact can cause irritation and minor ulceration. Ingestion can cause nausea, vomiting, fever, muscle twitching, seizure, rapid respiration, slow heart beat. Severe exposure may result in death. LD_{50} (oral, rat) = > 1000 mg/kg; LD_{50} (dermal, rat) = > 4000 mg/kg.

Long-Term Exposure: A cholinesterase inhibitor. A possible neurotoxicant.

Points of Attack: Respiratory system, CNS, cardiovascular system, skin, eyes

Medical Surveillance: Preliminary medical examination to detect chronic diseases of CNS, liver, heart, kidneys, lung and skin, as well as endocrinological or immunological disturbances, should protect susceptible individuals. Periodical medical examinations of internal organs, skin and eyes are important to avoid chronic occupational intoxications. They should include lab and patch tests if necessary[30]. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a drug or other inhalation therapy. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. Before employment and at regular times after that, the following are recommended: If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also consider CBC. Consider chest X-ray following acute overexposure

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is conscious and able to swallow, have victim drink 4−8 ounces of water. Do not induce vomiting. *Note to physician or authorized medical personnel*: Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a drug or other inhalation therapy. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure.

Personal Protective Methods: Reacts with the following absorbent materials: Cellulose-Based; Mineral-and Clay-Based; Dirt/Earth[101]. Wear protective eye protection, gloves and clothing to prevent any reasonable probability of dermal contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Wherever and whenever workplace conditions warrant respirator use, a respiratory protection program must be followed that meets one or more of the following requirements: OSHA's 29 CFR 1910.134, ANSI Z88.2, or European Standard EN 149.

Storage: Color code-Blue: Health Hazard/Poison. Store in a dark, secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong alkalis (such as sodium hydroxide and sodium bcarbonate). Stable when stored in glass or polyethylene containers.

Shipping: UN3082 Environmentally hazardous substances, liquid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: For solids, isolate spill or leak area in all directions for at least 25 meters/75 feet. For liquids, isolate spill or leak area in all directions for at least 50 meters/150 feet. Increase, in the downwind direction, as necessary. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Stop leak if you can do it without risk. Prevent entry into waterways, sewers, basements or confined areas. Cover with plastic sheet to prevent spreading. Absorb or cover with dry earth, sand or other non-combustible material and transfer to containers. Do not allow water to get inside containers.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen, sulfur, and carbon. *On small fire*, use dry chemical powder, carbon dioxide, water spray, or foam. *On large fire*, use water spray, fog or regular alcohol-resistant foam. Do not scatter material using straight water jet streams. Dike fire control water for later disposal; do not scatter the material. Move containers from fire area if you can do it without risk. *If tank, rail car or tank truck is involved in a fire*, isolate for 800 meters/0.5 mile in all directions; also, consider initial evacuation for 800 meters/0.5 mile in all directions. Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Do not allow water to get inside containers. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. *Always* stay away from tanks engulfed in fire. For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn.

Disposal Method Suggested: Do not discharge into drains or sewers. Dispose of waste material as hazardous waste using a licensed disposal contractor to an approved landfill. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. If allowed, incineration with effluent gas scrubbing (carbon dioxide may be released) is recommended[22]. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Noncombustible containers should be crushed and buried under more than 40 cm of soil[30]. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (204); (100).

United States Environmental Protection Agency, "Reregistration Eligibility Decision (RED), Pebulate," Office of Prevention, Pesticides and Toxic Substances, Washington, DC (November 1999). http://www.epa.gov/REDs/2500red.pdf

Pesticide Management Education Program, "Pebulate (Tillam) Herbicide Profile 3/85," Cornell University, Ithaca, NY (March 1985). http://pmep.cce.cornell.edu/profiles/herb-growthreg/naa-rimsulfuron/pebulate/herb-prof-pebulate.html

United States Environmental Protection Agency, Office of Pesticide Programs, *Pesticide Residue Limits, "Pebulate"*, 40 CFR 180.238, www.epa.gov/pesticides/food/viewtols.htm

Pelargonic Acid P:0184

Formula: $C_9H_{18}O_2$

Synonyms: Cirrasol-185A; Econosan; Emery 202 (mixture with *n*-octoic acid); Emfac-1202; Hexacid C-9; Nonanoic acid; *n*-Nonoic acid; *n*-Nonylic acid; 1-Octanecarboxylic acid; Pelargic acid; Pelargon; Scythe; West agro acid sanitizer

CAS Number: 112-05-0

HSDB Number: 5554 as nonanoic acid

RTECS Number: RA6650000

UN/NA & ERG Number: UN3265/153

EC Number: 203-931-2 [*Annex I Index No.*: 607-197-00-2]

Regulatory Authority and Advisory Information

Hazard Alert: Combustible, Primary irritant (w/o allergic reaction), Agricultural chemical.

Hazardous to aquatic life or environment, with possible long lasting effects[194]. Harmful to aquatic life with long lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: C, Xi; Risk phrases: R34; R36/37/39; R41; R53; Safety phrases: S1/2; S25; S26: S28; S36/37/39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Colorless or yellowish, combustible, oily liquid. Faint odor. Molecular weight 158.27; Specific gravity (H_2O:1) = 0.9055 @ 20°C; Boiling point = 255°C; Freezing/Melting point = 12.4°C; Boiling point = 255.5°C; Vapor pressure = 1.65×10^{-3} mmHg @ 25°C; Flash point = > 125°C; Autoignition temperature = 400°C; Explosive limits: LEL = 0.9%; UEL = 5.9%. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Slightly soluble in water; solubility 250 mg/L @ 25°C.

Potential Exposure: Pelargonic acid, a naturally occurring fatty acid herbicide/fungicide. It is used to control the growth of weeds and as a blossom thinner for apple and pear trees. It is also used as a food additive; as an ingredient in solutions used to commercially peel fruits and vegetables; in the manufacture of lacquers, plastics and pharmaceuticals.

Incompatibilities: Heated vapors may form explosive mixture with air. May react violently with strong oxidizers, bromine, 90% hydrogen peroxide, phosphorus trichloride, silver powders or dust. Incompatible with strong bases and silver compounds; mixture with some silver compounds may form explosive salts of silver oxalate.

Permissible Exposure Limits in Air:

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 13 milligram per cubic meter

PAC-2: 140 milligram per cubic meter

PAC-3: 840 milligram per cubic meter

Determination in Water: Octanol-water coefficient: Log $K_{ow} = >3.0$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation; ingestion; dermal contact

Harmful Effects and Symptoms

Short-Term Exposure: Corrosive. This material can cause irritation and chemical burns to the skin, eyes, and respiratory and digestive tracts. May cause permanent eye damage. Very harmful if swallowed. Repeated or prolonged dermal contact may cause dermatitis. Inhalation may cause lung edema, a medical emergency that can be delayed up to 72 hours. LD_{50} (oral, rat) = 15 g/kg; LD_{50} (dermal, rat) = > 5 g/kg.

Long-Term Exposure: Dermatitis; serious problems with the digestive tract and respiratory tracts.

Points of Attack: Skin, eyes, and respiratory tract

Medical Surveillance: Preliminary medical examination to detect chronic diseases of CNS, liver, heart, kidneys, lung and skin, as well as endocrinological or immunological disturbances, should protect susceptible individuals. Periodical medical examinations of internal organs, skin and eyes are important to avoid chronic occupational intoxications. They should include lab and patch tests when necessary[83]. Evaluation by a qualified allergist, including exposure history and testing, may help diagnose allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Do not induce vomiting when formulations containing petroleum solvents are ingested.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of dermal and/or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: SCBA >20 milligram per cubic meter. Wherever and whenever workplace conditions warrant respirator use, a respiratory protection program must be followed that meets one or more of the following government standards: OSHA's 29 CFR 1910.134, ANSI Z88.2, or European Standard EN 149.

Storage: Color code-White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area away from incompatible materials listed above. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. If this material contains a flammable carrier, sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fitting.

Spill Handling: First remove all sources of ignition. Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition prducts include oxides of carbon. On small fire, use dry chemical powder, carbon dioxide or water spray.On a large fire: use water spray, fog or alcohol-resistant foam. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal. Use water spray or fog; do not scatter material using straight water jet streams. *Fire involving storage or vehicular tanks:* Isolate for 800 meters/0.5 mile in all directions; also, consider initial evacuation for 800 meters/0.5 mile in all directions. Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Do not allow water to get inside containers. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. *Always* stay away from tanks engulfed in fire. For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn.

Disposal Method Suggested: Do not discharge into drains or sewers. Dispose of waste material as hazardous waste using a licensed disposal contractor to an approved landfill. Contact a licensed disposal facility about surplus and non-recyclable solutions. Burn in a chemical incinerator equipped with an afterburner and scrubber. Extra care must be exercised as the material in an organic solvent is highly flammable. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Incineration with effluent gas scrubbing is recommended. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Office of Pesticide Programs, "Pelargonic Acid Fact Sheet:" (April 2000). http://www.epa.gov/oppbppd1/biopesticides/ingredients/factsheets/factsheet_217500.htm

Pendimethalin P:0188

Formula: $C_{13}H_{19}N_3O_4$

Synonyms: AC 92553; Accotab; Aniline, 3,4-dimethyl-2,6-dinitro-*N*-(1-ethylpropyl)-; Benzenamine, 3,4-dimethyl-2,6-dinitro-*N*-(1-ethylpropyl)-; Benzenamine, *N*-(1-ethylpropyl)-3,4-dimethyl-2,6-dinitro-; Bullet (pendimethalin + cyanazine); Caswell No. 454BB; 3,4-Dimethyl-2,6-dinitro-*N*-(1-ethylpropyl)aniline; 2,5-Dinitro-*N*-(1-ethylpropyl)-3,4-xylidine; *N*-(1-Ethylpropyl)-3,4-dimethyl-2,6-dinitrobenzenamine; *N*-(1-Ethylpropyl)-3,4-dimethyl-2,6-dinitroanaline; *N*-(1-Ethylpropyl)-2,6-dinitro-3,4-xylidine; Go-Go-San; Herbadox; Pay-off; Pendimethaline; Penoxalin; Penoxaline; *N*-(3-Pentyl)-3,4-dimethyl-2,6-dinitroaniline; Prowl; Sipaxol; Squadron (with imazaquin); Stomp; Tata Panida; Tendimethalin; Valor; Way-up; 3,4-Xylidine, 2,6-dinitro-*N*-(1-ethylpropyl)-

CAS Number: 40487-42-1

HSDB Number: 6721

RTECS Number: BX5470000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 254-938-2 [*Annex I Index No.:*609-402-00-X]

Regulatory Authority and Advisory Information

Carcinogenicity[83]: EPA Group C, possible human carcinogen

Hazard Alert: Combustible, Possible risk of forming tumors, Possible endocrine disruptor, Sensitization hazard, Environmental hazard.

EPA Acceptable Daily Intake (ADI): Oral Reference Dose (RfD) = 0.04 mg/kg/day

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%

Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: Xi, N; Risk phrases: R33; R43; R50/53; Safety phrases: S2; S24; S29/35; S37; S41; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Yellow-orange crystalline solid. Mild nut-like odor. Commercial product is available as an emulsifiable concentrate. Molecular weight = 281.33; Specific gravity (H_2O:1) = 1.19 @ 25°C; Boiling point = (decomposes) 330°C; Freezing/Melting point = 55−58°C; Vapor pressure = 9.4×10^{-6} mmHg @ 25°C. Slightly soluble in water; solubility = 0.32 mg/L @ 20°C. Physical and toxicological properties may be affected by carrier solvents in commercial formulations.

Potential Exposure: Pendimethalin is a selective pre-emergence and postemergence 2,6-dinitroaniline herbicide used on various agricultural and non-agricultural sites to control broadleaf weeds and grassy weeds in crops such as apricot, carrot, cherry, corn, cotton, fig, garbanzos, garlic, olive, onion, nectarine, peach, pear, pecan, plum, rice and prune, and noncrop areas. It is applied to soil preplant, pre-emergence, and postemergence with ground and aerial equipment.

Incompatibilities: Reacts with oxidizers, acids and alkaline materials. Contact with strong oxidizers may cause fire and explosions.

Permissible Concentration in Water: State Drinking Water Guidelines: Arizona 280 μg/L; Florida 280 μg/L. Runoff from spills or fire control may cause water pollution.

Determination in Water: Method: USGS-NWQL O-1126-95; Procedure: gas chromatography-mass spectrometry with select-ion monitoring; Matrix: natural water; Detection Limit: 0.018 μg/L. Octanol-water coefficient: Log $K_{ow} = > 5.0$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Absorbed through the unbroken skin. Inhalation, ingestion

Harmful Effects and Symptoms

Short-Term Exposure: Irritates and possibly burns the skin, eyes, and respiratory tract. Eye contact may cause irritation, burning sensation, burns, and visual damage; inflammation of the conjunctiva, corneal opacity and slight physiologic dilatation of the pupils. Dermal contact causes irritation and possible burns. Rapidly absorbed through the unbroken skin and can be fatal. Causes irritation of the mucous membrane and upper respiratory tract. May cause violent sneezing and coughing. May cause increased perspiration, elevated temperature, perspiration, breathing, and heart rate; headache, weakness, nausea, abdominal pain, vomiting. Systemic intoxication is cumulative and has been fatal. High levels of exposure may be fatal. Inhalation may cause damage to the circulatory system and heart resulating in possible death due to cardiac failure. May be fatal if swallowed. Causes gastrointestinal irritation with nausea, vomiting and diarrhea. Symptoms are similar to those of acute inhalation. May cause liver and kidney damage. LD_{50} (oral, rat) = 1050−3180 mg/kg; LD_{50} (dermal, rat) = > 2 g/kg. LD_{50} (oral, rat) = 1050−3180 mg/kg; LD_{50} (dermal, rat) = > 2 g/kg.

Long-Term Exposure: may cause tumors. Thyroid toxin. This material is capable of bioaccumulating. May cause cancer. Skin sensitizer.

Points of Attack: Thyroid gland. Skin, kidneys, liver.

Medical Surveillance: Preliminary medical examination to detect chronic diseases of CNS, liver, heart, kidneys, lung and skin, as well as endocrinological or immunological disturbances, should protect susceptible individuals. Periodical medical examinations of internal organs, skin and eyes are important to avoid chronic occupational intoxications. They should include lab and patch tests when necessary[83]. This chemical is a suspected or known human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and advice for medical monitoring. Evaluation of thyroid function. Consult a physician if poisoning is suspected or if redness, itching, or burning of the eyes or skin develop. Evaluation by a qualified allergist, including exposure history and testing, may help diagnose allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Do not induce vomiting when formulations containing petroleum solvents are ingested

Personal Protective Methods: Reacts with the following absorbent materials: Cellulose-Based; Mineral-and Clay-Based; Expanded Polymeric[88]. Wear protective eye protection, gloves and clothing to prevent any reasonable probability of dermal and/or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: (1) Color code-Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. (2) Color code-Yellow Stripe: Reactivity Hazard; Store separately in a area isolated from flammables, combustibles, or other yellow coded materials. (2) Color code-Blue: Health Hazard/Poison. Store in a secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well ventilated area away from oxidizers, strong acids; strong bases and other incompatible materials listed above. Metal containers involving the transfer of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. If this material contains a flammable carrier, sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: First remove all sources of ignition. Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; water spray; alcohol foam or polymer foam extinguishers. Heated vapors in confined spaces can explode. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers can explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: It is the responsibility of chemical waste generators to determine if a discarded chemical is classified as a hazardous waste. See 40 CFR Parts 261.3 for United States Environmental Protection Agency guidelines for the classification determination. Additionally, in order to ensure complete and accurate classification, waste generators must consult state and local hazardous waste regulations. Organic pesticides, whether of botanical or synthetic origin, can be destroyed by incineration equipped with scrubbers to remove acid wastes.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, *Reregistration Eligibility Decision (RED), Pendimethalin*, Office of Prevention, Pesticides and Toxic Substances, Washington, DC (June 1997). http://www.epa.gov/REDs/0187red.pdf

EXTOXNET, Extension Toxicology Network, *Pesticide Information Profile, Pendimethalin*, Oregon State University, Corvallis, OR (June 1996). http://extoxnet.orst.edu/pips/pendimet.htm

Pentaborane P:0190

Formula: B_5H_9

Synonyms: Dihydropentaborane (9); Pentaborane (9); Pentaborane undecahydride; Pentaborano (Spanish); (9)-Pentaboron nonahydride; Pentaboron nonahydride; Pentaboron undecahydride; Stable pentaborane

CAS Registry Number: 19624-22-7

HSDB Number: 774

RTECS Number: RY8925000

UN/NA & ERG Number: (PIH) UN1380/135

EC Number: 243-194-4

Regulatory Authority and Advisory Information

Hazard Alert: Poison inhalation hazard: exposure can be lethal, Extremely flammable, Pyrophoric (Spontaneously flammable if impure. Approx. 35°C when pure[136]), Water reactive, Strong reducing agent.

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 500 lb (227 kg)

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500 lb (227 kg)

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T+, F+, Xi; Risk phrases: R12; R14; R17; R18; R36/37/38; Safety phrases: S9; S14; S16; S26; S33; S36/37/39; S41; S45 (see Appendix 4)

Description: Pentaborane is a colorless, volatile liquid. Unpleasant, sweetish odor, like sour milk. The Odor Threshold is 0.8 ppm. Molecular weight = 63.14; Specific gravity (H_2O:1) = 0.61 @ 25°C; Boiling point = 60°C; Freezing/Melting point = −47°C; Vapor pressure = 171 mmHg @ 25°C; Flash point = 30°C; Autoignition temperature: about 35°C. Explosive limits: LEL = 0.42%; UEL: 98%. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 4, Reactivity 2₩. Reacts slowly with water, decomposing forming heat and boric acid.

Potential Exposure: Pentaborane is used in rocket propellants and in gasoline additives.

Incompatibilities: Pentaborane is an extremely reactive reducing agent. It can ignite spontaneously in contact with air and many other materials. Reactions with oxygen are often violently explosive. Reacts with ammonia to form a diammoniate. Reacts on contact with water, oxidizers, halogens, including halogenated hydrocarbons. May sel-heat and ignite *spontaneously* in moist air, decomposes @ 150°C. Hydrolyzes slowly with heat in water to form boric acid. Contact with solvents, such as ketones, ethers and esters form shock-sensitive compounds. Pentaborane is stable in hydrocarbon solvents, but forms shock sensitive solutions in most carbonyl containing solvents. Corrosive to natural rubber, some synthetic rubbers and to some lubricants. Avoid dimethyl sulfoxide, direct sunlight and sources of ignition[101].

Permissible Exposure Limits in Air:

NIOSH IDLH = 1 ppm

Conversion factor: 1 ppm = 2.58 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 0.005 ppm/0.01 milligram per cubic meter TWA

NIOSH REL: 0.005 ppm/0.01 milligram per cubic meter TWA; 0.015 ppm/0.03 milligram per cubic meter STEL

ACGIH TLV[1]: 0.005 ppm/0.013 milligram per cubic meter TWA; 0.015 ppm/0.039 milligram per cubic meter STEL

Protective Action Criteria (PAC)* Ver. 29[138]
PAC-1: 0.015 ppm
PAC-2: **0.14_A** ppm
PAC-3: **0.51_A** ppm
*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.
DFG MAK: 0.005 ppm/0.013 milligram per cubic meter TWA; Peak Limitation Category II(2)
Arab Republic of Egypt: TWA 0.1 milligram per cubic meter, [skin], 1993; Australia: TWA 0.1 milligram per cubic meter, [skin], 1993; Austria: MAK 0.1 milligram per cubic meter, [skin], 1999; Belgium: TWA 0.1 milligram per cubic meter, [skin], 1993; Denmark: TWA 0.1 milligram per cubic meter, [skin], 1999; Finland: TWA 0.1 milligram per cubic meter, short-term exposure limit 0.3 milligram per cubic meter, [skin], 1999; France: VME 0.1 milligram per cubic meter, [skin], 1999; the Netherlands: MAC-TGG 0.1 milligram per cubic meter, [skin], 2003; Japan: 0.1 milligram per cubic meter, [skin], 1999; Norway: TWA 0.05 milligram per cubic meter, 1999; the Phillipines: TWA 0.1 milligram per cubic meter, [skin], 1993; Russia: STEL 0.05 milligram per cubic meter, 1993; Thailand: TWA 0.11 milligram per cubic meter, 1993; Turkey: TWA 0.1 milligram per cubic meter, [skin], 1993; United Kingdom: TWA 0.1 milligram per cubic meter, short-term exposure limit 0.3 milligram per cubic meter, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Several states have set guidelines or standards for pentaborane in ambient air[60] ranging from 0.16 μ/m^3 (Virginia) to 0.2 μ/m^3 (Connecticut) to 1.0−3.0 μ/m^3 (North Dakota) to 2.0 μ/m^3 (Nevada).

Determination in Air: No Analytical Method available.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Causes severe irritation to the respiratory tract. Pentaborane may affect the CNS; resulting in visual disturbances, poor judgment; behavioral changes; loss of recent memory; nausea, vomiting, drowsiness, and difficulty in focusing. Inhalation of higher concentrations, headache, dizziness, nervous excitation; muscular pain; muscle incoordination; cramps, tremors, convulsions, and coma may occur Death can occur by CNS poisoning.

Long-Term Exposure: Possibly neurotoxic. May have lasting effects.

Points of Attack: CNS; brain, eyes, skin.

Medical Surveillance: Preemployment and periodic physical examinations to determine the status of the workers' general health should be performed. These examinations should be concerned especially with any history of CNS disease, personality or behavioral changes; as well as liver, kidney or pulmonary disease of any significant nature. Chest X-ray, blood, liver, and renal function studies may be helpful.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *0.05 ppm:* Sa (APF = 10) (any supplied-air respirator). *0.125 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *0.25 ppm:* SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *1 ppm:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive pressure mode). *Escape:* GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted canister providing protection against the compound of concern]; or SCBAE (any appropriate escape-type, SCBA). *Note:* Make certain respirator has no exposed rubber gaskets.

Storage: Poison inhalation chemical (PIH); check oxygen content prior to entering storage area. Color code-Red Stripe: Flammability Hazard (4.2): Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 meters or a 1-hour fire wall from flammable or reactive materials.

Store flammable solids (spontaneously combustible) up to maximum allowable quantity per control area in an approved flammable storage area. Do not store in a basement. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration is not a danger. Store in tightly closed containers in a cool, well ventilated area away from oxidizers, halogens, water, halogenated hydrocarbons. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1380 Pentaborane, Hazard Class: 4.2; Labels: 4.2-Spontaneously combustible material, 6.1-Poisonous materials. Inhalation Hazard Zone A.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Do not touch spilled material, stop leak if you can do it without risk. For spills, dike for later disposal and do not apply water unless directed to do so. Clean up only under supervision of an expert. Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Avoid breathing vapors, and keep upwind. Avoid bodily contact with the material. Do not handle broken packages without protective equipment. Wash away any material which may have contacted the body with copious amounts of water or soap and water. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)
Day 0.4/0.6
Night 1.4/2.3

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 1250/400
Then: Protect persons downwind (miles/kilometers)
Day 2.9/4.7
Night 5.5/8.9

Fire Extinguishing: Reacts violently with halogenated extinguishing agents. Ignites spontaneously in air (spontaneously flammable if impure). Approx. 35°C when pure[136]. Boron hydrides present considerable fire and explosion hazard. They undergo explosive reaction with most oxidizing agents, including halogenated hydrocarbons. Thermal decomposition products may include toxic fumes and can react vigorously with oxidizing materials. Fires tend to reignite. Thermal decomposition products may include hydrogen bromide. Ignites spontaneously in air. Reacts violently with halogenated extinguishing agents. Fires tend to reignite. If material is on fire or involved in fire, do not extinguish unless flow can be stopped. *Do not use water or halogenated extinguishing agents*. Extinguish *small fires* with dry chemical or carbon dioxide. For *large fires* withdraw and let burn. Move container from fire area if you can do it without risk. Cool containers that are exposed to flames with water from the side until well after fire is out. *For massive fire* in cargo area, use unmanned hose holder or monitor nozzles; if this is impossible, withdraw from area and let fire burn. Wear positive pressure breathing apparatus and full protective clothing. If fire becomes uncontrollable or container is exposed to direct flame-evacuate for a radius of 1500 feet. If material is leaking (not on fire), downwind evacuation must be considered. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full

facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration with aqueous scrubbing of exhaust gases to remove B_2O_3 particulates.

References

(31); (173); (101); (138); (170).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Pentaborane, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

Pentachlorobenzene P:0200

Formula: C_6HCl_5

Synonyms: Benzene, pentachloro-; 1,2,3,4,5-Pentachlorobenzene; QCB

CAS Registry Number: 608-93-5

HSDB Number: 523

RTECS Number: DA6640000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 210-172-0 [*Annex I Index No.:* 602-074-00-5]

Regulatory Authority and Advisory Information

Carcinogenicity: EPA: Not Classifiable as to human carcinogenicity.

Hazard Alert: Flammable solid, Environmental hazard, Possible risk of forming tumors, Suspected reprotoxic hazard, Drug

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U183

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.055; Nonwastewater (mg/kg), 10

RCRA 40CFR264, appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 10 lb (4.54 kg).

List of Stockholm Convention POPs: Annex A (Elimination); Annex C (Unintentional production and release).

Hazard Symbols, Risk & Safety statements: Hazard Symbol: Risk phrases: F, Xn, N; R11; R22; R50/53; Safety phrases: S2; S29/35; S41; S46; S50; S60; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Pentachlorobenzene is a colorless crystalline solid. Pleasant aroma. Molecular weight = 250.34; Specific gravity (H_2O:1) = 1.8 @ 16°C; Boiling point = 277°C; Freezing/Melting point = 86°C; Vapor pressure = 6.5×10^{-3} mmHg @ 25°C;. Insoluble in water; solubility 0.65 mg/L.

Potential Exposure: Pentachlorobenzene is used primarily as a precursor in the synthesis of the fungicide pentachloronitrobenzene, and as a flame retardant. Drug/Therapeutic Agent; Fungicide; bactericide; wood preservative; industrial Insecticides.

Incompatibilities: Polychlorinated hydrocarbons Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, aluminum, liquid oxygen; potassium, sodium.

Permissible Exposure Limits in Air:

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 4.4 milligram per cubic meter

PAC-2: 49 milligram per cubic meter

PAC-3: 220 milligram per cubic meter

Determination in Air: Filter/XAD-2; workup with hexane; GC/ECD; NIOSH Analytical Method (IV) #5517, Polychlorobenzenes.

Determination in Water: A persistent organic pollutant. Octanol-water coefficient: Log $K_{ow} = > 5$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Permissible Concentration in Water: The United States Environmental Protection Agency has set a criterion of 0.5 μg/L based on toxicity studies.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: May affect the nervous system. LD_{50} = (oral-rat) 1080 mg/kg.

Long-Term Exposure: Pentachlorobenzene may affect the liver and kidneys, causing tissue lesions. Limited animal studies have produced developmental effects and decreased body weights in fetuses.

Points of Attack: Liver, kidneys.

Medical Surveillance: Liver and kidney function tests.

First Aid: *Skin Contact:* [52] Flood all areas of body that have contacted the substance with water. Don't wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others. *Eye Contact:* Remove any contact lenses at once. Flush eyes well with copious quantities of water or normal saline for at least 20−30 minutes. Seek medical attention. *Inhalation:* Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion:* If convulsions are not present, give a glass or two of water or milk to dilute the substance. Assure that the person's airway is unobstructed and contact a hospital or poison center immediately for advice on whether or not to induce vomiting.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/

manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in a refrigerator or a cool, dry place. Always store pesticides in their original containers, complete with labels that list ingredients, directions for use, and first aid steps in case of accidental poisoning. Never store pesticides in cabinets with or near food, animal feed, or medical supplies. Do not store pesticides in places where flooding is possible or in places where they might spill or leak into wells, drains, ground water, or surface water[72]. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources[52]. Dampen spilled material with alcohol to avoid dust, then transfer material to a suitable container. Use absorbent dampened with alcohol to pick up remaining material. Wash surfaces well with soap and water. Seal all wastes in vapor-tight plastic bags for eventual disposal. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include chlorine. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced.

References

(31); (173); (101); (138); (203); (100).

United States Environmental Protection Agency, *Pentachlorobenzene, Health and Environmental Effects Profile No. 141*, Office of Solid Waste, Washington, DC (April 30, 1980)

United States Environmental Protection Agency, *Chlorinated Benzenes: Ambient Water Quality Criteria*, Washington, DC (1980)

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 6, No. 1, 105−107 (1986)

Pentachloroethane P:0210

Formula: C_2HCl_5; CCl_3CHCl_2

Synonyms: Ethane pentachloride; Ethane, pentachloro-; NCI-C53894; Pentachloraethan (German); Pentachlorethane (French); Pentacloroetano (Spanish); Pentalin

CAS Registry Number: 76-01-7

HSDB Number: 2034

RTECS Number: KI6300000

UN/NA & ERG Number: UN1669/151

EC Number: 200-925-1 [*Annex I Index No.:* 602-017-00-4]

Regulatory Authority and Advisory Information

Carcinogenicity: NCI: Carcinogenesis Studies (gavage); clear evidence: mouse; equivocal evidence: rat; IARC: Animal Limited Evidence; Human No Adequate Data, *not classifiable as carcinogenic to humans*, Group 3, 1999.

Hazard Alert: Poison, Flammable, Pyrophoric hazard, Possible risk of forming tumors, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction), Environmental hazard.

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U184

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.055; Nonwastewater (mg/kg), 6.0

RCRA 40CFR264, appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8240 (5); 8270 (10)

Clean Water Act: Section 307(a)(1)Toxic Pollutants subject to effluent limitations as chlorinated ethanes.

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, appendix B)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T, F, N; Risk phrases: R40; R10; R17; R48/23; R51/53; R61; R62; Safety phrases: S1/2; S23; S29/35; S36/37; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [2-Hazard to waters (est.)]

Description: Pentachloroethane is a colorless, heavy, nonflammable liquid with a sweetish chloroform-or camphor-like odor. Molecular weight = 202.29; Specific gravity (H_2O:1) = 1.7 @ 20°C Boiling point = 162°C; Freezing/Melting point = −29°C; Vapor pressure = 7.5 mmHg @ 37°C; Flash point = 75°C (cc). Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 0. Practically insoluble in water.

Potential Exposure: Pentachloroethane is used in the manufacture of tetrachloroethylene and as a solvent for cellulose acetate, certain cellulose ethers; resins, and gums. It is also used as a drying agent for timber by immersion at temperatures greater than 100°C.

Incompatibilities: Pentachloroethane is pyrophoric; may self-ignite, especially in moist air. Violent reaction with alkali metals (i.e., lithium, sodium, potassium, rubidium, cesium, francium); will produce spontaneous explosive chloroacetylenes. Shock-and friction-sensitive material formed by mixture with potassium. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, moisture of any form, alcohols, heat, ammonia, ketones, esters, halogenated hydrocarbons, ethers, trichloroethylene. Contact with potassium may explode after a short delay. Reaction with alkalis or metals will produce a violent reaction. It is incompatible with strong oxidizing agents.

Permissible Exposure Limits in Air:

NIOSH REL: Handle with caution; See *NIOSH Pocket Guide*, Appendix C

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 130 milligram per cubic meter

PAC-2: 730 milligram per cubic meter

PAC-3: 1200 milligram per cubic meter

DFG MAK: 5 ppm/42 milligram per cubic meter TWA; Peak Limitation Category II(2)

Rumania: TWA 30 milligram per cubic meter; Yugoslavia: MAC 5 ppm/40 milligram per cubic meter.

Determination in Air: Use NIOSH Analytical Method (IV) #2517.

Permissible Concentration in Water: Clean Water Act: Section 307(a)(1)Toxic Pollutants subject to effluent limitations as chlorinated ethanes.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Pentachloroethane is an irritant and a strong CNS depressant. Pentachloroethane has a strong narcotic effect. Symptoms include prompt nausea, vomiting, abdominal pain with diarrhea; headaches, dizziness, confusion, drowsiness, and occasionally, convulsions. Visual disturbances may arise followed by coma and possible death from respiratory arrest or circulatory collapse. Death may occur by respiratory arrest or circulatory collapse. Occasionally, sudden death may occur due to ventricular fibrillation. Other effects may include weight gain, edema, loss of appetite; jaundice, and pain (due to enlarged liver). The chemical is very toxic with a probable oral lethal dose of 50−500 mg/kg or between 1 teaspoon and 1 ounce for a 150 lb person. In animals: irritation of eyes, skin; weakness, restlessness, irregular/irregularities of respiration, muscle incoordination; liver, kidney, lung changes (NIOSH)

Long-Term Exposure: Exposure to this material may result in injury to the liver, lungs and kidneys.

Points of Attack: Eyes, skin, respiratory system; CNS; liver, kidneys.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in a refrigerator away from alkalis, reactive metals; water. Where possible, automatically pump liquid from drums or other storage containers to process containers Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN1669 Pentachloroethane, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of boron and carbon,and flammable hydrogen. Fires should be extinguished using water, carbon dioxide; or dry chemical. Move container from fire area if you can do so without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Wear positive pressure breathing apparatus and special protective clothing. Remove and isolate contaminated clothing at the site. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBA that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced[22].

References

(31); (173); (101); (138); (170) (100).

National institute for Occupational Safety and Health (NIOSH), Profiles on Occupational Hazards for Criteria Document(2). Priorities: Pentachloroethane, Report PB-274,073, Cincinnati, OH pp 303−305 (1977)

United States Environmental Protection Agency, Chlorinated Ethanes: Ambient Water Quality Criteria, Washington, DC (1980)

United States Environmental Protection Agency, Chemical Hazard Information Profile Draft Reports: Pentachloroethane, Washington, DC (January 4, 1983)

United States Environmental Protection Agency, Chemical Hazard Information Profile: Pentachloroethane, Washington, DC, Chemical Emergency Preparedness Program (October 31, 1985)

Pentachloronaphthalene P:0220

Formula: $C_{10}H_3Cl_5$

Synonyms: Halowax 1013; Naphthalene, pentachloro-; 1,2,3,4,5-Pentachloronaphthalene

CAS Registry Number: 1321-64-8

HSDB Number: 2918

RTECS Number: QK0300000

EC Number: 215-320-8 [*Annex I Index No.:* 602-041-00-5]

Regulatory Authority and Advisory Information

United States Environmental Protection Agency GENETOX PROGRAM: Positive: Histidine reversion-Ames test, 1988.

Hazard Alert: Possible risk of forming tumors, Suspected reprotoxic hazard, Environmental hazard.

United States DOT Regulated marine pollutant (49CFR172.101, Appendix B) as naphthalenes

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: Xn, N; Risk phrases: R21/22; R36/38; R50/53; R63; Safety phrases: S2; S29/35; S41; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Pentachloronaphthalene is a pale yellow or white solid powder with an aromatic odor. Molecular weight = 300.38; Specific gravity (H_2O:1) = 1.67; Boiling point = 335.6°C. Freezing/Freezing/Melting point = 120°C; Vapor pressure = $<$ 1 mmHg @ 25°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Insoluble in water.

Potential Exposure: Used in electric wire insulation, in additives to specialized lubricants; and as a fire-and water-proofing agent. No longer produced or used in the US.

Incompatibilities: Violent reaction with strong oxidizers, aluminum, liquid oxygen; potassium, sodium. Heat may contributes to instability.

Permissible Exposure Limits in Air:

OSHA PEL: 0.5 milligram per cubic meter TWA [skin]

NIOSH REL: 0.5 milligram per cubic meter TWA [skin]

ACGIH TLV[1]: 0.5 milligram per cubic meter TWA [skin]

Protective Action Criteria (PAC) not available

DFG MAK: 0.5 milligram per cubic meter TWA [skin]

Australia: TWA 0.5 milligram per cubic meter, 1993; Austria: MAK 0.5 milligram per cubic meter, [skin], 1999; Belgium: TWA 0.5 milligram per cubic meter, 1993; Denmark: TWA 0.5 milligram per cubic meter, [skin], 1999; France: VME 0.5 milligram per cubic meter, 1999; Norway: TWA 0.5 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 0.5 milligram per cubic meter, 2003; Poland: MAC (TWA) 0.5 milligram per cubic meter, MAC (STEL) 1.5 milligram per cubic meter, 1999; Sweden: NGV 0.2 milligram per cubic meter, KTV 0.3 milligram per cubic meter, [skin], 1999; Switzerland: MAK-W 0.5 milligram per cubic meter, KZG-W 2.5 milligram per cubic meter, [skin], 1999; Turkey: TWA 0.5 milligram per cubic meter, [skin], 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 0.5 milligram per cubic meter [skin]

When skin contact also occurs, you may be overexposed, even though air levels are less than the limit listed above.

Determination in Air: Use NIOSH II(2), Method #S9.

Determination in Water: Octanol-water coefficient: $\text{Log } K_{ow} = > 8$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood. Naphthalenes and naphthenic acids are listed as United States DOT marine pollutants and may persist in the environment.

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin, and respiratory tract. Skin rash may occur if contaminated skin is exposed to sunlight. Can affect the nervous system; causing headache, fatigue, dizziness, vertigo (an illusion of movement); anorexia (loss of appetite).

Long-Term Exposure: Repeated or prolonged contact with skin may cause acne-like rash (chloracne), pruritus. May affect the liver, causing jaundice; liver necrosis

Points of Attack: Skin, liver, CNS.

Medical Surveillance: NIOSH lists the following tests: Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/ manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 5 milligram per cubic meter:* Sa (APF = 10) (any supplied-air respirator);* or SCBAF (APF = 50) (any SCBA with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/ MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive pressure mode). *Escape:* GmFOv100 (APF = 50) (any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister having an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA). *Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers. Where possible, automatically transfer material from drums or other storage containers to process containers Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Thermal decomposition products may include hydrogen chloride and oxides of carbon. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include hydrogen chloride and oxides of carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Pentachloronaphthalene, Trenton, NJ (December 1999)

Pentachloronitrobenzene P:0230

Formula: $C_6Cl_5NO_2$

Synonyms: Avicol (Pesticide); Bartilex; Batrilex; Benzene, pentachloronitro-; Botrilex; Brassicol; Brassicol 75; Brassicol earthcide; Brassicol super; Chinozan; Fartox; Folosan; Fomac 2; Fungichlor; GC 3944-3-4; Kobu; Kobutol; KP 2; Marisan forte; NCI-C00419; Nitropentachlorobenzene; Olipsan; Olpisan; PCNB; Pentachlornirtobenzol (German); Pentachloronitrobenzene; Pentagen; Phomasan; PKHNB; Quinosan; Quintocene; Quintoceno (Spanish); Quintozene; RTU1010; Saniclor 30; Terrachlor; Terraclor; Terraclor30 G; Terrafun; Tilcarex; Tripcnb; Tritisan

CAS Registry Number: 82-68-8; *(alt.)* 39378-26-2

HSDB Number: 1749

RTECS Number: DA6650000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171; UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 201-435-0 [*Annex I Index No.:* 609-043-00-5] (quintozene)

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Limited Evidence; Human No Adequate Data, *not classifiable as carcinogenic to humans*, Group 3, 1987; NCI: Carcinogenesis Studies (feed); no evidence: mouse; NTP: Carcinogenesis Studies (feed); no evidence: mouse. United States Environmental Protection Agency Gene-Tox Program, Negative: Host-mediated assay; *In vitro* UDS -human fibroblast; Negative: TRP reversion; S *cerevisiae-homozygosis*; Negative/limited: Carcinogenicity-mouse/rat; Inconclusive: B *subtilis* rec assay; *E coli polA* without S9; Inconclusive: Histidine reversion-Ames test; Inconclusive: D *melanogaster* sex-linked lethal.

Hazard Alert: Poison, Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Sensitization (skin), Environmental hazard.

Banned or Severely Restricted (Germany, U.S.) (UN)[13]

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U185

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.055; Nonwastewater (mg/kg), 4.8

RCRA 40CFR264, appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 100 lb (45.4 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: Xi, N; Risk phrases: R43; R50/53; R62; R63; Safety phrases: S2; S13; S24; S29/35; S37; S41; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)]

Description: Pentachloronitrobenzene forms colorless needles. Technical-grade PCNB contains an average of 97.8% PCNB, 1.8% hexachlorobenzene (HCB), 0.4% 2,3,4,5-tetrachloronitrobenzene (TCNB), and less than 0.1% pentachlorobenzene. Molecular weight = 295.34; Specific gravity (H_2O:1) = 1.72 @ 20°C; Boiling point = 328°C; Freezing/ Melting point = 144°C; Vapor pressure = 1×10^{-4} mbar @ 25°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Practically insoluble in water.

Potential Exposure: Those engaged in manufacture, formulation and application of this soil fungicide and seed treatment chemical. Peracetic acid is often used as a sterilizing agent in the medical, food service and pharmaceutical industries in combination hydrogen peroxide and acetic acid.

Incompatibilities: Aromatic nitro compounds range from slight to strong oxidizing agents. If mixed with strong reducing agents, including hydrides, alkali metals; aluminum (powder); phosphorus; metal powder; sulfides and nitrides, contact may initiate vigorous reactions that culminates in a detonation. The aromatic nitro compounds may explode in the presence of a base such as sodium hydroxide or potassium hydroxide even in the presence of water or organic solvents[101].

Permissible Exposure Limits in Air:

ACGIH TLV[1]: 0.4 ppm STEL not classifiable as a human carcinogen

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 1.5 milligram per cubic meter

PAC-2: 28 milligram per cubic meter

PAC-3: 62 milligram per cubic meter

Denmark: TWA 0.5 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 0.5 milligram per cubic meter, 2003; Russia[35,43] set a MAC in workplace air of 0.5 milligram per cubic meter and MAC values for ambient air in residential areas of 0.01 milligram per cubic meter on a momentary basis and 0.006 milligram per cubic meter on a daily average basis. A guideline in ambient air has been set[60] in Pennsylvania @ 2.47 μ/m^3.

Determination in Water: Fish Tox = 64.49856000 MATC (INTERMEDIATE)

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: May cause skin andeye irritation; sensitization with erythema, itching and edema. A rebuttable presumption against registration of PCNB for pesticidal uses was issued on October 13, 1977 by EPA on the basis of oncogenicity. In varying degrees, organochlorines are absorbed from the gut and also by the lung and across the skin[72].

Long-Term Exposure: There is limited evidence that this compound is an animal carcinogen. Human Tox = 2.10000 ppb (HIGH).

First Aid Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/ MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in a refrigerator or a cool, dry place away from strong bases. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required. UN2811

Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25meters/75 feet.(NJ). Isolation Distance, Fire: 800 meters/0.5 miles[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen spilled material with alcohol to avoid dust, then transfer material to a suitable container. Use absorbent dampened with alcohol to pick up remaining material. Wash surfaces well with soap and water. Seal all wasters in vapor-tight plastic bags for eventual disposal. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Thermal decomposition products may include hydrogen chloride and oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office. It has been observed that the product decomposes readily when burned with polyethylene. The compound is highly stable in soil in general, as would be expected on the basis of the polychlorinated aromatic structure[22].

References

(31); (173); (100).

United States Environmental Protection Agency, Pentachloronitrobenzene, Health and Environmental Effects Profile No. 142, Office of Solid Waste, Washington, DC (April 30, 1980)

(173); (101); (138); (80).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 5, No. 3, 11−16 (1985)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Chloronitrobenzenes (mixed isomers), Trenton, NJ (January 2007)

Pentachlorophenol P:0240

Formula: C_6HCl_5O; C_6Cl_5OH

Synonyms: Chem-tol; Chlon; Chlorophen; Cryptogil ol; Dowcide 7; Dowicide 7; Dowicide EC-7; Dowicide G; Dow pentachlorophenol DP-2 antimicrobial; Dura treet II; Durotox; EP30; Fungifen; Glaze penta; Grundier arbezol; 1-Hydroxypentachlorobenzene; Lauxtol; Lauxtol A; Liroprem; NCI-C54933; NCI-C55378; NCI-C56655; PCP; Penchlorol; Penta; Pentachlorofenol; Pentachlorophenate; 2,3,4,5,6-Pentachlorophenol; Pentachlorophenol, Dowicide EC-7; Pentachlorophenol, DP-2; Pentachlorophenol, technical; Pentachlorphenol (German); Pentaclorofenol (Spanish); Pentacon; Penta-Kil; Pentasol; Penwar; Peratox; Permacide; Permagard; Permasan; Permatox DP-2; Permatox penta; Permite; Phenol, pentachloro-; Pol nu; Preventol P; Priltox; Santobrite; Santophen; Santophen 20; Sinituho; Term-i-trol; Thompson's wood fix; Weedone; Woodtreat A

CAS Registry Number: 87-86-5

HSDB Number: 894

RTECS Number: SM6300000

UN/NA & ERG Number: UN3155/154

EC Number: 201-778-6 [*Annex I Index No.:* 604-002-00-8]

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen (Pentachlorophenol and by-products of its synthesis); IARC: Animal Sufficient Evidence; Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B, 1991; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies; NCI: Carcinogenesis Studies (feed); clear evidence: mouse; (feed); equivocal evidence: rat. United States Environmental Protection Agency Gene-Tox Program, Positive: Cell transformation-SA7/SHE; S *cerevisiae* gene conversion; Positive: S cerevisiae-forward mutation; Negative: Host-mediated assay; Mouse spot test; Negative: Histidine reversion-Ames test; S *cerevisiae-homozygosis*.

California Proposition 65 Chemical[102]: Cancer 1/1/1990.

Hazard Alert: Poison, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction), Environmental hazard. Listed for Tier 1 screening as an endocrine disruptor[88].

Banned or Severely Restricted (several countries) (UN)[13]

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR401.15 Section 307 Toxic Pollutants; 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): D037; Tox #s U242; D037, Regulated level = 100 mg/L.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA Toxicity Characteristic (Section 261.24), Maximum Concentration of Contaminants, regulatory level, 100 mg/L

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.089; Nonwastewater (mg/kg), 7.4

RCRA 40CFR264, appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8040 (5); 8270 (50)

United States National Primary Drinking Water Regulations: MCLG = zero mg/L; MCL = 0.001 mg/L

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, appendix B), severe pollutant

Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)] (as pentachlorophenol and its salts and esters)

Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T+, N; Risk phrases: R45; R24/25; R26; R36/37/38; R40; R50/53; R62; R63; Safety phrases: S1/2; S22; S29/35; S36/37; S45; S52; S41; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Pentachlorophenol is a colorless to white, crystalline solid. It has a benzene-like odor; pungent when hot. The Odor Threshold in water is 1600 μg/L and the taste threshold in water is 30 μg/L. Molecular weight = 266.32; Specific gravity (H_2O:1) = 1.98; Boiling point = 308.9°C (decomposes); Freezing/Melting point = 190°C (anhydrous); Vapor pressure = 0.0001 mmHg @ 25°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Practically insoluble in water; solubility in water = 0.001@ 20°C.

Potential Exposure: Pentachlorophenol (PCP) is a commercially produced bactericide, fungicide, and slimicide used primarily for the preservation of wood, wood products; and other materials. As a chlorinated hydrocarbon, its biological properties have also resulted in its use as an herbicide, and molluscicide. Two groups can be expected to encounter the largest exposures. One involves the small number of employees involved in the manufacture of PCP. All of these are presently under industrial health surveillance programs. The second and larger group are the formulators and wood theaters. Exposure, hygiene and industrial health practices can be expected to vary from the small theaters to the larger companies. The principal use as a wood preservative results in both point source water contamination at manufacturing and wood preservation sites and, conceivably, nonpoint source water contamination through runoff wherever there are PCP-treated lumber products exposing PCP to soil

Incompatibilities: Reacts violently with strong oxidizers, acids, alkalies, and water.

Permissible Exposure Limits in Air:

NIOSH IDLH = 2.5 milligram per cubic meter

OSHA PEL: 0.5 milligram per cubic meter TWA[skin]

NIOSH REL: 0.5 milligram per cubic meter TWA[skin]

ACGIH TLV[1]: 0.5 milligram per cubic meter TWA[skin]; BEI: 2 mg[total *PCP*]/g creatinine in urine/prior to last shift of workweek; 5 mg [free PCP]/L in plasma/end of Shift; confirmed animal carcinogen with unknown relevance to humans.

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 1 milligram per cubic meter

PAC-2: 15 milligram per cubic meter

PAC-3: 150 milligram per cubic meter

DFG MAK: [skin] Carcinogen Category 2

Australia: TWA 0.5 milligram per cubic meter, [skin], 1993; Austria: [skin], carcinogen, 1999; Belgium: TWA 0.5 milligram per cubic meter, [skin], 1993; Denmark: TWA 0.005 ppm (0.05 milligram per cubic meter), [skin], 1999; Finland: TWA 0.5 milligram per cubic meter; STEL 1.5 milligram per cubic meter, [skin], 1999; France: VME 0.5 milligram per cubic meter, [skin], continuous carcinogen, 1999; Hungary: TWA 0.2 milligram per cubic meter; STEL 0.4 milligram per cubic meter, [skin], 1993; the Netherlands: MAC-TGG 0.06 milligram per cubic meter, [skin], 2003; Norway: TWA 0.05 ppm (0.5 milligram per cubic meter), 1999; Poland: MAC (TWA) 0.5 milligram per cubic meter; MAC (STEL) 1.5 milligram per cubic meter, 1999; Russia: STEL 0.1 milligram per cubic meter, [skin], 1993; Sweden: NGV 0.5 milligram per cubic meter, KTV 1.5 milligram per cubic meter, [skin], 1999; Switzerland: MAK-W 0.05 ppm (0.5 milligram per cubic meter); STEL 0.1 ppm, [skin], 1999; Turkey: TWA 0.5 milligram per cubic meter, [skin], 1993; United Kingdom: TWA 0.5 milligram per cubic meter; STEL 1.5 milligram per cubic meter, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: confirmed animal carcinogen with unknown relevance to humans. The notation "skin" is added to indicate the possibility of cutaneous absorption. Russia[43] set a MAC in workplace air of 0.1 milligram per cubic meter and a MAC in ambient basis. Several states have set guidelines or standards for Pentachlorophenol in ambient air[60] ranging from zero (North Carolina) to 0.034 μ/m^3

(Massachusetts) to 1.67 μ/m^3 (New York) to 5.0 μ/m^3 (North Dakota and South Carolina) to 8.0 μ/m^3 (Virginia) to 10.0 μ/m^3 (Connecticut and South Dakota) to 12.0 μ/m^3 (Nevada and Pennsylvania) to 25.64 μ/m^3 (Kansas).

Determination in Air: Use NIOSH (IV) Analytical Method #5512, Pentachlorophenol; in blood, #8001; in urine, #8303; OSHA Analytical Method 39.

Determination in Water: Octanol-water coefficient: Log $K_{ow} = 5.0$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Permissible Concentration in Water: Safe Drinking Water Act (47FR 9352): MCL, 0.001 mg/L; MCLG, zero. State Drinking Water Guidelines: Arizona 220 μg/L; Maine 3 μg/L; Minnesota 1 μg/L. Wisconsin 100 μg/L.

Determination in Water: Methylene chloride extraction followed by gas chromatography with electron capture or halogen specific detection (EPA Method 608) or gas chromatography plus mass spectrometry (EPA Method 625). Fish Tox = 23.89351000 MATC (INTERMEDIATE) ppb.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact. Absorbed by the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Pentachlorophenol can cause liver and kidney problems. An increased risk of cancer. Pentachlorophenol irritates the eyes, skin, and respiratory tract. May affect the cardiovascular system. *Inhalation:* Levels of 1 milligram per cubic meter can cause severe irritation of the nose, throat and lungs. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Breathing dust or particulates tainted with pentachlorophenol can give rise to sneezing. *Skin:* A 0.04% solution can cause pain and inflammation at point of contact. Chloracne, a skin disorder, has been observed in workers in pentachlorophenol manufacturing plants and wood preserving operations. Profuse sweating and elevated temperature are symptoms of poisoning due to prolonged contact. Excessive skin exposure has caused human death. *Eyes:* Levels of 1 milligram per cubic meter may be irritating and excessive contact can lead to loss of sight due to corneal damage. *Ingestion:* The lethal human dose is approximately equal to 1 teaspoon for a 150 lb person. Ingestion of 4−8 ounces followed by prompt emergency treatment still produced symptoms of poisoning which included rapid breathing followed by a decrease in breathing rate, abdominal pain; reduced blood pressure; excessive and slurred speech and weakness.

Long-Term Exposure: Irritation of eyes, throat, nose and upper lungs have been reported by individuals using pentachlorophenol as an insecticide for periods of a few years. Chemical acne has been associated with prolonged exposure to this compound. May affect the CNS; kidneys, liver, lungs. May be a carcinogen in humans. May damage the developing fetus. There is limited evidence that pentachlorophenol is a teratogen in animals. Tumors have been detected in experimental animals. Human Tox = 1.00000 ppb MCL (HIGH).

Points of Attack: Eyes, skin, respiratory system; cardiovascular system, liver, kidneys, CNS. Cancer site in animals: liver.

Medical Surveillance: NIOSH lists the following tests: whole blood (chemical/metabolite); blood plasma; blood plasma, end-of-shift; blood serum; urine (chemical/metabolite); urine (chemical/metabolite), end-of-workweek; urine (chemical/metabolite), prior-to-shift; urine (chemical/metabolite), prior-to-last-shift-of-workweek. If symptoms develop or overexposure is suspected, the following may be useful: Urine test for pentachlorophenol. Liver and kidney function tests. Refer to the NIOSH Criteria Documents #78-174 and #76-147, *Manufacturing, formulating, and working safely with pesticides.*

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Nitrile, polyvinyl chloride, and Tychem (from E.I. du Pont de Nemours & Company) are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use SCBA > 1.4 milligram per cubic meter. NIOSH: *2.5 milligram per cubic meter:* CcrOv95 (APF = 10) [any air-purifying half-mask respirator with organic vapor cartridge(s) in combination with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or PaprOvHie (APF = 25) (any powered air-purifying respirator with an organic vapor cartridge in combination with a high-efficiency particulate filter); or Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) (any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister having an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Pentachlorophenol must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine) because violent reactions occur. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN3155 Pentachlorophenol, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire (The material itself does not burn). Thermal decomposition products may include hydrogen chloride, chlorinated phenol, chlorine, and oxides of carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire-fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office. Incineration (600° to 900°C) coupled with acequate scrubbing and ash disposal facilities[22]. Alternatively pentachlorophenol in wastewaters, for example, may be recovered and recycled.

References

(109); (102); (31); (173); (101); (138); (80); (100).

United States Environmental Protection Agency, Pentachlorophenol: Ambient Water Quality Criteria, Washington, DC (1980)

Rao, K. R., Ed., Pentachlorophenol: Chemistry, Pharmacology and environmental Toxicology, Proceedings of a Symposium, Pensacola, FL, June 1977, New York, Plenum Press (1978)

United States Environmental Protection Agency, Pentachlorophenol, Health and Environmental Effects Profile No. 143, Office of Solid Waste, Washington, DC (April 30, 1980)

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 3, No. 4, 73−77 (1983) and 4, No. 3, 24−26 (1984)

United States Public Health Service, "Toxicological Profile for Pentachlorophenol," Atlanta, Georgia, agency for Toxic Substances and Disease Registry (December 1988)

United States Environmental Protection Agency, Chemical Hazard Information Profile: Pentachlorophenol, Washington, DC, Chemical Emergency Preparedness Program (October 31, 1985)

New York State Department of Health, *Chemical Fact Sheet:* Pentachlorophenol, Bureau of Toxic Substance Assessment, Albany, NY (Version 2-March 1986 and Version 3)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Pentachlorophenol, Trenton, NJ (August 2002)

Pentaerythritol P:0250

Formula: $C_5H_{12}O_4$; $C(CH_2OH)_4$

Synonyms: 2,2-bis(Hydroxymethyl)-1,3-propanediol; Methane tetramethylol; Monopentaerythritol; PE; Pentaerythrite; Tetrahydroxymethylmethane; Tetramethylolmethane

CAS Registry Number: 115-77-5

HSDB Number: 872
RTECS Number: RZ2490000
UN/NA & ERG Number: UN1987 Alcohols, n.o.s., Hazard Class: 3; Labels: 3-Flammable liquid.
EC Number: 204-104-9
Regulatory Authority and Advisory Information
Hazard Alert: Combustible, Irritant (eye and upper resp.).
Hazard Symbols, Risk & Safety statements: Hazard Symbol: Xi; Risk phrases: R36/37; Safety phrases: S23; S24; S45 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Pentaerythritol is a white crystalline solid. Odorless. Molecular weight = 136.17; Specific gravity (H_2O:1) = 1.38; Boiling point = (sublimes) 276°C @30 mmHg; Freezing/Melting point = (sublimes) 262°C; Vapor pressure = 8×10^{-8} mmHg @ 25°C. Flash point = ~150°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 2, Reactivity 0. Slightly soluble in water; 6% @ 15°C.

Potential Exposure: Pentaerythritol is used in coatings and stabilizers; in the formation of alkyd resins and varnishes. It is used as an intermediate in the manufacture of plasticizers, explosives (PETN),and pharmaceuticals.

Incompatibilities: Dust may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong acids, organic acids, strong bases. Aquesous solution is acidic. Explosive compound is formed when a mixture of Pentaerythritol and thiophosphoryl chloride (CAS 3892-91-0) is heated.

Permissible Exposure Limits in Air:
OSHA PEL: 15 milligram per cubic meter (total inhalable dust) TWA; 5 milligram per cubic meter TWA, respirable fraction
NIOSH REL: 10 milligram per cubic meter (total inhalable dust) TWA; 5 milligram per cubic meter TWA, respirable fraction
ACGIH TLV[1]: 10 milligram per cubic meter TWA
Protective Action Criteria (PAC) Ver. 29[138]
PAC-1: 30 milligram per cubic meter
PAC-2: 90 milligram per cubic meter
PAC-3: 540 milligram per cubic meter
Australia: TWA 10 milligram per cubic meter, 1993; Belgium: TWA 10 milligram per cubic meter, 1993; Finland: TWA 10 milligram per cubic meter; STEL 20 milligram per cubic meter, 1999; France: VME 10 milligram per cubic meter, 1999; United Kingdom: TWA 10 milligram per cubic meter; STEL 20 milligram per cubic meter, total inhalable dust; TWA 4 milligram per cubic meter, respirable dust, 2000; the Netherlands: MAC-TGG 10 milligram per cubic meter (total dust), 2003; the Netherlands: MAC-TGG 5 milligram per cubic meter (respirable dust), 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 10 milligram per cubic meter. States which have set guidelines or standards for pentaerythritol in ambient air[60] include Virginia @ 80 μ/m^3 and Connecticut @ 300 μ/m^3.

Determination in Air: Use NIOSH IV Method #0500, total dust; Method #0600 (respirable dust), Particulates NOR.

Permissible Concentration in Water: Russia[43] set a MAC in water bodies used for domestic purposes of 0.1 mg/L.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms
Short-Term Exposure: Irritates the eyes and respiratory system. Feeding studies using human volunteers showed that 85% of Pentaerythritol fed was eliminated unchanged in the urine within 30 hours. There are, in general, no significant effects on health by common routes of exposure even at abnormal use concentrations.

Points of Attack: Eyes, respiratory system.

Medical Surveillance: There is no special test for this chemical. However, if illness occurs or overexposure is suspected, medical attention is recommended.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use dust respirator.

Storage: Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area away from organic acids, oxidizers.

Shipping: UN1987 Alcohols, n.o.s., Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include oxides of carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

Pentaerythritol Tetranitrate P:0255

Formula: $C_5H_8N_4O_{12}$; $C(CH_2ONO_2)_4$

Synonyms: Angicap; Angitet; Cardiacap; 1,3-Dinitrato-2,2-bis(nitratomethyl)propane; Nitropenta; Pentaerythrite tetranitrate; Pentaerithrityl tetranitrate; Pentaerithrityltetranitrat (German); Pentrita (Spanish); PETN; 1,3-Propanediol,2,2-bis[(nitrooxy) methyl]-, dinitrate (ester); Tetranitrato de pentaeritritilo (Spanish); Tétranitrate de pentaerithrityle (French); Vasitol; Vasodiatol

CAS Registry Number: 78-11-5; *(alt.)* 103842-90-6; *(alt.)* 108736-71-6

HSDB Number: 6313

RTECS Number: RZ2620000

UN/NA & ERG Number: UN0150 (Pentaerythrite tetranitrate, wetted or Pentaerythritol tetranitrate, wetted, or PETN, wetted or Pentaerythrite tetranitrate, or Pentaerythritol tetranitrate or PETN, desensitized)/112; UN3344 (Pentaerythrite tetranitrate mixture, desensitized, solid, n.o.s. with >10 % but not >20% PETN, by mass)/113

EC Number: 201-084-3 [*Annex I Index No.:* 603-035-00-5; 603-035-01-2]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 5000 (commercial grade).; *Theft hazard* 400 (commercial grade).

Hazard Alert: Explosive (when dry), Unstable chemical, Strong Oxidizer, Possible risk of forming tumors, Suspected of causing genetic defects.

Chemicals Subject to TSCA 12(b) Export Notification Requirements, Section 4 (1%)

Hazard Symbols, Risk & Safety statements: Hazard Symbol: E, O; Risk phrases: R1; R2; R3; R5; R8; R17; R62; Safety phrases: S1; S2; S35; S41 (see Appendix 4).

Description: Pentaerythrite tetranitrate (PETN) is a high explosive, especially when dry. PETN is a sand-like, white crystalline solid. Piratically odorless. Molecular weight = 316; Specific gravity (H_2O:1) = 1.8 @ 20°C; Boiling point = 205−215°C (explodes); Vapor pressure = negligible; 1.04×10^{-10} mmHg @ 25°C; 1.035×10^{-10} mmHg @ 25°C. Density 1.75−1.77 g/cm^3. Freezing/Melting point = 138−140°C. Autoignition temperature = (explodes) 210°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2; Flammability, 2; Reactivity, 4. Solubility in water = 4.3 mg/100 g @ 25°C. The principal hazard from PETN is blast from sudden and abrupt explosion; not from ruptured or bursting container fragments or rocketing projectiles.

Potential Exposure: First introduced following WWII, PETN shares the same chemical family as nitroglycerine. It is 70% more powerful than TNT. Used in the manufacture of fuses for detonation and explosive specialties, including the plastic explosive, Semtex, and in blasting caps. PETN is also used as a medical vasodilator to lower blood pressure by widening blood vessels to improve blood flow. PRTN has been used in terrorism attempts in 2001 by the so-called "shoe bomber," in 2009 by the "underwear bomber," and most recently in October 2010, hidden in printer cartridges being shipped internationally by passenger jet.

Incompatibilities: Treat PETN as an unstable explosive. Rapid heating can cause detonation when heated to 210°C. PETN is a dangerous high explosive and a strong oxidizer. PETN normally requires a blasting cap or other kind of detonator but may decompose explosively from concussion, shock, friction, static charges. Keep away from combustible materials; other oxidizers, for example, nitrates and permanganates. Contact with sulfur trioxide may cause detonation. Contact with reducing agents, e.g., zinc and alkaline metals may cause explosion. May explode in the presence of strong bases (i.e., sodium or potassium hydroxide). May react with heavy metals.

Permissible Exposure Limits in Air:

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 5 milligram per cubic meter

PAC-2: 55 milligram per cubic meter

PAC-3: 330 milligram per cubic meter

If material is mixed with TNT, see entry T:0920.

Determination in Air: NIOSH method not established. If material is mixed with TNT, see entry T:0920.

Determination in Water: Octanol-water coefficient: Log $K_{ow} = 1.60$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation of dust, fume, or vapor; ingestion of dust; percutaneous absorption from dust, skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Corrosive and highly irritating. Target organs are the skin and heart. Contact irritates the eyes, nose and throat. Can penetrate the skin. Exposure can cause red eyes, dizziness, irritability, headache, convulsions, nausea, vomiting.

PETN is a vasodialator and can affect the cardiovascular system, resulting in widening of blood vessels and the lowering of blood pressure. Medical care is advised.

Long-Term Exposure: Lowest published toxic dose (oral, man): 1669 mg/kg/8 year-continuous. [British Journal of Dermatology (87,498,1972)].

Medical Surveillance: If material is mixed with TNT, see entry T:0920.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Polyvinyl chloride is among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. The Webster skin test (colorimetric tests with alcoholic sodium hydroxide) or indicator soap should be used to make sure workers have washed all PETN off their skins.

Respirator Selection: 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100].; or Any air-purifying full facepiece respirator equipped with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100; or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter); or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter); or Any supplied-air respirator with a full facepiece that is operated in a pressure-demand or other positive-pressure mode. *Emergency or planned entry into unknown concentrations or IDLH conditions:* SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Check oxygen content prior to entering storage area. An explosive and a strong oxidizer. Color code-Red Stripe: Flammability Hazard: Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 meters or a 1-hour fire wall from flammable or reactive materials. Store flammable solids up to maximum allowable quantity per control area in an approved flammable storage area. Do not store in a basement. Store in a explosion-proof refrigerator and keep away from reducing agents[52]. Store in a cool, dark place in a airtight container, separately from all other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 meters or a 1-hour fire wall from flammable or reactive materials. Unless specified by manufacturer, store between 15 and 30°C. Protect from light. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Keep material wet with water and treat as an explosive. Keep away from heat, sources of ignition; metal, nitric acid; and reducing materials. Protect containers from shock. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Store in a cool, well ventilated area away from incompatible materials listed above. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage.

Shipping: UN3344 Pentaerythrite tetranitrate mixture, desensitized, solid, n.o.s. with >10% but not >20% PETN, by mass, Hazard Class: 4.1; Labels: 4.1-Flammable solid. UN0150 Pentaerythrite tetranitrate, wetted or Pentaerythritol tetranitrate, wetted, or PETN, wetted or Pentaerythrite tetranitrate, or Pentaerythritol tetranitrate or PETN, desensitized, Hazard Class: 1D; Labels:1D-Explosive (with a mass explosion hazard); D-Substances or articles which may mass detonate (with blast and/or fragment hazard) when exposed to fire.

Spill Handling: Seek expert help or contact manufacturer. Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen spilled material with water to avoid dust. Do not wash material to sewer. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Collect waste material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Seek expert help or contact manufacturer. This chemical is a dangerously explosive solid and a strong oxidizer. It will increase the activity of an existing fire. The major hazard from PETN is the blast from sudden and abrupt explosion; not necessarily from ruptured or bursting container fragments or rocketing projectiles. Thermal decomposition products incluse oxides of nitrogen and carbon. If material is on fire and conditions permit, do not extinguish. Evacuate area and let burn. Cool exposures using unattended monitors. If fire must be extinguished, use any agent appropriate for the burning material.If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Seek expert help with this explosive material. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. governing storage, transportation, treatment, and waste disposal.

References

(31); (173); (101); (138).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Pentaerythrite tetranitrate, Trenton, NJ October 2001

Chang, Kenneth, The New York Times news article, *Explosive on Planes Was Used in Past Plots*, New York, NY November 31, 1010.

Pentane P:0260

Formula: C_5H_{12}

Synonyms: Amyl hydride; Normalpentane; *n*-Pentane; *normal*-Pentane; *n*-Pentano (Spanish); Skellysolve-A

CAS Registry Number: 109-66-0

HSDB Number: 109

RTECS Number: RZ9450000

UN/NA & ERG Number: UN1265/128

EC Number: 203-692-4 [*Annex I Index No.:* 601-006-00-1]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Hazard Alert: Highly flammable, Environmental hazard.

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long lasting effects[293]. Toxic to aquatic life with long lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: F+, Xn, N; Risk phrases: R12; R51/53; R65; R66; R67; Safety phrases: S1; S2; S9; S16; S29; S33; S35; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Pentane is a colorless liquid. Gas above 36°C. Gasoline-like odor. Molecular weight = 72.2; Specific gravity (H_2O:1) = 0.63; Boiling point = 36°C; Freezing/Melting point = −130°C; Vapor pressure = 420 mmHg @ 25°C; 400 mmHg @ 18.5°C; Flash point = −49.4°C (cc); Autoignition temperature = 260°C; also listed @ 284 and 309°C. Explosive limits: LEL = 1.4%; UEL: 7.8%. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 4, Reactivity 0. Slightly soluble in water.

Potential Exposure: Pentane is used in manufacture of ice, low-temperature thermometers; in solvent extraction processes; as a blowing agent in plastics; as a fuel; as a chemical intermediate (for amylchlorides, e.g.).

Incompatibilities: Vapors may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Attacks some plastics, rubbers, and coatings.

Permissible Exposure Limits in Air:

NIOSH IDLH = 1500 ppm [LEL]

Conversion factor: 1 ppm = 2.95 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 1000 ppm/2950 milligram per cubic meter TWA

NIOSH REL: 120 ppm/350 milligram per cubic meter TWA; 610 ppm/1,800 milligram per cubic meter [15 min.] Ceiling Concentration

ACGIH TLV[1]: 600 ppm/1770 TWA

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 3000 ppm

PAC-2: 33,000 ppm

PAC-3: 2.00E + 05 ppm

DFG MAK: 1000 ppm/3000 milligram per cubic meter TWA; Peak Limitation Category II(2); Pregnancy Risk Group C

Australia: TWA 600 ppm (1800 milligram per cubic meter); STEL 750 ppm, 1993; Austria: MAK 600 ppm (1899 milligram per cubic meter), 1999; Belgium: TWA 600 ppm (1770 milligram per cubic meter); STEL 750 ppm (2210 milligram per cubic meter), 1993; Denmark: TWA 500 ppm (1500 milligram per cubic meter), 1999; Finland: TWA 500 ppm (1500 milligram per cubic meter); STEL 625 ppm (1800 milligram per cubic meter), 1999; France: VME 600 ppm (1800 milligram per cubic meter), 1999; Hungary: TWA 500 milligram per cubic meter; STEL 1500 milligram per cubic meter, 1993; the Netherlands: MAC-TGG 1800 milligram per cubic meter, 2003; the Phillipines: TWA 1000 ppm (2950 milligram per cubic meter), 1993; Poland: MAC (TWA) 1800 milligram per cubic meter; MAC (STEL) 2300 milligram per cubic meter, 1999; Russia: TWA 300 ppm; STEL 300 milligram per cubic meter, 1993; Sweden: NGV 600 ppm (1800 milligram per cubic meter), KTV 750 ppm (2000 milligram per cubic meter), 1999; Switzerland: MAK-W 600 ppm (1800 milligram per cubic meter), 1999; Turkey: TWA 1000 ppm (2950 milligram per cubic meter), 1993; United Kingdom: LTEL 600 ppm (1800 milligram per cubic meter); STEL 750 ppm, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 600 ppm. Russia[43] set a MAC in ambient air in residential areas of 100 milligram per cubic meter on a momentary basis and 25 milligram per cubic meter on an average daily basis. Several states have set guidelines or standards for pentane in ambient air[60] ranging from 7.0 milligram per cubic meter (Connecticut) to 18.0−22.5 milligram per cubic meter (North Dakota) to 30.0 milligram per cubic meter (Virginia) to 42.857 milligram per cubic meter (Nevada).

Determination in Air: Use NIOSH Analytical Method #1500, Hydrocarbons, BP 36-126°C; #2549, Volatile organic compounds[18].

Determination in Water: Octanol-water coefficient: Log $K_{ow} = > 3$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Pentane can affect you when breathed in. Exposure can cause lightheadedness and dizziness and may cause you to pass out. It may damage the nervous system; causing numbness, “pins and needles,” and weakness in the arms and legs. Skin contact may cause rash and a burning sensation.

Long-Term Exposure: Repeated or prolonged contact can cause dry, cracked skin.

Points of Attack: Eyes, skin, respiratory system; and CNS.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: examination of the nervous system. Nerve conduction studies should be considered.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Viton is among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *1200 ppm:* Sa (APF = 10) (any supplied-air respirator). *1500 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code-Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration is not a danger. Pentane must be stored to avoid contact with strong oxidizers (such as chlorine and bromine) because violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where pentane is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of pentane should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of pentane.

Shipping: UN1265 Pentanes Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Oil-skimming equipment and sorbent foams can be applied to slick if done immediately. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (100).

National institute for Occupational Safety and Health (NIOSH), "Criteria for a Recommended Standard: Occupational(2). Exposure to Alkanes," NIOSH Document Number 77-151, Cincinnati OH (1977)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Pentane, Trenton, NJ (February 2000)

2,4-Pentanedione P:0270

Formula: $C_5H_8O_2$: $CH_3COCH_2COCH_3$

Synonyms: Acetoacetone; Acetyl acetone; Diacetylmethane; Pentane-2,4-dione; 2-Propanone, acetyl

CAS Registry Number: 123-54-6; 81235-32-7

HSDB Number: 2064 as acetyl acetone

RTECS Number: SA1925000

UN/NA & ERG Number: UN2310/131

EC Number: 204-634-0 [*Annex I Index No.:* 606-029-00-0]

Regulatory Authority and Advisory Information

Hazard Alert: Highly flammable, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction).

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

European/International Regulations (*23-54-6*): Hazard Symbol: F+, Xn; Risk phrases: R11; R22; R62; R63; Safety phrases: S2; S21; S23; S24/25; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: 2,4-Pentanedione is a colorless to yellowish liquid with a sour, rancid odor. The Odor Threshold is 0.01 ppm. Molecular weight = 100; Specific gravity (H_2O:1) = 0.97 @ 20°C; Boiling point = 139°C; Freezing/Melting point = −23°C; Flash point = 34°C; Autoignition temperature = 340°C. Explosive limits: LEL = 2.4%; UEL: 11.6%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 0. Soluble in water.

Potential Exposure: Acetoacetic acid derivative. 2,4-Pentanedione is used in gasoline and lubricant additives, fungicides, insecticides, and colors manufacture; as a chemical intermediate and in the manufacture of metal chelates.

Incompatibilities: Vapors may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. reducing agents; halogens, aliphatic amines; alkanolamines, organic acids; isocyanates. Strong light may cause polymerization.

Permissible Exposure Limits in Air:

ACGIH TLV[1]: 25 ppm TWA [skin]

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 75 ppm

PAC-2: 110 ppm

PAC-3: 200 ppm
DFG MAK: 20 ppm/83 milligram per cubic meter TWA; skin absorption, Peak Limitation Category II(2) [skin]; Pregnancy Risk Group C

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin, and respiratory tract. Eye irritation may be severe. May affect the nervous system. If inhaled, will cause dizziness, coughing, headaches, convulsions, loss of consciousness and possible death. In addition, to neuropathy, 2,4-pentanedione causes thymic atrophy; it complexes with and inhibits the activities of oxidizing enzymes; it causes minor to severe eye injury and minor to moderate skin irritation in animals; and it has caused contact urticaria and allergic contact dermatitis in humans.

Long-Term Exposure: Repeated or prolonged contact may cause skin sensitization and allergy. High exposure may affect the brain. May affect the lungs, thymus, CNS. There is limited evidence of reproductive damage and mutations.

Points of Attack: Skin, brain, lungs, CNS; thymus, lungs.

Medical Surveillance: Evaluation by a qualified allergist. Evaluation of brain effects. Thymus function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration is not a danger. Store in stainless steel containers away from oxidizers, reducing agents; bases. Where possible, automatically pump liquid from drums or other storage containers to process containers Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN2310 Pentane-2,4-dione, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; alcohol foam; or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming),

withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 7, 25–26 (1981) (as Acetylacetone)

United States Environmental Protection Agency, Chemical Hazard Information Profile Draft Report: Pentanedione, Washington, DC, Office of Toxic Substances (August 25, 1988)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Pentane-2,4-dione, Trenton, NJ (August 1999)

1-Pentene P:0280

Formula: C_5H_{10}; $CH_3(CH_2)_2CH{=}CH_2$

Synonyms: Amylene; α-*n*-Amylene; Pentene; Pentylene; Propylethylene

CAS Registry Number: 109-67-1; *(alt.)* 25377-72-4

HSDB Number: 1086

RTECS Number: SB2179000

UN/NA & ERG Number: UN1108/128

EC Number: 246-916-6

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 ($\geq$1.00% concentration).

Hazard Alert: Extremely flammable, Possible polymerization hazard (heat), Environmental hazard.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: F+, T, N, Xi, Xn; Risk phrases: R5; R12; R36/37/38; R39/25; R51; R52/53; Safety phrases: S1; S7; S16; S26; S29; S36/37; S45; S61; S62 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Pentene is a colorless liquid. Molecular weight = 70.1; Specific gravity (H_2O:1) = 0.64 @ 20°C; Boiling point = 30°C; Freezing/Melting point = −165°C; Vapor pressure = 70.81 kPa @ 20°C; Flash point = −18°C; Autoignition temperature = 276°C. Explosive limits: LEL = 1.5%; 24,000 ppm[138]; UEL: 8.7%. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 4, Reactivity 1.

Potential Exposure: Workers in petroleum refineries and petrochemical plants.

Incompatibilities: Vapors may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Excessive heat may cause polymerization. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, heat. Incompatible with strong reducing agents such as hydrides; oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air:

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 120 ppm

PAC-2: 1300 ppm

PAC-3: 7700 ppm [> = 10% LEL, lower explosive limit but <50% LEL]

Russia[43] set a MAC for amylene in ambient air of residential areas @ 1.5 milligram per cubic meter both on a momentary and a daily average basis.

Determination in Water: Octanol-water coefficient: Log $K_{ow} = 2.8$. Values above 3.0 are likely to bioaccumulate in aquatic organisms.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Simple asphyxiant. Narcotic in high concentrations. May affect CNS. Moderately toxic by oral and inhalation routes.

Long-Term Exposure: There is no special test for this chemical. However, if illness occurs or overexposure is suspected, medical attention is recommended.

Points of Attack: Skin, eyes, respiratory tract, and nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Use protective gloves and safety goggles. Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/

clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area away from oxidizers. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration is not a danger. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1108 1-Pentene, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBA that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 2, No. 6, 69−71 (1982) and 3, No. 2, 56−57 (1983)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: n*-Pentene, Trenton, NJ (March 2007)

Peracetic Acid P:0290

Formula: $C_2H_4O_3$; CH_3COOOH

Synonyms: Acetic peroxide; Acetyl hydroperoxide; Acide peracetique (French); Acido peracetico (Spanish); Desoxon 1; Estosteril; Ethaneperoxoic acid; Hydrogen peroxide and peroxyacetic acid mixture; Hydroperoxide, acetyl; Monoperacetic acid; Osbon AC; Oxymaster; PAA; Peroxyacetic acid; Proxitane; Proxitane 4002

CAS Registry Number: 79-21-0

HSDB Number: 1106

RTECS Number: SD8750000

UN/NA & ERG Number: UN3107/145

EC Number: 201-186-8 [*Annex I Index No.:* 607-094-00-8]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Hazard Alert: Flammable, Possible risk of forming tumors, Primary irritant (w/o allergic reaction), Environmental hazard, Highly Reactive Substance and Explosive[15].

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg)

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500 lb (227 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 500 lb (227 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long lasting effects[291]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: F+, O, C, N; Risk phrases: R3; R5; R7, R10; R12; R20/21/22; R23/24/25; R34; R35; R51; Safety phrases: S1/2; S3/7; S14; S23; S26; S27; S29; S36/37/39; R45; R60; R61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Peracetic acid is a colorless liquid. Transported and stored in diluted solution with acetic acid and hydrogen peroxide to prevent explosion. Molecular weight = 76.06; Specific gravity (H_2O:1) = 1.2; Boiling point = 105°C (violent decomposition @ 110°C); Freezing/Melting point = 0.1°C; Flash point = 41.3°C (oc); 56°C (32% in dilute acetic acid and <6% hydrogen peroxide); Autoignition temperature = 198°C; Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 2 (Oxidizer). Soluble in water.

Incompatibilities: This material is a powerful oxidizer. Thermally unstable, it decomposes violently @ 110°C. Concentrated material is shock-and friction-sensitive. May explode if concentration exceeds 56% of carrier, due to evaporation. Isolate from other stored material, particularly accelerators, oxidizers, organic or combustible materials, olefins, hydrogen peroxide, acetic anhydride, reducing substances. Keep away from acids, alkalies, heavy metals, organic materials

Potential Exposure: This compound is used as polymerization initiator, curing agent; and cross-linking agent; as bactericide and fungicide, especially in food processing; a reagent in making caprolactam and glycerol; an oxidant for preparing epoxy compounds; a bleaching agent; a sterilizing agent; and a polymerization catalyst for polyester resins.

Incompatibilities: This material is a powerful oxidizer. Thermally unstable, it decomposes violently @ 110°C. Concentrated material is shock-and friction-sensitive. May explode if concentration exceeds 56% of carrier, due to evaporation. Isolate from other stored material, particularly accelerators, oxidizers, organic or combustible materials; olefins, hydrogen peroxide, acetic anhydride, reducing substances. Keep away from acids, alkalis, heavy metals; organic materials.

Permissible Exposure Limits in Air:

Protective Action Criteria (PAC)* Ver. 29[138]

PAC-1: $\mathbf{0.52}_{\mathbf{A}}$ milligram per cubic meter

PAC-2: $\mathbf{1.6}_{\mathbf{A}}$ milligram per cubic meter

PAC-3: $\mathbf{15}_{\mathbf{A}}$ milligram per cubic meter

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

DFG MAK: Carcinogen Category 3B; See section X(a)

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Eye contact can cause severe irritation and burns; may cause permanent damage. Irritates the respiratory tract. Contact may burn the skin. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Signs and symptoms of acute ingestion of peracetic acid may include corrosion of mucous membranes of mouth, throat, and esophagus with immediate pain and dysphagia (difficulty in swallowing); ingestion may cause gastrointestinal tract irritation. This is a very toxic compound. The probable human oral lethal dose is 50−500 mg/kg, or between 1 teaspoon and 1 ounce for a 150 lb persons.

Long-Term Exposure: There is limited evidence that peracetic acid causes cancer in animals. It may cause cancer of the lungs. High or repeated exposure may affect the liver and kidneys.

Points of Attack: Liver, kidneys, lungs.

Medical Surveillance: Liver and kidney function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water, or milk. Do not induce vomiting. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/

manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Butyl rubber and Viton are recommended. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Where there is no REL, at any detectable concentration:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]; CcrFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted acid gas canister]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Check oxygen content prior to entering storage area. Color code-Red Stripe: Flammability Hazard: Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 meters or a 1-hour fire wall from flammable or reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Keep in a cool, well-ventilated area, separated from organic and combustible materials. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Store in a cool, well ventilated area away from incompatible materials listed above. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage.

Shipping: UN3107 Organic peroxide type E, liquid, Hazard Class: 5.2; Labels: 5.2-Organic peroxide, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Avoid breathing vapors. Do not touch the spilled material; shut off all ignition sources and stop the leak if this can be done without risk. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Do not use spark-generating metals or organic materials for sweeping up or handling spilled material. Dispose of the absorbed peroxyacetic acid solution, in small quantities at a time, by placing it on the ground in a remote outdoor area and igniting with a long torch. Empty containers should be washed with a 10% sodium hydroxide solution. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid and a powerful oxidizer that can increase the activity of an existing fire. It explodes @ 230°F/110°C and is shock-sensitive, particularly if organic solvents are used in place of acetic acid as a carrier. Thermal decomposition products may include oxides of carbon. Fight fires from an explosion-resistant location. In advanced or massive fires, area should be evacuated. For small fires: use dry chemical, carbon dioxide; water spray; or foam. For large fires: flood area with water. If fire occurs in the vicinity of this compound, water should be used to keep containers cool. Cleanup and salvage operations should not be attempted until all of the peroxyacetic acid solution has cooled completely. Keep unnecessary people away; wear SCBA and full protective clothing. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions.

If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Peracetic Acid, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

(173); (101); (138).

New York State Department of Health, *Chemical Fact Sheet:* Peracetic Acid, Bureau of Toxic Substance Assessment, Albany, NY (April 1986)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Peroxyacetic acid, Trenton, NJ (October 2004)

Perchloromethyl Mercaptan P:0300

Formula: CCl_4S; CCl_3SCl

Synonyms: Clairsit; Mercaptan methylique perchlore (French); Perchloromethanethiol; PMM; Trichloromethane sulfenyl chloride; Trichloromethylsulfenyl chloride; Trichloromethyl sulfur chloride; Trichloromethylsulphenyl chloride PCV

CAS Registry Number: 594-42-3

HSDB Number: 886

RTECS Number: PB0370000

UN/NA & ERG Number: (PIH) UN1670 (inhalation zone B)/157

EC Number: 209-840-4

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Hazard Alert: Poison inhalation hazard, Extremely flammable; Corrosive (skin), Primary irritant (w/o allergic reaction), Environmental hazard.

OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 150 lb (67.5 kg)

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: F+ T+, N; Risk phrases: R21; R23/24/25; R26; R27/28; R34; R50/53 Safety phrases: S1; S7/9; S25; S26; S28; S29/35; S36/37/39; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Perchloromethyl mercaptan is a pale yellow oily liquid with a foul-smelling, unbearable, acrid odor. Molecular weight = 185.9; Specific gravity (H_2O:1) = 1.7 @ 20°C; Boiling point = (decomposes) 149°C; Vapor pressure = 3 mmHg @ 20°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Insoluble in water.

Potential Exposure: Perchloromethyl mercaptan is used as an intermediate for the synthesis of dyes and fungicides, such as Captan and Folpet. This chemical has been considered as a warfare tear gas because of its highly irritant properties.

Incompatibilities: Water contact forms HCl, sulfur and carbon dioxide. Reacts with alkalies, amines, hot water; alcohols, oxidizers, reducing agents; iron, and steel. Attacks most metals.

Permissible Exposure Limits in Air:

NIOSH IDLH = 10 ppm

Conversion factor: 1 ppm = 7.60 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 0.1 ppm/0.8 milligram per cubic meter TWA

NIOSH REL: 0.1 ppm/0.8 milligram per cubic meter TWA

ACGIH TLV[1]: 0.1 ppm/0.76 milligram per cubic meter TWA

Protective Action Criteria (PAC)* Ver. 29[138]

PAC-1: $\mathbf{0.013_A}$ ppm

PAC-2: $\mathbf{0.30_A}$ ppm

PAC-3: $\mathbf{0.90_A}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

Australia: TWA 0.1 ppm (0.8 milligram per cubic meter), 1993; Austria: MAK 0.1 ppm (0.8 milligram per cubic meter), 1999; Belgium: TWA 0.1 ppm (0.76 milligram per cubic meter), 1993; Denmark: TWA 0.1 ppm (0.8 milligram per cubic meter), 1999; Finland: STEL 0.1 ppm (0.8 milligram per cubic meter), 1999; France: VME 0.1 ppm (0.8 milligram per cubic meter), 1999; Norway: TWA 0.1 ppm (0.8 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 0.8 milligram per cubic meter, 2003; Switzerland: MAK-W 0.1 ppm (0.8 milligram per cubic meter), KZG-W 0.2 ppm, 1999; Turkey: TWA 0.1 ppm (0.8 milligram per cubic meter), 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 0.1 ppm. Several states have set guidelines or standards for PMM in ambient air[60] ranging from 8.0 μ/m^3 (North Dakota) to 13.0 μ/m^3 (Virginia) to 16.0 μ/m^3 (Connecticut) to 19.0 μ/m^3 (Nevada).

Determination in Air: Sample collection by charcoal tube, analysis by gas liquid chromatography.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin, and respiratory tract. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Signs and symptoms of acute exposure to perchloromethyl-mercaptan may lead to liver, heart, and kidney damage. Respiratory effects include coughing, dyspnea (shortness of breath), painful breathing; and lung congestion. Tachycardia (rapid heart rate) is often observed. Nausea, vomiting, abdominal cramping and diarrhea may also occur. Contact with Perchloromethyl mercaptan may result in severe dermatitis (red, inflamed skin), conjunctivitis (red, inflamed eyes), and burns with ulceration and severe pain. May cause death or permanent injury after short exposure to small quantities. Brief exposure to lower concentrations may produce CNS depression and lung, liver, and heart congestion. Severe exposures may be fatal. May be absorbed through the skin in quantities sufficient to cause general toxic effects. Ingestion may cause damage to mucous membranes and result in pain and burning of the mouth and throat; nausea, vomiting, cramps, and diarrhea. In severe cases, tissue ulceration and CNS depression may occur.

Medical Surveillance: NIOSH lists the following tests: Blood Gas Analysis; chest X-ray, electrocardiogram, liver function tests; pulmonary function tests; pulmonary function tests: forced vital capacity, forced expiratory volume (1 sec); sputum cytology; urinalysis (routine); white blood cell count/differential.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 1 ppm:* CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)];* Sa (APF = 10) (any supplied-air respirator).* *Up to 2.5 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode);* PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)].* *Up to 5 ppm:* CcrFOv (APF = 50) [any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s)]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or PaprTOv (APF = 50) [any powered, air-purifying respirator with a tight-fitting facepiece and organic vapor cartridge(s)];* or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode);* or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 10 ppm:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA). *Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Poison inhalation chemical (PIH); check oxygen content prior to entering storage area. Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in a cool, dry place. Protect from moisture, metals, oxidizing and reducing agents. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1670 Perchloromethyl mercaptan, Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Inhalation Hazard Zone B.

Spill Handling:

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30

Then: Protect persons downwind (miles/kilometers)

Day 0.2/0.3

Night 0.2/0.3

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 300/100

Then: Protect persons downwind (miles/kilometers)

Day 0.5/0.8

Night 0.9/1.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. It may be necessary to seek emergency assistance.

Fire Extinguishing: Thermal decomposition products may include hydrogen chloride and sulfur oxides. Fight small fires with dry chemical, carbon dioxide; water spray; or foam, and large fires with water spray, fog, or foam. Move containers containing this compound away from fire area if possible. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Positive pressure breathing apparatus and special protective clothing should be worn. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration together with a flammable solvent in a furnace equipped with afterburner and scrubber.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Perchloromethyl Mercaptan, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Perchloromethyl Mercaptan, Trenton, NJ (Februrary 2000).

Phenmedipham P:0335

Formula: $C_{16}H_{16}N_2O_4$

Synonyms: Aimsan; Betamix (phenmedipham + desmedipham); Betanal; Carbamic acid, (3-methylphenyl)-, 3-[(methoxycarbonyl)amino]phenyl ester; Carbanilic acid, *m*-methyl-, ester with methyl-*m* -hydroxycarbanilate (8CI); CQ 1451 (phenmedipham + desmedipham + ethofumesate); EC herbicide (phenmedipham + desmedipham + ethofumesate); EP 452; Fenmedifam; Carbanilic acid, *m*-hydroxy-, methyl ester, *m*-methylcarbanilate (ester) (8CI); *m*-Hydroxycarbanilic acid methyl ester *m*-methylcarbanilate; Keeper; Kemifam; 3-[(Methoxycarbonyl)amino]phenyl *N*-(3-methylphenyl)carbamate; Methyl *m*-hydroxycarbanilate *m*-methylcarbanilate; 3-(Methylphenyl)carbamic acid 3-[(methoxycarbonyl)amino]phenyl ester; Methyl 3-(*m*-tolylcarbamoyloxy)phenylcarbamate 3-Methoxycarbonylaminophenyl *N*-3′-methylphenylcarbamate; MSS Herbasan; NA 305 (phenmedipham + desmedipham + ethofumesate); NA 308 (phenmedipham + desmedipham + ethofumesate); Phenmediphame; Powertwin (phenmedipham + ethofumesate); Progress (phenmedipham + desmedipham + ethofumesate); S-4075;

Schering 4072; SN 38584; Spin-aid; Synbetan-p; Twin; Vangard

CAS Number: 13684-63-4

HSDB Number: 1402 as Betanal

UN/NA&ERG Number: UN2757 (Carbamate pesticides, solid, toxic)/151; UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

RTECS Number: FD9050000

EC Number: 237-199-0 [*Annex I Index No.:* 616-106-00-0]

Regulatory Authority and Advisory Information

Carcinogenicity[83]: EPA Group D, Not classifiable as a human carcinogen.

Hazard Alert: Poison, Possible neurotoxic effects (methyl carbamate), Combustible, Suspected reprotoxic hazard, Environmental hazard, Agricultural chemical.

Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: N; Risk phrases: R33; R50/53; R63; Safety phrases: S2; S29/35; S60; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water[lit.].

Description: Colorless crystalline solid, or needles; white powder. Odorless. Commercial product is available as an emulsifiable concentrate. Molecular weight = 300.31; Specific gravity (H_2O:1) = 0.28 g/cm^3 @ 20°C; Boiling point = (decomposes) 145°C; Freezing/Melting point = 139−144°C; Vapor pressure = 1×10^{-11} mmHg @ 25°C; Flash point = 75°C. Very slightly soluble in water; solubility = 1 to 5 mg/mL @ 21°C; 4.7 mg/L @ 25°C. Physical and toxicological properties may be affected by carrier solvents in commercial formulations.

Potential Exposure: A postemergence bis-carbamate/carbamate ester herbicide used to control of annual broadleaf weeds and grasses in sugar beets, spinach, strawberries, and sunflowers.

Incompatibilities: Decomposes >145°C. Esters ith acids to liberate heat along with alcohols and acids. Strong oxidizing acids may cause a vigorous reaction that is sufficiently exothermic to ignite the reaction products. Heat is also generated by the interaction of esters with caustic solutions. Flammable hydrogen is generated by mixing esters with alkali metals and hydrides. Carbamates are incompatible with reducing agents, strong acids, oxidizing acids, peroxides, and bases. Contact with active metals or nitrides cause the release of flammable, and potentially explosive, hydrogen gas. Releases oxides of nitrogen and carbon when heated to decomposition.

Determination in Water: Octanol-water coefficient: Log K_{ow} = >3.5. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Skin absorption, ingestion, inhalation

Harmful Effects and Symptoms

Short-Term Exposure: Eye pupils are small, blurred vision, eye watering, runny nose, cough, shortness of breath, salivation, nausea, stomach cramps, diarrhea, and vomiting, increased blood pressure, profuse sweating, hypermotility, hallucinations, agitation, tingling of the skin, slow heartbeat, convulsions, fluid in lungs, loss of consciousness, incontinence, breathing stops, death. Carbamates inhibit the acetylcholinesterase enzymes and alter the way in which nervous impulses are transmitted. However, within several hours carbamates spontaneously detach from the enzymes. LD_{50} (oral, rat) = >7 g/kg; LD_{50} (dermal, rat) = >2 g/kg.

Long-Term Exposure: A potent acetylcholinesterase (AChE) inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. Frequent expsure may cause liver damage. May cause skin dermatitis or allergy.

Points of Attack: Respiratory system, lungs, CNS, cardiovascular system, skin, eyes, plasma, and red blood cell cholinesterase. Evaluation by a qualified allergist, including exposure history and testing, may help diagnose allergy.

Medical Surveillance: Preliminary medical examination to detect chronic diseases of CNS, liver, heart, kidneys, lung and skin, as well as endocrinological or immunological disturbances, should protect susceptible individuals. Periodical medical examinations of internal organs, skin and eyes are important to avoid chronic occupational intoxications. They should include lab and patch tests when necessary[83]. Medical observation is recommended for 24−48 hours following breathing overexposure, as pulmonary edema may be delayed. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. Before employment and at regular times after that, the following are recommended: Plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When acetylcholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also consider complete blood count and chest X-ray following acute overexposure

First Aid: Speed in removing material from eyes and skin is of extreme importance. *Eyes:* Eye contact can cause dangerous amounts of these chemicals to be quickly absorbed through the mucous membrane into the bloodstream. Immediately and gently flush eyes with plenty of warm or cold water (NO hot water) for at least 15 minutes, occasionally lifting the upper and lower eyelids. Get medical aid immediately. *Skin:* Get medical aid. Dermal contact can cause dangerous amounts of these chemicals to be absorbed into the bloodstream. Wearing the appropriate PPE equipment and respirator for carbamate pesticides, immediately flush skin with plenty of soap and water for at least 15 minutes while removing contaminated clothing and shoes. Shampoo hair promptly if contaminated; protect eyes. *Ingestion:* Call poison control. Loosen all clothing. Never give anything by mouth to an unconscious person. Get medical aid. Do NOT induce vomiting. *If conscious, alert, and able to swallow, rinse mouth and have victim drink 4−8 ounces of water. Check to see if poison control instructs you to use ipecac syrup, otherwise administer slurry of activated charcoal (2 oz in 8 oz of water). If victim is *UNCONSCIOUnited States OR HAVING CONVULSIONS*, do nothing except keep victim warm. **In some cases you may be specifically instructed by poison control to induce vomiting by way of 2 tablespoons of syrup of ipecac (adult) washed down with a cup of water.* Do NOT give activated charcoal before or with ipecac syrup. *Inhalation:* Get medical aid. Do not contaminate yourself. Wearing the appropriate PPE equipment and respirator for carbamate pesticides, immediately remove the victim from the contaminated area to fresh air. If the victim is not breathing, administer artificial respiration. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. If breathing is difficult, administer oxygen through bag/mask apparatus until medical help arrives. Do not leave victim unattended

Note to physician or authorized medical personnel. Administer atropine, 2 mg (1/30 gr) intramuscularly or intravenously as soon as any local or systemic signs or symptoms of an intoxication are noted; repeat the administration of atropine every 3 to 8 minutes until signs of atropinization (mydriasis, dry mouth, rapid pulse, hot and dry skin) occur; initiate treatment in children with 0.05 mg mg/kg of atropine; repeat at 5 to 10 minute intervals. Watch respiration, and remove bronchial secretions if they appear to be obstructing the airway; intubate if necessary. *Medical note:* 2-PAMCI may be contraindicated in the case of some carbamate poisonings. As first aid for pulmonary edema, a doctor or authorized paramedic might consider administering a drug or other inhalation therapy. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Storage: Color code-Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location.

Shipping: UN2757 Carbamate pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material,

Spill Handling: First remove all sources of ignition. in all directions for at least 25 meters/75 feet. Increase, in the downwind direction, as necessary. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Stop leak if you can do it without risk. Prevent entry into waterways, sewers, basements or confined areas. Cover with plastic sheet to prevent spreading. Absorb or cover with dry earth, sand or other noncombustible material and transfer to containers. Do not allow water to get inside containers.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen and carbon. *On small fire*, use dry chemical powder, carbon dioxide, water spray, or foam. *On large fire*, use water spray, fog or alcohol-resistant foam. Do not scatter material using straight water jet streams. Dike fire control water for later disposal; do not scatter the material. Move containers from fire area if you can do it without risk. *Fire involving storage or vehicular tanks:* Isolate for 800 meters/0.5 mile in all directions; also, consider initial evacuation for 800 meters/0.5 mile in all directions. Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Do not allow water to get inside containers. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. *Always* stay away from tanks engulfed in fire. For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn.

Disposal Method Suggested: Do not discharge into drains or sewers. Dispose of waste material as hazardous waste using a licensed disposal contractor to an approved landfill. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Incineration with effluent gas scrubbing is recommended. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Office of Pesticide Programs, Pesticide Residue Limits, "Phenmedipham," 40 CFR 180.278, http://www.epa.gov/pesticides/food/viewtols.htm

Pesticide Management Education Program, "Phenmedipham (Betanal, Spin-Aid) herbicide Profile 2/85," Cornell University, Ithaca, NY (February 1985). http://pmep.cce.cornell.edu/profiles/herb-growthreg/naa-rimsulfuron/phenmedipham/herb-prof-phenmedipham.html

Perchloryl Fluoride P:0310

Formula: $ClFO_3$; ClO_3F

Synonyms: Chlorine oxyfluoride; Chlorine fluoride oxide; Trioxychlorofluoride

CAS Registry Number: 7616-94-6

HSDB Number: 2524 as trioxychlorofluoride
RTECS Number: SD1925000
UN/NA & ERG Number: (PIH) UN3083/124
EC Number: 231-526-0

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Theft hazard* 45 (≥25.67% concentration).

Hazard Alert: Poison inhalation hazard, Strong oxidizer, Possible hematological effects, Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated.

OSHA 29CFR1910.119, appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 5000 lb (2270 kg)

United States National Primary Drinking Water Regulations: MCLG = 4 mg[F]/L; MCL = 4 mg[F]/L; SMCL = 2.0 mg[F]/L, as Fluoride.

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T, O; Risk phrases: R5; R8, R9, R10; R20; R21; R26/27; R48/23; Safety phrases: S1; S8; S9; S16; S17; S23; S26; S28; S33; S36/37/39; S38; S41; S43; S45 (see Appendix 4)

Description: Perchloryl fluoride is a colorless gas. Characteristic sweet odor. Shipped as a liquefied compressed gas. Molecular weight = 102.5; Specific gravity (H_2O:1) = 1.4 @ 20°C; Boiling point = −46.7°C; Freezing/Melting point = −146°C; Relative vapor density (air = 1) = 3.64; Vapor pressure = 10.5 atm @ 25°C; 8944 mmHg @ 25°C; Relative vapor density (air = 1) = 3.64. Explosive limits: LEL = 56,000ppm, UEL: unknown. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 3 (Oxidizer). Slightly soluble in water; solubility = 0.06% @ 20°C.

Potential Exposure: Perchloryl fluoride has been used as a liquid oxidant in rocket propellant combinations; as an insulating gas in high voltage electrical systems; as a fluorinating agent in organic synthesis.

Incompatibilities: A strong oxidizing gas. Violent reaction with benzene, calcium hydride; combustibles, olefins, strong bases; sulfur, sulfuric acid; amines, reducing agents; alcohols. Contact with carbonaceous materials (such as charcoal) or finely divided metals (such as powdered magnesium and aluminum, zinc) are a fire and explosion hazard. Attacks some plastics, rubber, and coatings.

Permissible Exposure Limits in Air:

NIOSH IDLH = 100 ppm

Conversion factor: 1 ppm = 4.19 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 3 ppm/13.5 milligram per cubic meter TWA

NIOSH REL: 3 ppm/14 milligram per cubic meter TWA; 6 ppm/28 milligram per cubic meter STEL

ACGIH TLV[1]: 3 ppm/13 milligram per cubic meter TWA; 6 ppm/25 milligram per cubic meter STEL

Protective Action Criteria (PAC)* Ver. 29[138]

PAC-1: **1.5$_A$** ppm

PAC-2: **4$_A$** ppm

PAC-3: **12$_A$** ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

Australia: TWA 3 ppm (14 milligram per cubic meter); STEL 6 ppm, 1993; Austria: MAK 2.5 mg[F]/m^3, 1999; Belgium: TWA 3 ppm (13 milligram per cubic meter); STEL 6 ppm (25 milligram per cubic meter), 1993; Denmark: TWA 3 ppm (14 milligram per cubic meter), 1999; Finland: TWA 3 ppm (14 milligram per cubic meter); STEL 6 ppm (25 milligram per cubic meter), 1999; France: VME 3 ppm (14 milligram per cubic meter), 1999; Norway: TWA 3 ppm (14 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 14 milligram per cubic meter, 2003; Sweden: NGV 2 mg[F]/m^3, 1999; Switzerland: MAK-W 3 ppm (13 milligram per cubic meter), 1999; United Kingdom: TWA 3 ppm (13 milligram per cubic meter); STEL 6 ppm (26 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 6 ppm

Several states have set guidelines or standards for perchloryl fluoride in ambient air[60] ranging from 140−280 μ/m^3 (North Dakota) to 230 μ/m^3 (Virginia) to 270 μ/m^3 (Connecticut) to 333 μ/m^3 (Nevada).

Determination in Air: Sample collection by impinger or fritted bubbler; analysis by ion specific electrode.

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guidelines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg[F]/L. SafeDrinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg [F]/L; SMCL = 2 mg/F/L, as Fluoride.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the respiratory tract. May affect the blood, causing the destruction of red blood cells; formation of methemoglobinemia. Cyanosis and anemia may result. The liquid may cause frostbite.

Long-Term Exposure: May cause methemoglobinemia. Repeated high exposures can cause deposits of fluorides in the bones (fluorosis) that may cause pain, disability and mottling of the teeth. Repeated exposure may cause nausea, vomiting, loss of appetite; diarrhea or constipation.

Points of Attack: Respiratory system, skin, blood.

Medical Surveillance: NIOSH lists the following tests: Blood Gas Analysis; whole blood (chemical/metabolite), methemoglobin; CBC; chest X-ray; pulmonary function tests: forced vital capacity, forced expiratory volume (1 sec); sputum cytology; urine (chemical/metabolite); white blood cell count/differential. Consider the points of attack in preplacement and periodic physical examinations.

Fluoride level in urine (use NIOSH #8308). Levels higher than 4 mg/L may indicate overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If frostbite has occurred, seek medical attention immediately; do NOT rub the affected areas or flush them with water. In order to prevent further tissue damage, do NOT attempt to remove frozen clothing from frostbitten areas. If frostbite has NOT occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear eye protection to prevent any reasonable probability of eye contact. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 30 ppm:* Sa (APF = 10) (any supplied-air respirator). *Up to 75 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode).* *Up to 100 ppm:* SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive pressure mode). *Escape:* GmFS100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted canister providing protection against the compound of concern and having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA). *Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Check oxygen content prior to entering storage area. Poison gas. (1) Color code-Blue: Health Hazard/ Poison: Store in a secure poison location. This gas is highly toxic. Even slight exposure to these gasses can cause death. Store outdoors in a secure, restricted area that containing warning signs. This area must be roofed and shaded with the cylinders stored off the ground and separated from all other products assigned to other hazard categories and radiant heat sources on non-wooden floors. If indoors, store in a well-ventilated areas in temperatures not to exceed 50°C. (2) Color code-Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Oxidizers should be isolated from acids, metals, organic materials, and ammonium nitrate. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in a cool, well ventilated area away from incompatible materials listed above. Store in a cool, well ventilated area away from incompatible materials listed above. Store in a cool, well ventilated area away from incompatible materials listed above. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage.

Shipping: UN3083 Perchloryl fluoride, Hazard Class: 2.3; Labels: 2.3-Poisonous gas, 5.1-Oxidizer, Inhalation Hazard Zone B. UN3157 Liquefied gas, oxidizing, n.o.s., Hazard Class: 2.2; Labels: 2.2-Non-flammable compressed gas, 5.1-Oxidizer, Technical Name Required. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling:

Perchloryl fluoride

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30

Then: Protect persons downwind (miles/kilometers)

Day 0.1/0.2
Night 0.4/0.6
Large spills (From a large package or from many small packages)
First: Isolate in all directions (feet/meters) 1250/400
Then: Protect persons downwind (miles/kilometers)
Day 1.6/2.6
Night 4.8/7.7
If in a building, evacuate building and confine vapors by closing doors and shutting down HVAC systems. Restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak to disperse the gas. Wear chemical protective suit with SCBA to combat spills. Stay upwind and use water spray to "knock down" vapor; contain runoff. Stop the flow of gas, if it can be done safely from a distance. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place; and repair leak or allow cylinder to empty. Keep this chemical out of confined spaces, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include hydrogen fluoride, hydrogen chloride, fluorine and chlorine compounds and oxides of carbon. Nonflammable gas, but will support combustion and add to the intensity of an existing fire. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Incineration together with flammable solvent in furnace equipped with afterburner and scrubber.

References
(31); (173); (101); (138); (122).
New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Perchloryl Fluoride, Trenton, NJ (November 2001).

Phenanthrene P:0320

Formula: C_4H_{10}
Synonyms: Coal tar pitch volatiles: Phenanthren (German); Phenantrin
CAS Registry Number: 85-01-8
HSDB Number: 2166
RTECS Number: VB2600000
UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171
EC Number: 201-581-5
Regulatory Authority and Advisory Information
Carcinogenicity: IARC: Animal Inadequate Evidence; Human No Adequate Data, not classifiable as carcinogenic to humans, Group 3, 1987; EPA: Classification D, Not Classifiable as to human carcinogenicity. ACGIH: A1; Confirmed human carcinogen. /Coal tar pitch volatiles, as benzene soluble aerosol. Phenanthrene has not been identified as a carcinogen. Handle with caution as several related polynuclear aromatic hydrocarbons (PAHs) are known carcinogens. NIOSH has recommended that coal tar pitch volatiles, including polycyclic aromatic hydrocarbons (PAHs) be treated as potential human carcinogen.
Hazard Alert: Combustible, Environmental hazard.
OSHA, 29CFR1910 Specifically Regulated Chemicals (CFR1910.1002) as coal tar pitch volatiles
Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; Section 307(a)(1) Toxic pollutant designated, pursuant to of the and is subject to effluent limitations as polycyclic aromatic hydrocarbons (PAHs)
United States National Primary Drinking Water Regulations: MCLG = zero mg/L; MCL = 0.0002 mg/L as polycyclic aromatic hydrocarbons (PAHs).
RCRA 40CFR258, appendix 2
RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.059; Nonwastewater (mg/kg), 3.4
RCRA, 40CFR264, appendix 9, Ground Water Monitoring List, Suggested Testing Methods (PQL μg/L): 8100 (200); 8270 (10)
Superfund/EPCRA 40CFR302.4, Appendix A, Reportable Quantity (RQ): 100 lb (45.4 kg)
Canada, WHMIS, Ingredients Disclosure List Concentration: 1% as phenanthrene; 0.1% as coal tar pitch volatiles; DSL list.
Mexico, Drinking Water, Criteria (Ecological): 0.02 mg/L; wastewater: organic toxic pollutant.
Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T, Xn, N; Risk phrases: R40; R22; R50/53; Safety phrases: S29/35; S36/37; S41; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to waters.

Description: Phenanthrene is a white[2] crystalline substance. Weak aromatic odor. Polycyclic aromatic hydrocarbons (PAHs) are compounds containing multiple benzene rings and are also called polynuclear aromatic hydrocarbons. Molecular weight = 178.24; Specific gravity (H_2O:1) = 0.98 @ 4°C; Boiling point = 340°C @ 760 mmHg[2]; Freezing/Melting point = 99°C[2]; Flash point = 171°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 0. Insoluble in water.

Potential Exposure: Mutagen. Used for making dyes, other chemicals; explosives, pharmaceuticals; in biological research.

Incompatibilities: Dust may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air:

No specific standards have been established for phenanthrene.

NIOSH IDLH = 80 milligram per cubic meter as coal tar pitch volatiles

OSHA PEL: 0.2 milligram per cubic meter TWA [1910.1002] (benzene-soluble fraction). OSHA defines "coal tar pitch volatiles" in 29 CFR 1910.1002 as the fused polycyclic hydrocarbons that volatilize from the distillation residues of coal, petroleum (excluding asphalt), wood, and other organic matter.

NIOSH REL: 0.1 milligram per cubic meter (cyclohexane-extractable fraction). NIOSH considers coal tar products (i.e., coal tar, coal tar pitch, or creosote) to be potential occupational carcinogens

ACGIH TLV[1]: 0.2 milligram per cubic meter TWA (as benzene soluble aerosol); Confirmed Human Carcinogen

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 5.4 milligram per cubic meter

PAC-2: 59 milligram per cubic meter

PAC-3: 360 milligram per cubic meter

DFG MAK: [skin]

Several states have set guidelines or standards for coal tar pitch volatiles in ambient air[60] ranging from zero (North Carolina) to 0.0161 μ/m^3 (Kansas) to 0.48 μ/m^3 (Pennsylvania) to 2.0 μ/m^3 (Connecticut and Virginia) to 5.0 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method #5506 polycyclic aromatic hydrocarbons by HPLC; NIOSH Analytical Method #5515, Polycyclic aromatic hydrocarbons by GC; OSHA Analytical Method ID-58.

Permissible Concentration in Water: For the maximum protection of human health from the potential carcinogenic effects due to exposure of polynuclear aromatic hydrocarbons through ingestion of contaminated water and contaminated aquatic organisms, therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 1×10^{-5}, 1×10^{-6}, and 1×10^{-7}. The corresponding criteria are 28.0 ng/L, 2.8 ng/L, and 0.28 ng/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 311.0 ng/L, 31.1 ng/L, and 3.11 ng/L, respectively.

Determination in Water: Log $K_{ow} = > 4.5$. Values above 3.0 are likely to bioaccumulate in aquatic organisms.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Skin contact can cause irritation. A skin photo sensitizer, contaminated skin exposed to sunlight can develop rash, skin burns; and blisters. Irritates the eyes and respiratory tract.

Long-Term Exposure: May cause skin allergy. If allergy develops, very low future exposure can cause itching and skin rash.

Points of Attack: Skin, respiratory system; bladder, liver, kidneys.

Medical Surveillance: This chemical, according to ACGIH, is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. NIOSH lists: CBC; chest X-ray; pulmonary function tests: Forced Vital Capacity; Forced Expiratory Volume (1 sec); photopatch testing; sputum cytology; urinalysis (routine); cytology, hematuria[2].

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/ manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and

face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *At any detectable concentration over 0.1 milligram per cubic meter:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well -ventilated area away from strong oxidizers. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of carbon. This chemical is a combustible solid. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (173); (101); (138); (2); (100).

United States Environmental Protection Agency, "*Identification of Organic Compounds in Effluents from Industrial Sources*," EPA-560/3-75-002, Washington, DC, April 1975

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Phenanthrene, Trenton, NJ (August 1999)

Phenazopyridine & Phenazopyridine Hydrochloride P:0330

Formula: $C_{11}H_{12}ClN_5$

Synonyms: AP; 2,6-Diamino-3-phenylazopyridine; Diridone; DPP; Gastracid; Gastrotest; Mallophene; NC150; Phenazodine; Phenylazo; 3-(Phenylazo)-2,6-pyridinediamine; Pirid; Pyrazofen; Pyridacil; Pyridium; Pyripyridium; Sedural; Uridinal; Urodine; W 1655

hydrochloride: Azodine; Azodium; Azodyne; Azo gantrisin; Azo gastanol; Azo-mandelamine; Azomine; Azo-standard; Azo-stat; Azotrex; Baridium; Bisteril; Cystopyrin; Cystural; 2,6-Diamino-3-phenylazopyridine hydrochloride; 2,6-Diamino-3-(phenylazo)pyridine monohydrochloride; Di-azo; Diridone; Dolonil; Eucistin; Giracid; Mallofeen; Mallophene; NC150; NCI-C01672; Nefrecil; PAP; PDP; Phenazo; Phenazodine; Phenazopyridine hydrochloride; Phenazopyridinium chloride; β-Phenylazo-α,α'-diaminopyridine hydrochloride; 3-Phenylazo-2,6-diaminopyridine hydrochloride; Phenylazodiaminopyridine hydrochloride; Phenylazo-α,α'-diaminopyridine monohydrochloride; 3-(Phenylazo)-2,6-pyridinediamine, hydrochloride; Phenylazopyridine hydrochloride; Phenyl-idium; Phenyl-idium 200; Pirid; Piridacil; Pyrazodine; Pyrazofen; Pyredal; Pyridacil; Pyridenal; Pyridene; Pyridiate; Pyridium; Pyridivite; Pyripyridium; Pyrizin; Sedural; Suladyne; Sulodyne; Thiosulfil-A forte; Urazium; Uridinal; Uriplex; Urobiotic-250; Urodine; Urofeen; Uromide; Urophenyl; Uropyridin; Uropyrine; Utostan; Vestin; W 1655

CAS Registry Number: 94-78-0; 136-40-3 (hydrochloride)
HSDB Number: 3153
RTECS Number: US7700000; US7875000 (hydrochloride)
UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154; UN3249 (medicine, solid, toxic, n.o.s.)/151
EC Number: 202-363-2; 205-243-8 (hydrochloride)

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; (Phenazopyridine hydrochloride, CAS 136-40-3); IARC: Animal Sufficient Evidence; Human Limited Evidence, *possibly carcinogenic to humans*, Group 2B, 1987; NCI: Carcinogenesis Studies (feed); clear evidence: mouse; (feed); clear evidence: rat.

California Proposition 65 Chemical[102]: Cancer 1/1/1988; 1/1/1988 (hydrochloride).

Hazard Alert: Poison, Possible risk of forming tumors, Drug. *Hydrochloride*: Poison, Possible risk of forming tumors, Suspected of causing genetic defects, Drug.

Hazard Symbols, Risk & Safety statements: Hazard Symbol (hydrochloride): T, C, Xn; Risk phrases: R45; R22; R34; R36/37/38; R40; R62 (hydrochloride); Safety phrases: S25; S26; S27; S34; S36/37/39; S45; (see Appendix 4)

Description: Phenazopyridine is a red crystalline compound. Molecular weight = 213.27; 249.73 (hydrochloride); Freezing/Melting point = (fine base) 139°C; 233−238°C (hydrochloride). Slightly soluble in water.

Potential Exposure: Phenazopyridine hydrochloride has been used for 50 years as an analgesic drug either alone or in combination with other drugs to reduce pain associated with urinary tract infection. An azo dye used in urinary tract infections. Also used as a local anesthetic. Exposure to phenazopyridine hydrochloride occurs during manufacture and formulation.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air:
No standards or Protective Action Criteria (PAC) available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Can affect you if swallowed. Symptoms of exposure include diarrhea, nausea or vomitin; dehydration, decreased urine volume. May affect the development of red blood cells; causing cyanosis and methemoglobinemia and changes in blood sodium levels.

Long-Term Exposure: May affect the kidneys. Phenazopyridine hydrochloride was tested in mice and rats by oral administration. In female mice, it significantly increased the incidence of hepatocellular adenomas and carcinomas. In male and female rats, it induced tumors of the colon and rectum. Symptoms of exposure include deeply stained vomitus and urine, methemoglobinemia, Heinz body anemia; hepatic enlargement; abnormal renal function. May cause mutations.

Points of Attack: Blood. Kidneys.

Medical Surveillance: CBC. Kidney function tests.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy. *Note to Physician:* Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in a refrigerator or a cool, dry place. Protect from air and light. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN3249 Medicine, solid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: UN2811: Isolation Distance, Spill: 25meters/75 feet.(NJ). Isolation Distance, Fire: 800 meters/ 0.5 miles[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Thermal decomposition products may include hydrogen chloride and oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(109); (102); (31); (173); (101); (138).

Phenol P:0340

Formula: C_6H_6O; C_6H_5OH

Synonyms: Acide carbolique (French); Benzene, hydroxy-; Benzenol; Carbolic acid; Carbolsaure (German); ENT 1814; Fenol (Spanish); Hydroxybenzene; Monohydroxybenzene; Monophenol; NCI-C50124; Oxybenzene; Phenic acid; Phenole (German); Phenyl alcohol; Phenyl hydrate; Phenyl hydroxide; Phenylic acid; Phenylic alcohol

CAS Registry Number: 108-95-2

HSDB Number: 113

RTECS Number: SJ3325000

UN/NA & ERG Number: UN1671 (solid)/153; UN2312/153 (molten); UN2821 (solution)/153

EC Number: 203-632-7 [*Annex I Index No.:* 604-001-00-2]

Regulatory Authority and Advisory Information

Carcinogenicty: NCI: Carcinogenesis Bioassay (oral); no evidence: mouse, rat; IARC: Animal Inadequate Evidence; Human Inadequate Evidence*, not classifiable as carcinogenic to humans*, Group 3, 1999; EPA: Available data are inadequate for an assessment of human carcinogenic potential; Not Classifiable as to human carcinogenicity. United States Environmental Protection Agency Gene-Tox Program, Negative: N crassa-reversion. DFG Carcinogen Category: 3B

Hazard Alert: Exposure can be lethal, Flammable, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction).

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR401.15 Section 307 Toxic Pollutants; 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U188

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.039; Nonwastewater (mg/kg), 6.2

RCRA 40CFR264, appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8040 (1); 8270 (10)

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 1000 lb (454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T+, F; Risk phrases: R40; R10; R23/24/25; R34; R48/21/22/23; R62; R63; R68; Safety phrases: S1/2; S24/ 25; S26; S28; S36/37/39; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Phenol is a colorless to light-pink, crystalline solid. Sweet, acrid odor. Phenol liquefies by mixing with about 8% water. The Odor Threshold in air is 0.04 ppm and in water is 7.9 ppm. Molecular weight = 94.12; Boiling point = 182°C; Freezing/Melting point = 42.8°C; Relative vapor density (air = 1) = 1.00 @ 20°C; Vapor pressure = 0.4 mmHg @ 25°C; Relative vapor density (air = 1): 3.2; Flash point = 79.4°C (cc); Autoignition temperature = 715°C. Explosive limits: LEL = 1.3%; 9,000 ppm[138]; UEL: 8.6%. Hazard Identification (based on NFPA-704 M Rating System) (*liquid, crystals*): Health 4, Flammability 2, Reactivity 1 (Corrosive). Soluble in water; solubility = 9% @ 25°C.

Potential Exposure: Phenol is used as a pharmaceutical, in the production of fertilizer; coke, illuminating gas; lampblack, paints, paint removers; rubber, asbestos goods; wood preservatives; synthetic resins; textiles, drugs, pharmaceutical preparations; perfumes, bakelite, and other plastics (phenolformaldehyde resins); polymer intermediates (caprolactam, bisphenol-A and adipic acid). Phenol also finds wide use as a disinfectant and veterinary drug.

Incompatibilities: Vapors may form explosive mixture with air. The aqueous solution is a weak acid. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, calcium hypochlorite; aluminum chloride. acids. Reacts with metals.

Permissible Exposure Limits in Air:

NIOSH IDLH = 250 ppm

Conversion factor: 1 ppm = 3.85 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 5 ppm/19 milligram per cubic meter TWA [skin]

NIOSH REL: 5 ppm/19 milligram per cubic meter TWA [skin]; 15.6 ppm/60 milligram per cubic meter/15 min. Ceiling Concentration

ACGIH TLV[1]: 5 ppm/19 milligram per cubic meter TWA [skin], not classifiable as a human carcinogen; BEI: 250 mg [total phenol]/g creatinine in urine/end-of-shift

Protective Action Criteria (PAC)* Ver. 29[138]

PAC-1: **15**$_{\mathbf{A}}$ ppm

PAC-2: **23**$_{\mathbf{A}}$ ppm

PAC-3: **200**$_{\mathbf{A}}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

DFG MAK; [skin], Carcinogen Category: 3B

Arab Republic of Egypt: TWA 5 ppm (19 milligram per cubic meter), [skin], 1993; Australia: TWA 5 ppm (19 milligram per cubic meter), [skin], 1993; Austria: MAK 5 ppm (19 milligram per cubic meter), [skin], 1999; Belgium: TWA 5 ppm (19 milligram per cubic meter), [skin], 1993; Denmark: TWA 1 ppm (4 milligram per cubic meter), [skin], 1999; Finland: TWA 5 ppm (19 milligram per cubic meter); STEL 10 ppm (38 milligram per cubic meter), [skin], 1999; France: VME 5 ppm (19 milligram per cubic meter), [skin], 1999; the Netherlands: MAC-TGG 8 milligram per cubic meter, [skin], 2003Japan: 5 ppm (19 milligram per cubic meter), [skin], 1999; Norway: TWA 1 ppm (4 milligram per cubic meter), 1999; the Phillipines: TWA 5 ppm (10 milligram per cubic meter), [skin], 1993; Poland: MAC (TWA) 10 milligram per cubic meter; MAC (STEL) 20 milligram per cubic meter, 1999; Russia: TWA 5 ppm; STEL 0.3 milligram per cubic meter, [skin], 1993; Sweden: NGV 1 ppm (4 milligram per cubic meter), KTV 2 ppm (8 milligram per cubic meter), [skin], 1999; Switzerland: MAK-W 5 ppm (19 milligram per cubic meter), KZG-W 10 ppm (38 milligram per cubic meter), [skin], 1999; Thailand: TWA 5 ppm (19 milligram per cubic meter), 1993; Turkey: TWA 5 ppm (19 milligram per cubic meter), [skin], 1993; United Kingdom: TWA 5 ppm (20 milligram per cubic meter); STEL 10 ppm, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Russia[35][43] has also set a MAC for ambient air in residential areas of 0.01 milligram per cubic meter (10 μ/m^3) both on a momentary and a daily average basis. Many states have set guidelines or standards for phenol in ambient air[60] ranging, for example, from 10.0 μ/m^3 (New York) to 45.23 μ/m^3 (Kansas) to 52.0 μ/m^3 (Massachusetts) to 95.0 μ/m^3 (Indiana) to 190 μ/m^3 (Florida, North Dakota, South Carolina) to 315.0 μ/m^3 (Virginia) to 380.0 μ/m^3 (Connecticut, North Dakota, South Dakota) to 452.0 μ/m^3 (Nevada) to 456.0 μ/m^3 (Pennsylvania) to 95.0 μ/m^3 (North Carolina).

Determination in Air: Use NIOSH Analytical Method (IV) #2546, Cresols and Phenol, OSHA Analytical Method 32.

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 2000 μg/L; State Drinking Water Guidelines: California 4200 μg/L; Florida 10 μg/L; Maine 2100 μg/L; Minnesota 4000 μg/L; New Hampshire 4200 μg/L; Wisconsin 6000 μg/L.

Determination in Water: Methylene chloride extraction followed by gas chromatography with flame ionization or electron capture detection (EPA Method 604) or gas chromatography plus mass spectrometry (EPA Method 625). Octanol-water coefficient: Log $K_{ow} = 1.46$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Phenol and its vapor is corrosive to the eyes, skin, and respiratory tract. Eye contact can cause severe and painful burns and permanent damage. Skin contact may cause severe and painful burns, which promptly become anesthetized (numb) to touch, but deep damage and local gangrene can result. Significant skin contact or inhalation can cause death within minutes. Ulceration may follow. Inhalation can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. May affect the CNS; heart, liver, and kidneys; causing convulsions, coma, cardiac disorders; respiratory failure; collapse. Signs and symptoms of acute exposure to phenol may be severe, and range from tachycardia (rapid heart rate) and tachypnea (rapid respiratory rate) to hypotension (low blood pressure), weak pulse; cardiac failure; pulmonary edema; and respiratory arrest. Cardiac arrhythmias may be noted. Weakness, headache, dizziness, tinnitus (ringing in the ears), delirium, and shock are common. Seizures may often be followed by coma. Pallor, profuse sweating; dilated pupils; and a profound drop in body temperature may occur. Gastrointestinal effects may include nausea, abdominal pain; bloody vomitus; and bloody diarrhea. Renal insufficiency may lead to hematuria (bloody urine). Toxic hazard rating is very toxic: probable oral lethal dose (human) in 50−500 mg/kg. Ingestion of 1 gram has been lethal to humans. Lethal amounts may be absorbed through skin or inhaled. Industrial contact can cause chronic poisoning with kidney and liver damage.

Long-Term Exposure: Repeated or prolonged contact with skin may cause dermatitis. The substance may damage the liver, kidneys and have an effect on the pancreas; and heart muscle. May affect the CNS and cause nerve and/or brain damage. Phenol causes mutations and may cause reproductive damage in humans; and may be a cancer risk.

Points of Attack: Eyes, skin, respiratory system; liver, kidneys.

Medical Surveillance: niosh lists the following tests: liver function tests; urine (chemical/metabolite); urine (chemical/metabolite), last 2 hours of 8-hour exposure; urine (chemical/metabolite), end-of-shift; urine (chemical/metabolite), pre- & postshift; urinalysis. Urinary phenol (See also NIOSH #8305 *Phenol and p-cresol in urine*,). These tests should be repeated if overexposure is suspected. Interview for brain effects.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. If concentrated phenol gets on a large area of the skin, immediately rush victim to shower and use at full blast; remove all contaminated clothing; scrub the contaminated area with *soap* for at least 10 minutes—*water alone may be harmful*. If polyethyleneglycol-300 is available, swab exposed area with cotton soaked in it. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Rinse mouth. Give plenty of water and/or vegetable oil to drink. Do not allow the consumption of alcohol. Induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. For phenol <30%, sealed chemical materials with good to excellent resistance: polyethylene. For phenol >70%, sealed chemical materials with good to excellent resistance: butyl rubber; Neoprene, Teflon, Viton, Silvershield. Also, polyethylene, offers limited protection. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *50 ppm:* CcrOv95 (APF = 10) [any air-purifying half-mask respirator with organic vapor cartridge(s) in combination with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100]; Sa (APF = 10) (any supplied-air respirator). *125 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOvHie (APF = 25) (any air-purifying full facepiece respirator equipped with an organic vapor cartridge in combination with a high-efficiency particulate filter) *250 ppm:* CcrFOv100 (APF = 50) [air-purifying full facepiece respirator equipped with organic vapor cartridge(s) in combination with an N100, R100, or P100 filter]; or GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or PaprTOvHie (APF = 50) [any powered, air-purifying respirator with a tight-fitting facepiece and organic vapor cartridge(s) in combination with a high-efficiency particulate filter]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: (1) Color code-Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. (2) Color code-White stripe: Contact Hazard; Store separately; not compatible with materials in solid white category. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration is not a danger. Phenol must be stored to avoid contact with calcium hypochlorite and other strong oxidizers (such as chlorine and bromine), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping:

UN1671 Phenol, solid, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN2312 Molten phenol, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN2821 Phenol solutions, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Remove all ignition sources. Spills must be disposed of immediately by properly protected personnel; no others should remain in area. Flush with flooding quantities of water, then use caustic soda solution for neutralization. Remove and isolate contaminated clothing at the site. Establish forced ventilation to keep levels below explosive limit. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Absorb liquids in vermiculite, dry sand; earth or similar material and deposit in sealed containers for later disposal. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid or liquid. Flammable vapors are produced when phenol is heated. *Small fires:* dry chemical, carbon dioxide; water spray; or alcohol foam. *Large fires:* water spray, fog or foam; use water spray to cool containers in fire area. Move container from fire area if it can be done without risk; fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Thermal decomposition products may include oxides of carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Vapors are heavier than air and will collect in low areas. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration.

References

(31); National institute for Occupational Safety and Health (NIOSH), "Criteria for a Recommended Standard:(100). Occupational(2). Exposure to Phenol," NIOSH Document Number 76-196, Cincinnati OH (1976)

(173); (101); (138).

United States Environmental Protection Agency, Phenol: Ambient Water Quality Criteria, Washington, DC (1980)

United States Environmental Protection Agency, Phenol: Health and Environmental Effects Profile No. 144, Office of Solid Waste, Washington, DC (April 30, 1980)

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 3, No. 4, 77−84 (1983)

United States Public Health Service, "Toxicological Profile for Phenol," Atlanta, Georgia, agency for Toxic Substances and Disease Registry (December 1988)

United States Environmental Protection Agency, Chemical Hazard Information Profile: Phenol, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

New York State Department of Health, *Chemical Fact Sheet:* Phenol, Bureau of Toxic Substance Assessment, Albany, NY (April 1986)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Phenol, Trenton, NJ (June 2001).

Phenothiazine P:0360

Formula: $C_{12}H_9NS$; $S(C_6H_4)_2NH$

Synonyms: AFI-tiazin; Agrazine; Antiverm; Biverm; Contaverm; Dibenzoparathiazine; Dibenzothiazine; Dibenzo-1,4-thiazine; ENT 38; Feeno; Fenoverm; Fentiazin; Helmetina; Lethelmin; Nemazene; Nemazine; Orimon; Padophene; Penthazine; Phenegic; Phenosan; Phenoverm; Phenovis; Phenoxur; Phenthiazine; Reconox; Souframine; Thiodiphenylamin (German); Vermitin; Wurm-thional; XL-50

CAS Registry Number: 92-84-2

HSDB Number: 5279

RTECS Number: SN5075000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 202-196-5

Regulatory Authority and Advisory Information

United States Environmental Protection Agency Gene-Tox Program, Positive: Cell transformation-SA7/SHE.

Hazard Alert: Combustible solid, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction), Sensitization hazard (skin), Environmental hazard.

Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements:1 Hazard Symbol: T, Xi, Xn, N; Risk phrases: R20/21/22; R36/37/38; R40; R43; R48/22; R50/53; R62; R63; Safety phrases: R22; S26; S29/35; S36/37/39; S41; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Phenothiazine is a greenish-yellow to greenish-gray crystalline substance. Slight odor and taste. Molecular weight = 199.28; Boiling point = (decomposes) 371°C; Freezing/Melting point = 185°C (sublimes). Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Insoluble in water.

Potential Exposure: Phenothiazine is used as an insecticide; as a base for the manufacture of tranquilizers; as anthelmintic in medicine and veterinary medicine; it is used widely as an intermediate in pharmaceutical manufacture; polymerization inhibitor, antioxidant.

Incompatibilities: Organosulfides are incompatible with strong acids and acid fumes; elevated temperatures; sulfur oxides and nitrogen oxides can be produced. Contact with strong reducing agents such as hydrides; azo and diazo compounds, halocarbons, isocyanates can generate heat and may form explosive hydrogen gas.

Permissible Exposure Limits in Air:

OSHA PEL: None

NIOSH REL: 5 milligram per cubic meter TWA [skin]

ACGIH TLV: 5 milligram per cubic meter TWA [skin]

Protective Action Criteria (PAC) not available

Australia: TWA 5 milligram per cubic meter, [skin], 1993; Belgium: TWA 5 milligram per cubic meter, [skin], 1993; Denmark: TWA 5 milligram per cubic meter, [skin], 1999; Finland: TWA 5 milligram per cubic meter; STEL 10 milligram per cubic meter, [skin], 1999; France: VME 5 milligram per cubic meter, [skin], 1999; Norway: TWA 5 milligram per cubic meter, 1999; the Phillipines: TWA 5 milligram per cubic meter, [skin], 1993; the Netherlands: MAC-TGG 5 milligram per cubic meter, [skin], 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: 5 milligram per cubic meter [skin]. Several states have set guidelines or standards for Phenothiazine is ambient air[60] ranging from 50 μ/m^3 (North Dakota) to 80 μ/m^3 (Virginia) to 100 μ/m^3 (Connecticut) to 119 μ/m^3 (Nevada).

Determination in Air: No NIOSH Analytical Method available.

Determination in Water: Octanol-water coefficient: Log $K_{ow} = >4$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact. Skin absorption.

Harmful Effects and Symptoms

Short-Term Exposure: Phenothiazine can affect you when breathed in and by passing through your skin. Exposure can irritate the skin and eyes. Exposure can cause an inflammation in the eye (keratitis). This can also be made worse by sunlight (photosensitization) and cause a severe skin reaction with rash and color changes. Can cause a severe allergic liver reaction. High levels of exposure may affect the blood cells, causing hemolytic anemia; and toxic liver degeneration. Exposure may affect the nervous system; causing muscle twitching and shaking. May affect heart rhythm, causing irregular heartbeat.

Long-Term Exposure: Repeated or prolonged contact with skin may cause dermatitis and allergy. Can cause kidney and liver damage. Repeated or prolonged contact may cause skin sensitization as well as skin photophobia (abnormal visual intolerance to light). There is limited evidence that this chemical may damage the developing fetus. Several related phenothiazine compounds have been associated with human teratogenic effects.

Points of Attack: Skin, cardiovascular system, liver, kidneys, heart.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater, or significant skin contact), the following are recommended before beginning work and at regular times after that: examination of the nervous system and eyes. Liver function tests, especially bile salts. CBC. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. EKG.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothingmaterial for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures *over 5 milligram per cubic meter*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece respirator with a high efficiency particulate filter. Greater protection is provided by a powered-air purifying respirator. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location; keep acids away from bases and red, yellow, and blue-coded chemicals. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong acids (such as hydrochloric, sulfuric and nitric) since toxic fumes can result.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Phenothiazine may burn, but does not readily ignite. Thermal decomposition products may include oxides of sulfur, nitrogen and carbon. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve in combustible solvent and spray into incinerator equipped with afterburner and scrubber. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (80); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Phenothiazine,* Trenton, NJ (May 2000)

d-Phenothrin P:0364

Formula: $C_{23}H_{26}O_3$

Synonyms: AI3-29062; Caswell No. 652B; Cyclopropanecarboxylic acid, 2,2-dimethyl-3-(2-methyl-1-propenyl)-,(3-phenoxyphenyl) methyl ester; Cyclopropanecarboxylic acid, 2,2-dimethyl-3-(2-methylpropenyl)-, *m*-phenoxybenzyl ester; Cyclopropanecarboxylic acid, 2,2-dimethyl-3-(2-methyl-1-propenyl)-, (3-phenoxyphenyl)methyl ester; 2,2-Dimethyl-3-(2-methyl-1-propenyl) cyclopropanecarboxylic acid (3-phenoxyphenyl) methyl ester; ENT 27972; EPA Fenotrina (Spanish); Fenothrin, (±)-; (+)-*cis,trans*-Fenothrin; Fenothrin, (+)-*cis, trans*-; Fenothrin, Forte; Forte; Multicide-2154; OMS 1809; OMS 1810; (+)-*cis,trans*-Phenothrin; Phenothrin; 3-Phenoxybenzyld-*Z/E* chrysanthemate; 3-Phenoxybenzyl *d-Z/E* chrysanthemate; 3-Phenoxybenzyl *D-cis,trans*-chrysanthemate; 3-Phenoxybenzyl *cis,trans*-chrysanthemate; 3-Phenoxybenzyl (1RS)-*cis,trans*-chrysanthemate; 3-Phenoxybenzyl (±)-*cis, trans*-chrysanthemate; *m*-Phenoxybenzyl 2,2-dimethyl-3-(2-methylpropenyl)cyclopropanecarboxylate; 3-Phenoxybenzyl 2-dimethyl-3-(methylpropenyl) cyclopropanecarboxylate; 3-Phenoxybenzyl(1RS,3RS,1RS,3SR)-2,2-dimethyl-3-(2-methylprop-1-enyl)cyclop ropanecarboxylate; 3-Phenoxybenzyl (1RS)-*cis,trans*-2,2-dimethyl-3-(2-methylprop-1-enyl)cyclopropanecarboxylate; 3-Phenoxybenzyl(1RS)-*(Z),(E)*-2,2-dimethyl-3-(2-methylprop-1-enyl)cyclopropanecarboxylate; Phenoxythrin; PT-515; S-2539; Sumethrin; Sumithrin; Wellcide

CAS Number: 26002-80-2

HSDB Number: 3922

RTECS Number: GZ1975000

UN/NA & ERG Number: UN3082 (environmentally hazardous substances, liquid, n.o.s.)/171; UN3352 (liquid)/151; UN3349 (pyrethroid pesticide, solid, toxic)/151

EC Number: 207-404-5

Regulatory Authority and Advisory Information.

Hazard Alert: Poison, Combustible, Suspected reprotoxic hazard, Possible endocrine disruptor, Environmental hazard.
Clean water act: Section 311 Hazardous Substances/RQ (same as CERCLA) as pyrethrins
Permissible Exposure Limits for Chemical Contaminants: (CAL/OSHA) as pyrethrum
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%
Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.
Hazard Symbols, Risk & Safety statements: Hazard Symbol: Xi, Xn, N; Risk phrases: R20/21/22; R36; R38; R50/53; R63; Safety phrases: S2; S13; S29/35; S60; S61 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Pale yellow to yellow-brown liquid. Molecular weight = 350.44; Specific gravity (H_2O:1) = 1.06 @ 20°C; Boiling point = 293°C; Vapor pressure = 1×10^{-7} mmHg @ 25°C; Flash point = 105. Henry's Law constant = 6.8×10^{-6} atm-m^3/mol @ 25°C (est)[83]. Practically insoluble in water.

Potential Exposure: d-Phenenothrin is a pyrethroid insecticide whic is used world-wide to control household insects and to protect stored grain. It is frequently formulated with other insecticides and is formulated in a number of carriers (aerosols, oil, dust, emulsifiable concentrates), and in powders, shampoos and lotion.

Incompatibilities: Keep away from alkaline materials. May react violently with strong oxidizers, bromine, 90% hydrogen peroxide, phosphorus trichloride, silver powders or dust. Incompatible with silver compounds. Mixture with some silver compounds forms explosive salts of silver oxalate. Compounds of the carboxyl group react with all bases, both inorganic and organic (i.e., amines) releasing substantial heat, water and a salt that may be harmful. Incompatible with arsenic compounds (releases hydrogen cyanide gas), diazo compounds, dithiocarbamates, isocyanates, mercaptans, nitrides, and sulfides (releasing heat, toxic and possibly flammable gases), thiosulfates and dithionites (releasing hydrogen sulfate and oxides of sulfur).

Permissible Exposure Limits in Air:
NIOSH(2) IDLH = 5,000 ppm
OSHA PEL: 5 milligram per cubic meter TWA
NIOSH REL: 5 milligram per cubic meter TWA
ACGIH TLV[1]: 5 milligram per cubic meter TWA
STEL set by HSE(33) = 10 milligram per cubic meter.

Determination in Air: Collection by impinger or fritted bubbler, analysis by gas liquid chromatography/UV. See NIOSH IV, Method #5008[18], pyrethrum.

Permissible Concentration in Water: Acceptable Daily Intake (ADI) = 0.02 mg/kg as pyrethroid

Determination in Water: Octanol-water coefficient: Log $K_{ow} = > 6.0$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Harmful Effects and Symptoms

Short-Term Exposure: Pyrethroids can affect you when breathed in and by passing through your skin. Irritates the eyes and respiratory tract. High exposure can affect the nervous system causing headache, nausea, vomiting, fatigue, and restlessness, rhinorrhea (discharge of thin nasal mucous). Skin irritant/sensitizer my develop. LD_{50} (oral, rat) = > 5 g/kg[83].; LD_{50} (dermal, rat) = > 2 g/kg[83].

Long-Term Exposure: High or repeated exposure can cause lung allergy (with cough, wheezing and/or shortness of breath) or hay fever symptoms (sneezing, runny or stuffy nose). Allergic "pneumonia" can also occur with cough, chest pain, breathing difficulty and abnormal chest X-ray. Repeated attacks may lead to permanent scarring. Skin allergy may also develop with rash and itching, even with lower exposures. Dermal contact can cause rash with redness, blisters and intense itching. A severe generalized allergy can occur with weakness and collapse

Points of Attack: Respiratory system, skin, CNS, liver, and kidneys.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended: Employees should be screened for history of certain medical conditions which might place the employee at increased risk from pyrethroid exposure. Chronic respiratory disease: In persons with chronic respiratory disease, especially asthma, the inhalation of pyrethroids might cause exacerbation of symptoms due to its sensitizing properties. Lung function tests. These may be normal if the person is not having an attack at the time of the test. Consider chest X-ray if lung symptoms are present. Skin disease: Pyrethroids can cause dermatitis which may be allergic in nature. Persons with pre-existing skin disorders may be more susceptible to the effects of this agent. Evaluation by a qualified allergist, including exposure history and testing, may help diagnose allergy. Any employee developing the above-listed conditions should be referred for further medical examination[9].

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Applicators and other handlers must wear: Coveralls worn over long-sleeved shirt and long pants; Chemical-resistant gloves such as DuPont

Tychem suit fabrics, barrier laminate, or Viton; Chemical-resistant footwear plus socks; Protective eye wear; Chemical-resistant headgear for overhead exposure; Chemical-resistant apron when cleaning equipment, mixing, or loading[83]. Agricultural Use/Engineering Controls: When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the Worker Protection Standard (WPS) for agricultural pesticides, 40 CFR 170.240(d)(4-6), the handler PPE requirements may be reduced or modified as specified in the Worker Protection Standard. Firefighters should wear NIOSH approved SCBA and full protective clothing.

Respirator Selection: NIOSH/OSHA *for pyrethrum*: *50 milligram per cubic meter:* CcrOv95 (APF = 10) [any air-purifying half-mask respirator equipped with an organic vapor cartridge(s) in combination with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *125 milligram per cubic meter:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOvHie (APF = 25) (any air-purifying full facepiece respirator equipped with an organic vapor cartridge in combination with a high-efficiency particulate filter).*250 milligram per cubic meter:* CcrFOv100 (APF = 50) [any air-purifying full facepiece respirator equipped with organic vapor cartridge(s) in combination with an N100, R100, or P100 filter]; or PaprTOvHie (APF = 50) [any powered, air-purifying respirator with a tight-fitting facepiece and organic vapor cartridge(s) in combination with a high-efficiency particulate filter]; or SCBAF (APF = 50) (any SCBA with full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece).*5000 milligram per cubic meter:* SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd, Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code-Blue: Health Hazard/Poison. Store in a secure poison location at temperature <35°C and away from alkaline materials. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN3082 Environmentally hazardous substances, liquid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required. UN3349 Pyrethroid pesticide, solid toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous material. UN3352 Pyrethroid pesticide, liquid toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: First remove all sources of ignition. Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Ventilate area of spill or leak. Use water spray to reduce vapor. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of carbon. *On a small fire:* use dry chemical, CO_2 or water spray.On a large fire: use water spray, fog or regular foam. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal; do not scatter the material. Use water spray or fog; do not use straight streams. *Fire involving storage or vehicular tanks:* Isolate for 800 meters/0.5 mile in all directions; also, consider initial evacuation for 800 meters/0.5 mile in all directions. Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Do not get water inside containers. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. ALWAYS stay away from tanks engulfed in fire. For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies.

Disposal Method Suggested: Incineration would be an effective disposal procedure where permitted. If an efficient incinerator is not available, the product should be mixed with large amounts of combustible material and contact with the smoke should be avoided. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers.

References

(31); (173); (101); (138); (100).

International Programme on Chemical Safety (IPCS), "Environmental Health Criteria, d-Phenothrin," Geneva, Switzerland. (1990). http://www.inchem.org/documents/ehc/ehc/ehc96.htm

Journal of Pesticide Reform, "Insecticide Factsheet, Sumithrin (d-Phenothrin)," Northwest Coalition for Alternatives to Pesticides, Eugene, OR, Summer 2003, Vol 23, No. 2. http://www.pesticide.org/sumithrin.pdf

Jackson, D.; Luukinen, B.; Gervais, J.; Buhl, K.; Stone, D., *d-Phenothrin Technical Fact Sheet*; National Pesticide Information Center, Oregon State University Extension Services, Corvallis, OR (2011)

Phenoxybenzamine Hydrochloride P:0365

Formula: $C_{18}H_{22}ClNO$; $C_{18}H_{22}ClNO \cdot ClH$ (hydrochloride).

Synonyms: 688-A; Bensylyt NEN; Benzylamine, *N*-(2-chloroethyl)-*N*-(1-methyl-2-phenoxyethyl)-, hydrochloride Benzenemethanamine, *N*-(2-chloroethyl)-*N*-(1-methyl-2-phenoxyethyl)-, hydrochloride; 2-(*N*-Benzyl-2-chloroethylamino)-1-phenoxypropane hydrochloride; Benzyl (2-chloroethyl)(1-methyl-2-phenoxyethyl)amine hydrochloride; *N*-Benzyl-N-phenoxyisopropyl-*β*-chlorethylamine hydrochloride; Blocadren; *N*-(2-Chloroethyl)-*N*-(1-methyl-2-phenoxyethyl)benzenemethanamine hydrochloride; *N*-(2-Chloroethyl)-N-(1-methyl-2-phenoxyethyl)benzylamine, hydrochloride; Dibenzyline hydrochloride; Dibenzyran; Fenossibenzamina; Fenoxybenzamin; NCI-C01661; Phenoxybenzamide chloride; *N*-Phenoxyisopropyl-*N*-benzyl-*β*-chloroethylamine hydrochloride; *N*-2-Phenoxyisopropyl-*N*-benzyl-chloroethylamine hydrochloride; SKF 688A

CAS Registry Number: 63-92-3

HSDB Number: 4005

RTECS Number: DP3750000

UN/NA & ERG Number: UN3249 (Medicine, solid, toxic, n.o.s.)/151

EC Number: 200-269-7

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Animal Sufficient Evidence; Human Limited Evidence*, possibly carcinogenic to humans*, Group 2B

California Proposition 65 Chemical[102]: Cancer, 4/1/1988

Hazard Alert: Poison, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard.

Hazard Symbols, Risk & Safety statements:1 Hazard Symbol: T; Risk phrases: R45; R22; R40; R62; R63; Safety phrases: S22; S36/36/39; S41; S45 (see Appendix 4).

Description: White crystalline solid or powder. Odorless. Molecular weight = 340.32; Boiling point = 382°C; Freezing/Melting point = 138−140°C (hydrochloride); Flash point = 185°C. Practically insoluble in water; solubility = <0.1 mg/mL @ 20°C.

Potential Exposure: Used as an antihypertensive drug.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Sensitive upon exposure to light and air. May form unstable and explosive peroxides upon standing.

Routes of Entry: Ingestion, inhalation

Harmful Effects and Symptoms

Short-Term Exposure: Symptoms of exposure to this compound include nasal congestion, miosis, postural hypotension, tachycardia, gastrointestinal irritation, drowsiness and fatigue. May cause contact dematitis. LD_{50} = (oral-rat) <1 g/kg.

Long-Term Exposure: May cause cancer. Possible gastrointestinal tumors. Possible acute renal failure and acute tubular necrosis.

Points of Attack: Gastrointestinal system. Kidney, ureter, bladder.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method* if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed.

Personal Protective Methods: Wear positive pressure SCBA (SCBA). Wear chemical protective clothing that is specifically recommended by the manufacturer. It may provide little or no thermal protection. Structural firefighters' protective clothing provides limited protection in fire situations ONLY; it is not effective in spill situations where direct contact with the substance is possible.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA-or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA)

Storage: Color code-Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. Sensitive to exposure to light and air. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration is not a danger.

Shipping: UN3249 Medicine, solid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 meters/150 feet for liquids and at least 25 meters/75 feet for solids. Keep unauthorized personnel away. Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Stay upwind. Keep out of low areas. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Stop leak if you can do it without risk. Prevent entry into waterways, sewers, basements or confined areas. Cover with plastic sheet to prevent spreading. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Noncombustible. Thermal decomposition products may include hydrogen chloride and oxides of nitrogen and carbon. Containers may explode when heated. Runoff from fire control or dilution water may be corrosive and/or toxic and may cause pollution. Runoff may pollute waterways. If tank, rail car or tank truck is involved in a fire, ISOLATE for 800 meters/0.5 in all directions; also, consider initial evacuation for 800 meters/0.5 in all directions. Small Fire: Use dry chemical, CO_2 or water spray. *Large Fire*: Water spray, fog or regular foam. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal; do not scatter the material. Use water spray or fog; do not use straight streams. *Fire involving Tanks or Car/Trailer Loads:* Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Do not get water inside containers. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. *Always* stay away from tanks engulfed in fire. For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn. *Do not* get water inside containers.

Disposal Method Suggested: Use a licensed professional waste disposal service to dispose of this material. Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed. It is inappropriate and possibly dangerous to the environment to dispose of expired or waste pharmaceuticals by flushing them down the toilet or discarding them to the trash. Household quantities of expired or waste pharmaceuticals may be mixed with wet cat litter or coffee grounds, double-bagged in plastic, discard in trash. Larger quantities shall carefully take into consideration applicable DEA, EPA, and FDA regulations. If possible return the pharmaceutical to the manufacturer for proper disposal being careful to properly label and securely package the material. Alternatively, the waste pharmaceutical shall be labeled, securely packaged and transported by a state licensed medical waste contractor to dispose by burial in a licensed hazardous or toxic waste landfill or incinerator.

References

(109); (102); (31); (173); (101); (138).

Phenylcarbylamine Chloride P:0368

Formula: $C_7H_5Cl_2N$

Synonyms: Carbonimidic dichloride, phenyl-; *N*-(Dichloromethylene)aniline; Imidocarbonyl chloride, phenyl-; Phenylcarbonimidic dichloride; *N*-Phenyl-carbonimidic dichloride; Phenyl carbylamine chloride; Phenylimidocarbonyl chloride; *N*-Phenylimidophosgene; Phenyliminocarbonyl dichloride; *N*-Phenyliminocarbonyl dichloride; Phenylisonitrile dichloride

CAS Registry Number: 622-44-6

HSDB Number: 1255

RTECS Number: NJ6700000

UN/NA & ERG Number: (PIH) UN1672/151

EC Number: 210-735-0 [*Annex I Index No.:* 622-44-6]

Regulatory Authority and Advisory Information

Hazard Alert: Poison inhalation hazard, Combustible, Corrosive, Lacrimator, Water reactive (corrosive fumes).

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Hazard Symbols, Risk & Safety statements:1 Hazard Symbol: T, F, Xn; Risk phrases: R10; R23; R20/21/22; R29; R34; R35; R36/37/38; Safety phrases: S26; S36/37/39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class):

Description: An oily, clear to pale -yellow liquid. Onion-like odor. Molecular weight = 174.03; Density 1.265 g/cm^3. Specific gravity (H_2O:1) = 1.29 @ 20°C; Boiling point = 210°C; Freezing/Melting point = 196°C; Flash point = 79°C (cc). Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 0₩. Insoluble in water; slow decomposition with release of hydrogen chloride.

Potential Exposure: Phenylcarbylamine is used in organic synthesis; making other chemicals. A laboratory chemical and a former battlefield gas.

Incompatibilities: Reacts slowly with water releasing hydrogen chloride. Sealed containers stored at room temperature may explode, due to slow decomposition that builds up pressure. Heat increases the danger of explosion [101]. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. alcohols.

Determination in Water: Octanol-water coefficient: Log K_{ow} = 2.5−2.9. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, ingestion, skin and eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Phenylcarbylamine chloride is a potent vesicant/lacrimator. It may be fatal if inhaled, ingested, or through extended skin contact. Highly irritating to the eyes, skin, and respiratory tract. May be absorbed through the unbroken skin. Effects of contact or inhalation may be delayed. Inhalation exposure can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. TCLo = (inhal., human) 7 ppm/10M[NTIS]

Long-Term Exposure: Information on the chemical, physical, and health effects of this chemical are limited.

Points of Attack: Respiratory system.

Medical Surveillance: Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a drug or other inhalation therapy. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. Evaluation by a qualified allergist, including exposure history and testing, may help diagnose allergy. Any employee developing the above-listed conditions should be referred for further medical examination[9].

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method* if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed.

Personal Protective Methods: Wear positive pressure SCBA. Wear chemical protective clothing that is specifically recommended by the manufacturer. It may provide little or no thermal protection. Structural firefighters' protective clothing provides limited protection in fire situations ONLY; it is not effective in spill situations where direct contact with the substance is possible. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Respirator Selection: Where risk assessment shows air-pruifying respirators are appropriate, use a full-face respirator type (N100) United States or Type P3 (EN-143) respirators as backup to engineering controls. If the respirator is the sole means of protection, use a full-face supplied respirator. Use respirators and components tested and approved under appropriate government standards such aas NIOSH (US) or CEN (EU).

Storage: Poison inhalation chemical (PIH); check oxygen content prior to entering storage area. Color code-Blue: Health Hazard/Toxics/Poisons: Store in a secure, cool, poison location. Refrigerate. This material is somewhat volatile emits poisonous gas when heated; keep it out of direct sun and UV rays. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration is not a danger.

Shipping: UN1672 Phenylcarbylamine chloride, Hazard class: 6.1; Labels: 6.1-Poison Inhalation Hazard; Inhalation Hazard Zone B. PGI.

Spill Handling: Although zzzxxx listed in the current Emergency Response Guide, the following is listed for reference.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.1/0.2

As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 meters/150 feet for liquids and at least 25 meters/75 feet for solids. Keep unauthorized personnel away. Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Stay upwind. Keep out of low areas. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Stop leak if you can do it without risk. Prevent entry into waterways, sewers, basements or confined areas. Cover with plastic sheet to prevent spreading. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include hydrogen chloride and oxides of nitrogen and carbon. Non-combustible, substance itself does not burn but may decompose upon heating to produce corrosive and/or toxic fumes. Containers may explode when heated. Runoff from fire control or dilution water may be corrosive and/or toxic and may cause pollution. Runoff may pollute waterways. If tank, rail car or tank truck is involved in a fire, ISOLATE for 800 meters/0.5 in all directions; also, consider initial evacuation for 800 meters/0.5 in all directions. Small Fire: Use dry chemical, CO_2 or water spray. *Large Fire*: Water spray, fog or regular foam. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal; do not scatter the material. Use water spray or fog; do not use straight streams. *Fire involving Tanks or Car/Trailer Loads:* Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Do not get water inside containers. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. *Always* stay away from tanks engulfed in fire. For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn. *Do not* get water inside containers.

Disposal Method Suggested: Use a licensed professional waste disposal service to dispose of this material. Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed. It is not appropriate to dispose of expired or waste product such as lab chemicals by flushing them down the toilet or discarding them to the trash. Larger quantities shall carefully take into consideration applicable EPA, and FDA regulations. If possible return the lab chemicals to the manufacturer for proper disposal being careful to properly label and securely package the material. Alternatively, the waste lab chemicals shall be labeled, securely packaged and transported by a state licensed medical waste contractor to dispose by burial in a licensed hazardous or toxic waste landfill or incinerator. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Phenyldichloroarsine, #1494, Trenton, NJ (January 2002)

Phenyl Dichloroarsine (Agent PD)
P:0370

Formula: $C_6H_5AsCl_2$

Synonyms: Arsine, dichlorophenyl-; Arsonous dichloride, phenyl-; Diclorofenilarsina (Spanish); Dichloropheynylarsine; EPA No. E17001603; PD (military designation); Phenylarsinedichloride; Phenylarsonous dichloride; Phenyl arsonous dichloride; Phenyldichloroarsine

CAS Registry Number: 696-28-6

HSDB Number: 6043

RTECSNumber: CH5425000

UN/NA & ERG Number: (PIH) UN3280 (organoarsenic compound, n.o.s.)/151; UN1556/152

EC Number: 211-791-9 [*Annex I Index No.:* 033-002-00-5]

Regulatory Authority and Advisory Information

Carcinogenicity: DFG, Carcinogen, Category 3B, suspected, possibly carcinogenic.
Hazard Alert: Poison inhalation hazard: exposure can be lethal, Flammable, Strong reducing agent, Dangerously water and air reactive, Lacrimator, Environmental hazard.
United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P036
RCRA, 40CFR261, Appendix 8 Hazardous Constituents
Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500 lb (227 kg)
Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 1 lb (0.454 kg)
United States DOT 49CFR172.101, Inhalation Hazardous Chemical
Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.
Hazard Symbols, Risk & Safety statements: Hazard Symbol: T+, N; Risk phrases: R40; R23; R25; R50/53; Safety phrases: S1/2; S20/21; S28; S29; S41; S45; S60; S61 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]
As arsenic compounds:
Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) as arsenic compounds
Clean Water Act: Toxic Pollutant (Section 401.15) as arsenic and compounds
RCRA, 40CFR261, Appendix 8 Hazardous Constituents, D004 (arsenic compounds)
Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 1 lb (0.454 kg)
EPCRA (Section 313): Includes any unique chemical substance that contain arsenic as part of that chemical's infrastructure; Form R *de minimis* concentration reporting level: organics 1.0%.
United States DOT Regulated Marine Pollutant (49CFR172.101, appendix B)
Canada: Priority Substance List & Restricted Substances/Ocean Dumping FORBIDDEN (CEPA), National Pollutant Release Inventory (NPRI) (arsenic compounds).

Description: Phenyldichloroarsine is a colorless or light yellow liquid or gas. Odorless. Molecular weight = 222.93; Specific gravity (H_2O:1) = 1.65 @ 20°C; Boiling point = 254°C; Freezing/Melting point = −16°C; Flash point = 16°C; Vapor pressure = 0.021 mmHg @ 20°C;. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 2, Reactivity 2₩. Reaction with water; insoluble.

Potential Exposure: Phenyldichloroarsine is an organoarsenic compound used in organic synthesis and as a solvent. PD has been used as a military tear gas, vesicant and blister agent.

Incompatibilities: Contact with water forms HCl. Heat produces fumes of arsenic and chlorine. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Attacks some metals in the presence of moisture.

Permissible Exposure Limits in Air:
arsenic, organic compounds
NIOSH IDLH = 5 mg[As]/m^3
OSHA PEL: 0.5 mg[As]/m^3 TWA
NIOSH REL: Not established. See NIOSH Pocket Guide, Appendix A
ACGIH TLV[1]: 0.01 mg[As]/m^3 TWA; Confirmed Human Carcinogen; BEI established.
Protective Action Criteria (PAC)* Ver. 29[138]
phenyl dichloroarsine; dichlorophenylarsine
PAC-1: 0.0055 milligram per cubic meter
PAC-2: **0.061**$_{\mathbf{A}}$ milligram per cubic meter
PAC-3: **0.18**$_{\mathbf{A}}$ milligram per cubic meter
*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.
DFG MAK: Carcinogen Category 3B; See section X(a)

Determination in Air: Filter; Reagent: Ion chromatography/hydride atomic absorption: NIOSH IV [#5022, Arsenic, organo-](18).

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 10 μg[As]/L; State Drinking Water Guidelines: Arizona 10 μg[As]/L; Connecticut 10 μg[As]/L EPA Maximum Contaminant Level (MCL): 0.010 mg[As]/L [40 CFR 141.62]. Canadian Drinking Water Standards: IMAC 0.025 [As] mg/L.

Determination in Water: *For arsenic:* The atomic absorption graphite furnace technique is often used for measurement of total arsenic in water. It also has been standardized by EPA. Total arsenic may be determined by digestion followed by silver diethyldithiocarbamate; an alternative is atomic absorption; another is inductively coupled plasma optical emission spectrometry. See OSHA Method #ID-105 for arsenic[58]

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Phenyldichloroarsine reacts with many enzymes which damages the body. Phenyldichloroarsine will blind you and blister your skin severely, and with enough it will kill. You will know that you've been exposed when you feel immediate pain and you begin to vomit violently. Contact may cause burns to skin and eyes. Strong irritant to eyes, skin, and tissue. Corrosive if swallowed. Poisonous; may be fatal if inhaled, swallowed, or absorbed through skin. Vomiting and blistering are among symptoms of exposure. The median lethal dosage is 2600 mg-minute/m^3. The mean incapacitating dosage is 16 mg-minute/m^3 as a vomiting agent and 1800 mg-minute/m^3 as a blistering agent. 633 mg-minute/m^3 produces eye injury.

Long-Term Exposure: In animals: kidney damage; muscle tremor, seizure; possible gastrointestinal tract; reproductive effects; possible liver damage

Points of Attack: Skin, respiratory system; kidneys, CNS; liver, gastrointestinal tract; reproductive system.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Test for urine arsenic. Levels should not be greater than 100 micrograms per gram of creatinine in the urine. Examine the skin for abnormal growths. Liver and kidney function tests. Lung function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Note to physician: For severe poisoning BAL (British Anti-Lewisite), dimercaprol, dithiopropanol ($C_3H_8OS_2$) has been used to treat toxic symptoms of certain heavy metals poisoning—including arsenic. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5). For milder poisoning *penicillamine (not penicillin)* has been used, both with mixed success. Side effects occur with such treatment and it is never a substitute for controlling exposure. It can only be done under strict medical care.

Decontamination: This is very important, and you have to decontaminate as soon as you can. Extra minutes before decontamination might make a big difference. If you don't have the equipment and training don't enter the hot or the warm zone to rescue and decontaminate victims. If the victim can't move, decontaminate without touching and without entering the hot or the warm zone. Use clean water from any source; if possible, use a hose (spray or fog to prevent injury to the victim) or other system so that you won't have to touch the victim; don't even wait for soap or for the victim to remove clothing, begin washing immediately. Immediately flush the eyes with water for at least 15 minutes. Use caution to avoid hypothermia in children and the elderly. Wash—strip—wash—evacuate up wind and uphill: The approach is to immediately wash with water, then have the victim (not the first responder) remove all the victim's clothing, then wash again (with soap if available) and then move away from the hot zone in an upwind and up hill direction. Wash the victim with warm water and soap. Decontaminate with diluted household bleach (0.5%, or one part bleach to 200 parts water), but don't let any get in the victim's eyes, open wounds, or mouth. Wash off the diluted bleach solution after 15 minutes. Be sure you've decontaminated the victims as much as you can before they leave the area so that they don't spread the phenyldichloroarsine. Use the antidote "Anti-Lewisite." See above under "First Aid." Use 5% solution of common bleach (sodium hypochlorite) or calcium hypochlorite solution (48 ounces per 5 gallons of water) to decontaminate scissors used in clothing removal, clothes and other items.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Based on potential carcinogenicity the following is recommended by NIOSH: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area away from oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN3280 Organoarsenic compound, liquid, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required, Potential Inhalation Hazard (Special Provision 5). UN1556 Arsenic compounds, liquid, n.o.s. inorganic, including arsenates, n.o.s.; arsenites, n.o.s.; arsenic sulfides, n.o.s.; and organic compounds of arsenic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. Military driver shall be given full and complete information regarding shipment and conditions in case of emergency. AR 50-6 deals specifically with the shipment of chemical agents. Shipments of agent will be escorted in accordance with AR 740-32.

Spill Handling:

Agent PD when used as a weapon

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.2/0.3
Night 0.7/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 1000/300
Then: Protect persons downwind (miles/kilometers)
Day 1.1/1.8
Night 2.8/4.5

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.1/0.2

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include hydrogen chloride, arsenic fumes and oxides of carbon. Phenyl dichloroarsine may burn but does not ignite readily. Burned phenyl dichloroarsine is safer better than the unburned product. In case of fire, evacuate the area. If there is some reason that you have to put out the fire—for example, there are things you can't let burn nearby—use unattended equipment. You can fight phenyl dichloroarsine fires with water streams, water fog; ordinary foam; universal foam; and, for confined fires, carbon dioxide. Remember that phenyl dichloroarsine breaks down in water, forming toxic hydrochloric acid and arsenic chemicals. Wear positive pressure breathing apparatus. Move container from fire area if you can do it without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Water produces corrosive chlorine fumes. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to

fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (85); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Phenyl Dichloroarsine, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Phenyldichloroarsine, #1494, Trenton, NJ (August 2000)

m-Phenylenediamine P:0380

Formula: $C_6H_8N_2$

Synonyms: AI3-52607; 3-Aminoaniline; *m*-Aminoaniline; *meta*-Aminoaniline; Aminoaniline, *meta*-; Apco 2330; *meta*-Benzenediamine; *m*-Benzenediamine; 1,3-Benzenediamine; Benzene, 1,3-diamino-; C.I. 76025; C.I. Developer 11; Developer 11; Developer C; Developer H; Developer M; *meta*-Diaminobenzene; *m*-Diaminobenzene; 1,3-Diaminobenzene; Direct brown BR; Direct brown GG; 1,3-Fenilendiamina (Spanish); *m*-Fenilendiamina (Spanish); Metaphenylenediamine; 3-Phenylenediamine; *m*-Phenylenediamine; Phenylenediamine, *meta-*

CAS Registry Number: 108-45-2

HSDB Number: 5384

RTECS Number: SS7700000

UN/NA & ERG Number: UN1673/153

EC Number: 203-584-7 [*Annex I Index No.:* 612-147-00-3] (*m-*)

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Inadequate Evidence; Human No Adequate Data, *not classifiable as carcinogenic to humans*, Group 3, 1987. United States Environmental Protection Agency Gene-Tox Program, Positive: SHE-clonal assay; Histidine reversion-Ames test; Inconclusive: Rodent dominant lethal.

Hazard Alert: Poison, Combustible, Poison, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Sensitization hazard (skin), Primary irritant (w/o allergic reaction), Environmental hazard.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements:1 Hazard Symbol: T, N, Xi; Risk phrases: R20/21; R25; R3637/38; R40; R43; R50/53; R61; R62; R63; R68; Safety phrases: S1/2; S28; S29/35; S36/37; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: *m*-Phenylenediamine is a colorless to white crystalline substance that turns red upon exposure to air. Molecular weight = 108.16; Specific gravity (H_2O:1) = 1.14 g/cm^3 @ 20°C; Boiling point = 287°C; Freezing/Melting point = 64−66°C; Vapor pressure = 1 mmHg @ 100°C; Flash point = 137.8°C; Autoignition temperature = 555°C. Hazard Identification (based on NFPA-704 M Rating System): Health 0, Flammability 2, Reactivity 0. Soluble in water.

Potential Exposure: Used in making various dyes; as a curing agent for epoxy resin; rubber, textile fibers; urethanes, corrosion inhibitors; adhesives; in photographic and analytical procedures and processes.

Incompatibilities: Dust may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, acid chlorides; acid anhydrides; chloroformates. Heat and light contribute to instability. Keep away from metals.

Permissible Exposure Limits in Air:

ACGIH TLV[1]: 0.1 milligram per cubic meter TWA [skin]; A4, not classifiable as a human carcinogen

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 0.3 milligram per cubic meter

PAC-2: 21 milligram per cubic meter

PAC-3: 130 milligram per cubic meter

DFG MAK: [skin]; Carcinogen Category 3B

Austria [skin], Suspected: carcinogen, 1999; Denmark: TWA 0.1 milligram per cubic meter, 1999; Norway: TWA 0.1 milligram per cubic meter, 1999; Switzerland: MAK-W 0.1 milligram per cubic meter, [skin], 1999; the Netherlands: MAC-TGG 0.1 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen

Determination in Air: Use OSHA Analytical Method 87.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Contact can irritate the eyes and skin. Irritates the respiratory tract causing coughing, wheezing and/or shortness of breath. May affect the blood, causing the formation of methemoglobin and cyanosis with Blue coloration of the skin and lips; headache, fatigue, dizziness. High levels can cause troubled breathing; collapse and death. The *p*-isomer is more toxic and a more severe irritant than the *m*-isomers. LD_{50} = (oral-rat) 720-1600 mg/kg.

Long-Term Exposure: Repeated or prolonged contact may cause skin sensitization and allergy. If allergy develops, very low future exposure can cause itching and a skin rash. Repeated or prolonged inhalation exposure may cause asthma-like allergy. May cause kidney and liver impairment. Exposure may cause anemia.

Points of Attack: Respiratory system, skin, lungs, liver, kidneys, blood.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. CBC. Examination of the eyes and vision. Evaluation by a qualified allergist. Lung function tests. Blood methemoglobin levels. Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to Physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to this chemical of more than 0.1 milligram per cubic meter, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1673 Phenylenediamines (*o-, m-, p-*), Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; water spray; alcohol foam or polymer foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Controlled incineration whereby oxides of nitrogen are removed from the effluent gas by scrubber, catalytic or thermal device[22].

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: m*-Phenylenediamine, Trenton, NJ (August 1999)

o-Phenylenediamine P:0390

Formula: $C_6H_8N_2$

Synonyms: AI3-24343; 2-Aminoaniline; *o*-Benzenediamine; 1,2-Benzenediamine; C.I. 76010; C.I. Oxidation base 16; *o*-Diaminobenzene; 1,2-Diaminobenzene; 1,2-Fenilendiamina (Spanish); *o*-Fenilendiamina (Spanish); OPDA; Orthamine; *o*-Phenylenediamine; Phenylenediamine, ortho-; PODA

CAS Registry Number: 95-54-5

HSDB Number: 2893

RTECS Number: SS7875000

UN/NA & ERG Number: UN1673/153

EC Number: 202-430-6 [*Annex I Index No.:* 612-145-00-2]

Regulatory Authority and Advisory Information

Carcinogenicity: ACGIH: A3, Confirmed animal carcinogen with unknown relevance to humans. United States Environmental Protection Agency Gene-Tox Program, Negative: Rodent dominant lethal; *N crassa-aneuploidy*;

California Proposition 65 Chemical[102]: Cancer 5/15/1998

Hazard Alert: Poison, Combustible, Suspected of causing genetic defects, Sensitization hazard (skin), Environmental hazard.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.056; Nonwastewater (mg/kg), 5.6

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%.

Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T, N, Xi; Risk phrases: R45; R20/21; R25; R36; R43; R50/53; R62; R68; Safety phrases: S1/2; S28; S29/35; S36/37; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: *o*-Phenylenediamine is a white to brownish crystalline substance that turns red upon exposure to air. Molecular weight = 108.2; Boiling point = 257°C; Freezing/Melting point = 103.89°C; Flash point = 136.1 [101]; 156°C(cc). Explosive limits: LEL: 1.5%; UEL: unknown; Hazard Identification (based on NFPA-704 M Rating System): Health32, Flammability 1, Reactivity 0. Slightly soluble in water.

Potential Exposure: Used as an intermediate in the making of dyes; pesticides, pharmaceuticals, and rubber chemicals; in making fungicides and other chemicals; in photographic and analytical procedures and processes.

Incompatibilities: Dust may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, acid chlorides; acid anhydrides; chloroformates. Heat and light contribute to instability. Keep away from metals; 1,2-PHENYLENEDIAMINE a weak aromatic amine base neutralizes acids in exothermic reactions to form salts. May be incompatible with isocyanates, halogenated organics, peroxides, phenols (acidic), epoxides, anhydrides, and acid halides. Darkens on exposure to air (Roger Patrick, DuPont Engineer)[101].

Permissible Exposure Limits in Air:

ACGIH TLV[1]: 0.1 milligram per cubic meter TWA [skin]; confirmed animal carcinogen with unknown relevance to humans.

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 0.3 milligram per cubic meter

PAC-2: 35 milligram per cubic meter

PAC-3: 210 milligram per cubic meter

DFG MAK: [skin] Danger of skin sensitization; Carcinogen Category 3B

Austria: carcinogen, 1999; Denmark: TWA 0.1 milligram per cubic meter, 1999; Norway: TWA 0.1 milligram per cubic meter, 1999; Switzerland: MAK-W 0.1 milligram per cubic meter, [skin], carcinogen, 1999

Determination in Air: Use OSHA Analytical Method 87.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Contact can irritate the eyes and skin. Eye contact may cause permanent damage. Irritates the respiratory tract causing coughing, wheezing and/or shortness of breath. May affect the blood, causing the formation of methemoglobin and cyanosis with Blue coloration of the skin and lips. Can cause stomach ache, headache, fatigue, dizziness, shaking and convulsions. The *p*-isomer is more toxic and a more severe irritant than the *o*-isomers.

Long-Term Exposure: Repeated or prolonged contact may cause skin sensitization and allergy. If allergy develops, very low future exposure can cause itching and a skin rash. Repeated or prolonged inhalation exposure may cause asthma-like allergy. May cause kidney and liver impairment. Exposure may cause anemia.

Points of Attack: Respiratory system, skin, lungs, liver, kidneys, blood.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. CBC. Examination of the eyes and vision. Evaluation by a qualified allergist. Lung function tests. Blood methemoglobin levels. Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure,

begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to Physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to this chemical of more than 0.1 milligram per cubic meter, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers. Where possible, automatically transfer material from drums or other storage containers to process containers Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1673 Phenylenediamines (*o-, m-, p-*), Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; water spray; alcohol foam or polymer foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs *that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Controlled incineration whereby oxides of nitrogen are removed from the effluent gas by scrubber, catalytic or thermal device[22].

References

(102); (31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* o-Phenylenediamine, Trenton, NJ (August 1999)

p-Phenylenediamine P:0400

Formula: $C_6H_8N_2$; $H_2NC_6H_4NH_2$

Synonyms: 4-Aminoaniline; *p*-Aminoaniline; BASF Ursol D; *p*-Benzenediamine; 1,4-Benzenediamine; Benzofur D; C.I. 76060; C.I. Developer 13; C.I. Oxidation base 10; Developer PF; *p*-Diaminobenzene; 1,4-Diaminobenzene; 1,4-Diaminobenzol; Durafur black R; 1,4-Fenilendiamina (Spanish); *p*-Fenilendiamina (Spanish); Fouramine D; Fourrine 1; Fourrine D; Fur black 41867; Fur brown 41866; Furro D; Fur yellow; Futramine D; Nako H; Orsin; Pelagol D; Pelagol gray D; Peltol D; 1,4-Phenylenediamine; Phenylene diamine, para-; PPD; Renal PF; Santoflex IC; Tertral D; Ursol D; Vulkanox 4020; Zoba black D

hydrochloride: 1,4-Aminoaniline dihydrochloride; 1,4-Benzenediamine dihydrochloride; 1,4-Phenylenediame dihydrochloride

CAS Registry Number: 106-50-3; 624-18-0 (dihydrochloride)

HSDB Number: 2518

RTECS Number: SS8050000

UN/NA & ERG Number: UN1673/153

EC Number: 203-404-7 [*Annex I Index No.:* 612-028-00-6]; 210-834-9 [*Annex I Index No.:* 612-029-00-1] (*p*-phenylenediamine dihydrochloride)

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Inadequate Evidence; Human No Adequate Data*, not classifiable as carcinogenic to humans*, Group 3, 1978. United States Environmental Protection Agency Gene-Tox Program, Positive: Cell transformation-RLV F344 rat embryo; Positive: Cell transformation-SA7/SHE; D *melanogaster* sex-linked lethal; Negative: Carcinogenicity-mouse/rat; Rodent dominant lethal; Negative: *N crassa-aneuploidy*; Sperm morphology-mouse; Inconclusive: Mammalian micronucleus. DFG Carcinogen Category: 3B

Hazard Alert: Poison, Combustible, Strong reducing agent, Possible risk of forming tumors, Suspected of causing genetic defects, Environmental hazard, Sensitization hazard (skin), Primary irritant (w/o allergic reaction).

Banned or Severely Restricted (several countries) (UN)[13]

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

RCRA 40CFR264, appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 1 lb (0.454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

European/International Regulations (*includes dihydrochloride*): Hazard Symbol: T, N, Xi; Risk phrases: R40; R23/24/25; R36/37/38; R43; R50/53; R62; Safety phrases: S1/2; S28; S29/35; S36/37/38; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: *p*-Phenylenediamines are white to slightly red crystalline solids. They have been described as gray "light brown" which may result from exposure to air. Molecular weight = 108.14; 181.06 (dihydrochloride); Specific gravity (H_2O:1) = 1.1; Boiling point = 267°C (sublimes); Freezing/Melting point = 112.22°C[101]; Vapor pressure = < 1 mmHg @ 25°C; Flash point = 153.89°C; Autoignition temperature = 400°C. Explosive limits: LEL = 1.5%; UEL-unknown. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Slightly soluble in water; solubility = 4% @ 25°C.

Potential Exposure: *p*-Phenylenediamine has been used in dyestuff manufacture, in hair dyes; in photographic developers; in synthetic fibers; polyurethanes, and as a monomer and in the manufacture of improved tire cords. Also used as a gasoline additive and in making antioxidants.

Incompatibilities: Dust may form explosive mixture with air. A strong reducing agent. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, acid chlorides; acid anhydrides; chloroformates, and strong bases. Incompatible with organic anhydrides; isocyanates, aldehydes. Heat and light contribute to instability. Keep away from metals.

Permissible Exposure Limits in Air:

NIOSH IDLH = 25 milligram per cubic meter

OSHA PEL: 0.1 milligram per cubic meter TWA[skin]

NIOSH REL: 0.1 milligram per cubic meter TWA [skin]

ACGIH TLV[1]: 0.1 milligram per cubic meter TWA; not classifiable as a human carcinogen

Protective Action Criteria (PAC) Ver. 29[138]

106-50-3

PAC-1: 0.3 milligram per cubic meter

PAC-2: 6.8 milligram per cubic meter

PAC-3: 41 milligram per cubic meter

624-18-0, dihydrochloride

PAC-1: 0.44 milligram per cubic meter

PAC-2: 4.9 milligram per cubic meter

PAC-3: 29 milligram per cubic meter

DFG MAK: 0.1 milligram per cubic meter, measured as the, inhalable fraction TWA; Peak Limitation Category II (2); [skin], danger of skin sensitization; Carcinogen Category 3; Pregnancy Risk Group C

Australia: TWA 0.1 milligram per cubic meter, [skin], 1993; Austria: MAK 0.1 milligram per cubic meter, [skin], Suspected: carcinogen, 1999; Belgium: TWA 0.1 milligram per cubic meter, [skin], 1993; Denmark: TWA 0.1 milligram per cubic meter, [skin], 1999; Finland: TWA 0.1 milligram per cubic meter; STEL 0.3 milligram per cubic meter, [skin], 1999; France: VME 0.1 milligram per cubic meter, [skin], 1999; the Netherlands: MAC-TGG 0.1 milligram per cubic meter, [skin], 2003; the Phillipines: TWA 0.1 milligram per cubic meter, [skin], 1993; Poland: MAC (TWA) 0.1 milligram per cubic meter; MAC (STEL) 0.3 milligram per cubic meter, 1999; Russia: STEL 0.05 milligram per cubic meter, 1993; Sweden: NGV 0.1 milligram per cubic meter, KTV 0.3 milligram per cubic meter, [skin], 1999; United Kingdom: TWA 0.1 milligram per cubic meter, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Several states have set guidelines or standards for *p*-phenylenediamine in ambient air[60] ranging from 0.33 μ/m^3 (New York) to 1.0 μ/m^3 (Florida, North Dakota, South Carolina) to 1.6 μ/m^3 (Virginia) to 2.0 μ/m^3 (Connecticut and Nevada).

Determination in Air: Use OSHA Analytical Method 87.

Permissible Concentration in Water: Russia[35,43] set a MAC in surface water of 0.1 mg/L.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Contact can severely irritate and burn the eyes and skin. May cause permanent eye damage. Irritates the respiratory tract causing coughing, wheezing, and/or shortness of breath. Inhalation of dust may irritate the pharynx and larynx; bronchia asthmatic reactions. Swelling of mouth and throat may be observed following ingestion. Exposure can cause abdominal pain; nausea, high blood pressure, dizziness, seizures, and even coma. May affect the blood, causing the formation of methemoglobin and cyanosis with Blue coloration of the skin and lips, headache, fatigue, dizziness. High levels can cause troubled breathing; collapse and death. The *p*-isomer is more toxic and a more severe irritant than the *o*- and *m*-isomers.

Long-Term Exposure: Repeated or prolonged contact may cause skin sensitization and allergy. If allergy develops, very low future exposure can cause itching and a skin rash. Repeated or prolonged inhalation exposure may cause asthma-like allergy. May cause kidney and liver impairment. Repeated high exposure can cause cataracts. Exposure may cause anemia.

Points of Attack: Respiratory system, skin, lungs, liver, kidneys, blood.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Consider the points of attack in preplacement and periodic physical examinations. CBC. Examination of the eyes and vision. Evaluation by a qualified allergist. Lung function tests. Blood methemoglobin levels. Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water or a slurry of activated charcoal in water; and induce vomiting. Do not make an unconscious person vomit.

Note to Physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 2.5 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *Up to 5 milligram per cubic meter:* SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 25 milligram per cubic meter:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted canister providing protection against the compound of concern and having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA). *Note:* Causes eye irritation and damage; eye protection needed.

Storage: (1) Color code-Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. (2) Color code-Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in a area isolated from flammables, combustibles, or other yellow coded materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration is not a danger. Store in tightly closed containers in a cool, well ventilated area away from oxidizers, strong acids; acid chlorides; acid anhydrides; chloroformates and metals. Where possible, automatically transfer material from drums or other storage containers to process containers.

Shipping: UN1673 Phenylenediamines (*o-, m-, p-*), Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Establish forced ventilation to keep levels below explosive limit. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; water spray; alcohol foam or polymer foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Controlled incineration whereby oxides of nitrogen are removed from the effluent gas by scrubber, catalytic or thermal device[22].

References

(31); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Phenylenediamines, Washington, DC (June 1, 1978)

(173); (101); (138).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: p*-Phenylenediamine, Trenton, NJ (September, 1999)

Phenyl Glycidyl Ether P:0410

Formula: $C_9H_{10}O_2$

Synonyms: 1,2-Epoxy-3-phenoxypropane; 2,3-Epoxypropylphenyl ether; Glycidyl phenyl ether; PGE; Phenol-glycidaether (German); Phenol glycidyl ether; 3-Phenoxy-1,2-epoxypropane; Phenoxypropene oxide; Phenoxypropylene oxide; Phenyl-2,3-epoxypropyl ether

CAS Registry Number: 122-60-1

HSDB Number: 1821

RTECS Number: TZ3675000

UN/NA & ERG Number: UN2810 (toxic liquid, organic, n.o.s.)/153 (P)

EC Number: 204-557-2 [*Annex I Index No.:* 603-067-00-X]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Sufficient Evidence; Human No Adequate Data, *possibly carcinogenic to humans*, Group 2B, 1999; NIOSH: Potential occupational carcinogen. United States Environmental Protection Agency Gene-Tox Program, Positive: SHE-focus assay

California Proposition 65 Chemical[102]: Cancer 10/1/1990. *Developmental/Reproductive toxin, male delisted 4/4/2014*.

Hazard Alert: Poison, Combustible, Combustible, Possible polymerization hazard, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction), Sensitization hazard, Environmental hazard.

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T, N, Xi; Risk phrases: R45; R20; R36/37/38; R43; R68; R52/53; R62; R63; Safety phrases: S29/35; S41; S45; S53; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Phenyl glycidyl ether is a colorless liquid with an unpleasant sweet odor. Molecular weight = 150.19; Specific gravity (H_2O:1) = 1.11; Boiling point = 245°C; Freezing/Melting point = 3.3°C; Vapor pressure = 0.01 mmHg @ 20°C; Flash point = 120°C. Explosive limits: LEL = 1.1%; UEL-unknown. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Slightly soluble in water; solubility = 0.24% @ 20°C.

Potential Exposure: PGE is used to increase storage time and stability of halogenated compounds; as a reactive diluent in uncured epoxy resins to reduce the viscosity of the uncured system for ease in casting; adhesive, and laminating applications. NIOSH once estimated that 8000 workers are potentially exposed to PGE.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, amines, and curing agents. PGE can presumably form explosive peroxides.

Permissible Exposure Limits in Air:

NIOSH IDLH = 100 ppm, potential occupational carcinogen.

Conversion factor: 1 ppm = 6.14 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 10 ppm/60 milligram per cubic meter TWA

NIOSH REL: 1 ppm/6 milligram per cubic meter [15-min.] Ceiling Concentration; A potential occupational carcinogen. [skin]; Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV[1]: 0.1 ppm TWA [skin] danger of skin sensitization; confirmed animal carcinogen with unknown relevance to humans.

Protective Action Criteria (PAC) not available

DFG MAK: [skin], danger of skin sensitization; Carcinogen Category 2

Australia: TWA 1 ppm (6 milligram per cubic meter), 1993; Austria: [skin], carcinogen, 1999; Belgium: TWA

1 ppm (6.1 milligram per cubic meter), 1993; Denmark: TWA 1 ppm (5 milligram per cubic meter), 1999; Finland; STEL 10 ppm (60 milligram per cubic meter), [skin], 1999; France: VME 1 ppm (6 milligram per cubic meter), 1999; Norway: TWA 1 ppm (5 milligram per cubic meter), 1999; the Phillipines: TWA 10 ppm (62 milligram per cubic meter), 1993; Poland: MAC (TWA) 0.6 milligram per cubic meter; MAC (STEL) 3 milligram per cubic meter, 1999; Sweden: NGV 10 ppm (60 milligram per cubic meter), KTV 15 ppm (90 milligram per cubic meter), 1999; Switzerland: MAK-W 1 ppm (6 milligram per cubic meter), [skin], carcinogen, 1999; Turkey: TWA 10 ppm (60 milligram per cubic meter), 1993; United Kingdom: TWA 1 ppm (6.2 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: confirmed animal carcinogen with unknown relevance to humans. Several states have set guidelines or standards for PGE in ambient air[60] ranging from 60 μ/m^3 (Connecticut and North Dakota) to 100 μ/m^3 (Virginia) to 143 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV), Phenyl glycidyl ether.

Determination in Water: Octanol-water coefficient: Log $K_{ow} = 1.1$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: The substance irritates the eyes, skin, and the upper respiratory tract. Eye and skin irritation may be severe. Exposure could cause lowering of consciousness, with headaches; loss of concentration; dizziness and unconciousness.

Long-Term Exposure: Repeated or prolonged contact may cause skin sensitization and allergy. Possible hematopoietic, reproductive effects. A potential occupational carcinogen.

Points of Attack: Eyes, skin, CNS; hematopoietic system; reproductive system. The liquid destroys the skin's natural oils, causing dermatitis. Cancer site in animals: nasal cancer.

Medical Surveillance: NIOSH lists the following tests: pulmonary function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. butyl rubber; natural rubber, and polyvinyl alcohol are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated ina pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code -Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration is not a danger. Store in a refrigerator or in a cool, dry place. Protect from exposure to acids, bases, oxidizers, and curing agents. Where possible, automatically pump liquid from drums or other storage containers to process containers Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2810 Toxic liquids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling:

UN2810 Toxic liquids, organic, n.o.s.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.2/0.3
Night 0.7/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 1000/300
Then: Protect persons downwind (miles/kilometers)
Day 1.1/1.8
Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Follow by washing surfaces well, first with 60−70% ethanol; then with soap and with 60−70% ethanol; then with soap and water. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Concentrated waste containing no peroxides-discharge liquid at a controlled rate near a pilot flame. Concentrated waste containing peroxides-perforation of a container of the waste from a safe distance followed by open burning.

References

(102); (31); (173); (101); (138); (2); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Phenyl Glycidyl Ether, Washington, DC (1979)

National institute for Occupational Safety and Health (NIOSH), "Criteria for a Recommended Standard: Occupational Exposure to Glycidyl Ethers," NIOSH Document Number 78-166, Cincinnati OH (1978)

National institute for Occupational Safety and Health (NIOSH), Information Profiles on Potential Occupational Hazards: Glycidyl Ethers, Report PB-276,678, Rockville, pp 116−123 (October 1977)

Phenylhydrazine P:0420

Formula: $C_6H_8N_2$; $C_6H_5NHNH_2$

Synonyms: Fenilhidrazina (Spanish); Hydrazine-benzene; Hydrazinobenzene; Monophenylhydrazine

hydrochloride: Cloruro de fenilhidrazinio (Spanish); Phenylhydrazine monohydrochloride; Phenylhydrazin hydrochlorid (German); Phenylhydrazinium chloride

CAS Registry Number: 100-63-0; 59-88-1 (hydrochloride)

HSDB Number: 1117

RTECS Number: MV8925000; MV9000000 (hydrochloride)

UN/NA & ERG Number: UN2572/53

EC Number: 202-873-5 [*Annex I Index No.:* 612-023-00-9]; 200-444-7 (phenylhydrazinium chloride) [*Annex I Index No.:* 612-023-00-9]

Regulatory Authority and Advisory Information

Carcinogenicity: NIOSH: Potential occupational carcinogen.

California Proposition 65 Chemical[102]: (*Phenylhydrazine and its salts*) Cancer 7/1/1992.

Hazard Alert: Poison, Flammable, Strong reducing agent, Sensitization hazard (skin), Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Environmental hazard.

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hydrochloride:

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 1000/10,000 lb (454/4540 kg) (hydrochloride)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 1000 lb (454 kg) (hydrochloride)

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol (*includes hydrochloride*): T, F, N, Xi; Risk phrases: R45; R10; R23/24/25; R29/35; R36/38; R43; R48/23/24/25; R50; R62; R63; R68; R50; Safety phrases: S29/35; S53; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Phenylhydrazine is a colorless to pale yellow liquid or solid with a weak aromatic odor. The hydrochloride is a white to tan solid with a weak odor. Molecular weight = 108.16; 144.62 (hydrochloride); Specific gravity (H_2O:1) = 1.1 @ 20°C (base); Boiling point = (decomposes) 244°C (base); Freezing/Melting point = 20°C (base); 24°C (hemihydrate); 243−246°C (hydrochloride); Vapor pressure = 0.026 mmHg @ 25°C; Flash point = 88.9°C (cc) (base); Autoignition temperature = 174°C (base). Explosive limits: LEL = 1.1%; UEL-unknown. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 2; (*hydrochloride*). Slightly soluble in water.

Potential Exposure: Phenylhydrazine is a widely used reagent in conjunction with sugars, aldehydes, and ketones. In addition, to its use in the synthesis of dyes; pharmaceuticals, such as antipyrin; cryogenin, and pyramidone; and other organic chemicals. The hydrochloride salt is used in the treatment of polycythemia vera.

Incompatibilities: Phenylhydrazine is very reactive with carbonyl compounds, strong oxidizers; strong bases; alkali metals; ammonia, lead dioxide (violent). Attacks copper salts, nickel, and chromates.

Permissible Exposure Limits in Air:

NIOSH IDLH = 15 ppm, potential occupational carcinogen.

Conversion factor: 1 ppm = 4.42 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 5 ppm/22 milligram per cubic meter TWA [skin]

NIOSH REL: 0.14 ppm/0.6 milligram per cubic meter [120-min.] Ceiling Concentration [skin] A potential occupational carcinogen. [skin]; Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV[1]: 0.1 ppm/0.44 milligram per cubic meter TWA [skin]; confirmed animal carcinogen with unknown relevance to humans.

Protective Action Criteria (PAC) Ver. 29[138]

100-63-0, phenylhydrazine

PAC-1: 0.3 ppm

PAC-2: 6.4 ppm

PAC-3: 295 ppm

59-88-1, phenylhydrazine hydrochloride

PAC-1: 23 milligram per cubic meter

PAC-2: 250 milligram per cubic meter

PAC-3: 1500 milligram per cubic meter

DFG MAK: [skin], danger of skin sensitization; Carcinogen Category 3B

Arab Republic of Egypt: TWA 5 ppm (20 milligram per cubic meter), [skin], 1993; Australia: TWA 5 ppm (20 milligram per cubic meter); STEL 10 ppm, [skin], carcinogen, 1993; Austria: MAK 5 ppm (22 milligram per cubic meter), [skin], Suspected: carcinogen, 1999; Belgium: TWA 5 ppm (22 milligram per cubic meter); STEL 10 ppm, [skin], carcinogen, 1993; Denmark: TWA 0.1 ppm (0.6 milligram per cubic meter), [skin], 1999; Finland: STEL 5 ppm (22 milligram per cubic meter), [skin], 1999; Norway: TWA 0.6 milligram per cubic meter, 1999; the Phillipines: TWA 5 ppm (22 milligram per cubic meter), 1993; Poland: MAC (TWA) 20 milligram per cubic meter, 1999; Switzerland: MAK-W 5 ppm (22 milligram per cubic meter), [skin], 1999; Turkey: TWA 5 ppm (22 milligram per cubic meter), [skin], 1993; United Kingdom: CHAN, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: confirmed animal carcinogen with unknown relevance to humans. The Czech Republic:[35] MAC 1.0 milligram per cubic meter. Several states have set guidelines or standards for phenylhydrazine in ambient air[60] ranging from zero (North Dakota) to 66.7 μ/m^3 (New York) to 200.0 μ/m^3 (Connecticut, Florida, South Carolina and Virginia) to 476.0 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #3518.

Permissible Concentration in Water: Russia[35,43] set a MAC in water bodies used for domestic purposes of 0.01 mg/L of phenylhydrazine.

Determination in Water: Octanol-water coefficient: Log K_{ow} = 1.25. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: The dust and fumes can irritate and burn the eyes and skin. Inhalation can cause irritation, coughing, and difficult breathing. This material is poisonous if swallowed or if fumes are inhaled. Phenylhydrazine is a chronic poison. High levels can cause cyanosis and methemoglobinemia. Higher levels can cause troubled breathing; collapse, and even death. Exposure can cause headache, nausea, vomiting, lightheadedness, nervousness, shaking, seizures, and coma.

Long-Term Exposure: Repeated or prolonged contact may cause skin irritation, dermatitis, sensitization and allergy. May affect the blood, causing red cell damage, cyanosis, hemolytic anemia; kidney, and liver damage; vascular thrombosis. A potential occupational carcinogen; it may cause leukemia.

Points of Attack: Blood, respiratory system; liver, kidneys, skin. Cancer site in animals: tumors of the lungs, liver, blood vessels and intestine. May affect the bone marrow and cause leukemia.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. NIOSH lists the following tests: blood plasma, hemoglobin; CBC; liver function tests; pulmonary function tests; urine (chemical/metabolite), hemoglobin; urinalysis (routine); white blood cell count/differential. Evaluation by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to Physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-or dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive pressure mode). *Escape:* SCBAE (any appropriate escape-type, SCBA).

Storage: (1) Color code-Blue (*hydrochloride, 59-88-1*): Health Hazard: Store in a secure poison location. (2) Color code-Red Stripe (*100-63-0*): Flammability Hazard: Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 meters or a 1-hour fire wall from flammable or reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in a refrigerator under an inert atmosphere and protect from exposure to light, strong bases; ammonia, oxidizers, metal salts. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2572 Phenylhydrazine, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Avoid contact with solid and dust. Restrict access. Disperse and flush. Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Do not touch spilled material; stop leak if you can do it without risk. *Small liquid spills:* take up with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills:* collect powdered material in the most convenient and safest manner and deposit in sealed containers; move container from spill area. *Large spills:* dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid or solid, but does not easily ignite. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; alcohol foam; or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Controlled incineration whereby oxides of nitrogen are removed from the effluent gas by scrubber, catalytic or thermal device.

References

(102); (31); (173); (101); (138); (2); (100).

National institute for Occupational Safety and Health (NIOSH), “Criteria for a Recommended Standard: Occupational Exposure to Hydrazines,” NIOSH Document Number 78-172, Cincinnati OH (1978)

United States Environmental Protection Agency, Chemical Hazard Information Profile: Phenylhydrazine Hydrochloride, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Phenylhydrazine hydrochloride, Trenton, NJ (September1999)

Phenyl Isocyanate P:0430

Formula: C_7H_5NO; C_6H_5NCO

Synonyms: Carbanil; Fenylisokyanat; Isocyanic acid, Phenyl ester; Karbanil; Mondur P; Phenylcarbimide; Phenyl carbonimide

CAS Registry Number: 103-71-9

HSDB Number: 5356

RTECS Number: DA3675000

UN/NA & ERG Number: (PIH) UN2487/155

EC Number: 203-137-6

Regulatory Authority and Advisory Information

Hazard Alert: Poison inhalation hazard, Flammable liquid, Suspected reprotoxic hazard, Lacramator; Sensitization hazard (skin, lungs), Electrostatic hazard.

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T, F, Xi; Risk phrases: R10; R22; R26; R34; R37; R42/43; R51; Safety phrases: S/23; S/26; S28; S36/37/39; S38; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Phenyl isocyanate is a colorless liquid with an irritating odor. Molecular weight = 119.30; Boiling point = 160°C; Freezing/Melting point = −30°C; Flash point = 50−56°C; Autoignition temperature = >500°C. Explosive limits: LEL = 1.2%; UEL = unknown. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 2, Reactivity 0. Decomposes in water.

Potential Exposure: Phenyl isocyanate is used as a laboratory reagent and in organic synthesis.

Incompatibilities: May form explosive mixture with air. Isocyanates are highly flammable and reactive with many compounds, even with themselves. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Reaction with moist air, water or alcohols may form amines and insoluble polyureas and react exothermically, releasing toxic, corrosive or flammable gases, including carbon dioxide; and, at the same time, may generate a violent release of heat increasing the concentration of fumes in the air. Incompatible with amines, aldehydes, alkali metals, ammonia, carboxylic acids, caprolactum, alkaline materials, glycols, ketones, mercaptans, hydrides, organotin catalysts, phenols, strong acids, strong bases, strong reducing agents, urethanes, ureas. Elevated temperatures or contact with acids, bases, tertiary amines, and acyl-chlorides may cause explosive polymerization. Contact with metals may evolve flammable hydrogen gas. Attacks some plastics, rubber and coatings. Contact with metals may evolve flammable hydrogen gas. May accumulate static electrical charges, and may cause ignition of its vapors.

Permissible Exposure Limits in Air:

Protective Action Criteria (PAC)* Ver. 29[138]

PAC-1: 8.70E-04 ppm

PAC-2: $\mathbf{0.0096}_{\mathbf{A}}$ ppm

PAC-3: $\mathbf{0.029}_{\mathbf{A}}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript “**A**” and correspond to 60 minute values.

DFG MAK: Danger of skin and airway sensitization.

Russia[43] set a MAC in workplace air of 0.5 milligram per cubic meter.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Phenyl isocyanate can affect you when breathed in and by passing through your skin. Exposure can strongly irritate the skin, nose, throat and lungs. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. LD_{50} = (oral-rat) 800 mg/kg.

Long-Term Exposure: Phenyl isocyanate can cause an asthma-like lung allergy to develop with cough, shortness of breath and wheezing. Possible lung and allergic skin rash.

Points of Attack: Lungs, skin.

Medical Surveillance: For those with frequent or potentially high exposure the following are recommended before beginning work and at regular times after that. Lung function tests. These may be normal if the person is not having an attack at the time of the test. If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Consider chest X-ray after acute overexposure. Evaluation by a dermatologist. Evaluation by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures to phenyl isocyanate exists, as a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN2487 Phenyl isocyanate, Hazard class: 6.1; Labels: 6.1-Poisonous materials, 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.3/0.5
Night 0.4/0.6

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 500/150
Then: Protect persons downwind (miles/kilometers)
Day 1.0/1.5

Night 1.6/2.5

Fire Extinguishing: Phenyl isocyanate may burn, but does not readily ignite. Thermal decomposition products may include oxides of nitrogen. Containers may explode in fire. Use dry chemical, CO_2, water spray; or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Phenyl Isocyanate, Trenton, NJ (November 2000)

Phenyl Mercaptan P:0440

Formula: C_6H_6S; C_6H_5SH

Synonyms: Benzenethiol; Mercaptobenzene; Phenol, thio-; Phenylmercaptan; Phenylthiol; Thiophenol

CAS Registry Number: 108-98-5

HSDB Number: 5387 as thiophenol

RTECS Number: DC0525000

UN/NA & ERG Number: (PIH) UN2337/131

EC Number: 203-635-3

Regulatory Authority and Advisory Information

Hazard Alert: Poison inhalation hazard, Highly flammable liquid, Air reactive, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction), Environmental hazard, Agricultural chemical.

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P014

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500 lb (227 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 100 lb (45.4 kg)

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazardous to aquatic life or environment, with possible long lasting effects[291,292].

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T+; F, N, Xi; Risk phrases: R11; R23/24/25; R26; R29/35; R36/37/38; R41; R62; Safety phrases: S16; S21; S23; S25; S26; S28; S36/37/39; S41; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Phenyl mercaptan is a water white liquid. Repulsive, penetrating, rotten cabbage, garlic-like odor. Molecular weight = 110.18; Specific gravity (H_2O:1) = 2 @ 25 C°; Boiling point = 170°C; Freezing/Melting point = −9.4°C; 15°C; Vapor pressure = 1 mmHg @ 18°C; 2 mmHg @ 25°C; Flash point = 55.6°C. Explosive limits: LEL = 1.2%; UEL-unknown. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 3, Reactivity 0. Insoluble in water.

Potential Exposure: Phenyl mercaptan is used as a chemical intermediate in pesticide manufacture; as a mosquito larvicide. It is used in solvent formulations for the removal of polysulfide sealants.

Incompatibilities: At normal room temperature may vaporize forming explosive mixture with air. Violent reaction with strong oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, calcium hypochlorite, alkali metals. Oxidizes on exposure to air; supplied under nitrogen.

Permissible Exposure Limits in Air:

Odor threshold + 0.0003 ppm.

OSHA PEL: None

NIOSH REL: 0.1 ppm/0.5 milligram per cubic meter [15-min.] Ceiling Concentration

ACGIH TLV[1]: 0.1 ppm/0.45 milligram per cubic meter TWA [skin]

Protective Action Criteria (PAC)* Ver. 29[138]

PAC-1: 0.3 ppm

PAC-2: $\mathbf{0.53_A}$ ppm

PAC-3: $\mathbf{1.6_A}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

Australia: TWA 0.5 ppm (2 milligram per cubic meter), 1993; Belgium: TWA 0.5 ppm (2.3 milligram per cubic meter), 1993; Denmark: TWA 0.5 ppm (2.3 milligram per cubic meter), 1999; Finland: STEL 0.5 ppm (2.6 milligram per cubic meter), 1993; France: VME 0.5 ppm (2 milligram per cubic meter), 1999; Norway: TWA 0.5 ppm (2 milligram per cubic meter), 1999; Switzerland: MAK-W 0.5 ppm (2.3 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 2 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 0.5 ppm

Several states have set guidelines or standards for benzenethiol in ambient air[60] ranging from 20 μ/m^3 (North Dakota) to 35 μ/m^3 (Virginia) to 40 μ/m^3 (Connecticut) to 48 μ/m^3 (Nevada).

Determination in Air: Use OSHA Analytical Method PV-2075

Determination in Water: Octanol-water coefficient: Log $K_{ow} = 2.5$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Highly toxic via all routes. Inhalation, ingestion; skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Benzenethiol can affect you when breathed in and by passing through your skin. Irritates the eyes, skin, and respiratory tract. Benzenethiol can severely burn the eyes, causing permanent damage. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Exposure can cause weakness, dizziness, cough, wheezing, dyspnea (breathing difficulty). Higher levels can cause restlessness and irritability followed by paralysis and death. High or repeated exposure can cause liver, kidney or lung damage. Acute exposure to thiophenol may result in cough, troubled breathing; irritation of the lungs; and pneumonitis. Nausea, vomiting, and diarrhea are often seen. May affect the nervous system.

Long-Term Exposure: Repeated or prolonged contact with skin may cause dermatitis. May cause lung, kidney, liver, spleen damage.

Points of Attack: Eyes, skin, respiratory system; CNS; kidneys, liver, spleen

Medical Surveillance: If symptoms develop or overexposure is suspected, tests of the following may be helpful: Kidney and liver function. Lung function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 minutes, occasionally lifting upper and lower lids. If available, flush eyes with large amounts of 0.5% silver nitrate, followed immediately by very large amounts of water. Continue water for 15 minutes. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pneumonitis or pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *Up to 1 ppm:* CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)]; or Sa (APF = 10) (any supplied-air respirator). *Up to 2.5 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]. *Up to 5 ppm:* CcrFOv (APF = 50) [any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s)]; GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; PaprTOv (APF = 50) [any powered, air-purifying respirator with a tight-fitting facepiece and organic vapor cartridge(s)]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

Storage: (1) Color code-Blue: Health Hazard/Toxics/Poisons: Store under nitrogen in a secure poison location. (2) Color code-Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in air-tight containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, should be prohibited where benzenethiol is handled, used, or stored. Use only non-sparking tools and equipment, especially when opening and closing containers of benzenethiol.

Shipping: UN2337 Phenyl mercaptan, Hazard class: 6.1; Labels: 6.1-Poisonous materials, 3-Flammable liquid, Inhalation zone B.

Spill Handling:
Initial isolation and protective action distances
Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).
Small spills (From a small package or a small leak from a large package)
First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.1/0.2
Large spills (From a large package or from many small packages)
First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.2/0.3
Night 0.3/0.5
Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include sulfur dioxide and oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Dissolve in flammable solvent and burn in furnace equipped with afterburner and alkaline scrubber[22].

References
(31); (100).
United States Environmental Protection Agency, Chemical Hazard Information Profile: Thiophenol, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)
(173); (101); (138).
New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Benzenethiol, Trenton, NJ (July 2004)

Phenylmercury Acetate P:0450

Formula: $C_8H_8HgO_2$: $C_6H_5HgOOCCH_3$
Synonyms: Acetate phenylmercurique (French); (Aceato) phenylmercury; Acetato fenilmercurio (Spanish); Acetic acid, phenylmercury derivitive; Agrosan; Agrosand; Agrosan GN 5; Algimycin; Antimucin WDR; Benzene, (acetoxymercuri)-; Benzene, (acetoxymercurio); Bufen; Cekusil; Celmer; Ceresan; Ceresan universal; Ceresol; Contra creme; Dynacide; Femma; FMA; Fungitox OR; Gallotox; HL-331; Hong kien; Hostaquick; Kwiksan; Leytosan; Liquiphene; Mercuriphenyl acetate; Mercury(II) acetate, phenyl; Mercury (acetoxy)phenyl-; Mergamma; Mersolite; Mersolite 8; Metasol 30; Norforms; Nymerate; Pamisan; Phenmad; Phenomercury acetate; Phenylmurcuriacetate; Phenylmercuric acetate; Phenylquecksilberacetat (German); Phix; PMA; PMAC; PM acetate; PMAL; PMAS; Purasan-SC-10; Puraturf 10; Quicksan; Sanitized SPG; SC-110; Scutl; Seedtox; Shimmerex; Spor-kil; Tag; Tag 331; Tag HL 331; Tag fungicide; Trigosan; Ziarnik
CAS Registry Number: 62-38-4; *(alt.)* 1337-06-0; *(alt.)* 61840-45-7; *(alt.)* 64684-45-3
HSDB Number: 1670
RTECS Number: OV6475000
UN/NA & ERG Number: UN1674/151
EC Number: 200-532-5 [*Annex I Index No.:* 080-011-00-5]
Regulatory Authority and Advisory Information
Carcinogenicity: IARC: Human Inadequate Evidence, *possibly carcinogenic to humans*, Group 2B, 1993.

United States Environmental Protection Agency Gene-Tox Program, Positive: D *melanogaster*-whole sex chrom. loss; Positive: D *melanogaster*-nondisjunction; B *subtilis* rec assay.

California Proposition 65 Chemical[102]: Developmental toxin as mercury compounds.

Hazard Alert: Poison, Combustible, Possible risk of forming tumors, Organometallic, Strong reducing agent, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction), Environmental hazard.

Banned or Severely Restricted (several countries) (UN)[13]

United States National Primary Drinking Water Regulations: MCLG = 0.002 mg[Hg]/L; MCL = 0.002 mg [Hg]/L as mercury

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P092

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 100 lb (45.4 kg)

United States DOT Regulated Marine Pollutant (49CFR172.101, appendix B), severe pollutant

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T+, N; Risk phrases: R25; R34; R48/24/25; R50/53; R62; R63; Safety phrases: S1/2; S3; S24/25; S29/35; S37; S45; S60; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Phenylmercury acetate is a white or yellow crystalline solid. Molecular weight = 336.75; Freezing/Melting point = 148.9°C; Vapor pressure = 9 mmHg @ 95°C; Flash point = 60°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Slightly soluble in water; solubility = 1500 ppm @ 15°C; 0.44 g/100 mL @ 20°C.

Potential Exposure: Phenylmercury acetate is used as an antiseptic, fungicide; for fungal and bacterial control; herbicide and control of crabgrass; mildewcide for paints; slimicide in paper mills. It was also used in contraceptive gels and foams.

Incompatibilities: A strong reducing agent. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, halogens.

Permissible Exposure Limits in Air:

as organo mercury compound

NIOSH IDLH = 2 mg[Hg]/m^3

OSHA PEL: 0.01 milligram per cubic meter TWA; 0.04 milligram per cubic meter Ceiling Concentration

NIOSH REL: 0.01 milligram per cubic meter TWA; 0.03 milligram per cubic meter STEL [skin]

ACGIH TLV[1]: 0.01 milligram per cubic meter TWA; 0.03 milligram per cubic meter STEL [skin]

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 2 milligram per cubic meter

PAC-2: 22 milligram per cubic meter

PAC-3: 47 milligram per cubic meter

DFG MAK: 0.01 mg[Hg]/m^3 [skin] Danger of skin sensitization; Carcinogen Category 3

Australia: TWA 0.05 mg[Hg]/m^3, [skin], 1993; Belgium: TWA 0.05 mg[Hg]/m^3, [skin], 1993; Denmark: TWA 0.05 mg[Hg]/m^3, [skin], 1999; Finland: TWA 1 mg[Hg]/m^3, 1999; France: VME 0.1 mg[Hg]/m^3, [skin], 1999; Hungary: TWA 0.02 mg[Hg]/m^3; STEL 0.04 mg[Hg]/m^3, 1993; Japan: 0.05 mg[Hg]/m^3, 1999; Norway: TWA 0.05 mg[Hg]/m^3, 1999; the Phillipines: TWA 0.05 mg[Hg]/m^3, 1993; Poland: MAC (TWA) 0.05 mg[Hg]/m^3; MAC (STEL) 0.15 mg [Hg]/m^3, 1999; Russia: TWA 0.05 mg[Hg]/m^3; STEL 0.01 mg[Hg]/m^3, 1993; Sweden: NGV 0.05 mg[Hg]/m^3, [skin], 1999; Thailand: STEL 0.05 mg[Hg]/m^3, 1993; United Kingdom: LTEL 0.05 mg[Hg]/m^3; STEL 0.15 mg[Hg]/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 0.1 mg[Hg]/m^3 [skin]

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 2 μg[Hg]/L; Federal Drinking Water Guidelines: EPA 2 μg[Hg]/L; State Drinking Water Guidelines: Arizona 3 μg[Hg]/L.

Determination in Water: Total mercury is determined by flameless atomic absorption. Soluble mercury may be determined by 0.45 micron filtration followed by flameless atomic absorption.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin, and respiratory tract. Overexposure affects the kidneys, causing renal function failure. Extremely toxic. The probable oral lethal dose for humans is 5−50 mg/kg, between 7 drops and 1 teaspoonful for a 70 kg (150 lb) person. Symptoms arising from acute exposure may occur at varying intervals Up to several weeks following exposure. Ingestion of mercurial fungicide treated grain resulted in gastrointestinal irritation with nausea, vomiting, abdominal pain; and diarrhea. Alkylmercurials produce severe neurologic toxicity, such as loss of feeling in lips, tongue, and extremities; confusion, hallucinations, irritability, sleep disturbances; staggering walk; memory loss; slurred speech; auditory defects; emotional instability; and inability to concentrate. It is also a strong skin irritant; erythema and blistering may result 6−12 hours after exposure. Phenylmercury acetate, at sufficient concentration, is expected to be injurious to the eye externally. Mercury poisoning can cause “shakes,” irritability, sore gums; increased saliva; personality change and brain damage. Skin contact can cause burns, skin allergy and a gray skin color. Heating or contact with acid or acid “fumes” releases toxic mercury vapors.

Long-Term Exposure: Mercury accumulates in the body. Repeated or prolonged contact with skin may cause dermatitis. May affect the nervous system; causing nervous disorders. Based on animal tests, phenylmercuric acetate should be handled as a teratogen-with extreme caution. It also may cause mutations.

Points of Attack: Eyes, skin, CNS, peripheral nervous system, and kidneys.

Medical Surveillance: Before first exposure and every 6−12 months after, a complete medical history and examination is strongly recommended with: examination of the nervous system; including handwriting. Routine urine test (UA). Urine test for mercury (should be less than 0.02 mg/L). Consider lung function tests for persons with frequent exposures. After suspected illness or overexposure, repeat the above tests and get a blood test for mercury. Consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Antidotes and Special Procedures for medical personnel: The drug NAP (*n*-acetyl penicillamine) has been used to treat mercury poisoning, with mixed success.

Note to physician: For severe poisoning BAL (British Anti-Lewisite), dimercaprol, dithiopropanol ($C_3H_8OS_2$) has been used to treat toxic symptoms of certain heavy metals poisoning—including mercury. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Specific engineering controls are recommended in NIOSH Criteria Document #73-11024.

Respirator Selection: *Up to 0.1 milligram per cubic meter:* Sa (APF = 10) (any supplied-air respirator). *Up to 0.25 milligram per cubic meter:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *Up to 0.5 milligram per cubic meter:* SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 2 milligram per cubic meter:* SA: PD, PP (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive pressure mode). *Escape:* SCBAE (any appropriate escape-type, SCBA).

Storage: Color code -Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers (such as chlorine, bromine, and fluorine). Sources of ignition, such as smoking and open flames, are prohibited where phenylmercuric acetate is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN1674 Phenylmercuric acetate, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Spills should be collected with special mercury vapor suppressants or special vacuums. Kits specific for cleanup of mercury spills should be available. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, foam, or carbon dioxide on solution. Use water as necessary, but run-off should be limited and controlled to prevent it from entering streams of water supplies. Materials are extremely hazardous to health, but areas may be entered with extreme care. Full protective clothing, including SCBA; rubber gloves; boots and bands around legs, arms, and waist should be provided. No skin should be exposed. Thermal decomposition products may include mercury. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. React to produce soluble nitrate form, precipitate as mercuric sulfide. Return to supplier.

References

(102); (31); (173); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Phenylmercury Acetate, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

(173); (101); (138).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Phenylmercuric Acetate, Trenton, NJ (February 2000)

N-Phenyl-β-Naphthylamine P:0460

Formula: $C_{16}H_{13}N$; $C_{10}H_7NHC_6H_5$

Synonyms: 2-Anilinonaphthalene; β-Naphthylphenylamine; PBNA; 2-Phenylaminonaphthalene; Phenyl-β-naphthylamine

CAS Registry Number: 135-88-6

HSDB Number: 2888

RTECS Number: QV4550000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 205-223-9 [*Annex I Index No.:* 612-135-00-8]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Limited Evidence; Human Inadequate Evidence*, not classifiable as carcinogenic to humans*, Group 3, 1978; NCI: Carcinogenesis Studies (feed); equivocal evidence: mouse; no evidence: rat; NIOSH (*since metabolized to β-naphthylamine*): Potential occupational carcinogen.

Hazard Alert: Poison, Possible risk of forming tumors, Suspected reprotoxic hazard, Sensitization hazard, Environmental hazard.

Banned or Severely Restricted (Sweden) (UN)[13]

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

United States DOT Regulated marine pollutant (49CFR172.101, Appendix B) as naphthalenes

Hazardous to aquatic life or environment, with possible long lasting effects[293]. Toxic to aquatic life with long lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: Xn, N, Xi; Risk phrases: R36/38; R40; R43; R51/53; Safety phrases: S2; S26; S29/35; S36/37; S41; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [2-Hazard to waters (est.)]

Description: Phenyl-β-naphthylamine is a light gray powder. A combustible solid. Molecular weight = 219.30; Specific gravity (H_2O:1) = 1.24; Boiling point = 396°C; Freezing/Melting point = 107.8°C. Insoluble in water.

Potential Exposure: Phenyl-β-naphthylamine is used as a rubber antioxidant; as an inhibitor for butadiene; a stabilizer in lubricants and an intermediate in chemical synthesis.

Incompatibilities: Incompatible with oxidizers, strong acids; organic anhydrides; isocyanates, aldehydes.

Permissible Exposure Limits in Air:

OSHA PEL: None

NIOSH REL: A potential occupational carcinogen* [skin]; Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A. [**Note:* Since metabolized to β-naphthylamine].

ACGIH TLV[1]: not classifiable as a human carcinogen

Protective Action Criteria (PAC) not available

DFG MAK: Carcinogen Category 3B

Australia: carcinogen, 1993; Austria: Suspected: carcinogen, 1999; Belgium: carcinogen, 1993; Finland: carcinogen, 1999; Poland: MAC (TWA) 0.03 milligram per cubic meter, 1999; Sweden: carcinogen, 1999; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen

Several states have set guidelines or standards for this compound in ambient air[60] ranging from zero (North Dakota) to 3.0 μ/m^3 (Virginia) to 45.0 μ/m^3 (Pennsylvania).

Determination in Air: Use OSHA Analytical Method 96.

Determination in Water: Octanol-water coefficient: Log $K_{ow} = > 4$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood. Naphthalenes and naphthenic acids are listed as United States DOT marine pollutants and may persist in the environment.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: The main problem with this compound is that phenyl-β-naphthylamine, a known carcinogen, is both a contaminant in, and a metabolic product of PBNA. Phenyl-β-naphthylamine can affect you when breathed in and by passing through your skin. Contact can cause skin irritation and rash. Phenyl-β-naphthylamine should be handled as a carcinogen-with extreme caution. Exposure can affect the ability of the blood to carry oxygen (methemoglobinemia), causing cyanosis, a bluish skin color. Higher levels can cause headache and dizziness. Very high levels can cause death. LD_{50} = (oral-mouse) 1450 kg/mg.

Long-Term Exposure: Repeated or prolonged contact may cause skin irritation, sensitization, allergy; hypersensitivity to sunlight. A potential occupational carcinogen. Can cause methemoglobinemia (see above); anemia may result.

Points of Attack: Eyes, skin, bladder. *Cancer site:* bladder cancer; in animals: lung, pancreas.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: methemoglobin level. CBC.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Note to Physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage:Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from heat and oil. A regulated, marked area should be established where *N*-phenyl-β-naphthylamine is handled, used, or stored.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25meters/75 feet.(NJ). Isolation Distance, Fire: 800 meters/0.5 miles[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

National institute for Occupational Safety and Health (NIOSH), Metabolic Precursors of a Known Human carcinogen, β-Naphthylamine, Current Intelligence Bulletin No. 16, Rockville, MD (December 17, 1976)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: N*-Phenyl-*beta*-Naphthylamine, Trenton, NJ (January 2007)

o-Phenylphenol P:0470

Formula: $C_{12}H_{10}O$; C_6H_5-C_6H_4OH

Synonyms: Anthrapole 73; 2-Biphenylol; *o*-Biphenylol; (1,1′-Biphenyl)-2-ol; *o*-Biphenylol; *o*-Diphenylol; Dowicide 1; Dowcide 1 antimicrobial; *o*-Fenilfenol (Spanish); 2-Hydroxybiphenyl; *o*-Hydroxybiphenyl; 2-Hydroxy-1, 1′-biphenyl; *o*-Hydroxydiphenyl; 2-Hydroxydiphenyl; Invalon OP; Kiwiydiphenyl; Nectryl; Orthophenylphenol; Orthoxenol; *o*-Phenylphenol; 2-Phenylphenol; Preventol O extra; Remol TRF; Tetrosin OE; Tetrosin OE-N; Torsite; Tumescal OPE; *o*-Xenol

CAS Registry Number: 90-43-7

HSDB Number: 1753

RTECS Number: DV5775000

UN/NA & ERG Number: UN3143 Dyes, solid, toxic, n.o.s. [or] Dye intermediates, solid, toxic, n.o.s./151

EC Number: 201-993-5 [*Annex I Index No.:* 604-020-00-6]

Regulatory Authority and Advisory Information

Carcinogenicity: NCI: Carcinogenesis Studies (derm); no evidence: rat; IARC: Animal Limited Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1999

California Proposition 65 Chemical[102]: Cancer 8/4/2000.

Hazard Alert: Poison, Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction), Environmental hazard.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long lasting effects[291]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: Xi, N; Risk phrases: R36/38; R50; R62; R63; Safety phrases: S2; S22; S29/35; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: *o*-Phenylphenol is a white to buff-colored crystalline solid. Molecular weight = 170.22; Boiling point = 286°C; Freezing/Melting point = 57°C; Flash point = 124°C; Autoignition temperature = 530°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Slightly soluble in water.

Potential Exposure: *o*-Phenylphenol is used in the manufacture of plastics, resins, rubber, as Agricultural chemical, in making fungicides; as an intermediate in making dye stuffs and rubber chemicals; a germicide; used in food packaging.

Incompatibilities: Strong bases, strong oxidizers.

Permissible Exposure Limits in Air:

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 29 milligram per cubic meter

PAC-2: 320 milligram per cubic meter

PAC-3: 400 milligram per cubic meter

DFG MAK: No numerical value established. Other data may be available.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin, and respiratory tract. High exposures may affect the kidney, liver, and lungs; gastrointestinal tract; cardiovascular system, causing respiratory failure. *Inhalation:* Dusts can cause irritation of the nose, throat and lungs. *Skin:* Can cause severe irritation and burns. Concentrations of 0.5% or higher of the sodium form can cause irritation. *Eyes:* Can cause severe irritation, burns, and damage to cornea, especially the sodium form. *Ingestion:* Based on studies of phenol, can cause burning sensation and pain in mouth and throat, sores, abdominal pain; nausea, vomiting, diarrhea and skin rash. Larger doses may also cause muscle weakness, irregular rapid breathing; Blue coloration of the skin; shock, unconsciousness, collapse and death. Based on animal studies, 5 ounces would be lethal to a 150 lb healthy adult.

Long-Term Exposure: May cause kidney damage. Prolonged skin contact may cause severe irritation, sores, and skin allergy. Very irritating substances may affect the lungs; bronchitis may develop.

Points of Attack: Lungs, kidneys, skin.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended. Lung function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately.

If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures to o-phenylphenol, use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece respirator with a high efficiency particulate filter. Greater protection is provided by a powered-air purifying respirator. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from water. Sources of ignition, such as smoking and open flames, are prohibited where o-phenylphenol is used, handled, or stored in a manner that could create a potential fire or explosion hazard. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN3143 Dyes, solid, toxic, n.o.s. or Dye intermediates, solid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include oxides of carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(102); (31); (173); (101); (138); (100).

New York State Department of Health, *Chemical Fact Sheet: ortho*-Phenylphenol, Bureau of Toxic Substance Assessment, Albany, NY (April 1986)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: o*-Phenylphenol, Trenton, NJ (December 2000)

Phenylphosphine P:0480

Formula: C_6H_7P; $C_6H_5PH_2$

Synonyms: Fenylfosfin; Monophenylphosphine; PF; Phosphaniline

CAS Registry Number: 638-21-1

HSDB Number: 7199

RTECS Number: SZ2100000

UN/NA & ERG Number: UN2845 (Pyrophoric liquids, organic, n.o.s)/135

EC Number: 211-325-4

Regulatory Authority and Advisory Information

California Proposition 65 Developmental/Reproductive toxin 8/7/2009

Hazard Alert: Poison, Flammable liquid, Pyrophoric hazard, Strong reducing agent, Water reactive, Self-heating, Corrosive, Environmental hazard, Reproductive toxin.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: F, T, N, Xn; Risk phrases: R6; R11; R17; R20/21/

22; R23/24/25; R36/37/38; R39; R48/20; R51/53; R62; R65; R67; Safety phrases: S7; S16; S26; S29/35; S36/37/38; S45; S61; S62 (see Appendix 4)

Description: Phenylphosphine is a clear, colorless liquid. Foul odor. Molecular weight = 110.10; Specific gravity (H_2O:1) = 1.00 @ 16°C; Boiling point = 161°C; Freezing/Melting point = 13.8°C; Flash point = 73.3°C. ₩Low solubility in water; solubility = < 1 mg/mL @ 21°C. Decomposes in water forming noxious gases.

Potential Exposure: Polyphosphinate is used as an intermediate or a chemical reagent. Polyphosphinate compounds are used as catalysts and antioxidants disproportionate, when heated to give phosphonic acid derivatives plus PF.

Incompatibilities: A strong reducing agent. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Water reactive; spontaneously combustible in high concentrations in moist air. Potential exposure to gaseous phenylphosphine and phosphorus oxides when heated above 200°C. Organophosphates are susceptible to formation of highly toxic and flammable phosphine gas in the presence of strong reducing agents such as hydrideds and active metals. Partial oxidation by oxidizing agents may result in the release of toxic phosphorus oxides[101].

Permissible Exposure Limits in Air:

Conversion factor: 1 ppm = 4.50 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: None

NIOSH REL: 0.05 ppm/0.25 milligram per cubic meter Ceiling Concentration

ACGIH TLV[1]: 0.05 ppm/0.23 milligram per cubic meter Ceiling Concentration

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 0.0045 ppm

PAC-2: 0.05 ppm

PAC-3: 1.7 ppm

Australia: TWA 0.05 ppm (0.25 milligram per cubic meter), 1993; Belgium: STEL 0.05 ppm (0.23 milligram per cubic meter), 1993; Denmark: TWA 0.05 ppm (0.25 milligram per cubic meter), 1999; Finland: STEL 0.05 ppm (0.25 milligram per cubic meter), 1999; France: VLE 0.05 ppm (0.25 milligram per cubic meter), 1999; Switzerland: MAK-W 0.05 ppm (0.25 milligram per cubic meter), 1999; the Netherlands: MAC 0.25 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Ceiling Concentration 0.05 ppm. Several states have set guidelines or standards for PF in ambient air[60] ranging from 2.0 μ/m^3 (Virginia) to 2.5 μ/m^3 (North Dakota) to 6.0 μ/m^3 (Nevada).

Determination in Air: No method available.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: A level of 0.6 ppm is a threshold effect level for laboratory animals; hypersensitivity to sound and touch and mild hyperemia developed above this level. Above 2.2 ppm, chronic effects developed including decreases in red blood cells, dermatitis and severe testicular degeneration (which was, however, reversible)[53]. This material is highly toxic by inhalation and ingestion; mild respiratory irritant. Symptoms of exposure include mild respiratory irritation, dyspnea; nausea, vomiting, diarrhea, thirst; sensation of pressure in the chest; back pains; chills; stupor, and fainting with marked pulmonary edema. Phenylphosphine can affect you when breathed in. Exposure can cause nausea, loss of appetite; shaking (tremor), irritation of the eyes and flushed skin.

Long-Term Exposure: Repeated exposure can cause skin rash. Phenylphosphine can damage the blood cells. In animals: blood changes; anemia, testicular degeneration; loss of appetite; diarrhea, lacrimation (discharge of tears), hind leg tremor; dermatitis.

Points of Attack: Blood, CNS; skin, reproductive system.

Medical Surveillance: Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. If symptoms develop or overexposure is suspected, examination of the nervous system. If skin rash develops see a qualified allergist.

First Aid: *Eyes*: first check the victim for contact lenses and remove if present. Flush victim's eyes with water or normal saline solution for 20 to 30 minutes while simultaneously calling a hospital or poison control center. Do not put any ointments, oils, or medication in the victim's eyes without specific instructions from a physician. Immediately transport the victim after flushing eyes to a hospital even if no symptoms (such as redness or irritation) develop. *Skin:* immediately flood affected skin with water while removing and isolating all contaminated clothing. Gently wash all affected skin areas thoroughly with soap and water. Immediately call a hospital or poison control center even if no symptoms (such as redness or irritation) develop. Immediately transport the victim to a hospital for treatment after washing the affected areas. *Inhalation:* immediately leave the contaminated area; take deep breaths of fresh air. Immediately call a physician and be prepared to transport the victim to a hospital even if no symptoms (such as wheezing, coughing, shortness of breath, or burning in the mouth, throat, or chest) develop. Provide proper respiratory protection to rescuers entering an unknown atmosphere. Whenever possible, SCBA should be used; if not available, use a level of protection greater than or equal to that advised under protective clothing. *Ingestion:* if the victim is conscious and not convulsing, give 1 or 2 glasses of water to dilute the chemical and immediately call a hospital or poison control center. Generally, the induction of vomiting is not recommended outside of a physician's care due to the risk of aspirating the chemical into the victim's lungs. However, if the victim is conscious and not convulsing and if medical help is not readily available, consider the risk of inducing vomiting because of the high toxicity of the chemical ingested. Ipecac syrup or salt water may be used in such an emergency. Immediately transport the victim to a hospital. If the victim is convulsing or unconscious, do not give anything by mouth, ensure that the victim's airway is open and lay the victim on his/her side with the head lower than the body. Do not induce vomiting. Immediately transport the victim to a hospital[101].

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures *over 0.05 ppm*; Use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: store under inert gas. Pyrophoric in air, corrosive, reducing agent. (1) Red: Flammability Hazard: Store in a flammable (liquid or solid materials) storage area or approved cabinet away from sources if ignition. (2) White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. (3) Color code-Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in a area isolated from oxidizers and other yellow coded materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: UN2845 Pyrophoric liquids, organic, n.o.s Hazard Class: 4.2, Labels: 4.2-Spontaneously combustible material. Technical Name Required. *Note:* this chemical is also a strong reducing agent.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition (above 200°C) products include hydrogen phosphide and oxides of phosphorus and carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (170).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Phenylphosphine, Trenton, NJ (July 2001).

Phenylthiourea P:0490

Formula: $C_7H_8N_2S$; $C_6H_5NCHCSNH_2$

Synonyms: NCI-C02017; Phenylthiocarbamide; *N*-phenylthiourea; α-Phenylthiourea; Phenyl-2-thiourea; 1-Phenylthiourea; PTC; PTU

CAS Registry Number: 103-85-5

HSDB Number: 4105

RTECS Number: YU1400000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154; UN2767 (phenyl urea pesticides, solid)/151

EC Number: 203-151-2

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Sensitization hazard (skin), Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard.

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P093

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 100 lb (45.4 kg)

Hazard Symbols, Risk & Safety statements: Hazard Symbol: Xn, N, Xi; Risk phrases: R36/38; R43; R51/53; R62; R63; Safety phrases: S28; S36/37-45; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [2-Hazard to waters (est.)]

Description: *N*-phenylthiourea is a colorless crystalline solid. Molecular weight = 152.23; Freezing/Melting point = 148−154°C. Soluble in water.

Potential Exposure: Used as a repellent for rats, rabbits, and weasels; in the manufacture of rodenticides and in medical genetics.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Contact with acids or acid fumes produces toxic fumes of sulfur oxide.

Permissible Exposure Limits in Air:

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 0.27 milligram per cubic meter

PAC-2: 3 milligram per cubic meter

PAC-3: 18 milligram per cubic meter

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin, and respiratory tract. High exposures can cause lung irritation, coughing and/or shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Exposure may result in vomiting, difficult breathing; noisy breathing; cyanosis, and low body temperature. It is classified as extremely toxic. The probable oral lethal dose is 5−50 mg/kg or between 7 drops and 1 teaspoon for a 70 kg (150 lb) person.

Long-Term Exposure: Not tested for long-term health effects. May cause methemoglobinemia, cyanosis, and anemia. Phenylthiourea is reported to be similar to ANTU.

Points of Attack: Lungs, skin (possible allergic reaction).

Medical Surveillance. Lung function tests. Blood methemogloblin level. CBC. Consider chest X-ray following acute overexposure. Evaluation by a dermatologist and/or a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Note to Physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in a refrigerator or a cool, dry place.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN2767 Phenyl urea pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen spilled material with alcohol to avoid dust or use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide; water spray; alcohol foam or polymer foam extinguishers. Thermal decomposition products may include oxides of nitrogen, sulfur, and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Phenylthiourea, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

(173); (101); (138).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Phenylthiourea, Trenton, NJ (August 1999)

Phenyl Trichlorosilane P:0500

Formula: $C_6H_5Cl_3Si$

Synonyms: Phenylsilicon trichloride; Phenyl trichlorosilane; Silicon phenyl trichloride; Silane, trichlorophenyl-; Trichlorophenylsilane; Tricloro(fenil)silano (Spanish)

CAS Registry Number: 98-13-5

HSDB Number: 1039

RTECS Number: VV6650000

UN/NA & ERG Number: (PIH) UN1804/156

EC Number: 202-640-8

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade).

Hazard Alert: Poison inhalation hazard, Highly flammable liquid, Violently reactive with water, Corrosive, Primary irritant (w/o allergic reaction).

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500 lb (227 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 500 lb (227 kg)

United States DOT 49CFR172.101, Inhalation Hazardous Chemical (PIH).

Hazard Symbols, Risk & Safety statements: Hazard Symbol: F, T+, C, Xn; Risk phrases: R11; R14; R21/22; R26; R34; R35; R36/37/38; Safety phrases: S1; S23; S26; S28; S36/37/39; S41; S45; S53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Phenyl trichlorosilane is a colorless to light yellow liquid. Molecular weight = 211.55; Specific gravity (H_2O:1) = 1.3 @ 25°C; Boiling point = 202°C; Flash point = 80.6°C; 91°C (oc). Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 2₩. Reacts violently with water, rapidly releasing corrosive hydrogen chloride gas.

Potential Exposure: Phenyl trichlorosilane is used to make silicones for water repellants, insulating resins; heat resistant paints; and as a laboratory reagent.

Incompatibilities: vapor form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. The aqueous solution is higly acidic. Chlorosilanes react vigorously with bases and both organic and inorganic acids generating toxic and/or flammable gases. Chlorosilanes react with water, moist air, or steam to produce heat and toxic, corrosive fumes of hydrogen chloride. They may also produce flammable gaseous hydrogen. Attacks metals in the presence of moisture.

Permissible Exposure Limits in Air:

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: $\mathbf{0.6_A}$ ppm

PAC-2: $\mathbf{7.3_A}$ ppm

PAC-3: $\mathbf{33_A}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Corrosive to the eyes, skin, and respiratory tract. Eye contact may damage the corneas and cause blindness. Inhalation may cause throat to swell, causing suffocation; and may cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Highly toxic; may cause death or permanent injury after short inhalation exposure to small quantity. Chemical burns to all exposed membranes and tissues with severe tissue destruction. *Delayed:* after oral exposure stomach and intestines may perforate to be obstructed by scar tissue. Ingestion may cause mild to moderately severe oral and esophageal burns, with severe burns occurring in stomach. Perforations and peritonitis may occur. Severe irritation may produce spontaneous vomiting. Viscid white or blood-stained foamy mucus and threads of tissue may appear in mouth.

Long-Term Exposure: Many highly irritating substances can cause lung damage; bronchitis may develop.

Points of Attack: Lungs.

Medical Surveillance: For those with frequent or potentially high exposure, the following are recommended before beginning work and at regular times after that. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful. Lung function tests. Consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water, or milk; then give demulcents, such as milk, cornstarch, and water. Do not induce vomiting.

Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposure to phenyl trichlorosilane, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from water at temperatures below 50°C. Phenyl trichlorosilane can give off corrosive hydrogen chloride gas on contact with water, steam or moisture. Sources of ignition, such as smoking and open flames, are prohibited where Phenyl trichlorosilane is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN1804 Phenyltrichlorosilane, Hazard class: 8; Labels: 8-Corrosive material.

Spill Handling:

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

Phenyltrichlorosilane when spilled in water

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)
Day 0.3/0.5
Night 1.0/1.5

Stay upwind and uphill. Isolate the area of release or fire and deny entry. Remove all ignition sources. Stop the release if it can be done safely from a distance. All equipment used to handle this material must be grounded. Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. *Small spill*: Cover with *dry* earth, *dry* sand, or other noncombustible material followed with plastic sheet to minimize spreading or contact with water or rain. Use clean nonsparking tools to collect material and place material into loosely covered plastic containers for later disposal.

Prevent material and runoff from entering sewers and waterways if it can be done safely well ahead of the release. Use vapor suppressing foam to disperse vapors—contain runoff. Water spray may reduce vapor, but may not prevent ignition in enclosed spaces. Ventilate confined area if it can be done without placing personnel at risk. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible and corrosive liquid. Thermal decomposition products may include hydrogen chloride, chlorine and oxides of carbon. *Do not use water or hydrous agents. FOR CHLOROSILANES DO NOT USE WATER. USE AFFF ALCOHOL-RESISTANT, MEDIUM EXPANSION FOAM. Small fire*: use *dry* chemical, CO_2, *dry* sand, or alcohol-resistant foam. May react with foams releasing corrosive/toxic gases. *Large fire*: use water spray or alcohol-resistant foam if it is available in sufficient amounts. Under favorable conditions, experienced crews can use coordinated fog streams to sweep the flames off the surface of the burning liquid. Combustible material: may burn but does not ignite readily. Most vapors are heavier than air. They will spread along ground and collect in low or confined areas (sewers, basements, tanks). Vapors may travel to source of ignition and flash back. Containers may explode when heated or if contaminated with water. Keep exposures cool long after fire is out to protect against reignition. Do not direct straight streams into the liquid. Cool exposed containers with large quantities of water from unattended equipment or remove intact containers if it can be done safely. *Do not get water on spilled substance or inside containers.* If cooling streams are ineffective (*venting sound increases in volume and pitch, tank discolors or shows signs of deforming*), withdraw immediately to a secure location. Always stay away from ends of tanks, especially when engulfed in flames. If material or contaminated runoff from fire control enters waterways, notify downstream users of potentially contaminated water. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Trichlorophenylsilane, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Phenyl Trichlorosilane, Trenton, NJ (May 2000)

Phenytoin P:0510

Formula: $C_{15}H_{12}N_2O_2$

Synonyms: AI3-52498; Aleviatin; Antisacer; Auranile; Causoin; Citrullamon; Citrulliamon; Comital; Comitoina; Convul; Danten; Dantinal; Dantoinal; Dantoinal klinos; Dantoine; Denyl; Didan TDC 250; Difenilhidantoina (Spanish); Difenin; Difhydan; Dihycon; di-Hydan; Dihydantoin; di-Lan; Dilantin acid; Dilantine; Dillantin; Dintion; Diphantoin; Diphedal; Diphenine; Diphentoin; Diphentyn; Diphenylan; 5,5-Diphenylhydantoin; Diphenylhydantoin; 5,5-Diphenylimidazolidin-2,4-dione; 5,5-Diphenyl-2,4-imida zolidinedione; Diphenylhydantoine; di-Phetine; Ditoinate; DPH; EKKO; EKKO Capsules; Enkelfel; Elepsindon; Epamin; Epanutin; Epasmir 5; Epdantoine simple; Epelin; Epilan; Epilantin; Epinat; Epised; Eptal; Eptoin; Fenantoin; Fenidantoin S; Fenitoina; Fenylepsin; Fenytoine; Gerot-epilan-D; Hidan; Hidantilo; Hidantina; Hidantina senosian; Hidantina vitoria; Hidantomin; Hydantoin; Hydantoin, 5,5-diphenyl-; Hydantoinal; Ictalis simple; Idantoin 2,4-imidazolidinedione, 5,5-diphenyl-; Kessodanten; Labopal; Lehydan; Lepitoin; Lepsin; Minetoin; NCI-C55765; Neos-hidantoina; Neosidantoina; Novantoina; OM-hidantoine simple; OM-hydantoine; Oxylan; Phanantin; Phanatine; Phenatine; Phenatoine; Phenitoin; Ritmenal; Saceril; Sanepil; Silantin; Sodanthon; Sodantoin; Solantoin; Sylantoic; Tacosal; Thilophenyl; Toin; Toin unicelles; Zentronal; Zentropil

CAS Registry Number: 57-41-0; 630-93-3 (sodium salt)

HSDB Number: 3160

RTECS Number: MU1050000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154; UN3249 (Medicines, toxic, solid, n.o.s.)/151

EC Number: 200-328-6; 211-148-2 (phenytoin sodium)

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen (Phenytoin & Phenytoin sodium); IARC: Human Limited Evidence, animal Sufficient Evidence*, possibly carcinogenic to humans*, Group 2B, 1987.

California Proposition 65 Chemical[102]: Cancer 1/1/1988; Reproductive toxin 7/1/1987; Cancer 1/1/1988 (sodium salt).

Hazard Alert: Poison, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Drug.

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 15,000 lb (6810 kg)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U098

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 10 lb (4.54 kg)

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T, F, Xn; Risk phrases: R45; R11; R20/21/22; R23/24/25; R36/37/38; R39; R40; R50/53; R61; R62; R63; Safety phrases: S7; S16; S26; S36/37; S41; S45; S53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Phenytoin is a crystalline compound. Molecular weight = 252.27; Freezing/Melting point = 295−298°C; Ignition temperature = 585°C. Insoluble in water.

Potential Exposure: Phenytoin is an amide pharmaceutical used in the treatment of grand mal epilepsy, Parkinson's syndrome; and in veterinary medicine. Human exposure to phenytoin occurs principally during its use as a drug. Figures on the number of patients using phenytoin are not available, but phenytoin is given to a major segment of those individuals with epilepsy. The oral dose rate is initially 100 mg given 3 times per day and can gradually increase by 100 mg every 2−4 weeks until the desired therapeutic response is obtained. The intravenous dose is 200−350 mg/day.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Similar organic amides react with azo and diazo compounds, releasing toxic gases. Contact with reducing agents can release flammable gases. Amides are very weak bases but they can react as acids, forming salts. Mixing amides with dehydrating agents such as phosphorus pentoxide or thionyl chloride generates the corresponding nitrile[101].

Permissible Exposure Limits in Air:

No standards or Protective Action Criteria (PAC) available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Symptoms of exposure include blurred vision, hyperactivity, confusion, drowsiness, nausea, vomiting, epigastric pain; swelling of gums; fever, liver and kidney damage.

Long-Term Exposure: Phenytoin is carcinogenic in mice after oral administration or by intraperitoneal injection, producing lymphomas and leukemias.

Points of Attack: Liver, kidneys.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Liver and kidney function tests.

First Aid: *Skin Contact:* [52] Flood all areas of body that have contacted the substance with water. Don't wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others. *Eye Contact:* Remove any contact lenses at once. Flush eyes well with copious quantities of water or normal saline for at least 20−30 minutes. Seek medical attention. *Inhalation:* Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion:* If convulsions are not present, give a glass or two of water or milk to dilute the substance. Assure that the person's airway is unobstructed and contact a hospital or poison center immediately for advice on whether or not to induce vomiting.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Specific respirator(s) have not been recommended by NIOSH. However, based on potential carcinogenicity, and where the potential exists for exposure, the following might be considered: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full facepiece respirator with an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code -Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in a cool, dry place or in a refrigerator. Protection from air, light and moisture is recommended for long-term storage[52]. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical

Name Required. UN3249 Medicine, solid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: UN2811: Isolation Distance, Spill: 25meters/75 feet.(NJ). Isolation Distance, Fire: 800 meters/ 0.5 miles[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources:[52] Dampen spilled material with alcohol to avoid dust, then transfer material to a suitable container. Use absorbent dampened with alcohol to pick up remaining material. Wash surfaces well with soap and water. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: It is inappropriate and possibly dangerous to the environment to dispose of expired or waste pharmaceuticals by flushing them down the toilet or discarding them to the trash. Household quantities of expired or waste pharmaceuticals may be mixed with wet cat litter or coffee grounds, double-bagged in plastic, discard in trash. Larger quantities shall carefully take into consideration applicable DEA, EPA, and FDA regulations. If possible return the pharmaceutical to the manufacturer for proper disposal being careful to properly label and securely package the material. Alternatively, the waste pharmaceutical shall be labeled, securely packaged and transported by a state licensed medical waste contractor to dispose by burial in a licensed hazardous or toxic waste landfill or incinerator.

References

(109); (102); (31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Phenytoin, Trenton, NJ (April 2001).

Phorate P:0520

Formula: $C_7H_{17}O_2PS_3$

Synonyms: Aastar; AC3911; American cyanamid 3,911; *O*,*O*-Diaethyl-S-(aethylthio-methyl)-dithiophosphat (German); *O*,*O*-Diethyl *S*-ethylmercaptomethyl dithiophosphonate; *O*,*O*-Diethyl *S*-ethylthiomethyl dithiophosphonate; *O*,*O*-Diethyl *S*-(ethylthio)methyl phosphorodithioate; *O*,*O*-Diethyl *S*-[(ethylthio)methyl] phosphorodithioate; *O*,*O*-Diethylethylthiomethyl phosphorodithioate; *O*,*O*-Diethyl *S*-ethylthiomethyl thiothionophosphate; Dithiophosphatede *O*,*O*-diethyle et d'ethylthiomethyle (French); EL3911; ENT 24,042; Experimental insecticide 3911; Forato (Spanish); Geomet; Gramtox; Granutox; L11/6; Methanethiol, ethylthio-*S*-ester with *O*,*O*-diethyl phosphorodithioate; Phorat (German); Phorate-10G; Rampart; Terrathion granules; the met; Thimet; Vegfru; Vergfru Foratox

CAS Registry Number: 298-02-2

HSDB Number: 1183

RTECS Number: TD9450000

UN/NA & ERG Number: (PIH) UN3018 (organophosphorus pesticide, liquid, toxic)/152; UN2783 (organophosphorus pesticide, solid, n.o.s.)/152; UN2810 (toxic liquid, organic, n.o.s.)/153

EC Number: 206-052-2 [*Annex I Index No.:* 015-033-00-6]

Regulatory Authority and Advisory Information

United States Environmental Protection Agency Gene-Tox Program, Negative: D *melanogaster* sex-linked lethal; Negative: *In vitro* UDS-human fibroblast; TRP reversion; Negative: S *cerevisiae-homozygosis*; Inconclusive: B *subtilis* rec assay; *E coli polA* without S9; Inconclusive: Histidine reversion-Ames test.

Hazard Alert: Poison inhalation hazard: exposure can be lethal, Neurotoxin (cumulative), Combustible, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction), Environmental hazard.

Banned or Severely Restricted (Malaysia) (UN)[13]

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P094

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.021; Nonwastewater (mg/kg), 4.6

RCRA 40CFR264, appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8140 (2); 8270 (10)

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 10 lb (4.54 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 10 lb (4.54 kg)

United States DOT Regulated Marine Pollutant (49CFR172.101, appendix B), severe pollutant

United States DOT 49CFR172.101, Inhalation Hazard Chemical as organophosphates.

Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T+, N; Risk phrases: R27/28; R33; R50/53; R61; R62; R63; Safety phrases: S1/2; S28; S29; S35; S36/37; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)]

Description: Phorate is a clear mobile liquid with a skunk-like odor. Molecular weight = 260.39; Specific gravity (H_2O:1) = 1.16 @ 20°C; Boiling point = 290°C; 118−120°C @ 0.8 mm; Freezing/Melting point = −42.8°C; Vapor pressure = Vapor pressure = 8.4×10^{-4} mmHg @ 25°C; Flash point = 160°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 1, Reactivity 0. Practically insoluble in water; solubility = 0.005%.

Potential Exposure: Those engaged in the manufacture, formulation and application of this systemic and contact insecticide and acaricide. It is also used as a soil insecticide.

Incompatibilities: Water, alkalis. Hydrolyzed in the presence of moisture and by alkalis; may produce toxic oxides of phosphorus and sulfur. Strong oxidizers may cause release of toxic phosphorus oxides. Organophosphates, in the presence of strong reducing agents such as hydrides, may form highly toxic and flammable phosphine gas. Keep away from alkaline materials.

Permissible Exposure Limits in Air:

OSHA PEL: None

NIOSH REL: 0.05 milligram per cubic meter TWA; 0.2 milligram per cubic meter STEL [skin]

ACGIH TLV[1]: 0.05 milligram per cubic meter TWA, inhalable fraction and vapor; [skin] not classifiable as a human carcinogen; BEIA issued for Acetylcholinesterase inhibiting pesticides.

Protective Action Criteria (PAC)* Ver. 29[138]

PAC-1: 0.0036 milligram per cubic meter

PAC-2: $\mathbf{0.040_A}$ milligram per cubic meter

PAC-3: $\mathbf{0.12_A}$ milligram per cubic meter

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

Australia: TWA 0.05 milligram per cubic meter; STEL 0.2 milligram per cubic meter, [skin], 1993; Belgium: TWA 0.05 milligram per cubic meter, [skin], 1993; Denmark: TWA 0.05 milligram per cubic meter, [skin], 1999; France: VME 0.05 milligram per cubic meter, [skin], 1999; Norway: TWA 0.05 milligram per cubic meter, 1999; Switzerland: MAK-W 0.05 milligram per cubic meter, [skin], 1999; United Kingdom: TWA 0.05 milligram per cubic meter; STEL 0.2 milligram per cubic meter, [skin], 2000; the Netherlands: MAC-TGG 0.05 milligram per cubic meter, [skin], 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 0.2 milligram per cubic meter [skin]. Several states have set guidelines or standards for Phorate in ambient air[60] ranging from 0.5−2.0 μ/m^3 (North Dakota) to 0.8 μ/m^3 (Virginia) to 1.0 μ/m^3 (Connecticut and Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #5600, Organophosphorus pesticides.

Permissible Concentration in Water: Maine[61] has set a guideline for phorate in drinking water of 0.2 μg/L.

Determination in Water: Fish Tox = 0.13505000 ppb (EXTRA HIGH). Octanol-water coefficient: Log K_{ow} = > 3.5. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Acute exposure to phorate may produce the following signs and symptoms: pinpoint pupils; blurred vision; headache, dizziness, muscle spasms; and profound weakness. Vomiting, diarrhea, abdominal pain; seizures, and coma may also occur. The heart rate may decrease following oral exposure or increase following dermal exposure. Chest pain may be noted. Hypotension (low blood pressure) may occur, although hypertension (high blood pressure) is not uncommon. Dyspnea (shortness of breath) may be followed by respiratory collapse. Giddiness is common. This material is one of the more toxic organophosphorus insecticides. It is a cholinesterase inhibitor that acts on the nervous system; and produces toxicity similar to parathion. The probable oral lethal dose for humans is less than 5 mg/kg, i.e., a taste (less than 7 drops) for a 70 kg (150 lb) person. LD_{50} = (oral-rat) 37 mg/kg.

Long-Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure; resulting in convulsions, respiratory failure. May cause liver damage. Human Tox = 3.50000 ppm (HIGH).

Points of Attack: Respiratory system, lungs, CNS; cardiovascular system, skin, eyes, plasma and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also consider CBC. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Not available according to NIOSH. *The following is included for reference:* NIOSH: *(parathion) 0.5 milligram per cubic meter:* CcrOv95 (APF = 10) [any air-purifying half-mask respirator with organic vapor cartridge(s) in combination with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *1.25 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOvHie (APF = 25) (any powered air-purifying respirator with an organic vapor cartridge in combination with a high-efficiency particulate filter). *2.5 milligram per cubic meter:* CcrFOv100 (APF = 50) [any air-purifying full facepiece respirator equipped with organic vapor cartridge(s) in combination with an N100, R100, or P100 filter]; or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTOvHie (APF = 50) [any powered, air-purifying respirator with a tight-fitting facepiece and organic vapor cartridge(s) in combination with a high-efficiency particulate filter]; or SCBAF (APF = 50) (any SCBA with full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *10 milligram per cubic meter:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from water and alkalis. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN3018 Organophosphorus pesticides, liquid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN2783 Organophosphorus pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous material. UN2810 Toxic liquids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling:

Initial isolation and protective action distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.3/0.4
Night 0.8/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 600/200

Then: Protect persons downwind (miles/kilometers)

Day 1.4/2.3

Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Do not touch spilled material. Do not breathe vapors. Stay upwind; keep out of low areas. Remove all ignition sources. Ventilate area of spill or leak. This material is a combustible liquid. For a spill or leak of a combustible liquid, shut off ignition sources; no flares, smoking or flames in hazard area. Stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of phosphorus, sulfur and carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Wear positive pressure SCBA. Move container from fire area if you can do it without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (100).

United States Environmental Protection Agency, Phorate, Health and Environmental effects Profile No. 145, Office of Solid(2). Waste, Washington, DC (April 30, 1980)

(173); (101); (138).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Phorate, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Phorate, Trenton, NJ (September 2001).

Phosacetim P:0530

Formula: $C_{14}H_{13}Cl_2N_2O_2PS$

Synonyms: Acetimidoylphosphoramidothioic acid *O*,*O*-bis(*p*-chlorophenyl) ester; BAY 33819; Bayer 33819; *O*,*O*-Bis(*p*-chlorophenyl) acetimidoyl phosphoramidothioate; *O*,*O*-Bis(4-chlorophenyl) *N*-acetimidoyl phosphoramidothioate; *O*,*O*-Bis(4-chlorophenyl) 1-iminoethyl phosphoramidothioate; *O*,*O*-Bis(4-chlorophenyl)-1-iminoethylphosphoramidothioic acid; DRC-714; Gophacide; (1-Iminoethyl)phosphoramidothioic acid, *O*,*O*-bis(4-chlorophenyl) ester; Phosazetim; Phosphonodithio-imidocarbonic acid, acetimidoyl-, *O*,*O*-bis(*p*-chlorophenyl) ester; Phosphonodithioimidocarbonic acid, (1-iminoethyl)-, *O*,*O*-bis(*p*-chlorophenyl) ester

CAS Registry Number: 4104-14-7

HSDB Number: 6436

RTECS Number: TB4725000

UN/NA & ERG Number: (PIH) UN2783 (organophosphorus pesticides, solid, toxic)/152

EC Number: 223-874-7 [*Annex I Index No.:* 015-092-00-8]

Regulatory Authority and Advisory Information

Hazard Alert: Poison inhalation hazard: exposure can be lethal, Neurotoxin (cumulative), Combustible, Agricultural chemical, Environmental hazard.

Banned or Severely Restricted (Germany, Philippines) (UN)[13]

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 100 lb (45.4 kg)

United States DOT 49CFR172.101, Inhalation Hazard Chemical as organophosphates.

Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T+, N; Risk phrases: R27/28; R33; R50/53; Safety phrases: S1/2; S28; S29; S36/37; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)]

Description: Phosacetim is a crystalline solid. Molecular weight = 375.22. Hazard Identification (based on NFPA-704 M Rating System): Health 4 Flammability 1, Reactivity 0.

Potential Exposure: Used as a rodenticide.

Incompatibilities:Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, nitrates. May hydrolyze on contact with moisture.

Permissible Exposure Limits in Air:

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 0.34 milligram per cubic meter

PAC-2: 3.7 milligram per cubic meter

PAC-3: 11 milligram per cubic meter

Determination in Air: Use NIOSH Analytical Method (IV) #5600, Organophosphorus Pesticides.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact. Absorbed by the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Organic phosphorus insecticides are absorbed by the skin, as well as by the respiratory and gastrointestinal tracts. They are cholinesterase inhibitors. May be fatal if swallowed or by skin contact. Symptoms of exposure include headache, giddiness; blurred vision; nervousness, weakness, nausea, cramps, diarrhea, and discomfort in the chest. Signs include sweating, tearing, salivation, vomiting, cyanosis, convulsions, coma, loss of reflexes and loss of sphincter control. Highly toxic. LD_{50} oral rat is 3.7 mg/kg.

Long-Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure; resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, CNS; cardiovascular system, skin, eyes, plasma, and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also consider CBC. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage.

Shipping: UN2783 Organophosphorus pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling:

Initial isolation and protective action distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase

with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.3/0.4
Night 0.8/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 600/200
Then: Protect persons downwind (miles/kilometers)
Day 1.4/2.3
Night 2.8/4.5

Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include hydrogen chloride and oxides of phosphorus, sulfur, nitrogen and carbon. This chemical is a flammable solid. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (2); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Phosacetim, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

Phosfolan P:0540

Formula: $C_7H_{14}NO_3PS_2$

Synonyms: AC 47031; American cyanamid 47031; C.I. 47031; Cyclic ethylene(diethoxyphosphinothioyl)-dithioimidocarbonate; Cyclic ethylene *p*,*p*-diethylphosphono dithioimidocarbonate; Cylan; Cyolane; Cyolane insecticide; (Diethoxyphosphinyl)dithioimidocarbonic acid cyclic ethylene ester; 2-(Diethoxyphosphinylimino)-1,3-dithiolan; 2-(Diethoxyphosphinylimino)-1,3-dithiolane; *p*,*p*-Diethyl cyclic ethylene ester of phosphonodithioimidocarbonate; *p*,*p*-Diethyl cyclic ethylene ester of phosphonodithioimidocarbonic acid; Diethyl 1,3-dithiolan-2-ylidenephosphoramidate; EI 47031; ENT 25,830; 1,2-Ethanedithiol, cyclic ester with *p*,*p*-diethyl phosphonodithioimidocarbonate; 1,2-Ethanedithiol, cyclic ester with phosphonodithioimidocarbonic acid *p*,*p*-diethyl ester; Imidocarbonic acid, phosphonodithio-, cyclic ethylene *p*,*p*-diethyl ester; Phosphoroamidic acid, 1,3-dithiolan-2-ylidene-, diethyl ester

CAS Registry Number: 947-02-4

HSDB Number: 2824

RTECS Number: NJ6475000

UN/NA & ERG Number: (PIH) UN3464 (organophosphorus compound, solid, toxic, n.o.s)/151; UN2783 (organophosphorus pesticides, solid, toxic)/152

EC Number: 213-423-2 [*Annex I Index No.:* 015-111-00-X]

Regulatory Authority and Advisory Information

Hazard Alert: Poison inhalation hazard: exposure can be lethal, Neurotoxin (cumulative), Combustible, Highly Toxic, Environmental hazard, Sensitization hazard (skin), Agricultural chemical

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 100 lb (45.4 kg)

United States DOT 49CFR172.101, Inhalation Hazard Chemical as organophosphates.

Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T+, N, Xi; Risk phrases: R27/28; R33; R43; R51/53; Safety phrases: S1/2; S29; S36/37/39; S41; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [2-Hazard to waters (est.)]

Description: Phosfolan is a colorless to yellow solid. Molecular weight = 255.31; Boiling point = 115−118°C @ 0.001 mm; Freezing/Melting point = 37−45°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 1, Reactivity 0. Soluble in water.

Potential Exposure: An organophosphate, A potential danger to those involved in the manufacture, formulation and application of this insecticide.

Incompatibilities: Organophosphates are susceptible to formation of highly toxic and flammable phosphine gas in the presence of strong reducing agents such as hydrideds and active metals. Partial oxidation by oxidizing agents may result in the release of toxic phosphorus oxides[101] Incompatible with nitrates and water. May hydrolyze upon contact with water, steam and moisture, and produce toxic oxides of phosphorus, nitrogen, sulfur, and chlorine.

Permissible Exposure Limits in Air:

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 0.82 milligram per cubic meter

PAC-2: 9 milligram per cubic meter

PAC-3: 54 milligram per cubic meter

Routes of Entry: Inhalation, ingestion; skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Similar to parathion in health hazards. Death may result due to respiratory arrest as a result of paralysis of respiratory muscles and intense bronchoconstriction. Also considered a cholinesterase inhibitor. Symptoms similar to parathion include nausea, vomiting, abdominal cramps; diarrhea, excessive salivation; headache, giddiness, dizziness, tightness in the chest; blurring or dimness of vision; tearing, loss of muscle coordination; slurring of speech; twitching of muscles; drowsiness, difficulty in breathing; respiratory rales; and random jerky movements.

Long-Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage. May cause skin allergy.

Points of Attack: Respiratory system, lungs, CNS; cardiovascular system, skin, eyes, plasma and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also consider CBC. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates. Evaluation by a dermatologist and/or qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code -Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area away from oxidizers, nitrates and other incompatible materials listed above. Where possible, automatically transfer material from other storage containers to process containers.

Shipping: UN3464 Organophosphorus compound, solid, toxic, n.o.s, Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN2783 Organophosphorus pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling:

Initial isolation and protective action distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.3/0.4
Night 0.8/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 600/200
Then: Protect persons downwind (miles/kilometers)
Day 1.4/2.3
Night 2.8/4.5

Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Thermal decomposition products may include oxides of phosphorus, sulfur, nitrogen and carbon. Extinguish with dry chemical, carbon dioxide; water spray, foam, or fog. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Wear positive pressure breathing apparatus and special protective clothing. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Phosfolan, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

Phosgene (Agents CG & DP) P:0550

Formula: CCl_2O; $COCl_2$

Synonyms: Carbone (oxychlorure de) (French); Carbon dichloride oxide; Carbon oxychloride; Carbonic dichloride; Carbon oxychloride; Carbonylchlorid (German); Carbonyl chloride; Carbonyl dichloride; CG (military designation); Chloroformyl chloride; Combat gas; Diphosgene; DP (military designation for diphosgene); Fosgeno (Spanish); NCI-C60219; Phosgen (German); Trichloroacetyl chloride (diphosgene)

CAS Registry Number: 75-44-5; 503-38-8 (diphosgene)

HSDB Number: 796; 371 (diphosgene)

RTECS Number: SY5600000

UN/NA & ERG Number: (PIH) UN1076/125

EC Number: 200-870-3 [*Annex I Index No.:* 006-002-00-8]; 207-965-9 (diphosgene or trichloromethyl chloroformate)

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 500 (1.00% concentration); *Theft hazard* 15 ($\geq$0.17% concentration).

Carcinogenicity: EPA: Inadequate Information to assess carcinogenic potential.

Hazard Alert: Poison inhalation hazard: exposure can be lethal, Deadly poisonous gas with inadequate warning properties (do *not* inhale), Lung damaging agent, Dangerously water reactive, Corrosive, Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated, Environmental hazard, Primary irritant (w/o allergic reaction).

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); List of high risk pollutants (Section 63.74); Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 500 lb (227 kg)

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P095

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 10 lb (4.54 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT 49CFR172.101, Inhalation Hazardous Chemical (PIH)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard Symbols, Risk & Safety statements: Hazard Symbol *(75-44-5)*: T+, C, N, Xi, Xn; Risk phrases: R5; R21; R26; R34; R36/37/38; R39/26; Safety phrases: S1/2; S9; S26; S29/35; S33; S36/37/39; S38; S41, S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Phosgene (CG) is a colorless gas above 8.2°C. Fog-like when concentrated. Colorless, fuming liquid below 8.2°C. May have the appearance of a white cloud. Light yellow liquid when refrigerated or compressed. It is shipped as a liquefied compressed gas in steel cylinders. At low concentrations CG has a sweet (not pleasant) odor like newly mown hay, green corn, or moldy hay. In higher concentrations, it is poisonous with an odor that is suffocating, irritating, and pungent. The odor is only detectable for a short amount of time when CG is initially released and odor should not be regarded as a reliable indicator of overexposure. A fuming liquid below 8.3°C/47°F. Shipped as a liquefied compressed gas. The Odor Threshold is between 1.5−6 milligram per cubic meter. A choking agent, phosgene (CG) rapidly decompose in relative humidity over 70%. Molecular weight = 98.92; Specific gravity (H_2O:1) = 1.4 @ 20°C; Boiling point = 8.2°C; Freezing/Melting point = −128°C; Relative vapor density (air = 1) = 3.48; Vapor pressure = 1.61 atm @ 25°C; 750 mmHg @ 7.2°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 0, Reactivity 1. ₩ Slightly soluble in water; reacts with water forming hydrogen chloride acid and oxides of carbon.

Potential Exposure: Phosgene can be deadly at a concentration as low as 2 ppm. Phosgene is used as an intermediate in the manufacture of many industrial chemicals, including dyes and plastics; in the making of dyestuffs based on triphenylmethane, coal tar, and urea. It is also used in the organic synthesis of isocyanates and their derivatives, carbonic acid esters (polycarbonates); and acid chlorides. Other applications include its utilization in metallurgy; and in the manufacture of some insecticides and pharmaceuticals. Exposure to phosgene may occur during arc welding and in fires involving vinyl chloride; released from household paint removers and degreasers when they are used in the presence of heat. Phosgene (CG) has been used as a military choking, pulmonary agent since WW I, and has become a staple of chemical arsenals in many countries.

Persistence of Chemical Agent: Phosgene (CG & DO): Summer: 1to 10 minutes; Winter: 10 minutes to 1 hour.

Incompatibilities: Moisture, alkalis, ammonia, alcohols, copper. Reacts slowly in water to form corrosive hydrogen chloride and carbon dioxide. Violent reaction with strong oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alcohols, alkaline materials, strong acids, strong bases, alcohols, ammonia, amines, aluminum, alkali metals. Attacks many metals in presence of water. Phosgene (CG) reacts violently with strong oxidants, amines, alkalis, and many metals. Above 300°C, phosgene decomposes in the presence of moisture to form hydrochloric acid and carbon dioxide. In the presence of moisture, phosgene attacks plastic, rubber, coatings and many metals[77].

Permissible Exposure Limits in Air:

NIOSH IDLH = 2 ppm

Conversion factor: 1 ppm = 4.05 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 0.1 ppm/0.4 milligram per cubic meter TWA

NIOSH REL: 0.1 ppm/0.4 milligram per cubic meter TWA; 0.2 ppm/0.8 milligram per cubic meter [15-min.] Ceiling Concentration

ACGIH TLV[1]: 0.1 ppm/0.4 milligram per cubic meter TWA

Protective Action Criteria (PAC) **CG*** Ver. 29[138]

75-44-5

PAC-1: 0.027 ppm

PAC-2: $\mathbf{0.3_A}$ ppm

PAC-3: $\mathbf{0.75_A}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

Emergency Response Planning Guidelines

ERPG-1: Inappropriate

ERPG-2: 0.2 ppm

ERPG-3: 1 ppm

DFG MAK: 0.02 ppm; 0.082 milligram per cubic meter TWA; Peak Limitation Category I(2); Pregnancy Risk Group C

Austria: MAK 0.1 ppm (0.4 milligram per cubic meter), 1999; Denmark: TWA 0.05 ppm (0.2 milligram per cubic meter), 1999; Finland: STEL 0.05 ppm (0.2 milligram per cubic meter), [skin], 1999; France: VLE 0.1 ppm (0.4 milligram per cubic meter), 1999; Japan: 0.1 ppm (0.4 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 0.08 milligram per cubic meter, 2003; the Phillipines: TWA 0.1 ppm (0.1 milligram per cubic meter), 1993; Poland: MAC (TWA) 0.5 milligram per cubic meter; MAC (STEL) 1.5 milligram per cubic meter, 1999; Sweden: TGV 0.05 ppm (0.2 milligram per cubic meter), 1999; Switzerland: MAK-W 0.1 ppm (0.4 milligram per cubic meter), KZG-W 0.2 ppm (0.8 milligram per cubic meter), 1999; Thailand: TWA 0.1 ppm (0.4 milligram per cubic meter), 1993; Turkey: TWA 0.1 ppm (0.4 milligram per cubic meter), 1993; United Kingdom: TWA 0.02 ppm (0.08 milligram per cubic meter); STEL 0.06 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 0.1 ppm. The Czech Republic has set a TWA of 0.5 milligram per cubic meter and a ceiling value of 1.0 milligram per cubic meter in workplace air, and MAC in ambient air of 0.01 milligram per cubic meter and 0.003 milligram per cubic meter on a daily average basis. Several states have set guidelines or standards for phosgene in ambient air[60] ranging from zero (North Carolina) to 1.33 μ/m^3 (New York) to 4.0 μ/m^3 (Florida, North Dakota, South Carolina) to 7.0 μ/m^3 (Virginia) to 8.0 μ/m^3 (Connecticut) to 10.0 μ/m^3 (Nevada).

Determination in Air: Use OSHA Analytical Method 61.

Determination in Water: Octanol-water coefficient: Log $K_{ow} = -0.71$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Can be fatal if inhaled. Acute exposure to phosgene may result in severe irritation and burns of the skin, eyes, mucous membranes; and respiratory passages. Cough, dyspnea (shortness of breath), pain in the chest; and severe pulmonary edema may also occur. Cyanosis and anxiety may be observed. *Note:* The detection of the odor of phosgene at any time indicates the need for immediate, corrective action or withdrawal. *Inhalation:* Both immediate and delayed symptoms may be felt. Immediate symptoms of irritation to mouth, throat, and eyes; tearing, coughing, and difficult breathing are felt at levels of 5 ppm and above. Delayed effects are the accumulation of fluid in the lungs and death; if proper, rapid treatment is not obtained. The length of delay depends on the dose but may be between 2 and 15 hours. Death may result from short exposures to high levels (30 ppm, 17 minutes) or long exposures to low levels (3 ppm, 3 hours). Phosgene is particularly dangerous at low levels because lethal doses may be inhaled without warning symptoms. *Skin:* Contact with skin may lead to severe chemical burns. Liquid may cause frostbite. *Eyes:* Eye irritation begins @ 3−5 ppm. Severe and permanent damage may result. Liquid phosgene is more hazardous than vapor. Liquid may cause frostbite. *Ingestion:* Expected symptoms may include severe irritation and chemical burns of the mouth, throat, lungs and digestive tract.

Long-Term Exposure: Even low levels can cause permanent lung damage; emphysema, bronchitis, pulmonary fibrosis.

Points of Attack: Respiratory system, lungs, skin, eyes.

Medical Surveillance: Preemployment medical examinations should include chest X-rays and baseline pulmonary function tests. Consider chest X-ray following acute overexposure. The eyes and skin should be examined. Smoking history should be known. Periodic pulmonary function studies should be done. Workers who are known to have inhaled phosgene should remain under medical observation for at least 24 hours to insure that delayed symptoms do not occur.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately. If this chemical contacts the skin, flush with water immediately. If a person breathes in large amounts of this chemical, move the exposed person to fresh air at once and perform artificial respiration. When this chemical has been swallowed, get medical attention. Do not induce vomiting. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy. If frostbite has occurred, seek medical attention immediately; do NOT rub the affected areas or flush them with water. In order to prevent further tissue damage, do NOT attempt to remove frozen clothing from frostbitten areas. If frostbite has NOT occurred, immediately and thoroughly wash contaminated skin with soap and water.

Decontamination*:* Decontaminate as soon as possible. This is extremely important. If you don't have the equipment (TMV-4) has enter the hot zone to rescue and/or decontaminate victims. If the victim can't move, begin the decontamination process without touching and without entering the hot zone. Use clean water from any source; if possible, use a hose (spray or fog to prevent injury to the victim) or other system so that you won't have to touch the victim; don't even wait for soap or for the victim to remove clothing, begin washing immediately. Immediately flush the eyes with water for at least 15 minutes. Wash—strip—wash—evacuate up wind and uphill: The approach is to immediately wash with water, then have the victim (not the first responder) remove all the victim's clothing, then wash again (with soap if available); and subsequently move away from the hot zone in an upwind and up hill direction. Wash the victim with warm water and soap. Decontaminate with diluted household bleach (10%, or one part bleach to nine parts water), but don't let any of the bleach solution get in the victim's eyes, open wounds, or mouth. Rinse off the diluted bleach solution after 15 minutes. In order to prevent spreading the agent, be certain the victims have been decontaminated as much as possible before they leave the decontamination area. If you get any amount of the agent on yourself, decontaminate immediately. Even if you think you are not contaminated, be sure to thoroughly shower and change clothes as soon as you can after the incident

Personal Protective Methods:

General information: first responders should use a NIOSH-certified chemical, biological, radiological, nuclear (CBRN) SCBA with a level a protective suit when entering an area with an unknown contaminant or when entering an area where the concentration of the contaminant is unknown. Level a protection should be used until monitoring results confirm the contaminant and the concentration of the contaminant. *Note:* safe use of protective clothing and equipment requires specific skills developed through training and experience.

LEVEL A: (*RED ZONE*): select when the greatest level of skin, respiratory, and eye protection is required. This is the maximum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than the AEGL-2. A NIOSH-certified CBRN full-facepiece scba operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle. A totally encapsulating chemical protective (TECP) suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, and a hard hat worn under the TECP suit are optional items.

LEVEL B: (RED ZONE): Select when the highest level of respiratory protection is necessary but a lesser level of skin protection is required. This is the minimum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than AEGL-2. It differs from Level A in that it incorporates a non-encapsulating, splash-protective, chemical-resistant splash suit that provides Level A protection against liquids but is not airtight. A NIOSH-certified CBRN full-facepiece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle. A hooded chemical -resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL C: (YELLOW ZONE): Select when the contaminant and concentration of the contaminant are known and the respiratory protection criteria factors for using Air Purifying Respirators (APR) or Powered Air Purifying Respirators (PAPR) are met. This level is appropriate when decontaminating patient/victims. A NIOSH-certified CBRN tight-fitting APR with a canister-type gas mask or CBRN PAPR for air levels greater than AEGL-2. A NIOSH-certified CBRN PAPR with a loose-fitting facepiece, hood, or helmet and a filter or a combination organic vapor, acid gas, and particulate cartridge/filter combination or a continuous flow respirator for air levels greater than AEGL-1. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Escape mask, face shield, coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL D: (GREEN ZONE): Select when the contaminant and concentration of the contaminant are known and the concentration is below the appropriate occupational exposure limit or less than AEGL-1 for the stated duration times. Limited to coveralls or other work clothes, boots, and gloves.

Notes: Take all necessary precautions to prevent any reasonable probability of skin or eye contact. Where liquid phosgene is encountered, protective clothing should be supplied which is impervious to phosgene. Where gas is encountered above safe limits, Full-face gas masks with phosgene canisters or supplied air respirators should be used. Because of the potentially serious consequences of acute overexposure and the poor warning properties of the gas to the human senses, automatic continuous monitors with alarm systems are strongly recommended. Wear appropriate clothing to prevent any reasonable probability of skin or eye contact. Wear eye protection to prevent any possibility of eye contact. Employees should wash immediately when skin is wet or contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers.

Decontamination: Decontaminate as soon as possible. This is extremely important. If you don't have the equipment and training, don't enter the hot zone to rescue and/or decontaminate victims. If the victim can't move, begin the decontamination process without touching and without entering the hot zone. Use clean water from any source; if possible, use a hose (spray or fog to prevent injury to the victim) or other system so that you won't have to touch the victim; don't even wait for soap or for the victim to remove clothing, begin washing immediately. Immediately flush the eyes with water for at least 15 minutes. Wash—strip—wash—evacuate up wind and uphill: The approach is to immediately wash with water, then have the victim (not the first responder) remove all the victim's clothing, then wash again (with soap if available); and subsequently move away from the hot zone in an upwind and up hill direction. Wash the victim with warm water and soap. Decontaminate with diluted household bleach (10%, or one part bleach to nine parts water), but don't let any of the bleach solution get in the victim's eyes, open wounds, or mouth. Rinse off the diluted bleach solution after 15 minutes. In order to prevent spreading the agent, be certain the victims have been decontaminated as much as possible before they leave the decontamination area. If you get any amount of the agent on yourself, decontaminate immediately. Even if you think you are not contaminated, be sure to thoroughly shower and change clothes as soon as you can after the incident

Respirator Selection: *1 ppm:* Sa (APF = 10) (any supplied-air respirator). *2 ppm:* SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted canister providing protection against the compound of concern]; or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Check oxygen content prior to entering storage area. Poison gas. (1) Color code-Blue: Health Hazard/ Poison: Store in a secure poison location. This gas is highly toxic. Even slight exposure to these gasses can cause death. Store outdoors in a secure, restricted area that containing warning signs. This area must be roofed and shaded with the cylinders stored off the ground and separated from all other products assigned to other hazard categories and radiant heat sources on non-wooden floors. If indoors, store in a well-ventilated areas in temperatures not to exceed 50°C. (2) Color code-White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location; keep acids away from bases and red, yellow, and blue-coded chemicals. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Phosgene must be stored to avoid contact with water, moisture, or steam, since violent reactions occur. Store in tightly closed, steel containers in an isolated area away from the work area and separated from all other materials, as well as sunlight. Although phosgene in anhydrous equipment is not corrosive to ordinary metals; in presence of moisture, use monel, tantalum, or glass-lined storage containers. Phosgene should be stored away from heating and cooling ducts. Containers should be frequently inspected for leaks. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169 with the recommendations of the Compressed Gas Association.

Shipping: UN1076 Phosgene, Hazard Class: 2.3; Labels: 2.3-Poisonous gas, 8-Corrosive material, Inhalation, Hazard Zone A. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner. Military driver shall be given full and complete information regarding shipment and conditions in case of emergency. AR 50-6 deals specifically with the shipment of chemical agents. Shipments of agent will be escorted in accordance with AR 740-32.

Spill Handling:

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Phosgene

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 300/100
Then: Protect persons downwind (miles/kilometers)
Day 0.4/0.6
Night 1.7/2.7

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 1500/500
Then: Protect persons downwind (miles/kilometers)
Day 1.9/3.1
Night 6.7/10.8

Diphosgene

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.2/0.3
Night 0.3/0.5

CG, when used as a weapon

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 500/150
Then: Protect persons downwind (miles/kilometers)
Day 0.5/0.8
Night 2.0/3.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 3000/1000
Then: Protect persons downwind (miles/kilometers)
Day 4.7/7.5
Night 7.0+/11.0+*

*+ means distance can be larger in certain atmospheric conditions.

DP, when used as a weapon

Small spills (From a small package or a small leak from a large package)
First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.3
Night 0.4/0.8
Large spills (From a large package or from many small packages)
First: Isolate in all directions (feet/meters) 600/200
Then: Protect persons downwind (miles/kilometers)
Day 0.7/1.1
Night 1.5/2.4

Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Ventilate area of leak to disperse the gas. Stop flow of gas. If source of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. Phosgene may be neutralized by covering it with sodium bicarbonate or an equal mixture of soda ash and slaked lime; diatomite and expanded mica might also be used. After that cover immediately abundant with lime hydrate. After mixing, spray very carefully with water. Transfer slowly to a larger container of water. *Do not use water* directly on spill. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include hydrogen chloride and oxides of carbon. Phosgene may burn, but does not easily ignite. This gas is under pressure; containers may rupture and explode when heated. For small fires, use dry chemical or carbon dioxide. Use water spray, fog, or foam for larger fires. Move container from fire area if you can do so without risk. Stay away from the ends of tanks and cool exposed containers with water until well after the fire is out. Isolate the area until gas has dispersed. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. Do not get water inside containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode. Diphosgene (DP) will not burn. However, it is possible that a DP tank may be adjacent to a fire. In a fire, a storage tank will heat and the tank may over-pressurize and explode, so evacuate the area. When heated, DP breaks down to toxic phosgene, which breaks down into chlorine and hydrogen chloride gases. The danger from a heated DP tank is too great to risk a manned firefighting effort; if possible, an unattended fire monitor aimed at the upper part of the diphosgene tank will cool the tank and may prevent tank failure. In general, it's best to use a spray or fog pattern rather than a solid stream, to avoid spreading the burning fuel around.

Disposal Method Suggested: Principles and methods for destruction of chemical weapons: "Destruction of chemical weapons" means a process by which chemicals are converted in an essentially irreversible way to a form unsuitable for production of chemical weapons, and which in an irreversible manner renders munitions and other devices unusable as such. Each nation shall determine how it shall destroy chemical weapons, except that the following processes may not be used: dumping in any body of water, land burial or open-pit burning. It shall destroy chemical weapons only at specifically designated and appropriately designed and equipped facilities. Each nation shall ensure that its chemical weapons destruction facilities are constructed and operated in a manner to ensure the destruction of the chemical weapons; and that the destruction process can be verified under the provisions of this Convention (Organization for the Prohibition of Chemical Weapons; Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and Their Destruction). Return refillable compressed gas cylinders to supplier. Phosgene may be neutralized by covering it with sodium bicarbonate or an equal mixture of soda ash and slaked lime. After mixing, spray carefully with water. Transfer slowly to a larger container of water. *Do not use water* directly on spill. Pass controlled discharges of phosgene through 10% NaOH solution in a scrubbing tower [22]. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (173); (101); (138); (85); (86); (87); (169); (93); (94); (103); (105); (163); (176); (186); (187); (80); (100).

National institute for Occupational Safety and Health (NIOSH), "Criteria for a Recommended Standard: Occupational Exposure to Phosgene," NIOSH Document Number 76-137, Cincinnati OH (1976)

United States Environmental Protection Agency, Chemical Hazard Information Profile: Phosgene, Washington, DC (June 13, 1977)

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United States Environmental Protection Agency, Chemical Hazard Information Profile: Phosgene, Washington, DC,

Chemical Emergency Preparedness Program (November 30, 1987)

New York State Department of Health, *Chemical Fact Sheet:* Phosgene, Bureau of Toxic Substance Assessment, Albany, NY (March 1986)

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Phosgene Oxime (Agent CX) P:0555

Formula: $CHCl_2NO$

Synonyms: Carbonyl chloride oxime; CX; Dichlorformaldehyde-oxime; Dichloroformaldoxime; 1,2-Dichloroformoxime Dichloroformoxime; Dichlormethylen-hydroxylamine; Dichloroximinomethane; Kohlensauredichloridoxime (German)

CAS Registry Number: 1794-86-1

HSDB Number: 7600

RTECS Number: Not established

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154; 2810 (liquid)/154

Regulatory Authority and Advisory Information

Report any release of WMD to National Response Center 1-800-424-8802

Hazard Alert: Poison, Blister agent/vesicant, Median incapacitatingand lethal dose is low, May be an oxidizer.

While not a mandated "Federally-listed" waste, CX is more toxic than most RCRA listed chemicals. However, GF is a "listed" hazardous waste in some states where it may have been stockpiled by the military.

Description: Phosgene oxime (military designation CX) is a non-combustible urticant (nettle agent, blister agent) with a short (seconds to minutes) latency period. CX is a colorless, low-melting point (crystalline, white powder) solid or as a liquid (liquid above 39°C; solid below 35°C). On hot days (or at body temperature) it can appear as a yellowish-brown liquid. It has a high vapor pressure (the vapor pressure of the solid is high enough to produce symptoms), slowly decomposes at normal temperatures. It has an intense, disagreeable,penetrating, and violently irritating, peppery odor. Odor detectable at less than 0.3 ppm. Molecular weight = 113.93 daltons; Freezing/Melting point = 35°C to 40°C; boiling point = 129°C (with decomposition); Vapor density = 3.9; Vapor pressure = 11.2 mmHg @ 20°C (solid); 13 mmHg @40°C (liquid); Volatility = 1800 milligram per cubic meter @20°C; 76,000 milligram per cubic meter @ 40°C; Latent heat of vaporization = 101 cal/gr @ 40°C; Thermal decomposition temperature = < 128°C. Solubilty in water = dissolves slowly and completely. Hydrolysis products include hydrogen chloride and methylarsenic oxide.

History of the chemical: CX was invented in Germany in 1929; it is among the least well studied chemical warfare agents; therefore, detailed information is limited. Although it is believed that CX was never used on the battlefield, it was after WW II that the military tested concentrated phosgene oxime. These tests revealed that CX was a highly effective and painful chemical warfare agent. Phosgene oxime is of military interest because it easily penetrates garments and rubber much more quickly than do other chemical agents. It is possible that the Iraq is used CX in the Iran-Iraq war, and North Korea may have produced and stocked quantities of this chemical agent. Phosgene oxime (CX) gives off dangerous gas. It does takes very little of this gas to damage a victim's lungs. Terrorists might put CX in it an exploding bomb in order break up the solid into an aerosol that can penetrate the skin and lungs. Once exposed, the victim's feels immediate pain and the need to escape. Phosgene oxime (CX) easily penetrates fabrics and rubbers and cause great pain and skin damage (without blisters) in less than a minute. Soon after contact the skin dies. Recovery may take up to 6 months. Eye contact can cause blindness. Inhalation attacks the lungs, resulting in damage that can be permanent.

Potential Exposure: There's no industrial use for Phosgene oxime (CX) and because of its extreme instability, the pure material is not likely to be used in military operations[163]. CX is especially dangerous when mixed with other chemicals such as nerve agents. It burns away the skin making it more permeable to any other "added" agents. No other chemical agent is capable of producing immediate extreme pain followed by rapid local tissue death (necrosis). Post World War II studies indicate that concentrations below 8% cause no or inconsistent effects[76].

Persistence of Chemical Agent*: Soil*: about 2 hours. *Material surfaces and water*: relatively nonpersistent.

Incompatibilities: Phosgene oxime (CX) is among the most important halogenated oximes. CX reacts with water, sweat, and heat, forming hydrochloric acid. CX may be an oxidizer, and it may ignite combustibles, e.g., wood, paper, oil, or clothing). CX is incompatible with strong acids and bases; hydrides and other strong reducing agents such as hydrides; strong oxidizing acids, peroxides, and hydroperoxides. Not hydrolyzed by dilute acids; reacts violently in basic solutions forming carbon dioxide, hydrogen chloride, and hydroxylamine. Hydrolysis products include HCl and methylarsenic oxide. CX quickly penetrates rubber and clothing. Traces of many metals cause it to decompose; however, it corrodes most metals. Oximes are chemically similar to, but more reactive than amides. Incompatible with strong acids and bases, and especially incompatible with strong reducing agents such as hydrideds and active metals. Also incompatible with strongly oxidizing acids, peroxides, and hydroperoxides[101]. CX decomposes when in contact with many metals; it is corrosive to most metals, and contact with metals may evolve flammable hydrogen gas.

Permissible Exposure Limits in Air: Conversion factor = 1 ppm = 4.66 milligram per cubic meter @77°C

The immediately-dangerous-to-life-and-health (IDLH) concentration of CX has not been defined.

Protective Action Criteria (PAC) **CG*** Ver. 29[138]

PAC-1: $\mathbf{0.028_A}$ milligram per cubic meter
PAC-2: $\mathbf{0.083_A}$ milligram per cubic meter
PAC-3: $\mathbf{13_A}$ milligram per cubic meter
*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

Determination in Air:
Medial lethal dose = low ~3000 mg-min/m^3.
According to the United States Army Medical Research Institute of Chemical Defense (*USAMRICD), do NOT depend on the following for the detection of Agent CX*: M272 water testing kit, MINICAMS, ICAD, M21 remote sensing alarm, CAM, ACAMS, DAAMS, and M8A1 automatic chemical-agent detector alarm are incapable of detecting CX. Likewise, M8 and M9 paper should not be depended upon to detect Agent CX.

The M256A1 detector ticket reacts to the presence of CX, but the detection threshold is not known with certainty. Liquid detection: The portable M256A1 has a response time of up to 15 minutes. The following detectors are listed for Agent CX detection in the *Guide for the Selection of Chemical Detection Equipment for Emergency First Responders, 3rd Edition*, published by the United States Department of Homeland Security: Chemical Agent Detector C2 Kit (021330) for vapor, liquids, aerosols: Start-up time (based on experience) 1 to 5 minutes; response time (regardless of experience) 20−25 minutes (Anachemia Canada, Inc.); and M256A1 (T503) (063230COM) Chemical Agent Detector Simulator Training Kits for vapor only: Start-up time (based on experience) 1 to 5 minutes; response time (regardless of experience) 20−25 minutes (Anachemia Canada, Inc.)

The following detectors have the capacity to detect CX at the threshold limits given[191]:
Liquid: M18A2.0.5 milligram per cubic meter
Air: M90 (M90-D1-C).0.15 milligram per cubic meter
M93A1 Fox.10-100 mcg/L

Permissible Concentration in Water: Do NOT use the M272 water testing kit[191].

Determination in Water: Contact pollution control authorities and advise shutting water intakes. CX dissolves in water and breaks down into toxic products that are much less dangerous than phosgene oxime, but still poisonous. Do not allow people to drink water containing even the breakdown products.

Routes of Entry: Skin, eye contact, inhalation

Harmful Effects and Symptoms
Phosgene oxime (CX) is a rapid-acting casualty agent. Median lethal dose = ~3000 mg-min/m^3. The effects of phosgene oxime vapor and liquid on the skin, eyes, and lungs are almost instantaneous; causing immediate pain upon contact with the liquid and when the vapors are inhaled. Little is known about how CX works but it eats its way through protective clothing, the skin, and eventually reaches the blood. Phosgene oxime (CX) will cause blindness; kill skin horribly, and with enough of it on the skin a victim could die. *Eyes*: The eyes will immediately burn; the eyelids will swell, and the victim's cornea will scar, causing permanent damage to the eyes with possible blindness. *Lungs*: The effects are immediate: The victim will sneeze and cough, with runny nose. The lungs will fill with fluid causing pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. *Skin*: Immediate stinging pain will be felt. The skin reddens and will eventually blister (up to 12 hours after exposure). *Ingestion*: It's difficult to understand how one might swallow Phosgene oxime (CX), but it possibly may happen. Animal studies show that the victim's stomach and intestines would swell and bleed.

Short-Term Exposure: Pain and local tissue destruction occur immediately on contact with skin, eyes and mucous membranes. Phosgene oxime is rapidly absorbed from the skin and eyes and may result in systemic toxicity. Phosgene oxime causes redness, wheals (hives), and urticaria on the skin, but does not producea fluid-filled blister (vesication). Despite the lack of initial blister formation, phosgene oxime produces moretissuedamage than the blister agents. Known as a "nettle gas," CX produces immediate pain varying from a mild pricklingto almost intolerable pain similar to a severe bee sting. Phosgene oxime has no antidote. Treatment is similar to that ofthe mustard agents. It causes violent irritation to the mucous membranes of the nose and eyes. Even at low temperatureit has sufficient vapor pressure to produce tearing. When CX comes in contact to the skin, the area turns pale in 30 seconds and develops a red ring around the area. A wheal forms in about 30 minutes; the blanched area turns brown in24 hours and a scab forms in about a week. The scab usually falls off in about 3 weeks. Itching may be presentthroughout healing, which in some cases may be delayed beyond 2 months. [Army FM 3-9 and CDC] The LD$_{50}$ for skin exposure is estimated as 25 mg/kg. LCt$_{50}$ = no accurate data available; The estimated LCt$_{50}$ by inhalation is 1500−2000 mg · min/m^3; ICt$_{50}$ (respiratory) 25 mg-minute/m^3 Inhaled phosgene oxime is extremely irritating to the upper airways and causes pulmonary edema. Irritation occurs with exposures to 0.2 mg-min/m^3 and becomes unbearable at 3 mg-min/m^3. The estimated LCt$_{50}$ (the product of concentration times time that is lethal to 50% of the exposed population by inhalation) is 1500 to 2000 mg-min/m^3[76].

Long-Term Exposure: May cause permanent injury, including lung damage and blindness. Information is unavailable about the carcinogenicity, developmental toxicity, or reproductive toxicity from chronic or repeated exposure to phosgene oxime.

Points of Attack: Skin; mucous membranes of the nose and eyes.

Medical Surveillance: There are no specific tests to confirm exposure. Extreme pain may persist for days. Patients/victims should be observed for signs of whole-body (systemic) toxicity, including accumulation of fluid in the lungs (pulmonary edema). Gastric lavage is contraindicated following ingestion of this agent due to the risk of perforation of the esophagus or upper airway[77].

First Aid Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Decontamiation: *Note to first responders*: Depending on the dose and the equipment available to you: Evacuate the area and shut down heating, ventilation, and air conditioning systems to prevent further spread of Phosgene oxime (CX). Call for medical and hazmat assistance immediately. If you get CX on yourself, decontaminate immediately. Even if you think you are not contaminated, be sure to thoroughly shower and change clothes as soon as you can after the incident. Because of the rapid reaction of CX with the skin, decontamination may not be entirely effective once pain occurs. Nevertheless, decontaminate as rapidly as possible by flushing the area with large amounts of water to remove any agent that has not reacted with the skin. Wash the victim with warm water with soap. *Bleach doesn't work with CX.* Be certain you've decontaminated the victims as much as you can before they leave the area so that theydon't spread the Phosgene oxime (CX).

Personal Protective Methods:

General information: first responders should use a NIOSH-certified chemical, biological, radiological, nuclear (CBRN) SCBA with a level a protective suit when entering an area with an unknown contaminant or when entering an area where the concentration of the contaminant is unknown. Level a protection should be used until monitoring results confirm the contaminant and the concentration of the contaminant. *Note:* safe use of protective clothing and equipment requires specific skills developed through training and experience.

LEVEL A: (*RED ZONE*): select when the greatest level of skin, respiratory, and eye protection is required. This is the maximum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than the AEGL-2.

A NIOSH-certified CBRN full-facepiece scba operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle. A totally encapsulating chemical protective (TECP) suit that provides protection against CBRN agents.

Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, and a hard hat worn under the TECP suit are optional items.

LEVEL B: (RED ZONE): Select when the highest level of respiratory protection is necessary but a lesser level of skin protection is required. This is the minimum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than AEGL-2. It differs from Level A in that it incorporates a non-encapsulating, splash-protective, chemical-resistant splash suit that provides Level A protection against liquids but is not airtight.

A NIOSH-certified CBRN full-facepiece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL C: (YELLOW ZONE): Select when the contaminant and concentration of the contaminant are known and the respiratory protection criteria factors for using Air Purifying Respirators (APR) or Powered Air Purifying Respirators (PAPR) are met. This level is appropriate when decontaminating patient/victims. A NIOSH-certified CBRN tight-fitting APR with a canister-type gas mask or CBRN PAPR for air levels greater than AEGL-2. A NIOSH-certified CBRN PAPR with a loose-fitting facepiece, hood, or helmet and a filter or a combination organic vapor, acid gas, and particulate cartridge/filter combination or a continuous flow respirator for air levels greater than AEGL-1. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Escape mask, face shield, coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL D: (GREEN ZONE): Select when the contaminant and concentration of the contaminant are known and the concentration is below the appropriate occupational exposure limit or less than AEGL-1 for the stated duration times. Limited to coveralls or other work clothes, boots, and gloves.

Notes: Take all necessary precautions to prevent any reasonable probability of skin or eye contact. *CX quickly penetrates rubber and clothing.* Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Select when the highest level of respiratory protection is necessary but a lesser level of skin protection is required. This is the minimum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than AEGL-2. It differs from Level A in that it incorporates a non-encapsulating, splash-protective, chemical-resistant splash suit that provides Level A protection against liquids but is not airtight.

A NIOSH-certified CBRN full-facepiece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

Storage: Used detection equipment prior to entering storage area. *See above section: Determination in Air.* Poison gas. (1) Color code-Blue: Health Hazard/Poison: Store in a locked and secure poison location. Store outdoors in a secure, restricted area that containing warning signs. This area must be roofed and shaded with the cylinders stored off the ground and separated from all other products assigned to other hazard categories and radiant heat sources on non-wooden floors. Containers should be frequently inspected for leaks. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101.

Shipping: UN2811 (solid)/UN2810 (liquid) Toxic solids or liquids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. Military driver shall be given full and complete information regarding shipment and conditions in case of emergency. AR 50-6 deals specifically with the shipment of chemical agents. Shipments of agent will be escorted in accordance with AR 740-32.

Spill Handling:

UN2810 Toxic liquids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.2/0.3
Night 0.7/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 1000/300
Then: Protect persons downwind (miles/kilometers)
Day 1.1/1.8
Night 2.8/4.5

CX, when used as a weapon

Small spills [involving the release of approximately 52.83 gallons (200 liters) or less]

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.3/0.5

Large spills [*involving quantities greater than 52.83 gallons (200 liters)*]

First: Isolate in all directions (feet/meters) 300/90
Then: Protect persons downwind (miles/kilometers)
Day 0.6/1.0
Night 1.9/3.1

If a tank, rail car, or tank truck is involved in a fire, isolate it for 0.5 mi (800 m) in all directions; also, consider initial evacuation for 0.5 mi (800 m) in all directions.

Immediately evacuate everyone, including yourself. Immediately call for medical and hazmat assistance. Notify police, federal authorities, medical, hazmat, and emergency authorities. Immediately decontaminate victim. Don't touch the victim or allow Phosgene oxime (CX) to touch your skin or eyes. If possible, ventilate the area. If response personnel must walk through the spilled agent, wear the appropriate Level A protection. Keep combustibles, for example, wood, paper, and oil, away from the spilled agent. Use water spray to reduce aerosols or divert aerosol cloud drift. Avoid allowing water runoff to contact the spilled agent. Do not direct water at the spill or the source of the leak. Stop the leak if it is possible to do so without risk to personnel. Prevent entry into waterways, sewers, basements, or confined areas. Isolate the area until aerosol has dispersed[77].

Fire Extinguishing: Phosgene oxime (CX) is non-combuatible; it burns weakly, if at all. Thermal decomposition products of CX may include hydrogen chloride, chlorine and oxides of nitrogen and carbon. Containers may explode when heated. In case of fire, evacuate the area, including yourself. CX may be an oxidizer, and it may ignite combustible materials, for example, wood, paper, oil, or clothing. If there is some reason that you have to put out the fire—for example, there are things nearby that cannot be allowed to burn—use unattended equipment, then evacuate everyone immediately, including yourself. If you *must* extinguish a Phosgene oxime(CX) fire, use water streams, water fog, alcohol foam, universal foam, and, for confined fires, carbon dioxide. (For small fires, use dry chemical, carbon dioxide, or water spray. For large fires, use dry chemical, carbon dioxide, alcohol-resistant foam, or water spray.) Vapors are heavier than air and will collect in low areas. Keep out of these areas; stay upwind. Hazardous concentrations may spread along the ground and collect and stay in poorly ventilated, low-lying, or confined areas, for example, sewers, basements, and tanks. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Move containers from the fire area if it is possible to do so without risk to personnel. Dike fire control water for later disposal; do not scatter the material. For fire involving tanks or car/trailer loads, fight the fire from maximum distance or use unmanned hose holders or monitor nozzles. Do not get water inside containers. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tanks. Always stay away from tanks engulfed in fire. Run-off from fire control or dilution water may be corrosive and/or toxic, and it may cause pollution. If the situation allows, control and properly dispose of run-off (effluent).

Disposal Method Suggested

Seek expert advice from armed services (see Reference section), Center for Disease Control headquarters in Atlanta, Ga.

References

(31); (101); (138); (85); (86); (87); (169); (93); (94); (103); (105); (163); (175); (176); (186); (188); (191).

Phosmet P:0560

Formula: $C_{11}H_{12}NO_4PS_2$

Synonyms: APPA; Decemthion; Decemthion P-6; *O*,*O*-Dimethyl phthalimidiomethyl dithiophosphate; *O*,*O*-Dimethyl *S*-(*N*-phthalimidomethyl) dithiophosphate; *O*,*O*-Dimethyl *S*-phthalimidomethyl phosphorodithioate; ENT25,705; Fosmet (Spanish); Ftalophos; Imidan; Kemolate; *N*-(Mercaptomethyl)phthalimide *S*-(*O*,*O*-dimethyl phosphorodithioate); Percolate; Phosphorodithioic acid, *S*-[(1,3-dihydro-1,3-dioxo-isoindol-2-yl)methyl] *O*,*O*-dimethyl ester; Phosphorodithioic acid, *O*,*O*-dimethyl ester, *S*-ester with *N*-(mercaptomethyl) phthalimide; Phthalimide, *N*-(mercaptomethyl)-, *S*-ester with *O*,*O*-dimethyl phosphorodithioate; Phthalimido-*O*,*O*-dimethyl phosphorodithioate; Phthalimidomethyl *O*,*O*-dimethyl phosphorodithioate; Phthalophos; PMP; Prolate; R 1504; Smidan; Stauffer R 1504

CAS Registry Number: 732-11-6

HSDB Number: 1734

RTECS Number: TE2275000

UN/NA & ERG Number: (PIH) UN2783 (organophosphorus pesticides, solid, toxic)/152; UN3018 (organophosphorus pesticide, liquid, n.o.s.)/152; UN2811 (toxic solid, organic, n.o.s.)/153

EC Number: 211-987-4 [*Annex I Index No.:* 015-101-00-5]

Regulatory Authority and Advisory Information

Hazard Alert: Poison inhalation hazard, Possible cumulative neurotoxin, Combustible, Water reactive, Suspected of causing genetic defects, Suspected reprotoxic hazard, Environmental hazard.

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 10/10,000 lb (4.54/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 1 lb (0.454 kg)

United States DOT Regulated marine pollutant (49CFR172.101, Appendix B)

United States DOT 49CFR172.101, Inhalation Hazard Chemical as organophosphates

Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

European/International Regulations (not listed in Annex I, but the following may apply): Hazard Symbol: T+, N; Risk phrases: R21/22; R25; R33; R50/53; R62; R63; Safety phrases: S2; S22; S29, S36/37; S41; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)]

Description: Phosmet is a white crystalline solid. Molecular weight = 317.33; Boiling point = (decomposes below BP) >100°C; Freezing/Melting point = 72°C.Hazard; Vapor pressure = 4.9×10^{-7} mbar @ 20°C. Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 2₩. Slightly soluble in water, releases phthalic acid.

Potential Exposure: An organophosphorus insecticide and acaricide.

Incompatibilities: Organothiophosphates are susceptible to formation of highly toxic and flammable phosphine gas in the presence of strong reducing agents such as hydrideds and active metals. Partial oxidation by oxidizing agents may result in the release of toxic phosphorus oxides[101]. Compounds of the carboxyl group react with all bases, both inorganic and organic (i.e., amines) releasing substantial heat, water and a salt that may be harmful. Incompatible with arsenic compounds (releases hydrogen cyanide gas), diazo compounds, dithiocarbamates, isocyanates, mercaptans, nitrides, and sulfides (releasing heat, toxic and possibly flammable gases), thiosulfates and dithionites (releasing hydrogen sulfate and oxides of sulfur). Not compatible with other pesticides under alkaline conditions. Contact with water, steam or moisture forms phthalic acids. Slightly corrosive to metals in the presence of moisture.

Permissible Exposure Limits in Air:

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 0.049 milligram per cubic meter

PAC-2: 0.54 milligram per cubic meter

PAC-3: 77 milligram per cubic meter

Russia has set a ceiling value in workplace air of 0.3 milligram per cubic meter. Russia has also set a MAC in ambient air in residential area of 0.009 milligram per cubic meter on a once-daily basis and 0.004 milligram per cubic meter on an average daily basis.

Determination in Air: NIOSH Analytical Method (IV) Method #5600, Organophosphorus pesticides.

Permissible Concentration in Water: Russia[36] set a MAC in surface water of 0.2 mg/L.

Determination in Water: Fish Tox: 4.41815000 ppb MATC (HIGH). Octanol-water coefficient: Log $K_{ow} = 2.8$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact. Absorbed by the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes and skin on contact. This material is a highly toxic organophosphate; the probable oral lethal dose for humans is 50−500 mg/kg, or between 1 teaspoon and 1 oz for a 150 lb person. It is a cholinesterase inhibitor and has CNS effects. Oral lethal doses in humans have been reported @ 50 mg/kg. Acute exposure to phosmet may produce the following signs and symptoms: pinpoint pupils; blurred vision; headache, dizziness, muscle spasms; and profound weakness. Vomiting, diarrhea, abdominal pain; seizures, and coma may also occur. The heart rate may decrease following oral exposure or increase following dermal exposure. Chest pain may be noted. Hypotension (low blood pressure) may occur, although hypertension (high blood pressure) is not uncommon. Dyspnea (shortness of breath) may be followed by respiratory collapse. Giddiness is common.

Long-Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage. Human Tox = 7.00000 ppm Health Advisory (HIGH)

Points of Attack: Respiratory system, lungs, CNS; cardiovascular system, skin, eyes, plasma and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also consider CBC. Consider chest X-ray following acute overexposure. Liver function tests. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and/or slurry of activated charcoal in water; and induce vomiting. Do not make an unconscious person vomit. Obtain authorization and/or further instructions from the local hospital for administration of an antidote or performance of other invasive procedures. Transport to a health care facility.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area away from other pesticide, alkaline conditions, water and other forms of moisture. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN2783 Organophosphorus pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN3018 Organophosphorus pesticides, liquid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling:

Initial isolation and protective action distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.3/0.4
Night 0.8/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 600/200
Then: Protect persons downwind (miles/kilometers)
Day 1.4/2.3
Night 2.8/4.5

Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. As for other organophosphorus pesticides stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Remove and isolate contaminated clothing at the site. Do not touch spilled material. Use water spray to reduce vapors. Take up *small spills* with sand or other noncombustible absorbent material and place in containers for later disposal. Take up small, dry spills with clean shovel and place in clean, dry container. Dike far ahead of *large spills* for later disposal. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material may burn but does not ignite readily. Thermal decomposition products may include oxides of phosphorus, sulfur, nitrogen and carbon. *For small fires*, use dry chemical, carbon dioxide; water spray; or foam. *For large fires*, use water spray, fog, or foam. Stay upwind; keep out of low areas. Move container from fire area if you can do it without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter material. Wear positive pressure breathing apparatus and special protective clothing. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office. Small amounts may be decomposed with hypochlorite. For large amounts, incineration with effective gas scrubbing is recommended[22].

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Phosmet, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Decemthion, Trenton, NJ (March 1999)

Phosphamidon P:0570

Formula: $C_{10}H_{19}ClNO_5P$; $(CH_3O)_2POOC(CH_3)=C(Cl)CON(CH_2CH_3)_2$

Synonyms: Apamidon; C 570; C-570; (2-Chlor-3-diaethylamino-methyl-3-*oxo* -prop-1-en-yl)-dimethylphosphat (German); 2-Chloro-3-(diethylamino)-1-methyl-3-*oxo*-1-propenyldimethyl phosphate; 2-Chloro-2-diethylcarbamoyl-1-methylvinyl dimethyl phosphate; 1-Chlorodiethylcarbamoyl-1-propen-2-yl dimethyl phosphate; Ciba 570; Crophosphate; Dimecron; Dimecron 100; *O*,*O*-Dimethyl *O*-[2-chloro-2-(*N*,*N*-diethylcarbamoyl)-1-methylvinyl] phosphate; Dimethyl 2-chloro-2-diethylcarbamoyl-1-methylvinylphosphate; Dimethyl diethylamido-1-chlorocrotonyl(2) phosphate; *O*,*O*-Dimethyl-*O*-(1-methyl-2-chlor-2-*N*,*N*-diethyl-carbamoyl)-vinyl-phosphat (German); *O*,*O*-Dimethyl *O*-[1-methyl-(2-chloro-2-diethylcarbamoyl) vinyl] phosphate; Dimethyl phosphate of 2-chloro-*N*,*N*-diethyl-3-hydroxycrotonamide; Dimethyl phosphate ester with 2-chloro-*N*,*N*-diethyl-3-hydroxycrotonamide; Dimonex; Dixon; ENT25,515; Fosfamidon (Spanish); Fosfamidone; Foszfamidon; ML 97; Merkon phosphamidone; NCI-C00588; OMS 1325; OR1191; Phosphamidon; Phosphate de dimethyle et de(2-chloro-2-diethylcarbamoyl-1-methyl-vinyle) (French); Phosphoric acid, 2-chloro-3-(diethylamino)-1-methyl-3-*oxo*-1-propenyl dimethyl ester; Phosphoric acid, dimethyl ester, with 2-chloro-*N*,*N*-diethyl-3-hydroxycrotonamide

CAS Registry Number: 13171-21-6; 23783-98-4 [(Z) isomer]; 297-99-4 [(E) isomer]

HSDB Number: 1754

RTECS Number: TC2800000

UN/NA & ERG Number: (PIH) UN3018 (organophosphorus pesticide, liquid, toxic)/152

EC Number: 236-116-5 [*Annex I Index No.:* 015-022-00-6] (phosphamidon)

Regulatory Authority and Advisory Information

Carcinogenicity: NCI: Carcinogenesis Bioassay (feed); equivocal evidence: rat; no evidence: mouse.

Hazard Alert: Poison inhalation hazard, Combustible, Poison, Neurotoxin (cumulative), Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Environmental hazard.

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 100 lb (45.4 kg)

United States DOT Regulated Marine Pollutant (49CFR172.101, appendix B), severe pollutant

United States DOT 49CFR172.101, Inhalation Hazard Chemical as organophosphates.

Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)] (soluble liquid formulations of the substance that exceeds 1000 g active ingredient).

Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T+, N; Risk phrases: R24; R28; R33; R40; R50/53; R62; R63; R68; Safety phrases: S1/2; S23; S29; S36/37; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water (CAS: 13171-21-6).

Description: Phosphamidon is a pale yellow oily liquid. Molecular weight = 299.72; Specific gravity (H_2O:1) = 1.22; Boiling point = 162°C @ 1.5 mmHg; Freezing/Melting point = −45°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Soluble in water.

Potential Exposure: This material is used as an insecticide on citrus, cotton, and deciduous fruit and nuts. It is also an acaricide.

Incompatibilities: Compounds of the carboxyl group react with all bases, both inorganic and organic (i.e., amines) releasing substantial heat, water and a salt that may be harmful. Incompatible with arsenic compounds (releases hydrogen cyanide gas), diazo compounds, dithiocarbamates, isocyanates, mercaptans, nitrides, and sulfides (releasing heat, toxic and possibly flammable gases), thiosulfates and dithionites (releasing hydrogen sulfate and oxides of sulfur). Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Strong oxidizers may cause release of toxic phosphorus oxides. Organophosphates, in the presence of strong reducing agents such as hydrides, may form highly toxic and flammable phosphine gas. Keep away from alkaline materials. Attacks metals, such as aluminum, iron, tin.

Permissible Exposure Limits in Air:

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 0.027 milligram per cubic meter

PAC-2: 0.3 milligram per cubic meter

PAC-3: 21 milligram per cubic meter

Determination in Water: Fish Tox = 1445.67277000 ppb (EXTRA LOW); FISH STV (Sediment Toxicity Value): LOW; Octanol-water coefficient: Log $K_{ow} = < 0.9$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes. May affect the nervous system; causing convulsions, respiratory failure and death. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. This material is extremely toxic; the probable oral lethal dose for humans is 5−50 mg/kg, or between 7 drops and 1 teaspoonful for a 150 lb person. It is a cholinesterase inhibitor. Acute exposure to phosphamidon may produce pinpoint pupils; blurred vision; headache, dizziness, muscle spasms; and profound weakness. Vomiting, diarrhea, abdominal pain; seizures, and coma may also occur. The heart rate may decrease following oral exposure or increase following dermal exposure. Hypotension (low blood pressure) may occur, although hypertension (high blood pressure) is not uncommon. Chest pain may be noted. Respiratory effects include dyspnea (shortness of breath), respiratory depression; and respiratory paralysis. Psychosis may occur.

Long-Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage. Human Tox = 0.14000 pph (EXTRA HIGH).

Points of Attack: Respiratory system, lungs, CNS; cardiovascular system, skin, eyes, plasma and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also consider CBC. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Obtain autorization and/or further instructions from the local hospital for administration of an antidote or performance of other invasive procedures. Transport to a health care facility. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administeringa drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area away from alkalies.

Shipping: UN3018 Organophosphorus pesticides, liquid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Organophosphorus compounds

Initial isolation and protective action distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.3/0.4
Night 0.8/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 600/200
Then: Protect persons downwind (miles/kilometers)
Day 1.4/2.3
Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Do not touch spilled material. Do not breathe vapors. Stay upwind; keep out of low areas. Remove all ignition sources. Ventilate area of spill or leak. This material is a combustible liquid. For a spill or leak of a combustible liquid, shut off ignition sources; no flares, smoking or flames in hazard area. Stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material may burn, but does not ignite readily. Thermal decomposition products may include hydrogen chloride and oxides of phosphorus, nitrogen and carbon. *For small fires*: use dry chemical, carbon dioxide; water spray; or foam. *For large fires:* use water spray, fog, or foam. Stay upwind; keep out of low areas. Move containers from fire area if you do it without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Small quantities may be treated with alkali followed by landfill disposal. Large quantities should be incinerated with effluent gas scrubbing[22]. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Phosphamidon, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Phosphamidon, Trenton, NJ (September 1999)

Phosphine P:0580

Formula: H_3P; PH_3

Synonyms: Celphos; Delicia; Detia gas-EX-B; Fosfamia (Spanish); Hydrogen phosphide; Phosphorous trihydride; Phosphorous hydride; Phosphorated hydrogen; Phosphorwasserstoff (German); Phostoxin

CAS Registry Number: 7803-51-2

HSDB Number: 1233

RTECS Number: SY7525000

UN/NA & ERG Number: (PIH) UN2199/119

EC Number: 232-260-8 [*Annex I Index No.:* 015-181-00-1]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 ($\geq$1.00% concentration). (1% concentration); *Theft hazard* 15 ($\geq$0.67% concentration); Sabotage/Contamination Hazard: A placarded amount (commercial grade).

Carcinogenicity: EPA: Not Classifiable as to human carcinogenicity.

Hazard Alert: Poison inhalation hazard: exposure can be lethal, Highly toxic gas with inadequate warning properties, Lung damaging agent, Extremely flammable, Possibly spontaneously self-igniting on contact with air, Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated, Suspected of causing genetic defects, Environmental hazard.

Banned or Severely Restricted (several countries) (UN)[13]

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 5000 lb (2270 kg)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P096

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500 lb (227 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 100 lb (45.4 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT 49CFR172.101, Inhalation Hazardous Chemical (PIH).

Hazardous to aquatic life or environment, with possible long lasting effects[291]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: F+, T+, N; Risk phrases: R5; R12; R17; R21; R26; R33; R34; R44; R51; R62; Safety phrases: S1/2; S9; S28; S29/35; S33; S36/37; S38; S41; S45; S61; S63 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Phosphine is a colorless gas that is shipped as liquefied compressed gas. Odorless when pure. It has the odor of garlic or the foul odor of decaying fish. The level at which humans detect the odor of phosphine (odor threshold) does not provide sufficient warning of dangerous concentrations. Phosphine presents an additional hazard in that it ignites at very low temperatures. Shipped as a liquefied compressed gas. The pure compound is odorless. The Odor Threshold is 0.14 ppm. Molecular weight = 34.00; Specific gravity (H_2O:1) = 1.4 @ 20°C; Boiling point = −88°C; Freezing/Melting point = −134°C; Relative vapor density (air = 1): 1.18; Vapor pressure = 41.3 atm; >750 mmHg@ −88°C; Flash point = (flammable gas) 104°C; Autoignition temperature (depends on concentration and diluent) = 38−100°C. Explosive limits: LEL = 1.8%; UEL: unknown. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 4, Reactivity 2. Slightly soluble in water; solubility = 25 mL/100 mL @ 17°C.

Potential Exposure: Phosphine is used as a fumigant; in the semiconductor industry, as a doping agent for electronic components to introduce phosphorus into silicon crystals; in chemical synthesis; used as a polymerization initiator; as an intermediate for some flame retardants. Also, exposures may occur when acid or water comes in contact with metallic phosphides (aluminum phosphide, calcium phosphide). These two phosphides are used as insecticides or rodenticides for grain, and phosphine is generated during grain fumigation. When phosphine toxicity is suspected, but phosphine exposure is not obvious, one should suspect transdermal contamination and/or ingestion of phosphides. Phosphine may also evolve during the generation of acetylene from impure calcium carbide, as well as during metal shaving; sulfuric acid tank cleaning; rustproofing, ferrosilicon, phosphoric acid; and yellow phosphorus explosive handling.

Incompatibilities: Phosphine reacts with acids, air, copper, moisture, oxidizers, oxygen, chlorine, nitrogen oxides; metal nitrates; halogens, halogenated hydrocarbons; copper and many other substances, causing fire and explosion hazard. Extremely explosive; may ignite spontaneously on contact with air at (or about) 100°C. Attacks many metals. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong acids, amines, ammonia, ethylene oxide, metal nitrates, nitrous acid, phosgene, strong bases.

Permissible Exposure Limits in Air:

NIOSH IDLH = 50 ppm

Odor threshold = The level at which humans detect the odor of phosphine does not provide sufficient warning of dangerous concentrations.

Conversion factor: 1 ppm = 1.39 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 0.3 ppm/0.4 milligram per cubic meter TWA

NIOSH REL: 0.3 ppm/0.4 milligram per cubic meter TWA; 1 ppm/1 milligram per cubic meter STEL

ACGIH TLV[1]: 0.3 ppm/0.42 milligram per cubic meter TWA; 1 ppm/1.4 milligram per cubic meter STEL

DFG MAK: 0.1 ppm/0.14 milligram per cubic meter TWA; Peak Limitation Category II(2); Pregnancy Risk Group C

Protective Action Criteria (PAC) Phosphine* Ver. 29[138]

PAC-1: 1 ppm

PAC-2: **2.0_A** ppm

PAC-3: **3.6_A** ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

DFG MAK: 0.1 ppm/0.14 milligram per cubic meter TWA; Peak Limitation Category II(2); Pregnancy Risk Group C.

Arab Republic of Egypt: TWA 0.3 ppm (0.4 milligram per cubic meter), 1993; Australia: TWA 0.3 ppm (0.4 milligram per cubic meter); STEL 1 ppm (1 milligram per cubic meter), 1993; Austria: MAK 0.1 ppm (0.15 milligram per cubic meter), 1999; Belgium: TWA 0.3 ppm (0.42 milligram per cubic meter); STEL 1 ppm (1.4 milligram per cubic meter), 1993; Denmark: TWA 0.1 ppm (0.15 milligram per cubic meter), 1999; Finland: TWA 0.1 ppm (0.15 milligram per cubic meter); STEL 0.3 ppm (0.4 milligram per cubic meter), 1999; France: VME 0.1 ppm (0.13 milligram per cubic meter), VLE 0.3 ppm (0.4 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 0.4 milligram per cubic meter, 2003; Norway: TWA 0.1 ppm (0.15 milligram per cubic meter), 1999; the Phillipines: TWA 0.3 ppm (0.4 milligram per cubic meter), 1993; Poland: MAC (TWA) 0.1 milligram per cubic meter; MAC (STEL) 0.8 milligram per cubic meter, 1999; Russia: STEL 0.1 milligram per cubic meter, 1993; Sweden: NGV 0.3 ppm (0.4 milligram per cubic meter), KTV 1 ppm (1.4 milligram per cubic meter), 1999; Switzerland: MAK-W 0.1 ppm (0.15 milligram per cubic meter), KZG-W 0.2 ppm (0.3 milligram per cubic meter), 1999; Thailand: TWA 0.3 ppm (0.4 milligram per cubic meter), 1993; Turkey: TWA 0.3 ppm (0.4 milligram per cubic meter), 1993; United Kingdom: STEL 0.3 ppm (intermittent 0.42 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 1 ppm. Several states have set guidelines or standards for phosphine in ambient air[60] ranging from 1.33 μ/m^3 (New York) to 4.0 μ/m^3 (Florida and North Dakota) to 6.7 μ/m^3 (Virginia) to 8.0 μ/m^3 (Connecticut) to 10.0 μ/m^3 (Nevada and North Dakota) to 130 μ/m^3 (North Carolina).

Determination in Air: Use NIOSH Analytical Method #1003, Phosphine, OSHA Analytical Method ID-180. See also NIOSH Analytical Method #6002.

Permissible Concentration in Water: No criteria set, but EPA[32] has suggested a permissible ambient goal of 5.5 μg/L based on health effects.

Determination in Water: Phosphine cannot be used to contaminate water supplies; it breaks down in water. Octanol-water coefficient: Log K_{ow} = (estimated)—0.27. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Phosphine can be absorbed into the body by inhalation. Direct contact with phosphine liquid may cause frostbite.

Harmful Effects and Symptoms

Short-Term Exposure: Severe irritation to the respiratory tract. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Contact with the liquid may cause frostbite. May affect the CNS; cardiovascular system; heart, gastrointestinal tract; liver and kidneys. Phosphine is a super-toxic gas with a probable oral lethal dose of 5 mg/kg or 7 drops for a 150 lb person. An air concentration of 3 ppm is safe for long-term exposure, 500 ppm is lethal in 30 minutes, and concentration of 1000 ppm is lethal after a few breaths. Acute exposure to phosphine usually results in headache, cough, tightness and pain in the chest; shortness of breath; dizziness, lethargy, and stupor. Fatigue, muscle pain; chills, tremors, loss of coordination; seizures, and coma may be seen. Pulmonary edema and cardiac arrhythmias are common. Gastrointestinal symptoms include nausea, vomiting, abdominal pain; and diarrhea. Renal (kidney) damage, hepatic (liver) damage; and jaundice may also occur.

Long-Term Exposure: Chronic poisoning may cause toothache, swelling of the jaw; spontaneous fractures of bones. May cause anemia. May damage the liver and kidneys. The effects are cumulative. Can irritate the lungs; bronchitis may develop.

Points of Attack: Respiratory system, liver.

Medical Surveillance: NIOSH lists the following tests: Blood Gas Analysis; chest X-ray, electrocardiogram, pulmonary function tests: forced vital capacity, forced expiratory volume (1 sec); sputum cytology; white blood cell count/differential. For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, If phosphides have been ingested, **do not induce emesis**. Phosphides will release phosphine in the stomach; therefore, watch for signs similar to those produced by phosphine inhalation. Administer a slurry of activated charcoal at 1 gm/kg (usual adult dose: 60−90 g; child dose: 25−50 g). A soda can and a straw may be of assistance when offering charcoal to a child. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Decontamination: This is very important. The rapid physical removal of a chemical agent is essential. If you don't have the equipment and training, don't enter the hot or the warm zone to rescue and/or decontaminate victims. Medical personnel should wear the proper PPE. If the victim can't move, decontaminate without touching and without entering the hot or the warm zone. Metallic phosphides on clothes, skin, or hair can off-gas phosphine after contact with water or moisture, so a risk of secondary contamination may be present. Have the victim remove clothing; and seal contaminated clothes and personal belongings in a sealed double bag. For skin exposure to the metallic phosphides, scrape or brush all visible particles from the skin and hair. Use clean water from any source; if possible, use a hose (spray or fog to prevent injury to the victim) or other system to avoid touching the victim. Don't wait for soap or for the victim to remove clothing, begin washing immediately. Do not delay decontamination to obtain warm water; time is of the essence; use cold water instead. Immediately flush the eyes with water for at least 15 minutes. Use caution to avoid hypothermia in children and the elderly. Persons exposed only to phosphine gas do not pose substantial risks of secondary contamination. Vomitus containing phosphides can also off-gas phosphine. Rinse the eyes, mucous membranes; or open wounds with sterile saline or water and then move away from the hot zone in an upwind and up hill direction.

Personal Protective Methods:

General information: first responders should use a NIOSH-certified chemical, biological, radiological, nuclear (CBRN) SCBA with a level a protective suit when entering an area with an unknown contaminant or when entering an area where the concentration of the contaminant is unknown. Level a protection should be used until monitoring results confirm the contaminant and the concentration of the contaminant. *Note:* safe use of protective clothing and equipment requires specific skills developed through training and experience.

LEVEL A: (*RED ZONE*): select when the greatest level of skin, respiratory, and eye protection is required. This is the maximum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than the AEGL-2. A NIOSH-certified CBRN full-facepiece scba operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle. A totally encapsulating chemical protective (TECP) suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, and a hard hat worn under the TECP suit are optional items.

LEVEL B: (RED ZONE): Select when the highest level of respiratory protection is necessary but a lesser level of skin protection is required. This is the minimum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than AEGL-2. It differs from Level A in that it incorporates a non-encapsulating, splash-protective, chemical-resistant splash suit that provides Level A protection against liquids but is not airtight. A NIOSH-certified CBRN full-facepiece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle. A hooded chemical -resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL C: (YELLOW ZONE): Select when the contaminant and concentration of the contaminant are known and the respiratory protection criteria factors for using Air Purifying Respirators (APR) or Powered Air Purifying Respirators (PAPR) are met. This level is appropriate when decontaminating patient/victims. A NIOSH-certified CBRN tight-fitting APR with a canister-type gas mask or CBRN PAPR for air levels greater than AEGL-2. A NIOSH-certified CBRN PAPR with a loose-fitting facepiece, hood, or helmet and a filter or a combination organic vapor, acid gas, and particulate cartridge/filter combination or a continuous flow respirator for air levels greater than AEGL-1. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Escape mask, face shield, coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL D: (GREEN ZONE): Select when the contaminant and concentration of the contaminant are known and the concentration is below the appropriate occupational exposure limit or less than AEGL-1 for the stated duration times. Limited to coveralls or other work clothes, boots, and gloves.

Notes: Take all necessary precautions to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 3 ppm:* Sa (APF = 10) (any supplied-air respirator). *Up to 7.5 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *Up to 15 ppm:* GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted canister providing protection against the compound of concern]; SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 50 ppm:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive pressure mode). *Escape:* GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted canister providing protection against the compound of concern]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Check oxygen content prior to entering storage area. Poison gas. (1) Color code-Blue: Health Hazard/ Poison: Store in a secure poison location. This gas is highly toxic. Even slight exposure to these gasses can cause death. Store outdoors in a secure, restricted area that containing warning signs. This area must be roofed and shaded with the cylinders stored off the ground and separated from all other products assigned to other hazard categories and radiant heat sources on non-wooden floors. If indoors, store in a well-ventilated areas in temperatures not to exceed 50°C. (2) Color code-Red Stripe: Flammability Hazard: Store separately from all other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 meters or a 1-hour fire wall from flammable or reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration is not a danger. Phosphine must be stored to avoid contact with oxidizers (such as perchlorates, peroxides; permanganates, chlorates, and nitrates); strong acids (such as hydrochloric, sulfuric, and nitric); oxygen and halogenated hydrocarbons, since violent reactions occur. Store in tightly closed containers from physical damage. Use only non-sparking tools and equipment, especially when opening and closing containers of phosphine. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: UN2199 Phosphine, Hazard Class: 2.3; Labels: 2.3-Poisonous gas, 2.1-Flammable gas, Inhalation Hazard Zone A. Cylinders must be transported in a secure upright position, in a well -ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling:

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)
Day 0.2/0.3
Night 0.7/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 1250/400
Then: Protect persons downwind (miles/kilometers)
Day 0.8/1.2
Night 2.5/4.1

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Stop the flow of gas if it can be done safely. If source of leak is a cylinder and the leak cannot be stopped in place, remove leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. Keep this chemical out of confined space, such as a sewer because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable gas. Thermal decomposition products may include phosphonic acid, oxides of phosphorus and flammable hydrogen gas. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. If material is on fire or involved in a fire, do not extinguish unless flow can be stopped; use water in flooding quantities as fog; cool all affected containers with flooding quantities of water; apply water from as far a distance as possible; solid streams of water may be ineffective; use "alcohol" foam, carbon dioxide or dry chemical. Wear full protective clothing including SCBA; rubber gloves; boots, and bands around legs, arms, and waist. No skin surface should be exposed. For massive fires in cargo areas, use unmanned hose holders or monitor nozzles. Move containers from fire area. The gas is heavier than air and may travel along the ground to an ignition source. Container may explode in heat of fire. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office. Controlled discharges of Phosphine may be passed through

10% NAOH solution in a scrubbing tower. The product may be discharged to a sewer[22].

References

(31); (173); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Phosphine, Washington, DC, (2). Chemical Emergency Preparedness Program (November 30, 1987)

(173); (101); (138); (175).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 6, No. 2, 103−107 (1986)

New Jersey Department of Health and Senior Services, "Hazardous Substance Fact Sheet: Phosphine," Trenton, NJ (April 2004)

Phosphoric Acid, Ortho- P:0590

Formula: H_3O_4P; H_3PO_4

Synonyms: Acide phosphorique (French); Acido fosforico Spanish; Decon 4512; Evits; Orthophosphoric acid; *o*-Phosphoric acid; Phosphorsaeureloesungen (German); Sonac; WC-Reiniger; White phosphoric acid

CAS Registry Number: 7664-38-2

HSDB Number: 1187

RTECS Number: TB6300000

UN/NA & ERG Number: UN1805 (liquid)/154; UN3543 (solid)/154

EC Number: 231-633-2 [*Annex I Index No.:* 015-011-00-6]

Regulatory Authority and Advisory Information

Hazard Alert: Corrosive, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction),

FDA-over the counter drug.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 5000 lb (2270 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

European/International Regulations *(orthophosphoric acid)*: Hazard Symbol: C; Risk phrases: R15; R34; R36/37/38; R63; Safety phrases: S1/2; S26; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Phosphoric acid is a colorless, odorless, crystalline solid or a thick syrupy liquid. Physical state is strength and temperature dependent. Molecular weight = 98.00; Specific gravity (H_2O:1) = 1.87 (pure); 1.33 (50% solution) @ 25°C; Boiling point = decomposes <2132.8°C; Freezing/Melting point = 42.2°C Vapor pressure = 2.8×10^{-2} mmHg @ 20°C. Explosive limits: LEL = 17,900 ppm, UEL: unknown. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0 (Corrosive). Highly soluble in water; forms acidic solution.

Potential Exposure: Phosphoric acid is used in the manufacture of fertilizers, phosphate salts; polyphosphates, detergents, activated carbon; animal feed; ceramics, dental cement; pharmaceuticals, soft drinks; gelatin, rust inhibitors; wax, and rubber latex. Exposure may also occur during electropolishing, engraving, photoengraving, lithographing, metal cleaning; sugar refining; and water-treating.

Incompatibilities: The substance is a medium strong acid. Incompatible with strong caustics; most metals. Readily attacks and reacts with metals forming flammable hydrogen gas. *Do not mix with solutions containing bleach or ammonia.* Violently polymerizes on contact with azo compounds; epoxides, and other polymerizable compounds. Decomposes on contact with metals, alcohols, aldehydes, cyanides, ketones, phenols, esters, sulfides, halogenated organics; producing toxic fumes. Corrosive to common metals and possibly to some rubbers and plastics.

Permissible Exposure Limits in Air:

NIOSH IDLH = 1000 milligram per cubic meter

OSHA PEL: 1 milligram per cubic meter TWA

NIOSH REL: 1 milligram per cubic meter TWA; 3 milligram per cubic meter STEL

ACGIH TLV[1]: 1 milligram per cubic meter TWA; 3 milligram per cubic meter STEL

Protective Action Criteria (PAC)* Ver. 29[138]

PAC-1: **3**$_{\mathbf{E}}$ milligram per cubic meter

PAC-2: **30**$_{\mathbf{E}}$ milligram per cubic meter

PAC-3: 1**50**$_{\mathbf{E}}$ milligram per cubic meter

*ERPG [Emergency Response Planning Guidelines] are marked with a subscript "**E**."

DFG MAK: 2 milligram per cubic meter, inhalable fraction TWA; Peak Limitation Category I(2); Pregnancy risk Group C.

Arab Republic of Egypt: TWA 1 milligram per cubic meter, 1993; Australia: TWA 1 milligram per cubic meter; STEL 3 milligram per cubic meter, 1993; Austria: MAK 1 milligram per cubic meter, 1999; Belgium: TWA 1 milligram per cubic meter; STEL 3 milligram per cubic meter, 1993; Denmark: TWA 1 milligram per cubic meter, 1999; Finland: TWA 1 milligram per cubic meter; STEL 3 milligram per cubic meter [skin]1999; France: VME 1 milligram per cubic meter, VLE 3 milligram per cubic meter, 1999; Japan 1 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 1 milligram per cubic meter, 2003; Poland: MAC (TWA) 1 milligram per cubic meter; MAC (STEL) 3 milligram per cubic meter, 1999; Sweden: NGV 1 milligram per cubic meter, KTV 3 milligram per cubic meter, 1999; Switzerland: MAK-W 1 milligram per cubic meter, 1999; Thailand: TWA 1 milligram per cubic meter, 1993; United Kingdom: STEL 2 milligram per cubic meter, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL

3 milligram per cubic meter. Several states have set guidelines or standards for phosphoric acid in ambient air[60] ranging from 1.4 μ/m^3 (Massachusetts) to 10−30 μ/m^3 (North Dakota) to 10−33 μ/m^3 (Virginia) to 20.0 μ/m^3 (Connecticut) to 24.0 μ/m^3 (Nevada) to 25.0 μ/m^3 (South Carolina).

Determination in Air: Use NIOSH Analytical Method (IV) #7903, Inorganic Acids; OSHA Analytical Method ID-165-SG.

Determination in Water: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Corrosive to the eyes, skin, and respiratory tract. Eye contact may cause permanent damage. Inhalation can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Solid is especially irritating to skin in the presence of moisture. Corrosive if swallowed. May cause pain in the throat and stomach, nausea, vomiting and intense thirst. Severe exposures may result in shock with clammy skin, weak and rapid pulse; shallow breathing; reduced urine output; and death. 1−5 milligram per cubic meter may cause irritation of nose and throat. 4−11 milligram per cubic meter may cause coughing. Inhalation of acid mist can cause lung irritation. 1−5 milligram per cubic meter may cause irritation of nose and throat. 4−11 milligram per cubic meter may cause coughing.

Long-Term Exposure: Repeated or prolonged skin exposure may cause irritation, drying, cracking, and dermatitis. Can cause bronchitis to develop.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: Before beginning employment and at regular times after that, the following is recommended. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Natural rubber, Neoprene, nitrile + pvc, nitrile, Saranex, and polyvinyl chloride are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash or dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *25 milligram per cubic meter:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *50 milligram per cubic meter*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *1000 milligram per cubic meter*: SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code-White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Phosphoric acid must be stored to avoid contact with metals, aldehydes, cyanides, mercaptans and sulfides, because violent reactions occur.

Shipping: UN1805 Phosphoric acid solution, Hazard class: 8; Labels: 8-Corrosive material. UN3543 Phosphoric acid solid, Hazard class: 8; Labels: 8-Corrosive material.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Phosphoric acid is a non-combustible solid or liquid. Thermal decomposition products may include oxides of phosphorus. Contact with common metals may release flammable hydrogen gas. Use extinguishing agent suitable for surrounding fire. Use water only to keep fire-exposed containers cool and to flush away spills. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Add slowly to solution of soda ash and slaked lime with stirring, then flush to sewer with large volumes of water.

References

(31); (173); (101); (138); (2); (80); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 3, No. 4, 84−87 (1983)

New York State Department of Health, *Chemical Fact Sheet: Phosphoric Acid*, Bureau of Toxic Substance Assessment, Albany, NY (April 1986 and Version 2)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Phosphoric Acid,* Trenton, NJ (April 2004)

Phosphorus P:0610

Formula: P; P4

Synonyms: Bonide Blue death rat killer; Common sense cockroach and rat preparations; Exolite 405; Exolit LPKN275; Exolit VPK-N 361; Fosforo blanco (Spanish); Gelber phosphor (German); Phosphore blanc (French); Phosphorous yellow; Phosphorus-31; Phosphorus elemental, white; Rat-NIP; Red phosphorus; RP (military designation); ST CC4916140; Tetraphosphor (German); Weiss phosphor (German); White phosphorus; Yellow phosphorus

CAS Registry Number: 7723-14-0; 12185-10-3. Depending on source, both are listed as "white P." NIOSH lists 7723-14-0 as white.

HSDB Number: 1169

RTECS Number: TH3500000

UN/NA & ERG Number: UN1338 (Phosphorus, amorphous)/133; UN1381 (Phosphorus, white, dry; under water, in solution; Phosphorus, yellow, dry; yellow, under water; in solution)/136; UN2447 (Phosphorus, white, molten)/136

EC Number: 231-768-7 [*Annex I Index No.:* 015-001-00-1]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Theft hazard* 400 (Commercial grade).

Carcinogenicity: EPA: Not Classifiable as to human carcinogenicity.

Hazard Alert: Exposure can be lethal, Systemic agent (white P), Flammable solid, (red): Spontaneously flammable/self-heating (air-reactive, white/yellow), Suspected of causing genetic defects, Corrosion (skin); Human Data, Environmental hazard.

List 1, DEA chemical code 6795 (Red phosphorus); 6796 (White/Yellow Phosphorus) (Title 21 CFR1310.02)

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 1 lb (0.454 kg)

EPCRA Section 313 (yellow or white) Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, appendix B), severe pollutant, white, yellow dry, molten or in solution

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

^^Hazardous to aquatic life or environment, with possible long lasting effects: white/yellow[291]; red[194]

European/International Regulations (*7723-14-0*): Hazard Symbol: F, T+, C, N; Risk phrases: R3; R11 (red); R16 (red); R17; R26/28; R35; R51; R62; (red); R50 (white/yellow); Safety phrases: S1/2; S5; S7 (red); S26; S28 (white/yellow); S29; S38; S41; S43 (red); S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): Red: 2-Hazard to water; White/Yellow: 3-Severe hazard to water.

Description: Phosphorus is a white to yellow, soft, waxy solid with acrid fumes in air. *White/yellow* phosphorus is either a yellow or colorless, volatile, crystalline solid which darkens when exposed to light and ignites in air to form white fumes and greenish light. It has a garlic-like odor. Usually shipped or stored in water. Molecular weight = 123.88; Specific gravity (H_2O:1) = 1.8 @ 20°C; Boiling point = 280°C; Freezing/Melting point = (decomposes) 44°C; Vapor pressure = 0.026 mmHg @ 20°C; 0.181 mmHg @ 44.1°C; Autoignition temperature = 30°C. Hazard Identification (based on NFPA-704 M Rating System): (*white, red powder*) Health 4, Flammability 4, Reactivity 2. Insoluble in water.

Red phosphorus is a brick red, reddish-brown, or violet amorphous powder, frequently contaminated with a small amount of the yellow. Molecular weight = 30.97; Specific gravity (H_2O:1) = 1.8 @ 20°C; Boiling point = 281°C (with ignition @ 200°C); Freezing/Melting point = 45°C (sublimes); Flash point = 260°C; Autoignition temperature = 260°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 1. Insoluble in water.

Potential Exposure: White or yellow phosphorus is handled away from air so that exposure is usually limited. Phosphorus was at one time used for the production of matches or "lucifers" but has long since been replaced due to its chronic toxicity. It is used in the manufacture of munitions including tracer bullets, pyrotechnics, explosives, smoke bombs; and other incendiary agents; (because it spontaneously catches fire in air) and as a smoke agent (because it produces clouds of irritating white smoke). Phosphorus is used artificial fertilizers; rodenticides, phosphor bronze alloys; semiconductors, Electro-luminescent coating; and chemicals, such as phosphoric and metallic phosphides. RP is used as a choking/pulmonary agent.

Incompatibilities: Phosphorus, a pyrophoric solid, spontaneously ignite on contact with air, producing toxic phosphorus oxide fumes. Reacts with strong bases, releasing toxic phosphine gas. Phosphorus reacts violently with oxidizers, halogens, some metals, nitrites, sulfur, and many other compounds, causing a fire and explosion hazard. *White/yellow* reacts with air, halogens, halides, sulfur, oxidizers, alkali hydroxides (forming gas); and metals (forming reactive phosphides). *Red* is a combustible solid. Friction or contact with oxidizers can cause ignition. Incompatible with many other substances. Forms gas and phosphoric acid on contact with moisture. Opened packages of red phosphorus should be stored under inert gas blanket.

Permissible Exposure Limits in Air:

NIOSH IDLH = 5 milligram per cubic meter

OSHA PEL (*yellow*): 0.1 milligram per cubic meter TWA

NIOSH REL (*yellow*): 0.1 milligram per cubic meter TWA

ACGIH TLV[1] (*yellow*): 0.02 ppm/0.1 milligram per cubic meter TWA

Protective Action Criteria (PAC) Ver. 29[138]

7723-14-0

PAC-1: 0.27 milligram per cubic meter

PAC-2: 3 milligram per cubic meter

PAC-3: 18 milligram per cubic meter

12185-10-3

PAC-1: 0.3 milligram per cubic meter

PAC-2: 0.91 milligram per cubic meter

PAC-3: 5.5 milligram per cubic meter

DFG MAK (*White/yellow/red*): 0.05 milligram per cubic meter, inhalable fraction TWA; Peak Limitation Category II(2); Pregnancy Risk Group C; *Color code-Red:* No numerical value established.

Arab Republic of Egypt: TWA 0.1 milligram per cubic meter, 1993; Australia: TWA 0.1 milligram per cubic meter, 1993; Belgium: TWA 0.1 milligram per cubic meter, 1993; Denmark: TWA 0.1 milligram per cubic meter, 1999; Finland: STEL 0.1 milligram per cubic meter, [skin], 1999; France: VME 0.1 milligram per cubic meter, VLE 0.3 milligram per cubic meter, 1999; Hungary: TWA 0.3 milligram per cubic meter; STEL 0.06 milligram per cubic meter, 1993; the Netherlands: MAC-TGG 0.1 milligram per cubic meter, 2003; the Phillipines: TWA 0.1 milligram per cubic meter, 1993; Poland: MAC (TWA) 0.3 milligram per cubic meter, 1993; Russia: STEL 0.03 milligram per cubic meter, 1993; Switzerland: MAK-W 0.1 milligram per cubic meter, KZG-W 0.2 milligram per cubic meter, 1999; Thailand: TWA 0.1 milligram per cubic meter, 1993; Turkey: TWA 0.1 milligram per cubic meter, 1993; United Kingdom: LTEL 0.1 milligram per cubic meter; STEL 0.3 milligram per cubic meter, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 0.1 milligram per cubic meter. The Czech Republic:[35] TWA 0.03 milligram per cubic meter; 0.06 milligram per cubic meter STEL. Several states have set guidelines or standards for yellow phosphorus in ambient air[60] ranging from 0.33 μ/m³ (New York) to 1.0 μ/m³ (Florida) to 1.6 μ/m³ (Virginia) to 2.0 μ/m³ (Connecticut and Nevada) to 10.0−30.0 μ/m³ (North Dakota).

Determination in Air: Use NIOSH Analytical Method (IV) #7905.

Permissible Concentration in Water: EPA[32] has suggested a permissible ambient goal of 1.4 μg/L based on health effects. Russia[35,43] set a MAC in water bodies used for domestic purposes of 0.1 μg/L and in surface water used for fishery purposes of zero.

Determination in Water: Octanol-water coefficient: Log K_{ow} = (estimated)—0.27. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact. Yellow phosphorus can be absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Phosphorus is corrosive to the eyes, skin, and respiratory tract. Eye contact may lead to a total destruction of the eyes. Victims may experience spontaneous hemorrhaging of phosphorus-contaminated skin and mucous membranes. Sudden death, possibly due to irregular heartbeat, may occur after relatively minor (10−15%) burns. *Yellow:* Fumes are irritating to the respiratory tract and cause severe ocular irritation. On contact with the skin it may ignite and produce severe skin burns with blistering. Very high exposure may cause severe or fatal poisoning. *Color code-Red:* Irritates eyes. Corrosive if ingested. Inhalation can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. May affect the kidneys, liver. Exposure may result in death. Phosphorus is classified as super toxic. The probable lethal dose is less than 5 mg/kg (a taste or less than 7 drops) for 70 kg (150 lb) person. Signs and symptoms of acute exposure to phosphorus may be severe and occur in three stages. The first stage will involve burns, pain, shock, intense thirst; nausea, vomiting, diarrhea, severe abdominal pain; and "smoking stools." The breath and feces may have garlicky odor. The second stage will be a symptom-free period of several days in which the patient appears to be recovering. The third stage may be severe and include nausea, bloody vomitus; diarrhea (may be bloody), jaundice, liver enlargement with tenderness; renal damage; hematuria (bloody urine), and either oliguria (little urine formation) or anuria (no urine formation). Headache, convulsions, delirium, coma, cardiac arrhythmias; and cardiovascular collapse may also occur. If phosphorus contacts the eyes, then severe irritation and burns, blepharospasm (spasmodic winking), lacrimation (tearing), and photophobia (heightened sensitivity to light) may occur.

Long-Term Exposure: Phosphorus may affect the bones, causing bone degeneration (especially the jaw bone, known as "phossy" jaw), dental pain; salivation, jaw pain and swelling. This process can extend into one or both eye sockets. Repeated low exposure can cause low blood count (anemia), weight loss; and bronchitis. May cause jaundice; liver and kidney damage; cachexia. May cause nervous system damage.

Points of Attack: Respiratory system, liver, kidneys, jaw, teeth, blood, eyes, skin.

Medical Surveillance: NIOSH lists the following tests: CBC, anemia; dental X-ray/examination; liver function tests. Also consider EKG. Special consideration should be given to the skin, eyes, jaws, teeth, respiratory tract; and liver. Preplacement medical and dental examination with X-rays of teeth is highly recommended in the case of yellow phosphorus exposure. Poor dental hygiene may increase the risk in yellow phosphorus exposures, and any required dental work should be completed before workers are assigned to areas of possible exposure. Workers experiencing any jaw injury, tooth extraction; or any abnormal dental conditions should be removed from areas of exposure and observed. X-ray examinations may show necrosis; however, in order to prevent full development of sequestra, the disease should be diagnosed in earlier stages. Liver function should be evaluated periodically.

First Aid: There is no antidote for white phosphorus toxicity. If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and brush all traces of dry chemical from skin. Submerge burning phosphorus (yellow) in water or 1% copper sulfate solution if embedded in skin, or wash exposed area with large amounts of water. Seek medical attention immediately. Skin burns from yellow phosphorus should be observed for 1−3 days for possible delayed effects. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *1 milligram per cubic meter:* Sa (APF = 10) (any supplied-air respirator). *2.5 milligram per cubic meter:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *5 milligram per cubic meter:* SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive pressure mode). *Escape:* SCBAE (any appropriate escape-type, SCBA). *Note:* Substance causes eye irritation or damage; eye protection needed.

Storage: Color code-Red Stripe: Flammability Hazard (4.2): Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 meters or a 1-hour fire wall from flammable or reactive materials. Store flammable solids (spontaneously combustible) up to maximum allowable quantity per control area in an approved flammable storage area. Do not store in a basement. Color code-Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in a area isolated from flammables, combustibles, or other yellow coded materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Phosphorus must be stored in a cool, well ventilated area away from heat, direct sunlight; air, organic materials; oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates), since violent reactions occur. Always store away from alkaline materials because of the extreme fire hazard and because poisonous gas is produced. Always store yellow phosphorus under water and protect it from physical damage. Opened packages of red phosphorus should be stored under inert gas blanket. Sources of ignition, such as smoking and open flames, are prohibited where phosphorus is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1338 Phosphorus, amorphous, Hazard Class: 4.1; Labels: 4.1-Flammable solid. UN1381 Phosphorus, white, dry; under water, in solution; Phosphorus, yellow, dry; yellow, under water; in solution, Hazard Class: 4.2; Labels: 4.2-Spontaneously combustible material, 6.1-Poisonous materials. UN2447 Phosphorus white, molten, Hazard Class: 4.2; Labels: 4.2-Spontaneously combustible material, 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Keep spilled material wet and cover with wet sand or dirt. Collect solidified material in the most convenient and safe manner and cover with water in sealed containers. Ventilate area after cleanup is complete. Keep phosphorus out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Phosphorus (white/yellow) is a flammable solid which ignites spontaneously in moist air. Combustion in a confined space will deplete oxygen causing asphyxiation. Thermal decomposition products may include oxides of phosphorus and phosphoric acid if water is present. Fire may restart after it has been extinguished. *Small fires:* dry chemical, sand, water spray; or foam. *Large fires:* water spray, fog, or foam. Cool containers that are exposed to flames with water from the side until well after fire is out. *White/Yellow:* Deluge with water, taking care not to scatter, until fire is extinguished and phosphorus has solidified, then cover with wet sand or dirt. *Color code-Red:* Flood with water and when fire is extinguished, cover with wet sand or dirt. Extreme caution should be used during clean up of the more hazardous white phosphorus. *White/Yellow:* Ignites at approximately 30°C in air; ignition temperature is higher when air is dry. *Black:* Does not catch fire spontaneously. *Color code-Red:* Catches fire when heated in air to approximately 260°C and burns with formation of the pentoxide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Controlled incineration followed by alkaline scrubbing and particulate removal equipment.

References

(31); (173); (170)(100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 3, No. 4, 90–93 (1983)(2).

United States Environmental Protection Agency, Chemical Hazard Information Profile: P*hosphorus*, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Phosphorus* Trenton, NJ (October 2002)

Phosphorus Oxychloride P:0620

Formula: Cl_3OP; $POCl_3$

Synonyms: Fosforoxychlorid; Oxicloruro de fosforo (Spanish); Oxychlorid fosforecny; Phosphoric chloride; Phosphorus chloride oxide; Phosphorus oxytrichloride; Phosphoryl chloride; Phosphoryl trichloride

CAS Registry Number: 10025-87-3

HSDB Number: 784

RTECS Number: TH4897000

UN/NA & ERG Number: (PIH) UN1810/137

EC Number: 233-046-7 [*Annex I Index No.:* 015-009-00-5]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 5000 (≥1.00% concentration). (1% concentration); *Theft hazard* 220 (≥80.00% concentration); Sabotage/Contamination Hazard: A placarded amount (commercial grade).

Hazard Alert: Poison inhalation hazard: exposure can be lethal, High acute toxicity, Oxidizer, Violently reactive with water.

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 5000 lb (2270 kg)

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500 lb (227 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 1000 lb (454 kg)

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

United States National Primary Drinking Water Regulations: SMCL = 250 mg[Cl^-]/L as Chloride

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T+, C; Risk phrases: R14; R22; R26; R29; R34; R35; R37; R48/23; Safety phrases: S1/2; S7/8; S26; S36/37/39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Phosphorus oxychloride is a clear, colorless to yellow, fuming, oily liquid with a pungent and musty odor. Molecular weight = 153.32; Specific gravity (H_2O:1) = 1.69 @ 16°C; Boiling point = 105.6°C; Freezing/Melting point = 1.25°C; Vapor pressure = 40 mmHg @ 27°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 0, Reactivity 3₩ (Corrosive). Reacts with water; decomposes with heat.

Potential Exposure: Phosphorus oxychloride is used in the manufacture of pesticides, pharmaceuticals, plasticizers, gasoline additives; and hydraulic fluids.

Incompatibilities: A powerful oxidizer. Violently decomposes in water, forming heat and hydrochloric and phosphoric acids. Violent reaction with alcohols, phenols, amines, reducing agents; combustible materials; carbon disulfide; dimethylformamide, and many other many materials. Rapid corrosion of metals, except nickel and lead.

Permissible Exposure Limits in Air:

Conversion factor: 1 ppm = 6.27 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: None

NIOSH REL: 0.1 ppm/0.6 milligram per cubic meter TWA; 0.5 ppm/3 milligram per cubic meter STEL

ACGIH TLV[1]: 0.1 ppm/0.63 milligram per cubic meter TWA

Protective Action Criteria (PAC)* Ver. 29[138]

PAC-1: 0.3 ppm

PAC-2: 0.48 ppm

PAC-3: **0.85_A** ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

DFG MAK: 0.2 ppm/1.3 milligram per cubic meter TWA; Peak Limitation Category I(1); Pregnancy Risk Group C

Australia: TWA 0.1 ppm (0.6 milligram per cubic meter); STEL 0.5 ppm, 1993; Austria: MAK 0.2 ppm (1 milligram per cubic meter), 1999; Belgium: TWA 0.1 ppm (0.63 milligram per cubic meter); STEL 0.5 ppm, 1993; Denmark: TWA 0.1 ppm (0.6 milligram per cubic meter), 1999; Finland: STEL 0.5 ppm (3 milligram per cubic meter), [skin], 1999; France: VME 0.1 ppm (0.6 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 0.6 milligram per cubic meter, 2003; Russia: STEL 0.05 milligram per cubic meter, [skin], 1993; Switzerland: MAK-W 0.1 ppm (0.6 milligram per cubic meter), KZG-W 0.2 ppm (1.2 milligram per cubic meter), 1999; Turkey: TWA 0.5 ppm (3 milligram per cubic meter), 1993; United Kingdom: TWA 0.2 ppm (1.3 milligram per cubic meter); STEL 0.6 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 0.1 ppm. Several states have set guidelines or standards for $POCl_2$ in ambient air[60] ranging from 6.0−30.0 μ/m^3 (North Dakota) to 12.0 μ/m^3 (Connecticut) to 14.0 μ/m^3 (Nevada).

Determination in Air: No method available.

Permissible Concentration in Water: No criteria set. ($POCl_2$ decomposes in water).

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Corrosive to the eyes, skin, and respiratory tract. Eye contact can cause permanent damage. Inhalation of the vapors can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. This material is toxic by inhalation and ingestion and is strongly irritating to skin and tissues. It causes burns of the mucous membranes of the mouth and digestive tract; and may be fatal. Symptoms include burns and extensive reddening of eyes, pains in throat; coughing, labored breathing with a shortness of breath; dizziness, headache, weakness, nausea, vomiting, chest pain; bronchitis, bronchopneumonia, kidney, and liver damage.

Long-Term Exposure: May cause nephritis; kidney damage. May cause liver damage.

Points of Attack: Eyes, skin, respiratory system; CNS; kidneys, liver.

Medical Surveillance. Lung function tests. Test for liver and kidney functions. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water, or milk. Do not induce vomiting. Medical observation is

recommended for 24–48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pneumonitis or pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: (1) Color code-Blue: Health Hazard/Poison: Store in a secure poison location. (2) Color code-White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. (3) Color code-White stripe: Contact Hazard; Store separately; not compatible with materials in solid white category. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area away from incompatible materials listed above. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1810 Phosphorus oxychloride, Hazard class: 6.1; Labels: 6.1-Poisonous materials, 8-Corrosive material, Hazard Zone B.

Spill Handling:

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

when spilled on land

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.2/0.3
Night 0.4/0.6

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 300/90
Then: Protect persons downwind (miles/kilometers)
Day 0.7/1.1
Night 1.4/2.3

when spilled in water

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.2/0.3

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)
Day 0.4/0.6
Night 1.4/2.3

Keep material out of water sources and sewers; build dikes to contain flow as necessary; use water spray to knock down vapors; *Do not use water* on material itself; and neutralize spilled material with crushed limestone, soda ash; or lime. *For a land spill*, dig a pit, pond, lagoon, or holding area to contain liquid or solid material; dike surface flow using soil, sand bags; foamed polyurethane; or foamed concrete; absorb bulk liquid with fly ash or cement powder; neutralize with agricultural lime (slaked lime), crushed limestone; or sodium bicarbonate. *For a water spill*, neutralize with agricultural lime (slaked lime), crushed limestone; or sodium bicarbonate; use mechanical dredges or lifts to remove immobilized masses of pollutants and precipitates; adjust pH to neutral (pH-7). *For air spills* apply water spray or mist to knock down vapors; vapor knock down water is corrosive or toxic and should be diked for containment. Stop leak if you can do so without risk. Do not touch spilled material. Keep combustibles (wood, paper, oil, etc.) away from spilled material. Clean up only under supervision of an expert. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical reacts violently with moisture producing hydrochloric and phosphoric acids. Thermal decomposition products may include hydrogen chlorides and oxides of phosphorus and carbon. *Do not use water* unless used in flooding quantities to control a large fire by wetting down combustibles burning in vicinity of this material. Use dry chemical, carbon dioxide; or dry sand; *Do not use water* on material itself. Use water spray to absorb vapors and cool all affected containers with flooding quantities of water. Apply water from as far a distance as possible. Avoid breathing vapors; keep upwind. Wear SCBA. Avoid bodily contact with the material. Wear boots, protective gloves; and goggles. Do not handle broken packages without protective equipment. Wash away any material which may have contacted the body with copious amounts of water or soap and water. If contact with the material is anticipated, wear full protective clothing. Keep unnecessary people away; isolate hazard area and deny entry. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Pour onto sodium bicarbonate. Spray with aqueous ammonia and add crushed ice. Neutralize and pour into drain with running water. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 3, No. 4, 87–88 (1983)

United States Environmental Protection Agency, Chemical Hazard Information Profile: Phosphorus Oxychloride, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Phosphorus Oxychloride Trenton, NJ (September 2001).

Phosphorus Pentachloride P:0630

Formula: Cl_5P; PCl_5

Synonyms: Pentacloruro de fosforo (Spanish); Phosphore (pentachlorure de) (French); Phosphoric chloride; Phosphorpentachlorid (German); Phosphorus perchloride

CAS Registry Number: 10026-13-8

HSDB Number: 1205

RTECS Number: TB6125000

UN/NA & ERG Number: (PIH) UN1806/137

EC Number: 233-060-3 [*Annex I Index No.:* 015-008-00-X]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade).

Hazard Alert: Poison inhalation hazard, Powerful oxidizer, Corrosive, Violent reaction with water (releasing toxic gas); Air reactive.

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500 lb (227 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 500 lb (227 kg)

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

United States National Primary Drinking Water Regulations: SMCL = 250 mg$[Cl^-]$/L as Chloride

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: C; Risk phrases: R14; R22; R26; R28; R34; R37; R48/20; Safety phrases: S1/2; S7/8; S26; S36/37/39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Phosphorus pentachloride is a pale yellow, fuming solid with an odor like hydrochloric acid. Molecular weight = 208.22; Specific gravity (H_2O:1) = 3.60 @ 25°C; Boiling point = (sublimes) 160°C; Freezing/Melting point = (sublimes) 162°C; Vapor pressure = 1 mmHg @ 55.6°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 2₩. Reacts violently with water.

Potential Exposure: Phosphorus pentachloride is used as a as a chlorinating and dehydrating agent and as a catalyst. It is used in the manufacture of agricultural chemicals;

chlorinated compounds; gasoline additives, plasticizers and surfactants; and in pharmaceutical manufacture.

Incompatibilities: Phosphorus pentachloride is a powerful oxidizer. Reacts with water (violent), magnesium oxide, chemically active metals, such as sodium and potassium, alkalis, amines, carbamates, aluminum powder, combustibles, fluorine, phosphorus pentoxide, phosphorus trioxide, and many other substances. Hydrolyzes in water (even in humid air) to form hydrochloric acid and phosphoric acid. Corrosive to many metals, forming flammable and explosive hydrogen gas. Attacks plastic and rubber.

Permissible Exposure Limits in Air:

NIOSH IDLH = 70 milligram per cubic meter

OSHA PEL: 1 milligram per cubic meter TWA

NIOSH REL: 1 milligram per cubic meter TWA

ACGIH TLV[1]: 0.1 ppm/1 milligram per cubic meter TWA

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 2.6 milligram per cubic meter

PAC-2: 20 milligram per cubic meter

PAC-3: 200 milligram per cubic meter

DFG MAK: 1 milligram per cubic meter, measured as the, inhalable fraction TWA; Peak Limitation Category I(1); Pregnancy Risk Group C

Australia: TWA 0.1 ppm (1 milligram per cubic meter), 1993; Austria: MAK 1 milligram per cubic meter, 1999; Belgium: TWA 0.1 ppm (0.85 milligram per cubic meter), 1993; Denmark: TWA 1 milligram per cubic meter, 1999; Finland: STEL 1 milligram per cubic meter, [skin], 1999; France: VME 0.1 ppm (1 milligram per cubic meter), 1999; Japan 0.1 ppm (0.85 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 1 milligram per cubic meter, 2003; Norway: TWA 0.1 milligram per cubic meter, 1999; the Phillipines: TWA 1 milligram per cubic meter, 1993; Poland: MAC (TWA) 0.3 milligram per cubic meter; MAC (STEL) 0.9 milligram per cubic meter, 1999; Russia: TWA 0.1 ppm; STEL 0.2 milligram per cubic meter, [skin], 1993; Switzerland: MAK-W 1 milligram per cubic meter, KZG-W 2 milligram per cubic meter, 1999; Thailand: TWA 1 milligram per cubic meter, 1993; Turkey: TWA 1 milligram per cubic meter, 1993; United Kingdom: TWA 0.1 ppm (0.87 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 0.1 ppm Several states have set guidelines or standards for PCl5 in ambient air[60] ranging from 10.0 μ/m^3 (North Dakota) to 16.0 μ/m^3 (Virginia) to 20.0 μ/m^3 (Connecticut) to 24.0 μ/m^3 (Nevada).

Determination in Air: Use NIOSH II(5), Method #S-257.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: The substance is corrosive to the eyes, skin, the respiratory tract. Corrosive if swallowed. Exposure may cause pulmonary edema, a medical emergency that can be delayed for several hours; this can cause death by pulmonary edema or circulation shock. Fumes cause irritation of eyes and respiratory passages. Upon ingestion, immediate pain in the mouth and throat, abdominal pain; nausea, vomiting of mucoid and "coffee-ground" material, intense thirst; clammy skin, weak and rapid pulse; shallow respiration, and circulatory shock occur.

Long-Term Exposure: Repeated or prolonged contact with skin may cause dermatitis. May cause lung irritation; bronchitis may develop. Repeated or prolonged contact may cause liver and kidney damage.

Points of Attack: Respiratory system, lungs, eyes, skin, liver, kidneys.

Medical Surveillance: Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. NIOSH lists the following tests: chest X-ray; pulmonary function tests: forced vital capacity, forced expiratory volume (1 sec). Consider the points of attack in preplacement and periodic physical examinations. Lung function tests. Liver and kidney function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water, or milk. Do not induce vomiting. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 10 milligram per cubic meter:* Sa (APF = 10) (any supplied-air respirator).* *Up to 25 milligram per cubic meter:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode).* *Up to 50 milligram per cubic meter:* SCBAF (APF = 50) any SCBA with a full facepiece; or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 70 milligram per cubic meter:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA). *Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Check oxygen content prior to entering storage area. (1) Color code-White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. (2) Color code-Yellow Stripe (strong oxidizer): Reactivity Hazard; Store separately in a area isolated from flammables, combustibles, or other yellow coded materials. yellow stripe. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area away from all other combustible and oxidizable materials, and moisture. Where possible, automatically transfer material storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Store in a cool, well ventilated area away from incompatible materials listed above. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage.

Shipping: UN1806 Phosphorus pentachloride, Hazard class: 8; Labels: 8-Corrosive material.

Spill Handling: when spilled in water

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.2/0.3

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.3/0.5
Night 1.0/1.5

Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Keep material out of water sources and sewers. Use water spray to knock down vapors. *Do not use water* on material itself; neutralize spilled material with crushed limestone, soda ash; or lime. Avoid breathing vapors; keep upwind. Avoid bodily contact with the materials. Do not handle broken packages without protective equipment. Wash away any materials which may have contacted the body with copious amounts of water or soap and water. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: A noncombustible solid. Thermal decomposition products may include hydrogen chloride, phosphorus trichloride, chlorine and oxides of phosphorus. If material is involved in fire then use dry chemical, carbon dioxide; or dry sand. *Do not use water* on material itself. If large quantities of combustibles are involved, use water in flooding quantities (i.e., spray or fog), and use water spray to absorb vapors. Avoid breathing vapors; keep upwind. Wear SCBA. Avoid bodily contact with the material; wear boots, protective gloves; and goggles. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Decompose with water, forming phosphoric and hydrochloric acids. Neutralize acids and dilute if necessary for discharge into the sewer system.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Phosphorus Pentachloride, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Phosphorus Pentachloride, Trenton NJ (August 1999)

Phosphorus Pentasulfide P:0640

Formula: P_2S_5; P_4S_{10}; P_4S_{10}

Synonyms: Pentasulfure de phosphore (French); Phosphoric sulfide; Phosphorus pentasulfide; Phosphorus persulfide; Phosphorus sulfide; Sulfur phosphide; Thiophosphoric anhydride

CAS Registry Number: 1314-80-3

HSDB Number: 1251

RTECS Number: TH4375000

UN/NA & ERG Number: UN1340 (free from yellow or white phosphorus)/139

EC Number: 215-242-4 [*Annex I Index No.:* 015-104-00-1]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade).

Hazard Alert: Flammable solid, Strong reducing agent, Pyrophoric hazard, Violently water reactive, Environmental hazard. Primary irritant (w/o allergic reaction).

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U189

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 100 lb (45.4 kg)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long lasting effects[291]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: F, Xn, N; Risk phrases: R2; R10; R14/15; R15/29; R17; R20/22; R29; Safety phrases: S1; S2; S29, S30; S35; S41; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Phosphorus pentasulfide is a greenish-gray to yellow, crystalline solid with an odor of rotten eggs. The Odor Threshold is 0.005 ppm. Molecular weight = 222.24 (P2S5); 444.6 (P4S10); Specific gravity (H_2O:1) = 2.1; Boiling point = 514°C @ 760 mmHg[136]; Freezing/Melting point = 275°C; Vapor pressure = 1 mmHg @ 300°C; Autoignition temperature (dry air) = 142°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 2 ₩. Reacts violently with water releasing phosphorus pentaoxide and highly toxic and flammable gases of hydrogen sulfide (may form explosive mixture with air) and sulfur dioxide.

Potential Exposure: Phosphorus pentasulfide is used as an intermediate in the manufacture of lubricant additives; insecticides, flotation agents; lubricating oil; ignition compounds; and matches. It is also used to introduce sulfur into rubber, and organic chemicals, such as pharmaceuticals.

Incompatibilities: Flammable solid; dust may form explosive mixture with air. Contact with water forms phosphorus pentoxide and an explosive mixture of hydrogen sulfide with air. Phosphorus pentasulfide is incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, ammonia, strong acids, strong bases, alcohols. Reaction with water or moisture in the air releases heat, hydrogen sulfide (H_2S), sulfur dioxide, and phosphoric acid. Pyrophoric hazard, may self-ignite in moist air.

Permissible Exposure Limits in Air:

NIOSH IDLH = 250 milligram per cubic meter

OSHA PEL: 1 milligram per cubic meter TWA

NIOSH REL: 1 milligram per cubic meter TWA; 3 milligram per cubic meter STEL

ACGIH TLV[1]: 1 milligram per cubic meter TWA; 3 milligram per cubic meter STEL

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 3 milligram per cubic meter

PAC-2: 130 milligram per cubic meter

PAC-3: 750 milligram per cubic meter

Australia: TWA 1 milligram per cubic meter; STEL 3 milligram per cubic meter, 1993; Austria: MAK 1 milligram per cubic meter, 1999; Belgium: TWA 1 milligram per cubic meter; STEL 3 milligram per cubic meter, 1993; Denmark: TWA 1 milligram per cubic meter, 1999; Finland: STEL 1 milligram per cubic meter, 1999; France: VME 1 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 1 milligram per cubic meter, 2003; the Phillipines: TWA 1 milligram per cubic meter, 1993; Poland: TWA 1 milligram per cubic meter; STEL 3 milligram per cubic meter, 1999; Switzerland: MAK-W 1 milligram per cubic meter, KZG-W 2 milligram per cubic meter, 1999; Thailand: TWA 1 milligram per cubic meter, 1993; Turkey: TWA 1 milligram per cubic meter, 1993; United Kingdom: TWA 1 milligram per cubic meter; STEL 3 milligram per cubic meter, 2000; Argentina, Bulgaria, Columbia, Jordan, South

Korea, New Zealand, Singapore, Vietman: ACGIH TLV: STEL 3 milligram per cubic meter. Several states have set guidelines or standards for P_2S_5 in ambient air[60] ranging from 10 μ/m^3 (North Dakota) to 16 μ/m^3 (Virginia) to 20 μ/m^3 (Connecticut)to 24 μ/m^3 (Nevada).

Determination in Air: No method available.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Severely irritates the eyes, skin, and respiratory tract. Inhalation of fumes produced by phosphorus compounds may cause irritation of pulmonary tissues with resultant acute pulmonary edema. The hazards of phosphorus pentasulfide are the same as for hydrogen sulfide to which it rapidly hydrolyzes in the presence of moisture. Symptoms include apnea, coma, convulsions, lacrimation (discharge of tears), photophobia (abnormal visual intolerance to light), kerato-conjunctivitis, corneal vesiculation; respiratory system irritation; dizziness, headaches, fatigue, irritability, insomnia, gastrointestinal disturbances.

Long-Term Exposure: Chronic exposure may lead to lung irritation, cough, bronchitis, and pneumonia.

Points of Attack: Respiratory system, lungs, CNS; eyes, skin.

Medical Surveillance: NIOSH lists the following tests: chest X-ray; pulmonary function tests: forced vital capacity, forced expiratory volume (1 sec). Consider the points of attack in preplacement and periodic physical examinations. Lung function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods:

General information: first responders should use a NIOSH-certified chemical, biological, radiological, nuclear (CBRN) SCBA with a level a protective suit when entering an area with an unknown contaminant or when entering an area where the concentration of the contaminant is unknown. Level a protection should be used until monitoring results confirm the contaminant and the concentration of the contaminant. *Note:* safe use of protective clothing and equipment requires specific skills developed through training and experience.

LEVEL A: (*RED ZONE*): select when the greatest level of skin, respiratory, and eye protection is required. This is the maximum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than the AEGL-2. A NIOSH-certified CBRN full-facepiece scba operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle. A totally encapsulating chemical protective (TECP) suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, and a hard hat worn under the TECP suit are optional items.

LEVEL B: (RED ZONE): Select when the highest level of respiratory protection is necessary but a lesser level of skin protection is required. This is the minimum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than AEGL-2. It differs from Level A in that it incorporates a non-encapsulating, splash-protective, chemical-resistant splash suit that provides Level A protection against liquids but is not airtight. A NIOSH-certified CBRN full-facepiece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle. A hooded chemical -resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL C: (YELLOW ZONE): Select when the contaminant and concentration of the contaminant are known and the respiratory protection criteria factors for using Air Purifying Respirators (APR) or Powered Air Purifying Respirators (PAPR) are met. This level is appropriate when decontaminating patient/victims. A NIOSH-certified CBRN tight-fitting APR with a canister-type gas mask or CBRN PAPR for air levels greater than AEGL-2. A NIOSH-certified CBRN PAPR with a loose-fitting facepiece, hood, or helmet and a filter or a combination organic vapor, acid gas, and particulate cartridge/filter combination or a continuous flow respirator for air levels greater than AEGL-1. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Escape mask, face shield, coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL D: (GREEN ZONE): Select when the contaminant and concentration of the contaminant are known and the concentration is below the appropriate occupational exposure limit or less than AEGL-1 for the stated duration times. Limited to coveralls or other work clothes, boots, and gloves.

Notes: Take all necessary precautions to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 10 milligram per cubic meter* Sa (APF = 10) (any supplied-air respirator).* *Up to 25 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode).* *Up to 50 milligram per cubic meter:* SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 250 milligram per cubic meter:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* GmFS100 (APF = 50) [Any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted canister providing protection against the compound of concern and having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA). *Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code-Red: Flammability Hazard: Store in a flammable materials storage area. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area away from moisture, water, alcohols, strong oxidizers; acids alkalies. Where possible, automatically transfer material from drums or other storage containers to process containers Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1340 Phosphorus pentasulfate, free from yellow or white phosphorus, Hazard Class: 4.3; Labels: 4.3-Dangerous when wet material, 4.1-flammable solid.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of phosphorus, sulfur and carbon. This chemical is a flammable solid. Use dry chemical, carbon dioxide; sand. Consider the use of sodium chloride-base extinguisher suitable for metal fires. *Do not use water.* If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Decompose with water, forming phosphoric acid, sulfuric acid and hydrogen sulfide. Provisions must be made for scrubbing hydrogen sulfide emissions. The acids may then be neutralized and diluted slowly to solution of soda ash and slaked lime with stirring, then flush to sewer with large volumes of water.

References

(31); (173); (101); (138); (170); (175); (190); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 3, No. 4, 89–90 (1983)

Phosphorus Pentoxide P:0650

Formula: O_5P2; P_2O_5

Synonyms: Diphosphorus pentoxide; Pentoxido de fosforo (Spanish); Phosphoric anhydride; Phosphorus(V) oxide; Phosphorus(5+) oxide; Phosphorus pentaoxide; Phosphorus oxide; POX

CAS Registry Number: 1314-56-3

HSDB Number: 847

RTECS Number: TH3945000

UN/NA & ERG Number: UN1807/137

EC Number: 215-236-1 [*Annex I Index No.:* 015-010-00-0]

Regulatory Authority and Advisory Information

Hazard Alert: Violent exothermic reaction with water, Corrosive.

United States Environmental Protection Agency, FIFRA 1998 Status of Pesticides: Active registration

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 10 lb (4.54 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 1 lb (0.454 kg)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: C; Risk phrases: R35; Safety phrases: S1/2; S22; S26; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Phosphorus pentoxide is a white crystalline solid. Molecular weight = 141.94; Freezing/Melting point = 340°C; it begins to sublime @ 360°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 2₩ (Corrosive). Reacts with water; violent reaction releasing heat and corrosive phosphoric acid.

Potential Exposure: This material is used as an intermediate in organic synthesis, catalyst, condensing agent; dehydrating agent; in the preparation of acrylate esters, surfactants, sugar refining; medicine, fire extinguishing; and special glasses.

Incompatibilities: Reacts violently and exothermically with water, forming ignition level heat and highly corrosive phosphoric acid. Keep away from the combination of moisture and combustible materials. Phosphorus pentoxide reacts violently with the following: perchloric acid; ammonia, hydrofluoric acid; oxidizers, hydrogen fluoride; formic acid, oxygen difluoride, potassium, sodium, propargyl alcohol; calcium oxide; inorganic bases; sodium hydroxide and chlorine trifluoride. Attacks many metals in presence of water. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, alcohols, ammonia. Undergoes hazardous or violent reactions with metal hydroxides and oxides, formic acid, hydrogen fluoride and hydrofluoric acid, iodides, metals (in particular potassium and sodium), ammonia, and proparygl alcohol[88,136].

Permissible Exposure Limits in Air:

Protective Action Criteria (PAC)* Ver. 29[138]

PAC-1: $\mathbf{1_E}$ milligram per cubic meter

PAC-2: $\mathbf{10_E}$ milligram per cubic meter

PAC-3: $\mathbf{50_E}$ milligram per cubic meter

*ERPG [Emergency Response Planning Guidelines] are marked with a subscript "**E**."

DFG MAK: 2 milligram per cubic meter, measured as inhalable fraction TWA; Peak Limitation Category I(2); Pregnancy Risk Group C

Austria: MAK 1 milligram per cubic meter, 1999; Denmark: ceiling 1 milligram per cubic meter, 1999; France: VME 1 milligram per cubic meter, 1999; Hungary: TWA 1 milligram per cubic meter; STEL 2 milligram per cubic meter, 1993; Norway: TWA 1 milligram per cubic meter, 1999; Poland: MAC (TWA) 1 milligram per cubic meter; STEL 3 milligram per cubic meter, 1999; Russia: STEL 1 milligram per cubic meter, [skin], 1993; the Netherlands: MAC-TGG 1 milligram per cubic meter, 2003; Turkey: TWA 1 milligram per cubic meter, 1993; United Kingdom: STEL 2 milligram per cubic meter, 2000

Permissible Concentration in Water: No criteria set (reacts with water).

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Highly corrosive to the eyes, skin, and respiratory tract. Eye contact may lead to a total destruction of the eyes. Particles in contact with eyes react vigorously and even a small amount may cause permanent burns. Contact with the skin will cause severe burns. Corrosive if ingested; will damage the gastrointestinal tract. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Signs and symptoms of acute exposure to phosphorus pentoxide may include severe burns, pain, shock, intense thirst; nausea, vomiting, diarrhea, severe abdominal pain; and "smoking stools." The breath and feces may have a garlicky odor. A symptom-free period of several days may follow. Exposure to phosphorus pentoxide may also result in bloody vomitus and diarrhea, jaundice, liver enlargement with tenderness; renal damage; hematuria (bloody urine), and either oliguria (scanty urination) or anuria (suppression of urine formation). Headache, convulsions, delirium, coma, cardiac arrhythmias; and cardiovascular collapse may occur. If phosphorus pentoxide contacts the eyes, severe irritation and burns, blepharospasm (spasmodic winking), lacrimation (tearing), and photophobia (heightened sensitivity to light) may occur. Victims may experience spontaneous hemorrhaging of phosphorus pentoxide-contaminated skin and mucous membranes.

Long-Term Exposure: Highly corrosive materials can cause lung damage; bronchitis may develop.

Points of Attack: Lungs, skin, eyes

Medical Surveillance. Lung function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure,

begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water, or milk. Do not induce vomiting. Obtain authorization and/or further instructions from the local hospital for administration of an antidote or performance of other invasive procedures. Rush to a health care facility.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. *Never pour water into this substance*; always add POX slowly to water when diluting or dissolving.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area away from incompatible materials listed above.

Shipping: UN1807 Phosphorus pentoxide, Hazard class: 8; Labels: 8-Corrosive material.

Spill Handling: Keep unnecessary people away. Stay upwind. Keep out of low areas. Ventilate closed spaces before entering them. Stop leak if possible without risk. Do not touch spilled material. Use water spray to reduce vapors, but do not put water on leak or spill. Keep combustibles away from spilled material. Dike spilled area and keep water away from spill. Clean up requires supervision by an expert. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Does not support combustion. Dangerously reactive with water. Thermal decomposition products may include phosphorus oxides. For small fires, use dry chemical, carbon dioxide; or sand. *Do not use water* or hydrous extinguishers. Wear positive pressure breathing apparatus and special protective clothing. Keep combustibles away from spilled material. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. *For large fires*, flood fire area with water from a distance. Do not get solid stream of water on spilled material or in open containers. From a secure, explosion-proof location, use water spray to cool exposed containers long after flames have been extinguished. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Decompose with water, forming phosphoric and hydrochloric acids. The acids may then be neutralized and diluted slowly to solution of soda ash and slaked lime with stirring then flush to sewer with large volumes of water.

References

(31); (173); (101); (138); (80); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: *Phosphorus Pentoxide*, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

Phosphorus Trichloride P:0660

Formula: Cl_3P; PCl_3

Synonyms: Chloride of phosphorus; Phosphore (trichlorure de) (French); Phosphorous chloride; Phosphortrichlorid (German); Phosphorus chloride; Trichloro; Tricloruro de fosforo (Spanish)

CAS Registry Number: 7719-12-2

HSDB Number: 1031

RTECSNumber: TH3675000

UN/NA & ERG Number: (PIH) UN1809/137

EC Number: 231-749-3 [*Annex I Index No.:* 015-007-00-4]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 15,000 (1% concentration); *Theft hazard* 45 (≥3.48% concentration); Sabotage/Contamination Hazard: A placarded amount (commercial grade).

Hazard Alert: Poison inhalation hazard: exposure can be lethal, High acute toxicity; Violently reactive with water, Strong reducing agent, Corrosive,

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 15,000 lb (6810 kg)

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 1000 lb (454 kg)

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

United States National Primary Drinking Water Regulations: SMCL = 250 mg[Cl^-]/L as Chloride

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T+, C; Risk phrases: R14; R26/28; R34; R37; R48/20; Safety phrases: S1/2; S7/8; S26; S36/37/39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Phosphorus trichloride is a colorless to yellow, fuming liquid. Odor like hydrochloric acid. Molecular weight = 137.32; Specific gravity (H_2O:1) = 1.58; Boiling point = 76°C; Freezing/Melting point = −112°C; Vapor pressure = 100 mmHg @ 21°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 0, Reactivity 2₩. Reacts with water, releasing white fumes and forming hydrochloric acid.

Potential Exposure: Phosphorus trichloride is used as an intermediate and as a chlorinating agent and catalyst; in the manufacture of agricultural chemicals; pharmaceuticals, chlorinated compounds; dyes, gasoline additives; acetyl cellulose; phosphorus oxychloride; plasticizers, saccharin, and surfactants.

Incompatibilities: Phosphorus trichloride is a strong reducing Violent reaction with water, producing heat and hydrochloric and phosphorous acids. Violent reaction with hydrides, alcohols, phenols and bases; water, when in contact with combustible organics; chemically active metals: sodium, potassium, aluminum; strong sulfuric or nitric acid. Attacks most metals except nickel and lead; may generate flammable hydrogen gas on contact with metals. Attacks plastics, rubber, and coatings.

Permissible Exposure Limits in Air:

NIOSH IDLH = 25 ppm

Conversion factor: 1 ppm = 5.62 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 0.5 ppm/3 milligram per cubic meter TWA

NIOSH REL: 0.2 ppm/1.5 milligram per cubic meter TWA; 0.5 ppm/3 milligram per cubic meter STEL

ACGIH TLV[1]: 0.2 ppm/1.1 milligram per cubic meter TWA; 0.5 ppm/2.8 milligram per cubic meter STEL

Protective Action Criteria (PAC)* Ver. 29[138]

PAC-1: $\mathbf{0.34_A}$ ppm

PAC-2: $\mathbf{2_A}$ ppm

PAC-3: $\mathbf{5.6_A}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

DFG MAK: 0.5 ppm/2.8 milligram per cubic meter TWA; Peak Limitation Category I(1); Pregnancy Risk Group C

Arab Republic of Egypt: TWA 0.5 ppm (3 milligram per cubic meter), 1993; Australia: TWA 0.2 ppm (1.5 milligram per cubic meter); STEL 0.5 ppm (3 milligram per cubic meter), 1993; Austria: MAK 0.25 ppm (1.5 milligram per cubic meter), 1999; Belgium: TWA 0.2 ppm (1.1 milligram per cubic meter); STEL 0.5 ppm (2.8 milligram per cubic meter), 1993; Denmark: TWA 0.2 ppm (1.2 milligram per cubic meter), 1999; Finland: STEL 0.5 ppm (3 milligram per cubic meter), [skin], 1999; France: VME 0.2 ppm (1.5 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 1.5 milligram per cubic meter, 2003; Japan 0.2 ppm (1.1 milligram per cubic meter), 1999; Norway: TWA 0.2 ppm (1.5 milligram per cubic meter), 1999; the Phillipines: TWA 0.5 ppm (3 milligram per cubic meter), 1993; Poland: MAC (TWA) 3 milligram per cubic meter, 1999; Russia: TWA 0.2 ppm; STEL 0.2 milligram per cubic meter, [skin], 1993; Turkey: TWA 0.5 ppm (3 milligram per cubic meter), 1993; United Kingdom: TWA 0.2 ppm (1.1 milligram per cubic meter); STEL 0.5 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 0.5 ppm. Several states have set guidelines or standards for PCl_3 in ambient air[60] ranging from 15−30 μ/m^3 (North Dakota) to 30 μ/m^3 (Connecticut) to 36 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method 6402.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Can be lethal if inhaled or swallowed. Corrosive to the eyes, skin, and respiratory tract. Corrosive if swallowed. Inhalation can cause pulmonary edema, a medical emergency that can be delayed for several hours. Very high levels of exposure to vapors can cause death. This material is highly toxic; it may cause death or permanent injury. Exposure may cause dizziness, headache, anorexia, respiratory difficulties; nausea, and vomiting. It can also cause liver and lung disturbances. Occupational exposure has caused coughs, bronchitis, pneumonia, and conjunctivitis.

Long-Term Exposure: Highly corrosive materials can cause lung damage; bronchitis may develop.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered.NIOSH lists the following tests: chest X-ray, electrocardiogram, pulmonary function tests: forced vital capacity, forced expiratory volume (1 sec); sputum cytology; white blood cell count/differential.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water, or milk. Do not induce vomiting. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *10 ppm:* SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *25 ppm:* SaF: Pd, Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted canister providing protection against the compound of concern]; or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance causes eye irritation or damage; eye protection needed.

Storage: Color code -Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Phosphorus trichloride must be stored to avoid contact with acetic acid, aluminum, chromyl chloride; fluorine, alcohol, nitric acid; sodium, potassium, water, hydroxylamine, and lead dioxide, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from water and moisture. Phosphorous trichloride corrodes most metals and will attack some forms of plastics, rubber and coatings.

Shipping: UN1809 Phosphorous trichloride, Hazard class: 6.1; Labels: 6.1-Poisonous materials, 8-Corrosive material, Inhalation Zone B.

Spill Handling:

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

when spilled on land

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.3/0.5

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 300/90
Then: Protect persons downwind (miles/kilometers)
Day 0.6/1.0
Night 1.4/2.3

when spilled in water

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.2/0.3

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)
Day 0.5/0.8
Night 1.6/2.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material may burn but does not easily ignite. Thermal decomposition products may include hydrogen chloride and oxides of phosphorus. Use carbon dioxide or dry chemical on fires involving phosphorus trichloride. *Do not use water*. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. Spray cooling water on containers that are exposed to flames until well after fire is out. Do not get water inside containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Decompose with water, forming phosphoric and hydrochloric acids. The acids may then be neutralized and diluted slowly to solution of soda ash and slaked lime with stirring, then flush to sewer with large volumes of water.

References

(31); (173); (101); (138); (2); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 3, No. 4, 93−94 (1983)

United States Environmental Protection Agency, Chemical Hazard Information Profile: Phosphorus Trichloride, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Phosphorous Trichloride, Trenton, NJ (March 2001).

48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered.

Phthalic Anhydride P:0670

Formula: $C_8H_4O_3$

Synonyms: Anhidrido ftalico (Spanish); Anhydride phthalique (French); Araldite HT 901; 1,2-Benzenedicarboxylic anhydride; 1,2-Benzenedicarboxylic acid anhydride; 1,2-Dioxophthalan phthalandione; 1,3-Dioxophthalan; Esen; HT 901; 1,3-Isobenzofurandione; NCI-C03601; PAN; Phthalandione; 1,3-Phthalandione; Phthalanhydride; Phthalic acid anhydride; Phthalsaeureanhydrid (German); Retarder AK; Retarder esen; Retarder PD; TGL 6525; Vulkalent B/C

CAS Registry Number: 85-44-9

HSDB Number: 4012

RTECS Number: TI3150000

UN/NA & ERG Number: UN2214/156

EC Number: 201-607-5 [*Annex I Index No.:* 607-009-00-4]

Regulatory Authority and Advisory Information

Carcinogenicity: NCI: Carcinogenesis Bioassay (feed).

United States Environmental Protection Agency Gene-Tox Program, Negative: Carcinogenicity-mouse/rat.

Hazard Alert: Combustible, Reactive with water, Sensitization hazard (skin), Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Corrosive (with moisture), Primary irritant (w/o allergic reaction).

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U190

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.055; Nonwastewater (mg/kg), 28

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 5000 lb (2270 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: Xi; Risk phrases: R22; R36/R37/38; R41; R42/43; R62; R63; Safety phrases: S2; S23; S24/25; S26; S37/39; S46 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Phthalic Anhydride is moderately flammable, white solid (flake) or a clear, colorless, mobile liquid (molten) Characteristic, acrid, choking odor. Molecular weight = 148.12 (flake); 1.20 (molten); Specific gravity (H_2O:1) = 1.5 @ 4°C; Boiling point = (sublimes) 295°C; Freezing/Melting point = 17.78°C; Vapor pressure = 0.0015 mmHg @ 20°C Flash point = 151.67°C (cc); Autoignition temperature = 570°C. Explosive limits: LEL = 1.7%; UEL: 10.5%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0₩. Reacts exothermically with water. Aqueous solution is corrosive.

Potential Exposure: Phthalic anhydride is used in plasticizers; in the manufacture of phthaleins; benzoic acid; alkyd and polyester resins; synthetic indigo; and phthalic acid;

which is used as a plasticizer for vinyl resins. To a lesser extent, it is used in the production of alizarin, dye, anthranilic acid; anthraquinone, diethyl phthalate; dimethyl phthalate; erythrosine, isophthalic acid; methylaniline, phenolphthalein, phthalamide, sulfathalidine, and terephthalic acid. It has also found uses as a pesticide intermediate.

Incompatibilities: Dust forms an explosive mixture with air. Phthalic anhydride reacts exothermically with water. The reactions are sometimes slow, but can become violent when local heating accelerates their rate. Acids accelerate the reaction with water. Incompatible with acids, strong oxidizing agents, alcohols, amines, and bases[101]. Converted to phthalic acid in hot water. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. caustics, ammonia, amines, water. Reacts violently with copper oxide or sodium nitrite + heat.

Permissible Exposure Limits in Air:

NIOSH IDLH = 60 milligram per cubic meter

Conversion factor: 1 ppm = 6.06 milligram per cubic meter @ 25°C & 1 atm

Odor Threshold = 0.05 ppm.

OSHA PEL: 2 ppm/12 milligram per cubic meter TWA

NIOSH REL: 1 ppm/6 milligram per cubic meter TWA

ACGIH TLV[1]: 1 ppm/6.1 milligram per cubic meter TWA; danger of sensitization; not classifiable as a human carcinogen

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 18 milligram per cubic meter

PAC-2: 56 milligram per cubic meter

PAC-3: 10,000 milligram per cubic meter

DFG MAK: Danger of skin sensitization; No numerical value established. Data may be available.

Australia: TWA 1 ppm (6 milligram per cubic meter), 1993; Austria: MAK 1 milligram per cubic meter, 1999; Belgium: TWA 1 ppm (6.1 milligram per cubic meter), 1993; Denmark: TWA 2 milligram per cubic meter, 1999; Finland: TWA 0.2 milligram per cubic meter, 1999; France: VLE 6 milligram per cubic meter, 1999; Hungary: TWA 1 milligram per cubic meter; STEL 2 milligram per cubic meter, 1993; the Netherlands: MAC-TGG 1 milligram per cubic meter, 2003; Norway: TWA 2 milligram per cubic meter, 1999; the Phillipines: TWA 2 ppm (12 milligram per cubic meter), 1993; Poland: MAC (TWA) 1 milligram per cubic meter; STEL 2 milligram per cubic meter (vapors and aerosols), 1999; Russia: STEL 1 milligram per cubic meter, [skin], 1993; Sweden: NGV 2 milligram per cubic meter, TGV 3 milligram per cubic meter, 1999; Switzerland: MAK-W 1 milligram per cubic meter, KZG-W 2 milligram per cubic meter, 1999; United Kingdom: TWA 4 milligram per cubic meter; STEL 12 milligram per cubic meter, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Russia[43] set a MAC for ambient air in residential areas of 0.1 milligram per cubic meter (100 μ/m^3). Several states have set guidelines or standards for phthalic anhydride in ambient air[60] ranging from 0.82 μ/m^3 (Massachusetts) to 60−240 μ/m^3 (North Dakota) to 100 μ/m^3 (Virginia) to 120 μ/m^3 (Connecticut) to 143 μ/m^3 (Nevada).

Determination in Air: Use NIOSH II(3), Method #S179; OSHA Analytical Method 90.

Determination in Water: Octanol-water coefficient: Log $K_{ow} = 1.58$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin, and respiratory tract. *Inhalation:* May cause irritation of nose, throat and mouth with coughing, sneezing, shortness of breath; and excessive discharge and bleeding from nose. Studies suggest that this will occur at about 4 ppm. *Skin:* Rapid chemical burns may occur on contact with wet skin. Molten material may cause severe burns unless removed immediately. *Eyes:* May cause severe irritation and chemical burns on contact or at dust levels above 5 ppm. *Ingestion:* May cause severe irritation to mouth and throat. Animal studies suggest that death may occur from ingestion of 4−8 ounces.

Long-Term Exposure: May cause irritation of nose, mouth, throat, and lungs. Repeated or prolonged contact may cause conjuctivitis; nasal ulcer bleeding. Allergy may develop in sensitive individuals which can lead to bronchial asthma. Repeated or prolonged skin contact may cause dermatitis, skin sensitization; and allergy. In animals: liver, kidney damage.

Points of Attack: Eyes, skin, respiratory system; liver, kidneys.

Medical Surveillance: NIOSH lists the following tests: chest X-ray; pulmonary function tests: forced vital capacity, forced expiratory volume (1 sec); urine (chemical/metabolite). Lung function tests may be normal if person is not having an attack at the time. If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water, or milk. Do not induce vomiting.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/

manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid or dust-proof goggles when working with powders or dust, unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *30 milligram per cubic meter:* Qm (APF = 25) (any quarter-mask respirator). *60 milligram per cubic meter:* 95 XQ [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or 95F (APF = 10) (any air-purifying full facepiece respirator equipped with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100); or PaprHie (APF = 25)* (any powered air-purifying respirator with a high-efficiency particulate filter); or SA* (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: (1) Color code-White stripe (*flake*): Contact Hazard; not compatible with materials in solid white category. (2) Color code-White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration is not a danger. Phthalic anhydride must be stored to avoid contact with strong oxidizers (such as chlorine and bromine), since violent reactions occur. Sources of ignition (such as smoking and open flames) are prohibited where phthalic anhydride is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2214 Phthalic anhydride with >.05 % maleic anhydride, Hazard class: 8; Labels: 8-Corrosive material.

Spill Handling: Stay upwind and uphill. Isolate the area of release or fire and deny entry. Remove all ignition sources. Stop the release if it can be done safely from a distance. All equipment used to handle this material must be grounded. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. *Small spill*: Cover with *dry* earth, *dry* sand, or other noncombustible material followed with plastic sheet to minimize spreading or contact with water or rain. Use clean nonsparking tools to collect material and place material into loosely covered plastic containers for later disposal. Prevent material and runoff from entering sewers and waterways if it can be done safely well ahead of the release. Use vapor suppressing foam to disperse vapors—contain runoff. Water spray may reduce vapor, but may not prevent ignition in enclosed spaces. Ventilate confined area if it can be done without placing personnel at risk. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Thermal decomposition products may includes oxides of carbon. *Small fire*: use *dry* chemical, CO_2, *dry* sand, or alcohol -resistant foam. May react with foams releasing corrosive/toxic gases. *Large fire*: use water spray or alcohol-resistant foam if it is available in sufficient amounts. Under favorable conditions, experienced crews can use coordinated fog streams to sweep the flames off the surface of the burning liquid. Combustible material: may burn but does not ignite readily. Most vapors are heavier than air. They will spread along ground and collect in low or confined areas (sewers, basements, tanks). Vapors may travel to source of ignition and flash back. Containers may explode when heated or if contaminated with water. Keep exposures cool long after fire is out to protect against reignition. Do not direct straight streams into the liquid. Cool exposed containers with large quantities of water from unattended equipment or remove intact containers if it can be done safely. *Do not get water on spilled substance or inside containers*. If cooling streams are ineffective (*venting sound increases in volume and pitch, tank discolors or shows signs of deforming*), withdraw immediately to a secure location. Always stay away from ends of tanks, especially when engulfed in flames. If material or contaminated runoff from fire control enters waterways, notify downstream users of potentially contaminated water. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Use a licensed professional waste disposal service to dispose of this material. Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Phthalic Anhydride, Health and Environmental Effects Profile No. 147, Office of Solid Waste, Washington, DC (April 30, 1980)

New York State Department of Health, *Chemical Fact Sheet:* Phthalic Anhydride, Bureau of Toxic Substance Assessment, Albany, NY (March 1986 and Version 2)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Phthalic Anhydride, Trenton, NJ (August 2001).

Phylloquinone P:0690

Formula: $C_{31}H_{46}O_2$

Synonyms: Antihemorrhagic vitamin; Aqua mephyton; Combinal K1; Kativ N; Kephton; Kinadion; Konakion; Mephyton; 2-Methyl-3-phythyl-1,4-naphthochinon (German); 2-Methyl-3-(3,7,11,15-tetramethyl-2-hexadecenyl)-1,4-naphthalenedione; Monodion; Phyllochinon (German); α-Phylloquinone; *trans*-Phylloquinone; Phytomenadione; Phytonadione; Vitamin K_1

CAS Registry Number: 84-80-0

HSDB Number: 3162

RTECS Number: QJ5800000

UN/NA & ERG Number: UN3249 (Medicines, toxic, solid, n.o.s.)/151

EC Number: 201-564-2

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Environmental hazard, Drug.

Superfund/EPCRA 302, Extremely Hazardous Substances: Dropped From Listing in 1988.

United States DOT Regulated marine pollutant (49CFR172.101, Appendix B) as naphthalenes

Hazardous to aquatic life or environment, with possible long lasting effects[291].(?)

Hazard Symbols, Risk & Safety statements: Hazard Symbol: Xi; Risk phrases: R36/37/38; R51; Safety phrases: S16; S26; S27; S29; S36/37/39 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Phylloquinone is an odorless yellow viscous oil or crystals. Molecular weight = 450.77; Boiling point = 140−145°C @ 0.001 mm; Freezing/Melting point = −4°C; −20°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 0. Insoluble in water.

Potential Exposure: Phylloquinone is a dietary component essential for normal biosynthesis of several factors required for clotting of blood; as a therapeutic drug used to correct bleeding tendency; and as a food supplement.

Incompatibilities: Phylloquinone is photosensitive; decomposes in sunlight and is destroyed by alkali hydroxides and reducing agents such as hydrideds and active metals. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air:

No standards or Protective Action Criteria (PAC) available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Permissible Concentration in Water: Naphthalenes and naphthenic acids are listed as United States DOT marine pollutants and may persist in the environment.

Harmful Effects and Symptoms

Short-Term Exposure: High oral toxicity. Intravenous injection can cause toxic responses and occasionally death. Rapid intravenous administration of phylloquinone has produced flushing, irregular breathing; and chest pains. In newborns, can cause hemolytic anemia and hemoglobinuria. In patients who have severe liver disease, administration of large doses of menadione or phylloquinone may further depress function of liver. Individuals resistant to coumarin may have unusual sensitivity to the antidotal effects of vitamin K.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/ manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles

and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Store in a secure, dark poison location under inert gas such as argon. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area away from alkali hydroxides and reducing agents. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN3249 Medicine, solid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Wear self-contained (positive pressure if available) breathing apparatus and full protective clothing. Shut off ignition sources; no flares, smoking or flames in hazard area. Keep combustibles (wood, paper, oil, etc.) away from spilled material. Do not touch spilled material. *Small spills:* absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills:* dike far ahead of spill for later disposal. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: It is inappropriate and possibly dangerous to the environment to dispose of expired or waste drugs and pharmaceuticals by flushing them down the toilet or discarding them to the trash. Household quantities of expired or waste pharmaceuticals may be mixed with wet cat litter or coffee grounds, double-bagged in plastic, discard in trash. Larger quantities shall carefully take into consideration applicable DEA, EPA, and FDA regulations. If possible return the pharmaceutical to the manufacturer for proper disposal being careful to properly label and securely package the material. Alternatively, the waste pharmaceutical shall be labeled, securely packaged and transported by a state licensed medical waste contractor to dispose by burial in a licensed hazardous or toxic waste landfill or incinerator.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Phylloquinone, Washington, DC, Chemical Emergency Preparedness Program (October 31, 1985)

Physostigmine P:0700

Formula: $C_{15}H_{21}N_3O_2$

Synonyms: Calabarine; Erserine; Eserine; Eserolein; Fisostigmina (Spanish); Methylcarbamate (ester); Methylcarbamic acid, ester with eseroline; Physostol

CAS Registry Number: 57-47-6

HSDB Number: 3161

RTECS Number: TJ2100000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154; UN1544 (Alkaloids, solid, n.o.s.)/151

EC Number: 200-332-8 [*Annex I Index No.:* 614-020-00-8]

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Combustible, Highly toxic, Nerve toxin/cholinesterase inhibitor

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P204

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.056; Nonwastewater (mg/kg), 1.4

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 100 lb (45.4 kg)

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T+, N; Risk phrases: R1/2; R26/28; R33; Safety phrases: S25; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Physostigmine is a white crystalline solid. Odorless. Molecular weight = 275.39; Freezing/Melting point = 86−87°C (unstable form); 105−106°C (stable form); Vapor pressure = 1×10^{-5} mmHg @ 25°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 1. Slightly soluble in water.

Potential Exposure: Physostigmine, an alkaloid, originally derived from the calabar bean (*Physostigma venenosum*) isa potent and reversible inhibitor of cholinesterase. Material is used as a cholinergic (anticholinesterase) agent and as a veterinary medication. Although listed as a carbamate pesticide, physostigmine is not registered for use as an agricultural chemical in the United States.

Incompatibilities: Light and heat.

Permissible Exposure Limits in Air:

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 0.41 milligram per cubic meter

PAC-2: 4.5 milligram per cubic meter

PAC-3: 27 milligram per cubic meter

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms Super toxic. Probable oral lethal dose is less than 5 mg/kg for a 70 kg (150 lb.) person. Material is a cholinesterase inhibitor. Effects of exposure may involve the respiratory, gastrointestinal, cardiovascular, and CNS. Death occurs due to respiratory paralysis or impaired cardiac function. Time to death may vary from 5 minutes to 24 hours, in severely poisoned patients, depending on factors such as the dose and route. Persons with asthma and/or persons that require drugs containing choline esters are at risk (EPA, 1998/cameo).

Short-Term Exposure: Super toxic. Probable oral lethal dose is less than 5 mg/kg for a 70 kg (150 lb) person. Material is a cholinesterase inhibitor. Effects of exposure may involve the respiratory, gastrointestinal, cardiovascular, and CNS. Death occurs due to respiratory paralysis or impaired cardiac function. Time to death may vary from 5 minutes to 24 hours, in severely poisoned patients, depending on factors, such as the dose and route. Persons with asthma and/or persons that require drugs containing choline esters are at risk (EPA, 1998/cameo). General symptoms include increased secretions, fatigability, and generalized weakness; involuntary twitching; severe weakness of skeletal muscles. Symptoms of exposure to material by major organ system: gastrointestinal: lack of appetite; nausea and vomiting; abdominal cramps and diarrhea. CNS: confusion, lack of coordination, slurred speech; loss of reflexes; rapid irregular breathing; generalized convulsions; and coma. Cardiovascular: slowed heart beat resulting in hypotension and fall in cardiac output.

Long-Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, CNS; cardiovascular system, skin, eyes, plasma and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also consider CBC. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash

immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN1544 Alkaloids, solid, n.o.s. or Alkaloid salts, solid, n.o.s. poisonous, Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. As for other carbamate pesticides, avoid breathing dusts and fumes from burning materials. Keep upwind. Avoid bodily contact with the material. Wash away any material which may have contacted the body with copious amounts of water or soap and water. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen and carbon. As for other carbamates, extinguish fire using agent suitable for type of surrounding fire (material itself burns with difficulty). Use water in flooding quantities as fog. Use alcohol foam, carbon dioxide or dry chemical. Wear SCBA when fighting fires.If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: It is not appropriate to dispose of expired or waste drugs or waste product such as lab chemicals by flushing them down the toilet or discarding them to the trash. Larger quantities shall carefully take into consideration applicable EPA, and FDA regulations. If possible return the lab chemicals to the manufacturer for proper disposal being careful to properly label and securely package the material. Alternatively, the waste lab chemicals shall be labeled, securely packaged and transported by a state licensed medical waste contractor to dispose by burial in a licensed hazardous or toxic waste landfill or incinerator. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Physostigmine, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

Picloram P:0710

Formula: $C_6H_3Cl_3N_2O_2$

Synonyms: Amdon; Amdon grazon; 4-Aminotrichloropicolinic acid; 4-Amino-3,5,6-trichloro-2-picolinic acid; 4-Amino-3,5,6-trichloropicolinic acid; 4-Amino-3,5,6-trichloro-2-pyridinecarboxylic acid; 4-Amino-3,5,6-trichloropyridine-2-carboxylic acid; 4-Amino-3,5,6-trichlorpicolinsaeure (German); ATCP; Borolin; K-Pin; NCI-C00237; NSC 233899; Picolinic acid, 4-Amino-3,5,6-trichloro-; 2-Pyridine carboxylic acid, 4-amino-3,5,6-trichloro-; Tordon; Tordon 10K; Tordon 22K; Tordon 101 mixture; 3,5,6-Trichloro-4-aminopicolinic acid

CAS Registry Number: 1918-02-1

HSDB Number: 1151

RTECS Number: TJ7525000

UN/NA & ERG Number: UN2588 (Pesticides, solid, toxic, n.o.s.)/151

EC Number: 217-636-1

Regulatory Authority and Advisory Information

Carcinogenicity: NCI: Carcinogenesis Bioassay (feed); equivocal evidence: rat; no evidence: mouse; IARC: Animal Limited Evidence; Human No Available Data*, not classifiable as carcinogenic to humans*, Group 3, 1991.

Hazard Alert: Poison, Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard. Listed for Tier 1 screening as an endocrine disruptor[88].

Banned or Severely Restricted (Sweden) (UN)[13]

United States National Primary Drinking Water Regulations: MCLG = 0.5 mg/L; MCL = 0.5 mg/L

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Hazardous to aquatic life or environment, with possible long lasting effects[291].(?)

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T, Xi; Risk phrases: R36; R51; R62; R63; Safety phrases: S26 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to waters.

Description: Picloram is a colorless powder. Chlorine odor. Molecular weight = 241.46; Melting/Freezing point = (decomposes) 218−219°C. Vapor pressure = 6.15×10^{-7} mmHg @ 36.7°C. Solubility in water; solubility = 425 ppm @ 25°C.

Potential Exposure: A potential danger to those involved in the manufacture, formulation or application of this herbicide.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Compounds of the carboxyl group react with all bases, both inorganic and organic (i.e., amines) releasing substantial heat, water and a salt that may be harmful. Incompatible with arsenic compounds (releases hydrogen cyanide gas), diazo compounds, dithiocarbamates, isocyanates, mercaptans, nitrides, and sulfides (releasing heat, toxic and possibly flammable gases), thiosulfates and dithionites (releasing hydrogen sulfate and oxides of sulfur). This material is acidic. Reacts with hot concentrated alkali (hydrolyzes), strong bases. May attack metals.

Permissible Exposure Limits in Air:

OSHA PEL: 15 milligram per cubic meter TWA, total dust; 5 milligram per cubic meter TWA, respirable fraction

NIOSH REL: See Appendix D of the *NIOSH Pocket Guide*

ACGIH TLV[1]: 10 milligram per cubic meter TWA; not classifiable as a human carcinogen

Protective Action Criteria (PAC) not available

Australia: TWA 10 milligram per cubic meter; STEL 20 milligram per cubic meter, 1993; Belgium: TWA 10 milligram per cubic meter; STEL 20 milligram per cubic meter, 1993; Denmark: TWA 10 milligram per cubic meter, 1999; Finland: TWA 10 milligram per cubic meter; STEL 20 milligram per cubic meter, 1999; France: VME 10 milligram per cubic meter, 1999; Russia: STEL 2 milligram per cubic meter, 1993; Switzerland: MAK-W 10 milligram per cubic meter, 1999; United Kingdom: TWA 10 milligram per cubic meter; STEL 20 milligram per cubic meter, 2000; the Netherlands: MAC-TGG 10 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen

Russia set a MAC for ambient air of 0.03 milligram per cubic meter on a once-daily basis and 0.02 milligram per cubic meter on an average daily basis. Several states have set guidelines or standards for picloram in ambient air[60] ranging from 0.1−0.2 milligram per cubic meter (North Dakota) to 0.16 milligram per cubic meter (Virginia) to 0.2 milligram per cubic meter (Connecticut) to 0.238 milligram per cubic meter (Nevada).

Determination in Air: Filter; none; Gravimetric; NIOSH IV, Particulates NOR: Method #0500, total dust; Method #0600 (respirable dust).

Permissible Concentration in Water: U.S.Safe Drinking Water Act (47FR 9352): MCL, 0.5 mg/L; MCLG, 0.5 mg/L. The United States Environmental Protection Agency has set a lifetime health advisory of 0.49 mg/L. States which have set guidelines for Picloram in drinking water[61] include Kansas at 0.175 mg/L and Maine at 0.3 mg/L.

Determination in Water: Fish Tox = 703.55815000 ppb (VERY LOW).

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin, and respiratory tract. Exposure can cause nausea. Human Tox = 500.00000 ppb (VERY LOW).

Long-Term Exposure: Picloram should be handled as a carcinogen-with extreme caution. It may cause liver problems and damage the testes. May affect the kidneys. In animals: liver, kidney changes.

Points of Attack: Eyes, skin, respiratory system; liver, kidneys. Cancer site in animals: liver, uterus, pituitary gland.

Medical Surveillance: Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for Exposures over *10 milligram per cubic meter*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from acids, bases, and metals. A regulated, marked area should be established where this chemical is handled, used or stored. The use of picloram has been restricted. Be sure that your operation follows regulations. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2588 Pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Decomposes above 200°C. Thermal decomposition products may include hydrogen chloride and oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: This chlorinated brush killer is usually formulated with 2,4-D and the disposal problems are similar. Incineration @ 1000°C for 2 seconds is required for thermal decomposition. Alternatively, the free acid can be precipitated from its solutions by addition of a mineral acid. The concentrated acid can then be incinerated and the dilute residual solution disposed in an area where several years' persistence in the soil can be tolerated.

References

(31); (173); (101); (138); (80); (100).

United States Environmental Protection Agency, "Alert: Picloram," Washington, DC, Office of Drinking Water (August 1987)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Picloram, Trenton, NJ (May 2001).

Picolines P:0720

Formula: C_6H_7N

Synonyms: *2-Picoline (o-isomer):* AI3-2409; AI3-24109; α-Methylpyridine; 2-Methylpyridine; Metilpiridina (Spanish); NSC 3409; α-Picoline; *o*-Picoline; 2-Picoline; Picoline; Pyridine, 2-methyl-; Pyridine, methyl-

3-Picoline (m-isomer): β-Picoline; *m*-Picoline; β-Methylpyridine; *m*-Methylpyridine; 3-Methylpyridine; Pyridine, 3-methyl

4-Picoline (p-isomer): γ-Picoline; *p*-Picoline; γ-Methylpyridine; *p*-Methylpyridine; 4-Methylpyridine; Pyridine, 4-methyl

CAS Registry Number: 109-06-8 (2-Picoline); 108-99-6 (3-Picoline); 108-89-4 (4-Picoline); 1333-41-1 (mixed isomers)

HSDB Number: 101 (2-Picoline); 4254 (3-Picoline)

RTECS Number: TJ4900000 (2-Picoline); TJ5000000 (3-Picoline); UT5425000 (4-Picoline)

UN/NA & ERG Number: UN2313/129

EC Number: 203-643-7 [*Annex I Index No.:* 613-036-00-2] (2-Picoline); 203-636-9 (3-Picoline); 203-626-4 [*Annex I Index No.:* 613-037-00-8] (4-Picoline); 215-588-6 (methylpyridine or mixed isomers)

Regulatory Authority and Advisory Information (2-Picoline)

o-isomer:

Hazard Alert: Highly flammable liquid (*o- & m-* isomers), Flammable (*p*-isomer).

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U191

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 5000 lb (2270 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

European/International Regulations (*2-picoline*): Hazard Symbol: F+, Xn; Risk phrases: R11; R20/21/22; R36/37; Safety phrases: S2; S26; S36; (*4-picoline*) Hazard Symbol:

T, F; Risk phrases: R11; R20/22; R24; R36/37/38; Safety phrases: S1/2; S21; S26; S36; S41; S45 (see Appendix 4). WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water. (*all isomers*)

Description: Picolines are colorless liquids. Strong, unpleasant, pyridine-like odor."Picoline" is often used as mixed isomers and physical data for the other isomers are listed. The *o*-isomer is the most heavily regulated (see above). Molecular weight = 93.14 (*m-and o*-isomers); Specific gravity (H_2O:1) = 0.95 @ 15°C (*o*-isomer); 0.96 @ 25°C (*m*-isomer) Boiling point = 129°C (*o*-isomer); 143−144°C (*m*-isomer); 145°C (*p*-isomer); Freezing/Melting point = −70°C (*o*-isomer); −18°C (*m* -isomer); 3.7°C (*p*-isomer); Vapor pressure = 11.2 mmHg @ 45°C (*o*-isomer); Flash point = 39°C (oc) (*o*-isomer); 37.8°C (cc) (*m*-isomer); 57°C (*p*-isomer); Autoignition temperature = 535°C (*o*-isomer). Explosive limits (*o*-isomer): LEL = 1.4%; UEL: 8.6%. Hazard Identification (based on NFPA-704 M Rating System): (*2-isomer*) Health 3, Flammability 3, Reactivity 0; *(3-and 4-isomer*s) Health 2, Flammability 2, Reactivity 0. Soluble in water. Floats on water; poisonous, flammable vapor is produced[136].

Potential Exposure: (*o*-isomer); Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction), (*m*-isomer): Possible risk of forming tumors, Primary irritant (w/o allergic reaction). Picolines are used as intermediates in pharmaceutical manufacture, pesticide manufacture; and in the manufacture of dyes and rubber chemicals. It is also used as a solvent.

Incompatibilities: Vapors may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Attacks copper and its alloys.

Permissible Exposure Limits in Air:
Odor threshold = 0.023 ppm.
Protective Action Criteria (PAC) Ver. 29[138]
109-06-8, 2-picoline
PAC-1: 5 ppm
PAC-2: 7.7 ppm
PAC-3: 46 ppm
108-99-6, 3-picoline
PAC-1: 5 ppm
PAC-2: 49 ppm
PAC-3: 300 ppm

Permissible Concentration in Water: There are no United States criteria but the maximum allowable concentration in Class I waters for the production of drinking water has been set in Russia at 0.05 mg/L[43]. The EPA has suggested[32] a permissible ambient goal of 316 μg/L based on health effects.

Determination in Water: Octanol-water coefficient: Log K_{ow} = 1.2 (all-isomers). Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Corrosive to the eyes, skin, and respiratory tract. Exposure can cause nausea, vomiting, diarrhea and abdominal pain. *Inhalation:* May cause irritation to mouth, nose and throat. Odor is very disagreeable above 30 ppm. However, people often become insensitive to the odor after a period of time, so odor detection cannot be relied upon as an indication of exposure. Exposure far above the OEL may cause you to pass out. Levels of 8000 ppm caused death in all exposed rats within 1.5 hours. *Skin:* Readily absorbed and may contribute to symptoms. Irritation with rash or burning sensation on contact. May cause severe irritation if not promptly removed. *Eyes:* May cause severe irritation. *Ingestion:* Irritation and upset of digestive system may occur. Muscle weakness, loss of coordination; diarrhea, and unconsciousness may result. Animal studies suggest that death may occur by ingestion of 1−2 fluid ounces for a 150 lb person.

Long-Term Exposure: Repeated exposure to picoline can cause headache, dizziness, weakness, loss of coordination; double vision and coma. Animal studies suggest that symptoms similar to those listed under ingestion would occur. Liver and kidney damage may also occur. Corrosive substances can irritate the lungs; bronchitis may develop.

Points of Attack: Skin, eyes, liver and kidneys, lungs.

Medical Surveillance: Liver and kidney function tests. Lung function tests. Consider chest X-ray following acute overexposure. Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode. A respirator providing protection against organic vapors may be of use to sensitive individuals and during entry or escape from a contaminated area.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration is not a danger. Store in tightly closed containers in a cool, well ventilated area away from oxidizers, strong acids; acid chlorides; chloroformates, copper metals and alloys. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN2313 Picolines, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include fumes of cyanide and oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, 2-Picoline, Health and Environmental Effects Profile No. 148, Office of Solid Waste, Washington, DC (April 30, 1980)

(173); (101); (138).

New York State Department of Health, *Chemical Fact Sheet:* Picoline(s), Bureau of Toxic Substance Assessment, Albany, NY (March 1986)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Picoline, Trenton, NJ (August, 1999)

Picric Acid P:0730

Formula: $C_6H_3N_3O_7$; $C_6H_2(NO_2)_3OH$

Synonyms: Acide picrique (French); Acido picrico (Spanish); Carbazotic acid; C.I. 10305; 2-Hydroxy-1,3, 5-trinitrobenzene; Lyddite; Melinite; Nitroxanthic acid; PA; Pertite; Phenol trinitrate; Phenol, 2,4,6-trinitro-; Picral; Picronitric acid; Pikrinsaeure (German); Shimose; Trinitrophenol; Trinitrofenol (Spanish); 1,3,5-Trinitrophenol; 2,4,6-Trinitophenol

CAS Registry Number: 88-89-1

HSDB Number: 2040

RTECS Number: TJ7875000

UN/NA & ERG Number: UN0154 (dry or wetted with <30% water, by mass)/112; UN3364 (wetted *with not <10%* water, by mass)/113; UN1344 (wetted with not <30% water, by mass)/113

EC Number: 201-865-9 [*Annex I Index No.:* 609-009-00-X]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 5000 (commercial grade); *Theft hazard* 400 (commercial grade).

United States Environmental Protection Agency Gene-Tox Program, Inconclusive: D *melanogaster* sex-linked lethal.

Hazard Alert: Explosive when dry: OSHA Class A Explosive (1910.109), Combustible, Suspected reprotoxic hazard.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: E, T; Risk phrases: R1; R2; R4; R10; R23/24/25; Safety phrases: S1/2; S28; S35; R37; R45; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Picric acid is a pale yellow, odorless solid. Usually found in solution with 10%−20% water. *Must be kept wetted; the crystalline form is highly unstable.* The dry crystal form is explosive upon rapid heating or mechanical shock. Molecular weight = 229; Specific gravity (H_2O:1) = 1.76 @ 25°C; Boiling point = (explodes above 300°C); Freezing/Melting point = 123°C; Vapor pressure = 1 mmHg @ 25°C; Flash point = 150°C; Autoignition temperature = (explodes) 300°C. Explosive limits: LEL = 12,000 ppm, UEL: unknown; Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 4, Reactivity 4; (*wet*): Health 2, Flammability 2, Reactivity 2. Slightly soluble in water; solubility = 1%.

Potential Exposure: Picric acid is used in the synthesis of dye intermediates and in manufacturing picrates; in the manufacture of explosives, rocket fuels; fireworks, colored glass; matches, electric batteries; and disinfectants. It is also used in the pharmaceutical and leather industries; in copper and steel etching; forensic chemistry; histology, textile printing; and photographic emulsions.

Incompatibilities: *Explosive when dry.* Violent reaction with oxidizers and reducing materials. Air or oxygen is not required for decomposition. Shock sensitive compounds can be formed on contact with plaster, concrete. An explosive mixture results when the aqueous solution crystallizes. May explosively decompose from heat, shock, friction, or concussion. Copper, lead, zinc and other metals, or their salts can form other salts that are initiators and much more sensitive to shock than this chemical. Corrodes metals.

Permissible Exposure Limits in Air:

NIOSH IDLH = 75 milligram per cubic meter

Conversion factor: 1 ppm = 9.37 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 0.1 milligram per cubic meter TWA [skin]

NIOSH REL: 0.1 milligram per cubic meter TWA [skin]; 0.3 milligram per cubic meter STEL

ACGIH TLV[1]: 0.1 milligram per cubic meter TWA

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 0.3 milligram per cubic meter

PAC-2: 17 milligram per cubic meter

PAC-3: 100 milligram per cubic meter

DFG MAK: 0.1 milligram per cubic meter, inhalable fraction; [skin] danger of skin sensitization; Carcinogen Category 3B.

Australia: TWA 0.1 milligram per cubic meter; STEL 0.3 milligram per cubic meter, [skin], 1993; Austria: MAK 0.1 milligram per cubic meter, [skin], 1999; Belgium: TWA 0.1 milligram per cubic meter; STEL 0.3 milligram per cubic meter, [skin], 1993; Denmark: TWA 0.1 milligram per cubic meter, [skin], 1999; Finland: TWA 0.1 milligram per cubic meter; STEL 0.3 milligram per cubic meter, [skin], 1999; France: VME 0.1 milligram per cubic meter, [skin], 1999; Hungary: TWA 0.1 milligram per cubic meter; STEL 0.2 milligram per cubic meter, [skin], 1993; the Netherlands: MAC-TGG 0.1 milligram per cubic meter, [skin], 2003; Norway: TWA 0.1 milligram per cubic meter, 1999; the Phillipines: TWA 0.1 milligram per cubic meter, [skin], 1993; Poland: MAC (TWA) 0.1 milligram per cubic meter; MAC (STEL) 0.3 milligram per cubic meter, 1999; Switzerland: MAK-W 0.1 milligram per cubic meter, KZG-W 0.2 milligram per cubic meter, [skin], 1999; Turkey: TWA 0.1 milligram per cubic meter, [skin], 1993; United Kingdom: TWA 0.1 milligram per cubic meter; STEL 0.3 milligram per cubic meter, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 0.1 milligram per cubic meter. Several states have set guidelines or standards for picric acid in ambient air[60] ranging from 0.33 μ/m^3 (New York) to 1.0 μ/m^3 (Florida, South Carolina) to 1.0−3.0 μ/m^3 (North Dakota) to 1.6 μ/m^3 (Virginia) to 2.0 μ/m^3 (Connecticut and Nevada). Russia set a MAC for ambient air of 10 μ/m^3 on a once-daily basis.

Determination in Air: Collection on a mixed cellulose ester membrane filter, extraction with aqueous methanol measurement by high performance liquid chromatography with UV detector. See NIOSH (II-4), Method #S-228.

Permissible Concentration in Water: To protect human health: no criteria set due to insufficient data[6]. Russia[35,43] set a MAC in water bodies used for domestic purposes of 0.5 mg/L.

Determination in Water: Methylene chloride extraction followed by gas chromatography with flame ionization or electron capture detection (EPA Method 604); or gas chromatography plus mass spectrometry (EPA Method 625). Octanol-water coefficient: Log K_{ow} = 2.0. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact. Absorbed by the skin.

Harmful Effects and Symptoms

Short-Term Exposure: LD_{50} = (oral-rat) 200 mg/kg. Irritates the eyes, skin, and respiratory tract. Corneal injury may occur from exposure to picric acid dust and solutions. Dust or fume may cause eye irritation which may be aggravated by sensitization. Inhalation of high concentrations of dust by one worker caused temporary coma followed by weakness, myalgia, anuria, and later polyuria. Following ingestion of picric acid, there may be headache, vertigo, nausea, vomiting, diarrhea, yellow coloration of the skin; hematuria, and albuminuria. High doses may cause destruction of erythrocytes, hemorrhagic nephritis; and hepatitis. High doses which cause systemic intoxication will color all tissues yellow, including the conjunctive and aqueous humor; and cause yellow vision.

Long-Term Exposure: Picric acid dust or solutions are potent skin sensitizers. The cutaneous lesions which appear usually on exposed areas of the upper extremities consist of dermatitis with erythema and vesicular eruptions. Desquamation may occur following repeated or prolonged contact. Skin usually turns yellow upon contact, and areas around nose and mouth as well as the hair are most often affected. May cause liver effects; hepatitis, hematuria (blood in the urine), albuminuria, kidney effects; nephritis.

Points of Attack: Eyes, skin, kidneys, liver, blood.

Medical Surveillance: NIOSH lists the following tests: liver function tests; urinalysis (routine). Preplacement and periodic medical examinations should focus on skin disorders; such as hypersensitivity, atopic dermatitis; and liver and kidney function. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. CBC.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Natural rubber, Neoprene, and Nitrile are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash or dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 0.5 milligram per cubic meter:* Qm (APF = 25) (any quarter-mask respirator). *Up to 1 milligram per cubic meter*: 95 XQ [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators]. The following filters may also be used: N99, R99, P99, N100, R100, P100; or Sa (APF = 10) (any supplied-air respirator). *Up to 2.5 milligram per cubic meter:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *Up to 5 milligram per cubic meter:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 75 milligram per cubic meter:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or Sa: Pd,Pp (APF = 1000): ASCBA (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: UN0154 Explosive. UN1344 Color code-Red Stripe: Flammability Hazard: Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8—10 meters or a 1-hour fire wall from flammable or reactive materials. Store flammable solids up to maximum allowable quantity per control area in an approved flammable storage area. Do not store in a basement. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in an explosion-proof refrigerator away from oxidizers, reducing agents; and metals. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN0154 Picric acid, dry or wetted with <30% water, by mass, Hazard Class: 1D; Labels:1D-Explosive (with a mass explosion hazard); D-Substances or articles which may mass detonate (with blast and/or fragment hazard) when exposed to fire. UN1344 Picric acid, wetted with not less than 30% water, Hazard Class: 4.1; Labels: 4.1-Flammable solid.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen spilled material with alcohol to avoid dust, then transfer material to a suitable container for eventual disposal. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable solid. More powerful than TNT, picric acid explodes above 572°F/300°C. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Controlled incineration in a rotary kiln incinerator equipped with particulate abatement and wet scrubber devices[22].

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Nitrophenols: Ambient Water Quality Criteria, Washington, DC 1980

Picrotoxin P:0740

Formula: $C_{30}H_{34}O_{13}$

Synonyms: Cocculin; Cocculus; Coques du levant (French); Fish berry; Indian berry; Oriental berry; Picrotin, compounded with picrotoxinin (1:1); Picrotoxine

CAS Registry Number: 124-87-8

HSDB Number: 6385

RTECS Number: TJ9100000

UN/NA & ERG Number: UN3172/153; UN3462/153

EC Number: 204-716-6

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Combustible, Highly poisonous, Environmental hazard.

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 500 lb (227 kg).

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T+, N; Risk phrases: R28; R23/24/25; R36/37/38; R50; R52/53; Safety phrases: S1; S22; S28; S29/35; S36/37/39; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Picrotoxin is an odorless crystalline solid with a very bitter taste. Molecular weight = 602.64; Freezing/Melting point = 203°C; Vapor pressure = 1×10^{-5} mmHg @ 25°C. Explosive limits: LEL = 17,000 ppm, UEL: unknown; Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Practically insoluble in cold water; soluble in boiling water.

Potential Exposure: An alkaloid poison and convulsant. Used in medicine as a CNS stimulant and antidote for barbiturate poisoning. Reportedly, this material is not currently regarded as a useful therapeutic agent since it is not a selective respiratory stimulant.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air:

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 0.024 milligram per cubic meter

PAC-2: 0.27 milligram per cubic meter

PAC-3: 1.6 milligram per cubic meter

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Highly toxic and a dose of 20 mg may produce symptoms of severe poisoning. A human lethal dose of 1.5 mg/kg has been reported. It is an alkaloid convulsant poison. Picrotoxin is a powerful stimulant and affects all portions of the CNS. At doses approaching convulsant levels, signs and symptoms include salivation, elevated blood pressure; frequent vomiting; rapid breathing.

Points of Attack: CNS.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature. Effects may be delayed, keep victim under observation.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code -Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area away. Where possible, automatically transfer material from drums or other storage containers to process containers.

Shipping: UN3462 Toxins, extracted from living sources, solid, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN3172 Toxins, extracted from living sources, (solid or liquid) Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Remove and isolate contaminated clothing at the site. If water pollution occurs, notify appropriate authorities. Do not touch spilled material; stop leak if you can do it without risk. Use water spray to reduce vapors. *Small spills*: take up with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills:* with clean shovel place material into clean, dry container and cover; move containers from spill area. *Large spills:* dike far ahead of spill for later disposal. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide; water spray; or foam for small fires. Use water spray, fog, or foam for large fires. Move container from fire area if this can be done without risk. Isolate hazard area and deny entry. Wear positive pressure breathing apparatus and special protective clothing. Thermal decomposition products may include oxides of carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: It is inappropriate and possibly dangerous to the environment to dispose of expired or waste drugs and pharmaceuticals by flushing them down the toilet or discarding them to the trash. Household quantities of expired or waste pharmaceuticals may be mixed with wet cat litter or coffee grounds, double-bagged in plastic, discard in trash. Larger quantities shall carefully take into consideration applicable DEA, EPA, and FDA regulations. If possible return the pharmaceutical to the manufacturer for proper disposal being careful to properly label and securely package the material. Alternatively, the waste pharmaceutical shall be labeled, securely packaged and transported by a state licensed medical waste contractor to dispose by burial in a licensed hazardous or toxic waste landfill or incinerator.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Picrotoxin, Washington, DC, Chemical Emergency Preparedness Program November 30, 1987

Pindone P:0760

Formula: $C_{14}H_{14}O_3$; $C_6H_4(CO)_2CHCOC(CH_3)_3$

Synonyms: Chemrat; *tert*-Butyl valone; 1,3-Dioxo-2-pivaloy-lindane; Pival; Pivalyl; 2-Pivalyl-1,3-indandione; Pivalyl Valone; Pivaldione (French)

CAS Registry Number: 83-26-1

HSDB Number: 1756

RTECS Number: NK6300000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154; UN2588 (Pesticides, solid, toxic, n.o.s.)/151

EC Number: 201-462-8 [*Annex I Index No.:* 606-016-00-X]

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Agricultural Chemical, Environmental hazard.

Hazardous to aquatic life or environment, with possible long lasting effects[291]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T, N; Risk phrases: R25 R48/25; R50/53; Safety phrases: S1/2; S29/35; S37; S45; S60; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to waters.

Description: Pindone is a bright yellow crystalline solid or powder. May turn yellow-brown on contact with air. Nearly odorless. Molecular weight = 230.28; Specific gravity (H_2O:1) = 1.06 @ 25°C; Boiling point = 178°C (decomposes); Melting/Freezing point = 105−110°C; 205−210°C (Na salt). Practically insoluble in water; solubility = 0.002% @ 25°C.

Potential Exposure: Pindone is used as an anticoagulant and rodenticide. A potential danger to those involved in manufacture, formulation and application of this chemical.

Incompatibilities: Ketone substances are incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, nitrated amines; azo, diazo, azido compounds, carbamates, organic cyanates.

Permissible Exposure Limits in Air:

NIOSH IDLH = 100 milligram per cubic meter

OSHA PEL: 0.1 milligram per cubic meter TWA

NIOSH REL: 0.1 milligram per cubic meter TWA

ACGIH TLV[1]: 0.1 milligram per cubic meter TWA

Protective Action Criteria (PAC) not available

Australia: TWA 0.1 milligram per cubic meter, 1993; Belgium: TWA 0.1 milligram per cubic meter, 1993; Denmark: TWA 0.1 milligram per cubic meter, 1999; France: VME 0.1 milligram per cubic meter, 1999; Norway: TWA 0.1 milligram per cubic meter, 1999; Switzerland: MAK-W 0.1 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 0.1 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 0.1 milligram per cubic meter. Several states have set guidelines or standards for pindone in ambient air[60] ranging from 1.0−3.0 μ/m^3 (North Dakota) to 1.6 μ/m^3 (Virginia) to 2.0 μ/m^3 (Connecticut and Nevada).

Determination in Air: No method available.

Routes of Entry: Inhalation, ingestion.

Harmful Effects and Symptoms

Short Term Exposure: Nosebleeds (epostaxis), excessive bleeding of minor cuts and bruises; smoky urine; black tarry stools; abdominal and back pain. Reduced blood-clotting which leads to hemorrhaging; symptoms resembling warfarin: depressed formation of prothrombin and capillary fragility; leading to hemorrhages.

Points of Attack: Blood prothrombin.

Medical Surveillance: NIOSH lists the following tests: blood plasma, Prothrombin Time; CBC; urinalysis (routine), red blood cells/count.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 0.5 milligram per cubic meter:* Qm (APF = 25) (any quarter-mask respirator). *Up to 1 milligram per cubic meter*: 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *Up to 2.5 milligram per cubic meter:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *Up to 5 milligram per cubic meter:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 100 milligram per cubic meter:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in a refrigerator or a cool, dry place.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN2588 Pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25meters/75 feet.(NJ). Isolation Distance, Fire: 800 meters/ 0.5 miles[70]. Remove all sources of ignition and dampen spilled material with 60%−70% ethanol to avoid airborne dust, then transfer material to a suitable container. Wash surfaces well with soap and water. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include oxides of carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Use a licensed professional waste disposal service to dispose of this material. Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed[22]. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (80); (100).

Piperazine P:0770

Formula: $C_4H_{10}N_2$; $C_4H_{12}Cl_2N_2$; $C_4H_{10}N_2 \cdot 2HCl$; $C_4H_{10}N_2$ Hcl (monochloride)

Synonyms: Antiren; *N*,*N*-Diethylene diamine; 1,4-Diethylenediamine; Dihydrochloride salt of diethylenediamine; Dispermine; Dowzene; Hexahydro-1,4-diazine; Hexahydropyrazine; Lumbrical; Piperazidine; Piperazin (German); Piperazine dihydrochloride; Piperazine hydrochloride; Pyrazine hexahydride

CAS Registry Number: 110-85-0; 142-64-3 (hydrochloride)

HSDB Number: 1093

RTECS Number: TK7800000; TL4025000 (hydrochloride)

UN/NA & ERG Number: UN2579/153

EC Number: 203-808-3 [*Annex I Index No.:* 612-057-00-4]; 205-551-2 [*Annex I Index No.:* 612-241-00-4] (hydrochloride)

Regulatory Authority and Advisory Information

Hazard Alert: Flammable, Primary irritant (w/o allergic reaction), Sensitization hazard (skin, resp.), Suspected of causing genetic defects, Suspected reprotoxic hazard, Environmental hazard, Agricultural chemical.

Banned or Severely Restricted (several countries) (UN)[13]

Canada, WHMIS, Ingredients Disclosure List Concentration 0.1%, piperazine and piperazine dihydrochloride.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: Xn, C, Xi; Risk phrases: R34; R36/37/38; R42/43; R62; R63; Safety phrases: S1/2; S22; S26; S36/37/39; S45; (*hydrochloride*): Hazard Symbol: Xn, C, N; Risk phrases: R10; R36/38; R42/43; R62; R63; R52/53; R62; Safety phrases: S1/2; S22; S29/35; S36/37; S45; S61; S63; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Piperazine and piperazine dihydrochloride are white to cream-colored needles or powder. Characteristic ammonia-like odor. Combustible solids that do not easily ignite. Molecular weight = 86.16 (piperazine); 159.08 (dihydrochloride); Specific gravity (H_2O:1) = 1.1 @ 20°C; Boiling point = 146°C; Freezing/Melting point = 106°C; 335°C (*dihydrochloride*); Flash point = 87.8°C. Explosive limits: LEL: 40,000 ppm, UEL: unknown. Hazard Identification (based on NFPA-704 M Rating System): (*piperazine*) Health 3, Flammability 2, Reactivity 0. Soluble in water.

Potential Exposure: (Piperazine): Primary irritant (w/o allergic reaction), (dihydrochloride) Agricultural chemical, Suspected reprotoxic hazard. Piperazine is used to manufacture anthelmintics, antifilarials, antihistamines, and tranquilizers; the dihydrochloride is used in the manufacture of fibers, pharmaceuticals and insecticides. They are used as an intermediate in the manufacture of, pesticides, rubber chemicals and fibers. Also, piperazine is widely available, effective, and safe when used on an occasional basis against ascaride infections. It is also considerably cheaper than other anthelminthic drugs. In some countries where ascariasis is not endemic and where piperazine was used predominantly for the treatment of pinworn, it has been withdrawn from use on the grounds that other effective drugs are now available. Clinical dosages occasionally induce transient neurological signs and, in some circumstances, the drug may generate small amounts of *nitrosamine* in the stomach, which at considerably greater dosage in experimental animals has been demonstrated to have a carcinogenic potential.

Incompatibilities: Aqueous solution is a strong base. Violent reaction with strong oxidizers and dicyanofurazan. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, nitrogen compounds, carbon tetrachloride. Attacks aluminum, copper, nickel, magnesium and zinc.

Permissible Exposure Limits in Air:

ACGIH TLV (*piperazine and piperazine dihydrochloride*): *2010 Notice of intended change*: 0.1 milligram per cubic meter measured as inhalable fraction and vapor TWA; Danger os sentitization; not classifiable as a human carcinogen

NIOSH REL (*dihydrochloride*): 5 milligram per cubic meter TWA

110-85-0

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 0.09 milligram per cubic meter

PAC-2: 8.9 milligram per cubic meter

PAC-3: 54 milligram per cubic meter

DFG MAK (*piperazine*): Danger of skin and airway sensitization.

Denmark: TWA 0.1 ppm (0.35 milligram per cubic meter), 1999; Norway: TWA 0.1 ppm (0.3 milligram per cubic meter), 1999; Sweden: NGV 0.1 ppm (0.3 milligram per cubic meter), KTV 0.3 ppm (1 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 0.1 milligram per cubic meter, 2003.

dihydrochloride

OSHA PEL: None

NIOSH REL: 5 milligram per cubic meter TWA

ACGIH TLV[1]: 5 milligram per cubic meter TWA

DFG MAK: Danger of skin and airway sensitization; No numerical value established. Data may be available.

Australia: TWA 5 milligram per cubic meter, 1993; Belgium: TWA 5 milligram per cubic meter, 1993; Denmark: TWA 5 milligram per cubic meter, 1999; France: VME 5 milligram per cubic meter, 1999; Switzerland: MAK-W 5 milligram per cubic meter, 1999; United Kingdom: TWA 5 milligram per cubic meter, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 5 milligram per cubic meter, 2003.

Determination in Air: No method available.

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Piperazine can affect you when breathed in and by passing through your skin. Piperazine is a corrosive chemical and eye contact can cause severe irritation and burns. Skin contact can cause irritation or a skin allergy, with rash at even very low exposure levels. Exposure can cause a lung allergy to develop, with cough and wheezing triggered by even low exposures. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. High exposures can cause weakness, tremors, visual changes and trigger seizures. It can also interfere with the ability of the blood to carry oxygen; causing headaches, dizziness and cyanosis, a bluish color to the skin and lips.

Long-Term Exposure: Repeated exposure to piperazine dihydrochloride can cause skin sensitization and asthma-like allergy.

Points of Attack: Lungs, skin.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Lung function tests. These may be normal if the person is not having an attack at the time of the test. Blood methemoglobin level. Evaluation by a dermatologist and/or a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water, or milk. Do not induce vomiting. Medical observation is

recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Note to Physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures *over 5 milligram per cubic meter*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece respirator with a high efficiency particulate filter. Greater protection is provided by a powered-air purifying respirator. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Piperazine must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates), since violent reactions occur. Sources of ignition, such as smoking and open flames, are prohibited where piperazine is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Store in tightly closed containers in a cool, well-ventilated area. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN2579 Piperazine, Hazard class: 8; Labels: 8-Corrosive material.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Piperazine is a combustible solid. Thermal decomposition products may include oxides of nitrogen and carbon. The monochloride or hydrochloride will also produce hydrogen chloride. Use dry chemical, water spray; or alcohol foam extinguishers. Piperazine dihydrochloride may burn, but does not readily ignite. Extinguish fire using an agent suitable for type of surrounding fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Piperazine Dihydrochloride, Trenton, NJ (September 2004)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Piperazine, Trenton, NJ (April 2004)

Piperidine P:0780

Formula: $C_5H_{11}N$

Synonyms: Azacyclohexane; Cyclopentimine; Cypentil; Hexahydropyridine; Hexazane; Pentamethyleneimine; Peperidin (German)

CAS Registry Number: 110-89-4

HSDB Number: 114

RTECS Number: TM3500000

UN/NA & ERG Number: UN2401/132

EC Number: 203-813-0 [*Annex I Index No.:* 613-027-00-3]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration). (≥1.00% concentration).

Hazard Alert: Corrosive, Highly flammable, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction), Environmental hazard.

List 1, DEA chemical code 2704 (Title 21 CFR1310.02)

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 15,000 lb (6810 kg)

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 1000 lb (454 kg)

Hazardous to aquatic life or environment, with possible long lasting effects[194]. Harmful to aquatic life with long lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: F+, T, C, N; Risk phrases: R11; R16; R23/24; R34; R48/21/22; R60; R61; R62; R63; Safety phrases: S1/2; S16; S21; S26; S27; S29; S41; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Piperidine is a clear, colorless liquid. Pepper, ammonia or amine odor. Molecular weight = 85.17; Boiling point = 106°C; Specific gravity (H_2O:1) = 0.87 @ 20°C; Freezing/Melting point = −9°C; Vapor pressure = 40mm Hg @ 29°C; Flash point = 2.8°C. Explosive limits: LEL: 1.4%, UEL: 10.3%. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 3, Reactivity 0. Soluble in water; forms a strong basic solution.

Potential Exposure: Piperidine is used in agriculture and pharmaceuticals; intermediate for rubber accelerators; as a solvent; as a curing agent for rubber and epoxy resins; catalyst for condensation reactions; as an ingredient in oils and fuels; complexing agent; manufacture of local anesthetics; in analgesics; pharmaceuticals, wetting agents; and germicides; synthetic flavoring. Not registered as a pesticide in the Unied States.

Incompatibilities: Piperidine is a highly flammable liquid. Vapor may form explosive mixture with air (at room temperature). A medium-strong base. Reacts violently with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Piperidine neutralizes acids in exothermic reactions to form salts plus water. May be incompatible with isocyanates, halogenated organics, peroxides, phenols (acidic), epoxides, anhydrides, and acid halides. Flammable gaseous hydrogen may be generated in combination with strong reducing agents, such as hydrides[101].

Permissible Exposure Limits in Air:

Protective Action Criteria (PAC)* Ver. 29[138]

PAC-1: $\mathbf{6.6}_{\mathbf{A}}$ ppm

PAC-2: $\mathbf{33}_{\mathbf{A}}$ ppm

PAC-3: $\mathbf{110}_{\mathbf{A}}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

United Kingdom: TWA 1 ppm/3.5 milligram per cubic meter [skin]

Russia[43] MAC (workplace air) 0.2 milligram per cubic meter

Permissible Concentration in Water: Russia[43] set a MAC in water bodies used for domestic purposes of 0.06 mg/L.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Corrosive to the eyes, skin, and respiratory tract. Sore throat, coughing, labored breathing; and dizziness occur after inhalation. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Exposure may cause increased blood pressure. May cause permanent injury after short exposure to small amounts. Ingestion may involve both irreversible and reversible changes. 30−60 mg/kg may cause symptoms in humans. Symptoms upon oral administration include weakness, nausea, vomiting, salivation, labored respiration; muscular paralysis; and asphyxiation. Redness, pain, and burns occur upon contact with skin.

Long-Term Exposure: Irritating substances may cause lung irritation; bronchitis may develop. Prolonged or repeated exposures may affect the liver and kidneys.

Points of Attack: Lungs, blood, liver, kidneys.

Medical Surveillance: Monitor blood pressure. Lung function tests. Liver and kidney function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: (1) Color code-White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location; keep acids away from bases and red, yellow, and blue-coded chemicals. (2) Color code-Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area away from oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN2401 Piperidine, Hazard Class: 8; Labels: 8-Corrosive material, 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Shut off ignition sources; no flares, smoking, or flames in hazard area. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors; do not get water inside container. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills:* dike far ahead of spill for later disposal. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a highly flammable liquid. Thermal decomposition products may include oxides of nitrogen and carbon. *Small fires:* dry chemical, carbon dioxide; water spray; or alcohol foam. *Large fires:* water spray, fog, or alcohol foam. Move container from fire area if you can do it without risk. Do not get water inside container. Cool containers that are exposed to flames with water from the side until well after fire is out. Withdraw immediately in case of rising sound from venting safety device or any discoloration of tank due to fire. Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low area. Wear self-contained (positive pressure if available) breathing apparatus and full protective clothing. Isolate for ½ mile in all directions if tank car or truck is involved in fire. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Piperidine, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

(173); (101); (138).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Piperidine, Trenton, NJ (September, 1999).

Pirimicarb P:0785

Formula: $C_{11}H_{18}N_4O_2$

Synonyms: Abol; Aficida; Aphox; Carbamic acid, dimethyl-, 2-(dimethylamino)-5,6-dimethyl-4-pyrimidinyl ester; 2-Dimethylamino-5,6-dimethyl-4-pyrimidinyl dimethylcarbamate; 2-(Dimethylamino)-5,6-dimethyl-4-pyrimidinyldimethylcarbamate; 2-Dimethylamino-5,6-di methylpryimidin-4-yl *N,N*-dimethylcarbamate; Dimethyl carbamic acid 2-(dimethylamino)-5,6-dimethyl-4-pyrimidinyl ester; 5,6-Dimethyl-2-dimethylamino-4-pyrimidinyldimethylcarbamate; ENT 27,766; Fernos; Pirimikarb; Pirimor; PP 062; Pyrimor; Rapid

CAS Number: 23103-98-2

RTECS Number: EZ9100000

HSDB Number: 7005

UN/NA & ERG Number: UN2757 (carbamate pesticides, solid, toxic)/151; UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 245-430-1 [*Annex I Index No.:* 006-035-00-8]

Regulatory Authority and Advisory Information

Carcinogenicity[83]: EPA, Likely to be carcinogenic to humans.

California Proposition 65 Chemical[102]: Cancer, 7/1/2008

Hazard Alert: Poison, Possible neurotoxic effects (dimethyl carbamate), Suspected reprotoxic hazard, Environmental hazard, Agricultural chemical.

Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T, N; Risk phrases: R45; R25; R33; R50/53; Safety phrases: S1/2; S23; S29; S37; S45; S60; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Colorless crystalline solid. Odorless. Commercial product may be available as a liquid. Molecular weight = 238.39; Specific gravity (H_2O:1) = 1.21 @20°C; Boiling point = 370°C; Freezing/Melting point = 90.5°C. Vapor pressure = 9×10^{-6} mmHg @ 25°C; Flash point = 180°C. Soluble in water; solubility = 3 g/L. Physical and toxicological properties may be affected by carrier solvents in commercial formulations.

Potential Exposure: Primicarb is a carbamate (N-methyl) insecticide. Originally registered in the United States for non-food use on alfalfa grown for seed in selected. Elsewhere it is used on a wide range of cereals, potatoes, fruits, vegetables and other crop.

Incompatibilities: May react with strong oxidizers such as chlorates, peroxides, and nitrates. May form explosive materials with phosphorus pentachloride.

Determination in Water: FDA Method 232.4. Organophosphorous Residues General Methods for Nonfatty Foods Using Acetone Extraction and Isolation in Organic Phase. No detection limit. FDA Method 242.1. Organonitrogen Residues General Method for Nonfatty Foods Including Acetone Extraction and Isolation in Organic Phase. No detection limit. Octanol-water coefficient: Log $K_{ow} = <1.75$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Skin absorption, ingestion and inhalation

Harmful Effects and Symptoms

Short-Term Exposure: Eye pupils are small, blurred vision, eye watering, runny nose, cough, shortness of breath, salivation, nausea, stomach cramps, diarrhea, and vomiting, increased blood pressure, profuse sweating, hypermotility, hallucinations, agitation, tingling of the skin, slow heartbeat, convulsions, fluid in lungs, loss of consciousness, incontinence, breathing stops, death. Carbamates inhibit the acetylcholinesterase enzymes and alter the way in which nervous impulses are transmitted. However, within several hours carbamates spontaneously detach from the enzymes. LD_{50} (oral, rat) = 100−145 mg/kg; LD_{50} (dermal, rat) = >500[83]

Long-Term Exposure: A potent acetylcholinesterase (AChE) inhibitor; cumulative effect is possible. Neutoxic. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, CNS, cardiovascular system, skin, eyes, plasma and red blood cell cholinesterase

Medical Surveillance: Medical observation is recommended for 24−48 hours following breathing overexposure, as pulmonary edema may be delayed. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. Routine biological monitoring of pesticide applicators and field workers includes testing of plasma and red blood cell acetylcholinesterase levels (for enzyme poisoned by this chemical). These tests are normally accurate only if done within about 2 hours of exposure. If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When acetylcholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving carbamate pesticides is recommended until enzyme levels recover. Do not drink any alcoholic beverages before or during use. Also consider CBC and chest X-ray following acute overexposure

First Aid: Speed in removing material from eyes and skin is of extreme importance. Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of dermal and/or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. DuPont Tychem suit fabrics[88] All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust -proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: SCBA >0.51 milligram per cubic meter NIOSH: *At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000): (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus). *Escape*: GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front -or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code-Blue: Health Hazard/Poison. Store in a secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong alkalis (such as sodium hydroxide and sodium bicarbonate). Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25meters/75 feet.(NJ). Isolation Distance, Fire: 800 meters/0.5 miles[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Increase, in the downwind direction, as necessary. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Stop leak if you can do it without risk. Prevent entry into waterways, sewers, basements or confined areas. Cover with plastic sheet to prevent spreading. Absorb or cover with dry earth, sand or other non-combustible material and transfer to containers. Do not allow water to get inside containers.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen and carbon. *On small fire*, use dry chemical powder, carbon dioxide, water spray, or foam. *On large fire*, use water spray, fog or alcohol-resistant foam. Do not scatter material using straight water jet streams. Dike fire control water for later disposal; do not scatter the material. Move containers from fire area if you can do it without risk. *Fire involving storage or vehicular tanks:* Isolate for 800 meters/0.5 mile in all directions; also, consider initial evacuation for 800 meters/0.5 mile in all directions. Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Do not allow water to get inside containers. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. *Always* stay away from tanks engulfed in fire. For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies.

Disposal Method Suggested: Do not discharge into drains or sewers. Dispose of waste material as hazardous waste using a licensed disposal contractor to an approved landfill. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Incineration with effluent gas scrubbing is recommended. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(102); (31); (173); (101); (138); (100).

United States Environmental Protection Agency, Office of Pesticide Programs, "Pesticide Fact Sheet: Pirimicarb," http://www.epa.gov/opprd001/factsheets/pirimicarb.pdf

Pesticide Management Education Program, "Pirimicarb (Pirimor) Chemical Profile 4/85," Cornell University, Ithaca, NY (April 1985). http://pmep.cce.cornell.edu/profiles/insect-mite/mevinphos-propargite/pirimicarb/insect-prof-pirimicarb.html

New Jersey Department of Health and Senior Services, "Hazardous Substance Fact Sheet: Pirimicarb," Trenton NJ (March 1989, rev. January 2001). http://www.state.nj.us/health/eoh/rtkweb/1544.pdf

Pirimifos-ethyl P:0790

Formula: $C_{13}H_{24}N_3O_3PS$

Synonyms: *O*-[2-(Diethylamino)-6-methyl-4-pyrimidinyl] *O*,*O*-diethyl phosphorothioate; 2-Diethylamino-6-methylpyrimidin-4-yl diethylphosphorothionate; *O*,*O*-Diethyl

O-(2-diethylamino-6-methyl-4-pyrimidinyl) phosphorothioate; Diethyl *O*-(2-diethylamino-6-methyl-4-pyrimidinyl) phosphorothioate; Diethyl 2-dimethylamino-4-methylpyrimidin-6-yl phosphorothionate; Ethyl pirimiphos; Fernex; Phosphorothioic acid, *O*-[2-(diethylamino)-6-methyl-4-pyrimidinyl] *O*,*O*-diethyl ester; PP211; Primicid; Primifosethyl; Primotec; Prinicid; R 42211; Solgard

CAS Registry Number: 23505-41-1

HSDB Number: 6454

RTECS Number: TF1610000

UN/NA & ERG Number: (PIH) UN3278 (organophosphorus compound, liquid, toxic n.o.s.)/151

EC Number: 245-704-0 [*Annex I Index No.:* 015-099-00-6]

Regulatory Authority and Advisory Information

Hazard Alert: Poison inhalation hazard, Neurotoxin (cumulative), Combustible, Suspected of causing genetic defects, Environmental hazard.

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 1000 lb (454 kg)

United States DOT Regulated Marine Pollutant (49CFR172.101, appendix B), severe pollutant

United States DOT 49CFR172.101, Inhalation Hazard Chemical as organophosphates.

Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T, N; Risk phrases: R21; R25; R33; R50/53; Safety phrases: S1/2; S23; S29, S36/37; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)]

Description: Pirimifos-ethyl is a straw-colored liquid. Molecular weight = 333.43; It decomposes @ 130°C; no boiling point can be determined; Vapor pressure = 0.0003 mmHg. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 1. Decomposes in water.

Potential Exposure: A potential danger to those involved in the manufacture, formulation and application of this organophosphate soil insecticide.

Permissible Exposure Limits in Air:

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 2.3 milligram per cubic meter

PAC-2: 25 milligram per cubic meter

PAC-3: 28 milligram per cubic meter

Determination in Water: Log $K_{ow} = >4.5$. Values above 3.0 are likely to bioaccumulate in aquatic organisms. Fish Tox = 1.70268000 ppb MATC (HIGH).

Routes of Entry: Inhalation, ingestion; skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: As with other organophosphorus pesticides, symptoms are secondary to cholinesterase inhibition: headache, giddiness; blurred vision; nervousness, weakness, nausea, cramps, diarrhea, and discomfort in the chest. Other signs include sweating, tearing, salivation, vomiting, cyanosis, convulsions, coma, loss of reflexes and loss of sphincter control.

Long-Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, CNS; cardiovascular system, skin, eyes, plasma and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also consider CBC. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All

protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code -Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area away from oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN3278 Organophosphorus compound, liquid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required, Potential Inhalation Hazard (Special Provision 5).

Spill Handling:

Initial isolation and protective action distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.3/0.4
Night 0.8/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 600/200
Then: Protect persons downwind (miles/kilometers)
Day 1.6/2.6
Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. As with other organophosphorus pesticides, stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills:* dike far ahead of spill for later disposal. Remove all ignition sources. Ventilate area of spill or leak. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material may burn, but does not ignite readily. Thermal decomposition products may include oxides of nitrogen, phosphorus, sulfur and carbon. For small fires, use dry chemical, carbon dioxide; water spray; or foam. For large fires, use water spray, fog, or foam. Stay upwind; keep out of low areas. Move containers from fire area if you can do it without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Pirimiphos-Ethyl, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

Pirimiphos-methyl P:0791

Formula: $C_{11}H_{20}N_3O_3PS$

Synonyms: Actellic; Actellifog; AI3-27699; Blex; Caswell No. 334B; *O*-[2-(Diethylamino]-6-methyl-4-pyrimidinyl) *O*, *O*-dimethyl phosphorothioate; *O*-(2-Diethylamino-6-methylpyrimidin-4-yl) *O,O*-dimethyl phosphorothioate; *O*-[2-(Diethylamino)-6-methyl-4-pyrimidinyl]-*O,O*-dimethyl phosphorothioate; 2-Diethylamino-6-methylpyrimidin-4-yl dimethyl phosphorothionate; *O,O*-Dimethyl-*O*-[2-(diethylamino)-6-methyl-4-pyrimidinyl]; *O,O*-Dimethyl *O*-[2-(diethylamino)-6-methyl-4-pyrimidinyl]phosphorothioate; ENT 27699GC; Dominator ear tag; Double barrel ear tag; Methylpirimiphos; Methylpyrimiphos; Phosphorothioic acid, *O*-[2-(diethylamino)-6-methyl-4-pyrimidinyl] *O,O*-dimethyl ester; Plant protection PP511; PP511; 4-Pyrimidinol, 2-(diethylamino)-6-methyl-, *O*-ester with *O,O*-dimethyl phosphorothioate; Pyridimine phosphate; Silosan; Sybol; Tomahawk

CAS Number: 29232-93-7

HSDB Number: 6984

RTECS Number: TF1410000

UN/NA & ERG Number: UN2783 (organophosphorus pesticide, solid, n.o.s.)/152; UN3018 (organophosphorus pesticide, liquid, toxic)/152

EC Number: 249-528-5 [*Annex I Index No.*:015-134-00-5]

Regulatory Authority and Advisory Information

Carcinogenicity[83]: EPA, Not yet determined

Hazard Alert: Poison, Neurotoxin (cumulative), Suspected of causing genetic defects, Reproduction Hazard, Sensitization hazard, Environmental hazard.

DOT Inhalation Hazard Chemicals as organophosphates

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%

Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: Xn, N; Risk phrases: R22; R33; R50/53; Safety phrases: S2; S29; S41; S42/43; S60; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to waters

Description: Light yellow, straw colored, or amber oily liquid. Odorless when pure. Molecular weight = 305.33; 274.4; Specific gravity (H_2O:1) = 1.17 @ 20°C; Freezing/Melting point = 21°C; Boiling point = (decomposes) 387°C; Specific gravity (H_2O:1) = 1.157 @ 30 mmHg; Vapor pressure = 3.8×10^{-6} mmHg @ 25°C; Flash point = 45°C. Henry's Law constant = 6.0×10^{-7} atm-m^3/mol @ 25°C (est)[83]. Slightly soluble in water; solubility = ~15 mg/L @ 25°C.

Potential Exposure: Pirimiphos-methyl is a post -harves organophosphate insecticide/acaricide used to control a variety of insects in stored grain products and seed such as corn, rice, wheat and sorghum. It is also incorporated into cattle ear tags, and used for the fogging treatment of iris bulbs and preharvest cleanup of fruits and vegetables.

Incompatibilities: May react violently with antimony(V) pentafluoride. Incompatible with strong acids and alkalies, lead diacetate, magnesium, silver nitrate. In the presence of strong reducing agents such as hydrides, organophosphates form highly toxic and flammable phosphine gas. Contact with oxidizers can cause the release of toxic oxides of phosphorus.

Determination in Air: OSHA versatile sampler-2; Toluene/Acetone; Gas chromatography/Flame ionization detection; NIOSH IV, Method #5600, Organophosphorus Pesticides[18].

Determination in Water: Octanol-water coefficient: Log K_{ow} = >4.0. Values above 3.0 are likely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion, through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Eye pupils are small; blurred vision; eye watering; runny nose; cough; shortness of breath; salivation; dizziness; nausea, stomach cramps, diarrhea, and vomiting; increased blood pressure; profuse sweating; hypermotility, hallucinations; irritability; tingling of the skin; drowsiness; slow heartbeat; convulsions; fluid in lungs; loss of consciousness; incontinence; breathing stops; death. Organophosphates inhibit the action of acetylcholinesterase enzymes, and alter the way in which nervous impulses are transmitted. The effects can last for hours, days, or much longer. The action of the enzymes is reestablished after new enzymes are formed. LD_{50} (oral, rat) = 1200−1400 mg/kg; LD_{50} (dermal, rat) = >1900 mg/kg.

Long-Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. Organophosphates may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage. May cause contact dermatitis.

Points of Attack: Respiratory system, skin, CNS, cardiovascular system, blood cholinesterase. Evaluation by a qualified allergist, including exposure history and testing, may help diagnose allergy.

Medical Surveillance: Medical observation is recommended for 24−48 hours following breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic might consider administering a drug or other inhalation therapy.

Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. Routine biological monitoring of pesticide applicators and field workers includes testing of plasma and red blood cell acetylcholinesterase levels (for enzyme poisoned by this chemical). These tests are normally accurate only if done within about 2 hours of exposure. If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When acetylcholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate pesticides is recommended until enzyme levels recover. Do not drink any alcoholic beverages before or during use as it promotes absorption of organophosphates. Evaluation by a qualified allergist, including exposure history and testing, may help diagnose allergy. In addition to comprehensive initial medical and work histories emphasizing reproductive experience and menstrual history, patient should have physical examination and testing of genito-urinary tract, sperm count, motility and morphology. If required, other tests, such as serum testosterone, serum follicle-stimulating hormone (FSH), and serum lutenizing hormone (LH), may be indicated.

First Aid: Speed in removing material from eyes and skin is of extreme importance. Eye contact can cause dangerous amounts of these chemicals to be quickly absorbed through the mucous membrane into the bloodstream. Immediately and gently flush eyes with plenty of warm or cold water (NO hot water) for at least 15 minutes, occasionally lifting the upper and lower eyelids. Get medical aid immediately. *Skin:* Get medical aid. Dermal contact can cause dangerous amounts of these chemicals to be absorbed into the bloodstream. Wearing the appropriate PPE equipment and respirator for organophosphate pesticides, immediately flush skin with plenty of soap and water for at least 15 minutes while removing contaminated clothing and shoes. Shampoo hair promptly if contaminated. *Ingestion:* Call poison control. Loosen all clothing. Never give anything by mouth to an unconscious person. Get medical aid. Do NOT induce vomiting. *If conscious, alert, and able to swallow, rinse mouth and have victim drink 4−8 ounces of water do NOT induce vomiting but immediately administer slurry of activated charcoal (2 oz in 8 oz of water). If victim is *unconscious or having convulsions,* do nothing except keep victim warm. **In some cases you may be specifically instructed by poison control to induce vomiting by way of 2 tablespoons of syrup of ipecac (adult) washed down with a cup of water.* Do NOT give activated charcoal before or with ipecac syrup. *Inhalation:* Get medical aid. Do not contaminate yourself. Wearing the appropriate PPE equipment and respirator for organophosphate pesticides, immediately remove the victim from the contaminated area to fresh air. If the victim is not breathing, administer artificial respiration. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. If breathing is difficult, administer oxygen through bag/mask apparatus until medical help arrives. Do not leave victim unattended
Note to physician or authorized medical personnel. Administer atropine, 2 mg (1/30 gr) intramuscularly or intravenously as soon as any local or systemic signs or symptoms of an intoxication are noted; repeat the administration of atropine every 3 to 8 minutes until signs of atropinization (mydriasis, dry mouth, rapid pulse, hot and dry skin) occur; initiate treatment in children with 0.05 mg mg/kg of atropine; repeat at 5 to 10 minute intervals. Watch respiration, and remove bronchial secretions if they appear to be obstructing the airway; intubate if necessary. *Notes to physician or authorized medical personnel*: *N*-methylpyridinium-2-aldoxime (2-PAMCI) when used in conjunction with atropine reacts with the phosphorylated cholinesterase, thereby restoring normal activity to by removing the phosphorylating group. The combination of these two chemicals is synergistic and must be administered within minutes to a few hours following exposure (depending on the specific agent) to be effective. Give 2-PAMCI (Pralidoxime; Protopam), 2.5 gm in 100 mL of sterile water or in 5% dextrose and water, intravenously, slowly, in 15−30 minutes; if sufficient fluid is not available, give 1 gm of 2-PAMCI in 3 mL of distilled water by deep intramuscular injection; repeat this every half hour if respiration weakens or if muscle fasciculation or convulsions recur. Also Diazepam, an anticonvulsant, might be considered

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of dermal and/or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. One recommendation is the use of DuPont Tychem suit fabrics[88] All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Engineering controls should be used wherever feasible to maintain airborne concentrations of this chemical below the prescribed exposure limit. Respirators and protective equipment are less effective than engineering controls, and should be used only in nonroutine or emergency situations which may result in exposure concentrations in excess of the TWA environmental limit. *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode).

Storage: Color code-Blue: Health Hazard/Poison. Store at 2−8°C in a secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Where possible, automatically transfer material from other storage containers to process containers. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN2783 Organophosphorus pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN3018 Organophosphorus pesticides, liquid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling:

Initial isolation and protective action distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.3/0.4
Night 0.8/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 600/200
Then: Protect persons downwind (miles/kilometers)
Day 1.4/2.3
Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Do not touch spilled material. Do not breathe vapors. Stay upwind; keep out of low areas. Remove all ignition sources. Ventilate area of spill or leak. This material is a combustible liquid. For a spill or leak of a combustible liquid, shut off ignition sources; no flares, smoking or flames in hazard area. Stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Decomposes >120°C. Thermal decomposition products may include oxides of phosphorus, sulfur, nitrogen and carbon. May be fatal if inhaled, ingested or absorbed through skin. Inhalation or contact with some of these materials will irritate or burn skin and eyes. Vapors may cause dizziness or suffocation. *Small fires:* dry chemical, carbon dioxide; water spray; or foam. *Large fires:* water spray, fog, or foam. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Firefighting gear (including SCBA) may not provide adequate protection. If exposure occurs, remove and isolate gear immediately and thoroughly decontaminate personnel. Wear positive pressure breathing apparatus and special protective clothing. Remove and isolate contaminated clothing at the site. Move container from fire area if you can do so without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Destruction by alkali hydrolysis or incineration. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Office of Pesticide Programs, Pesticide Residue Limits, *Pirimiphos-methyl,* 40 CFR 180.409, http://www.epa.gov/pesticides/food/viewtols.htm

International Programme on Chemical Safety (IPCS), *Data Sheets on Pesticides, Pirimiphos-methyl*, Geneva, Switzerland (January 1983). http://www.inchem.org/documents/pds/pds/pest49_e.htm

Pesticide Management Education Program, *Pirimiphos-methyl (Actellic) Chemical Fact Sheet: 6/85,* Cornell

University, Ithaca, NY (June 1985), http://pmep.cce.cornell.edu/profiles/insect-mite/mevinphos-propargite/pirimiphos-methyl/insect-prof-actellic.html

United States Environmental Protection Agency, *Interim Reregistration Eligibility Decision (IRED) Facts, Pirimiphos-Methyl*, Office of Prevention, Pesticides and Toxic Substances, Washington, DC (January 2003). http://www.epa.gov/REDs/factsheets/pirimiphosmethyl_ired_fs.htm

Platinum P:0800

Formula: Pt

Synonyms: Elemental platinum; Platin (German); Platinum black

CAS Registry Number: 7440-06-4 (platinum metal)

HSDB Number: 6479

RTECS Number: TP2160000 (Platinum metal)

UN/NA & ERG Number: Metal powder, in bulk, may be pyrophoric: UN3089

EC Number: 231-116-1

Regulatory Authority and Advisory Information

Hazard Alert:Flammable solid (powder/dust), Pyrophoric (powder in bulk), Known catalytic activity; Possible risk of forming tumors.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0% platinum elemental

Hazard Symbols, Risk & Safety statements: Hazard Symbol: F (dust/powder); Risk phrases: R10; R17; R18; Safety phrases: S21 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): Non hazard to water. (*metal* size >1mm)

Description: Platinum is a soft, ductile, malleable, silver-white metal. It is found in the metallic form and as the arsenide, sperrylite. It forms complex soluble salts, such as Na_2PtCl_6. It also forms halides. Metallic platinum is insoluble in water. Platinum(IV) chloride is red-brown crystals or powder. Molecular weight = 195.09; 336.89 [Platinum(IV) chloride] Freezing/Melting point = (decomposes) 370°C. Soluble in water.

Potential Exposure: Platinum and its alloys have high electrical conductivity and excellent catalytic properties. They are used in relays, contacts and tubes in electronic equipment, in spark plug electrodes for aircraft; and windings in high-temperature electrical furnaces. Platinum alloys are used for standards for weight, length, and temperature measurement. Platinum and platinum catalysts, for example, hexachloroplatinic acid and H_2PtCl_6, are widely used in the chemical industry in persulfuric, nitric, and sulfuric acid production, in the synthesis of organic compounds and vitamins, and for producing higher octane gasoline. They are coming into use in catalyst systems for control of exhaust pollutants from automobiles. They are used in the equipment for handling molten glass and manufacturing fibrous glass; in laboratory, medical, and dental apparatus; in electroplating; in photography; in jewelry; and in X-ray fluorescent screens. Because platinum complexes are used as antitumor agents, the potential for carcinogenic activity is present; tests to clarify this aspect should be conducted. While low levels of emissions of platinum particulate have been observed from some catalyst-equipped automobiles, the major potential source of Pt is from the disposal of spent catalysts.

Incompatibilities: Dust or powder may form explosive mixture with air. Platinum metal is incompatible with aluminum; acetone, arsenic, ethane, hydrazine, hydrogen peroxide; lithium, phosphorus, selenium, tellurium, various fluorides.

Permissible Exposure Limits in Air:

NIOSH IDLH = 4 mg [Pt]/m^3

OSHA PEL (*soluble salts, as Pt*) 0.002 mg[Pt]/m^3 TWA

NIOSH REL (*metal*): 1 milligram per cubic meter; (*soluble salts, as Pt*): 0.002 mg[Pt]/m^3 TWA

ACGIH TLV[1] (*soluble salts, as Pt*): 1 milligram per cubic meter (metal); 0.002 mg[Pt]/m^3 TWA

7440-06-4

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 3 milligram per cubic meter

PAC-2: 33 milligram per cubic meter

PAC-3: 200 milligram per cubic meter

DFG MAK (*chloroplatinates*): 0.002 mg[Pt]/m^3 Ceiling Concentration (peak should not be exceeded); danger of skin and airway sensitization.

Australia: TWA 1 milligram per cubic meter, 1993; Austria: MAK 1 milligram per cubic meter, 1999; Belgium: TWA 1 milligram per cubic meter, 1993; Finland: TWA 1 milligram per cubic meter, 1999; France: VME 1 milligram per cubic meter, 1999; Hungary: TWA 0.001 milligram per cubic meter; STEL 0.002 milligram per cubic meter, 1993; Norway: TWA 0.002 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 1 milligram per cubic meter, 2003; Switzerland: MAK-W 0.002 mg[Pt]/m^3, 1999; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietman: ACGIH TLV: TWA 1 milligram per cubic meter. Several states have set guidelines or standards for platinum in ambient air[60] ranging from 0.1 μ/m^3 (Nevada) to 0.4–20.0 μ/m^3 (Connecticut) to 10.0 μ/m^3 (North Dakota) to 330.0 μ/m^3 (Virginia).

Determination in Air: Use NIOSH Analytical Method (IV) #7300, #7303, Elements by ICP; #8310, Metals in urine; #8005, Elements in blood or tissue, OSHA Analytical Method ID-121; ID-130-SG; NIOSH II(7), Method S-19, Soluble salts.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Metal dust and fume may cause irritation of the eyes, skin, and respiratory tract. Metal particles in the eye can cause scratching and possible damage. Hazards arise from the dust, droplets, spray, or mist of complex salts of platinum, but not from the metal itself. These salts are sensitizers of the skin, nasal mucosa; and bronchi, and cause allergic phenomena. One case of contact dermatitis from wearing a ring made of platinum alloy is recorded.

Long-Term Exposure: Characteristic symptoms of poisoning occur after 2–6 months' exposure and include pronounced irritation of the throat and nasal passages, which results in violent sneezing and coughing; bronchial irritation, which causes respiratory distress; and irritation of the skin, which produces cracking, bleeding and pain. Respiratory symptoms can be so severe that exposed individuals may develop status asthmaticus. After recovery, most individuals develop allergic symptoms and experience further asthma attacks when exposed to even minimal amounts of platinum dust or mists. Mild cases of dermatitis involve only erythema and urticaria of the hands and forearms. More severe cases affect the face and neck. All pathology is limited to allergic manifestations. EPA research efforts indicate that platinum is more active biologically and toxicologically than previously believed. It methylates in aqueous media, establishing a previously unrecognized biotransformation and distribution mechanism.

Points of Attack: Respiratory system, skin, eyes.

Medical Surveillance: NIOSH lists the following tests: whole blood (chemical/metabolite); biologic tissue/biopsy; urine (chemical/metabolite). In preemployment and periodic physical examinations, the skin, eyes, and respiratory tract are most important. Any history of skin or pulmonary allergy should be noted, as well as exposure to other irritants or allergens, and smoking history. Periodic assessment of pulmonary function may be useful.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When chloroplatinic acid has been swallowed, get medical attention. If victim is *conscious*, administer water, or milk. Do not induce vomiting.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear appropriate splash or dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: (for soluble Pt salts): *Up to 0.05 milligram per cubic meter:* Sa:Cf$^{£}$ (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *Up to 0.1 milligram per cubic meter:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 4 milligram per cubic meter:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full facepiece respirator with an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA). Note: Substance cause eye iritation and damage; eye protection needed.

Storage: UN3089 Color code-Red Stripe: Flammability Hazard: Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8–10 meters or a 1-hour fire wall from flammable or reactive materials. Store flammable solids up to maximum allowable quantity per control area in an approved flammable storage area. Do not store in a basement. UN2507 Color code-White (*chloroplatinic acid*): Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with this chemical, personnel should be trained on its proper handling and storage.

Shipping: UN3089 Metal powders, flammable, n.o.s., Hazard Class: 4.1; Labels: 4.1-Flammable solid.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Platinum powder is a combustible solid. Thermal decomposition products may include metal oxides. Use dry chemicals appropriate for metal fires. *Do not use water*. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Catalyst disposal is expected to be the largest contributor of Pt to the environment. The value of the metal would help to offset the cost of reclaiming the Pt from discarded catalysts. If direct vehicular emissions of Pt are found to be significant, particulate taps, which are available at reasonable cost, may provide a technological solution. In any event, recovery and recycling is the preferred technique for both health and economic reasons. Details of platinum recovery and recycling from plating wastes, platinum metal refinery effluents; spent catalysts and precious metals scrap have been published.

References

(31); (173); (101); (138); (2); (170); (100).

United States Environmental Protection Agency, a Literature Search and Analysis of Information Regarding Uses, Production, Consumption, Reported Medical Cases and Toxicology of Platinum and Palladium, Report PB-238,546, Research Triangle Park, NC (April 1974)

National Academy of Sciences, Medical and Biologic Effects and Environmental Pollutants: Platinum Group Metals, Washington, DC (1977)

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 3, 74–75 (1981)

United States Environmental Protection Agency, Chemical Hazard Information Profile: Platinous Chloride, Washington, DC, Chemical Emergency Preparedness Program (October 31, 1985)

United States Environmental Protection Agency, Chemical Hazard Information Profile: Platinum Tetrachloride, Washington, DC, Chemical Emergency Preparedness Program (October 31, 1985)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Platinum, Trenton, NJ (September 2002)

Polybrominated Biphenyls (PBBs)

P:0810

Formula: $C1_2H_4Br_6$; $Br_3C_6H_2$-$C_6H_2Br_3$

Synonyms: Decabromobiphenyl; Firemaster BP-6; Firemaster FF-1; HBB; NCI-C53634; 2,4,5,2′,4′,5′-Hexabromobiphenyl; PBBs; PBB (BP-6); PBB (FF-1); Polybrominated biphenyl (BP-6); Polybrominated biphenyl (FF-1); Tetrabromo(tetrabromophenyl)benzene

CAS Registry Number: 59536-65-1; 67774-32-7; 36355-01-8 (hexabromobiphenyl); 27858-07-7 (octabromobiphenyl); 59536-65-1 (Firemaster BP-6)

Polybrominated biphenyls category include the following:

p-Bromodiphenyl ether	101-55-3
Decabromobiphenyl	13654-09-6
Decabromodiphenyl ether	1163-19-5
*p,p′*Dibromodiphenyl ether	2050-47-7
Hexabromobiphenyl	59080-40-9
Hexabromo-1,1′-biphenyl	36355-01-8
Hexabromodiphenyl ether	36483-60-0
Nonabromodiphenyl ether	63936-56-1
Octabromobiphenyl	27858-07-7
Octabromobiphenyl	61288-13-9
Octabromodiphenyl ether	32536-52-0
Pentabromodiphenyl ether	32534-81-9
Polybrominated biphenyl	59536-65-1
Polybrominated biphenyl mixture	67774-32-7
Tetrabromodiphenyl ether	40088-47-9
Tribromodiphenyl ether	49690-94-0

HSDB Number: 7064

RTECS Number: DV5330000 (hexabromobiphenyl); LK5060000 (Firemaster BP-6); LK5065000 (Firemaster FF-1)

UN/NA & ERG Number: UN3152 (Polyhalogenated biphenyls, solid)/171; UN3151 (Polyhalogenated biphenyls, liquid)/171

EC Number: 252-994-2 (hexabromobiphenyl); 248-696-7 (octabromobiphenyl or [tetrabromo(tetrabromophenyl)benzene]); 237-137-2 (decabromobiphenyl)

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Human Limited Evidence, animal Sufficient Evidence, *possibly carcinogenic to humans*, Group 2B.

California Proposition 65 Chemical[102]: Cancer 1/1/1988; Reproductive toxin 10/1/1994

Hazard Alert: Exposure can be lethal, Combustible, Endocrine disruptor (high/59536-65-1), Suspected of causing genetic defects, Suspected reprotoxic hazard.

Chemicals Subject to TSCA 12(b) Export Notification Requirements, Section 5: Any combination of the following substances resulting from a chemical reaction (as well as the individual chemicals): Tetrabromodiphenyl ether (CAS:40088-47-9); Pentabromodiphenyl ether (CAS: 32534-81-9); Hexabromodiphenyl ether(CAS: 36483-60-0); Heptabromodiphenyl ether(CAS: 68928-80-3); Octabromodiphenyl ether (CAS: 32536-52-0); Nonabromodiphenyl ether (CAS: 63936-56-1). For details, see the Proposed Significant NewUse Rule (69 FR 70404, December 6, 2004).

Banned or Severely Restricted (Canada, USA) (UN)[13] (Germany, EEC) (UN)[35], and several United States states and DC; others have legislation under consideration.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, N575 (PBBs)

RCRA 40CFR264, appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8080 (50); 8250 (100)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%. CAS 67774-32-7

Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)] [13654-09-6 (deca-); 36355-01-8 (hexa-); 27858-07-7 (octa-)]

List of Stockholm Convention POPs: Annex A (Elimination) *included in the same category are the following: hexabromobiphenyl (CAS 59080-40-9); hexabromobiphenyl ether (CAS 59080-40-9) and heptabromodiphenyl ether (CAS 68928-80-3); Tetrabromodiphenyl ether CAS (40088-47-9); and Pentabromodiphenyl ether (CAS 32534-81-9).*

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T+; Risk phrases: R27/28; R50/53; R62; R63; Safety phrases: S13; S28; S41; S45 (see Appendix 4)

Description: Hexabromobiphenyl is the predominant isomer. These materials are heavy, highly brominated compounds. Typical is hexabromobiphenyl, $Br_3C_6H_2$-$C_6H_2Br_3$: White chalky substance, softens at 72°C. Molecular weight = 627.62; decomposes @ 300° to 400°C. It will be used as an illustrative example of such compounds. PBBs are produced by direct bromination of biphenyl and it could be anticipated that very complex mixtures of compounds differing from each both in number of bromine atoms per molecule and by positional isomerism are formed. The possibility also exists (analogous to the PCBs) that halogenated dibenzofurans, for example, brominated dibenzofurans, may be trace contaminants in certain PBB formulations. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 1, Reactivity 0. Polybrominated diphenylethers (PBDEs), especially p- or o-mixtures of polybrominated diphenyl ethers, which are widely used as flame retardants in various consumer products, including children's clothes, furniture foam and upholstery, curtain materials, mattresses, consumer electronics, and wire insulation. Studies have shown that PBDEs accumulate in the environment and living organisms. These compounds have also been associated with liver toxicity, thyroid toxicity, and neurodevelopmental toxicity in humans[NCSL].

Potential Exposure: The polybrominated biphenyls (PBBs) are inert substances and have been employed, primarily as fire retardants. For example, the PBBs were incorporated into thermoplastics at a concentration of about 15% to increase the heat stability of the plastic to which it is added. In 1973, one to two tons of PBBs, a highly toxic flame retardant, were accidentally mixed into an animal feed supplement and fed to cattle in Michigan. Contamination also resulted from traces of PBBs being discharged into the environment at the manufacturing site and at other facilities involved in handling PBBs. Approximately 250 dairy and 500 cattle farms were quarantined; tens of thousands of swine and cattle and more than one million chickens were destroyed; and lawsuits involving hundreds of millions of dollars were instituted. Before the nature of the contamination was recognized, many of the contaminated animals had been slaughtered, marketed, eaten; and eggs and milk of the contaminated animals were also consumed. Thus, large numbers of people have been exposed to PBBs; they are persistent in the environment and are concentrated in body fat. While commercial manufacture and distribution of PBBs have currently ceased, the full extent of the problem has not yet been assessed.

Incompatibilities: Polybrominated biphenyls (PBBs) are very unreactive. Materials in this category may be incompatible with strong oxidizing (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.; contact may cause fires or explosions) and reducing agents such as hydrides, nitrides, alkali metals, and sulfides. Also, PBBs may be incompatible with various amines, nitrides, azo/diazo compounds, alkali metals, and epoxides. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air:

No standards or Protective Action Criteria (PAC) available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Long-Term Exposure: Confirmed carcinogen. Experimental teratogenic and reproductive effects. Mutation data reported.

Points of Attack: Liver, kidneys, skin.

Medical Surveillance: These chemicals are suspected or confirmed human carcinogens. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Consider the points of attack in preplacement and periodic physical examinations. Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Based on potential carcinogenicity the following is recommended by NIOSH: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA-or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code -Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN3152 Polyhalogenated biphenyls, solid or Polyhalogenated terphenyls, solid, Hazard class: 9; Labels: 9-Miscellaneous hazardous material. UN3151 Polyhalogenated biphenyls, liquid or Polyhalogenated terphenyls, liquid, Hazard class: 9; Labels: 9-Miscellaneous hazardous material.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Flame retardants in this category are of great concern to firefighters. Thermal decomposition products may include highly poisonous bromine compounds and oxides of carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(109); (102); (31); (173);

United States Environmental Protection Agency, Status Assessment of Toxic Chemicals: Polybrominated Biphenyls, Report EPA-600/2-79-210k, Washington, DC (December 1979)

(173); (101); (138).

National Toxicology Program, NTP: Technical Report on the Toxicology and Carcinogenesis Bioassay of Polybrominated Biphenyl Mixture (Firemaster FF-1), Technical Report Series No. 244, NIH Publication No. 82-1800, Research Triangle Park, North Carolina (1982)

National Conference of State Legislatures (NCSL), *State Regulation of Flame Retardants in Consumer Products*, 2015, Washington, DC. http://www.ncsl.org/aboutus.aspx

Polychlorinated Biphenyls (PCBs)

P:0820

Formula: $C_{12}H_{10\text{-}X}Cl_X$

Synonyms: Aroclor; Aroclor 1221; Aroclor 1232; Aroclor 1242; Aroclor 1248; Aroclor 1254; Aroclor 1260; Aroclor 1262; Aroclor 1268; Aroclor 2565; Aroclor 4465; Biphenyl, Chlorinated; 1,1′-Biphenyl, chloro derivs.; Biphenyl, polychloro-; Chlophen; Chlorextol; Chlorinated biphenyl; Chlorinated diphenyl; Chlorinated diphenylene; Chloro biphenyl; Chloro 1,1-biphenyl; Chlorodiphenyl; Clophen; Dykanol; Diphenyl, chlorinated; Fenclor; Inerteen; Kanechlor; Kanechlor 300; Kanechlor 400; Kanechlor 500; Montar; Noflamol; PCB; PCBS; Phenochlor; Phenoclor; Polychlorobiphenyl; Pyralene; Pyranol; Santotherm; Santotherm FR; Sovol; the rminol FR-1

CAS Registry Number: 1336-36-3 (Aroclor PCBs); 53469-21-9; *(alt.)* 11104-29-3 (Aroclor 1242) (42% Cl); 12672-29-6 (Aroclor 1248) (48% Cl); 11097-69-1 (Aroclor 1254) (54% Cl); 11096-82-5 (Aroclor 1260) (60% Cl); 37324-23-5 (Aroclor 1262) (62% Cl); 11100-14-4 (Aroclor 1268) (68% Cl); 55720-99-5 (PCB oxide)

HSDB Number: 3945 (1336-36-3); 6355 (53469-21-9); 6356 (12672-29-6); 6357 (11097-69-1); 1822 (11096-82-5)

RTECS Number: TQ1350000; TQ1356000 (Aroclor 1242) (42% Cl); TQ1358000 (Aroclor 1248) (48% Cl); TQ1360000 (Aroclor 1254) (54% Cl); TQ1362000 (Aroclor 1260) (60% Cl); TQ1364000 (Aroclor 1262) (62% Cl); TQ1366000 (Aroclor 1268) (68% Cl)

UN/NA & ERG Number: UN2315 (liquid)/171; UN3432 (solid)/171

EC Number: 215-648-1 [*Annex I Index No.:* 602-039-00-4] (PCBs)

Regulatory Authority and Advisory Information

Carcinogenicity: (*1336-36-3*): NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Animal Sufficient Evidence; Human Limited Evidence, Group 2A, 1998; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies; NIOSH: Potential occupational carcinogen.

California Proposition 65 Chemical[102]: Cancer 10/1/1989; Reproductive toxin 1/1/1991; (containing ≥60% chlorine by molecular weight) 1/1/1988

Hazard Alert: Poison, Combustible, Endocrine disruptor (high), Environmental hazard. (1336-36-3) Listed for Tier 1 screening as an endocrine disruptor[88].

Chemicals Subject to TSCA 12(b) Export Notification Requirements, Section 6.

Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)] *as PCBs*.

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Aroclor 1242 NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC *(PCB)*: Animal Sufficient Evidence; Human Limited Evidence, Group 2A, 1987; EPA *(PCB)*: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies.

Aroclor 1254 NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; NCI: Carcinogenesis Bioassay (feed); equivocal evidence: rat; IARC *(PCB)*: Animal Sufficient Evidence; Human Limited Evidence, Group 2A, 1987; EPA *(PCB)*: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies. United States Environmental Protection Agency Gene-Tox Program, Negative: Cytogenetics-male germ cell; Rodent dominant lethal (Aroclor 1242); Negative: SHE-clonal assay; Rodent dominant lethal; Negative: Sperm morphology-mouse; Inconclusive: Mammalian micronucleus (Aroclor 1254)

Persistent Organic Pollutants (UN)

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR401.15 Section 307 Toxic Pollutants; 40CFR423, Appendix A Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.10; Nonwastewater (mg/kg), 10, total PCBs, sum of all PCB isomers, or all AROCLORS

RCRA 40CFR264, appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8080 (50); 8250 (100)

United States National Primary Drinking Water Regulations: MCLG = zero mg/L; MCL = 0.0005 mg/L.

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 1 lb (0.454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

United States DOT Regulated Marine Pollutant (49CFR172.101, appendix B), severe pollutant

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1% (Aroclor 1254; Aroclor 1260; Chlorodiphenyl (42% chlorine); Polychlorinated biphenyls, carcinogen) *Note:* The EPA requires the following: All PCB transformer locations must be cleared of stored combustible materials (solvents, paints, paper, etc.). All PCB transformers must be registered with the local fire department. All PCB-containing equipment must be posted with a large yellow label and the exterior door of the vault, machinery room door and any other means of exit must also be marked with PCB yellow ID labels. All PCB-containing transformers must be inspected every three[3] weeks; leaks must be repaired within two[2] days and reported to the EPA within five[5] days. In order to prevent fires, EPA recently required that high voltage network transformers be removed and that enhanced electrical protection be added on many types of PCB transformers in commercial buildings.

List of Stockholm Convention POPs: Annex A (Elimination); Annex C (Unintentional production and release) *as PCBs*

Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol (*PCB*): Xn, N; Risk phrases: R45; R33; R50/53; Safety phrases: S2; S35; S41; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Arochlor 1242 is a colorless to light-yellow colored, viscous liquid with a mild, hydrocarbon odor. Molecular weight = 258 (approx); Specific gravity (H_2O:1) = 1.39 @ 25°C; Boiling point = 325−366°C; Freezing/Melting point = −18°C; Vapor pressure = 0.001 mmHg @ 25°C. Insoluble in water. Arochlor 1254 is acolorless to pale-yellow, viscous liquid (resinous state) or solid (below 10°C) with a mild, hydrocarbon odor. Molecular weight = 326 (approx); Specific gravity (H_2O:1) = 1.39 @ 25°C; Boiling point = 365−390°C; Freezing/Melting point = −18°C; Vapor pressure = 0.00006 mmHg @ 25°C. Insoluble in water. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. $C_{12}H_{10-x}Cl_x$, diphenyl rings, in which one or more hydrogen atoms are replaced by a chlorine atom. Most widely used are chlorodiphenyl (42% chlorine), containing 3 chlorine atoms in unassigned positions, and chlorodiphenyl (54% chlorine) containing 5 chlorine atoms in unassigned positions. These compounds are light, straw-colored liquids with typical chlorinated aromatic odors; 42% chlorodiphenyl is a mobile liquid and 54% chlorodiphenyl is a viscous liquid. Insoluble in water. Polychlorinated biphenyls are prepared by the chlorination of biphenyl and hence are complex mixtures containing isomers of chlorobiphenyls with different chlorine contents. It should be noted that there are 209 possible compounds obtainable by substituting chlorine for hydrogen from one to ten different positions on the biphenyl ring system. An estimated 40−70 different chlorinated biphenyl compounds can be present in each of the higher chlorinated commercial mixtures. For example. Aroclor 1254 contains 69 different molecules, which differ in the number and position of chlorine atoms. It should also be noted that certain PCB commercial mixtures (no longer produced in the United States) but produced in France, Germany, and Japan have been shown to contain other classes of chlorinated derivatives, for example, chlorinated naphthalenes and chlorinated dibenzofurans. The possibility that naphthalene and dibenzofuran contaminate the technical biphenyl feedstock used in the preparation of the commercial PCB mixtures cannot be excluded.

Potential Exposure: (Aroclor 1242): Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, (Aroclor 1254) Agricultural chemical, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard. PCBs are mixtures of individual chemicals which are no longer produced in the United States, but are still found in the environment. Chlorinated diphenyls are used alone and in combination with chlorinated naphthalenes. They are stable, thermoplastic, and nonflammable; and are used in heat transfer and hydraulic fluids; lubricants; and insecticide formulations; they found use in insulation for electric cables and wires; in the production of electric condensers; as additives for extreme pressure lubricants; and as a coating in foundry use. Polychlorinated biphenyls (PCBs, first introduced into commercial use more than 45 years ago) are one member of a class of chlorinated aromatic organic compounds which are of increasing concern because of their apparent ubiquitous dispersal, persistence in the environment; and tendency to accumulate in food chains; with possible adverse effects on animals at the top of food webs; including man.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air:
NIOSH IDLH = 5 milligram per cubic meter, chlorodiphenyl (42% chlorine) & (54% chlorine)
Protective Action Criteria (PAC) Ver. 29[138]
1336-36-3, (Aroclor PCBs); (42% Cl); 53469-21-9; (Aroclor 1242) (42% Cl)
PAC-1: 13 milligram per cubic meter
PAC-2: 140 milligram per cubic meter
PAC-3: 840 milligram per cubic meter
12674-11-2, (Aroclor 1016)
PAC-1: 5.6 milligram per cubic meter
PAC-2: 62 milligram per cubic meter
PAC-3: 460 milligram per cubic meter
11104-28-2, (Aroclor 1221) (21% Cl)
PAC-1: 12 milligram per cubic meter
PAC-2: 130 milligram per cubic meter
PAC-3: 790 milligram per cubic meter
11141-16-5, (Aroclor 1232) (32% Cl)
PAC-1: 13 milligram per cubic meter
PAC-2: 150 milligram per cubic meter
PAC-3: 890 milligram per cubic meter
12672-29-6, (Aroclor 1248) (48% Cl)
PAC-1: 6.6 milligram per cubic meter
PAC-2: 72 milligram per cubic meter
PAC-3: 2200 milligram per cubic meter
11097-69-1, (Aroclor 1254) (54% Cl)
PAC-1: 1.5 milligram per cubic meter
PAC-2: 68 milligram per cubic meter
PAC-3: 200 milligram per cubic meter
11096-82-5, (Aroclor 1260) (60% Cl); (Aroclor 1261/1262) (61% Cl)
PAC-1: 0.41 milligram per cubic meter
PAC-2: 4.5 milligram per cubic meter
PAC-3: 260 milligram per cubic meter
37324-23-5, (Aroclor 1262) (62% Cl)
PAC-1: 34 milligram per cubic meter
PAC-2: 370 milligram per cubic meter
PAC-3: 2200 milligram per cubic meter
11100-14-4, (Aroclor 1268) (68% Cl)
NIOSH IDLH = 5 milligram per cubic meter, potential occupational carcinogen.
PAC-1: 33 milligram per cubic meter
PAC-2: 360 milligram per cubic meter
PAC-3: 2200 milligram per cubic meter
OSHA PEL: 1 milligram per cubic meter TWA [skin]
NIOSH REL: 0.001 milligram per cubic meter TWA (The REL also applies to other PCBs); A potential occupational carcinogen. Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A.
ACGIH TLV[1]: 1 milligram per cubic meter TWA [skin]
DFG MAK: 0.1 ppm/1.1 milligram per cubic meter TWA; Peak Limitation Category II(8) [skin]; Carcinogen Category 3B; Pregnancy Risk Group B
Australia: TWA 1 milligram per cubic meter; STEL 2 milligram per cubic meter, [skin], carcinogen, 1993; Austria: MAK 0.1 ppm (1 milligram per cubic meter), [skin], suspected carcinogen, 1999; Belgium: TWA 1 milligram

per cubic meter; STEL 2 milligram per cubic meter, [skin], 1993; Finland: TWA 0.5 milligram per cubic meter; STEL 1.5 milligram per cubic meter, [skin], 1993; France: VME 1 milligram per cubic meter, [skin], 1999; Japan: 0.1 milligram per cubic meter, [skin], 2A carcinogen, 1999; the Netherlands: MAC-TGG 1 milligram per cubic meter, [skin], 2003; the Phillipines: TWA 1 milligram per cubic meter, [skin], 1993; Poland: MAC (TWA) 1 milligram per cubic meter, 1999; Sweden: NGV 0.01 milligram per cubic meter, KTV 0.3 milligram per cubic meter, [skin], carcinogen, 1999; Switzerland: MAK-W 0.1 ppm (1 milligram per cubic meter), [skin], 1999; United Kingdom: TWA 0.1 milligram per cubic meter, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 1 milligram per cubic meter [skin]

54% chlorine

NIOSH IDLH = 5 milligram per cubic meter

OSHA PEL: 0.5 milligram per cubic meter TWA [skin]

NIOSH REL: 0.001 milligram per cubic meter (applies to all PCBs) TWA [skin]. See *NIOSH Pocket Guide*, Appendix A

ACGIH TLV[1]: 0.5 milligram per cubic meter TWA [skin]; confirmed animal carcinogen with unknown relevance to humans.

DFG MAK: 0.05 ppm/0.70 milligram per cubic meter TWA; Peak Limitation Category II(8) [skin]; Carcinogen Category 3B; Pregnancy Risk Group B

Australia: TWA 0.5 milligram per cubic meter; STEL 1 milligram per cubic meter, [skin], Carcinogen, 1993; Austria: MAK 0.05 ppm (0.5 milligram per cubic meter), [skin], suspected carcinogen, 1999; Belgium: TWA 0.5 milligram per cubic meter; STEL 1 milligram per cubic meter, [skin], 1993; France: VME 0.5 milligram per cubic meter, [skin], 1999; Japan: 0.1 milligram per cubic meter, [skin], 2A carcinogen, 1999; Norway: TWA 0.01 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 0.5 milligram per cubic meter, [skin], 2003; Poland: MAC (TWA) 1 milligram per cubic meter, 1999; Sweden: NGV 0.1 milligram per cubic meter, KTV 0.3 milligram per cubic meter, [skin], carcinogen, 1999; Switzerland: MAK-W 0.05 ppm (0.5 milligram per cubic meter), [skin], 1999; Turkey: TWA 1 milligram per cubic meter, [skin], 1993; United Kingdom: TWA 0.1 milligram per cubic meter, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: confirmed animal carcinogen with unknown relevance to humans. The Czech Republic has set a TWA of 0.5 milligram per cubic meter and a ceiling value of 1.0 milligram per cubic meter.

PCB oxide: 0.5 milligram per cubic meter, inhalable fraction [skin]

Determination in Air: Use NIOSH Analytical Method #5503, Polychlorobiphenyls; #8004, Polychlorobiphenyls in serum; #PV-2089, Chlorodiphenyl (42% Chlorine); #PV-2088, Chlorodiphenyl (54% Chlorine).

Permissible Concentration in Water: Safe Drinking Water Act (47FR 9352): MCL, 0.0005 mg/L; MCLG, zero. Federal Drinking Water Standards: Clean Water Act, the ambient criterion for PCBs in navagable waters 0.001 μg/L; Federal Drinking Water Guidelines: EPA 0.5 μg/L; State Drinking Water Standards: New Jersey 0.5 μg/L; State Drinking Water Guidelines: Arizona 0.008 μg/L; Connecticut 0.5 μg/L; Maine 0.5 μg/L; Minnesota 0.04 μg/; Wisconsin 0.03 μg/L.

Determination in Water: Gas chromatography (EPA Method 608) or gas chromatography plus mass spectrometry (EPA Method 625). Octanol-water coefficient: Log $K_{ow} = 6.25$ (54% Chlorine) (estimated). Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact. Inhalation of fume or vapor and percutaneous absorption of liquid,ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: *Inhalation:* May produce irritation to nose, throat and lungs. The vapors can cause coughing and/or difficulty in breathing. Levels above 10 milligram per cubic meter are reported to be unbearable. Inhalation may contribute significantly to all symptoms of long-term exposure. *Skin:* Absorption moderate. Contributes significantly to all symptoms of long-term exposure. Sensitized individuals may develop a rash after 2 days exposure by contact or inhalation. *Eyes:* May produce irritation and burns. Levels of 10 milligram per cubic meter are severely irritating. *Ingestion:* Absorption in digestive system contributes significantly to all symptoms of long-term exposure. There are no reported deaths of humans due to a single ingestion. However, experiments in animals suggest that ingestion of 6−10 fluid ounces would cause death to a healthy 150 lb adult.

Long-Term Exposure: Skin changes; thymus gland problems; immune deficiencies; reproductive or nervous system difficulties; increased risk of cancer. Repeated or prolonged contact with skin may cause acne-like skin rash (chloroacne). The substance may cause liver damage. High exposure can damage the nervous system. PCBs are readily absorbed into the body by all routes of exposure. They may persist in tissues for years after exposure stops. The symptoms below may be due to PCBs or to chemical contaminants. High levels of PCB vapor, 1−10 milligram per cubic meter, may produce burning feeling in eyes, nose and face; dry throat; lung and throat irritant; nausea, dizziness, and aggravation of acne. These may be felt immediately or be delayed weeks or months. Chemical acne, black heads; dark patches on skin; and unusual eye discharge have been reported by all routes of exposure. Although some sensitive individuals have reported these effects after two days, onset may not occur for months. These effects may last for months. Digestive disturbance have been reported in some individuals. PCBs may impair the function of the immune system. High levels of PCBs been shown to produce cancer and birth defects in laboratory animals. Whether PCBs produce these effects in humans is not known.

Points of Attack: Liver, skin, nervous system. Cancer site in animals: liver. Dermal (Skin), Developmental (effects during periods when organs are developing), Endocrine (Glands and Hormones), Hepatic (Liver), Immunological (Immune System), Neurological (Nervous System)[76].

Medical Surveillance: This class of chemicals is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. NIOSH lists the following tests: Adipose Tissue; whole blood (chemical/metabolite); blood serum; blood plasma; liver function tests. Before beginning employment and at regular times after that, the following are recommended: Serum Triglycerides level. Exam of the skin. Examination of the nervous system. Nerve conduction studies should be considered.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. *Chlorodiphenyl* (42% chlorine) 53469-21-9 Prevent skin contact. **8 hr** (more than 8 hours of resistance to breakthrough >0.1 micron g/cm/min): butyl rubber gloves, suits, boots; Neoprene rubber gloves, suits, boots; Teflon gloves, suits, boots; Viton gloves, suits; Saranex coated suits, Barricade coated suits; Responder suits; **4 hr** (At least 4 but < 8 hours of resistance to breakthrough >0.1 micron g/cm^2/min): 4H and Silver Shield gloves. *Chlorodiphenyl* (54% chlorine) 11097-69-1 Prevent skin contact. **8 hr** (more than 8 hours of resistance to breakthrough >0.1 micron g/cm/min): butyl rubber gloves, suits, boots; Neoprene rubber gloves, suits, boots; Teflon gloves, suits, boots; Viton gloves, suits, Saranex coated suits, Barricade coated suits; Responder suits; **4 hr** (At least 4 but <8 hours of resistance to breakthrough >0.1 micron g/cm^2/min): 4H and Silver Shield gloves. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Specific engineering controls are recommended in NIOSH Criteria Document: #77-225, *Occupational Exposure to Polychlorinated Biphenyls.*

Respirator Selection: NIOSH: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) (any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister having an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code -Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with these chemicals all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers (such as chlorine, bromine, and fluorine). A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2315 Polychlorinated biphenyls, liquid, Hazard class: 9; Labels: 9-Miscellaneous hazardous material. UN3432 Polychlorinated biphenyls, solid, Hazard class: 9; Labels: 9-Miscellaneous hazardous material.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Spills of one[1] pound or more must be reported to the EPA.

Fire Extinguishing: PCBs may burn but do not easily ignite. Thermal decomposition products may include hydrogen chloride and dioxins, including chlorinated dibenzofurans and chlorinated dibenzodioxines. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration @1648°C with scrubbing to remove any chlorine-containing products. In addition, some chemical waste landfills have been approved for PCB disposal. More recently, treatment with metallic sodium has been advocated which yields a low molecular weight polyphenylene and sodium chloride.

References

(109); (102); (31); National institute for Occupational Safety and Health (NIOSH), “Criteria for a Recommended Standard: (100). Occupational(2). Exposure to Polychlorinated Biphenyls,” NIOSH Document Number 77-225, Cincinnati OH (1977)

(173); (101); (138).

United States Environmental Protection Agency, Polychlorinated Biphenyls: Ambient Water Quality Criteria, Washington, DC (1980)

National Academy of Sciences, Polychlorinated Biphenyls, Washington, DC (1979)

World Health Organization, Polychlorinated Biphenyls and Triphenyls, Environmental Health Criteria No. 2, Geneva, Switzerland (1976)

Sax, N. I., Ed., “*Dangerous Properties of Industrial Materials Report*,” 3, N0. 4, 95−100 (1983) and 6, No. 2, 28−34 (1986)

United States Public Health Service, “Toxicological Profile for Selected PCB’s,” Atlanta, Georgia, agency for Toxic Substances and Disease Registry (November 1987)

New York State Department of Health, *Chemical Fact Sheet:* PCB’s, Bureau of Toxic Substance Assessment, Albany, NY (March 1986 and Version 2)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Polychlorinated Biphenyls, Trenton, NJ (April 2002)

Potassium Metal P:0840

Formula: K

Synonyms: Elemental potassium; Kalium

CAS Registry Number: 7440-09-7

HSDB Number: 698

RTECSNumber: TS6460000

UN/NA & ERG Number: UN2257/130; UN1420 (metal alloys)/138; metal powder, in bulk, may be pyrophoric: UN3089 (Metal powder, flammable, n.o.s.)/170

EC Number: 231-119-8 [*Annex I Index No.:* 019-001-00-2]

Regulatory Authority and Advisory Information

Hazard Alert (powder, dust): Pyrophoric hazard, Highly flammable, Dangerously water reactive.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: F, C; Risk phrases: R11; R14/15; R29; R17; R34; R51; Safety phrases: S1/2; S5 (If appropriate); S8; S21; S43; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Potassium is a soft silvery metal. Molecular weight = 39.1; Specific gravity (H_2O:1) = 0.89; Boiling point = 774°C; Freezing/Melting point = 64°C; Autoignition temperature = 441°C. Hazard Identification (based on NFPA-704 M Rating System) (*lump*): Health 3, Flammability 3, Reactivity 3₩. Reacts violently with water releasing corrosive potassium hydroxide and flammable hydrogen gas.

Potential Exposure: Used as a reagent and in sodium-potassium alloys which are used as high-temperature heat transfer media.

Incompatibilities: Air contact causes spontaneous ignition. Violent reaction with water, forming heat, spattering, corrosive potassium hydroxide and explosive hydrogen. The heat from the reaction can ignite the hydrogen that is generated. A powerful reducing agent. Violent reaction with oxidizers, organic materials; carbon dioxide; heavy metal compounds; carbon tetrachloride; halogenated hydrocarbons; easily oxidized materials; and many other substances. Store under nitrogen, mineral oil, or kerosene. Oxidizes and forms unstable peroxides under storage conditions. Potassium metal containing an oxide coating is an extremely dangerous explosion hazard and should be removed by an expert and destroyed.

Permissible Exposure Limits in Air:

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 2.3 milligram per cubic meter

PAC-2: 25 milligram per cubic meter

PAC-3: 150 milligram per cubic meter

Permissible Concentration in Water: No criteria set. (Reacts violently with water).

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Potassium can affect you when breathed in. Inhalation of dusts or mists can irritate the eyes, nose, throat and lungs with sneezing, coughing and sore throat. Higher exposures may cause a build-up of fluid in the lungs (pulmonary edema). This can cause death. Skin and eye contact can cause severe burns leading to permanent damage.

Long-Term Exposure: Prolonged exposure to fumes can cause sores of the inner nose and nasal septum. Fumes can irritate the lungs; bronchitis may develop.

Points of Attack: Lungs, skin

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure.

First Aid: *Eye Contact:* Immediately remove any contact lenses and flush with large amounts of water. Continue without stopping for at least 30 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately.

Skin Contact: Quickly remove contaminated clothing. Immediately wash area with large amounts of water. Seek medical attention immediately.

Breathing: Remove the person from exposure. Begin (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposure to potassium, use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive mode or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Red Stripe: Dangerous when wet materials release flammable gases on contact with water. Do not store this material in a room protected by water sprinkler systems. Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 meters or a 1-hour fire wall from flammable or reactive materials. Do not store in a basement. Color code-Red Stripe: Flammability Hazard (4.2): Store flammable solids (spontaneously combustible) up to maximum allowable quantity per control area in an approved flammable storage area. Do not store in a basement. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Potassium must be stored to avoid contact with carbon monoxide and moisture, compounds of heavy metals (such as silver oxide and silver chloride) and carbon tetrachloride, since violent reactions occur. Store under nitrogen, mineral oil, or kerosene. Sources of ignition, such as smoking, create a potential fire or explosion hazard. Protect containers against physical damage. Wherever potassium is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN2257Potassium, Hazard Class: 4.3; Labels: 4.3-Dangerous when wet material. UN1420 Potassium, metal alloys and metal alloys, liquid, Hazard Class: 4.3; Labels: 4.3-Dangerous when wet material. UN3089 Metal powder, flammable, n.o.s. Hazard Class: 4.2; Labels: 4.2-Spontaneously combustible material.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. Keep potassium out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Potassium is spontaneously combustible. Use dry chemical, dry graphite; soda ash; or lime extinguishers. *Do not use water*, carbon dioxide; or foam. Potassium may ignite in presence of moisture or itself if exposed to air. Thermal decomposition products may include metal oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (170); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Potassium, Trenton, NJ (may 2003)

Potassium Arsenate P:0850

Formula: AsH_2KO_4; KH_2AsO_4

Synonyms: Arsenic acid, Monopotassium salt; Arseniato potasico (Spanish); Macquer's salt; Monopotassium arsenate; Monopotassium dihydrogen arsenate; Potassium acid arsenate; Potassium arsenate, monobasic; Potassium dihydrogen arsenate; Potassium hydrogen arsenate

CAS Registry Number: 7784-41-0

HSDB Number: 1235

RTECS Number: CG1100000

UN/NA & ERG Number: UN1677/151

EC Number: 232-065-8

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen: Arsenic and inorganic arsenic compounds; IARC: Human Sufficient Evidence, 1980; Animal Limited Evidence*, carcinogenic to humans*, Group 1, 1987

California Proposition 65 Chemical[102]: (*inorganic arsenic*) Cancer 2/27/1987

Hazard Alert: Poison, Possible risk of forming tumors, Environmental hazard.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 1 lb (0.454 kg)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

As arsenic compounds:

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) as arsenic compounds

United States National Primary Drinking Water Regulations: MCLG = zero mg[As]/L; MCL = 0.010 mg [As]/L as Arsenic.

Clean Water Act: Toxic Pollutant (Section 401.15) as arsenic and compounds

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, D004 (arsenic compounds)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 1 lb (0.454 kg)

EPCRA (Section 313): Includes any unique chemical substance that contains arsenic as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: inorganics 0.1%; organics 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, appendix B) as arsenates, liquid, n.o.s.; arsenates, solid, n.o.s.; arsenical pesticides liquid, toxic, flammable, n.o.s.

Canada: Priority Substance List & Restricted Substances/ Ocean Dumping FORBIDDEN (CEPA), National Pollutant Release Inventory (NPRI) (arsenic compounds).

Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T, N; Risk phrases: R45; R23/25; R50/53; Safety phrases: S29; S53; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Potassium arsenate is a colorless to white crystalline solid. Molecular weight = 180.04; Specific gravity (H_2O:1) = 2.8 @ 20 · C; Boiling point = 463°C; Freezing/Melting point = 288°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability0, Reactivity 1.

Potential Exposure: Potassium arsenate is used in the textile, tanning, preserving hides; in the textile printing and paper industries; and as an insecticide in fly baits, especially for fly paper; as laboratory reagent.

Incompatibilities: A weak base. Reacts with strong oxidizers, bromine azide, acids and decomposes on contact with strong acids producing acetic acid fumes. Arsine, a very deadly gas, can be released in the presence of acid, acid mists, or hydrogen gas.

Permissible Exposure Limits in Air:

NIOSH IDLH = 5 mg[As]/m^3, potential occupational carcinogen.

OSHA PEL: 0.010 mg[As]/m^3 TWA; cancer hazard that can be inhaled. See [1910.1018]

NIOSH REL: 0.002 mg[As]/m^3 15 min. Ceiling Concentration. A potential occupational carcinogen. Limit exposure to lowest feasible concentration; See Appendix A.

ACGIH TLV[1]: 0.01 mg[As]/m^3 TWA; Confirmed Human Carcinogen

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 3.6 milligram per cubic meter

PAC-2: 40 milligram per cubic meter

PAC-3: 240 milligram per cubic meter

DFG TRK: 0.10 mg[As]/m^3; BAT: 1.30 μg[As]/L in urine/ end-of-shift; Carcinogen Category 1

Arab Republic of Egypt: TWA 0.2 milligram per cubic meter, 1993; Australia: TWA 0.05 milligram per cubic meter, carcinogen, 1993; Belgium: TWA 0.2 milligram per cubic meter, 1993; Denmark: TWA 0.05 milligram per cubic meter, 1999; Finland: carcinogen, 1993; France: VME 0.2 milligram per cubic meter, 1993; Hungary: STEL 0.5 milligram per cubic meter, carcinogen, 1993; India: TWA 0.2 milligram per cubic meter, 1993; Norway: TWA 0.02 milligram per cubic meter, 1999; the Phillipines: TWA 0.5 milligram per cubic meter, 1993; Poland: MAC (TWA) 0.01 milligram per cubic meter, 1999; Sweden: NGV 0.03 milligram per cubic meter, carcinogen, 1999; Switzerland: TWA 0.1 milligram per cubic meter, carcinogen, 1999; Thailand: TWA 0.5 milligram per cubic meter, 1993; Turkey: TWA 0.5 mg(As)/m^3, 1993; Turkey: TWA 0.5 milligram per cubic meter, 1993; United Kingdom: TWA 0.1 milligram per cubic meter, carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH: TLV: Confirmed Human Carcinogen. Russia[43] set a MAC of 0.003 milligram per cubic meter on an average daily basis for residential areas. Several states have set guidelines or standards for arsenic in ambient air: [60] 0.06 milligram per cubic meter (California Prop. 65), 0.0002 μ/m^3 (Rhode Island), 0.00023 μ/m^3 (North Carolina), 0.024 μ/m^3 (Pennsylvania), 0.05 μ/m^3 (Connecticut), 0.07−0.39 μ/m^3 (Montana), 0.67 μ/m^3 (New York), 1.0 μ/m^3 (South Carolina), 2.0 μ/m^3 (North Dakota), 3.3 μ/m^3 (Virginia), 5 μ/m^3 (Nevada).

Determination in Air: NIOSH Analytical Methods (inorganic arsenic): #7300, #7301,#7303, #7900, #9102; OSHA Analytical Methods ID-105. The American Conference of Government Industrial Hygienists (ACGIH) Method 803 measures total particulate arsenic in air.

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 10 μg[As]/L; State Drinking Water Guidelines: Arizona 10 μg[As]/L; Connecticut 10 μg[As]/L EPA Maximum Contaminant Level (MCL): 0.010 mg[As]/L [40 CFR 141.62]. Canadian Drinking Water Standards: IMAC 0.025 [As] mg/L.

Determination in Water: *For arsenic:* The atomic absorption graphite furnace technique is often used for measurement of total arsenic in water. It also has been standardized by EPA. Total arsenic may be determined by digestion followed by silver diethyldithiocarbamate; an alternative is atomic absorption; another is inductively coupled plasma optical emission spectrometry. See OSHA Method #ID-105 for arsenic[58]

Routes of Entry: Inhalation, ingestion; skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Arsenic can cause skin damage or problems with circulatory systems, and may have increased risk of cancer. Potassium arsenate can affect you when breathed, and may enter through skin. Potassium arsenate is a carcinogen; handle with extreme caution. Eye contact causes irritation, burns and red, watery eyes. Skin contact can cause burning, itching, and rash. Breathing can cause irritation with sneezing and coughing. High or repeated exposures can cause disturbed sleep; with numbness and weakness of arms and legs; and can cause poor appetite; nausea, cramps and if severe, vomiting and diarrhea.

Long-Term Exposure: Long-term exposure can cause ulcer or hole in the nasal septum; hoarseness and sore eyes also occur. Repeated exposure can cause nervous system damage. Repeated skin contact can cause thickened skin and/or patchy area of darkening and loss of pigment.

Points of Attack: Nervous system, skin.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Test for urine arsenic. Levels should not be greater than 100 micrograms per gram of creatinine in the urine. Examine the skin for abnormal growths. Liver and kidney function tests. Before beginning employment and at regular times after that, the following are recommended: examination of the nose, skin, eyes, nails, nervous system. Test for urine arsenic (may not be accurate within 2 days of eating shellfish or fish; most accurate at the end of a workday). At NIOSH recommended exposure levels, urine arsenic should not be greater than 50−100 micrograms per liter of urine. After suspected overexposure, repeat these tests. Also examine your skin periodically for abnormal growths. Skin cancer from arsenic is easily cured when detected early.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to Physician: For severe poisoning BAL has been used. For milder poisoning penicillamine (*not penicillin*) has been used, both with mixed success. Side effects occur with such treatment and it is never a substitute for controlling exposures. It can only be done under strict medical care.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All

protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Eye protection is included in the recommended respiratory protection. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Specific engineering controls are required under OSHA 1910.1018, *Inorganic Arsenic*. See also NIOSH Criteria Document #75-149, *Inorganic Arsenic*.

Respirator Selection: Based on potential carcinogenicity the following is recommended by NIOSH: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA-or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA). ***Requirements for Respiratory Protection for Inorganic Arsenic Particulate Except for Those With Significant Vapor Pressure:*** $<$ or $= 100\ \mu g/m^3$ (micrograms per cubic meter) (1) Half-mask air-purifying respirator equipped with high-efficiency filter*; or (2) Any half-mask supplied air respirator. $<$ or $= 500\ \mu g/m^3$ (1) Full facepiece air-purifying respirator equipped with high-efficiency filter*; (2) Any full-facepiece supplied-air respirator; or (3) Any full-facepiece SCBA. $<$ or $= 10{,}000\ \mu g/m^3$ (1) Powered air-purifying respirators in all inlet face coverings with high-efficiency filters*; or (2) Half-mask supplied-air respirators operated in positive-pressure mode. $<$ or $= 20{,}000\ \mu g/m^3$ Supplied-air respirator with full facepiece, hood, or helmet or suit, operated in positive-pressure mode. $>20{,}000\ \mu g/m^3$, unknown concentrations, or firefighting Any full-facepiece SCBA operated in positive-pressure mode.

*A high-efficiency filter means a filter that is at least 99.97% efficient against mono-disperesed particles of 0.3 μm (micrometers) in diameter or higher.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. A regulated, marked area should be established where potassium arsenate is handled, used, or stored as required by OSHA Standard 29 CFR 1910.1018 for inorganic arsenic. Potassium arsenate must be stored to avoid contact with acids. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: UN1677 Potassium arsenate, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include arsenic trioxide and potassium oxide. Extinguish fire using an agent suitable for type of surrounding fire. Potassium arsenate itself does not burn. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(109); (102); (31); (173); (101); (138); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 3, No. 4, 101–103 (1983)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Potassium Arsenate, Trenton, NJ (October 2004)

Potassium Arsenite P:0860

Formula: As_2HKO_4; $KAsO_2 \cdot HAsO_2$; $AsH_3O_3 \cdot xK$

Synonyms: Arsenito potasico (Spanish); Arsenous acid, potassium salt; Arsenite de potassium (French); Arsonic acid, potassium salt; Fowler's solution (liquid); Kaliumarsenit (German); NSC 3060; Potassium metaarsenite

CAS Registry Number: 13464-35-2; 1332-10-1 (solution)

HSDB Number: 1256

RTECS Number: CG3800000

UN/NA & ERG Number: UN1678/154

EC Number: 236-680-2 [*Annex I Index No.:* 033-002-00-5] (potassium arsenite); 233-337-9 (potassium arsonate)

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen: Arsenic and inorganic arsenic compounds; IARC: Human Sufficient Evidence, 1980; Animal Limited Evidence, *carcinogenic to humans*, Group 1, 1987

California Proposition 65 Chemical[102]: Carcinogen (as arsenic) 2/27/1987.

Hazard Alert: Poison, Possible risk of forming tumors, Suspected of causing genetic defects, Environmental hazard.

United States National Primary Drinking Water Regulations: MCLG = zero mg[As]/L; MCL = 0.010 mg[As]/L as Arsenic.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg) (10124-50-2)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 1 lb (0.454 kg) (10124-50-2)

Arsenic compounds:

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) as arsenic compounds

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, D004 (arsenic compounds)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 1 lb (0.454 kg)

EPCRA (Section 313): Includes any unique chemical substance that contains arsenic as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: inorganics 0.1%; organics 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, appendix B) as arsenates, liquid, n.o.s.; arsenates, solid, n.o.s.; arsenical pesticides liquid, toxic, flammable, n.o.s.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. as arsenic, water-soluble compounds, n.o.s.

Canada: Priority Substance List & Restricted Substances/ Ocean Dumping FORBIDDEN (CEPA), National Pollutant Release Inventory (NPRI) (arsenic compounds).

Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T, N; Risk phrases: 45; R23/25; R50/53; R53; R62; Safety phrases: S1/2; S20/21; S28; S29; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Potassium arsenite is a white crystalline solid. Molecular weight = 146; Decomposes below Freezing/ Melting point @ 300°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Soluble in water.

Potential Exposure: Potassium metaarsenite is used in veterinary medicine; and for chronic dermatitis in man. Potassium arsenite reduces silver salt to metallic silver during mirror silvering. Currently, it is probably not being used for this purpose.

Incompatibilities: A weak base. Reacts with acids and decomposes on contact with strong acids producing acetic acid fumes. Arsine, a very deadly gas, can be released in the presence of acid or acid mist. Incompatible with alkaloidal salts, strong oxidizers; bromine azide, hypophosphites, sulfites in acid solution; iron salts; heavy metals and heavy metal compounds. Hydrogen gas can react with inorganic arsenic to form the highly toxic gas, arsine.

Permissible Exposure Limits in Air:

NIOSH IDLH = 5 mg[As]/m^3, potential occupational carcinogen.

OSHA PEL: 0.010 mg[As]/m^3 TWA; cancer hazard that can be inhaled. See [1910.1018]

NIOSH REL: 0.002 mg[As]/m^3 15 min. Ceiling Concentration. A potential occupational carcinogen. Limit exposure to lowest feasible concentration; See Appendix A.

ACGIH TLV[1]: 0.01 mg[As]/m^3 TWA; Confirmed Human Carcinogen

Protective Action Criteria (PAC) Ver. 29[138]

13464-35-2

PAC-1: 2.9 milligram per cubic meter

PAC-2: 32 milligram per cubic meter

PAC-3: 190 milligram per cubic meter

DFG TRK: 0.10 mg[As]/m^3; BAT: 1.30 μg[As]/L in urine/ end-of-shift; Carcinogen Category 1

Arab Republic of Egypt: TWA 0.2 milligram per cubic meter, 1993; Australia: TWA 0.05 milligram per cubic meter, carcinogen, 1993; Belgium: TWA 0.2 milligram per cubic meter, 1993; Denmark: TWA 0.05 milligram per cubic meter, 1999; Finland: carcinogen, 1993; France: VME 0.2 milligram per cubic meter, 1993; Hungary: STEL 0.5 milligram per cubic meter, carcinogen, 1993; India: TWA 0.2 milligram per cubic meter, 1993; Norway: TWA 0.02 milligram per cubic meter, 1999; the Phillipines: TWA 0.5 milligram per cubic meter, 1993; Poland: MAC (TWA) 0.01 milligram per cubic meter, 1999; Sweden: NGV 0.03 milligram per cubic meter, carcinogen, 1999; Switzerland: TWA 0.1 milligram per cubic meter, carcinogen, 1999; Thailand: TWA 0.5 milligram per cubic meter, 1993; Turkey: TWA 0.5 mg(As)/m^3, 1993; Turkey: TWA 0.5 milligram per cubic meter, 1993; United Kingdom: TWA 0.1 milligram per cubic meter, carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH: TLV: Confirmed Human Carcinogen. Russia[43] set a MAC of 0.003 milligram per cubic meter on an average daily basis for residential areas. Several states have set guidelines or standards for arsenic in ambient air:[60] 0.06 milligram per cubic meter (California Prop. 65), 0.0002 μ/m^3 (Rhode Island), 0.00023 μ/m^3 (North Carolina), 0.024 μ/m^3 (Pennsylvania), 0.05 μ/m^3 (Connecticut), 0.07−0.39 μ/m^3 (Montana), 0.67 μ/m^3 (New York), 1.0 μ/m^3 (South Carolina), 2.0 μ/m^3 (North Dakota), 3.3 μ/m^3 (Virginia), 5 μ/m^3 (Nevada).

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 10 μg[As]/L; State Drinking Water Guidelines: Arizona 10 μg[As]/L; Connecticut 10 μg[As]/L EPA Maximum Contaminant Level (MCL): 0.010 mg[As]/L [40 CFR 141.62]. Canadian Drinking Water Standards: IMAC 0.025 [As] mg/L.

Determination in Water: *For arsenic:* The atomic absorption graphite furnace technique is often used for measurement of total arsenic in water. It also has been standardized by EPA. Total arsenic may be determined by digestion followed by silver diethyldithiocarbamate; an alternative is atomic absorption; another is inductively coupled plasma optical emission spectrometry. See OSHA Method #ID-105 for arsenic[58]

Routes of Entry: Inhalation, ingestion; skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin, and respiratory tract. Skin contact can cause irritation with a burning sensation; itching. High exposure can cause loss of appetite; garlic or metallic taste; nausea, vomiting, and muscle cramps. May affect the CNS; digestive tract; circulatory system; causing loss of fluids and electrolytes; collapse, shock and death. Very toxic: probable oral lethal dose in humans is 50−500 mg/kg, or between 1 teaspoonful and 1 ounce for a 150 lb adult. Nausea, vomiting and diarrhea result from arsenic ingestion. Patient may go into collapse and shock with weak, rapid pulse; cold sweat; coma, and death. Exposure at low level may result in death.

Long-Term Exposure: Arsenic can cause skin damage or problems with circulatory systems, and may have increased risk of cancer. May cause liver damage; cirrhosis, jaundice. A skin allergen. Repeated or prolonged contact may cause skin sensitization. Itching or skin pigmentation changes may occur. May affect the peripheral nervous system, causing weakness in the hands and feet. May cause an ulcer on the inner nose and perforation of the nasal septum, and cirrhosis. This substance is carcinogenic to humans. Chronic arsenic poisoning may manifest itself by loss of appetite; cramps, nausea, constipation, or diarrhea.

Points of Attack: Liver, skin.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Test for urine arsenic. Arsenic should not be greater than 100 micrograms per gram of creatinine in the urine. Tests are most accurate at the end of a workday and may be inaccurate within 2 days of eating shellfish. If abnormal growths are detected on the skin, they can be easily cured when detected early. Liver function testing. Examination of the nervous system. Examination of the nose, eyes, nails, and skin.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy. *Note to physician:* For severe poisoning BAL (British Anti-Lewisite), Dimercaprol, dithiopropanol ($C_3H_8OS_2$) has been used to treat toxic symptoms of certain heavy metals poisoning—including arsenic. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5). For milder poisoning *penicillamine (not penicillin)* has been used, both with mixed success. Side effects occur with such treatment and it is never a substitute for controlling exposure. It can only be done under strict medical care.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: **Requirements for Respiratory Protection for Inorganic Arsenic Particulate*Except for Those With Significant Vapor Pressure*:** $<$ or $= 100\ \mu g/m^3$ (micrograms per cubic meter) (1) Half-mask air-purifying respirator equipped with high-efficiency filter*; or (2) Any half-mask supplied air respirator. $<$ or $= 500\ \mu g/m^3$ (1) Full facepiece air-purifying respirator equipped with high-efficiency filter*; (2) Any full-facepiece supplied-air respirator; or (3) Any full-facepiece SCBA. $<$ or $= 10{,}000\ \mu g/m^3$ (1) Powered air-purifying respirators in all inlet face coverings with high-efficiency filters*; or (2) Half-mask supplied-air respirators operated in positive-pressure mode. $<$or $= 20{,}000\ \mu\ g/m^3$ Supplied-air respirator with full facepiece, hood, or helmet or suit, operated in positive-pressure mode. $>20{,}000\ \mu g/m^3$, unknown concentrations, or firefighting Any full-facepiece SCBA operated in positive-pressure mode.

*A high-efficiency filter means a filter that is at least 99.97% efficient against mono-disperesed particles of 0.3 μm (micrometers) in diameter or higher.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. A regulated, marked area should be established where potassium arsenite is handled, used, or stored as required by OSHA Standard 29 CFR 1910.1018 for inorganic arsenic. Store in tightly closed containers in a cool, well ventilated area away from acids, acid fumes; alkaloidal salts; strong oxidizers; bromine azide; hypophosphites, sulfites in acid solution; iron salts; heavy metals and heavy metal compounds. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1678 Potassium arsenite (solid), Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Avoid inhalation and skin contact. Dike far ahead of spill for later disposal. Do not touch spilled material; stop leak if you can do it without risk. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120 (q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include arsenic, phosgene, and potassium oxide. Extinguish fire using agents suitable for surrounding fire. Potassium arsenite itself does not burn. Keep unnecessary people away; stay upwind; keep out of low areas. Wear full protective clothing and SCBA. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(109); (102); (31); (173); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Potassium Arsenite, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

(173); (101); (138).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Potassium Arsenite, Trenton, NJ (August 1999)

Potassium Bromate P:0870

Formula: $BrKO_3$; $KBrO_3$

Synonyms: Bromato potasico (Spanish); Bromic acid, potassium salt

CAS Registry Number: 7758-01-2

HSDB Number: 1253

RTECS Number: EF8725000

UN/NA & ERG Number: UN1484/140

EC Number: 231-829-8 [*Annex I Index No.:* 035-003-00-6]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human Inadequate Evidence, animal Sufficient Evidence, *possibly carcinogenic to humans*, Group 2B, 1999; EPA: Likely to produce cancer in humans (inhalation, as bromates); Available data are inadequate for an assessment of human carcinogenic potential (oral route, as bromates); Limited evidence of carcinogenicity based on epidemiologic studies[72].

California Proposition 65 Chemical[102]: Cancer 1/1/1990

Hazard Alert: Strong oxidizer, Possible risk of forming tumors, Suspected of causing genetic defects, Environmental hazard.

United States National Primary Drinking Water Regulations: MCLG = zero mg[BrO_3^-]/L; MCL = 0.010 mg[BrO_3^-]/L, as bromates

United States National Primary Drinking Water Regulations: zero as bromate; MCL = 0.010 mg/L

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T, O; Risk phrases: R45; R2; R3; R8; R9; R25; R50; R62; Safety phrases: S29; S41; S45; S53 (see Appendix 4).

Hazardous to aquatic life or environment, with possible long lasting effects[293]. Toxic to aquatic life with long lasting Do not allow release to the environment unless proper permits are obtained from the federal government. effects.

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Potassium bromate is a white crystalline solid. Molecular weight = 167.01; Specific gravity (H_2O:1) = 3.3 @ 20°C; Decomposes @ 370°C; Freezing/Melting point = 350°C; also reported @ 435°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 3 (Oxidizer). Soluble in water.

Potential Exposure: Potassium bromate is used as animal feed additive, food additive; flavor and packaging material; as a laboratory reagent; an oxidizing agent.

Incompatibilities: A strong oxidizer.Violent reaction with many compounds, including reducing agents; chemically active metals; combustible materials, strong acids, alkaline earth sulfides, aluminum carbides, aluminum, amines, calcium sulfide, carbides, chlorine trifluoride, glycerin, hydrides, hydrochloric acid, hydrogen peroxide, hydrogen sulfide, hydroxylamine, magnesium, metal powders, metal sulfides, molybdenum, phenylhydrazine, phosphorous red/ friction, phosphorous trichloride, silicon, sulfides, sulfur, sulfur dioxide, sulfur/friction, sulfuric acid, tungsten, hydrogen trisulfide. Incompatible with aluminum, copper.

Permissible Exposure Limits in Air:

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 0.3 milligram per cubic meter

PAC-2: 3.1 milligram per cubic meter

PAC-3: 89 milligram per cubic meter

Permissible Exposure Limits in Water: Safe Drinking Water Act (47FR 9352): MCLG = zero mg/L; MCL = 0.010 mg/L as bromates

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Potassium bromate can affect you when breathed in and may enter the body through the skin. Skin and eye contact can cause irritation, and burns may occur with prolonged contact. Breathing the mist or dust can irritate the nose, throat, and bronchial tubes, causing sneezing and coughing. Overexposure can cause kidney damage. Ingestion may affect the gastrointestinal tract and CNS.

Long-Term Exposure: Bromates may cause an increase risk of cancer. This substance is possibly carcinogenic to humans. May affect the nervous system causing headache, irritability, impaired thinking and personality changes. May cause kidney damage. May cause lung irritation; bronchitis may develop.

Points of Attack: Lungs, kidneys, nervous system.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended. Lung function tests. If symptoms develop or overexposure is suspected, the following may also be useful: kidney function tests. Examination of the nervous system. Interview for brain damage.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/ manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposure to potassium bromate use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece respirator equipped with particulate(dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/ MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Check oxygen content prior to entering storage area. Color code-Yellow: Reactive Hazard; Store in a location separate from other materials, especially organic materials, flammables and combustibles, and other incompatible materials. Oxidizers, including oxidizing gases, should have a boundary separation of 8−10 meters or a 1-hour fire wall from flammable or reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Potassium bromate must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates) and other incompatible materials listed above, since violent reactions can occur. Protect storage containers against physical damage. Avoid storage on wood floors. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Store in a cool, well ventilated area away from incompatible materials listed above. Store in a cool, well ventilated area away from incompatible materials listed above. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101

and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage.

Shipping: UN1479 Potassium bromate, Hazard Class: 5.1; Labels: 5.1-Oxidizer.

Spill Handling: *Caution:* Incompatible absorbents: Cellulose-Based Absorbents, Expanded Polymeric Absorbents[101]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. Keep potassium bromate out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Thermal decomposition products may include hydrogen bromide, potassium oxide, and oxygen, which will increase fire hazard. Use water only. Do not use chemical or carbon dioxide extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(102); (31); (101); (138); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 7, 70−71 (1981)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Potassium Bromate, Trenton, NJ (July 2005)

Potassium Chlorate P:0880

Formula: $ClKO_3$; $KClO_3$

Synonyms: Berthollet's salt; Chlorate de potassium (French); Chlorate of potash; Chloric acid, Potassium salt; Fekabit; Kaliumchlorat (German); Oxymuriate of potash; Pearl ash; Potash chlorate; Potassium (chlorate de) (French); Potassium oxymuriate; Potcrate; Salt of tartar

CAS Registry Number: 3811-04-9

HSDB Number: 1110

RTECS Number: FO0350000

UN/NA & ERG Number: UN2427 (solution)/140; UN1485 (solid)/140

EC Number: 223-289-7[017-004-00-3]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Theft hazard* 400 (Commercial grade).

Hazard Alert: Strong oxidizer, Environmental hazard, FDA-over the counter drug.

Hazardous to aquatic life or environment, with possible long lasting effects[293]. Toxic to aquatic life with long lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: O, Xn; Risk phrases: R9; R20/R22; R51/53; Safety phrases: S1; S13; S16; S26; S27; S29; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Potassium chlorate is a white crystalline solid. Molecular weight = 122.55; Boiling point = decomposes below BP @ ~400°C; Freezing/Melting point = 356°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 1 (Oxidizer). Soluble in water.

Potential Exposure: Potassium chlorate is used in the manufacture of soap, glass, pottery, and many potassium salts; as an oxidizing agent; in explosives; matches, textile printing; disinfectants, and bleaching.

Incompatibilities: A strong oxidizer. Potentially explosive. Decomposes on heating above 400°C, on contact with strong acids producing toxic fumes including chlorine dioxide, chlorine fume, s and oxygen. Violent reaction with combustibles, oxidizers, strong acids; and reducing materials. Attacks many metals in presence of water.

Permissible Exposure Limits in Air:

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 5.6 milligram per cubic meter

PAC-2: 6.2 milligram per cubic meter

PAC-3: 370 milligram per cubic meter

Permissible concentration in Water: *Chlorates:* State Drinking Water Guidelines: California 800 μg/L; Maine 7 μg/L.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Potassium chlorate can affect you when breathed in. Irritates the eyes, skin, and respiratory tract. Prolonged contact can cause eye and skin burns and possible permanent damage. Exposure lowers the ability of the blood to carry oxygen (methemoglobinemia). This can result in a bluish color to skin and lips, headache, dizziness, collapse and even death. Breathing the dust or mist can cause nose and throat irritation with sneezing, coughing and sore throat. High exposure may cause kidney damage.

Long-Term Exposure: May cause lung damage; bronchitis may develop. Repeated exposures may affect the kidneys and CNS.

Points of Attack: Lungs, kidneys, nervous system.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: A blood test for methemoglobin level. Kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to Physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures to potassium chlorate use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Check oxygen content prior to entering storage area. Oxidizer. Potentially explosive. Color code-Yellow: Reactive Hazard; Store in a location separate from other materials, especially organic materials, flammables and combustibles, and other incompatible materials. Oxidizers, including oxidizing gases, should have a boundary separation of 8−10 meters or a 1-hour fire wall from flammable or reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Potassium chlorate must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates) and strong acids (such as hydrochloric, sulfuric, and nitric); since violent reactions occur. Protect storage containers from physical damage. Avoid storage on wood floors. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Store in a cool, well ventilated area away from incompatible materials listed above. Store in a cool, well ventilated area away from incompatible materials listed above. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage.

Shipping: UN1479 Potassium chlorate, Hazard Class: 5.1; Labels: 5.1-Oxidizer. UN2427 Potassium chlorate, *aqueous solution*, Hazard Class: 5.1; Labels: 5.1-Oxidizer, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use water spray only. Do not use dry chemical, halon, foam, or carbon dioxide extinguishers. Thermal decomposition products may include hydrogen chloride and oxides of chlorine, metal, and carbon and oxygen which may increase intensity of fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Potassium Chlorate, Trenton, NJ (October 2004)

Potassium Chromate P:0900

Formula: CrK_2O_4; $Cr_2K_2O_7$; K_2CrO_4; $K_2Cr_2O_7$

Synonyms: *chromate:* Bipotassium chromate; Chromate of potassium; Dipotassium chromate; Dipotassium monochromate; Neutral potassium chromate; Potassium chromate (VI); Tarapacaite. *dichromate:* Bichromate of potash; Chromic acid, dipotassium salt; Dipotassium dichromate; Iopezite; Kaliumdichromat (German); Potassium bichromate; Potassium dichromate(VI)

CAS Registry Number: 7789-00-6; 7778-50-9 (dichromate)

HSDB Number: 1249

RTECS Number: GB2940000 (chromate); HX7680000 (dichromate)

UN/NA & ERG Number: UN3288 (Toxic solid, inorganic, n.o.s.)/151; UN1479/140 (dichromate)

EC Number: 232-140-5 [*Annex I Index No.:* 024-006-00-8]; 231-906-6 [*Annex I Index No.:* 024-002-00-6] (dichromate)

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human Sufficient Evidence; Animal Sufficient Evidence, *carcinogenic to humans*, Group 1, 1997; NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen. United States Environmental Protection Agency Gene-Tox Program, Positive: SHE-clonal assay; *In vitro* cytogenetics-nonhuman; Positive: B *subtilis* rec assay; Positive: CHO gene mutation (dichromate)

Hazard Alert: Poison, Strong oxidizer, Corrosive, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Inhalation hazard (possible cancer), Primary irritant (w/o allergic reaction), Sensitization hazard, Environmental hazard.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. as chromate; 0.1%, potassium dichromate

Hazardous Substance (EPA) (RQ = 1000/454)[4]

Priority Toxic Pollutant (EPA)[6]

As chromium compounds:

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

United States National Primary Drinking Water Regulations: MCLG = 0.01 mg[Cr]/L; MCL = 0.1 mg[Cr]/L as Chromium

Clean Water Act: 40CFR116.4 Hazardous Substances; RQ 40CFR117.3 (same as CERCLA); 40CFR423, Appendix A, Priority Pollutants; 40CFR401.15 Section 307 Toxic Pollutants as chromium and compounds.

EPA EPA Acceptable daily intake (ADI): Chromium (VI) = 0.175 mg/day/man; Chromium(III) = 125 mg/day/man. EPA estimated adequate and safe intake (EASI) levels for chromium: **Infants:** age 0.0−0.5 yr: 0.01−0.04 mg/day; age 0.5−1.0 yr: 0.02−0.06 mg/day. **Children** age 1−3 yr: 0.02−0.08 mg/day; age 4−6 yr: 0.03−0.12 mg/day; age 7−10 yr: 0.05−0.20 mg/day; age > or = to 11 yr: 0.05−0.20 mg/day.

Adults: 0.05−0.20 mg/day.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, D007 (chromium compounds)

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: O, T, N, Xi; Risk phrases: R45; R8, R20/22; R23/25; R33; R36/37/38; R43; R49; R50/53; R61; R62; R63; Safety phrases: S20/21; S26; S28; S29; S36/37; S45; S53; S60; S61; S41 (see Appendix 4); (*chromate*): Hazard Symbol: T+, N, Xi; Risk phrases: R49; R46; R36/37/38; R43; R50/53; Safety phrases: S53; S45; S60; S61; (*dichromate*)

Hazard Symbol: T+, N; Risk phrases: R45; R36/37/38; R46; R60; R61; R8; R21; R25; R26; R34; R42/43; R46; R48/23; R49; R50/53; Safety phrases: S53; S45; S60; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to waters.

Description: Potassium chromate(VI) is a yellow crystalline solid. Molecular weight = 194.20; Freezing/Melting point = 974°C. Soluble in water.

Potassium dichromate(VI) is a yellowish-red crystalline solid. Molecular weight = 294.2; Specific gravity (H_2O:1) = 2.7; Boiling point = decomposition @ 500°C; Freezing/Melting point = 398°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 3 (Oxidizer). Soluble in water.

Potential Exposure: Potassium chromate is used in printing: photomechanical processing; chrome-pigment production; and wool preservative methods; to make dyes, pigments, inks and enamels; as an oxidizing agent; analytical reagent; in electroplating; explosives.

Incompatibilities: A powerful oxidizer. Violent reactions with combustibles, organics, powdered metals; or easily oxidizable substances. Contact with hydroxylamine, hydrazine causes explosion.

Permissible Exposure Limits in Air:

7789-00-6

NIOSH IDLH = 15 mg[Cr(VI)]/m^3, potential occupational carcinogen.

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 0.56 milligram per cubic meter

PAC-2: 9.7 milligram per cubic meter

PAC-3: 58 milligram per cubic meter

OSHA PEL: 0.1 mg[CrO$_3$]/m^3 Ceiling Concentration

NIOSH REL: 0.001 mg[CrO$_3$]/m^3 TWA, potential carcinogen, limit exposure to lowest feasible level. NIOSH considers all Cr(VI) compounds (including chromic acid; *tert*-butyl chromate; zinc chromate; and chromyl chloride) to be potential occupational carcinogens.

ACGIH TLV[1]: 0.05 mg[Cr]/m^3 TWA, Confirmed Human Carcinogen; BEI issued

DFG MAK: Danger of skin sensitization; Carcinogen Category 2; TRK: 0.05 mg[Cr]/m^3; 20 μg/L [Cr] in urine at end-of-shift.

United Kingdom: carcinogen, 2000; the former USSR-UNEP/IRPTC joint project[43] give a MAC in workplace air of 0.01 milligram per cubic meter. Connecticut[60] has set a guideline for chromium trioxide in ambient air of 0.25 μ/m^3; Sweden [35] for potassium chromate at 0.02 milligram per cubic meter as a TWA in workplace air. North Carolina[60] has set a guideline for ambient air for both compounds of zero.

Protective Action Criteria (PAC) Ver. 29[138]

7778-50-9 (dichromate)

PAC-1: 0.42 milligram per cubic meter

PAC-2: 8.8 milligram per cubic meter

PAC-3: 44 milligram per cubic meter

Determination in Air: Use NIOSH Analytical Methods #7600, 7604, 7605, 7703, 9101 and OSHA Analytical Methods ID-103, ID-215, W-4001.

Permissible concentration in Water: State Drinking Water Guidelines: California 10 μg[Cr(VI)]/L; Maine 35 μg[Cr(VI)]/L. Federal Drinking Water Guidelines: EPA 100 μg[Cr]/L.

Determination in Water: Total chromium may be determined by digestion followed by atomic absorption, or by colorimetry (diphenylcarbazide); or by inductively coupled plasma (CP) optical emission spectrometry. Chromium (VI) may be determined by extraction and atomic absorption or colorimetry (using diphenylhydrazide). Dissolved total Cr or Cr(VI) may be determined by 0.45 μ filtration followed by the above-cited methods[49].

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Potassium chromates can affect you when breathed in. It can also pass into inner layers of the skin. Eye contact can cause severe damage with possible loss of vision. Irritation of nose, throat and bronchial tubes can occur, with cough and/or wheezing. Skin contact can cause severe irritation, deep ulcers, or an allergic skin rash.

Long-Term Exposure: Chromium may cause allergic dermatitis. Potassium chromate is a human carcinogen. Potassium chromates can cause a sore or perforated nasal septum; with bleeding, discharge or crusting. May cause skin allergy. Can cause lung irritation; bronchitis may develop.

Points of Attack: Lungs, skin.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. NIOSH lists the following tests: Blood gas analysis, CBC; chest X-ray, electrocardiogram, liver function tests; pulmonary function tests; sputum cytology, urine (chemical/metabolite), urinalysis (routine), white blood cell count/differential. Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: examination of the nose and skin. If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Also check your skin daily for little bumps or blisters, the first sign of "chrome ulcers." If not treated early, these can last for years after exposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Prevent skin contact. (as chromic acid and chromates) **8 hr** (more than 8 hours of resistance to breakthrough >0.1 micron g/cm/min): polyethylene gloves, suits, boots; polyvinyl chloride gloves, suits, boots; Saranex coated suits; **4 hr** (At least 4 but <8 hours of resistance to breakthrough >0.1 micron g/cm^2/min): butyl rubber gloves, suits, boots; Viton gloves, suits. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation For *potassium dichromate* Neoprene and polyvinyl chloride are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash

immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH, as chromates: *at any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Check oxygen content prior to entering storage area. Oxidizers should be isolated from acids, metals, organic materials, and ammonium nitrate. (1) Color code-Yellow: Reactive Hazard; Store in a location separate from other materials, especially organic materials, flammables and combustibles, and other incompatible materials. Oxidizers, including oxidizing gases, should have a boundary separation of 8–10 meters or a 1-hour fire wall from flammable or reactive materials. (2) Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Potassium chromates must be stored to avoid contact with combustible, organic, or other easily oxidized materials (such as paper, wood, sulfur, aluminum, hydrazine, and plastics), since violent reactions occur. A regulated, marked area should be established where potassium chromate is handled, used, or stored. Where possible, automatically transfer material from drums or other storage containers to process containers Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Store in a cool, well ventilated area away from incompatible materials listed above. Store in a cool, well ventilated area away from incompatible materials listed above. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage.

Shipping: UN1479 Oxidizing solid, n.o.s., Hazard Class: 5.1; Labels: 5.1-Oxidizer, Technical Name Required. UN3288 Toxic solids, inorganic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. Keep potassium dichromate out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical may burn but does not easily ignite. Thermal decomposition products may include oxides of chromium, potassium and carbon. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(109); (31); (122); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 7, 71–73 (1981) and 8, No. 5, 86–94 (1988)(2). (Potassium Chromate)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Potassium Dichromate*, Trenton, NJ (September 1996)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Potassium Chromate*, Trenton, NJ (June 2003)

United States Environmental Protection Agency, *Health Assessment Document: Chromium,* EPA 600/8-83-014F, Washington, DC, (1984).

Potassium Cyanide P:0910

Formula: CNK; KCN

Synonyms: Cianuro potasico (Spanish); Cyanide of potassium; Cyanure de potassium (French); Hydrocyanic acid, Potassium salt; Kalium-cyanid (German)

CAS Registry Number: 151-50-8

HSDB Number: 1245

RTECS Number: TS8750000

UN/NA & ERG Number: UN1680/157

EC Number: 205-793-3

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade).

Hazard Alert: Poison, Systemic agent, Water reactive, Organometallic, Strong reducing agent, Suspected of causing genetic defects, Suspected reprotoxic hazard, Environmental hazard.

United States National Primary Drinking Water Regulations: MCLG = 0.2 mg[CN$^-$]/L; MCL = 0.2 mg [CN$^-$]/L as cyanide.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P098

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 10 lb (4.54 kg)

United States DOT Regulated Marine Pollutant (49CFR172.101, appendix B)

Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T+, N; Risk phrases: R26/27/28; R32; R50/53; R62; R63; Safety phrases: S1; S7; S28; S29; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Canada, National Pollutant Release Inventory (NPRI); CEPA Priority Substance List, Ocean dumping prohibited

As cyanide compounds:

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants, as cyanide, total

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P030 as cyanides soluble salts and complexes, n.o.s.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents. as cyanides, soluble salts and complexes, n.o.s.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. as cyanide compounds, inorganic, n.o.s.

Description: Potassium cyanide are white lumps, granular powder, or colorless solution. It may be shipped as capsules, tablets, or pellets. Toxic hydrogen cyanide gas released by potassium cyanide has a distinctive, weak bitter almond odor, but many people cannot detect it; the odor does not provide adequate warning of hazardous concentrations. Molecular weight = 65.12; Specific gravity (H_2O:1) = 1.55 @ 20°C; Boiling point = 1625°C; Freezing/Melting point = 633.9°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0₩. Soluble in water; solubility = 72% @ 25°C; with slow decomposition forming a strong alkaline solution.

Potential Exposure: Used in electroplating, steel hardening; extraction of precious metals form ores; as a fumigant; in insecticides; a reagent in analytical chemistry.

Incompatibilities: A strong reducing agent; keep away from oxidizers. Potassium cyanide decomposes on contact with water, humidity, carbon dioxide, strong acids (such as hydrochloric, sulfuric, and nitric acids), and acid salts, producing highly toxic and highly flammable hydrogen cyanide gas. Potassium cyanide absorbs water from air (is hygroscopic or deliquescent); the aqueous solution is a strong base. Incompatible with organic anhydrides; isocyanates, alkylene oxides; epichlorohydrin, aldehydes, alcohols, glycols, phenols, cresols, caprolactum, strong oxidizers; nitrogen trichloride; sodium chlorate. Attacks aluminum, copper, zinc in the presence of moisture.

Permissible Exposure Limits in Air:

NIOSH IDLH = 25 mg[CN]/m^3

OSHA PEL: 5 mg[CN]/m^3/4.7 ppm TWA

NIOSH REL: 5 mg[CN]/m^3/4.7 ppm/10 min., Ceiling Concentration

ACGIH TLV[1]: 5 mg[CN]/m^3 [skin] Ceiling Concentration

Protective Action Criteria (PAC)* Ver. 29[138]

PAC-1: **5.3**$_{\mathbf{A}}$ milligram per cubic meter

PAC-2: **19**$_{\mathbf{A}}$ milligram per cubic meter

PAC-3: **40**$_{\mathbf{A}}$ milligram per cubic meter

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

DFG MAK: 2 mg[CN]/m^3, inhalable fraction TWA; Peak Limitation Category II(1) [skin]; Pregnancy Risk Group: C

Skin contact may contribute significantly in overall exposure.

Australia: TWA 5 milligram per cubic meter, [skin], 1993; Austria: MAK 5 mg[CN]/m^3, [skin], 1999; Denmark: TWA 5 milligram per cubic meter, [skin], 1999; France: VME 5 mg[CN]/m^3, [skin], 1999; Poland: TWA 0.3 mg[CN]/m^3, ceiling 10 mg[CN]/m^3, 1999; Switzerland: MAK-W 5 milligram per cubic meter, KZG-W 10 milligram per cubic meter, [skin], 1999; United Kingdom: TWA 5 mg[CN]/m^3, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Ceiling Concentration 5 milligram per cubic meter [skin]. Russia [43] has set MAC values for ambient air in residential areas of 0.009 milligram per cubic meter on a momentary basis and 0.004 milligram per cubic meter on an average daily basis. Several states have set guidelines or standards for cyanides in ambient air[60] ranging from 16.7 μ/m^3 (New York) to 50.0 μ/m^3 (Florida and North Dakota) to 80.0 μ/m^3 (Virginia) to 100 μ/m^3 (Connecticut and South Dakota) to 125 μ/m^3 (South Carolina) to 119.0 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #7904, Cyanides. See also Method #6010, Hydrogen cyanide[18].

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 200 μg[CN]/L; State Drinking Water Standards: California 150 μg[CN]/L; State Drinking Water Guidelines: Arizona 220 μg[CN]/L; Maine. 140 μg [CN]/L; Minnesota 100 μg[CN]/L. United States Army field drinking-water standards for cyanide: 2 mg[CN]/L assuming a water consumption of 15 L/day and 6 mg[CN]/L assuming a water consumption of 5 L/day. United States Army field drinking-water standards for cyanide, long-term consumption 0.5 mg[CN]/L; Short-term consumption; Raw water constituents (maximum) 20 mg[CN]/L.

Determination in Water: Distillation followed by silver nitrate titration or colorimetric analysis using pyridine pyrazolone (or barbituric acid).

Routes of Entry: Inhalation, ingestion; skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Potassium cyanide is corrosive to the eyes, skin, and the respiratory tract. Contact can cause skin and eye burns, and possible permanent eye damage. Inhalation can cause lung irritation with coughing, sneezing, and difficult breathing; slow gasping respiration. Corrosive if swallowed. These substances may affect the CNS. Symptoms include headaches, confusion, nausea, pounding heart, weakness, unconsciousness and death.

Long-Term Exposure: Repeated or prolonged contact with potassium cyanide may cause thyroid gland enlargement and interfere with thyroid function. May cause nosebleed and sores in the nose; changes in blood cell count. May cause CNS damage with headache, dizziness, confusion; nausea, vomiting, pounding heart; weakness in the arms and legs; unconsciousness and death. May affect liver and kidney function.

Points of Attack: Liver, kidneys, skin, cardiovascular system; CNS; thyroid gland.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Urine thiocyanate levels. Blood cyanide levels. CBC. Evaluation of thyroid function. Liver function tests. Kidney function tests. CNS tests. EKG.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep under observation for 24−48 hours as symptoms may return. Use amyl nitrate capsules if symptoms develop. All area employees should be trained regularly in emergency measures for cyanide poisoning and in CPR. A cyanide antidote kit should be kept in the immediate work area and must be rapidly available. Kit ingredients should be replaced every 1−2 years to ensure freshness. Persons trained in the use of this kit; oxygen use, and CPR must be quickly available. *Note to physician:* For severe poisoning BAL (British Anti-Lewisite), Dimercaprol, dithiopropanol ($C_3H_8OS_2$) has been used to treat toxic symptoms of certain heavy metals poisoning—including arsenic. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5). For milder poisoning *penicillamine (not penicillin)* has been used, both with mixed success. Side effects occur with such treatment and it is never a substitute for controlling exposure. It can only be done under strict medical care. *Note to physician:* For severe poisoning BAL (British Anti-Lewisite), Dimercaprol, dithiopropanol ($C_3H_8OS_2$) has been used to treat toxic symptoms of certain heavy metals poisoning—including arsenic. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5). For milder poisoning *penicillamine (not penicillin)* has been used, both with mixed success. Side effects occur with such treatment and it is never a substitute for controlling exposure. It can only be done under strict medical care.

Personal Protective Methods:

General information: first responders should use a NIOSH-certified chemical, biological, radiological, nuclear (CBRN) SCBA with a level a protective suit when entering an area with an unknown contaminant or when entering an area where the concentration of the contaminant is unknown. Level a protection should be used until monitoring results confirm the contaminant and the concentration of the contaminant. *Note:* safe use of protective clothing and equipment requires specific skills developed through training and experience.

LEVEL A: (RED ZONE): select when the greatest level of skin, respiratory, and eye protection is required. This is the maximum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than the AEGL-2. A NIOSH-certified CBRN full-facepiece scba operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle. A totally encapsulating chemical protective (TECP) suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, and a hard hat worn under the TECP suit are optional items.

LEVEL B: (RED ZONE): Select when the highest level of respiratory protection is necessary but a lesser level of skin protection is required. This is the minimum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than AEGL-2. It differs from Level A in that it incorporates a nonencapsulating, splash-protective, chemical-resistant splash suit that provides Level A protection against liquids but is not airtight. A NIOSH-certified CBRN full-facepiece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL C: (YELLOW ZONE): Select when the contaminant and concentration of the contaminant are known and the respiratory protection criteria factors for using Air Purifying Respirators (APR) or Powered Air Purifying Respirators (PAPR) are met. This level is appropriate when decontaminating patient/victims. A NIOSH-certified CBRN tight-fitting APR with a canister-type gas mask or CBRN PAPR for air levels greater than AEGL-2. A NIOSH-certified CBRN PAPR with a loose-fitting facepiece, hood, or helmet and a filter or a combination organic vapor, acid gas, and particulate cartridge/filter combination or a continuous flow respirator for air levels greater than AEGL-1. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Escape mask, face shield, coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL D: (GREEN ZONE): Select when the contaminant and concentration of the contaminant are known and the concentration is below the appropriate occupational exposure limit or less than AEGL-1 for the stated duration times. Limited to coveralls or other work clothes, boots, and gloves.

Notes: Take all necessary precautions to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid, unless full facepiece respiratory protection is worn. Wear dust-proof goggles and face shield when working with powders or dust, unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *When used as a weapon, use SCBA Respirator Certified By NIOSH For CBRN Environments. Up to 25 milligram per cubic meter:* Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or Sa: Pd,Pp (APF = 1000): ASCBA (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive pressure mode). *Escape:* GmFS100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted canister providing protection against the compound of concern and having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from strong acids; acid salts; oxidizers, light and moisture. Where possible, automatically transfer material from drums or other storage containers to process containers.

Shipping: UN1680 Potassium cyanide, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling:

Initial isolation and protective action distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 300/90
Then: Protect persons downwind (miles/kilometers)
Day 0.2/0.3
Night 0.8/1.2

Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete.

Remove all ignition sources. This chemical has a lower explosive limit; ventilate closed spaces before entering them. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include hydrogen cyanide gas and oxides of nitrogen and metal. KCN is not combustible itself but it decomposes in the presence of moisture, damp air, or carbon dioxide; producing highly toxic and flammable hydrogen cyanide gas and oxides of nitrogen. NO acidic dry chemical extinguishers. NO hydrous agents. NO water. NO carbon dioxide. Use dry chemical and foam on surrounding fires. Vapors are heavier than air and may collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. Do not allow water to enter open containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office. Add strong alkaline hypochlorite and react for 24 hours. Then flush to sewer with large volumes of water[22].

References

(31); (173); (101); (138); (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Potassium Cyanide, Trenton NJ (August 2005)

Potassium Dichloroisocyanurate P:0920

Formula: $C_3Cl_2KN_3O_3$; $KCl_2(NCO)_3$

Synonyms: ACL-59; Dichloroisocyanuric acid, potassium salt; Dichloro-*s*-triazine-2,4,6(1H,3H,5H)-trione potassium deriv; 1,3-Dichloro-*s*-triazine-2,4,6(1H,3H,5H) trione potassium salt; Dichlor-*s*-triazin-2,4,6(1H,3H,5H) trione potassium; Isocyanuric acid, dichloro-, potassium salt; Potassium dichloro-*s*-triazinetrione; Potassium troclosene; *s*-Triazine-2,4,6(1H,3H,5H)-trione, dichloro-, potassium deriv; 1,3,5-Triazine-2,4,6(1H,3H,5H)-trione, 1,3-dichloro-, potassium salt; Troclosene potassium

CAS Registry Number: 2244-21-5

HSDB Number: 5871

RTECS Number: XZ1850000

UN/NA & ERG Number: UN2465 (Dichloroisocyanuric acid salts)/140

EC Number: 218-828-8 [*Annex I Index No.:* 613-030-00-X]

Regulatory Authority and Advisory Information

Hazard Alert: Strong oxidizer, Water reactive, Environmental hazard.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: O, Xn, N; Risk phrases: R22; R24/25; R31; R36/37; R50/53; Safety phrases: S2; S8; S26; S29; S41; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)]

Description: Potassium dichloroisocyanurate is a white crystalline solid. Chlorine odor. Molecular weight = 237.07; Freezing/Melting point = (decomposes) 250°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 2, Oxidizer ₩. Reacts with water; Slightly soluble; solubility = 10–50 mg/mL @ 20°C [193].

Potential Exposure: Potassium dichloroisocyanurate is used in household bleaches, dishwashing compounds and detergents.

Incompatibilities: A strong oxidizer; violent reaction with reducing agents; combustibles, organics; easily chlorinated or oxidized materials; ammonia, urea, other nitrogen compounds; calcium hypochloride; other alkalies and moisture. Contact with ammonium compounds or hydrated salts can cause a very vigorous reaction. Prolonged exposure to heat/fire may result in the vigorous decomposition of the material with the rupture of its containers, it will accelerate the burning of combustible materials. Chlorine plus alcohols would yield alkyl hypochlorites. They decompose in the cold and explode on exposure to sunlight or heat. Tertiary hypochlorites are less unstable than secondary or primary hypochlorites[NFPA 491M, Cameo].

Permissible Exposure Limits in Air:
No standards or Protective Action Criteria (PAC) available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Potassium dichloroisocyanurate can affect you when breathed in. Exposure can severely irritate the eyes. It can also irritate the nose, throat and air passages. Contact can cause skin and eye irritation.

Long-Term Exposure: May cause lung irritation and damage.

Points of Attack: Lungs, skin.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following is recommended. Lung function tests. consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to potassium dichloroisocyanurate exists, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Check oxygen content prior to entering storage area. Color code-Yellow: Reactive Hazard; Store in a location separate from other materials, especially organic materials, flammables and combustibles, and other incompatible materials. Oxidizers, including oxidizing gases, should have a boundary separation of 8−10 meters or a 1-hour fire wall from flammable or reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from combustibles (like wood, paper and oil), ammonia, urea, other nitrogen compounds; calcium hypochlorite; other alkalis and moisture. Do not store on wooden floors. Where possible, automatically transfer material from drums or other storage containers to process containers Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Store in a cool, well ventilated area away from incompatible materials listed above. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage.

Shipping: UN2465 Dichloroisocyanuric acid, dry or Dichloroisocyanuric acid salts, Hazard Class: 5.1; Labels: 5.1-Oxidizer.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. *Do not use water*. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Potassium dichloroisocyanurate is not flammable. Potassium dichloroisocyanurate is a strong oxidizer and a dangerous fire hazard on contact with combustible (such as wood, paper, and oil). Thermal decomposition products may include hydrogen cyanide, hydrogen chloride, chlorine gas and oxides of nitrogen and potassium. Use dry chemical, or CO_2 extinguishers. Use water to keep fire-exposed containers cool. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Potassium Dichloroisocyanurate, Trenton, NJ (May 2002)

Potassium Fluoride P:0940

Formula: FK; KF

Synonyms: Fluorure de potassium (French); Potassium fluorure (French)

CAS Registry Number: 7789-23-3

HSDB Number: 7481

RTECS Number: TT0700000

UN/NA & ERG Number: UN1812/154

EC Number: 232-151-5 [*Annex I Index No.:* 009-005-00-2]

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Suspected reprotoxic hazard, Agricultural chemical.

United States National Primary Drinking Water Regulations: MCLG = 4 mg[F]/L; MCL = 4 mg[F]/L; SMCL = 2.0 mg [F]/L, as Fluoride.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T; Risk phrases: R23/24/25; R63; Safety phrases: S1/2; S26; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Potassium fluoride is a white crystalline solid. Molecular weight = 58.1; Specific gravity (H_2O:1) = 2.48 @ 20°C; Boiling point = 1502°C; Freezing/Melting point = 858°C; Vapor pressure = 0.75 mmHg @ 869°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Soluble in water.

Potential Exposure: Potassium fluoride is used in etching glass; as a preservative and insecticide.

Incompatibilities: Incompatible with strong acids; reacts releasing hydrogen fluoride. Aqueous solutions corrode glass and consequently are prepared and stored in polyethylene containers. The pure solid may be stored in glass containers. Reacts violently with (Pt + BrF_3)[101].

Permissible Exposure Limits in Air:

NIOSH IDLH = 250 mg[F]/m^3

OSHA PEL: 3 ppm/2.5 mg[F]/m^3 TWA

NIOSH REL: 3 ppm/2.5 mg[F]/m^3 TWA; 6 ppm/5 mg[F]/m^3, 15 min. Ceiling Concentration

ACGIH TLV[1]: 2.5 mg[F]/m^3 TWA; not classifiable as a human carcinogen; BEI: 3 mg[F]/g creatinine in urine *prior* to end-of-shift; 10 mg[F]/g creatinine in urine end-of-shift

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 23 milligram per cubic meter

PAC-2: 250 milligram per cubic meter

PAC-3: 1500 milligram per cubic meter

DFG MAK: 1 mg[F]/m^3, inhalable fraction [skin]; Peak Limitation Category II(4); Pregnancy Risk Group C; BAT: 7.0 mg[F]/g creatinine in urine at end-of-shift; 4.0 mg[F]/g creatinine in urine at the beginning of the next shift

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guidelines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg[F]/L. SafeDrinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg[F]/L; SMCL = 2 mg/F/L, as Fluoride.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Potassium fluoride can affect you when breathed in. Inhalation of dust or mist can cause severe irritation and burns of the eyes and skin. May cause permanent eye damage. Inhalation can cause irritation of the nose and throat causing sneezing, coughing and sore throat. High exposure can irritate the lungs, causing a build-up of fluid in the lungs. This can cause death.

Long-Term Exposure: These effects do not occur at the levels of fluorides used in water to prevent cavities. Repeated exposure can cause fluoride to build-up in the body. Can irritate the lungs; bronchitis may develop. Repeated exposure can cause fluoride to build up in the body causing stiffness, brittle bones; and crippling. Prolonged contact can cause sores in the nose and perforated septum.

Points of Attack: Lungs, skin.

Medical Surveillance: NIOSH lists the following tests: chest X-ray, electrocardiogram, pulmonary function tests: forced vital capacity, forced expiratory volume (1 sec); pelvic X-ray; sputum cytology; urine (chemical/metabolite); urine (chemical/metabolite) pre-and postshift; urinalysis (routine); CBC/differential.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA *12.5 milligram per cubic meter:* Qm (APF = 25) (any quarter-mask respirator). *25 milligram per cubic meter:* 95XQ (APF = 10)* [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or SA* (any supplied-air respirator). *62.5 milligram per cubic meter:* Sa:Cf (APF = 25)*+ (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25)* *if not present as a fume* (any powered, air-purifying respirator with a high-efficiency particulate filter). *125 milligram per cubic meter:* 100F (APF = 50)+ [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *250 milligram per cubic meter:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50)+ [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or SCBAE (any appropriate escape-type, SCBA). *Substance reported to cause eye irritation or damage; may require eye protection. +May need acid gas sorbent.

Storage: (1) Color code-White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Aqueous solutions corrode glass and consequently are prepared and stored in polyethylene containers. The pure solid may be stored in glass containers. (2) Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Potassium fluoride must be stored to avoid contact with strong acids (such as hydrochloric, sulfuric, and nitric), since violent reactions occur. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1812 Potassium fluoride, solid, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide; water spray; or foam extinguishers. Thermal decomposition products may include potassium oxide and fluorine. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173) (101); (138); (122). (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Potassium Fluoride, Trenton, NJ (November 2004)

Potassium Hydroxide P:0950

Formula: HKO; KOH
Synonyms: Caustic potash; Hidroxido potasico (Spanish); Hydroxide de potassium (French); Kaliumhydroxid (German); KOH; LYE; Potassa; Potasse caustique (French); Potassium hydrate; Potassium (hydrixyde de) (French)
CAS Registry Number: 1310-58-3; 548-08-7 (liquid)
HSDB Number: 1234
RTECS Number: TT2100000
UN/NA & ERG Number: UN1813 (solid)/154; UN1814 (solution)/154
EC Number: 215-181-3 [*Annex I Index No.:* 019-002-00-8]
Regulatory Authority and Advisory Information
Hazard Alert: Suspected of causing genetic defects, Violently water reactive Primary irritant (w/o allergic reaction).
Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)
Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 1000 lb (454 kg)
Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.
Hazard Symbols, Risk & Safety statements: Hazard Symbol: T, C; Risk phrases: R14/15; R21/22; R35; R62; Safety phrases: S26; S37/39; S45 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.
Description: Potassium hydroxide is a white deliquescent solid. Molecular weight = 56.1; Specific gravity (H_2O:1) = 2.04; Boiling point = 1327°C; Freezing/Melting point = 380°C; also reported @ 406°C (varies with water content). Hazard Identification (based on NFPA-704 M Rating System) (*45%*): Health 3, Flammability 0, Reactivity 1₩. Soluble in water; solubility = 107% @ 15°C; violent reaction, releasing heat and forming a caustic solution.
Potential Exposure: KOH is generally used as an alkali and in the manufacture of other potassium compounds.
Incompatibilities: A strong base. Violent reaction with acids, alcohols, water, metals (when wet), halogenated hydrocarbons; maleic anhydride. Heat is generated if KOH comes in contact with water and carbon dioxide from the air. Corrosive to zinc, aluminum, tin and lead in the presence of moisture releasing combustible/explosive hydrogen gas. Can absorb water from air and give off sufficient heat to ignite surrounding combustible materials.
Permissible Exposure Limits in Air:
OSHA PEL: None
NIOSH REL: 2 milligram per cubic meter Ceiling Concentration
ACGIH TLV[1]: 2 milligram per cubic meter Ceiling Concentration
Protective Action Criteria (PAC) Ver. 29[138]
PAC-1: 0.18 milligram per cubic meter
PAC-2: 2 milligram per cubic meter
PAC-3: 54 milligram per cubic meter
Australia: TWA 2 milligram per cubic meter, 1993; Austria: MAK 2 milligram per cubic meter, 1999; Belgium: STEL 2 milligram per cubic meter, 1993; Denmark: TWA 2 milligram per cubic meter, 1999; Finland: TWA 2 milligram per cubic meter, 1999; Japan: STEL 2 milligram per cubic meter, 1999; Norway: TWA 2 milligram per cubic meter, 1999; the Netherlands: MAC 2 milligram per cubic meter, 2003; Switzerland: MAK-W 2 milligram per cubic meter, 1999; United Kingdom: STEL 2 milligram per cubic meter, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Ceiling Concentration 2 milligram per cubic meter. Several states have set guidelines or standards for KOH in ambient air[60] ranging from 16.0 μ/m^3 (Virginia) to 20 μ/m^3 (North Dakota) to 48 μ/m^3 (Nevada).
Determination in Air: Use NIOSH Analytical Method (IV) #7401, alkaline Dusts.
Routes of Entry: Inhalation, ingestion; skin and/or eye contact.
Harmful Effects and Symptoms
Short-Term Exposure: Potassium hydroxide can affect you when breathed in. Potassium hydroxide is highly corrosive. Eye contact causes immediate severe burns and can lead to blindness. Skin contact causes severe skin burns. Exposure can irritate the nose, throat, and airways; causing sneezing, coughing, and sores in the nose. Higher levels can irritate the lungs and cause a build-up of fluid (pulmonary edema). This can cause death. Ingestion may be fatal; causes epigastrium, hermatemesis, collapse, and stricture of esophagus.
Long-Term Exposure: May cause sores in the nose and perforation of the nasal septum. May cause lung damage.
Points of Attack: Eyes, skin, respiratory system.
Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following is recommended. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure.
First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be

delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. For solutions of 30%−70%, natural rubber; Neoprene, nitrile, nitrile + PVC, Neoprene + natural rubber, and polyethylene are recommended. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid or dust-proof goggles and face shield when working with powders or dusts, unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures over 2 milligram per cubic meter, use an NIOSH/MSHA or European Standard EN 149-approved full facepiece respirator with a high efficiency particulate filter. More protection is provided by a powered-air purifying respirator. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. *Where there is potential for high exposures exists*, use an NIOSH/MSHA or European Standard EN 149-approved supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use an NIOSH/MSHA or European Standard EN 149-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-White stripe: Contact Hazard; Store separately; not compatible with materials in solid white category. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Potassium hydroxide must be stored to avoid contact with water or moisture and metals, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from acids, explosives, combustible materials and organic peroxides. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored.

Shipping: UN1814 (solution) & UN1813 (solid); Potassium hydroxide, solid or solution, Hazard class: 8; Labels: 8-Corrosive material.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate the area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Potassium hydroxide may ignite surrounding material if it absorbs water. Thermal decomposition products may include oxide of potassium. Extinguish fire using an agent suitable for type of surrounding fire. Potassium hydroxide itself does not burn. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dilute with large volume of water, neutralize and flush to sewer[22].

References

(31); (173); (101); (138); (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Potassium Hydroxide, Trenton, NJ (May 2001).

(173); (101); (138).

Potassium Nitrate P:0960

Formula: KNO_3

Synonyms: Kaliumnitrat (German); Niter; Nitre; Nitric acid, potassium salt; Saltpeter; Vicknite

CAS Registry Number: 7757-79-1

HSDB Number: 1227

RTECS Number: TT3700000

UN/NA & ERG Number: UN1486/140

EC Number: 231-818-8

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Theft hazard* 400 (Commercial grade).

Hazard Alert: Strong oxidizer, Suspected of causing genetic defects, Suspected reprotoxic hazard.

United States National Primary Drinking Water Regulations: MCLG = 10 mg[N]/L; MCL = 10 mg[N]/L nitrate measured as Nitrogen.

FDA-over the counter drug

Hazard Symbols, Risk & Safety statements: Hazard Symbol: O, Xi, Xn; Risk phrases: R8; R22; R25; R36/37/

38; R62; R63; Safety phrases: S1; S7; S21; S24/25; S26; S36; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Potassium nitrate is an odorless, white or colorless crystalline powder with a salty, taste. Molecular weight = 101; Specific gravity (H_2O:1) = 2.1; Boiling point = (decomposes) 400°C; Freezing/Melting point = 334°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 3, Oxidizer. Highly soluble in water; solubility = 36% @ 25°C.

Potential Exposure: Used to make explosives, gunpowder, fireworks, rocket fuel; matches, fertilizer, fluxes, glass manufacture; and as a diuretic

Incompatibilities: A powerful oxidizer. Dangerously reactive and friction-and shock-sensitive when mixed with organic materials and many materials. Violent reactions with reducing agents; chemically active metals; charcoal, trichloroethylene.

Permissible Exposure Limits in Air:

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 9 milligram per cubic meter

PAC-2: 100 milligram per cubic meter

PAC-3: 600 milligram per cubic meter

Permissible Exposure Limits in Water: Safe Drinking Water Act (47FR 9352): MCLG = 10 mg[N]/L; MCL = 10 mg[N]/L nitrate measured as Nitrogen.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Contact can cause eye and skin irritation. Inhalation can cause respiratory tract irritation, coughing, and wheezing. High levels of exposure can interfere with the blood's ability to carry oxygen, causing headache, dizziness, cyanosis, methemoglobinemia, with Blue color to the skin and lips. Higher levels can cause breathing difficulty, collapse and death.

Long-Term Exposure: There is limited evidence that this chemical can damage the developing fetus. Infants below the age of 6 months who drink water containing nitrate in excess of of the MCL could become seriously ill and, if untreated, may die. Symptoms include shortness of breath and blue-baby syndrome.

Points of Attack: Blood.

Medical Surveillance: Blood test for methemoglobin.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to Physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Check oxygen content prior to entering storage area. Color code-Yellow: Reactive Hazard; Store in a location separate from other materials, especially organic materials, flammables and combustibles, and other incompatible materials. Oxidizers, including oxidizing gases, should have a boundary separation of 8—10 meters or a 1-hour fire wall from flammable or reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from all other materials. Do not store on wooden floors. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Store in a cool, well ventilated area away from incompatible materials listed above. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage.

Shipping: UN1486 Potassium nitrate, Hazard Class: 5.1; Labels: 5.1-Oxidizer.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until

cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Thermal decomposition products may include oxides of nitrogen and potassium. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Potassium Nitrate, Trenton, NJ (November 2004)

Potassium Nitrite P:0970

Formula: KNO_2

Synonyms: Kaliumnitrat (German); Niter; Nitre; Nitrous acid, Potassium salt; Saltpeter; Vicknite

CAS Registry Number: 7758-09-0

HSDB Number: 1216

RTECS Number: TT3750000

UN/NA & ERG Number: UN1488/140

EC Number: 231-832-4 [*Annex I Index No.:* 007-011-00-X]

Regulatory Authority and Advisory Information

Hazard Alert: Combustible, Strong oxidizer, Suspected of causing genetic defects, Suspected reprotoxic hazard, Environmental hazard.

United States National Primary Drinking Water Regulations: MCLG = 1 mg[N]/L; MCL = 1 mg[N]/L nitrite measured as Nitrogen

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazardous to aquatic life or environment, with possible long lasting effects[291]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: O, T, N; Risk phrases: R8; R25; R22; R35; R51; R62; R63; Safety phrases: S1/2; S26; S29; S36/37/39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Potassium nitrite is a white to yellowish crystalline solid. Molecular weight = 85.1; Specific gravity (H_2O:1) = 1.92; Boiling point = decomposition starts @ 350°C; explosion @ 535°C; Freezing/Melting point = 440°C. Hazard Identification (based on NFPA-704 M Rating System): Health 0, Flammability 1, Reactivity 2 (Oxidizer). Soluble in water; solubility = 280 gm/100 mL.

Potential Exposure: Potassium nitrite is used in chemical analysis, as a food additive; in fertilizers; in medications as a vasodilator and as antidote for cyanide poisoning.

Incompatibilities: A strong oxidizer. Reacts violently with combustible and reducing materials. Heat above 530°C may cause explosion. Incompatible with cyanide salts; boron, ammonium sulfate; potassium amide; and acids. Decomposes on contact with even weak acids producing toxic nitrogen oxide fumes.

Permissible Exposure Limits in Air:

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 4.1 milligram per cubic meter

PAC-2: 45 milligram per cubic meter

PAC-3: 3000 milligram per cubic meter

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Potassium nitrite can affect you when breathed in. Contact can cause eye and skin burns. Breathing the dust or mist can irritate the nose, throat and lungs, and may cause cough with phlegm. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. High levels can affect the vascular system and interfere with the ability of the blood to carry oxygen (methemoglobinemia), causing headaches, weakness, dizziness and cyanosis, a bluish color to the skin and lips. Higher levels can cause troubled breathing; collapse and even death.

Long-Term Exposure: Repeated skin contact causes dermatitis; drying and cracking. May cause lung irritation; bronchitis may develop. There is limited evidence that potassium nitrite may damage the developing fetus. Infants below the age of 6 months who drink water containing nitrite in excess of of the MCL could become seriously ill and, if untreated, may die. Symptoms include shortness of breath and blue-baby syndrome.

Points of Attack: Eyes, skin, blood, lungs.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: blood test for methemoglobin. Lung function tests. Consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Note to Physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposure to potassium nitrite, use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece respirator with a high efficiency particulate filter. Greater protection is provided by a powered-air purifying respirator. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Check oxygen content prior to entering storage area. Color code-Yellow: Reactive Hazard; Store in a location separate from other materials, especially organic materials, flammables and combustibles, and other incompatible materials. Oxidizers, including oxidizing gases, should have a boundary separation of 8−10 meters or a 1-hour fire wall from flammable or reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from acids, cyanide salts; boron, ammonium sulfate and potassium amide. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Store in a cool, well ventilated area away from incompatible materials listed above. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage.

Shipping: UN1488 Potassium nitrite, Hazard Class: 5.1; Labels: 5.1-Oxidizer. UN1479 Oxidizing solid, n.o.s., Hazard Class: 5.1; Labels: 5.1-Oxidizer, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. Keep potassium nitrite out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Store in a cool, well ventilated area away from incompatible materials listed above. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage.

Fire Extinguishing: Does not burn but may ignite other combustible materials. Thermal decomposition products may include oxides of nitrogen and potassium. Use dry chemical, CO_2, water spray; or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Potassium Nitrite, Trenton, NJ (November 2004)

Potassium Permanganate P:0980

Formula: $KMnO_4$

Synonyms: Cairox; Chameleon mineral; C.I. 77755; Condy's crystals; Kaliumpermanganat (German); Permanganic acid, potassium salt; Permanganate de potassium (French); Permanganate of potash; Permanganato potasico (Spanish); Potassium (permanganate de) (French); Purple salt

CAS Registry Number: 7722-64-7

HSDB Number: 1218

RTECS Number: SD6475000

UN/NA & ERG Number: UN1490/140

EC Number: 231-760-3 [*Annex I Index No.:* 025-002-00-9]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Theft hazard* 400 (Commercial grade).

United States Environmental Protection Agency Gene-Tox Program, Negative: *In vitro* cytogenetics-nonhuman; N crassa-reversion; Negative: B *subtilis* rec assay.

Hazard Alert: Neurotoxic (cumulative) as Mn, Strong oxidizer, Suspected of causing genetic defects, Suspected reprotoxic hazard, Environmental hazard.

List II, DEA chemical code 6579 (Title 21 CFR1310.02)

United States Environmental Protection Agency, FIFRA 1998 Status of Pesticides: Pesticide subject to registration or re-registration

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 100 lb (45.4 kg).

Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: O, Xn, N; Risk phrases: R8; R22; R36/37/38; R50/53; R62; R63; Safety phrases: S1; S2; S17; S22; S24; S26; S29/35; S37, R61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Potassium permanganate is a dark purple crystalline solid. Molecular weight = 158.03; Specific gravity (H_2O:1) = 2.7@ 20°C; Freezing/Melting point = (decomposition, with evolution of oxygen) $<240°C$. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 3 (Oxidizer). Highly soluble in water.

Potential Exposure: Potassium permanganate is used in solutions as a disinfectant, topical antibacterial agent; deodorizer, bleaching agent; and in air and water purification.

Incompatibilities: Potassium permanganate is a powerful oxidizing agent, that is, it will initiate a fire or explosion if brought into contact with reducing materials; combustibles, organic materials; strong acids; or oxidizable solid, liquid or gas; glycerin, ethylene glycol; polypropylene, hydroxylamine, hydrogen trisulfide; antimony, arsenic, sulfuric acid; hydrogen peroxide; phosphorus, and any finely divided combustible material. It will decompose, and release oxygen, if brought into contact with heat, alcohol, acids, ferrous salts; iodides and oxalates.

Permissible Exposure Limits in Air:

Manganese:

NIOSH IDLH = 500 mg[Mn]/m^3

OSHA PEL: 5 mg[Mn]/m^3 Ceiling Concentration (inorganic compounds and fume)

NIOSH REL: 1 mg[Mn]/m^3 TWA; 3 mg[Mn]/m^3 STEL

ACGIH TLV[1] 0.02 mg[Mn]/m^3, respirable fraction; 0.1 mg[Mn]/m^3, inhalable fraction; not classifiable as a human carcinogen.

DFG MAK (*inorganic compounds and fume*): 0.5 mg[Mn]/m^3 inhalable fraction (Mn and its inorganic compounds); Pregnancy Risk Group C

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 8.6 milligram per cubic meter

PAC-2: 14 milligram per cubic meter

PAC-3: 150 milligram per cubic meter

DFG MAK: 0.5 mg[Mn]/m^3 inhalable fraction (Mn and its inorganic compounds); Pregnancy Risk Group C

Australia: TWA 5 mg[Mn]/m^3, 1993; Belgium: TWA 5 mg [Mn]/m^3, 1993; Denmark: TWA 2.5 mg[Mn]/m^3, 1999; Finland: TWA 0.5 mg[Mn]/m^3, 1999; Hungary: TWA 0.3 mg[Mn]/m^3, short-term exposure limit 0.6 mg[Mn]/m^3, 1993; Japan: 0.3 mg[Mn]/m^3, respirable dust, 1999; Poland: MAC (TWA) 0.3 mg[Mn]/m^3; MAC 5 mg[Mn]/m^3, 1999; Sweden: NGV 1 mg[Mn]/m^3, KTV 2.5 mg[Mn]/m^3 (resp. dust), 1999; Sweden: NGV 2.5 mg[Mn]/m^3, KTV 5 mg [Mn]/m^3 (total dust), 1999; United Kingdom: LTEL 5 mg [Mn]/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 0.2 mg[Mn]/m^3.

Determination in Air: *Manganese:* Use NIOSH Analytical Method, Elements by ICP, #7300; #7301; #7303; #9102; Elements in blood or tissue, #8005; Metals in urine, #8310; OSHA Analytical Method, ID-125G or ID121.

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 50 μg[Mn]/L; State Drinking Water Standards: New York: 300 μg[Mn]/L; State Drinking Water Guidelines: California 500 μg[Mn]/L; Connecticut: 500 μg

[Mn]/L; Maine: 500 μg[Mn]/L; Minnesota: 300 μg[Mn]/L; New Hampshire: 100 μg[Mn]/L. World Health Organization (WHO) limit: 400 μg(Mn)/L

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: *Inhalation:* Irritates the respiratory tract, causing coughing and chest tightness. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. *Skin:* Concentrated solutions may cause severe irritation and burns. Dilute solutions can cause brown staining of the skin and hardening of outer skin layer. Penetration is poor. *Eyes:* Concentrated solution or crystalline material can cause severe irritation and damage that may be permanent. *Ingestion:* Dilute solutions (1%) may cause burning of the throat, nausea, vomiting and stomach pain. Concentrations of 2%−3% may cause anemia and swelling of the throat with a possibility of suffocation. More concentrated solutions may result in above symptoms plus the onset of kidney damage and circulatory collapse. The probable lethal dose is 1½ teaspoons (10 grams) for a 150 lb (70 kilogram) adult.

Long-Term Exposure: May cause mutations and might pose a cancer risk or reproduction hazard. May cause lung effects.

Points of Attack: Lungs, skin.

Medical Surveillance: NIOSH lists the following tests (for manganese and fume): whole blood (chemical/metabolite); biologic tissue/biopsy; CBC; chest X-ray; pulmonary function tests; urine (chemical/metabolite); urinalysis (routine). For those with frequent or potentially high exposure the following are recommended before beginning work and at regular times after that. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give egg whites and milk. A tracheotomy may be required if swelling in throat blocks air. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid, unless full facepiece respiratory protection is worn. Wear dust-proof goggles when working with powders or dust, unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 10 milligram per cubic meter:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *Up to 25 milligram per cubic meter:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); PaprHie (APF = 25) (any powered air-purifying respirator with a high-efficiency particulate filter). *Up to 50 milligram per cubic meter:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 500 milligram per cubic meter:* Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); ASCBA (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Check oxygen content prior to entering storage area. Color code-Yellow: Reactive Hazard; Store in a location separate from other materials, especially organic materials, flammables and combustibles, and other incompatible materials. Oxidizers, including oxidizing gases, should have a boundary separation of 8−10 meters or a 1-hour fire wall from flammable or reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Potassium permanganate must be stored to avoid contact with strong acids (such as hydrochloric, sulfuric, and nitric); any organic material; or any other combustible or oxidizable solid, liquid or gas, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area. Protect containers from physical damage. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Store in a cool, well ventilated area away from incompatible materials listed above. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage.

Shipping: UN1490 Potassium permanganate, Hazard Class: 5.1; Labels: 5.1-Oxidizer.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. *Liquid:* Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. *Dry material:* Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. *Large spills:* Clean up should be performed by trained personnel. Cover the weak reducing agents, such as sodium thiosulfate, bisulfites, or ferrous salts. Bisulfites or ferrous salts need an additional promoter of three molar sulfuric acids to accelerate reaction. Transfer slurry or sludge to large container of water and neutralize with soda ash. Keep potassium permanganate out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Potassium permanganate does not burn. However, it is a powerful oxidizer. Potassium permanganate decomposes @ 240°C/464°F and releases oxygen which will greatly intensify an ongoing fire. Thermal decomposition products may include oxides of potassiuma nd metal. Use dry chemical or carbon dioxide extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: React with reducing agent, neutralize and flush to sewer[22].

References

(31); (173); (101); (138); (2); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 8, No. 4, 2–12 (1988)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Potassium Permanganate, Bureau of Toxic Substance Assessment, Albany, NY (Version 2, February 1986 and Version 3)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Potassium Permanganate, Trenton, NJ (May 2002)

Potassium Persulfate P:0990

Formula: $K_2O_8S_2$; $K_2S_2O_8$

Synonyms: Anthion; Dipotassium peroxodisulphate; Dipotassium persulfate; Potassium persulphate; Potassium peroxydisulphate; Potassium peroxydisulfate; Peroxydisulfuric acid, Disodium salt

CAS Registry Number: 7727-21-1

HSDB Number: 2638

RTECS Number: SE0400000

UN/NA & ERG Number: UN1492/140

EC Number: 231-781-8 [*Annex I Index No.:* 016-061-00-1] [dipotassium peroxodisulphate]

Regulatory Authority and Advisory Information

Hazard Alert: Strong oxidizer, Sensitization hazard (skin, resp.).

United States National Primary Drinking Water Regulations: SMCL = 250 mg[SO_4^{-2}]/L as sulfate

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%, as persulfate compounds.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: O, Xi, Xn; Risk phrases: R8; R9; R22; R36/37/38; R42/43; Safety phrases: S2; S17; S22; S24; S26; S37 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Potassium persulfate is a colorless or white, odorless crystalline material. Molecular weight = 272.34; Specific gravity (H_2O:1) = 2.5 @ 20°C; Boiling point = 109.5°C; Freezing/Melting point = (decomposes) <100°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 3, Oxidizer. Soluble in water.

Potential Exposure: Potassium persulfate is used as a bleaching and oxidizing agent; it is used in redox polymerization catalysts; in the defiberizing of wet strength paper and in the desizing of textiles. Soluble in water.

Incompatibilities: A strong oxidizer. Incompatible with combustible, organic or other readily oxidizable materials; sulfur, metallic dusts, such as aluminum dust; chlorates and perchlorates. Attacks chemically active metals. Keep away from moisture.

Permissible Exposure Limits in Air:

ACGIH: 0.1 mg $[S_2O_8]/m^3$ TWA *as persulfates*

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 0.3 milligram per cubic meter

PAC-2: 26 milligram per cubic meter

PAC-3: 160 milligram per cubic meter

Permissible Concentration in Water: No criteria set. (Aqueous solution decomposes even at room temperature).

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Potassium persulfate can affect you when breathed in. Breathing the dust or mist can cause eye, nose and throat irritation with sneezing, coughing and sore throat. Contact with skin and eyes can cause burns and permanent damage. Prolonged or repeated exposures may lead to sores of the inner nose. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: May cause sores of the inner nose. Skin contact may cause skin rash, with dryness and cracking. May cause lung irritation.

Points of Attack: Lungs.

Medical Surveillance: For those with frequent or potentially high exposure the following are recommended before beginning work and at regular times after that. Lung function tests. If symptoms develop or overexposure is suspected, the following may also be useful: consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA or European Standard EN 149-approved dust mask when dust is encountered. Where there is potential exists for exposures *over 5 milligram per cubic meter*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece respirator with a high efficiency particulate filter. Greater protection is provided by a powered-air purifying respirator. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Check oxygen content prior to entering storage area. Color code-Yellow: Reactive Hazard; Store in a location separate from other materials, especially organic materials, flammables and combustibles, and other incompatible materials. Oxidizers, including oxidizing gases, should have a boundary separation of 8−10 meters or a 1-hour fire wall from flammable or reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Potassium persulfate must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates); strong oxidizers (such as chlorine, bromine, and fluorine); and chemically active metals (such as potassium, sodium, magnesium, and zinc), since violent reactions occur. Protect storage against physical damage. Store in tightly closed containers in a cool, well-ventilated area away from moisture. Store in a cool, well ventilated area away from incompatible materials listed above. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage.

Shipping: UN1492 Potassium persulfate, Hazard Class: 5.1; Labels: 5.1-Oxidizer.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. Keep potassium persulfate out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Thermal decomposition products may include oxides of potassium and sulfur. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Use large volumes of reducing agents (bisulfites, e.g.). Neutralize with soda ash and drain into sewer with abundant water.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Potassium Persulfate, Trenton, NJ (May 1986)

Potassium Silver Cyanide P:1000

Formula: AgC_2KN_2; $KAg(CN)_2$

Synonyms: **Potassium silver cyanide**; Argentate(1-), bis (cyano-C)-, potassium; Argentate(1-), dicyano-, potassium; Argentates(i)(sol), dicyano-; Cianuro de plata y potasio (Spanish); Dicyano potassium argentate; Potassium argentocyanide; Potassium argentocyanide; Potassium bis(cyano-c) argentate (1-); Potassium bis(cyano-c)argentate(1-); Potassium cyanoargentate(I); Potassium dicyanoargentate; Silver potassium cyanide

CAS Registry Number: 506-61-6

HSDB Number: 6053

RTECS Number: TT5775000

UN/NA & ERG Number: UN1588 (cyanides, inorganic, solid, n.o.s.)/157

EC Number: 208-047-0 (potassium dicyanoargentate)

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Highly toxic, Dangerously reactive with water, Primary irritant (w/o allergic reaction), Environmental hazard.

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P099

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500 lb (227 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 1 lb (0.454 kg)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T+, N, Xi: Risk phrases: R26/27/28; R32; R36/37/38; R50/53; Safety phrases: S1/2; S7; S26; S27; S29; S37/39; S45; S60; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Cyanide compounds:

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

United States National Primary Drinking Water Regulations: MCLG = 0.2 mg[CN^-]/L; MCL = 0.2 mg [CN^-]/L as cyanide

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants, as cyanide, total

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P030 as cyanides soluble salts and complexes, n.o.s.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents. as cyanides, soluble salts and complexes, n.o.s.

EPCRA (Section 313): X + CN-where X = H+ or any other group where a formal dissociation may occur. For example, KCN or Ca(CN)2. Form R *de minimis* concentration reporting level: 1.0%. Section 313 Category Code N106 (cyanide compounds)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%., Cyanide compounds, inorganic, n.o.s.

United States DOT Regulated Marine Pollutant (49CFR172.101, appendix B) as cyanide mixtures, cyanide solutions or cyanides, inorganic, n.o.s.

Silver compounds:

Clean Water Act: Section 307 Toxic Pollutants as silver and compounds.

RCRA Section 261 Hazardous Constituents, as silver compounds, n.o.s., waste number not listed.

EPCRA (Section 313): Includes any unique chemical substance that contains silver as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: 1.0%. Section 313 Category Code N740 (silver compounds).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Potassium silver cyanide is a white crystalline solid. Molecular weight = 199.01; Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0₩. Soluble in water; dangerously reaction releasing cyanide vapors.

Potential Exposure: Potassium silver cyanide is used in silver plating; as a bactericide; and in the manufacture of antiseptics. Not registered for use as a pesticide in the United States

Incompatibilities: Contact with acid, acid fumes release hydrogen cyanide. Incompatible with water, steam, or when heated to decomposition, emits toxic and flammable cyanide vapors. Potassium silver cyanide reacts with carbon dioxide releasing hydrogen cyanide. Light sensitive. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Acids precipitate silver cyanide from its aqueous solution. Fusion with metal chlorates, perchlorates, nitrates or nitrites can cause violent explosions[136].

Permissible Exposure Limits in Air:
NIOSH IDLH = 25 mg[CN]/m^3
OSHA PEL: 5 mg[CN]/m^3/4.7 ppm TWA
NIOSH REL: 5 mg[CN]/m^3/4.7 ppm/10 min., Ceiling Concentration
ACGIH TLV[1]: 5 mg[CN]/m^3 [skin] Ceiling Concentration
Protective Action Criteria (PAC) Ver. 29[138]
PAC-1: 2.9 milligram per cubic meter
PAC-2: 32 milligram per cubic meter
PAC-3: 190 milligram per cubic meter
DFG MAK: 2 mg[CN]/m^3, inhalable fraction TWA; Peak Limitation Category II(1) [skin]; Pregnancy Risk Group: C

Determination in Air: Use NIOSH Analytical Method (IV) #7904, Cyanides. See also Method #6010, Hydrogen cyanide[18].

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 200 μg[CN]/L; State Drinking Water Standards: California 150 μg[CN]/L; State Drinking Water Guidelines: Arizona 220 μg[CN]/L; Maine. 140 μg [CN]/L; Minnesota 100 μg[CN]/L. United States Army field drinking-water standards for cyanide: 2 mg[CN]/L assuming a water consumption of 15 L/day and 6 mg[CN]/L assuming a water consumption of 5 L/day. United States Army field drinking-water standards for cyanide, long-term consumption 0.5 mg[CN]/L; Short-term consumption; Raw water constituents (maximum) 20 mg[CN]/L.

Determination in Water: Distillation followed by silver nitrate titration or colorimetric analysis using pyridine pyrazolone (or barbituric acid).

Routes of Entry: Inhalation, ingestion, skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: The primary health hazard is as a cyanide. It is poisonous and may be fatal if inhaled, swallowed or absorbed through the skin. Fire may produce irritating or poisonous gases. As a cyanide, massive doses may produce, without warning, sudden loss of consciousness and prompt death from respiratory arrest. Smaller but still lethal doses result in illness that may be prolonged for 1 or more hours. Other symptoms may include numbness in throat, salivation, nausea, anxiety, dizziness, irregular breathing; odor of bitter almonds may be noted on breath, blood pressure may rise, slowing of the heart beat; sensation of constriction in the chest; unconsciousness followed by violent convulsions and paralysis. LD_{50} = (oral-rat) 21 mg/kg.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Use amyl nitrate capsules if symptoms develop. All area employees should be trained regularly in emergency measures for cyanide poisoning and in CPR. A cyanide antidote kit should be kept in the immediate work area and must be rapidly available. Kit ingredients should be replaced every 1−2 years to ensure freshness. Persons trained in the use of this kit; oxygen use, and CPR must be quickly available.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 25 milligram per cubic meter:* Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive pressure mode). *Escape:* GmFS100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted canister providing protection against the compound of concern and having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage.

Shipping: UN1588 Cyanides, inorganic, solid, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include hydrogen cyanide, cyanide and oxides of nitrogen, potassium, metal and carbon. Use dry chemical, carbon dioxide; water spray; or foam for *small fire*s; and water spray, fog, or foam for *large fires*. Move containers of this material away from fire area if this can be done without risk. Isolate hazard area and deny entry. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Wear positive pressure breathing apparatus and special protective clothing. Fight fire from maximum distance. Dike fire control water for later disposal. Do not scatter the material. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (173); (101); (138); (2); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Potassium Silver Cyanide, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

Potassium Sulfide P:1010

Formula: K_2S

Synonyms: Dipotassium monosulfide; Dipotassium sulfide; Hepar sulfurous; Potassium monosulfide

CAS Registry Number: 1312-73-8

HSDB Number: 1204

RTECS Number: TT6000000 (anhydrous); TT6008000 (hydrated)

UN/NA & ERG Number: UN1382 (anhydrous)/135; UN1847 (hydrated)/153

EC Number: 215-197-0 [*Annex I Index No.:* 016-006-00-1]

Regulatory Authority and Advisory Information

Hazard Alert: Highly flammable solid, Pyrophoric hazard (dry), Environmental hazard.

Hazardous to aquatic life or environment, with possible long lasting effects[291].

Hazard Symbols, Risk & Safety statements: Hazard Symbol: C, N; Risk phrases: R10; R31; R34; R50; Safety phrases: S1/2; S26; S29; S41; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Potassium sulfide is a brownish-red crystalline solid. Molecular weight = 110.26; Freezing/Melting point = 840°C. Soluble in water.

Potential Exposure: Potassium sulfide is used as a reagent in analytical chemistry; and in pharmaceutical preparations.

Incompatibilities: May explosively decompose from shock, friction, or concussion. Dust or granules may spontaneously ignite on contact with air. The aqueous solution is a strong base; reacts violently with strong acids and acid fumes. The solid material decomposes on contact with acids producing hydrogen sulfide, and oxidizers producing sulfur dioxide.

Permissible Exposure Limits in Air:

No standards or Protective Action Criteria (PAC) available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Potassium sulfide can affect you when breathed in. Breathing the dust or mist can irritate the eyes, nose and throat with sneezing, coughing and sore throat. Potassium sulfide is a corrosive chemical and contact with skin and eyes can cause burns. High exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: Corrosive materials can cause lung problems; bronchitis may develop. Prolonged exposure can lead to sores or ulcers of the inner lining of the nose.

Points of Attack: Lungs, skin.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water, or milk. Do not induce vomiting. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures to potassium sulfide use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. Where there is potential for high exposures and liquid potassium sulfide exists, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: (1) Color code-Red Stripe: Flammability Hazard (4.2): Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 meters or a 1-hour fire wall from flammable or reactive materials. Store flammable solids (spontaneously combustible) up to maximum allowable quantity per control area in an approved flammable storage area. Do not store in a basement. (2) Color code-White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Potassium sulfide must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates) and strong acids (such as hydrochloric, sulfuric, and nitric); since violent reactions occur. Sources of ignition, such as smoking and open flames, are prohibited where potassium sulfide is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Protect storage against physical damage.

Shipping: UN1382 Potassium sulfide, anhydrous or Potassium sulfide with <30% water of crystallization, Hazard Class: 4.2; Labels: 4.2-Spontaneously combustible material.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Thermal decomposition products may include hydrogen sulfide and oxides of sulfur. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include hydrogen sulfide and sulfur oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to

fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (170); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Potassium Sulfide, Trenton, NJ (March 2001).

Procarbazine & Procarbazine Hydrochloride P:1020

Formula: $C_{12}H_{19}N_3O$; $CH_3NHNHCH_2C_6H_4CONHCH(CH_3)_2$
Synonyms: Ibenzmethyzine; 2-(*p*-Isopropyl carbamoyl benzyl)-1-methylhydrazine; *N*-Isopropyl-α-(2-methylhydrazino)-*p*-toluamide *N* isopropyl; Matulane; 4-[(2-Methylhydrazino)methyl]-*N*-isopropylbenzamide; 1-[Methyl-2-(-isopropylcarbamoyl)benzyl]hydrazine; MIH; Natulan; NSC-77213; PCB; RO 4-6467

hydrochloride: Ibenzmethyzine hydrochloride; Ibenzmethyzin hydrochloride; IBZ; 1-(*p*-Isopropylcarbamoylbenzyl)-2-methylhydrazine hydrochloride; 2-[*p*-(Isopropylcarbamoyl) benzyl]-1-methylhydrazine hydrochloride; *N*-Isopropyl-*p*-(2-methylhydrazinomethyl)benzamidehydrochloride; *N*-Isopropyl-α-(2-methylhydrazino)-*p*-toluamide hydrochloride; Matulane; MBH; *N*-(1-Methylethyl)-4-[(2-methylhydrazino)methyl]benzamide monohydrochloride; *p*-(*N*′-Methylhydrazinomethyl)-*N*-isopropylbenzamide hydrochloride; 1-Methyl-2-*p*-(isopropylcarbamoyl)-benzohydrazine hydrochloride; 1-Methyl-2-(*p*-isopropylcarbamoylbenzyl)hydrazine hydrochloride; MIH hydrochloride; Nathulane; Natulan; Natulanar; Natulan hydrochloride; NCI-C01810; NSC-77213; PCBhydrochloride; Procarbazin (German); RO 4-6467

CAS Registry Number: 671-16-9; 366-70-1 (hydrochloride)
HSDB Number: 3250 (671-16-9)
RTECS Number: XS4550000; XS472000 (hydrochloride)
UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154
EC Number: 211-582-2; 206-678-6 (hydrochloride)

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen (Procarbazine & Procarbazine hydrochloride); IARC: (hydrochloride) Animal Sufficient Evidence; Human Limited Evidence, *probably carcinogenic to humans*, Group 2A, 1998; NTP: Report on Carcinogens, 2014; NCI: Carcinogenesis Studies (ipr); clear evidence: mouse, rat 1979.

California Proposition 65 Chemical[102]: Cancer (methylhydrazine and its salts) 7/1/1992; (procarbazine) 1/1/1988; (procarbazine hydrochloride) cancer 1/1/1988; Developmental/Reproductive toxin 7/1/1990.

Hazard Alert: Poison, Possible risk of forming tumors, Reproductive toxin: possible risk of gene damage/impaired fertilty; Suspected reprotoxic hazard, Drug.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T; Risk phrases: R45; R20/21/22; R27/28; R46; R50/53; R61; R62; R63; R68; Safety phrases: S13; S22; S36/37/39; S45; S53; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Procarbazine is a white to pale yellow crystalline powder with a slight odor. Molecular weight = 221.34. The hydrochloride has a similar description. Molecular weight = 257.80; Freezing/Melting point = 223−236°C (hydrochloride). Soluble in water.

Potential Exposure: Procarbazine is available in capsule form. The primary use of this drug is as an antineoplastic agent in the treatment of advanced Hodgkin's disease, and oat-cell carcinoma of the lung. The hydrochloride compound is used in treatment. The FDA approved use of procarbazine hydrochloride in 1969 and indicated that the drug should be used as an adjunct to standard therapy. Possible exposure occurs during manufacture of the drug and direct exposure during its subsequent administration to patients. Some of the metabolites of procarbazine hydrochloride are both carcinostatic and carcinogenic.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air: No standard set.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Can cause nausea, vomiting, diarrhea, stomach pain; loss of appetite and weight loss. Symptoms of exposure include [52] nausea, vomiting, anorexia, dry mouth; dysphagia, diarrhea, constipation, chills and fever; sweating, weakness, edema, cough, dermatitis, jaundice, headache, insomnia, coma.

Long-Term Exposure: A probable human carcinogen. There is some evidence that it causes cancer of the nervous system; blood forming organs; breast, lung, uterus, and leukemia in humans. It has been shown to cause cancer in the same sites in animals. May damage the testes. The hydrochloride is a teratogen in animals and may decrease the body's ability to produce blood cells, causing reduced white blood cells with increased infection and general weakness, reduced platelets; causing bleeding when cut or bruised; and/or reduced blood cells (anemia).

Points of Attack: Blood.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. CBC.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/ manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA-or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code -Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in a refrigerator or a cool, dry place. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25meters/75 feet.(NJ). Isolation Distance, Fire: 800 meters/ 0.5 miles[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen spilled material with water to avoid dust, than transfer material to a suitable container. Use absorbent dampened with water to pick up remaining material. Wash surfaces well with soap and water. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fireighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: It is inappropriate and possibly dangerous to the environment to dispose of expired or waste drugs and pharmaceuticals by flushing them down the toilet or discarding them to the trash. Household quantities of expired or waste pharmaceuticals may be mixed with wet cat litter or coffee grounds, double-bagged in plastic, discard in trash. Larger quantities shall carefully take into consideration applicable DEA, EPA, and FDA regulations. If possible return the pharmaceutical to the manufacturer for proper disposal being careful to properly label and securely package the material. Alternatively, the waste pharmaceutical shall be labeled, securely packaged and transported by a state licensed medical waste contractor to dispose by burial in a licensed hazardous or toxic waste landfill or incinerator.

References

(109); (102); (31); (173); (100).

National Cancer Institute, Bioassay of Procarbazine for Possible Carcinogenicity, DHHS Publication No. (NIH) 79-819, National Technical Information Service, Springfield, VA (1979)

(173); (101); (138).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Procarbazine hydrochloride, Trenton, NJ (August 2002)

Promecarb P:1030

Formula: $C_{12}H_{17}NO_2$: $C_6H_3(CH_3)(OCONHCH_3)CH(CH_3)_2$
Synonyms: Carbamic acid, methyl-, *m-cym*-5-yl ester; Carbamic acid, 3-methyl-5-(1-methylethyl)phenyl-, methyl ester; Carbamic acid, *N*-methyl-, 3-methyl-5-isopropropylphenyl ester; Carbamult; Carbanilic acid, 3-isopropyl-5-methyl-, methyl ester; *m-cym*-5-yl-methylcarbamate; ENT27,300; ENT 27,300-A; EP316; 3-Isopropyl-5-methylcarbamic acid methyl ester; 3-Isopropyl-5-methylphenyl *N*-methylcarbamate; 5-Isopropyl-*m*-tolyl methyl-carbamate; Methylcarbamic acid *m-cym*-5-yl ester; *N*-Methylcarbamic acid 3-methyl-5-isopropylphenyl ester; 5-Methyl *m*-cumenyl methylcarbamate; 3-Methyl-5-isopropyl-*N*-methyl carbamate; (3-Methyl-5-isopropylphenyl)-*N*-methylcarbamat (German); 3-Methyl-5-isopropylphenyl-*N*-methyl carbamate; 3-Methyl-5-(1-methylethyl)phenol methylcarbamate; 3-Methyl-5-(1-methylethyl)phenyl-carbamic acid methyl ester; Minacide; Morton EP-316; Phenol, 3-methyl-5-(1-methylethyl)-, methylcarbamate; Schering 34615; UC 9880; Union Carbide UC-9880
CAS Registry Number: 2631-37-0
HSDB Number: 1554
RTECS Number: FB8050000
UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154; UN2757 (carbamate pesticides, solid, toxic)/151
EC Number: 220-113-0 [*Annex I Index No.:* 006-037-00-9]
Regulatory Authority and Advisory Information
Hazard Alert: Poison, Highly toxic, Possible neurotoxic effects (methyl carbamate), Environmental hazard, Agricultural chemical.
United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P201
Superfund/EPCRA [40CFR 302 and 355, F R: 8/16/06, Vol 71, No. 158] Reportable Quantity (RQ): 1000 lb (454 kg)
RCRA, 40CFR261, Appendix 8 Hazardous Constituents
RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.056; Nonwastewater (mg/kg), 1.4
Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg)
Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 1000 lb (454 kg)
United States DOT Regulated Marine Pollutant (49CFR172.101, appendix B).
Hazardous to aquatic life or environment, with possible long lasting effects[291]. Do not allow release to the environment unless proper permits are obtained from the federal government.
Hazard Symbols, Risk & Safety statements: Hazard Symbol: T, N; Risk phrases: R25; R33; R50/53; Safety phrases: S1/2; S24; S29/35; S37; S41; S45; S60; S61 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.
Description: Promecarb is a colorless, odorless, crystalline solid. Molecular weight = 207.3; Boiling point = 345°C; Freezing/Melting point = 87−88°C; Vapor pressure = 3×10^{-5} mmHg @ 25°C;. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 1. Slightly soluble in water.
Potential Exposure: A potential danger to those involved in the manufacture, formulation or application of this non-systemic contact insecticide.
Incompatibilities: Alkalis.
Permissible Exposure Limits in Air:
Protective Action Criteria (PAC) Ver. 29[138]
PAC-1: 1.5 milligram per cubic meter
PAC-2: 16 milligram per cubic meter
PAC-3: 96 milligram per cubic meter
Determination in Water: Fish Tox = 33.48370000 ppb (INTERMEDIATE)
Routes of Entry: Inhalation, ingestion; skin and/or eye contact.
Harmful Effects and Symptoms
Short-Term Exposure: Promecarb is highly toxic by ingestion and is absorbed through the intact skin. It is a reversible cholinesterase inhibitor and its effects are related to action on the nervous system. Symptoms of exposure include diarrhea, nausea, vomiting, excessive salivation; headache, pinpoint pupils; and uncoordinated muscle movements are all common symptoms of exposure to carbamate insecticides.
Long-Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.
Points of Attack: Respiratory system, lungs, CNS; cardiovascular system, skin, eyes, plasma and red blood cell cholinesterase.
Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal."

Reassignment to work not involving carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also consider CBC. Consider chest X-ray following acute overexposure

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area away from alkaline materials.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25meters/75 feet.(NJ). Isolation Distance, Fire: 800 meters/0.5 miles[70]. Keep unnecessary people away; isolate hazard areas and deny entry. Stay upwind and keep out of low areas. Do not touch spilled material or breathe the dusts, vapors, or fumes from burning materials. Use water spray to reduce vapors. Do not handle broken packages without protective equipment. Wash away any material that may have contacted the body with soap and water. Take up *small spills* with sand or other noncombustible absorbent material and place in containers for later disposal. *Small dry spills:* with clean shovel place material into clean, dry container and cover; move containers from spill area. Dike far ahead of *large spills* for later disposal. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Soil Adsorption Index (K_{oc}) = 200, (estimate).

Fire Extinguishing: Extinguish fire using agent suitable for the surrounding fire, as the material itself burns with difficulty. Use water in flooding quantities as a fog. Use alcohol foam, carbon dioxide; or dry chemical. Thermal decomposition products may include oxides of nitrogen and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: *Small quantities:* treat with alkali and then bury. *Large quantities:* incineration[22]. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Promecarb, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

Prometon P:1034

Formula: $C_{10}H_{19}N_5O$

Synonyms: 2,4-Bis(isopropylamino)-6-methoxy-*s*-triazine; 2,6-Diisopropylamino-4-methoxytriazine; *N,N′*-Diisopropyl-6-methoxy-1,3,5-triazine-2,4-diamine; *N,N′*-Diisopropyl-6-methoxy-1,3,5-triazine-2,4-diyldiamine; G-31435; Gesafram; Gesafram 50; Gesagram; Ground zero;

Kleenwalk; 2-Methoxy-4,6-bis(isopropylamino)-1,3,5-triazine; 2-Methoxy-4,6-bis(isopropylamino)-*s*-triazine; 6-Methoxy-*N,N'*-bis(1-methylethyl)-1,3,5-triazine-2,4-diamine; Methoxypropazine; Nix; Noxall; Ontrack; Primatol; Prometone; *s*-Triazine, 2,4-bis(isopropylamino)-6-methoxy-; Weed-Go

CAS Number: 1610-18-0

HSDB Number: 1519

UN/NA & ERG Number: UN2763 (triazine pesticide, solid, toxic)/151

EC Number: 216-548-0

RTECS Number: XY4200000

Regulatory Authority and Advisory Information

Carcinogenicity[83]: EPA Group D, Not classifiable as a human carcinogen.

Hazard Alert: Poison, Combustible, Suspected reprotoxic hazard, Sensitization hazard, Environmental hazard.

Potential Ground water Pollutant [California FAC (Section 13149)]

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T, N, Xn; Risk phrases: R22; R36/37/38; R34; R40; R42; R51/53; Safety phrases: S16; S22; S26; S29/35; S36/37/39; S45; S53, S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Colorless crystalline solid or white powder. Odorless. Molecular weight 225.28; Specific gravity (H_2O:1) = 1.09 @ 20°C; Boiling point = 324°C; Freezing/Melting point = 91.5°C; Vapor pressure = 7.7×10^{-6} mmHg @ 20°C. Soluble in water; solubility = 750 mg/L @ 20°C.

Potential Exposure: A nonselective pre-emergence and postemergence triazine herbicide. Use around buildings, storage areas, industrial sites, fences, recreational areas, rights-of-way, railroads, pipelines, lumberyards, tank farms, and similar areas. Controls broadleaf weeds and grasses over an extended period of time

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. UV causes decomposition.

Permissible Concentration in Water: Federal Drinking Water Guidelines: 10 ppb[93]; EPA Alert: 400 μg/L; State Drinking Water Guidelines: Florida 105 μg/L; Maine 100 μg/L; Minnesota 100 μg/L; Wisconsin 90 μg/L Runoff from spills or fire control may cause water pollution.

Determination in Water: Octanol-water coefficient: Log $K_{ow} = \sim 3$. Values above 3.0 May bioaccumulate in marine organisms.

Routes of Entry: Inhalation, passing through the skin, ingestion

Harmful Effects and Symptoms

Short-Term Exposure: May cause skin and severe eye irritation. Moderately poisonous if ingested or inhaled. LD_{50} (oral, rat) = 1450 mg/kg $- >$ 2 g/kg; (dermal, rat) = >2 g/kg.

Long-Term Exposure: May cause lung irritation and damage. May cause skin allergy. Contact with some triazine compounds (such as atrazine) may increase risks for tumors known to be associated with hormonal factors. These have been observed in both animals and human beings, and are consistent with the known effects on the hypothalamic pituitary gonadal axis. Repeated exposure may cause weight loss and reduced red blood cell count. May cause reproductive and fetal effects.

Points of Attack: Liver, lungs, skin. Reproductive cells.

Medical Surveillance: Preliminary medical examination to detect chronic diseases of CNS, liver, heart, kidneys, lung and skin, as well as endocrinological or immunological disturbances, should protect susceptible individuals. Periodical medical examinations of internal organs, skin and eyes are important to avoid chronic occupational intoxications. They should include lab and patch tests when necessary[83]. Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following is recommended: Lung function tests. Consider chest X-ray following acute overexposure. Evaluation by a qualified allergist. Examination of the nervous system. In addition to comprehensive initial medical and work histories emphasizing reproductive experience and menstrual history, patient should have physical examination and testing of genito-urinary tract, sperm count, motility and morphology. If required, other tests, such as serum testosterone, serum FSH, and serum LH, may be indicated.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water or milk and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Applicators and other handlers must wear: Coveralls worn over long-sleeved shirt and long pants; Chemical-resistant gloves such as DuPont Tychem suit fabrics, barrier laminate, or Viton; Chemical-resistant footwear plus socks; Protective eye wear; Chemical-resistant headgear for overhead exposure; Chemical-resistant apron when cleaning equipment, mixing, or loading[83]. Agricultural Use/Engineering Controls: When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the Worker Protection Standard (WPS) for agricultural pesticides, 40 CFR 170.240(d)(4-6), the handler PPE requirements may be reduced or modified as specified in the Worker Protection Standard. Firefighters should wear NIOSH approved SCBA and full protective clothing.

Respirator Selection: Engineering control must be effective to ensure that exposure to cyanazine does not occur. Where there is potential exists for exposures to cyanazine use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece respirator with a pesticide cartridge. Increased protection is obtained from full facepiece air purifying respirators.

Where there is potential for high exposures exists, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air-respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Blue: Health Hazard/Poison. Store in a secure poison location. Prior to working with cyanazine all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN2763 Triazine pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: First remove all sources of ignition. Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. If appropriate, moisten to prevent dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen and carbon. *On a small fire:* use dry chemical, CO_2 or water spray. *On a large fire:* use water spray, fog or regular foam. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal; do not scatter the material. Use water spray or fog; do not use straight streams. *Fire involving tanks or car/trailer loads*: Isolate for 800 meters/0.5 mile in all directions; also, consider initial evacuation for 800 meters/0.5 mile in all directions. Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Do not get water inside containers. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. ALWAYS stay away from tanks engulfed in fire. For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (100).

Pesticide Management Education Program, "Prometon (Pramitol) Herbicide Profile 2/85," Cornell University, Ithaca, NY (February 1985). http://pmep.cce.cornell.edu/profiles/herb-growthreg/naa-rimsulfuron/prometon/herb-prof-prometon.html

Prometryn P:1036

Formula: $C_{10}H_{19}N_5S$

Synonyms: A-1114; A13-60366; 2,4-Bis(isopropylamino)-6-(methylmercapto)-*S*-triazine; 2,4-Bis(isopropylamino)-6-(methylthio)-*S*-triazine; 2,4-Bis(isopropylamino)-6-(methylthio)-1,3,5-triazine; *N,N′*-Bis(1-methylethyl)-6-methylthio-1,3,5-triazine-2,4-diamine; *N,N′*-Bis(1-methylethyl)-6-(methylthio)-1,3,5-triazine-2,4-diamine; Caparol; Cotton Pro; Caswell No. 097; *N,N′*-Di-isopropyl-6-methylthio-1,3,5-triazine-2,4-diamine; *N,N′*-Di-isopropyl-6-methylthio-1,3,5-triazine-2,4-diyldiamine; G 34161; Gesagard; Mercasin; Mercazin; Merkazin; 2-(Methyl mercapto)-4,6-bis(isopropylamino)-*S*-triazine; 2-(Methylthio)-4,6-bis(isopropylamino)-*S*-triazine; NSC 163049; Polisin; Primapin; Primatol-Q; Promet; Prometrene; Prometrex; Prometrin; Selectin; Selectin-50; Selektin; Sesagard; Suprend; *S*-Triazine,4,6-bis(isopropylamino)-2-(methylmercapto)-; *S*-Triazine, 2,4-bis(isopropylamino)-6-(methylthio)-; 1,3,5-Triazine-2,4-diamine, *N,N′*-bis(1-methylethyl)-6-(methylthio)-; Uvon

CAS Number: 7287-19-6

HSDB Number: 4060

RTECS Number: XY4390000

UN/NA & ERG Number: UN2763 (triazine pesticide, solid, toxic)/151

EC Number: 230-771-3

Regulatory Authority and Advisory Information

Carcinogenicity[83]: EPA Group E, Evidence of noncarcinogenicity for human.

Hazard Alert: Combustible, Suspected of causing genetic defects, Suspected reprotoxic hazard, Sensitization hazard (skin), Agricultural Chemical, Primary irritant (w/o allergic reaction), Environmental hazard.

Potential Ground water Pollutant [California FAC Section 13145(d)/12811, active]

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%

Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: N, Xn; Risk phrases: R11; R20/21/22; R37; R51/53; R62; R63; Safety phrases: S16; S26; S29; S36/37; S60; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Colorless crystalline solid. Molecular weight = 241.385; Specific gravity (H_2O:1) = 1.16 @20°C; Boiling point = 295°C; Freezing/Melting point = 119°C; Vapor pressure = 1.24×10^{-6} mmHg @ 20°C. Slightly soluble in water; solubility = 48 ppm @ 20°C.

Potential Exposure: Prometryn, a triazine herbicide, is used to control several annual grasses and broadleaf weeds in terrestrial food and feed crops. Among its major applications are on cotton and celery and is often used on dill and pigeon peas.

Determination in Air: Filter; none; Gravimetric; NIOSH IV [Particulates NOR; #0500 (total), #0600 (respirable)][18].

Permissible Concentration in Water: Federal Drinking Water Guidelines: 30 ppb[93]. State Drinking Water Guidelines: Florida 28 μg/L. Runoff from spills or fire control may cause water pollution.

Determination in Water: Octanol-water coefficient: Log $K_{ow} = > 3.0$. Values >3.0 may bioaccumulate in marine organisms.

Routes of Entry: Inhalation, passing through the skin, ingestion

Harmful Effects and Symptoms

Short-Term Exposure: May cause skin and severe eye irritation. Moderately poisonous if ingested or inhaled. LD_{50} (oral, rat) = <2 g/kg[83]; LD_{50} (dermal, rat) = > 3 g/kg[83].

Long-Term Exposure: May cause lung irritation and damage. May cause skin allergy. Contact with some triazine compounds (such as atrazine) may increase risks for tumors known to be associated with hormonal factors. These have been observed in both animals and human beings, and are consistent with the known effects on the hypothalamic pituitary gonadal axis. Repeated exposure may cause weight loss and reduced red blood cell count. May be mutagenic. May be a liver, kidney and blood toxin.

Points of Attack: Kidney, liver, blood, lungs, skin

Medical Surveillance: Preliminary medical examination to detect chronic diseases of CNS, liver, heart, kidneys, lung and skin, as well as endocrinological or immunological disturbances, should protect susceptible individuals. Periodical medical examinations of internal organs, skin and eyes are important to avoid chronic occupational intoxications. They should include lab and patch tests when necessary[83]. Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following is recommended: Lung function tests. Consider chest X-ray following acute overexposure. Evaluation by a qualified allergist. Examination of the nervous system. Live and kidney function tests. CBC.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water or milk and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Applicators and other handlers must wear: Coveralls worn over long-sleeved shirt and long pants; Chemical-resistant gloves such as DuPont Tychem suit fabrics, barrier laminate, or Viton; Chemical-resistant footwear plus socks; Protective eye wear; Chemical-resistant headgear for overhead exposure; Chemical-resistant apron when cleaning equipment, mixing, or loading[83]. Agricultural Use/Engineering Controls: When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the Worker Protection Standard (WPS) for agricultural pesticides, 40 CFR 170.240(d)(4-6), the handler PPE requirements may be reduced or modified as specified in the Worker Protection Standard. Firefighters should wear NIOSH approved SCBA and full protective clothing.

Respirator Selection: Engineering control must be effective to ensure that exposure to cyanazine does not occur. Where there is potential exists for exposures to cyanazine use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece respirator with a pesticide cartridge. Increased protection is obtained from full facepiece air purifying respirators.

Where there is potential for high exposures exists, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air-respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Blue: Health Hazard/Poison. Store in a secure poison location. Prior to working with cyanazine all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: Triazine pesticides, solid, toxic, n.o.s. require a shipping label of "poisonous materials." This material fall in DOT/UN Hazard Class 6.1.

Spill Handling: First remove all sources of ignition. Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. If appropriate, moisten to prevent dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include toxic oxides of sulfur, nitrogen and carbon. *On a small fire:* use dry chemical, CO_2 or water spray. On a large fire, use water spray, fog or regular foam. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal; do not scatter the material. Use water spray or fog; do not use straight streams. *Fire involving storage or vehicular tanks:* Isolate for 800 meters/0.5 mile in all directions; also, consider initial evacuation for 800 meters/0.5 mile in all directions. Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Do not get water inside containers. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. ALWAYS stay away from tanks engulfed in fire. For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, *Reregistration Eligibility Decision (RED), Prometryn,* Office of Prevention, Pesticides and Toxic Substances, Washington, DC (February 1996). http://www.epa.gov/REDs/0467.pdf

EXTOXNET, Extension Toxicology Network, *Pesticide Information Profile, Prometryn*, Oregon State University, Corvallis, OR (June 1996). http://extoxnet.orst.edu/pips/prometry.htm

United States Environmental Protection Agency, Office of Pesticide Programs, Pesticide Residue Limits, *Prometryn*, 40 CFR 180.222. http://www.setonresourcecenter.com/40CFR/Docs/wcd0004c/wcd04cd7.asp

Pronamide P:1040

Formula: $C_{12}H_{11}Cl_2NO$

Synonyms: Benzamide, 3,5-dichloro-*N*-(1,1-dimethyl-2-propynyl); Campbell's Rapier; 3,5-Dichloro-*N*-(1,1-dimethyl-2-propynyl)benzamide; 3,5-Dichloro-*N*-(1,1-dimethylprop-2-ynyl)benzamide; 3,5-Dichloro-*N*-(1,1-dimethylpropynyl) benzamide; *N*-(1,1-Dimethylpropynyl)-3,5-dichlorobenzamide; Kerb; Kerb50W; Kerb propyzamide 50; Propyzamide; Rapier

CAS Registry Number: 23950-58-5

HSDB Number: 5118

RTECS Number: CV3460000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 245-951-4 [*Annex I Index No.:* 616-055-00-4]

Regulatory Authority and Advisory Information

Carcinogenicity: EPA, Classification 2B, Probable human carcinogen (2006)

California Proposition 65 Chemical[102]: Cancer 5/1/1996.

Hazard Alert: Combustible, Environmental hazard.

Banned or Severely Restricted (USA) (UN)[13]

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U192

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.093; Nonwastewater (mg/kg), 1.5

RCRA 40CFR264, appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T, Xn, N; Risk phrases: R45; R20/21/22; R36/

R37; R50/53; Safety phrases: S26; S29; S36/37/39; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)]

Description: Pronamide is a colorless crystalline solid or powder. Molecular weight = 256.14; Freezing/Melting point = 155−156°C; Vapor pressure = 1.3×10^{-4} mbar @ 25°C. Practically insoluble in water; solubility = 15 ppm @ 25°C.

Potential Exposure: A potential danger to those involved in the manufacture, formulation and application of this selective herbicide.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Compounds of the carboxyl group react with all bases, both inorganic and organic (i.e., amines) releasing substantial heat, water and a salt that may be harmful. Incompatible with arsenic compounds (releases hydrogen cyanide gas), diazo compounds, dithiocarbamates, isocyanates, mercaptans, nitrides, and sulfides (releasing heat, toxic and possibly flammable gases), thiosulfates and dithionites (releasing hydrogen sulfate and oxides of sulfur).

Permissible Exposure Limits in Air:
No standards or Protective Action Criteria (PAC) available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Permissible Concentration in Water: The EPA has derived a lifetime health advisory of 0.052 mg/L (52 μg/L).

Determination in Water: Extraction with methylene chloride, separation by capillary-column gas chromatography; then measurement using a nitrogen-phosphorus detector. Fish Tox = 13901.63079000 ppb (VERY LOW).

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Eye contact can cause irritation. Inhalation can cause irritation of the respiratory tract with cough, phlegm, and/or chest tightness. The acute oral LD_{50} for male rats is 8350 mg/kg and for female rats is 5620 mg/kg (insignificantly toxic in both cases).

Long-Term Exposure: Applying the criteria described in EPA's final guidelines for assessment of carcinogenic risk, pronamide has tentatively been classified in Group C: possible human carcinogen. This category is for substances with limited evidence of carcinogenicity in animals in the absence of human data. There is limited animal evidence of liver cancer. Human Tox = 22.72727ppb (INTERMEDIATE)

Points of Attack: Cancer site in animals: liver.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA-or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-face-piece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code -Green: General storage may be used. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers. Where possible, automatically transfer material from drums or other storage containers to process containers. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Soil Adsorption Index (K_{oc}) = 200.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide; or water spray extinguishers. Thermal decomposition products may include hydrogen chloride and oxides of nitrogen and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(102); (31); (173); (101); (138); (100).

United States Environmental Protection Agency, "Alert: Pronamide," Washington, DC, Office of Drinking Water (August 1987)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Pronamide, Trenton, NJ (July 2005)

Propachlor P:1045

Formula: $C_{11}H_{14}ClNO$; $(ClCH_2CO)N(C_6H_5)CH(CH_3)_2$

Synonyms: Acetamide, 2-chloro-*N*-isopropyl-; Acetamide, 2-chloro-*N*-(1-methylethyl)-*N*-phenyl-; Aclid; AI3-51503; Albrass; Bexton; Bexton 4L; Chloressigsaeure-*N*-isopropylanilid (German); α-Chloro-*N*-isopropylacetanilide; 2-Chloro-*N*-isopropylacetanilide; 2-Chloro-*N*-isopropyl-*N*-phenylacetamide; 2-Chloro-*N*-(1-methylethyl)-*N*-phenylacetamide; CIPA; CP31393; *N*-Isopropyl-α-chloroacetanilide; *N*-Isopropyl-2-chloroacetanilide; Niticid; Propachlore; Propacloro (Spanish); Ramrod; Ramrod 65; Satecid

CAS Registry Number: 1918-16-7

HSDB Number: 1200

RTECS Number: AE1575000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171; UN2588 (Pesticides, solid, toxic, n.o.s.)/151; UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 217-638-2 [*Annex I Index No.:* 616-008-00-8]

Regulatory Authority and Advisory Information

Carcinogenicity: EPA, Likely to be carcinogenic to humans (2006)

California Proposition 65 Chemical[102]: Cancer 2/27/2001.

Hazard Alert: Poison, Possible risk of forming tumors, Environmental hazard, Sensitization hazard, Agricultural chemical.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T, N, Xn, Xi; Risk phrases: R45; R5; R20/21/22; R36; R43; R44; R49; R50/53; Safety phrases: S24; S29; S36/37/39; S41; S45; S53; S60; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)]

Description: Propachlor is a light tan solid. Molecular weight = 211.71; Specific gravity (H_2O:1) = 2.24 @ 25°C; Boiling point = 110°C @ 0.03 mm; Freezing/Melting point = 67−77°C; Vapor Pressure = 2.5×10^{-4} mbar @ 25°C. Flash point = about 316°C. Henry's Law constant = 3.6×10^{-7} atm-m^3/mol @ 25°C (est)[72] Slightly soluble in water.

Potential Exposure: Those engaged in the manufacture, formulation and application of this preemergence herbicide which is used to combat annual grasses and broad-leaved weeds in corn, soybeans, cotton, sugar cane and vegetable crops.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Attacks carbon steel. Compounds of the carboxyl group react with all bases, both inorganic and organic (i.e., amines) releasing substantial heat, water and a salt that may be harmful. Incompatible with arsenic compounds (releases hydrogen cyanide gas), diazo compounds, dithiocarbamates, isocyanates, mercaptans, nitrides, and sulfides (releasing heat, toxic and possibly flammable gases), thiosulfates and dithionites (releasing hydrogen sulfate and oxides of sulfur).

Permissible Exposure Limits in Air: Russia[35,43] set a MAC in work-place air of 0.5 milligram per cubic meter.

Permissible Concentration in Water: Russia[35,43] set a MAC in water bodies used for domestic purposes of 0.01 mg/L and in water for fishery purposes of zero. The EPA has set a lifetime health advisory of 0.092 mg/L (92 μg/L). States which have set guidelines for propachlor in drinking water include Kansas @ 700 μg/L and Maine @ 200 μg/L.

Determination in Water: Fish Tox = 17.92643000 ppb MATC (INTERMEDIATE). Octanol-water coefficient: Log K_{ow} = <2.3. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: The maximal tolerated dosage of propachlor without adverse effect is reported as 133.3 mg/kg/day in both rats and dogs. Other workers reported slight organ pathology in rats, mice, and rabbits @ 100 mg/kg/day or higher; this agrees approximately with the former data.

Long-Term Exposure: May be a mutagen. Human Tox = 10.93750 ppb; Chronic Human Carcinogen Level (INTERMEDIATE).

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure.Pregnant women should avoid contact. Employees should be notified by a physician that this chemical may affect reproductive system. In addition to comprehensive initial medical and work histories emphasizing reproductive experience and menstrual history, patient should have physical examination and testing of genitourinary tract, sperm count, motility and morphology. If required, other tests, such as serum testosterone, serum FSH, and serum LH, may be indicated.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA-or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-face-piece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN2588 Pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling:

UN2811: Isolation Distance, Spill: 25meters/75 feet.(NJ). Isolation Distance, Fire: 800 meters/0.5 miles[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Soil Adsorption Index (K_{oc}) = 80.

Fire Extinguishing: Decomposes @ ~170°C. Thermal decomposition products may include hydrogen chloride and oxides of nitrogen and carbon. This chemical usually is a combustible solid. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Alkaline hydrolysis would yield *N*-isopropylaniline. However, incineration @ 850°C together with flue gas scrubbing is the preferred disposal method[22].

References

(102); (31); (173); (101); (138); (100).

United States Environmental Protection Agency, *Alert: Propachlor*, Washington, DC, Office of Drinking Water (August 1987)

United States Environmental Protection Agency, Integrated Risk Information System (IRIS) *Propachlor*, Washington, DC, various dates. http://www.epa.gov/IRIS/subst/0096.htm

Propadiene P:1050

Formula: C_3H_4; $H_2C{=}C{=}CH_2$

Synonyms: Allene; Allylenel; Dimethylenemethane; 1,2-Propadiene; Propadieno (Spanish)

CAS Registry Number: 463-49-0

HSDB Number: 5135

RTECS Number: BA040000

UN/NA & ERG Number: UN2200/116

EC Number: 207-335-3 (as Allene)

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Hazard Alert: Extremely flammable gas; Unstable, may explode (high heat), Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated.

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg).

Hazard Symbols, Risk & Safety statements: Hazard Symbol: F+; Risk phrases: R5; R2; R12; R21; Safety phrases: S1; S9; S15; S16; S33; S38; S41; S45(see Appendix 4).

WGK[100] (German Aquatic Hazard Class): Non hazard to water.

Description: Propadiene is a colorless, flammable gas or liquid with a sweet odor. Molecular weight = 40.1; Specific gravity (H_2O:1) = 1.79 @ 20°C; Boiling point = −32°C; Freezing/Melting point = −146°C. Explosive limits: LEL = 2.1%; 21,000 ppm[138]; UEL-unknown. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 4, Reactivity 3. Insoluble in water.

Potential Exposure: Used in chemical synthesis and as a component in mixtures with methyl acetylene, which make up specialty welding gases.

Incompatibilities: Extremely flammable gas or liquid. Vapor or liquid forms explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, nitrogen oxides.

Permissible Exposure Limits in Air:

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 230 ppm

PAC-2: 2500 ppm

PAC-3: 15,000 ppm

Determination in Air: Use NIOSH Analytical Method (IV) #1500, Hydrocarbons.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Propadiene can affect you when breathed in. Exposure can cause irritation of the eyes, nose and throat. Very high levels can cause you to feel dizzy, lightheaded and to pass out. Extremely high levels could cause death. Contact with the liquid may cause frostbite.

Long-Term Exposure: Unknown at this time.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof goggles, unless full facepiece respiratory protection is worn. Wear splash-proof chemical goggles and face shield when working with liquid, unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures to propadiene exists, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Check oxygen content prior to entering storage area. Flammable gas. Color code-Red Stripe: Flammability Hazard: Store separately from all other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 meters or a 1-hour fire wall from flammable or reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Propadiene must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine), strong acids (such as hydrochloric, sulfuric, and nitric) and nitrogen oxides; since violent reactions occur. Sources of ignition, such as smoking and open flames, are prohibited where propadiene is handled, used, or stored. Wherever propadiene is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Store cylinders in well-ventilated areas away from potential heat sources. Protect cylinders from physical damage. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: UN2200 Propadiene, stabilized, Hazard Class: 2.1; Labels: 2.1-Flammable gas. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Ventilate area of leak to disperse the gas. Stop the flow of gas if it can be done safely. If source of leak is a cylinder and the leak cannot be stopped in place, remove leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. Keep this chemical out of confined space, such as a sewer because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extremely flammable gas. Thermal decomposition products may include oxides of carbon. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Return refillable compressed gas cylinders to supplier. Nonrefillable cylinders should be disposed of in accordance with local, state and federal regulations. Allow remaining gas to vent slowly into atmosphere in an unconfined area or exhaust hood. Refillable-type cylinders should be returned to original supplier with any valve caps and outlet plugs secured and valve protection caps in place.

References
(31); (173); (101); (138); (2); (100).
New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Propadiene, Trenton, NJ (February 2001).

Propane P:1060

Formula: $C_3H_2O_8$; $CH_3CH_2CH_3$
Synonyms: A-108; Dimethylmethane; Hydrocarbon propellent A-108; *n*-Propane; Propano (Spanish); Propyl hydride
CAS Registry Number: 74-98-6
HSDB Number: 1672
RTECS Number: TX2275000
UN/NA & ERG Number: UN1978/115; UN1075 (liquefied)/115
EC Number: 200-827-9 [*Annex I Index No.:* 601-003-00-5]
Regulatory Authority and Advisory Information
Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 60,000. *Note*: Facilities are not required to count propane in tanks of 10,000 lbs or less. The higher threshold of 60,000 pounds is set to focus on the screening of high-volume propane users; not on nonindustrial propane users.
Hazard Alert: Extremely flammable gas, Agricultural Chemical, Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated.
Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg).
Hazard Symbols, Risk & Safety statements: Hazard Symbol: F+, Xn; Risk phrases: R2; R5; R12; R21; Safety phrases: S1; S2; S9; S16; S33; S38; S41; S45 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): Non hazard to water.
Description: Propane is a colorless gas that is odorless when pure (a foul-smelling odorant is often added). Molecular weight = 44.11; Specific gravity (H_2O:1) = 0.49 @ 20°C; Boiling point = −42.2°C; Freezing/Melting point = −187.8°C; Relative vapor density (air = 1) = 1.55; Vapor pressure = 8.4 atm @ 21°C; 750 mmHg @ −42°C; Flash point = flammable gas (−104°C); Autoignition temperature = 450°C. Explosive limits: LEL = 2.1%°C; UEL: 9.5%. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 4, Reactivity 0. Slightly soluble in water; solubility = 0.01%.
Potential Exposure: Propane is used as a household, industrial and vehicle fuel; it is used as a refrigerant and aerosol propellant; it is used as an intermediate in petrochemical manufacture.
Incompatibilities: Flammable gas. May form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Liquid attacks some plastics, rubber and coatings.
Permissible Exposure Limits in Air:
NIOSH IDLH = 2100 ppm [LEL]
Conversion factor: 1 ppm = 1.80 milligram per cubic meter @ 25°C & 1 atm
Odor Threshold = 2700 ppm.
OSHA PEL: 1000 ppm/1800 milligram per cubic meter TWA
NIOSH REL: 1000 ppm/1800 milligram per cubic meter TWA
ACGIH TLV[1]: 1000 ppm TWA *as aliphatic hydrocarbon gas* (C_1–C_4)
Protective Action Criteria (PAC)* Ver. 29[138]
PAC-1: $\mathbf{5500_A}$ ppm
PAC-2: $\mathbf{17{,}000_A}$ ppm
PAC-3: $\mathbf{33{,}000_A}$ ppm
*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.
DFG MAK: 1000 ppm/1800 milligram per cubic meter TWA; Peak Limitation Category II(4); Pregnancy Risk Group D
Australia: asphyxiant, 1993; Austria: MAK 1000 ppm (1800 milligram per cubic meter), 1999; Belgium: asphyxiant, 1993; Denmark: TWA 1000 ppm (1800 milligram per cubic meter), 1999; Finland: TWA 800 ppm (1100 milligram per cubic meter), 1999; Hungary: asphyxiant, 1993; the Phillipines: TWA 1000 ppm (1800 milligram per cubic meter), 1993; Switzerland: MAK-W 1000 ppm (1800 milligram per cubic meter), 1999; United Kingdom: asphyxiant, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 2500 ppm
Determination in Air: By combustible gas meter NIOSH (II-2) Method #S-87; OSHA Analytical Methods PV-2077. Use NIOSH Analytical Method (IV) #1500, Hydrocarbons.
Permissible Concentration in Water: No criteria set, but EPA[32] has suggested a permissible ambient goal of 120,000 μg/L based on health effects.
Routes of Entry: Inhalation, ingestion; skin and/or eye contact.
Harmful Effects and Symptoms
Short-Term Exposure: Very high levels may produce the following symptoms, due primarily to lack of oxygen: dizziness, lightheadedness, disorientation, headache, numbness, vomiting, unconsciousness and death from suffocation. Narcotic at high levels. Contact with the liquid can cause frostbite.
Long-Term Exposure: No effects reported.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately

with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If frostbite has occurred, seek medical attention immediately; do NOT rub the affected areas or flush them with water. In order to prevent further tissue damage, do NOT attempt to remove frozen clothing from frostbitten areas. If frostbite has NOT occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Neoprene, nitrile + PVC, Polyurethane, and polyethylene are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *2,100 ppm:* Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* SCBAE (any appropriate escape-type, SCBA).

Storage: Check oxygen content prior to entering storage area. Flammable gas. Color code-Red Stripe: Flammability Hazard: Store separately from all other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 meters or a 1-hour fire wall from flammable or reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration is not a danger. Propane must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine), since violent reactions occur. Sources of ignition, such as smoking and open flames, are prohibited where propane is handled, or stored. Use only nonsparking tools and equipment, especially when opening and closing containers of propane. Wherever propane is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: UN1978 Propane, Hazard Class: 2.1; Labels: 2.1-Flammable gas. UN1075 Petroleum gases, liquefied or Liquefied petroleum gas, Hazard Class: 2.1; Labels: 2.1-Flammable gas. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Stop the flow of gas if it can be done safely. If source of leak is a cylinder and the leak cannot be stopped in place, remove leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. Keep this chemical out of confined space, such as a sewer because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable gas. Thermal decomposition products may include oxides of carbon. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (2); (100).

New York State Department of Health, *Chemical Fact Sheet:* Propane, Bureau of Toxic Substance Assessment, Albany, NY (February 1986)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Propane, Trenton, NJ (May 2004)

1,3-Propane Sultone P:1070

Formula: $C_3H_6O_3S$

Synonyms: 3-Hydroxy-1-propanesulphonic acid sultone; 3-Hydroxy-1-propanesulphonic acid γ-sultone; 3-Hydroxy-1-propanesulphonic acid sulfone; 1,2-Oxathrolane 2,2-dioxide; 1-propanesulfonic acid-3-hydroxy-g-sultone; 1,3-Propanesultone; 1,2-Oxathiolane 2,2-dioxide; 1-Propanesulfonic acid-3-hydroxy-g-sulfone; Propane sultone

CAS Registry Number: 1120-71-4

HSDB Number: 1673

RTECS Number: RP5425000

UN/NA & ERG Number: UN2810 (toxic liquid, organic, n.o.s.)/153; UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 214-317-9 [*Annex I Index No.:* 016-032-00-3]

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Human No Adequate Data, animal Sufficient Evidence, *possibly carcinogenic to humans*, Group 2B, 1999; NIOSH: Potential occupational carcinogen. United States Environmental Protection Agency Gene-Tox Program, Positive: Carcinogenicity-mouse/rat EPA; Positive: Cell transformation-RLV F344 rat embryo EPA; Positive: Cell transformation-SA7/SHE; Host-mediated assay EPA; Positive: *E coli polA* without S9; Histidine reversion-Ames test EPA; Positive: S *cerevisiae* gene conversion; S *cerevisiae-homozygosis* EPA; Positive: *S pombe*-reversion EPA; Positive/dose response: *In vitro* SCE-nonhuman EPA; Positive/dose response: *In vitro* UDS-human fibroblast EPA; Inconclusive: SHE-clonal assay.

California Proposition 65 Chemical[102]: Cancer 1/1/1988.

Hazard Alert: Poison, Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction).

Banned or Severely Restricted (Sweden) (UN)[13]

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U193

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T; Risk phrases: R45; R21/22; R62; R63; Safety phrases: S29; S53; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: 1,3-Propane sultone is a white crystalline solid or a colorless liquid above 30°C. It releases a foul odor as it melts. Molecular weight = 122.14; Specific gravity (H_2O:1) = 1.39 @ 25°C; Boiling point = 180°C @ 30 mm; 155−157°C @ 14 mm; Freezing/Melting point = 31°C; Flash point >113°C[30]. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Soluble in water; solubility = 10%.

Potential Exposure: A potential danger to those involved in use of this chemical intermediate to introduce the sulfopropyl group ($-CH_2CH_2CH_2SO_3-$) into molecules of other products.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air:

NIOSH IDLH = Not determined. Potential occupational carcinogen

OSHA PEL: None

NIOSH REL: A potential occupational carcinogen.* [skin]; Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV[1]: Exposures by all routes should be carefully controlled to levels as low as possible. confirmed animal carcinogen with unknown relevance to humans.

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 1.6 milligram per cubic meter

PAC-2: 18 milligram per cubic meter

PAC-3: 110 milligram per cubic meter

DFG MAK: [skin] Carcinogen Category 2

Austria [skin], carcinogen, 1999; Switzerland: carcinogen, 1999; United Kingdom: carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: confirmed animal carcinogen with unknown relevance to humans. Several states have set guidelines or standards for propane sultone in ambient air[60] ranging from zero (North Dakota) to 0.03 μ/m^3 (New York) to 3.0 μ/m^3 (Virginia).

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin and respiratory system. More irritating if heated.

Long-Term Exposure: Potential occupational carcinogen. Other long-term effects are unknown at this time.

Points of Attack: Eyes, skin, respiratory system. Cancer site in animals: skin tumors, leukemia, gliomas.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid, unless full facepiece respiratory protection is worn. Wear dust-proof goggles and face shield when working with powders or dust, unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN2810 Toxic liquids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling:

UN2811: Isolation Distance, Spill: 25meters/75 feet.(NJ). Isolation Distance, Fire: 800 meters/0.5 miles[70].

UN2810 Toxic liquids, organic, n.o.s.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.2/0.3
Night 0.7/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 1000/300
Then: Protect persons downwind (miles/kilometers)

Day 1.1/1.8
Night 2.8/4.5

Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Thermal decomposition products may include oxides of sulfur and carbon. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(109); (102); (31); (173); (101); (138); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 4, No. 3, 82−85 (1984)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* 1,2-Oxathiolane-2,2-Dioxide, Trenton, NJ (June 2000)

Propanil P:1080

Formula: $C_9H_9Cl_2NO$; $Cl_2C_6H_3NHCOC_2H_5$

Synonyms: AI3-31382; BAY 30130; Chem rice; Crystal propanil-4; DCPA; *N*-(3,4-Dichlorophenyl)propanamide; 3′,4′-Dichlorophenylpropionanilide; 3′,4′-Dichloropropionanilide; 3,4-Dichloropropionanilide; Dichloropropionanilide; Dipram; DPA; Farmco propanil; FW-734; Herbax technical; Montrose propanil; NSC31312; Propanamide, *N*-(3,4-dichlorophenyl)-; Propanide; Propionanilide, 3′,4′-dichloro-; Propionic acid 3,4-dichloroanilide; Rogue; Stam; Stam LV10; Stam F-34; Stampede 3E; Stam supernox; Strel; Surpur; Synpran N; Vertac

CAS Registry Number: 709-98-8; *(alt.)* 11096-32-5

HSDB Number: 1226

RTECS Number: UE4900000

DOT ID and ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 211-914-6 [*Annex I Index No.:* 616-009-00-3]

Regulatory Authority and Advisory Information

United States Environmental Protection Agency Gene -Tox Program, Positive: B *subtilis* rec assay; 1988, Negative: Aspergillus-forward mutation; E coli pol A without S9; 1988, Negative: Histidine reversion-Ames test; 1988, Negative: *In vitro* UDS-human fibroblast; TRP reversion; 1988, Negative: S *cerevisiae-homozygosis*

Hazard Alert: Combustible, Suspected reprotoxic hazard, Environmental hazard.

Safe Drinking Water Act (47FR 9352): Priority List (55FR 1470) as DCPA (and its acid metabolites)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Hazardous to aquatic life or environment, with possible long lasting effects[291]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: Xn, N; Risk phrases: R22; R50; R62; Safety phrases: S2; S22; S29/35; S41; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Propanil is a colorless solid. The technical product is a brown crystalline solid. Molecular weight = 218.09; Specific gravity (H_2O:1) = 1.22 @ 25°C; Freezing/Melting point = 91−93°C (pure); 88−91°C (technical grade); Freezing/Melting point (pure) = 89−92°C (pure); 85−89°C (technical grade); Vapor pressure = 2.6×10^{-7} mmHg @ 30°C. Flash point = ≥ 110°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. Slightly soluble in water; solubility = 125 ppm @ 22°C. Commercial formulations use carrier solvents that may change the physical properties shown.

Potential Exposure: Propanil is used as a postemergent herbicide for rice and spring wheat. A potential danger to those involved in the manufacture, formulation, and application of this contact herbicide.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air:

No standards or Protective Action Criteria (PAC) available. This substance may still be harmful or dangerous; follow safe work and usage practices.Russia[43] set a MAC in work-place air of 0.1 milligram per cubic meter and has set MAC values for ambient air in residential areas of 0.005 milligram per cubic meter on a once-daily basis and 0.001 milligram per cubic meter on a daily average basis.

Permissible Concentration in Water: Russia[43] set a MAC in water bodies used for domestic purposes of 0.1 mg/L.

Determination in Water: Fish Tox = 0.48990000 ppb (EXTRA HIGH). Octanol-water coefficient: Log $K_{ow} = > 3$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Propanil is well tolerated by experimental animal on a chronic basis, and there is little or no indication of mutagenic or oncogenic properties of the compound. The highest no-adverse-effect concentration of propanil based on reproduction in the rat and acute, subchronic, and chronic studies in rats and dogs is 400 pm in the diet. Based on this data, an ADI was calculated at 0.02 mg/kg/day. LD_{50} (oral-rat) 2756 mg/kg (male); 2343 mg/kg (female).

Long-Term Exposure: Human Tox = 35.00000 ppb (INTERMEDIATE)

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Green: General storage may be used. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Soil Adsorption Index (K_{oc}) = 149

Fire Extinguishing: This chemical is a combustible solid. Thermal decomposition products may include hydrogen chloride and oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Hydrolysis in acidic or basic media yields the more toxic substance, 3,4-dichloraniline, and is not recommended.

References

(31); (173); (101); (138); (80); (100).

Propargyl Alcohol P:1090

Formula: C_3H_4O; $HC{\equiv}CCH_2OH$

Synonyms: AI3-24359; Alcohol propargilico (Spanish); Ethynylcarbinol; Ethynyl methanol; 1-Hydroxy-2-propyne; 3-Hydroxy-1-propyne; Methanol, ethynyl-; Propiolic alcohol; 1-Propyne-3-ol; 3-Propynol; 2-Propynol; 2-Propyn-1-ol; 1-Propyn-3-ol; Prop-2-yn-1-ol; 2-Propynyl alcohol; Propynyl alcohol

CAS Registry Number: 107-19-7

HSDB Number: 6054

RTECS Number: UK5075000

UN/NA & ERG Number: UN1986/131; UN2929/131

EC Number: 203-471-2 [*Annex I Index No.:* 603-078-00-X]

Regulatory Authority and Advisory Information

Hazard Alert: Exposure can be lethal, Highly flammable liquid, Highly toxic, Polymerization hazard, Sensitization hazard (skin), Possible risk of forming tumors, Suspected reprotoxic hazard, Environmental hazard.

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P102

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 1000 lb (454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long lasting effects[293]. Toxic to aquatic life with long lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T+, N, Xi; Risk phrases: R11; R19; R26/27/28; R34; R43; R51/53; Safety phrases: S1/2; S21; S26; S28; S29/35; S33; S36/37/39; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Propargyl alcohol is a colorless liquid with a geranium-like odor. Molecular weight = 56.06; Specific gravity (H_2O:1) = 0.95 @ 25°C; Boiling point = 114°C; Freezing/Melting point = −52°C; Vapor pressure = 15.6 mmHg @ 25°C;. Flash point = 36°C; Explosive limits: LEL = 3.4%; UEL: 70%. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 3, Reactivity 3. Soluble in water.

Potential Exposure: Propargyl alcohol is used as a corrosion inhibitor, soil fumigant; solvent, stabilizer, and chemical intermediate.

Incompatibilities: Vapor may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, phosphorus pentoxide. May polymerize under the influence of heat, oxidizers, peroxides, light. Attacks many plastics.

Permissible Exposure Limits in Air:

Conversion factor: 1 ppm = 2.29 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: None

NIOSH REL: 1 ppm/2 milligram per cubic meter TWA [skin]

ACGIH TLV[1]: 1 ppm/2.3 milligram per cubic meter TWA [skin]

Protective Action Criteria (PAC)* Ver. 29[138]

PAC-1: $\mathbf{2.5}_\mathbf{A}$ ppm

PAC-2: $\mathbf{16}_\mathbf{A}$ ppm

PAC-3: $\mathbf{72}_\mathbf{A}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

DFG MAK: 2 ppm; 4.7 milligram per cubic meter TWA; Peak Limitation Category I(2); [skin]; Pregnancy Risk Group D

Australia: TWA 1 ppm (2 milligram per cubic meter), [skin], 1993; Austria: MAK 2 ppm (9 milligram per cubic meter), [skin], 1999; Belgium: TWA 1 ppm (2.3 milligram per cubic meter), [skin], 1993; Denmark: TWA 1 ppm (2.5 milligram per cubic meter), [skin], 1999; Finland: TWA 1 ppm (2 milligram per cubic meter); STEL 3 ppm (6 milligram per cubic meter), [skin], 1999; France: VME 1 ppm (2 milligram per cubic meter), [skin], 1999; the Netherlands: MAC-TGG

2 milligram per cubic meter, [skin], 2003; the Phillipines: TWA 1 ppm

(1 milligram per cubic meter), [skin], 1993; Russia: STEL 1 milligram per cubic meter, 1993; Switzerland: MAK-W 1 ppm (2 milligram per cubic meter), [skin], 1999; United Kingdom: TWA 1 ppm (2.3 milligram per cubic meter); STEL 3 ppm, [skin], 2000: Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 1 ppm [skin]

Determination in Air: Use OSHA Analytical Method 97.

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Severe health hazard. CNS depressant. May be fatal is absorbed through skin or inhaled. Causes severe irritation. High concentrations are extremely destructive to mucous membranes, upper respiratory tract, eyes, and skin. Symptoms of exposure may include burning sensation, coughing, wheezing, laryngitis, shortness of breath, headache, nausea, and vomiting[136].

Short-Term Exposure: Propargyl alcohol can affect you when breathed and by passing through skin. Irritates the eyes, skin, and respiratory tract. Contact can severely burn the eyes, causing permanent damage. Skin contact can irritate the skin and allow dangerous amounts to enter the body. Affects the CNS. Exposure can cause you to feel dizzy, lightheaded and to have trouble concentrating. High exposures can cause liver and kidney damage; coma and death.

Long-Term Exposure: Propargyl alcohol may damage the liver and kidneys.

Points of Attack: Skin, respiratory system; CNS; liver, kidneys.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately.

If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: (1) Color code-Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. (2) Color code-Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. (2) Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration is not a danger. Propargyl alcohol must be stored to avoid contact with alkalis, mercury(II) sulfate; oxidizing materials and phosphonic anhydride, since violent reactions occur. Sources of ignition, such as smoking and open flames, are prohibited where propargyl alcohol is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gallons or more of propargyl alcohol should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of Propargyl alcohol. Wherever propargyl alcohol is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1986 Alcohols, flammable, toxic, n.o.s., Hazard Class: 3; Labels: 3-Flammable liquid, 6.1-Poisonous materials, Technical Name Required. UN2929 Toxic liquids, flammable, organic, n.o.s., Hazard class: 6.1; Labels: 6.1-Poison Inhalation Hazard, 3-Flammable liquid, Technical Name Required.

Spill Handling:

Toxic liquids, flammable, organic, n.o.s.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.3/0.5
Night 0.8/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 600/180
Then: Protect persons downwind (miles/kilometers)
Day 1.4/2.3
Night 2.9/4.6

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include hydrogen chloride and oxides of nitrogen. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Propargyl Alcohol, Trenton, NJ (November 2004)

Propazine P:1110

Formula: $C_9H_{16}ClN_5$

Synonyms: 2,4-bis(Isopropylamino)-6-chloro-*s*-triazine; 2,4-Bis(propylamino)-6-chlor-1,3,5-triazin (German); 2-Chloro-4,6-bis(isopropylamino)-*s*-triazine; Gesamil; MAXX-90; Milogard; Plantulin; Primatol P; Propasin; Propazin; Prozinex

CAS Registry Number: 139-40-2

HSDB Number: 1400

RTECS Number: XY5300000

UN/NA & ERG Number: UN2763 (triazine pesticide, solid, toxic)/151

EC Number: 205-359-9 [*Annex I Index No.:* 613-067-00-1]

Regulatory Authority and Advisory Information

Carcingenicity: EPA, Cancer Classification: Not Likely to be Carcinogenic to Humans. *Note:* Originally classified in 1989 as a Group C carcinogen, or possible human carcinogen.

Hazard Alert: Poison, Possible risk of forming tumors, Suspected of causing genetic defects, Environmental hazard, Possible sensitization hazard.

Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: Xn, N; Risk phrases: R40; R50/53; Safety phrases: S2; S29; S36/37; S41; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)]

Description: Propazine is a colorless crystalline solid or powder. Molecular weight = 229.75; 230.09; Freezing/Melting point = 214°C; Vapor pressure = 1.3×10^{-7} mmHg @ 20°C. Slightly soluble in water; solubility = 9.0 ppm @ 20°C; 4.5×10^{-4} g/100 mL @ 20°C.

Potential Exposure: A potential danger to those involved in the manufacture, formulation and application of this triazine pre-emergence selective herbicide used to control annual broadleaf weeds and grasses.

Permissible Exposure Limits in Air:

No United States standards or Protective Action Criteria (PAC) available. This substance may still be harmful or dangerous; follow safe work and usage practices. Russia[43] set a MAC in work-place air of 5.0 milligram per cubic meter and a MAC in ambient air in residential areas of 0.04 milligram per cubic meter both on a momentary and an average daily basis.

Permissible Concentration in Water: Russia[43] set a MAC in water bodies used for domestic purposes of 1.0 mg/L. The United States Environmental Protection Agency has determined a lifetime health advisory of 0.014 mg/L (14 μg/L) (see "References" below). States which (31); have set guidelines for propazine in drinking water[61] include Kansas @ 325 μg/L and Maine @ 93 μg/L; (100).

Determination in Water: Analysis of propazine is by a gas chromatographic (GC) method applicable to the determination of certain nitrogen-phosphorus containing pesticides in water samples. In this method, approximately 1 liter of sample is extracted with methylene chloride. The extract is concentrated and the compounds are separated using capillary column GC. Measurement is made using a nitrogen-phosphorus detector. The method detection limit has not been determined for propazine, but it is estimated that the detection limits for analytes included in this method are in the range of 0.1−2 μg/L. Fish Tox = 938.12580000 ppb (VERY LOW). Octanol-water coefficient: Log $K_{ow} = \sim 3$ Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact. May be absorbed by the skin.

Harmful Effects and Symptoms

Short-Term Exposure: May cause eye irritation. Contact dermatitis was reported in workers involved in propazine manufacturing. Poisonous if ingested. No other information on the health effects of propazine in humans was found in the available literature.

Long-Term Exposure: May cause skin allergy. Human Tox = 10.00000 ppb (INTERMEDIATE).

Points of Attack: Skin.

Medical Surveillance: Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from heat, moisture, oxidizers, alkaline environments. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN2763 Triazine pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Soil Adsorption Index (K_{oc}) = 154.

Fire Extinguishing: This chemical is a combustible solid. Thermal decomposition products may include hydrogen chloride and oxides of nitrogen oxides and carbon. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138).

United States Environmental Protection Agency, “Alert: Propazine,” Washington, DC, Office of Drinking Water (August 1987)

Propham P:1120

Formula: $C_{10}H_{13}NO_2$: $C_6H_5NHCOOCH(CH_3)_2$

Synonyms: Ban-hoe; Beet-kleen; Carbanilic acid, isopropyl ester; Chem-hoe; IPPC; Isopropyl carbanilate; Isopropyl carbanilic acid ester; Isopropyl-*N*-phenyl-carbamat (German); *o*-Isopropyl-*N*-phenyl carbamate; Isopropyl phenylcarbamate; Isopropyl-*N* -phenyl carbamate; Isopropyl-*N*-phenyurethan (German); Ortho grass killer; *N*-Phenylcarbamate d’isopropyle (French); Phenylcarbamic acid 1-methylethyl ester; *N*-Phenyl isopropyl carbamate; Premalox; Profam; Propham; Triherbide; Triherbide-IPC; Tuberit; Tuberite

CAS Registry Number: 122-42-9

HSDB Number: 602

RTECS Number: FD9100000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171; UN2757 (carbamate pesticides, solid, toxic)/151

EC Number: 204-542-0

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Inadequate Evidence; Human No Available Data, *not classifiable as carcinogenic to humans*, Group 3, 1987

Hazard Alert: Poison, Possible neurotoxic effects (methyl carbamate), Environmental hazard, Agricultural chemical.

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U363

Superfund/EPCRA [40CFR 302 and 355, F R: 8/16/06, Vol 71, No. 158] Reportable Quantity (RQ): 1000 lb (454 kg)

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 1 lb (0.454 kg).

Hazardous to aquatic life or environment, with possible long lasting effects[291]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T, F, Xn; Risk phrases: R11; R22; R23/24/25; R33; R36/37/38; R39/23/24/25; SR40; R46; R50; Safety phrases: S7; S16; S26; S29/35; S36/37; S45; S53; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Propham is a colorless crystalline solid. Molecular weight = 179.24; Boiling point = Thermal decomposition above 150°C; Freezing/Melting point = 87−88°C; 84°C (technical grade); Vapor pressure = 1.35×10^{-4} mmHg. Practically insoluble in water; solubility = 0.25 g/L @25°C.

Potential Exposure: A potential danger to those involved in the manufacture, formulation and application of this carbamate/organonitrogen grass-control herbicide.

Incompatibilities: Carbamates are incompatible with reducing agents, strong acids, oxidizing acids, peroxides, and bases. Contact with active metals or nitrides cause the release of flammable, and potentially explosive, hydrogen gas. May react violently with bromine, ketones. Incompatible with azo dyes, caustics, ammonia, amines, boranes, hydrazines, strong

Permissible Exposure Limits in Air:

No United States standards or Protective Action Criteria (PAC) available. This substance may still be harmful or dangerous; follow safe work and usage practices. Russia[43] set a MAC in work-place air of 2.0 milligram per cubic meter and a MAC in ambient air of residential areas of 0.02 milligram per cubic meter, both on a momentary and an average daily basis.

Determination in Air: Organonitrogen pesticides. OSHA versatile sampler-2; Reagent; High-pressure liquid chromatography/UV detection; NIOSH Analytical Method (IV) #5601.

Permissible Concentration in Water: Russia[43] set a MAC in water bodies used for domestic purposes of 0.2 mg/L. The EPA has set a lifetime health advisory of 0.12 mg/L.

Determination in Water: Analysis of propham is by a high-performance liquid chromatographic (HPLC) method applicable to the determination of certain carbamate and urea pesticides in water samples. This method requires a solvent extraction of approximately 1 liter of sample with methylene chloride using a separatory funnel. The methylene chloride extract dried and concentrated to a volume of 10 mL or less. Compounds are separated by HPLC, and measurement is conducted with a UV detector. The method detection limit has not been determined for propham, but it is estimated that the detection limits for analytes included in this method are in the range of 1−5 μg/L. Fish Tox = 5112.55273000 ppb (VERY LOW).

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Doses to rats of 2000 mg/kg produced loss of righting reflex, ptosis, piloerection, decreased locomotor activity; chronic pulmonary disease; rugation and irregular thickening of the stomach. The acute oral LD_{50} values in male and female rats were reported to be 3,000 232 mg/kg and 2,360 118 mg/kg, respectively. Carbamates are cholinesterase inhibitors. Symptoms of exposure include headache, giddiness; blurred vision; nervousness, weakness, nausea, cramps, diarrhea, and discomfort in the chest. Signs include sweating, tearing, salivation, vomiting, cyanosis, convulsions, coma, loss of reflexes and loss of sphincter control. LD_{50} = 3274 mg/kg[NIOSH].

Long-Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage. Human Tox = 100.00000 ppb (VERY LOW).

Points of Attack: Respiratory system, lungs, CNS; cardiovascular system, skin, eyes, plasma and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also consider CBC. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required. UN2757 Carbamate pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Soil Adsorption Index (K_{oc}) = 200 (estimate).

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include oxides of nitrogen and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, “Alert: Propham,” Washington, DC, Office of Drinking Water (August 1987)

NIOSH Manual of Analytical Methods, 4th Edition, Issue 1, *Organonitrogen pesticides*, page 7 of 21, Cincinnati, OH, 1/15/1998.

Propiconazole P:1125

Formula: $C_{15}H_{17}Cl_2N_3O_2$

Synonyms: Alamo; Banner; Benit; Break; Bumper; Caswell No. 323EE; CGA-64250; CGA-92710F; Desmel; (±)-1-[2-(2,4-Dichlorophenyl)-4-propyl-1,3-dioxolan-2-ylmethyl]-1*H*-1,2,4-triazole; 1-[(2-(2,4-Dichlorophenyl)-4-propyl-1,3-dioxolan-2-yl)methyl]-1*H*-1,2,4-triazole; 1-[2-(2,4-Dichlorophenyl)-4-propyl-1,3-dioxolan-2-yl]-methyl-1*H*-1,2,4,-triazole; Fidis; Juno; Manti S; Maxx; Novel; Orbit; Practis; Proconazole; Propimax; Radar; Restore; Spire; Stratego (trifloxystrobin + propiconazole); Taspa; Tilt; 1*H*-1,2,4-Triazole, 1-[(2-(2,4-dichlorophenyl)-4-propyl-1,3-dioxolan-2-yl)methyl]-; Wocosin

CAS Number: 60207-90-1; 75881-82-2

HSDB Number: 6731
RTECS Number: XZ4620000
UN/NA & ERG Number: UN3082 (environmentally hazardous substances, liquid, n.o.s.)/171; UN3077 (environmentally hazardous substances, solid, n.o.s.)/171
EC Number: 262-104-4 [*Annex I Index No.:* 613-205-00-0]
Regulatory Authority and Advisory Information
Carcinogenicity[83]: EPA Group C, possible human carcinogen
Hazard Alert: Poison (category 3), Suspected reprotoxic hazard, Possible endocrine disruptor; Sensitization hazard (skin), Environmental hazard.
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%
Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.
Regulations: Hazard Symbol: T, Xn, Xi, N; Risk phrases: R40; R21; R22; R43; R50/53; R63; Safety phrases: S1/2; S29; S36/37; S41; S46; S60; S61 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to waters.
Description: Colorless solid or a yellow thick liquid. Odorless. Commercial product is available as an emulsifiable concentrate. Physical and toxicological properties may be affected by carrier solvents in commercial formulations. Molecular weight = 342.22; Specific gravity (H_2O:1) = 1.33 @ 20°C; Boiling point = (decomposes); Freezing/Melting point = -25°C; Vapor pressure = 4.2×10^{-7} mmHg @ 20°C; Flash point = 244°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Soluble in water; solubility = 112 ppm.
Potential Exposure: Propiconazole is a triazole fungicide used to control fungi on a broad range of crops and turf. Used on ornamentals, range land and rights-of-way to prevent and control powdery mildew and fungi on hardwoods and conifers.
Incompatibilities: The triazoles are sensitive to heat, friction, and impact. Sensitivity varies with the type substitution to the triazole ring. Metal chelated and halogen substitution of the triazol ring make for a particularly heat sensitive material. Azido and nitro derivatives have been employed as high explosives. No matter the derivative these materials should be treated as explosives[88].
Permissible Concentration in Water: Federal Drinking Water Guidelines: 9 ppb[93] State Drinking Water Guidelines: Maine 9 μg/L. Runoff from spills or fire control may cause water pollution.
Determination in Water: Octanol-water coefficient: Log $K_{ow} = > 3.5$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.
Routes of Entry: Inhalation, passing through the skin and ingestion

Harmful Effects and Symptoms
Short-Term Exposure: Irritates the skin, eyes, and respiratory tract. Eye contact may cause irritation, burning sensation, and damage. Harmful if ingested, inhaled or absorbed through the skin. Inhalation should be avoided; use NIOSH- or CEN (UK)-approved air purifying respirators for pesticides. May be harmful if swallowed. LD_{50} (oral, rat) = >1000 mg/kg; LD_{50} (dermal, rat) = >4 g/kg.
Medical Surveillance: This chemical is a suspected or known human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and advice for medical monitoring. Consult a physician if poisoning is suspected or if redness, itching, or burning of the eyes or skin develop. Skin sensitizer.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Do not induce vomiting when formulations containing petroleum solvents are ingested. Evaluation by a qualified allergist, including exposure history and testing, may help diagnose allergy.
Personal Protective Methods: Wear positive pressure SCBA. Wear chemical protective clothing that is specifically recommended by the manufacturer. DuPont Tychem Suit Fabrics is recommended by one government source[88]. It may provide little or no thermal protection. Structural firefighters' protective clothing provides limited protection in fire situations ONLY; it is not effective in spill situations where direct contact with the substance is possible.
Respirator Selection: Based on potential carcinogenicity the following is recommended by NIOSH: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA-or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).
Storage: Color code-Blue: Health Hazard/Poison. Store in a secure poison location. Refrigerate. Prior to working with this chemical all handlers should be trained on its proper

handling and storage. Store in tightly closed containers in a cool, well ventilated area. If this material contains a flammable carrier, sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN3082 Environmentally hazardous substances, liquid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required. UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: For solids, isolate spill or leak area in all directions for at least 25 meters/75 feet. Increase, in the downwind direction, as necessary. First remove all sources of ignition. Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Stop leak if you can do it without risk. Prevent entry into waterways, sewers, basements or confined areas. Cover with plastic sheet to prevent spreading. Absorb or cover with dry earth, sand or other noncombustible material and transfer to containers. If you spill this chemical, you should dampen the solid spill material with water, then transfer the dampened material to a suitable container. Use absorbent paper dampened with water to pick up any remaining material. Seal your contaminated clothing and the absorbent paper in a vapor-tight plastic bag for eventual disposal. Wash all contaminated surfaces with a soap and water solution. Do not reenter the contaminated area until the Safety Officer (or other responsible person) has verified that the area has been properly cleaned. Do not allow water to get inside containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Treat as an explosive. Thermal decomposition products may include hydrogen chloride and oxides of nitrogen and carbon. See "Incompatibilities" section. As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 meters/150 feet for liquids and at least 25 meters/75 feet for solids. *Fire involving storage or vehicular tanks:* Isolate for 800 meters/0.5 mile in all directions; also, consider initial evacuation for 800 meters/0.5 mile in all directions. *On a small fire:* use dry chemical, CO_2, water spray or regular *foam. On a large fire:* use water spray, fog or regular foam. Do not scatter spilled material with high pressure streams of water. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal. *Fire involving tanks:* From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. Always stay away from tanks engulfed in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Contact a licensed disposal facility about surplus and nonrecyclable solutions. Burn in a chemical incinerator equipped with an afterburner and scrubber. Extra care must be exercised as the material in an organic solvent is highly flammable. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office. Incineration or permanganate oxidation.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Office of Pesticide Programs, Pesticide Residue Limits, "Propiconazole," 40 CFR 180.434, http://www.epa.gov/pesticides/food/viewtols.htm

EXTOXNET, Extension Toxicology Network, "Pesticide Information Profile, Propiconazole," Oregon State University, Corvallis, OR (October 1997). http://pmep.cce.cornell.edu/profiles/extoxnet/metiram-propoxur/propiconazole-ext.html

β-Propiolactone P:1130

Formula: $C_3H_4O_2$

Synonyms: Betaprone; BPL; Hydracrylic acid, β-lactone; 3-Hydroxypropionic acid lactone; NSC21626; 2-Oxetanone; Propanoic acid, 3-hydroxy-, β-lactone; 3-Propanolide; Propanolide; 1,3-Propiolactone; 3-Propiolactone; Propiolactone; β-Propionolactone; Propionolactone, b

CAS Registry Number: 57-57-8

HSDB Number: 811

RTECS Number: RQ7350000

UN/NA & ERG Number: UN3382/151; UN2810 (toxic liquid, organic, n.o.s.)/153[101]

EC Number: 200-340-1[*Annex I Index No.:* 606-031-00-1]

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Human No Adequate Data, animal Sufficient Evidence, *possibly carcinogenic to humans*, Group 2B, 1999; NIOSH: Potential occupational carcinogen; OSHA: Potential human carcinogen. United States Environmental Protection Agency Gene-Tox Program, Positive: Carcinogenicity-mouse/rat; SHE-focus assay; Positive: Cell transformation-SA7/SHE; Positive: D *melanogaster*-reciprocal translocation; Positive: Host -mediated assay; L5178Y cells *In vitro*-TK test; Positive: N crassa-forward mutation; N crassa-reversion; Positive: *E coli polA* without S9; Histidine reversion-Ames test; Positive: D *melanogaster* sex-linked lethal; Positive: *In vitro* UDS-human fibroblast; Positive: S *cerevisiae* gene conversion; S *cerevisiae-homozygosis*; Positive: S cerevisiae-reversion; Positive/dose response: *In vitro* SCE-nonhuman; Negative: Sperm morphology-mouse; Inconclusive: Mammalian micronucleus; Positive: CHO gene mutation

California Proposition 65 Chemical[102]: Cancer 1/1/1988.

Hazard Alert: Poison, Flammable, Polymerization hazard (w/heat), Possible risk of forming tumors, Suspected reprotoxic hazard.

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR 1910.1013)

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500 lb (227 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T+, F; Risk phrases: R45; R5; R10; R26; R36/38; R44; R50/53; R60; R61; R62; Safety phrases: S15; S53; S45.; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: β-Propiolactone is a colorless liquid which slowly hydrolyzes to hydracrylic acid and must be cooled to remain stable. Molecular weight = 72.06; Specific gravity (H_2O:1) = 1.15 @ 20°C; Boiling point = (decomposes) 162°C; Freezing/Melting point = −33.4°C; Vapor pressure = 3 mmHg @ 25°C; Flash point = 75°C. Explosive limits: LEL = 2.9%; UEL-unknown. Hazard Identification (based on NFPA-704 M Rating System): Health 0, Flammability 2, Reactivity 0₩. Soluble in water; solubility = 37%. Reacts with water, releasing irritating 3-hydroxypropionic acid.

Potential Exposure: β-Propiolactone is used as a chemical intermediate in synthesis of acrylic acid and esters, acrylate plastics; as a vapor sterilizing agent; phase disinfectant; and a viricidal agent.

Incompatibilities: Reacts with water, causing decomposition and forming 3-hydroxypropionic acid (CAS: 503-66-3), an irritant. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Incompatible with acetates, halogens, thiocyanates, thiosulfates, strong oxidizers; strong bases. Forms explosive mixture with air above 75°C. May polymerize upon storage or due to warming. Stable if kept under refrigeration @ 5 to 10°C/40 to 50°F.

Permissible Exposure Limits in Air:

NIOSH IDLH = Not determined. Potential occupational carcinogen

OSHA PEL: Cancer suspect agent. Exposures of workers to this chemical is to be controlled through the required use of engineering controls, work practices; and personal protective equipment, including respirators. See 29CFR 1910.1003-1910.1016 for specific details of these requirements.

NIOSH REL: A potential occupational carcinogen. [skin]; Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV[1]: 0.5 ppm/1.5 milligram per cubic meter TWA; confirmed animal carcinogen with unknown relevance to humans

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 1.5 ppm

PAC-2: 5 ppm

PAC-3: 30 ppm

DFG MAK: [skin] Carcinogen Category 2

Australia: TWA 0.5 ppm (1.5 milligram per cubic meter), carcinogen, 1993; Austria: carcinogen, 1999; Belgium: TWA 0.5 ppm (1.5 milligram per cubic meter), carcinogen, 1993; Denmark: TWA 0.1 ppm (1.5 milligram per cubic meter), 1999; Finland: carcinogen, 1999; France: carcinogen, 1993; Poland: MAC (TWA) 1 milligram per cubic meter, 1999; Sweden: carcinogen, 1999; Switzerland: MAK-W 0.5 ppm (1.5 milligram per cubic meter), carcinogen, 1999; United Kingdom: carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: confirmed animal carcinogen with unknown relevance to humans. Several states have set guidelines or standards for propiolactone in ambient air[60] ranging from zero (North Dakota) to 5.0 μ/m^3 (New York) to 7.5 μ/m^3 (South Carolina) to 15 μ/m^3 (Florida and Virginia) to 22.5 μ/m^3 (Connecticut) to 36.0 μ/m^3 (Nevada).

Routes of Entry: Inhalation, ingestion, dermal and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Corrosive to the eyes. May cause corneal opacity and blindness. Irritates the respiratory tract.

Contact with skin causes irritation, burns, and blistering; fluid from blisters may cause additional blistering of adjacent skin. Ingestion causes burns of mouth and stomach. The toxicity potential of this material via inhalation or ingestion is high; may cause death or permanent injury after very short exposures to small quantities.

Long-Term Exposure: A potential occupational carcinogen. May cause frequent urination, dysuria, hematuria (blood in the urine). May affect the liver and kidneys. May cause tumors and cancer.

Points of Attack: Kidneys, skin, lungs, eyes, liver. Cancer site in animals: tumors of the liver, skin and stomach.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Based on its high toxicity and carcinogenic effects in animals, preplacement and periodic examinations should include a history of exposure to other carcinogens; alcohol and smoking habits; medication and family history. The skin, eye, lung, liver, and kidney should be evaluated. Sputum cytology may be helpful in evaluating the presence or absence of carcinogenic effects. Kidney and liver function tests. Periodic lung function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. butyl rubber is among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Specific engineering controls are required for this chemical. Refer to OSHA Standard: *beta-Propiolactone, 29 CFR 1910.1013.*

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Poison inhalation chemical (PIH); check oxygen content prior to entering storage area. Color code-Blue: Health Hazard/Poison: Store in a cool secure poison location. Avoid storing in areas of exposure to the direct rays of the sun or heat and in areas of high fire hazard. Tends to polymerize on storage. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration is not a danger. Store in a refrigerator or a freezer in glass containers and protect from air and light. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN3382 Toxic by inhalation liquid, n.o.s. with an $LC_{50} \leq 1000$ mL/m^3 and saturated vapor concentration ≥ 10 LC_{50}, Hazard class: 6.1; Labels: 6.1 Technical Name Required, Inhalation Hazard Zone B. UN2810 Toxic liquids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling:

UN3382 Toxic by inhalation liquid, n.o.s.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)
First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.2/0.3
Night 0.7/1.2
Large spills (From a large package or from many small packages)
First: Isolate in all directions (feet/meters) 1000/300
Then: Protect persons downwind (miles/kilometers)
Day 1.1/1.8
Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fireighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(109); (102); (31); (173); (101); (138); (100).
Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 3, No. 2, 57−60 (1983)
United States Environmental Protection Agency, Chemical Hazard Information Profile: Propiolactone, Beta-, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)
New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: beta*-Propiolactone, Trenton, NJ (August 2002)

Propionaldehyde P:1140

Formula: C_3H_6O; CH_3CH_2COH
Synonyms: Aldehyde propionique (French); Methylacetaldehyde; NCI-C61029; Propaldehyde; Propanal; *n*-Propanal; 1-Propanal; Propanaldehyde; 1-Propanone; Propional; Propionic aldehyde; Propyl aldehyde; Propylic aldehyde
CAS Registry Number: 123-38-6
HSDB Number: 1193
RTECS Number: UE0350000
UN/NA & ERG Number: UN1275/129 (P)
EC Number: 204-623-0 [*Annex I Index No.:* 605-018-00-8]
Regulatory Authority and Advisory Information
Carcinogenicity: EPA: Inadequate Information to assess carcinogenic potential.
Hazard Alert: Highly flammable, Polymerization hazard; Suspected of causing genetic defects, Primary irritant (w/o allergic reaction).
Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)
Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 1 lb (0.454 kg)
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
Hazard Symbols, Risk & Safety statements: Hazard Symbol: F, Xi; Risk phrases: R11; R19; R36/37/38; R41; R62; Safety phrases: S2; S9; S16; S21; S25; S29 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Propionaldehyde is a colorless liquid. Very strong, intensive fruit odor. Molecular weight = 58.08; Specific gravity (H_2O:1) = 0.9 @ 20°C; Boiling point = 48°C; Freezing/Melting point = −80°C; Flash point = −30°C(oc); Vapor pressure = 750 mmHg @ 48°C Autoignition temperature = 207°C. Explosive limits: LEL = 2.6%; UEL: 17%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 2. Slightly soluble in water.

Potential Exposure: Used as a synthetic flavoring; as a disinfectant and preservative; to make propionic acid; in plastic and rubber manufacturing; to make alkyl resins and plasticizers.

Incompatibilities: Incompatible with strong acids; amines. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Strong caustics; reducing agents can cause explosive polymerization. Can self-ignite if finely dispersed on porous or combustible material, such as fabric. Heat or UV light can cause decomposition. Aldehydes are frequently involved in self-condensation or polymerization reactions. These reactions are exothermic; they are often catalyzed by acid. Aldehydes are readily oxidized to give carboxylic acids. Flammable and/or toxic gases are generated by the combination of aldehydes with azo, diazo compounds, dithiocarbamates, nitrides, and strong reducing agents. Aldehydes can react with air to give first peroxo acids, and ultimately carboxylic acids. These autoxidation reactions are activated by light, catalyzed by salts of transition metals, and are autocatalytic (catalyzed by the products of the reaction). The addition of stabilizers (antioxidants) to shipments of aldehydes retards autoxidation[101].

Permissible Exposure Limits in Air:

ACGIH TLV[1]: 20 ppm/48 milligram per cubic meter TWA

Protective Action Criteria (PAC)* Ver. 29[138]

PAC-1: $\mathbf{45_A}$ ppm

PAC-2: $\mathbf{260_A}$ ppm

PAC-3: $\mathbf{840_A}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

Determination in Air: NIOSH Analytical Method #2539, aldehydes, screening.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the skin causing a burning sensation and rash on contact. Inhalation can irritate the respiratory tract and may cause nosebleeds, sore throat; cough and phlegm. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: Can irritate the lungs; bronchitis may develop. Testing has not been completed to determine the carcinogenicity of propionaldehyde. However, the limited studies to date indicate that these substances have chemical reactivity and mutagenicity similar to acetaldehyde and malonaldehyde. Therefore, NIOSH recommends that careful consideration should be given to reducing exposures to this aldehyde. Further information can be found in the *NIOSH Current Intelligence Bulletin 55: Carcinogenicity of Acetaldehyde and Malonaldehyde, and Mutagenicity of Related Low-Molecular-Weight Aldehydes* [DHHS (NIOSH), Publication No. 91-112].

Points of Attack: Lungs, skin.

Medical Surveillance: Lung function test. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24–48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well ventilated area away from oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1275 Propionaldehyde, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of carbon. *Do not use water.* Use dry chemical, carbon dioxide extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Propionaldehyde, Trenton, NJ (May 2006)

Propionic Acid P:1150

Formula: $C_3H_6O_2$: CH_3CH_2COOH

Synonyms: Acide propionique (French); Carbonyethane; Carboxyethane; Ethanecarboxylic acid; Ethylformic acid; Metacetonic acid; Methylacetic acid; Propanoic acid; Propionic acid Grain preserver; Prozoin; Pseudoacetic acid; Sentry grain preserver; Tenox P grain preservative

CAS Registry Number: 79-09-4

HSDB Number: 1192

RTECS Number: UE5950000

UN/NA & ERG Number: UN1848 (propionic acid with not <10% and <90% acid by mass)/132; UN3463 (propionic acid, with not <90 % acid by mass)/132

EC Number: 201-176-3 [*Annex I Index No.:* 607-089-00-0]

Regulatory Authority and Advisory Information

Hazard Alert: Flammable liquid, Corrosive (skin, eyes), Suspected of causing genetic defects, Primary irritant (w/o allergic reaction). Listed for Tier 1 screening as an endocrine disruptor[88].

United States Environmental Protection Agency, FIFRA 1998 Status of Pesticides: Pesticide subject to registration or re-registration

FDA-over the counter drug

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 5000 lb (2270 kg)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: C, T, F; Risk phrases: R10; R34; R36/38; R62; Safety phrases: S1/2; S23; S36; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Propionic acid is a colorless liquid. Sharp, rancid odor. The Odor Threshold is 0.16 ppm. Molecular weight = 74.09; Specific gravity (H_2O:1) = 0.998 @ 25°C; Boiling point = 141°C; Freezing/Melting point = −22°C; Vapor pressure = 3 mmHg @ 25°C; Flash point = 52.2°C (cc); 57°C (oc); Autoignition temperature = 465°C. Explosive limits: LEL = 2.9%; 11.000 ppm[138]; UEL: 12.1%[17]. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 0. Soluble in water, releases heat.

Potential Exposure: Propionic acid is used in the manufacture of inorganic propionates and propionate esters which are used as mold inhibitors, electroplating additives; emulsifying agents; flavors and perfumes. It is an intermediate in pesticide manufacture, pharmaceutic manufacture; and in the production of cellulose propionate plastics. Also used as grain preservative.

Incompatibilities: The substance is a medium strong acid. Incompatible with sulfuric acid, strong bases; ammonia, isocyanates, alkylene oxides; epichlorohydrin. Reacts with bases; strong oxidizers; and amines, causing fire and explosion hazard. Attacks many metals forming flammable/explosive hydrogen gas.

Permissible Exposure Limits in Air:

Conversion factor: 1 ppm = 3.03 milligram per cubic meter @ 25°C & 1 atm
OSHA PEL: None
NIOSH REL: 10 ppm/30 milligram per cubic meter TWA; 15 ppm/45 milligram per cubic meter STEL
ACGIH TLV[1]: 10 ppm/30 milligram per cubic meter TWA
Protective Action Criteria (PAC) Ver. 29[138]
PAC-1: 15 ppm
PAC-2: 28 ppm
PAC-3: 170 ppm
DFG MAK: 10 ppm/31 milligram per cubic meter TWA; Peak Limitation Category I(2); [skin]; Pregnancy Risk Group C.
Australia: TWA 10 ppm (30 milligram per cubic meter); STEL 15 ppm, 1993; Austria: MAK 10 ppm (30 milligram per cubic meter), 1999; Belgium: TWA 10 ppm (30 milligram per cubic meter); STEL 15 ppm, 1993; Denmark: TWA 10 ppm (30 milligram per cubic meter), 1999; Finland: TWA 10 ppm, [skin], 1999; France: VME 10 ppm (30 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 31 milligram per cubic meter, 2003; Russia: STEL 20 milligram per cubic meter, 1993; Sweden: NGV 10 ppm (30 milligram per cubic meter), KTV 15 ppm (45 milligram per cubic meter), 1999; Switzerland: MAK-W 10 ppm (30 milligram per cubic meter), KZG-W 20 ppm (60 milligram per cubic meter), 1999; United Kingdom: TWA 10 ppm (31 milligram per cubic meter); STEL 15 ppm (46 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietman: ACGIH TLV: TWA 10 ppm. Russia[43] set a MAC for ambient air in residential areas of 0.015 milligram per cubic meter (15 μ/m^3) on a momentary basis. Several states have set guidelines or standards for propionic acid in ambient air[60] ranging from 300−450 μ/m^3 (North Dakota) to 500 μ/m^3 (Virginia) to 600 μ/m^3 (Connecticut) to 714 μ/m^3 (Nevada).

Determination in Air: No method available.

Determination in Water: Octanol-water coefficient: Log $K_{ow} = 0.31$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Corrosive to the eyes, skin, and respiratory tract. Contact can cause severe eye burns, leading to permanent damage. Skin contact causes skin burns. Inhalation can cause irritation of the respiratory tract with mild cough; asthmatic response were found in medical reports of acute exposure of workers.

Long-Term Exposure: May cause an asthma-like allergy. May irritate the lungs; may lead to lung damage.

Points of Attack: Skin, eyes, and respiratory system.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that. Lung function tests. These may be normal if person is not having an attack at the time of the test.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water, or milk. Do not induce vomiting.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. ACGIH recommends Neoprene, nitrile rubber and polyvinyl chloride as protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures *over 10 ppm*; Use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece powered-air purifying respirators. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air purifying respirators. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration is not a danger. Store in containers made of aluminum or stainless steel. Propionic acid will corrode steel. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates), ignition sources or heat. Outside or detached storage is preferred. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1848 Propionic acid, Hazard class: 8; Labels: 8-Corrosive material. UN3463 Propionic acid, with not <90% acid by mass, Hazard Class 8; Labels: 8-Corrosive material, 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Cover spilled material with soda ash or sodium bicarbonate. Mix and add water. Neutralize and drain to sewer with plenty of water. Use water spray to dilute spill and disperse vapor. Or, absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration in admixture with flammable solvent.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Propionic Acid, Trenton, NJ (April 2001).

Propionic Anhydride P:1160

Formula: $C_6H_{10}O_3$

Synonyms: Methylacetic anhydride; Propanoic anhydride; Propionic acid anhydride; Propionyl oxide

CAS Registry Number: 123-62-6

HSDB Number: 1215

RTECS Number: UF9100000

UN/NA & ERG Number: UN2496/156

EC Number: 204-638-2 [*Annex I Index No.:* 607-010-00-X]

Regulatory Authority and Advisory Information

Hazard Alert: Flammable, Corrosive, Violently water reactive.

List 1, DEA chemical code 8328 (Title 21 CFR1310.02)

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 5000 lb (2270 kg).

Hazard Symbols, Risk & Safety statements: Hazard Symbol: C, F; Risk phrases: R10; R14; R34; Safety phrases: S1/2; S26; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Propionic anhydride is a colorless liquid. Strong, pungent, unpleasant odor. Molecular weight = 130.16; Specific gravity (H_2O:1) = 1.01 @ 20°C; Boiling point = 167°C; Freezing/Melting point = −45°C; Vapor pressure = 1 mmHg @ 21°C; Flash point = 62.8°C; Autoignition temperature = 285°C. Explosive limits: LEL = 1.3%; 20,000 ppm[138]; UEL: 9.5%. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 1₩. Decomposes exothermically in water forming heat and propionic acid which is flammable (NFPA 2).

Potential Exposure: Used in the manufacture of perfumes, flavorings, alkyd resins; dyestuffs, pharmaceuticals; as an esterifying agent for fats, oils, and cellulose; dehydrating medium for nitrations and sulfonations.

Incompatibilities: Vapors may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, reducing agents; alcohols and metals. Contact with water forms heat + flammable propionic acid. Compounds of the carboxyl group react with all bases, both inorganic and organic (i.e., amines) releasing substantial heat, water and a salt that may be harmful. Incompatible with arsenic compounds (releases hydrogen cyanide gas), diazo compounds, dithiocarbamates, isocyanates, mercaptans, nitrides, and sulfides (releasing heat, toxic and possibly flammable gases), thiosulfates and dithionites (releasing hydrogen sulfate and oxides of sulfur).

Permissible Exposure Limits in Air:

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 7.1 milligram per cubic meter

PAC-2: 78 milligram per cubic meter

PAC-3: 470 milligram per cubic meter

Permissible Concentration in Water: High concentrations are dangerous to aquatic life. May be dangerous if it enters water intakes.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin, and respiratory tract. Eye contact can cause burns and permanent damage. Contact with liquid causes burns of skin. Ingestion causes burns of the mouth and stomach. High exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: May cause skin allergy. Can irritate the lungs; bronchitis may develop.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water, or milk. Do not induce vomiting. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well ventilated area away from oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN2496 Propionic anhydride, Hazard class: 8; Labels: 8-Corrosive material.

Spill Handling: Stay upwind and uphill. Isolate the area of release or fire and deny entry. Remove all ignition sources. Stop the release if it can be done safely from a distance. All equipment used to handle this material must be grounded. Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. *Small spill*: Cover with *dry* earth, *dry* sand, or other noncombustible material followed with plastic sheet to minimize spreading or contact with water or rain. Use clean nonsparking tools to collect material and place material into loosely covered plastic containers for later disposal. Prevent material and runoff from entering sewers and waterways if it can be done safely well ahead of the release. Use vapor suppressing foam to disperse vapors—contain runoff. Water spray may reduce vapor, but may not prevent ignition in enclosed spaces. Ventilate confined area if it can be done without placing personnel at risk. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of carbon. *Small fire*: use *dry* chemical, CO_2, *dry* sand, or alcohol-resistant foam. May react with foams releasing corrosive/toxic gases. *Large fire*: use water spray or alcohol-resistant foam if it is available in sufficient amounts. Under favorable conditions, experienced crews can use coordinated fog streams to sweep the flames off the surface of the burning liquid. Combustible material: may burn but does not ignite readily. Most vapors are heavier than air. They will spread along ground and collect in low or confined areas (sewers, basements, tanks). Vapors may travel to source of ignition and flash back. Containers may explode when heated or if contaminated with water. Keep exposures cool long after fire is out to protect against reignition. Do not direct straight streams into the liquid. Cool exposed containers with large quantities of water from unattended equipment or remove intact containers if it can be done safely. *Do not get water on spilled substance or inside containers*. If cooling streams are ineffective (*venting sound increases in volume and pitch, tank discolors or shows signs of deforming*), withdraw immediately to a secure location. Always stay away from ends of tanks, especially when engulfed in flames. If material or contaminated runoff from fire control enters waterways, notify downstream users of potentially contaminated water. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156.

Disposal Method Suggested: Use a licensed professional waste disposal service to dispose of this material. Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Propionic Anhydride, Trenton, NJ (July 1999)

Propionitrile P:1170

Formula: C_3H_5N; CH_3CH_2CN

Synonyms: Cianuro de etilo (Spanish); Cyanoethane; Ether cyanatus; Ethyl cyanide; Hydrocyanic ether; Propanenitrile; Propionic nitrile propylnitrile

CAS Registry Number: 107-12-0

HSDB Number: 117

RTECS Number: UF9625000

UN/NA & ERG Number: UN2404/131

EC Number: 203-464-4

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 ($\geq$1.00% concentration).

Hazard Alert: Exposure can be lethal, Highly flammable liquid, Poison, Corrosive, Suspected reprotoxic hazard, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction).

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P101

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR264, appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8015 (60); 8240 (5)

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500 lb (227 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 10 lb (4.54 kg)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T+; Risk phrases: R11; R27/28; R41; R62; R63; Safety phrases: S1; S13; S21; S24/25; S28; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Propionitrile is a colorless liquid with a pleasant, sweetish, ethereal odor. Molecular weight = 55.09; Specific gravity (H_2O:1) = 0.78 @ 20°C; Boiling point = 97°C; Freezing/Melting point = −104°C; Vapor pressure = 35 mmHg @ 30°C; Flash point = 2.2°C (cc). Explosive limits: LEL = 3.1%; 30.000 ppm[138]; UEL-unknown. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 3, Reactivity 1. Soluble in water; solubility = 12%.

Potential Exposure: Used as a solvent in petroleum refining, as a chemical intermediate; a raw material for drug manufacture; and a setting agent.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides., reducing agents. Hydrogen cyanide is produced when propionitrile is heated to decomposition. Reacts with acids, steam, warm water; producing toxic and flammable hydrogen cyanide fumes. Nitriles may polymerize in the presence of metals and some metal compounds. They are incompatible with acids; mixing nitriles with strong oxidizing acids can lead to extremely violent reactions. Nitriles are generally incompatible with other oxidizing agents such as peroxides and epoxides. The combination of bases and nitriles can produce hydrogen cyanide. Nitriles are hydrolyzed in both aqueous acid and base to give carboxylic acids (or salts of carboxylic acids). These reactions generate heat. Peroxides convert nitriles to amides. Nitriles can react vigorously with reducing agents. Acetonitrile and propionitrile are soluble in water, but nitriles higher than propionitrile have low aqueous solubility. They are also insoluble in aqueous acids[101].

Permissible Exposure Limits in Air:
Conversion factor: 1 ppm = 2.25 milligram per cubic meter @ 25°C & 1 atm
OSHA PEL: None
NIOSH REL: TWA 6 ppm/14 milligram per cubic meter; *Nitriles:* 2 ppm, Ceiling Concentration, not to be exceeded in any 15-minute work period.
ACGIH TLV[1]: None
Protective Action Criteria (PAC)* Ver. 29[138]
PAC-1: 0.27 ppm
PAC-2: $\mathbf{3.0}_{\mathbf{A}}$ ppm
PAC-3: $\mathbf{9.1}_{\mathbf{A}}$ ppm
*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Contact may cause burns to skin and eyes. May affect the iron metabolism, causing asphyxia. It is highly toxic. Forms cyanide in the body. This super toxic compound has a probable oral lethal dose in humans of less than 5 mg/kg or a taste (less than 7 drops) for a 70 kg (150 lb) person[101]. Exposure results in headache, dizziness, rapid pulse; deep-rapid breathing; nausea, vomiting, unconsciousness, convulsions and possible death. May cause cyanosis (blue coloration of skin and lips caused by lack of oxygen).

Long-Term Exposure: Chronic exposure over long periods may cause fatigue and weakness. Can cause same general symptoms as hydrogen cyanide but onset of symptoms is likely to be slower. May cause liver and kidney damage. See NIOSH Criteria Document 212 *Nitriles*.

Points of Attack: In animals: liver, kidney damage

Medical Surveillance: Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Use amyl nitrate capsules if symptoms develop. All area employees should be trained regularly in emergency measures for cyanide poisoning and in CPR. A cyanide antidote kit should be kept in the immediate work area and must be rapidly available. Kit ingredients should be replaced every 1–2 years to ensure freshness. Persons trained in the use of this kit; oxygen use, and CPR must be quickly available.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. For engineering controls, see NIOSH Criteria Document 212 *Nitriles*.

Respirator Selection: *60 ppm:* CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)]; or Sa (APF = 10) (any supplied-air respirator). *150 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]. *300 ppm:* CcrFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted acid gas canister]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister]; or PaprTOv (APF = 50) [any powered, air-purifying respirator with a tight -fitting facepiece and organic vapor cartridge(s)]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *1000 ppm:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code -Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration is not a danger. Store in an explosion-proof refrigerator. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN2404 Propionitrile, Hazard Class: 3; Labels: 3-Flammable liquid, 6.1-Poisonous material.

UN1992 Flammable liquids, toxic, n.o.s., Hazard Class: 3; Labels: 3-Flammable liquid, 6.1-Poisonous materials, Technical Name Required.

Spill Handling:

Nitriles spill

Initial isolation and protective action distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)
Day 0.3/0.5
Night 0.5/0.8

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Do not touch spilled material; stop leak if you can do it without risk. Use water spray to reduce vapors. *Small spills:* take up with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills:* dike far ahead of spill for later disposal. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include hydrogen cyanide vapors and oxides of nitrogen and carbon and other toxic chemicals. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Alcoholic NaOH followed by calcium hypochlorite may be used, as may incineration[22]. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile Draft Report: Propionitrile, Washington, DC (September 2, 1983)

United States Environmental Protection Agency, Chemical Hazard Information Profile: Propionitrile, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

Propoxur P:1180

Formula: $C_{11}H_{15}NO_3$

Synonyms: 58-12-315; Arprocarb; BAY39007; BAY 5122; Bayer 39007; Bayer B 5122; Baygon; Blattanex; Blattosep; Bolfo; Boruho; Boruho 50; Brygou; Carbamic acid, methyl-, *o*-isopropoxyphenyl ester; Dalf dust; ENT25,671;

Invisi-gard; IPMC; *o*-(2-Isopropoxyphenyl) *N*-methylcarbamate; *o*-Isopropoxyphenyl *N*-methylcarbamate; *o*-Isopropoxyphenyl methylcarbamate; 2-Isopropoxyphenyl *N*-methylcarbamate; 2-Isopropoxyphenyl methylcarbamate; 2-(1-Methylethoxy)phenyl *N*-methylcarbamate; OMS 33; PHC; Phenol, 2-(1-methylethoxy)-, methylcarbamate; Propotox; Propoxylor; Sendran; Suncide; Tendex; Unden

CAS Registry Number: 114-26-1

HSDB Number: 603

RTECS Number: FC3150000

UN/NA & ERG Number: UN2757 (carbamate pesticides, solid, toxic)/151; UN2811 (toxic solid, organic, n.o.s.)/153

EC Number: 204-043-8 [*Annex I Index No.:* 006-16-00-4]

Regulatory Authority and Advisory Information

Carcinogenicity: EPA, Classification 2B, Probable human carcinogen (2006). United States Environmental Protection Agency Gene-Tox Program, Negative: B *subtilis* rec assay; TRP reversion; Negative: S *cerevisiae* gene conversion; Inconclusive: B *subtilis* rec assay

California Proposition 65 Chemical[102]: Cancer 8/11/06.

Hazard Alert: Poison, Possible neurotoxic effects (methyl carbamate), Combustible, Suspected of causing genetic defects, Suspected reprotoxic hazard, Environmental hazard, Agricultural chemical.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U411

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.056; Nonwastewater (mg/kg), 1.4

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 1 lb (0.454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, appendix B)

Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T, N; Risk phrases: R25; R33; R50/53; R62; R63; Safety phrases: S29; S37; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Propoxur is a white to tan crystalline solid or powder. Faint characteristic odor. Molecular weight = 209.27. Boiling point = (decomposes). Freezing/Melting point = 91.5°C. Vapor pressure = 9.75 mmHg @ 20°C. Flash point = > 149°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Slightly soluble in water; solubility = 2 g/L @ 20°C.

Potential Exposure: Personnel engaged in the manufacture, formulation and application of this organonitrogen agricultural chemical and pesticide.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, alkalis, heat, and moisture. Emits highly toxic methyl isocyanate fumes when heated to decomposition.

Permissible Exposure Limits in Air:

OSHA PEL: None

NIOSH REL: 0.5 milligram per cubic meter TWA

ACGIH TLV[1]: 0.5 milligram per cubic meter TWA; confirmed animal carcinogen with unknown relevance to humans. BEIA issued for Acetylcholinesterase inhibiting pesticides

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 1.5 milligram per cubic meter

PAC-2: 6.7 milligram per cubic meter

PAC-3: 40 milligram per cubic meter

DFG MAK: 2 milligram per cubic meter measured as the, inhalable fraction TWA; Peak Limitation Category II(8)

Australia: TWA 0.5 milligram per cubic meter, 1993; Austria: MAK 0.5 milligram per cubic meter, 1999; Belgium: TWA 0.5 milligram per cubic meter, 1993; Denmark: TWA 0.5 milligram per cubic meter, 1999; Finland: TWA 0.5 milligram per cubic meter; STEL 1.5 milligram per cubic meter, 1993; France: VME 0.5 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 0.5 milligram per cubic meter, 2003; Poland: MAC (TWA) 0.5 milligram per cubic meter; MAC (STEL) 2 milligram per cubic meter, 1999; Switzerland: MAK-W 0.5 milligram per cubic meter, 1999; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: confirmed animal carcinogen with unknown relevance to humans. Several states have set guidelines or standards for Baygon in ambient air[60] ranging from $5-20\ \mu/m^3$ (North Dakota) to $8\ \mu/m^3$ (Virginia) to $10\ \mu/m^3$ (Connecticut) to $12\ \mu/m^3$ (Nevada).

Determination in Air: Organonitrogen pesticides. OSHA versatile sampler-2; Reagent; High-pressure liquid chromatography/UV detection; NIOSH Analytical Method (IV) #5601.

Determination in Water: Fish Tox = 168.01099000 MATC (LOW). Octanol-water coefficient: Log $K_{ow} = 1.5$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Propoxur can affect you when breathed in and quickly enters the body by passing through the skin. Severe poisoning can occur from skin contact. It is a moderately toxic carbamate chemical. Exposure can cause severe carbamate poisoning, with symptoms of headaches, sweating, nausea and vomiting; diarrhea, muscle twitching; loss of coordination and even death. May affect the nervous system; liver, kidneys. A cholinesterase inhibitor. $LD_{50} = 83$ mg/kg[77].

Long-Term Exposure: Propoxur may cause mutations. Handle with extreme caution. It may damage the developing fetus. Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage. Human Tox = 94.85095 ppb CHCL (Chronic Human Carcinogen Level) (LOW).

Points of Attack: CNS; liver, kidneys, gastrointestinal tract; blood cholinesterase.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: serum and red blood cell cholinesterase levels (a test for the enzyme in the body affected by propoxur). These tests are only useful if done 1−2 after exposure and can return to normal before the person feels well. Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of “normal.” Reassignment to work not involving carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also consider CBC. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures over 0.5 milligram per cubic meter, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from heat, moisture, oxidizers, alkaline environments. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN2757 Carbamate pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25meters/75 feet.(NJ). Isolation Distance, Fire: 800 meters/0.5 miles[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Soil Adsorption Index (K_{oc}) = 30.

Fire Extinguishing: This chemical is a combustible solid. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Highly toxic gases are produced in fire, including methyl isocyanate. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(102); (31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Propoxur, Trenton, NJ (July 2005)

NIOSH Manual of Analytical Methods, 4th Edition, Issue 1, *Organonitrogen pesticides*, page 7of 21, Cincinnati, OH, 1/15/1998.

n-Propyl acetate P:1190

Formula: $C_5H_{10}O_2$: $CH_3COOCH_2CH_2CH_3$

Synonyms: Acetate de propyle normal (French); Acetic acid, propyl ester; Acetic acid, *n*-propyl ester; 1-Acetoxypropane; Propyl acetate; *n*-Propyl acetate; 1-Propyl acetate; Propylacetate

CAS Registry Number: 109-60-4

HSDB Number: 161

RTECS Number: AJ3675000

UN/NA & ERG Number: UN1276/129 (stabilized)

EC Number: 203-686-1 [*Annex I Index No.:* 607-024-00-6]

Regulatory Authority and Advisory Information

Hazard Alert: Highly Flammable; Polymerization hazard (nonstabilized), Primary irritant (w/o allergic reaction).

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: F; Risk phrases: R11; R19; R36; R66; R67; Safety phrases: S2; S16; S21; S23; S26; S29; S33; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: *n*-Propyl acetate is a colorless liquid with a mild, fruity odor. The Odor Threshold is 70 milligram per cubic meter and 2.8 milligram per cubic meter (New Jersey Fact Sheet). Molecular weight = 102.15 (both isomers); Specific gravity (H_2O:1) = 0.84 @ 20°C; Boiling point = 101.5°C; Freezing/Melting point = −92.2°C; Vapor pressure = 36 mmHg @ 25°C; Flash point = 13°C; Autoignition temperature = 450°C. Explosive limits: LEL = 1.7% @ 38°C; UEL: 8.0%. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 3, Reactivity 0. Slightly soluble in water; solubility = 2%.

Potential Exposure: Propyl acetate is a used as a solvent for plastics and cellulose ester resins; perfume ingredient; component of food flavoring. It is also used as a chemical intermediate.

Incompatibilities: Contact with nitrates, strong oxidizers; strong alkalis; strong acids; may pose risk of fire and explosions. Attacks plastic.

Permissible Exposure Limits in Air:

NIOSH IDLH = 1700 ppm

Conversion factor: 1 ppm = 4.18 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 200 ppm/840 milligram per cubic meter TWA

NIOSH REL: 200 ppm/840 milligram per cubic meter TWA; 250 ppm/1050 milligram per cubic meter STEL

ACGIH TLV[1]: 200 ppm/835 milligram per cubic meter TWA; 250 ppm/1040 milligram per cubic meter STEL

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 250 ppm

PAC-2: 1300 ppm

PAC-3: 8000 ppm

DFG MAK: 100 ppm/420 milligram per cubic meter TWA; Peak Limitation Category I(2); Pregnancy Risk Group D.

Australia: TWA 200 ppm (840 milligram per cubic meter); STEL 250 ppm, 1993; Austria: MAK 200 ppm (840 milligram per cubic meter), 1999; Belgium: TWA 200 ppm (835 milligram per cubic meter); STEL 250 ppm (1040 milligram per cubic meter), 1993; Finland: TWA 200 ppm (840 milligram per cubic meter); STEL 250 ppm (1050 milligram per cubic meter), 1993; France: VME 200 ppm (840 milligram per cubic meter), 1999; Hungary: TWA 200 milligram per cubic meter; STEL 600 milligram per cubic meter, [skin], 1993; the Netherlands: MAC-TGG 420 milligram per cubic meter, 2003; Norway: TWA 100 ppm (420 milligram per cubic meter), 1999; the Phillipines: TWA 200 ppm (840 milligram per cubic meter), 1993; Poland: MAC (TWA) 200 milligram per cubic meter; MAC (STEL) 1000 milligram per cubic meter, 1999; Russia: TWA 200 ppm; STEL 200 milligram per cubic meter, 1993; Switzerland: MAK-W 200 ppm (840 milligram per cubic meter), KZG-W 400 ppm, 1999; Turkey: TWA 200 ppm (840 milligram per cubic meter), 1993; United Kingdom: TWA 200 ppm (849 milligram per cubic meter); STEL 250 ppm (1060 milligram per cubic meter); Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 250 ppm

Several states have set guidelines or standards for propyl acetate in ambient air[60] ranging from 8.4−10.5 milligram per cubic meter (North Dakota) to 14 milligram per cubic meter (Virginia) to 16.8 milligram per cubic meter (Connecticut) to 20 milligram per cubic meter (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #1401, alcohols II; #1405, alcohols, Combined; OSHA Analytical Method 7, Organic Vapors.

Determination in Water: Octanol-water coefficient: Log $K_{ow} = 1.23$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: *n*-Propyl acetate can affect you when breathed in. Exposure can irritate the eyes, nose, and throat. Very high levels are narcotic and may affect the nervous system and cause you to feel dizzy, lightheaded, and to pass out.

Long-Term Exposure: Prolonged or repeated contact can cause drying and cracking of the skin.

Points of Attack: Eyes, skin, respiratory system; CNS.

Medical Surveillance: There is no special test for this substance. However, if illness occurs or overexposure is suspected, medical attention is recommended.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. butyl rubber; polyvinyl alcohol, and Silvershield are recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 1700 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or CcrFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted acid gas canister]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code -Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration is not a danger. *n*-Propyl acetate must be stored to avoid contact with nitrates, strong oxidizers (such as chlorine, bromine, and fluorine) and strong acids (such as hydrochloric, sulfuric, and nitric); since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. *n*-Propyl acetate will dissolve some plastics and resins. Sources of ignition, such as smoking and open flames, are prohibited where *n*-propyl acetate is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of *n*-propyl acetate should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of *n*-propyl acetate.

Shipping: UN1276 *n*-Propyl acetate, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: n*-Propyl Acetate, Trenton, NJ (March 2001).

Propyl Alcohol P:1200

Formula: C_3H_8O (*n*-); $C_6H_{14}O$ (*iso*-)

Synonyms: Alcohol C-3; Alcool propylique (French); Ethyl carbinol; 1-Hydroxypropane; Optal; Osmosol extra; Propanol-1; 1-Propanol; *n*-Propanol; Propanole (German); Propyl alcohol; Propyl alcohol, *normal*; 1-Propyl alcohol; *n*-Propyl alkohol (German); Propylic alcohol (*isopropyl alcohol*) 2-Methylpentan-1-ol; 2-Methyl-1-pentanol

CAS Registry Number: 71-23-8; 105-30-6 (*iso*-)

HSDB Number: 115; 2890 (*iso*-)

RTECS Number: UH8225000 (*n*-)

UN/NA & ERG Number: UN1274 (*n*-propanol)/129

EC Number: 200-746-9 [*Annex I Index No.:* 603-003-00-0 (*n*-)]; 203-285-1 [2-methylpentan-1-ol]

Regulatory Authority and Advisory Information

United States Environmental Protection Agency Gene-Tox Program, Negative: *In vitro* SCE-nonhuman

Hazard Alert: Highly Flammable liquid, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction).

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: F, Xi; Risk phrases: R2; R11; R36/37/38; R41; R47; R61; R63; R67; Safety phrases: S2; S7; S16; S21; S26; S39 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: The two isomers of propyl alcohol are *n*-propyl alcohol and isopropyl alcohol. The Odor Threshold is 5.3 *ppm*[41] and 2.6 ppm (NJ). Both are colorless, volatile liquids. Alcohol odor. Isopropyl alcohol is discussed in a separate entry in this volume. *n*-Propanol: Molecular weight = 60.11; Specific gravity (H_2O:1) = 0.81 @ 20°C; Boiling point = 97°C; Freezing/Melting point = −127°C; Vapor pressure = 15 mmHg @ 25°C; Flash point = 22.2°C; Autoignition temperature = 412°C. Explosive limits: LEL = 2.2%; UEL: 13.7%. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 3, Reactivity 0. Soluble in water.

Isopropanol; Molecular weight = 102.2; Specific gravity (H_2O:1) = 0.80 @ 20°C; Boiling point = 130°C. Soluble in water.

Potential Exposure: *n*-Propyl alcohol is used as as solvent in lacquers, dopes; to make cosmetics; dental lotions; cleaners, polishes, and pharmaceuticals; as a surgical antiseptic. It is a solvent for vegetable oils, natural gums and resins; rosin, shellac, certain synthetic resins; ethylcellulose, and butyral; as a degreasing agent; as a chemical intermediate.

Incompatibilities: Vapors may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. *n*-Propanol reacts with alkali metal, nitrides and strong reducing agents to give flammable and/or toxic gases. Reacts with oxoacids and carboxylic acids to form esters plus water. Converted by oxidizing agents to propanal or propionic acid. May initiate the polymerization of isocyanates and epoxides[101].

Permissible Exposure Limits in Air:

NIOSH IDLH = 800 ppm

Odor Threshold = 5.3 ppm[41]; 2.6 ppm[70] (*iso*-)

OSHA PEL: 200 ppm/500 milligram per cubic meter TWA

NIOSH REL: 200 ppm/500 milligram per cubic meter TWA; 250 ppm/625 milligram per cubic meter STEL [skin]

ACGIH TLV[1]: 100 ppm/246 milligram per cubic meter TWA; Not Classifiable as a Human Cardinogen

Protective Action Criteria (PAC) Ver. 29[138]

71-23-8

PAC-1: 250 ppm

PAC-2: 670 ppm

PAC-3: 4000 ppm
105-30-6, *(iso-)*
OSHA PEL: 400 ppm/980 milligram per cubic meter TWA
NIOSH REL: 400 ppm/980 milligram per cubic meter TWA; 500 ppm/1225 milligram per cubic meter STEL
ACGIH TLV[1]: 200 ppm/492 milligram per cubic meter TWA; 400 ppm/984 milligram per cubic meter STEL, Not Classifiable as a Human Cardinogen; BEI issued.
Protective Action Criteria (PAC) Ver. 29[138]
PAC-1: 0.087 ppm
PAC-2: 0.96 ppm
PAC-3: 67 ppm
DFG MAK: 200 ppm/500 milligram per cubic meter [skin]; BAT: 50 mg[Acetone]/L in blood or urine/end-of-shift as isopropyl alcohol
Australia: TWA 200 ppm (500 milligram per cubic meter); 200 ppm (492 milligram per cubic meter) STEL [skin], 1993; Austria: MAK 200 ppm (500 milligram per cubic meter), 1999; Belgium: TWA 200 ppm (492 milligram per cubic meter); STEL 250 ppm, [skin], 1993; Denmark: TWA 200 ppm (500 $mg.m^3$), [skin], 1999; Finland: TWA 200 ppm (500 milligram per cubic meter); STEL 250 ppm, [skin], 1999; France: VME 200 ppm (500 milligram per cubic meter), 1999; Hungary: TWA 100 milligram per cubic meter; STEL 200 milligram per cubic meter, 1993; Norway: TWA 100 ppm (245 milligram per cubic meter), 1999; Poland: MAC (TWA) 200 milligram per cubic meter; MAC (STEL) 600 milligram per cubic meter, 1999; Russia: STEL 10 milligram per cubic meter, 1993; Sweden: NGV 150 ppm (350 milligram per cubic meter), KTV 250 ppm (600 milligram per cubic meter), 1999; Switzerland: MAK-W 200 ppm (500 milligram per cubic meter), [skin], 1999; Turkey: TWA 200 ppm (500 milligram per cubic meter), 1993; United Kingdom: TWA 200 ppm (500 milligram per cubic meter); STEL 250 ppm, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 250 ppm [skin]. Russia[35][43] set a MAC values for ambient air in residential areas[60] of 0.3 milligram per cubic meter both on a momentary and a daily average basis. Several states have set guidelines or standards for propanol in ambient air[60] ranging from 0.67 milligram per cubic meter (Massachusetts) to 5.0−6.25 milligram per cubic meter (North Dakota) to 8.0 milligram per cubic meter (Virginia) to 10.0 milligram per cubic meter (Connecticut) to 11.905 milligram per cubic meter (Nevada).

Determination in Air: Use NIOSH Analytical Method #1401, alcohols[18].

Permissible Concentration in Water: EPA[32] has suggested a permissible ambient goal of 6,900 μg/L based on health effects. Russia[35,43] set a MAC in water bodies used for domestic purposes of 0.25 mg/L.

Routes of Entry: Inhalation of vapor, percutaneous absorption, ingestion, skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Propyl alcohol can affect you when breathed in and by passing through your skin. Irritates the eyes, skin, and respiratory tract. May cause serious eye damage. Prolonged skin contact can cause a burning sensation and rash. Exposure to high concentrations can affect the CNS and cause headaches, drowsiness, dizziness, and confusion; ataxia, gastrointestinal pain; abdominal cramps; nausea, vomiting, diarrhea. High levels can cause unconsciousness.

Long-Term Exposure: Repeated skin exposure may cause drying and cracking of the skin. Propyl alcohol may cause mutations. Handle with extreme caution. This chemical is listed by the state of New Jersey as a Special Health Hazard and a data sheet (listed below) states that this chemical may be a carcinogen in humans: It has been shown to cause liver carcinomas and sarcoma, spleen sarcoma, and leukemia in animals. It should be treated with caution.

Points of Attack: Eyes, skin, respiratory system; gastrointestinal tract; CNS. May cause liver damage. It may cause brain or nerve damage.

Medical Surveillance: Liver function tests. Evaluate for brain and nerve effects including cerebellar, autonomic and peripheral nervous systems; changes in memory; concentration, sleeping pattern, and mood; headaches and fatigue. Positive and borderline individuals should be referred for neuropsychological testing. Eye evaluation by an opthomologist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Neoprene, Teflon, nitrile, and polyvinyl acetate are recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 800 ppm:* CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)]; or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]; or

GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code-Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration is not a danger. Propyl alcohol must be stored to avoid contact with strong oxidizers, (such as chlorine and bromine), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where propyl alcohol is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gallons or more of propyl alcohol should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN1274, *n*-Propanol, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (2); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile Draft Report: *n*-Propanol, Washington, DC (March 31, 1983)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Propyl Alcohol, Trenton, NJ (June 2005)

Popylamine P:1210

Formula: C_3H_9N; $CH_3CH_2CH_2NH_2$

Synonyms: 1-Aminopropane; 1-Iodopropane; Mono-*n*-propylamine; Monopropylamine; Propanamine; *n*-Propilamina (Spanish); Propylamine

CAS Registry Number: 107-10-8

HSDB Number: 5162

RTECS Number: UN9100000

UN/NA & ERG Number: UN1277/132

EC Number: 203-462-3

Regulatory Authority and Advisory Information

Hazard Alert: Highly flammable liquid, Corrosive, Primary irritant (w/o allergic reaction).

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U194

RCRA, 40CFR261, Appendix 8 Hazardous Constituents
Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 5000 lb (2270 kg)
Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.
Hazard Symbols, Risk & Safety statements: Hazard Symbol: F+, C; Risk phrases: R11; R20/21/22; R34; Safety phrases: S7; S9; S16; S21; S26; S36/37/39; S41; S45 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: *n*-Propylamine is a water-white liquid with a strong irritating odor similar to that of ammonia. Molecular weight = 59.3; Specific gravity (H_2O:1) = 0.72 @ 20°C; Boiling point = −83°C; Freezing/Melting point = −83°C; Vapor pressure = 248 mmHg @ 20°C; Flash point = < −37°C; Autoignition temperature = 318°C. Explosive limits: LEL = 2.0%, 2000 ppm[138]; UEL: 10.4%. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 3, Reactivity 0. Soluble in water forming a highly alkaline soluation.

Potential Exposure: Propylamine is used to make textile resins, drugs, pesticides, and other chemicals.

Incompatibilities: Vapors may form explosive mixture with air. Violent reaction on contact with oxidizers and mercury, strong acids; organic anhydrides; isocyanates, aldehydes, nitroparrafins, halogenated hydrocarbons; alcohols and many other compounds. Attacks many metals and alloys, especially those of copper. Aqueous solution is acidic and may attack glass.

Permissible Exposure Limits in Air:
Protective Action Criteria (PAC) Ver. 29[138]
PAC-1: 5.4 ppm
PAC-2: 59 ppm
PAC-3: 100 ppm
Finland: STEL 5 ppm (12 milligram per cubic meter), [skin], 1999; Russia[43] set a MAC in work-place air of 5 milligram per cubic meter. It should be recognized that propylamine can be absorbed through your skin, thereby increasing your exposure.

Permissible Concentration in Water: Russia[43] set a MAC in water bodies used for domestic purposes of 0.5 mg/L.

Determination in Water: Octanol-water coefficient: Log $K_{ow} = 0.2$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact. Absorbed by the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Propylamine can affect you when breathed in and by passing through your skin. Corrosive to the eyes, skin, and respiratory tract. Propylamine can cause severe eye burns leading to permanent damage and blindness. Contact can cause severe skin burns. Breathing Propylamine can irritate the lungs, causing coughing and/or shortness of breath. Higher exposures can cause a build-up of fluid in the lungs (pulmonary edema). This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: Overexposure or repeated lower exposure may damage the lungs, liver, kidneys and/or heart muscle. Some amines cause skin or lung sensitization and allergy; however, it is not known if this chemical causes these allergies.

Points of Attack: Lungs, liver, kidneys, heart.

Medical Surveillance: Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. Before beginning employment and at regular times after that, the following are recommended. Lung function tests. If symptoms develop or overexposure is suspected, the following also may be useful: tests for kidney and liver function. Consider chest X-ray after acute overexposure. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Teflon and polyvinyl acetate are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to propylamine exists, use a NIOSH/MSHA (US) or EN149

(Europe)-approved supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a MSHA/NOSH approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.
Storage: Color code-Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration is not a danger. Propylamine is incompatible with strong acids (such as hydrochloric, sulfuric, and nitric); acid anhydrides; acid chlorides; strong oxidizers (such as chlorine, bromine, and fluorine), carbon dioxide; and triethynyl aluminum. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Sources of ignition, such as smoking and open flames, are prohibited where Propylamine is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gallons or more of propylamine should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of propylamine. Wherever propylamine is used, handled, manufactured, or stored use explosion-proof electrical equipment and fittings.
Shipping: UN1277 Propylamine, Hazard Class: 3; Labels: 3-Flammable liquid, 8-Corrosive material.
Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.
Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Water may be ineffective for fighting fires. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.
Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.
References
(31); (173); (101); (138); (100).
New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Propylamine, Trenton, NJ (March 2001).

Propyl Chloroformate P:1220

Formula: $C_4H_7ClO_2$: $ClCOOC_3H_7$
Synonyms: Carbonochloridic acid, Propyl ester; Chloroformic acid propyl ester; Propyl chlorocarbonate; *n*-Propyl chloroformate
CAS Registry Number: 109-61-5
HSDB Number: 5392
RTECS Number: LQ6830000
UN/NA & ERG Number: (PIH) UN2740/155
EC Number: 203-687-7 [*Annex I Index No.:* 607-142-00-8]
Regulatory Authority and Advisory Information
Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 ($\geq$1.00% concentration). ($\geq$1.00% concentration).
Hazard Alert: Poison inhalation hazard, Highly flammable liquid, Corrosive, Lacrimator, Water reactive, Unstable chemical (decomposes).
Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 15,000 lb (6810 kg)
Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500 lb (227 kg)
Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 500 lb (227 kg)
United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: F+, T; Risk phrases: R12; R23; R29; R34; Safety phrases: S1/2; S16; S26; S36; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Propyl chloroformate is a colorless liquid. Molecular weight = 122.56; Boiling point = 114−116°C; Flash point = 10°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 4, Reactivity 2₩. Insoluble in water; slowly decomposes releasing heat and hydrochloric acid.

Potential Exposure: Propyl chloroformate is used in organic synthesis; as an intermediate for polymerization initiators; may have been used as a military poison gas.

Incompatibilities: Propyl chloroformate forms explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, water and alcohols. Reaction with water forms heat and hydrochloric acid. Attacks some metals and coating in the presence of moisture.

Permissible Exposure Limits in Air:

Protective Action Criteria (PAC)* Ver. 29[138]

PAC-1: 0.34 ppm

PAC-2: $\mathbf{3.7_A}$ ppm

PAC-3: $\mathbf{11_A}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: A lacrimator; vapors cause tearing. Corrosive to eyes, skin, and mucous membranes. May cause burns and permanent eye damage. Poisonous: may be fatal if inhaled, swallowed or absorbed through skin. Effects may include severe pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: May cause lung damage.

Points of Attack: Lungs.

Medical Surveillance. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water, or milk. Do not induce vomiting. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Poison inhalation chemical (PIH); check oxygen content prior to entering storage area. (1) Color code-Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. This gas is highly toxic. Even slight exposure to these gasses can cause death. Store outdoors in a secure, restricted area that containing warning signs. This area must be roofed and shaded with the cylinders stored off the ground and separated from all other products assigned to other hazard categories and radiant heat sources on non-wooden floors. If indoors, store in a well-ventilated areas in temperatures not to exceed 50°C. (2) Color code-Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area away from oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN2740 *n*-Propyl chloroformate, Hazard class: 6.1; Labels: 6.1-Poison Inhalation Hazard, 3-Flammable liquid, 8-Corrosive material. Inhalation Hazard Zone B.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.2/0.3

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)
Day 0.5/0.8
Night 0.8/1.3

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include hydrogen chloride, chlorine fumes and oxides of carbon. *Small fires:* Dry chemical, carbon dioxide extinguishers. Move container from fire area if you can do so without risk. Dike fire control water for later disposal; do not scatter the material. Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Wear positive pressure breathing apparatus and special protective clothing. Isolate for ½ mile in all directions if tank car or truck is involved in fire. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. Spray cooling water on containers that are exposed to flames until after fire is out. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Propyl Chloroformate, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Propyl Chloroformate, Trenton, NJ (September 2001).

Propylene P:1230

Formula: C_3H_6; $CH_2{=}CHCH_3$

Synonyms: Isobutylene; Methylethene; Methylethylene; NCI-C50077; Propene; 1-Propene; Propileno (Spanish)

CAS Registry Number: 115-07-1; *(alt.)* 676-63-1; *(alt.)* 33004-01-2

HSDB Number: 175

RTECS Number: UC6470000

UN/NA & ERG Number: UN1077/115

EC Number: 204-062-1 [*Annex I Index No.:* 601-011-00-9]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 ($\geq$1.00% concentration).

Carcinogenicity: IARC: Animal Inadequate Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1994; NCI: Carcinogenesis Studies (inhalation); no evidence: mouse, rat.

Hazard Alert: Extremely flammable gas, Possible risk of forming tumors, Possible polymerization hazard, Frostbite/

Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated.

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg)

Global Warming potential (100-year time horizon): negligible[Dow 5/29/2015].

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: F+, Xn; Risk phrases: R5; R12; R21; Safety phrases: S1; S2; S9; S16; S33; S38; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): Non hazard to water.

Description: Propylene is a colorless gas. Slight odor. The Odor Threshold is 23 ppm. Molecular weight = 42.1; Specific gravity (H_2O:1) = 0.59 @ 20°C; Boiling point = −48°C; Freezing/melting point = −185°C; Vapor pressure = 7.6×10^3 mmHg @ 25°C; Flash point = Flammable gas (−72°C); Autoignition temperature = 455°C. Explosive limits: LEL = 2.0%; UEL: 11.1%. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 4, Reactivity 1. Insoluble in water.

Potential Exposure: Propylene is used in production of fabricated polymers, fibers, polypropylene resins; solvents, isopropyl alcohol, propylene dimer, and trimer as gasoline components and detergent raw materials; propylene oxide; cumene, synthetic glycerol; isoprene, and oxo-alcohols.

Incompatibilities: Propylene forms explosive mixture with air. Violent reaction with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, and many other compounds. Able to form unstable peroxides; can polymerize, especially in heat, direct sunlight, oxidizers and other chemicals.

Permissible Exposure Limits in Air:

ACGIH TLV[1]: 500 ppm/860 milligram per cubic meter TWA, not classifiable as a human carcinogen

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 1500 ppm

PAC-2: 2800 ppm

PAC-3: 17,000 ppm

Australia: asphyxiant, 1993; Belgium: asphyxiant, 1993; Hungary: asphyxiant, 1993; Russia: STEL 100 milligram per cubic meter, 1993; Switzerland: MAK-W 10000 ppm (17500 milligram per cubic meter), 1999; United Kingdom: asphyxiant, 2000; the Netherlands: MAC-TGG 900 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Russia[43] set a MAC in ambient air in residential areas of 3.0 milligram per cubic meter both on a momentary and a daily average basis.

The oxygen content should be tested regularly to ensure that it is at least 19% by volume.

Permissible Concentration in Water: Russia[43] set a MAC in water bodies used for domestic purposes of 0.5 mg/L.

Determination in Water: Octanol-water coefficient: Log $K_{ow} = 1.8$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Propylene can affect you when breathed in. Exposure to high levels can cause you to feel dizzy and lightheaded. Very high levels can cause you to pass out from lack of oxygen. Death can result. Contact with liquefied propylene can cause frostbite.

Long-Term Exposure: Exposure may cause an irregular heartbeat. It may also damage the liver.

Points of Attack: Liver, heart, liver.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: liver function tests. Holter monitor (a special 24 hour EKG to look for irregular heart beat).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If frostbite has occurred, seek medical attention immediately; do NOT rub the affected areas or flush them with water. In order to prevent further tissue damage, do NOT attempt to remove frozen clothing from frostbitten areas. If frostbite has NOT occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid, unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Exposure to propylene is dangerous because it can replace oxygen and lead to suffocation. Only NIOSH/MSHA or European Standard EN 149-approved

SCBA with a full facepiece operated in positive pressure mode should be used in oxygen deficient environments.

Storage: Check oxygen content prior to entering storage area. Flammable gas. Color code-Red Stripe: Flammability Hazard: Store separately from all other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 meters or a 1-hour fire wall from flammable or reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration is not a danger. Propylene must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat or direct sunlight. Sources of ignition, such as smoking and open flames, are prohibited where propylene is handled, used, or stored. Use only nonsparking tools and equipment, especially when opening and closing containers of propylene. Wherever propylene is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Piping should be electrically bonded and grounded. Procedures for the handling, use and storage of propylene cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: UN1077 Propylene, Hazard Class: 2.1; Labels: 2.1-Flammable gas. UN1075 Petroleum gases, liquefied or Liquefied petroleum gas, Hazard Class: 2.1; Labels: 2.1-Flammable gas. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Put on protective clothing and equipment. Remove tank or cylinder to an open area. Allow to bleed off slowly into atmosphere. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable gas or liquid. Thermal decomposition products may include oxides of carbon (carbon dioxide and/or carbon monoxide). Stop flow of gas. Use carbon dioxide or dry chemical. Use water spray, fog, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers and protect firefighters. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Use a licensed professional waste disposal service to dispose of this material, perhaps using controlled incineration. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (100).

New York State Department of Health, *Chemical Fact Sheet:* Propylene, Bureau of Toxic Substance Assessment, Albany, NY (April 1986)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Propylene, Trenton, NJ (May 2004)

Propylene Chlorohydrin P:1240

Formula: C_3H_7ClO; $CH_3CHClCH_2OH$

Synonyms: 2-Chloro-1-propanol; 2-Chloropropanol; β-Chloropropyl alcohol; 2-Chloropropyl alcohol; 1-Propanol, 2-chloro-; 1-Chloro-2-propanol with 2-chloro-1-propanol (127-00-4)

CAS Registry Number: 78-89-7 (2-chloropropan-1-ol); 127-00-4 (1-chloropropan-2-ol)

HSDB Number: 5223 (2-chloropropan-1-ol); 1341 (1-chloropropan-2-ol)

RTECS Number: UA8925000

UN/NA & ERG Number: UN2611/131

EC Number: 201-154-3 (2-chloropropan-1-ol); 204-819-6 (1-chloropropan-2-ol).

Regulatory Authority and Advisory Information

Carcinogenicity: *(78-89-7 & 204-819-6)* ACGIH: Not classifiable as a human carcinogen

Hazard Alert: Poison, Combustible, Poison (ingestion).

Hazard Symbols, Risk & Safety statements: Hazard Symbol: Xn; Risk phrases: R10; R22; R36/37/38; R41; R50/53; Safety phrases: S16; S26; S36/37; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Propylene chlorohydrin is a colorless liquid. Molecular weight = 94.54; Boiling point = (78-89-7) 126; 133−134°C; Flash point = (CAS:78-89-7) >40°C; 52°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 0. Soluble in water.

Potential Exposure: This material is used in organic synthesis; to make other chemicals.

Incompatibilities: Vapor may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Alcohols are sensitive to light and oxidation. It is unstable in solution. It undergoes hydrolysis in aqueous buffers. Contact with alkali metals, nitrides, and strong reducing agents may form flammable and/or toxic gases. May react with anhydrides forming acids and esters, generating noticeable heat, and also with oxoacids and carboxylic acids to form esters plus water, but the heat of reaction in the latter case typically is low. May initiate the polymerization of isocyanates and epoxides.

Permissible Exposure Limits in Air:

78-89-7 & 204-819-6

ACGIH TLV[1]: 1 ppm/4 milligram per cubic meter [skin], not classifiable as a human carcinogen

Routes of Entry: Inhalation, ingestion; skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Poisonous by ingestion. Propylene chlorohydrin can affect you when breathed in and by passing through your skin. It is moderately toxic by inhalation and skin contact. Contact can severely irritate and may burn the eyes. Breathing propylene chlorohydrin can irritate the nose and throat. Contact can irritate the skin. Overexposure may cause you to be lightheaded, unsteady and drowsy.

Long-Term Exposure: It may cause destruction of red blood cells (hemolysis).

Points of Attack: Skin, eyes, blood.

Medical Surveillance: Blood tests. However, if illness occurs or overexposure is suspected, medical attention is recommended.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposure to propylene chlorohydrin, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: (1) Color code-Blue: Health Hazard/Poison: Store in a secure poison location. (2) Color code-Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials.

Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers (such as chlorine, bomine, and fluorine). Sources of ignition, such as smoking and open flames, are prohibited where propylene chlorohydrin is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN2611Propylene chlorohydrin, Hazard class: 6.1; Labels: 6.1-Poisonous materials, 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak

until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include hydrogen chloride and oxides of carbon. Use dry chemical, carbon dioxide; or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Propylene Chlorohydrin, Trenton, NJ (March 1998)

Propylene Glycol P:1250

Formula: $C_3H_8O_2$: $CH_3CHOHCH_2OH$

Synonyms: 1,2-Dihydroxypropane; Methyl ethylene glycol; Methyl glycol; 1,2-Propanediol

CAS Registry Number: 57-55-6

HSDB Number: 174

RTECS Number: TY2000000

UN/NA & ERG Number: Not regulated

EC Number: 200-338-0

Regulatory Authority and Advisory Information

United States Environmental Protection Agency Gene-Tox Program, Negative: SHE-clonal assay.

Hazard Alert: Combustible, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction), FDA-over the counter drug.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: Xi; Risk phrases: R36/37/38; R62; R63; Safety phrases: S24/25; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Propylene glycol is a colorless, odorless, syrupy liquid. Molecular weight = 76.1; Boiling point = 187°C; Specific gravity (H_2O:1) = 1.04 @ 20°C; Freezing/Melting point = −60°C; Flash point = 99°C (cc); Autoignition temperature = 371°C. Explosive limits: LEL = 2.6%; 8,000 ppm[138]; UEL: 12.5%. Hazard Identification (based on NFPA-704 M Rating System): Health 0, Flammability 1 (must be preheated), Reactivity 0; NJDHSS: Health 1, Flammability 1, Reactivity 0 Soluble in water.

Potential Exposure: Propylene glycol is used as a solvent; emulsifying agent; food and feed additive; flavor, in manufacture of plastics; as a plasticizer, surface-active agent; antifreeze, solvent, disinfectant, hydroscopic agent; coolant in refrigeration systems; pharmaceutical, brake fluid; and many others.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong acids (especially nitric acid), strong bases, permanganates, dichromates; may cause a violent reaction.

Permissible Exposure Limits in Air:

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 30 milligram per cubic meter

PAC-2: 1300 milligram per cubic meter

PAC-3: 7900 milligram per cubic meter

United Kingdom: TWA 150 ppm, total vapor and particulates; STEL 10 milligram per cubic meter, particulates, 2000.

Determination in Air: NIOSH Analytical Method #5523, Glycols.

Determination in Water: Octanol-water coefficient: Log $K_{ow} = -0.9$.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin, and respiratory tract. Two fluid ounces (60 mL) has caused stupor which lasted for a few hours which was followed by complete recovery.

Long-Term Exposure: A mild allergen. Repeated or prolonged contact may cause skin sensitization and allergy. Therapeutic doses given for over a year have been associated with seizures; no further seizures occurred upon withdrawal of medication.

Points of Attack: Skin.

Medical Surveillance: Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation., Polyethylene, Nitrile+PVC, butyl rubber; polyvinyl chloride, Tychem (from E.I. du Pont de Nemours & Company), Trellchem, and Responder are among the recommended protective materials. Butyl rubber, Nitrile, and Neoprene, and Neoprene + natural rubber are among the glove materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Green: General storage may be used. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration is not a danger. Store in a well-ventilated area away from ignition sources. Store in tightly closed containers in a cool, well ventilated area away from oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: Not subject to regulation.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber.

All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (100).

New York State Department of Health, *Chemical Fact Sheet:* Propylene Glycol, Bureau of Toxic Substance Assessment, Albany, NY (April 1986)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Propylene Glycol, Trenton, NJ (September 2009)

Propylene Glycol Dinitrate P:1260

Formula: $C_3H_6N_2O_6$; $CH_3CHONO_2CH_2ONO_2$

Synonyms: PGDN; Propylene glycol-1,2-dinitrate; 1,2-Propanediol, dinitrate; 1,2-Propylene glycol dinitrate Note: Otto fuel is primarily propylene glycol dinitrate.

CAS Registry Number: 6423-43-4; 106602-80-6 (otto fuel)

HSDB Number: 6823 (6423-43-4)

RTECS Number: TY6300000

UN/NA & ERG Number: UN/NA0473 (EXPLOSIVE)/112

EC Number: 229-180-0

Regulatory Authority and Advisory Information

Hazard Alert: Explosive, Strong Oxidizer, Primary irritant (w/o allergic reaction).

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: O, Xn; Risk phrases: R2; R3; R5; R8; R9; R23/24/25; R34; R36/37/38; R44; Safety phrases: S7/8; S16; S17; S36/37/39; S41; S45(see Appendix 4)

Description: Propylene glycol dinitrate is an explosive. It is a colorless, high-boiling liquid (solid below −8°C) with a disagreeable odor. Molecular weight = 166.11; Specific gravity (H_2O:1) = 1.37 @ 20°C; Boiling point = (decomposes) 92°C @ 7.5 mmHg @ 0°C; Freezing/Melting point = −30°C; Flash point = 99°C. Vapor pressure = 0.07 mmHg @ 22°C; Explosive limits: LEL = 17,000 ppm, UEL: unknown. Strong oxidizer. Slightly soluble in water; solubility = 0.1%.

Otto fuel: Molecular weight = 170.

Potential Exposure: Propylene glycol dinitrate has been used as a torpedo propellant. The explosion potential is similar to ethylene glycol dinitrate.

Incompatibilities: Explosive. A strong oxidizer. Contact with ammonia compounds, amines, strong acids; reducing agents; combustible materials may result in fire and explosion. It is similar to ethylene glycol dinitrate in explosion potential. Propylene glycol dinitrate may explode if strongly shocked or heated. Propylene glycol dinitrate is explosive. Acts as a strong oxidizing agent. Heating may cause a violent combustion or explosion producing toxic fumes (nitrogen oxides). May also decompose explosively from shock, friction or from a build-up of electrostatic charge that sparks suddenly to ground. Can begin a vigorous reaction that culminates in an explosion if mixed with reducing agents including hydrides, sulfides, and nitrides and numerous ordinary combustible materials. Reacts violently with al, bp, cyanides, esters, pn2h, p, nacn, sncl2, sodium hypophosphite, and thiocyanates. Reacts with acids and with alkalis, including ammonia and amines[101].

Permissible Exposure Limits in Air:

Conversion factor: 6.79 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: None

NIOSH REL: 0.05 ppm/0.3 milligram per cubic meter TWA [skin]

ACGIH TLV[1]: 0.05 ppm/0.34 milligram per cubic meter TWA [skin]; BEIM issued for methemoglobin inducers

Protective Action Criteria (PAC)* Ver. 29[138]

6423-43-4 (propylene glycol dinitrate) & 106602-80-6 (otto fuel which is primarily propylene glycol dinitrate)

PAC-1: **0.17**$_\mathbf{A}$ ppm

PAC-2: **1.0**$_\mathbf{A}$ ppm

PAC-3: **13**$_\mathbf{A}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

DFG MAK: 0.05 ppm/0.34 milligram per cubic meter TWA; Peak Limitation Category I(1) [skin]

Australia: TWA 0.05 ppm (0.3 milligram per cubic meter), [skin], 1993; Austria: MAK 0.05 ppm (0.3 milligram per cubic meter), [skin], 1999; Belgium: TWA 0.5 ppm (0.35 milligram per cubic meter), [skin], 1993; Denmark: TWA 0.02 ppm (0.2 milligram per cubic meter), [skin], 1999; Finland: TWA 0.02 ppm (0.2 milligram per cubic meter); STEL 0.06 ppm, [skin], 1999; France: VME 0.05 ppm (0.3 milligram per cubic meter), [skin], 1999; the Netherlands: MAC-TGG 0.3 milligram per cubic meter, [skin], 2003; Sweden: NGV 0.1 ppm (0.7 milligram per cubic meter), KTV 0.3 ppm (2 milligram per cubic meter), [skin], 1999; Switzerland: MAK-W 0.05 ppm (0.35 milligram per cubic meter), [skin], 1999; United Kingdom: TWA 0.2 ppm (1.4 milligram per cubic meter); STEL 0.2 ppm, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietman: ACGIH TLV: TWA 0.05 ppm [skin]. Several states have set guidelines or standards for propylene glycol dinitrate in ambient air[60] ranging from 3 μ/m^3 (North Dakota) to 5 μ/m^3 (Virginia) to 6 μ/m^3 (Connecticut) to 7 μ/m^3 (Nevada).

Determination in Air: See OSHA Analytical Method 43.

Routes of Entry: Inhalation, ingestion, dermal and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Propylene glycol dinitrate can affect you when breathed in and by passing through your skin. Exposure can cause headaches, stuffy nose; eye irritation; a "drunken" feeling with impaired balance, visual disturbance. Higher exposures can interfere with the ability of the blood to carry oxygen (methemoglobinemia). This causes cyanosis, a bluish color to the skin and can lead to death. Propylene glycol dinitrate can cause the blood pressure to drop rapidly. Human volunteers at 0.2 ppm exposure exhibited headaches and disruption in visually evoked response. At 0.5 ppm, marked impairment in balance was noted. At 1.5 ppm eye irritation occurred, in addition[53].

Long-Term Exposure: May cause liver and kidney damage.

Points of Attack: Eyes, CNS; blood, liver, kidneys.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: blood tests for methemoglobin level. Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Note to Physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures *over 0.05 ppm*; Use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Check oxygen content prior to entering storage area. Explosive. Must be stored in a cool, ventilated place, away from acute fire hazards and easily oxidized materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Propylene glycol dinitrate must be stored to avoid contact with ammonia compounds, amines, oxidizers, reducers or combustible material, since violent reactions occur. Store it tightly closed containers in a cool, well-ventilated area away from heat and avoid shocking or jolting containers. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Store in a cool, well ventilated area away from incompatible materials listed above. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage.

Shipping: UN0473 Substances, explosive, n.o.s., Hazard Class: 1.1A; Labels:1.1A-Explosive (with a mass explosion hazard); A-Substances which are expected to mass detonate very soon after fire reaches them, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Propylene Glycol Dinitrate, Trenton, NJ (August 2005)

Propylene Glycol Monomethyl Ether P:1270

Formula: $C_4H_{10}O_2$: $CH_3OCH_2CHOHCH_3$

Synonyms: Dowtherm 209; 1-Methoxy-2-hydroxypropane; 1-Methoxy-2-propanol; 2-Methoxy-1-methylethanol; PGME; Propylene glycol methyl ether

CAS Registry Number: 107-98-2

HSDB Number: 1016 as 1-methoxy-2-hydroxypropane

RTECS Number: UB7700000

UN/NA & ERG Number: UN3092/129 (P)

EC Number: 203-539-1

Regulatory Authority and Advisory Information

Hazard Alert: Highly flammable liquid, Possible polymerization hazard (glycol ethers), Reproductive toxin: Suspected of causing genetic defects, Primary irritant (w/o allergic reaction).

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: None assigned; Risk phrases: R11; R19; R20/21/22; R62; Safety phrases: S2; S21; S24/25; S26; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

as glycol ethers:

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) includes mono-and di-ethers of ethylene glycol, diethyl glycol; and triethylene glycol R-$(OCH_2CH_2)_n$-OR′ where n = 12, or 3; R = alkyl or aryl groups; R′ = R, H, or groups which, when removed, yield glycol ethers with the structure: R-$(OCH_2CH)_n$-OH. Polymers are excluded from the glycol category

EPCRA Section 313: Certain glycol ethers are covered. R-$(OCH_2CH_2)_n$-OR'; Where n = 1 2 or 3; R = alkyl C7 or less; or R = phenyl or alkyl substituted phenyl; R′ + H, or alkyl C7 or less; or OR' consisting of carboxylic ester, sulfate, phosphate, nitrate or sulfonate. Form R *de minimis* concentration reporting level: 1.0%.

Description: Propylene glycol monomethyl ether is a colorless liquid. Ethereal odor. The Odor Threshold is 10 ppm. Molecular weight = 90.12; Specific gravity (H_2O:1) = 0.96 @ 20°C; Boiling point = 119°C; Freezing/Melting point = (sets to glass) −95°C; Vapor pressure = 13 mmHg @ 25°C; Flash point = 31.8°C[101]; Autoignition temperature = 272°C. Explosive limits: LEL = 1.6%; 20,000 ppm[138]; UEL: 18.8%. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 3, Reactivity 0. Soluble in water.

Potential Exposure: Propylene glycol monomethyl ether is used as a solvent for coatings; cellulose esters and acrylics; acrylics dyes; inks, and stains. It may also be used as a heat-transfer fluid.

Incompatibilities: Vapor may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, acid chlorides, acid anhydrides, isocyanates, aluminum, and copper. Hygroscopic (i.e., absorbs moisture from the air). May slowly form reactive peroxides during prolonged storage or on exposure to air and light.

Permissible Exposure Limits in Air:

Conversion factor: 1 ppm = 3.69 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: None

NIOSH REL: 100 ppm/360 milligram per cubic meter TWA: 150 ppm/540 milligram per cubic meter STEL

ACGIH TLV[1]: 100 ppm TWA; 150 ppm STEL

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 100 ppm

PAC-2: 160 ppm

PAC-3: 660 ppm

DFG MAK: 100 ppm/370 milligram per cubic meter TWA; Peak Limitation Category I(2); Pregnancy Risk Group C.

Austria: MAK 100 ppm (375 milligram per cubic meter), 1999; Belgium: TWA 100 ppm (369 milligram per cubic meter); STEL 150 ppm (553 milligram per cubic meter), 1993; Denmark: TWA 50 ppm (185 milligram per cubic meter), 1999; Finland: TWA 100 ppm (360 milligram per cubic meter); STEL 150 ppm, [skin], 1999; France: VME 100 ppm (360 milligram per cubic meter), 1999; Norway: TWA 50 ppm (180 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 375 milligram per cubic meter, 2003; Switzerland: MAK-W 100 ppm (360 milligram per cubic meter), KZG-W 200 ppm (720 milligram per cubic meter), 1999; United Kingdom: TWA 100 ppm (375 milligram per cubic meter); STEL 300 ppm, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 150 ppm. Several states have set guidelines or standards for PGME in ambient air[60] ranging from 3.6−5.4 milligram per cubic meter (North Dakota) to 6.0 milligram per cubic meter (Virginia) to 7.2 milligram per cubic meter (Connecticut).

Determination in Air: Use NIOSH Analytical Method #2554; OSHA Analytical Method 99.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Propylene glycol monomethyl ether can affect you when breathed in and by passing through your skin. Contact can irritate the eyes and skin. Exposure can irritate the nose and throat. Very high levels may cause lung, liver, and kidney damage. Very high levels of propylene glycol monomethyl ether may cause CNS depression; dizziness and lightheadedness; and unconsciousness.

Long-Term Exposure: Causes skin dryness; dermatitis. May cause liver an kidney damage. Can irritate the lungs; bronchitis may develop.

Points of Attack: Eyes, skin, respiratory system; CNS.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function tests. Lung function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures over 100 ppm; Use an NIOSH/MSHA or European Standard EN 149-approved respirator with an organic vapor cartridge/canister. More protection is provided by a full facepiece respirator than by a half-mask respirator, and even greater protection is provided by a powered-air purifying respirator. *Where there is potential for high exposures exists*, use an NIOSH/MSHA or European Standard EN 149-approved supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use an NIOSH/MSHA or European Standard EN 149-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration is not a danger. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers (such as chlorine, bromine, and fluorine). Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN3092 1-Methoxy-2-propanol, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific _recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or foam extinguishers. Water may be ineffective. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Propylene Glycol Monomethyl Ether, Trenton, NJ (August 2005)

Propyleneimine P:1280

Formula: C_3H_7N

Synonyms: Aziridina, 2-metil (Spanish); Aziridine, 2-methyl-; 2-Methylazaclycloprópane; 2-Methylaziridine; 2-Methylethylenimine; 2-Methylethylen imine; Propilenimina (Spanish); Propylene imine; 1,2-Propyleneimine

CAS Registry Number: 75-55-8

HSDB Number: 739

RTECS Number: CM8050000

UN/NA & ERG Number: UN1921 (stabilized)/131

EC Number: 200-878-7 [*Annex I Index No.:* 613-033-00-6]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Carcinogenicity: NTP 13 th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen (as 2-Methylaziridine); IARC: Human No Adequate Data, animal Sufficient Evidence*, possibly carcinogenic to humans*, Group 2B, 1999; NIOSH: Potential occupational carcinogen. United States Environmental Protection Agency Gene-Tox Program, Positive: Carcinogenicity-mouse/rat; SHE-clonal assay; Positive: Cell transformation-RLV F344 rat embryo; Host-mediated assay; Positive: *E coli polA* without S9; Histidine reversion-Ames test; Positive: *In vitro* UDS-human fibroblast; S *cerevisiae-homozygosis*; Positive: *S pombe*-reversion; Positive/dose response: Cell transformation-BALB/c-3T3.

California Proposition 65 Chemical[102]: Cancer 1/1/1988.

Hazard Alert: Poison, Highly flammable, Polymerization hazard (nonstabilized), Possible risk of forming tumors, Suspected reprotoxic hazard, Environmental hazard.

Banned or Severely Restricted (Belgium, Sweden) (UN)[13]

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P067

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 10,000 lb (4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 1 lb (0.454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazardous to aquatic life or environment, with possible long lasting effects[293]. Toxic to aquatic life with long lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: F+, T+, N; Risk phrases: R45; R11; R19; R26/27/28; R41; R50/53; Safety phrases: S1; S29; S45; S53; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Propyleneimine is a fuming, colorless, oily liquid with a strong ammonia-like odor. Molecular weight = 57.1; Specific gravity (H_2O:1) = 0.81 @ 16°C; Boiling point = 66.7°C; Freezing/Melting point = −65°C; Vapor pressure = 140 mmHg @ 25°C; Flash point = −3.89°C (cc). Explosive limits: LEL = 2.3%; 13,000 ppm[138]; UEL: 15.1%. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 4, Reactivity 0. Soluble in water.

Potential Exposure: Propyleneimine is used in the modification of latex surface coating resins; in the production of polymers for use in the paper and textile industries as coatings and adhesives.

Incompatibilities: Vapors or liquid form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, water, carbonyl compounds; quinones, sulfonyl halides. May explode in heat. Subject to violent polymerization in contact with acids. Hydrolyzes in water to form methylethanolamine.

Permissible Exposure Limits in Air:
NIOSH IDLH = 100 ppm, potential occupational carcinogen.
OSHA PEL: 2 ppm/5 milligram per cubic meter TWA [skin]
NIOSH REL: 2 ppm/5 milligram per cubic meter TWA [skin]; A potential occupational carcinogen; Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A.
ACGIH TLV[1]: 2 ppm/5 milligram per cubic meter TWA; 0.4 ppm/1 milligram per cubic meter STEL [skin]; confirmed animal carcinogen with unknown relevance to humans.
Protective Action Criteria (PAC)* Ver. 29[138]
PAC-1: 0.4 ppm
PAC-2: $\mathbf{12_A}$ ppm
PAC-3: $\mathbf{23_A}$ ppm
*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.
DFG MAK: [skin] Carcinogen Category 2; Germ Cell Mutation Category 3B
Australia: TWA 2 ppm (5 milligram per cubic meter), [skin], carcinogen, 1993; Austria: [skin], carcinogen, 1999; Denmark: TWA 2 ppm (5 milligram per cubic meter), [skin], 1999; Finland: STEL 2 ppm (5 milligram per cubic meter), [skin], carcinogen, 1999; France: carcinogen, 1993; Japan: 2 ppm (4.7 milligram per cubic meter), [skin], 1999; the Netherlands: MAC-TGG 0.6 $\mu g/m^3$, 2003; the Phillipines: TWA 2 ppm (5 milligram per cubic meter), [skin], 1993; Russia: TWA 2 ppm, 1993; Switzerland: MAK-W 2 ppm (5 milligram per cubic meter), [skin], carcinogen, 1999; Turkey: TWA 2 ppm (5 milligram per cubic meter), [skin], 1993; United Kingdom: carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: confirmed animal carcinogen with unknown relevance to humans. Several states have set guidelines or standards for propyleneimine. in ambient air[60] ranging from zero (North Dakota) to 12 μ/m^3 (Pennsylvania) to 50 μ/m^3 (Connecticut and Virginia) to 119 μ/m^3 (Nevada).
Determination in Air: No method available.
Routes of Entry: Inhalation, skin absorption; ingestion, eye and/or skin contact.
Harmful Effects and Symptoms
Short-Term Exposure: Severely irritates the eyes, skin, and respiratory tract. Contact may cause skin burns and permanent eye damage. Symptoms of exposure include inflammation and blistering of the skin, eye, and upper respiratory tract; irritation, nausea, itching, and periodic vomiting. Headache, dizziness, and pain in the temple. Shortness of breath; and increased nasal and laryngeal secretion are seen. It is toxic after acute exposure. LD_{50} = (oral-rat) 19 mg/kg (highly toxic).
Long-Term Exposure: Caused skin drying and dermatitis. A potential occupational carcinogen. May affect the kidneys.
Points of Attack: Eyes, skin. Cancer site in animals: nasal tumors, breast, brain, leukemia.
Medical Surveillance: NIOSH lists the following tests: CBC; granulocytic leukemia. Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended. Lung function tests.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.
Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: NIOSH: *At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted canister providing protection against the compound of concern]; or SCBAE (any appropriate escape-type, SCBA).
Storage: (1) Color code-Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. (2) Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Propyleneimine must be stored to avoid contact with acids and strong oxidizers (such as chlorine, bromine, and fluorine) because violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where propyleneimine. is used, handled, or

stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gallons or more of Propyleneimine should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of propyleneimine. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN1921 Propyleneimine, stabilized, Hazard Class: 3; Labels: 3-Flammable liquid, 6.1-Poisonous materials.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Avoid breathing vapors; avoid bodily contact with the material. Toxic gases, including oxides of nitrogen and carbon monoxide are released in a fire. Do not handle broken packages without protective equipment. Wash away any material which may have contacted the body with copious amounts of water or soap with water. Use water spray to disperse vapors and dilute standing pools of liquid. Keep sparks and flames away. Attempt to stop leak if it can be done without hazard. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Controlled incineration (incinerator equipped with a scrubber or thermal unit to reduce nitrogen oxides emissions).

References

(109); (102); (31); (173); (101); (138); (100).

Dermer, O. C. and Ham, G. E., Ethyleneimine and Other Aziridines, New York, Academic Press (1969)

United States Environmental Protection Agency, Chemical Hazard Information Profile: Propyleneimine, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Propylene Imine, Trenton, NJ (August 2005)

Propylene Oxide P:1290

Formula: C_3H_6O

Synonyms: AD 6; Epoxypropane; 1,2-Epoxypropane; 2,3-Epoxypropane; Methyl ethylene oxide; Methyl oxirane; NCI-C50099; Oxido de propileno (Spanish); Oxyde de propylene (French); Oxirane, methyl-; Propane, 1,2-epoxy-; Propene oxide; Propylene epoxide; 1,2-Propylene oxide

CAS Registry Number: 75-56-9

HSDB Number: 173

RTECS Number: TZ2975000

UN/NA & ERG Number: UN1280/127

EC Number: 200-879-2 [*Annex I Index No.:* 603-055-00-4]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Human Inadequate Evidence, animal Sufficient Evidence, *possibly carcinogenic to humans*, Group 2B, 1997; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies; NIOSH: Potential occupational carcinogen; NCI: Carcinogenesis Studies (inhalation); clear evidence: mouse; some evidence: rat; equivocal evidence: rat. United States Environmental Protection Agency Gene-Tox Program, Positive: Carcinogenicity-mouse/rat; Cell transformation-SA7/SHE EPA; Positive: *N crassa*-reversion; D *melanogaster* sex-linked lethal EPA; Positive: *S pombe*-reversion

EPA; Negative: Rodent dominant lethal EPA; Positive: CHO gene mutation.

California Proposition 65 Chemical[102]: Cancer 1/1/1988

Hazard Alert: Extremely flammable liquid, Polymerization hazard: Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction), Highly Reactive Substance; Explosive[15].

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg)

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 10,000 lb (4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 100 lb (45.4 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: F+,T; R45; R46; R19; R12; R20/21/22; R36/37/38; R62; R63; Safety phrases: S1; S53; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Propylene oxide is a colorless liquid. Ethereal odor. Molecular weight = 58.1; Boiling point = 34°C; Specific gravity (H_2O:1) = 0.83 @ 20°C; Freezing/Melting point = −112°C; Vapor pressure = 538 mmHg @ 25°C; Flash point = −37.2°C; Autoignition temperature = 450°C. Explosive limits: LEL = 2.3%; UEL: 36 to 38.5%. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 4, Reactivity 2. Soluble in water; solubility = 41%.

Potential Exposure: Propylene oxide is used as an intermediate in the production of polyether polyols and propylene glycol; as a fumigant; in the production of adducts as urethane foam ingredients; in detergent manufacture; as a component in brake fluids.

Incompatibilities: Vapors may form explosive mixture with air. Reacts with strong oxidizers, anhydrous metal chlorides; chlorine, iron, strong acids; caustics and peroxides. Polymerization may occur due to high temperatures or contamination with alkalis, aqueous acids; amines, metal chlorides; and acidic alcohols. Attacks some plastics, coatings and rubber.

Permissible Exposure Limits in Air:

NIOSH IDLH = 400 ppm, potential occupational carcinogen

Conversion factor: 1 ppm = 2.38 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 100 ppm/240 milligram per cubic meter TWA

NIOSH REL: A potential occupational carcinogen. [skin]; Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A

ACGIH TLV[1]: 2 ppm/4.8 milligram per cubic meter TWA, sensitizer; confirmed animal carcinogen with unknown relevance to humans. (2000)

Protective Action Criteria (PAC)* Ver. 29[138]

PAC-1: $\mathbf{73_A}$ ppm

PAC-2: $\mathbf{290_A}$ ppm

PAC-3: $\mathbf{870_A}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

DFG MAK: [skin] Carcinogen Category 2

Australia: TWA 20 ppm (50 milligram per cubic meter), carcinogen, 1993; Austria: carcinogen, 1999; Belgium: TWA 20 ppm (48 milligram per cubic meter), 1993; Denmark: TWA 5 ppm (12 milligram per cubic meter), [skin], 1999; Finland: TWA 5 ppm (12 milligram per cubic meter), carcinogen, 1999; France: VME 20 ppm (50 milligram per cubic meter), carcinogen, 1999; the Netherlands: MAC -TGG 6 milligram per cubic meter, 2003; the Phillipines: TWA 100 ppm (240 milligram per cubic meter), 1993; Russia: STEL 1 milligram per cubic meter, [skin], 1993; Sweden: NGV 5 ppm (12 milligram per cubic meter), KTV 10 ppm (25 milligram per cubic meter), 1999; Switzerland: MAK-W 2.5 ppm (6 milligram per cubic meter), carcinogen, 1999; Turkey: TWA 100 ppm (240 milligram per cubic meter), 1993; United Kingdom: TWA 5 ppm (12 milligram per cubic meter), carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: confirmed animal carcinogen with unknown relevance to humans. Russia set a MAC for ambient air in residential areas of 0.08 milligram per cubic meter. Several states have set guidelines or standards for propylene oxide in ambient air[60] ranging from 0.0833 μ/m^3 (Kansas) to 1.0 μ/m^3 (Connecticut) to 15.0 μ/m^3 (Massachusetts) to 167.0 μ/m^3 (New York) to 250.0 μ/m^3 (South Carolina) to 500.0 μ/m^3 (North Dakota) to 625.0 μ/m^3 (Pennsylvania) to 850.0 μ/m^3 (Virginia) to 1190.0 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method #1612. Propylene oxide; OSHA Analytical Method 88.

Permissible Concentration in Water: Russia has set[35] a MAC value of 0.01 mg/L in water bodies used for domestic purposes and 0.005 mg/L in water bodies used for fishery purposes.

Determination in Water: Octanol-water coefficient: Log K_{ow} = < 0.02.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Propylene oxide may irritate or burn the skin, eyes, and respiratory tract. Contact with the liquid can cause blindness and death. This material is moderately toxic by inhalation and ingestion. It may cause irreversible and reversible changes. Skin contact with the material or solutions of the material cause irritation; diluted solutions are more irritating than undiluted materials. Dermatitis (red, inflamed skin) is common. Exposure may cause mild depression of the CNS and eye, nasal, and lung irritation. Other signs and symptoms of acute exposure may include headache, nausea, vomiting, and unconsciousness. Victims may appear as if they are in a drunken stupor. Pulmonary edema may occur.

Long-Term Exposure: Repeated or prolonged contact may cause skin sensitization. This substance is possibly carcinogenic to humans. May decrease fertility in males and females. May cause lung damage; pneumonia may develop.

Points of Attack: Eyes, skin, respiratory system. Cancer site in animals: nasal tumors, stomach.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: liver function tests. Examination of the eyes and vision.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Teflon and butyl rubber are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted canister providing protection against the compound of concern]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code -Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration is not a danger. Propylene oxide must be stored to avoid contact with anhydrous metal chlorides, iron, strong acids (such as hydrochloric, sulfuric, and nitric); strong bases and peroxides; copper or copper alloys, since violent reactions occur. Propylene oxide will attack some forms of plastics, rubber and coatings. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where propylene oxide is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gallons or more of propylene oxide should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of propylene oxide. Wherever propylene oxide is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN1280 Propylene oxide, Hazard Class: 3; Labels: 3-Flammable liquid

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of carbon. Extinguish with dry chemical, carbon dioxide; water spray, fog or foam. Firefighting should be done from a safe distance or from a protected location. Wear self-contained (positive pressure if available) breathing apparatus and full protective clothing. Isolate for ½ mile in all directions if tank car or truck is involved in fire. Move container from area if you can do so without risk. Spray cooling water on containers that are exposed to flames until well after fire is out. For massive fire in cargo area, use unmanned hose holder or monitor nozzles; if this is impossible, withdraw from area and let fire burn. Withdraw immediately in case of rising sound from venting safety device or any discoloration of tank due to fire. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Concentrated waste containing no peroxides-discharge liquid at a controlled rate near a pilot flame. Concentrated waste containing peroxides-perforation of a container of the waste from a safe distance followed by open burning[22].

References

(109); (102); (31); (173); (101); (138); (2); (100).

Bogyo, D. A., Lande, S. S., Meylan, W. M., Howard, P. H., and Santodonato, J., Syracuse Research Corp. Center for Chemical Hazard Assessment, Investigation of Selected Potential Environmental Contaminants: Epoxides, Report EPA-560/11-08-005, Washington, DC, United States Environmental Protection Agency (March 1980)

United States Environmental Protection Agency, Chemical Hazard Information Profile: Propylene Oxide, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

New York State Department of Health, *Chemical Fact Sheet:* Propylene Oxide, Bureau of Toxic Substance Assessment, Albany, NY (April 1986 and Version 2)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Propylene Oxide, Trenton, NJ (April 2002)

n-Popyl Nitrate P:1310

Formula: $C_3H_7NO_2$: $CH_3CH_2CH_2NO_2$

Synonyms: Nitrate de propyle *normal* (French); Nitric acid, propyl ester; Propyl nitrate; Nitric acid, *n*-propyl ester; Propyl ester of nitric acid

CAS Registry Number: 627-13-4

HSDB Number: 7198

RTECS Number: UK0350000

UN/NA & ERG Number: UN1865/131

EC Number: 210-985-0

Regulatory Authority and Advisory Information

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard Alert: Explosive (shock sensitive), Highly flammable liquid, Strong Oxidizer (H271).

Hazard Symbols, Risk & Safety statements: Hazard Symbol: F, O: Risk phrases: R2; R3; R5; R8; R9; R11; R44; Safety phrases: S16; S21; S17; S41 (see Appendix 4)

Description: *n*-Propyl nitrate is a colorless to pale yellow liquid. Ethereal odor. Molecular weight = 105.11; Specific gravity (H_2O:1) = 1.1 @ 20°C; Boiling point = 111°C; Freezing/Melting point = −100°C; Vapor pressure = 18 mmHg @ 25°C; Flash point = 20°C. Autoignition temperature = 175°C; Explosive limits: LEL = 2%/ 20,000 ppm[138]; UEL: 100%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Instability 3 Capable of detonation or explosive decomposition or explosive reaction but requires a strong initiating source or must be heated under confinement before initiation. (Oxidizer). Slightly soluble in water.

Potential Exposure: Propyl nitrate has been used as an intermediate as a rocket propellant and as an ignition improver in diesel fuels.

Incompatibilities: Vapor may form explosive mixture with air. Reacts with reducing agents, combustible materials; may be violent. A shock-sensitive explosive. The shock sensitivity is removed by addition of 1%−2% of propane, butane, chloroform, ethyl ether, or methyl ether[101]. May explode on heating. Forms explosive mixtures with combustible materials. This material is an organonitrate. They can range from slight to strong oxidizing agents. If mixed with reducing agents, including hydrides, sulfides, and nitrides, they may begin a vigorous reaction that culminates in a detonation. Nitroalkanes are milder oxidizing agents, but still react violently with reducing agents at higher temperature and pressures. Nitroalkanes react with inorganic bases to form explosive salts. The presence of metal oxides increases the thermal sensitivity of nitroalkanes. Nitroalkanes with more than one nitro group are generally explosive. Contact with either strong oxidizers or with combustibles may cause fires and explosions[101].

Permissible Exposure Limits in Air:
NIOSH IDLH = 500 ppm
Conversion factor: 1 ppm = 4.30 milligram per cubic meter @ 25°C & 1 atm
OSHA PEL: 25 ppm/110 milligram per cubic meter TWA
NIOSH REL: 25 ppm/105 milligram per cubic meter TWA; 40 ppm/170 milligram per cubic meter STEL
ACGIH TLV[1]: 25 ppm/107 milligram per cubic meter TWA; 40 ppm/172 milligram per cubic meter STEL; BEIM issued for methemoglobininducers.
Protective Action Criteria (PAC) Ver. 29[138]
PAC-1: 40 ppm
PAC-2: 330 ppm
PAC-3: 2000 ppm (Warning: 10% of LEL)
DFG MAK: 25 ppm/110 milligram per cubic meter TWA; Peak Limitation Category II(2)
Australia: TWA 25 ppm (110 milligram per cubic meter); STEL 40 ppm, 1993; Austria: MAK 25 ppm (110 milligram per cubic meter), 1999; Belgium: TWA 25 ppm (107 milligram per cubic meter); STEL 40 ppm (172 milligram per cubic meter), 1993; Denmark: TWA 25 ppm (110 milligram per cubic meter), 1999; Finland: TWA 25 ppm (105 milligram per cubic meter), 1999; Norway: TWA 20 ppm (90 milligram per cubic meter), 1999; the Phillipines: TWA 25 ppm (110 milligram per cubic meter), 1993; the Netherlands: MAC-TGG 1 10 milligram per cubic meter, 2003; Switzerland: MAK-W 25 ppm (110 milligram per cubic meter), 1999; Turkey: TWA 25 ppm (110 milligram per cubic meter), 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 40 ppm. Several states have set guidelines or standards for propyl nitrate in ambient air[60] ranging from 1.05−1.70 milligram per cubic meter (North Dakota) to 1.75 milligram per cubic meter (Virginia) to 2.1 milligram per cubic meter (Connecticut) to 2.5 milligram per cubic meter (Nevada).

Determination in Air: Use NIOSH II(3), Method #S-227; OSHA Analytical Method 7.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: None listed for humans according to NIOSH[2] but other sources[24] state that vapor inhalation causes low blood pressure; hypotony and hemoglobin defect; anoxia and cyanosis. In animals: irritation of the eyes, skin; methemoglobinemia, anoxia, cyanosis, dyspnea (breathing difficulty), weakness, dizziness, headache.

Points of Attack: May attack the blood.

Medical Surveillance: NIOSH lists the following tests: whole blood (chemical/metabolite), methemoglobin; CBC; urinalysis.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to Physician: Consider treatment for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 250 ppm:* Sa (APF = 10) (any supplied-air respirator). *Up to 500 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS* [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted canister providing protection against the compound of concern]; or SCBAE (any appropriate escape-type, SCBA).
*End-of-service life indicator (ESLI) required.

Storage: Check oxygen content prior to entering storage area. (1) Color code-Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. (2) Color code-Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Oxidizers should be isolated from acids, metals, organic materials, and ammonium nitrate. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration is not a danger. Protect containers against physical damage. Outdoor or detached storage is preferred. Indoor storage should be in a flammable liquid storage room. Propyl nitrate should be isolated from combustible materials and oxidizing agents. Wear Neoprene gloves, plastic coverall and SCBA. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Store in a cool, well ventilated area away from incompatible materials listed above. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage.

Shipping: UN1865 *n*-Propyl nitrate, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. After covering the spills with soda ash, mix and spray with water. Scoop into a bucket of water and let it stand for 2 hours. Neutralize with 6M-HCl and pass into the drain with sufficient water. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. On fires in which containers are not exposed, use dry chemical foam or carbon dioxide. Water spray may be ineffective as an extinguishing agent. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. Use water from unmanned monitors or house-holders to keep fire-exposed containers cool If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration: large quantities of material may require nitrogen oxide removal by catalytic or scrubbing processes[22]. An alternative route suggested involves pouring over soda ash, neutralizing with HCl and flushing to the drain with water.

References

(31); (173); (101); (138).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: n*-Propyl Nitrate, Trenton, NJ (July 2001).

Propylthiouracil P:1315

Formula: $C_7H_{10}N_2OS$

Synonyms: 2,3-Dihydro-6-propyl-2-thioxo-4(1H)-pyrimidinone; 2-Mercapto-4-hydroxy-6-*N*-propylpyrimidine; 2-Mercapto-6-propyl-4-pyrimidone; 2-Mercapto-6-propyl-pyrimid-4-one; Procasil; Propacil; Propilthiouracil; 6-Propil-tiouracile; Propycil; 6-Propyl-2-thio-2,4(1H,3H)pyrimidine-dione; Propyl-thiorist; Propyl-thiorit; Propylthiouracil; 4-Propyl-2-thiouracil; 6-Propylthiouracil; 6-Propyl-2-thiouracil; 6-*N*-Propylthiouracil; 6-*N*-Propyl-2-thiouracil; Prothycil; Propyl-thyracil; Prothiucil; Prothiurone; Prothyran; Protiural; PTU (thyreostatic); 4(1H)-Pyrimidinone, 2,3-dihydro-6-propyl-2-thioxo-; 2-Thio-4-*oxo*-6-propyl-1,3-pyrimidine; 2-Thio-6-propyl-1,3-pyrimidin-4-one; 6-Thio-4-propyluracil; Thiuragyl; Thyreostat II; Uracil, 6-propyl-2-thio-

CAS Registry Number: 51-52-5

HSDB Number: 3390

RTECS Number: YR1400000

UN/NA & ERG Number: UN3249 (Medicine, solid, toxic, n.o.s.)/151

EC Number: 200-103-2

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen.

California Proposition 65 Chemical[102]: Cancer, 1/1/1988

Hazard Alert: Poison, Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: Xn, Xi; Risk phrases: R45; R22; R40; R51; R62; R63; Safety phrases: S1/2; S36/37; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: White crystalline solid or powder. Odorless. Bitter taste. Molecular weight = 170.23; Freezing/Melting point = 219−221°C; Vapor pressure = 6.9×10^{-8} mmHg @ 25°C (est.)[72]; Flash point = ~300°C. Henry's Law constant = 1.1×10^{-9} atm-m^3/mol @ 25°C (est)[72] Practically insoluble in water; solubility = < 1 mg/mL @ 20°C.

Potential Exposure: Medication (antihyperthyroid; thyroid inhibitor) with human and veterinary applications.

Incompatibilities: This chemical is probably combustible; it's dust may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Forms complexes with divalent metals. Reacts with sulfhydryl-oxidizing agents[193]. Sensitive to light and may be sensitive to air.

Permissible Exposure Limits in Air: No standards or Protective Action Criteria (PAC) available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Determination in Water: Octanol-water coefficient: Log K_{ow} = < 1. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Ingested, inhaled, possibly absorbed through the skin.

Harmful Effects and Symptoms

Symptoms of exposure to this compound include recurrent painful skin lesions, fatigue, migratory polyanthralgias of hands and knees, palpable spleen, splenomegaly, amenorrhea, low-grade fever, gingivostomatitis, weakness, weight loss, dark red-brown colored urine, necrotizing vasculitis, leukopenia, cutaneous vasculitis, nasal congestion, enlarged thyroid, necrotic ulcerations on the lower extremities, bloody nasal discharge and cough. Other symptoms include fever, sore throat, rash and malaise. The most serious reaction to this chemical may be agranulocytosis. It may also cause pain and stiffness in the joints, paresthesias, headache, nausea and loss or depigmentation of hair. On rare occasions, exposure to this material may cause drug fever, hepatitis and nephritis. Other symptoms include urticaria, anorexia, hypoprothrombinemia with purpura and hepatic injury. Exposure may also cause a tendency to hemorrhage, lupus-like syndrome, hypothyroidism, galactorrhea, migratory polyarthritis, reversible tinnitus, hearing loss, hypocalcemia, jaundice, hepatic necrosis and liver disease similar to chronic active hepatitis. It may also cause goiter in infants born to women following exposure to this compound.

Short-Term Exposure: Harmful if ingested or inhaled. LD_{50} = (oral-rat) ~1300 mg/kg.

Long-Term Exposure: May cause cancer, brain damage. Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard.

Points of Attack: Kidney, ureter, bladder, reproductive system.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure.Pregnant women should avoid contact. Employees should be notified by a physician that this chemical may affect the reproductive system. In addition to comprehensive initial medical and work histories emphasizing reproductive experience and menstrual history, patient should have physical examination and testing of genito-urinary tract, sperm count, motility and morphology. If required, other tests, such as serum testosterone, serum FSH, and serum LH, may be indicated.

First Aid Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear chemical goggles and face shield unless full-facepiece respiratory protection is worn.

Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Based on potential carcinogenicity the following is recommended by NIOSH: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA-or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code-Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location away from exposure to light, in a tightly closed container, under an inert atmosphere, at cold, refrigerated temperatures.

Shipping: UN3249 Medicine, solid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: UN2811: Isolation Distance, Spill: 25meters/75 feet.(NJ). Isolation Distance, Fire: 800 meters/ 0.5 miles[70]. *Small spills and leakage*: Dampen spilled solid material with 5% ammonium hydroxide, then transfer the dampened material to a suitable container. Use absorbent paper dampened with 5% ammonium hydroxide to pick up any remaining material. Your contaminated clothing and the absorbent paper should be sealed in a vapor-tight plastic bag for eventual disposal. Wash all contaminated surfaces with 5% ammonium hydroxide followed by washing with a soap and water solution. Do not reenter the contaminated area until the Safety Officer (or other responsible person) has verified that the area has been properly cleaned.

Fire Extinguishing: Thermal decomposition products may include toxic fumes of oxides of nitrogen, sulfur and carbon. This chemical is probably combustible. Fires involving 6-*N*-propyl-2-thiouracil may be controlled with a dry chemical, carbon dioxide or halon extinguisher.

Disposal Method Suggested: It is inappropriate and possibly dangerous to the environment to dispose of expired or waste pharmaceuticals by flushing them down the toilet or discarding to trash. Household quantities of expired or waste pharmaceuticals may be mixed with wet cat litter or coffee grounds, double-bagged in plastic, discard in trash. Larger quantities shall carefully take into consideration applicable DEA, EPA, and FDA regulations. If possible return the pharmaceutical to the manufacturer for proper disposal being careful to properly label and securely package the material. Alternatively, the waste pharmaceutical shall be labeled, securely packaged and transported by a state licensed medical waste contractor to dispose by burial in a licensed hazardous or toxic waste landfill or incinerator.

References

(109); (102); (31); (173); (101); (138); (100).
HSDB cameo, RTECS

Prothoate P:1320

Formula: $C_9H_{20}NO_3PS_2$

Synonyms: AC18682; American Cyanamid 18682; *O*,*O*-Diethyldithiophosphorylacetic acid *N*-monoisopropylamide; *O*,*O*-Diethyl *S*-(*N* -isopropylcarbamoylmethyl) dithiophosphate; *O*,*O*-Diethyl *S*-(*N*-isopropylcarbamoylmethyl) phosphorodithioate; *O*,*O*-Diethyl *S*-isopropylcarbamoylmethyl phosphorodithioate; ENT 24,652; FAC; FAC20; Fostion; Isopropyl diethyldithiophosphorylacetamide; *N*-Isopropyl-2-mercaptoacetamide *S*-ester with *O*,*O*-diethyl phosphorodithioate; L 343; *N*-Monoisopropylamide of *O*,*O*-diethyldithiophosphorylacetic acid; Oleofac; Phosphorodithioic acid *O*,*O*-diethyl esters, ester with *n*-isopropyl-2-mercaptoacetamide; Phosphorodithioic acid, *O*,*O*-diethyl *S*-(2-[(1-methylethyl)amino]-2-oxoethyl) ester; Telefos; Trimethoate

CAS Registry Number: 2275-18-5

HSDB Number: 2844

RTECS Number: TD8225000

UN/NA & ERG Number: (PIH) UN2783 (organophosphorus pesticides, solid, toxic)/152

EC Number: 218-893-2 [*Annex I Index No.:* 015-032-00-0]

Regulatory Authority and Advisory Information

Hazard Alert: Poison inhalation hazard: exposure can be lethal, Neurotoxin (cumulative), Combustible, Agricultural chemical, Environmental hazard.

Banned or Severely Restricted (Malaysia) (UN)[13]

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 100 lb (45.4 kg)

United States DOT Regulated Marine Pollutant (49CFR172.101, appendix B)

United States DOT 49CFR172.101, Inhalation Hazard Chemical as organophosphates.

Hazardous to aquatic life or environment, with possible long lasting effects[194]. Harmful to aquatic life with long lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T+, N; Risk phrases: R27/28; R33; R50/53; Safety phrases: S1/2; S28; S29; S36/37; S41; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Prothoate is an amber to yellow crystalline solid with a camphor-like odor. Molecular weight = 285.39;

Boiling point = 135°C @ 0.1 mm; Freezing/Melting point = 29°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 1, Reactivity 0. Slightly soluble in water.

Potential Exposure: A potential danger to those involved in the manufacture, formulation and application of the systemic acaricide and insecticide.

Incompatibilities: Organophosphates are susceptible to formation of highly toxic and flammable phosphine gas in the presence of strong reducing agents such as hydrideds and active metals. Partial oxidation by oxidizing agents may result in the release of toxic phosphorus oxides[101] Compounds of the carboxyl group react with all bases, both inorganic and organic (i.e., amines) releasing substantial heat, water and a salt that may be harmful. Incompatible with arsenic compounds (releases hydrogen cyanide gas), diazo compounds, dithiocarbamates, isocyanates, mercaptans, nitrides, and sulfides (releasing heat, toxic and possibly flammable gases), thiosulfates and dithionites (releasing hydrogen sulfate and oxides of sulfur).

Permissible Exposure Limits in Air:

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 0.15 milligram per cubic meter

PAC-2: 1.7 milligram per cubic meter

PAC-3: 10 milligram per cubic meter

Determination in Air: OSHA versatile sampler-2; Toluene/Acetone; Gas chromatography/Flame photometric detection for sulfur, nitrogen, or phosphorus; NIOSH Analytical Method (IV) Method #5600, Organophosphorus pesticides.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: This is a highly toxic material capable of causing death or permanent injury due to exposures during normal use. Small doses at frequent intervals are additive. Similar to parathion[88,1998]. Symptoms may include nausea, vomiting, abdominal cramps; diarrhea, excessive salivation; headache, giddiness, dizziness, weakness, muscle twitching; difficult breathing; blurring or dimness of vision; and loss of muscle coordination. Death may occur from failure of the respiratory center, paralysis of the respiratory muscles; intense bronchoconstriction; or all three. Can be fatal from ingestion and skin contact.

Long-Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, CNS; cardiovascular system, skin, eyes, plasma and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1–2 weeks while red blood cell levels may be reduced for 1–3 months. When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an examination of the nervous system. Also consider CBC. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation. If material has been ingested, induce vomiting with ipecac.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full-facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN2783 Organophosphorus pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling:

Initial isolation and protective action distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.3/0.4
Night 0.8/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 600/200
Then: Protect persons downwind (miles/kilometers)
Day 1.4/2.3
Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Do not touch spilled material; stop leak if you can do it without risk. Use water spray to reduce vapors. *Small spills:* take up with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills:* with clean shovel place material into clean, dry container and cover; move containers from spill area. *Large spills:* dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of phosphorus, sulfur, nitrogen and carbon. This material may burn, but does not ignite readily. For small fires, use dry chemical, carbon dioxide; water spray; or foam. For large fires, use water spray, fog, or foam. In fighting fires, stay upwind; keep out of low areas. Move containers from fire area if you can do it without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Wear positive pressure breathing apparatus and special protective clothing. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Prothoate, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

Pyrene P:1330

Formula: $C_{16}H_{10}$

Synonyms: Benzo(def)phenanthrene; Pireno (Spanish); Pyren (German); β-Pyrene

CAS Registry Number: 129-00-0

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

HSDB Number: 4023

RTECS Number: UR2450000

EC Number: 204-927-3

Regulatory Authority and Advisory Information

Carcinogenicty: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen. NIOSH has recommended that coal tar pitch volatiles, including polycyclic aromatic hydrocarbons (PAHs) be treated as potential human carcinogen. IARC: Animal Inadequate Evidence; Human No Adequate Data, *not classifiable as carcinogenic to humans*, Group 3, 1987; EPA: Not Classifiable as to human carcinogenicity.

Hazard Alert: Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Sensitization hazard, Primary irritant (w/o allergic reaction), Environmental hazard.

OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR 1910.1002) as coal tar pitch volatiles.

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; Section 307(a)(1) Toxic pollutant designated, pursuant to of the and is subject to effluent limitations as polycyclic aromatic hydrocarbons (PAHs)

United States National Primary Drinking Water Regulations: MCLG = zero mg/L; MCL = 0.0002 mg/L as polycyclic aromatic hydrocarbons (PAHs).

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.067; Nonwastewater (mg/kg), 8.2

RCRA 40CFR264, appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8100 (200); 8270 (10)

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 1000/10,000 lb (454/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 5000 lb (2270 kg)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T+, F, N, Xn, Xi; Risk phrases: R40; R10, R22; R23/24/25; R26; R36/37/38; R39; R40; R43; R48/20; R50/53; R62; R65; R67; Safety phrases: S7; S22; S23; S24/25; S28; S29; S36/37/39; S45; S53; S60; S61; S62 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [2-Hazard to water. (est.)]

Description: Pyrene is a colorless crystalline solid when pure or pale yellow plates (impure). Polycyclic aromatic hydrocarbons (PAHs) are compounds containing multiple benzene rings and are also called polynuclear aromatic hydrocarbons. Solids and solutions have a Blue fluorescence (Merck Index). Molecular weight = 202.25; Boiling point 404°C @ 760 mmHg;[2] Freezing/Melting point = 151°C[2].; Vapor pressure = 1.3 mmHg @ 23°C; Flash point = 199°C. Explosive limits: LEL = 0.6%; UEL: 3.9%. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 2, Reactivity 0. Practically insoluble in water.

Potential Exposure: Pyrene is used as an industrial chemical and in biochemical research.

Incompatibilities: Pyrene Dust may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Pyrene reacts with nitrogen oxides to form nitro derivatives. It also reacts with 70% nitric acid[NTP, 1992, cameo].

Permissible Exposure Limits in Air:

NIOSH IDLH = 80 milligram per cubic meter as coal tar pitch volatiles

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 0.15 milligram per cubic meter

PAC-2: 1.7 milligram per cubic meter

PAC-3: 110 milligram per cubic meter

DFG MAK: [skin]

Determination in Air: Use NIOSH Analytical Method #5506 polycyclic aromatic hydrocarbons by HPLC; NIOSH Analytical Method #5515, Polycyclic aromatic hydrocarbons by GC; OSHA Analytical Method ID-58.

Permissible Concentration in Water: For the maximum protection of human health from the potential carcinogenic effects due to exposure of polynuclear aromatic hydrocarbons through ingestion of contaminated water and contaminated aquatic organisms, therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 1×10^{-5}, 1×10^{-6}, and 1×10^{-7}. The corresponding criteria are 28.0 ng/L, 2.8 ng/L, and 0.28 ng/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 311.0 ng/L, 31.1 ng/L, and 3.11 ng/L, respectively. The World Health Organization (WHO) recommends a maximum of 2 μg/L for specific PAHs, but this list does not include pyrene.

Determination in Water: Octanol-water coefficient: Log $K_{ow} = \sim 5$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact. Can be absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Pyrene is a skin irritant, a suspected mutagen; and an equivocal tumor-causing agent. Workers exposed to 3–5 milligram per cubic meter of pyrene exhibited some teratogenic effects. Pyrene is a polycyclic aromatic hydrocarbon (PAH). The acute toxicity of pure PAHs appears low when administered orally or dermally to rats or mice. Human exposure to PACs or PAHs is almost exclusively via the gastrointestinal and respiratory tracts, and approximately 99% is ingested in the diet. Despite the high concentrations of pyrene to which humans may be exposed through food, there is currently little information available to implicate diet-derived PAHs as the cause of serious health effects.

Long-Term Exposure: The DFG[3] states that PAHs are present at particularly high levels in coal tar oils and related pyrolysis products of organic materials and are carcinogenic (category 1) in animal studies.

Points of Attack: Skin, respiratory system; bladder, liver, kidneys.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Preplacement and regular physical examinations are indicated for workers having contact with acenaphthene in the work-place. NIOSH lists: CBC; chest X-ray; pulmonary function tests: Forced Vital Capacity; Forced Expiratory Volume (1 sec); photopatch testing; sputum cytology; urinalysis (routine); cytology, hematuria[2].

First Aid: *Skin Contact:*[52] Flood all areas of body that have contacted the substance with water. Don't wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others. *Eye Contact:* Remove any contact lenses at once. Immediately flush eyes well with copious quantities of water or normal saline for at least 20−30 minutes. Seek medical attention. *Inhalation:* Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion:* Contact a physician, hospital or poison center at once. If the victim is unconscious or convulsing, do not induce vomiting or give anything by mouth. Assure that this airway is open and lay him on his side with his head lower than his body and transport immediately to a medical facility. If conscious and not convulsing, give a glass of water to dilute the substance. Vomiting should not be induced without a physician's advice.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Based on potential carcinogenicity the following is recommended by NIOSH: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA-or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code -Blue: Health Hazard/Poison: Store in a secure poison location Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in a cool, dry place.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Remove all sources of ignition and dampen spilled material with toluene to avoid airborne dust, then transfer material to a suitable container. Ventilate the spill area and use absorbent dampened with toluene to pick up remaining material. Wash surfaces well with soap and water. Seal all wastes in vapor-tight plastic bags for eventual disposal. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed[22].

References

(109); (31); (101); (138); (2); (18); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Pyrene, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

(173); (101); (138).

United States Environmental Protection Agency, "*Identification of Organic Compounds in Effluents from Industrial Sources*," EPA-560/3-75-002, April 1975

Pyrethrum P:1340

Formula: $C_{20\text{-}2}1H_{28\text{-}30}O_{3\text{-}5}$; $C_{20}H_{28}O_3/C_{21}H_{28}O_5/C_{21}H_{30}O_3/C_{22}H_{30}O_5/C_{21}H_{28}O_3/C_{22}H_{28}O_5$

Synonyms: Buhach; Chrysanthemum cinerareaefolium; Cinerin I; Cinerin II; Dalmation insect flowers; Firmotox; Insect powder; Jasmolin I; Jasmolin II; Piretrina (Spanish); Pyrethrin I; Pyrethrin II; Pyrethrum; Pyrethrum insecticide; Trieste flowers. *Note*: Pyrethrum is a variable mixture of chrysanthemic esters cinerin, jasmolin, and pyrethrin[77] Synthetic analogs of these naturally occurring compounds are referred to as "pyrethroids."

CAS Registry Number: 121-21-1 (I); 121-29-9 (II); 8003-34-7

HSDB Number: 6302 (I)

RTECS Number: UR4200000

UN/NA & ERG Number: UN2902 (Pesticides, liquid, toxic, n.o.s.)/151

EC Number: 232-319-8; 204-455-8 [*Annex I Index No.:* 613-023-00-1] (I); 204-462-6 [*Annex I Index No.:* 613-024-00-7] (II)

Regulatory Authority and Advisory Information

Carcinogenicity: EPA, Suggestive Evidence of Carcinogenicity, but Not Sufficient to Assess Human Carcinogenic.

Hazard Alert: Poison, Combustible, Suspected of causing genetic defects, Environmental hazard.

Permissible Exposure Limits for Chemical Contaminants (CAL/OSHA) as pyrethrum

Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

European/International Regulations (*I & II*): Hazard Symbol: Xn, N; Risk phrases: R0/21/22; R50/53; R62; Safety phrases: S2; S13; S29; S60; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Type I and II:

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 1 lb (0.454 kg)

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P008

Description: Pyrethrum is a variable mixture of compounds which are found in cinerin, jasmolin, and pyrethrin. Pyrethrum is a brown, viscous oil or solid. Molecular weight = 328.49 (I); Specific gravity (H_2O:1) = 1.52 (approx.) @ 20°C; Boiling point = 170°C @ 0.1 mm (decomposition); Vapor pressure = 3.8×10^{-5} mmHg @ 25°C; Class IIIA Combustible Liquid: Flash point ≥ 60°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Insoluble in water. *Note*: Physical and toxicological properties may be affected by the carrier solvents used in commercial formulations.

Potential Exposure: Pyrethrins are used as an ingredient of various contact insecticides. Those engaged in the isolation, formulation, or application of these materials.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Compounds of the carboxyl group react with all bases, both inorganic and organic (i.e., amines) releasing substantial heat, water and a salt that may be harmful. Incompatible with arsenic compounds (releases hydrogen cyanide gas), diazo compounds, dithiocarbamates, isocyanates, mercaptans, nitrides, and sulfides (releasing heat, toxic and possibly flammable gases), thiosulfates and dithionites (releasing hydrogen sulfate and oxides of sulfur).

Permissible Exposure Limits in Air:

NIOSH IDLH = 5000 milligram per cubic meter

OSHA PEL: 5 milligram per cubic meter TWA

NIOSH REL: 5 milligram per cubic meter TWA

ACGIH TLV[1]: 5 milligram per cubic meter TWA; not classifiable as a human carcinogen

121-21-1, Pyrethrin (1)

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 15 milligram per cubic meter

PAC-2: 25 milligram per cubic meter

PAC-3: 150 milligram per cubic meter

DFG MAK: 5 milligram per cubic meter, inhalable fraction, danger of skin sensitization; Peak Limitation Category II(2)

Arab Republic of Egypt: TWA 5 milligram per cubic meter, 1993; Australia: TWA 5 milligram per cubic meter, 1993; Austria: MAK 5 milligram per cubic meter, 1999; Belgium: TWA 5 milligram per cubic meter, 1993; Denmark: TWA 5 milligram per cubic meter, 1999; Finland: TWA 5 milligram per cubic meter; STEL 10 milligram per cubic meter, 1999; France: VME 5 milligram per cubic meter, 1999; the Netherlands: MAC-TGG

5 milligram per cubic meter, 2003; Norway: TWA 5 milligram per cubic meter, 1999; Thailand: TWA 5 milligram per cubic meter, 1993; Turkey: TWA 5 milligram per cubic meter, 1993; United Kingdom: TWA 5 milligram per cubic meter; STEL 10 milligram per cubic meter, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Several states have set guidelines or standards for pyrethrum in ambient air[60] ranging from 16.7 μ/m^3 (New York) to 50.0 μ/m^3 (Florida and South Carolina) to 50.0−100.0 μ/m^3 (North Dakota) to 80.0 μ/m^3 (Virginia) to 100.0 μ/m^3 (Connecticut) to 119.0 μ/m^3 (Nevada).

Determination in Air: Collection by impinger or fritted bubbler, analysis by gas liquid chromatography/UV. See NIOSH IV, Method #5008[18], pyrethrum.

Determination in Water: Fish Tox: 2.38748000 ppb (HIGH).

Routes of Entry: Inhalation, ingestion; skin and/or eye absorption.

Harmful Effects and Symptoms

Short-Term Exposure: Pyrethrum can affect you when breathed in and by passing through your skin. Irritates the eyes and respiratory tract. High exposure can affect the nervous system causing headache, nausea, vomiting, fatigue, and restlessness and rhinorrhea (discharge of thin nasal mucous).

Long-Term Exposure: High or repeated exposure can cause lung allergy (with cough, wheezing and/or shortness of breath) or hay fever symptoms (sneezing, runny or stuffy nose). Allergic "pneumonia" can also occur with cough, chest pain; breathing difficulty and abnormal chest X-ray. Repeated attacks may lead to permanent scarring. Skin allergy may also develop with rash and itching, even with lower exposures. Skin contact can cause rash with redness, blisters and intense itching. A severe generalized allergy can occur with weakness and collapse. Human Tox = 68.09339 ppb Chronic Human Carcinogen Level (CHCL) (LOW).

Points of Attack: Respiratory system, skin, CNS.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended. Lung function tests. These may be normal if the person is not having an attack at the time of the test. Consider chest X-ray if lung symptoms are present. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear appropriate clothing to prevent rep Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/ clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear eye protection to prevent any possibility of eye contact. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *50 milligram per cubic meter:* CcrOv95 (APF = 10) [Any air-purifying half-mask respirator with organic vapor cartridge(s) in combination with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *125 milligram per cubic meter:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOvHie (APF = 25) (any powered air-purifying respirator with an organic vapor cartridge in combination with a high-efficiency particulate filter). *250 milligram per cubic meter:* CcrFOv100 (APF = 50) [Any air-purifying full facepiece respirator equipped with organic vapor cartridge(s) in combination with an N100, R100, or P100 filter]; or PaprTOvHie (APF = 50) [any powered, air-purifying respirator with a tight-fitting facepiece and organic vapor cartridge(s) in combination with a high-efficiency particulate filter]; or SCBAF (APF = 50) (any SCBA with full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *5000 milligram per cubic meter:* SaF: Pd, Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd, Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Pyrethroids must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates) and alkalines, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN2902 Pesticides, liquid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Soil Adsorption Index (K_{oc}): 100000 (estimate).

Fire Extinguishing: Class IIIA Combustible Liquid: Flash point $\geq 60°C$ and $<93.3°C$. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire-fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Pyrethrum, Trenton, NJ (August 2002)

Pyridaben P:1342

Formula: $C_{19}H_{25}ClN_2OS$

Synonyms: Bas-300; 2-(*tert*-Butyl)-5-(4-*tert*-butylbenzylthio)-4-chloropyridazin-3-(2*H*)one; NCI-129; Nester; Pyramite; 3(2*H*)-Pyridazinone, 4-chloro-2-(1,1-dimethylethyl)-5-[((4-(1,1-dimethylethyl) phenyl)methyl)thio]-; Sanmite

CAS Number: 96489-71-3

HSDB Number: 7052

RTECS Number: UR6149000

UN/NA & ERG Number: UN2588 (Pesticide, solid, poisonous, n.o.s.)/151; UN2902 (Pesticide, liquid, poisonous, n.o.s.)/151

EC Number: 405-700-3 [*Annex I Index No.:* 613-149-00-7]

Regulatory Authority and Advisory Information

Carcinogenicity[83]: EPA Group E, Evidence of noncarcinogenicity for human.

Hazard Alert: Poison, Suspected reprotoxic hazard, Environmental hazard.

EPA Oral reference dose (RfD) = 0.50 mg/kg/day. (NOAEL = 50 mg/kg/day, UF = 100) was selected for use in assessing acute dietary risk for the general population. EPA acute RfD of 0.13 mg/kg/day NOAEL = 13 mg/kg/day, uncertainty factor (UF) = 100 for use in assessing acute dietary risk for females 13 years and older[83].

Hazard Alert: Suspected reprotoxic hazard, Environmental hazard.

Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T, N; Risk phrases: R23/25; R50/53; R63; Safety phrases: S1/2; S29; S36/37; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: White to tan crystalline solid or powder. Faint vanilla odor. Commercial product is available as an emulsifiable concentrate or wettable powder. Molecular weight = 364.92; Specific gravity (H_2O:1) = 1.19 @ 20°C; Boiling point = (decomposes); Freezing/Melting point = 109−112°C; Vapor pressure = 2×10^{-7} mmHg @ 25°C; Flash point = $>200°C$; Autoignition temperature = 395°C. Practically insoluble in water; solubility = <0.5 mg/L. Physical and toxicological properties may be affected by carrier solvents in commercial formulations.

Potential Exposure: Pyridaben is a pyridazinone insecticide/acaricide/miticide used to control mites, whiteflies, leafhoppers and psyllids on fruit trees, vegetables, ornamentals and other field crops. It is also used to control pests in apple, grapes, pear, pistachio, stone fruits, and the tree nuts group[83].

Incompatibilities: Dust may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Concentration in Water: Runoff from spills or fire control may cause water pollution.

Determination in Water: Octanol-water coefficient: Log $K_{ow} = > 6.0$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, ingestion, eyes, dermal absorption.

Harmful Effects and Symptoms

Short-Term Exposure: May be fatal if inhaled. Do not breathe dust or spray mist. Avoid contact with skin. Causes moderate injury. Do not get in eyes or on clothing[83]. Absorbed through the unbroken skin. Harmful if swallowed. LD_{50} (oral, rat) = 600−1100 mg/kg; LD_{50} (dermal, rat) = > 2 g/kg.

Long-Term Exposure: May be a developmental/reproduction hazard.

Points of Attack: Reproductive system; DNA, testes, ovaries.

Medical Surveillance: In addition to comprehensive initial medical and work histories emphasizing reproductive experience and menstrual history, patient should have physical examination and testing of genito-urinary tract, sperm count, motility and morphology. If required, other tests, such as serum testosterone, serum FSH, and serum LH, may be indicated.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. Give artificial respiration if victim is not breathing. *Do not* use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves.

Personal Protective Methods: Applicators and other handlers must wear: Coveralls worn over long-sleeved shirt and long pants; Chemical-resistant gloves such as DuPont Tychem suit fabrics, barrier laminate, or Viton; Chemical-resistant footwear plus socks; Protective eye wear; Chemical-resistant headgear for overhead exposure; Chemical-resistant apron when cleaning equipment, mixing, or loading[83]. Agricultural Use/Engineering Controls: When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the Worker Protection Standard (WPS) for agricultural pesticides, 40 CFR 170.240(d)(4-6), the handler PPE requirements may be reduced or modified as specified in the Worker Protection Standard. Firefighters should wear NIOSH approved SCBA and full protective clothing.

Respirator Selection: For handling activities, use a dust/mist filtering respirator. or a NIOSH approved respirator with a N, P, R, or HE prefilter[83]. *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code-Blue: Health Hazard/Possible Human Carcinogen: Store in a tightly closed container in a dry, well-ventilated and secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Where possible, automatically transfer material from other storage containers to process containers. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN2588 Pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN2902 Pesticides, liquid, toxic. UN2902 Pesticides, liquid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: For solids, *small spill*, isolate spill or leak area in all directions for at least 25 meters/75 feet. Increase, in the downwind direction, as necessary. For a *large spill* evacuate downwind at least 100 meters/330 feet. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Stop leak if you can do it without risk. Keep combustibles (wood, paper, oil, etc.) away from spilled material. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Stop leak if you can do it without risk. Do not allow water to get inside containers. *Small dry spill*: With clean shovel place material into clean, dry container and cover loosely; move containers from spill area. *Large spill*: Dike far ahead of liquid spill for later disposal. Following product recovery, flush area with water. Prevent entry into waterways, sewers, basements or confined areas. Cover with plastic sheet to prevent spreading. Absorb or cover with dry earth, sand or other noncombustible material and transfer to containers. Do not allow water to get inside containers. Prevent entry into waterways, sewers, basements or confined areas. Cover with plastic sheet to prevent spreading. Absorb or cover with dry earth, sand or other noncombustible material and transfer to containers.

Fire Extinguishing: Thermal decomposition products may include hydrogen chloride and oxides of nitrogen, sulfur, and carbon. As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 meters/150 feet for liquids and at least 25 meters/75 feet for solids. *Fire involving storage or vehicular tanks:* Isolate for 800 meters/0.5 mile in all directions; also, consider initial evacuation for 800 meters/0.5 mile in all directions. *On a small fire:* use dry chemical, CO_2, water spray or regular *foam. On a large fire:* use water spray, fog or regular foam. Do not scatter spilled material with high pressure streams of water. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal. *Fire involving tanks:* From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. Always stay away from tanks engulfed in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: It is the responsibility of chemical waste generators to determine the toxicity and physical properties and of a discarded chemical and to properly identify its classification and certification as a hazardous waste and to determine the disposal method. United States Environmental Protection Agency guidelines for the classification determination are listed in 40 CFR Parts 261.3. Additionally, waste generators must consult and follow all regional, national, state and local hazardous waste laws to ensure complete and accurate classification and disposal methods. Follow recommendations for the disposal of pesticides and pesticide containers. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Office of Pesticide Programs, Pesticide Residue Limits, "Pyridaben," 40 CFR 180.494, http://www.epa.gov/pesticides/food/viewtols.htm

Pyridine P:1345

Formula: C_5H_5N

Synonyms: Azabenzene; Azine; CP 32; NCI-C55301; Pyridin (German)

CAS Registry Number: 110-86-1

HSDB Number: 118

RTECS Number: UR8400000

UN/NA & ERG Number: UN1282/129

EC Number: 203-809-9 [*Annex I Index No.*: 613-002-00-7]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Limited Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 2000; NCI: Carcinogenesis studies (water); clear evidence: mouse; equivocal evidence: rat; NTP: Carcinogenesis studies (drinking water); some evidence: rat. United States Environmental Protection Agency Gene-Tox Program, Positive/dose response: *In vitro* SCE-nonhuman.

California Proposition 65 Chemical[102]: Cancer 5/17/2002.

Hazard Alert: Poison, Highly flammable, Possible risk of forming tumors, Suspected reprotoxic hazard. Primary irritant (w/o allergic reaction).

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U196, DO38

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA Toxicity Characteristic (Section 261.24), Maximum Concentration of Contaminants, regulatory level, 5.0 mg/L

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.014; Nonwastewater (mg/kg), 16

RCRA 40CFR264, appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8240 (5); 8270 (10)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 1000 lb (454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T, F, Xn; Risk phrases: R45; R11; R20/21/22;

R51; R61, Safety phrases: S2; S21; S26; S28; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Pyridine is a colorless liquid. Nauseating, sickening fish-like odor. The Odor Threshold is 0.17 ppm. Molecular weight = 79.1; Specific gravity (H_2O:1) = 0.98 @ 20°C; Boiling point = 115°C. Melting/Freezing point = −42°C; Vapor pressure = 21 mmHg @ 25°C; Flash point = 20°C; Autoignition temperature = 482°C. Explosive limits: LEL = 1.8%; 20,000 ppm[138]; UEL: 12.4%. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 3, Reactivity 0. Soluble in water.

Potential Exposure: Pyridine is used as a solvent in the chemical industry and as a denaturant for ethyl alcohol; as an intermediate in the production of pesticides; in pharmaceuticals; in the manufacture of paints, explosives, dyestuffs, rubber, vitamins, sulfa drugs; and disinfectants.

Incompatibilities: Violent reaction with strong oxidizers; strong acids; chlorosulfonic acid; maleic anhydride; oleum iodine.

Permissible Exposure Limits in Air:

NIOSH IDLH = 1000 ppm[LEL]

Conversion factor: 1 ppm = 3.24 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 5 ppm/15 milligram per cubic meter TWA

NIOSH REL: 5 ppm/15 milligram per cubic meter TWA

ACGIH TLV[1]: 1 ppm/3.1 milligram per cubic meter TWA

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 3 ppm

PAC-2: 19 ppm

PAC-3: 3600 ppm *ppm (> = 10% LEL, lower explosive limit but <50% LEL)

DFG MAK: [skin] 5 ppm/16 milligram per cubic meter TWA; Peak Limitation Category II(2)

Arab Republic of Egypt: TWA 5 ppm (15 milligram per cubic meter), 1993; Australia: TWA 5 ppm (15 milligram per cubic meter), 1993; Austria: MAK 5 ppm (15 milligram per cubic meter), 1999; Belgium: TWA 5 ppm (16 milligram per cubic meter), 1993; Denmark: TWA 5 ppm (15 milligram per cubic meter), 1999; Finland: TWA 5 ppm (15 milligram per cubic meter); STEL 10 ppm (30 milligram per cubic meter), [skin], 1999; France: VME 5 ppm (15 milligram per cubic meter), VLE 10 ppm, 1999; the Netherlands: MAC-TGG 0.9 milligram per cubic meter, 2003; Norway: TWA 5 ppm (15 milligram per cubic meter), 1999; the Phillipines: TWA 5 milligram per cubic meter, 1993; Poland: MAC (TWA) 5 milligram per cubic meter; MAC (STEL) 30 mg/me, 1999; Russia: STEL 5 milligram per cubic meter, 1993; Sweden: NGV 5 ppm (16 milligram per cubic meter), KTV 10 ppm (35 milligram per cubic meter), 1999; Switzerland: MAK-W 5 ppm (15 milligram per cubic meter), KZG-W 10 ppm (30 milligram per cubic meter), 1999; Turkey: TWA 5 ppm (15 milligram per cubic meter), 1993; United Kingdom: TWA 5 ppm (16 milligram per cubic meter); STEL 10 ppm (33 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 5 ppm. The Czech Republic: MAC 5.0 milligram per cubic meter[35]. Russia[35,43] has also set a MAC for the ambient air in residential areas of 0.08 milligram per cubic meter both on a momentary and a daily average basis. Several states have set guidelines or standards for pyridine in ambient air[60] ranging from 2.0 μ/m^3 (New York) to 35.714 μ/m^3 (Kansas) to 150 μ/m^3 (Indiana) to 150.0−300.0 μ/m^3 (North Dakota) to 250.0 μ/m^3 (Virginia) to 300.0 μ/m^3 (Connecticut, Florida) to 357.0 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method #1613;[18] OSHA Analytical Method 7.

Permissible Concentration in Water: EPA[32] has suggested a permissible ambient goal of 207 μg/L. Russia[43] set a MAC in water bodies used for domestic purposes of 200 μg/L and in water bodies used for fishery purposes of 10 μg/L.

Determination in Water: Octanol-water coefficient: Log $K_{ow} = 0.65$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation of vapor, percutaneous absorption of liquids,ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin, and respiratory tract. May affect the CNS; can cause stomach upset, headache, increased urinary frequency, dizziness, lightheadedness, confusion, coma, and death. *Inhalation:* May cause nose and throat irritation at low levels. Above 5 ppm the odor may no longer be detected but a characteristic taste may remain. Exposures of 6−12 ppm have caused headache, dizziness, nervousness, trouble sleeping, nausea and vomiting. *Skin:* Contact with liquid may cause painful irritation, and first-degree burns. Longer contact may cause second-degree burns. *Eyes:* Vapors may cause irritation. Contact with liquid can cause irritation, burns, and permanent eye damage. *Ingestion:* 2−3 mL (1/15-1/10 fl oz) may cause loss of appetite; nausea, fatigue and depression. Swallowing ½ cup has resulted in vomiting, diarrhea, fever, abdominal pain; bluish tint to the skin; confusion, hallucinations, severe lung congestion and death.

Long-Term Exposure: Affects the CNS; brain, liver and kidneys. Can cause skin allergy. Ingestion of about 2 mL (1/10 fl oz) three times/day for a prolonged period resulted in lever and kidney damage and death. Long-term inhalation of levels of 125 ppm in addition to the symptoms listed above, may result in damage to the nervous system.

Points of Attack: Eyes, skin; CNS; liver, kidneys, gastrointestinal tract.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. NIOSH lists the following tests: Expired Air; liver function tests; urinalysis. If symptoms develop or overexposure is suspected, the following may be useful: examination of the nervous system; interview for brain effects, kidney function tests. Evaluation by a qualified allergist, including careful exposure history an special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Polyethylene is among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Based on potential carcinogenicity the following is recommended by NIOSH: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA-or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

NIOSH: *125 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]. *250 ppm:* CcrFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted acid gas canister]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or PaprTOv (APF = 50) [any powered, air-purifying respirator with a tight-fitting facepiece and organic vapor cartridge(s)]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *1000 ppm:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance causes eye irritation or damage; eye protection needed.

Storage: Color code-Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration is not a danger. Pyridine must be stored to avoid contact with strong oxidizers (such as chloride, bromine, and fluorine); strong acids (such as hydrochloride, sulfuric, and nitric), chlorosulfonic acid; maleic anhydride; and oleum iodine; because violent reactions occur. Sources of ignition, such as smoking and open flames, are prohibited where pyridine is used, handles, or stored in a manner that could create a potential fire or explosion hazard. Metal containers used in the transfer of 5 gallons or more of pyridine should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of pyridine. Wherever pyridine is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1992 Flammable liquids, toxic, n.o.s., Hazard Class: 3; Labels: 3-Flammable liquid, 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Controlled incineration whereby nitrogen oxides are removed from the effluent gas by scrubber, catalytic or thermal devices[22].

References

(102); (31); (173); (101); (138); (2); (100).

United States Environmental Protection Agency, Pyridine, Health and Environmental Effects Profile No. 150, Office of Solid Waste, Washington, DC (April 30, 1980)

New York State Department of Health, *Chemical Fact Sheet:* Pyridine, Bureau of Toxic Substance Assessment, Albany, NY (March 1986 and Version 2)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Pyridine, Trenton, NJ (March 2002)

Pyrimethanil P:1348

Formula: $C_{12}H_{13}N_3$

Synonyms: 4,6-Dimethyl-*N*-phenyl-2-pyrimidinamine; N-(4,6-Dimethylpyrimidin-2-yl)aniline; Scala; SN 100309

CAS Number: 53112-28-0

HSDB Number: 6916***RTECS Number:*** Not found

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171; UN3082 (environmentally hazardous substances, liquid, n.o.s.)/171

EC Number: 414-2220-3 [*Annex I Index No.:* 612-240-00-9]

Regulatory Authority and Advisory Information

Carcinogenicity[83]: EPA Group C, possible human carcinogen.

Hazard Alert: Possible endocrine disruptor, Environmental hazard.

Hazardous to aquatic life or environment, with possible long lasting effects[293]. Toxic to aquatic life with long lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: N; Risk phrases: R51/53; Safety phrases: S2; S29; S60; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [2-Hazard to waters (est.)]

Description: Pyrimethanil is a white to light yellow crystalline powder. Commercial product is available as a brown emulsifiable concentrate. Molecular weight = 199.26; Specific gravity (H_2O:1) = 1.16 @ 20°C; Freezing/Melting point = 93.3°C; Vapor pressure = 2×10^{-5} mmHg @ 25°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. Practically insoluble in water. Physical and toxicological properties may be affected by carrier solvents in commercial formulations.

Potential Exposure: A pyrimidine fungicide used on grapes, strawberries, tomatoes, onions, beans, cucumbers, eggplant, and ornamental plants.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Determination in Water: Octanol -water coefficient: Log $K_{ow} = 2.5-2.8$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, ingestion, dermal and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Harmful if inhaled. May cause skin, eye, and respiratory tract irritation. May be harmful if swallowed or if absorbed through skin. LD_{50} (oral, rat) = >4 g/kg; LD_{50} (dermal, rat) = >5 g/kg.

Long-Term Exposure: Possible human carcinogen.

Points of Attack: May affect major organs.

Medical Surveillance: This chemical is a suspected or known human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and advice for medical monitoring.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least

15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Applicators and other handlers must wear: Coveralls worn over long-sleeved shirt and long pants; Chemical-resistant gloves such as DuPont Tychem suit fabrics, barrier laminate, or Viton; Chemical-resistant footwear plus socks; Protective eye wear; Chemical-resistant headgear for overhead exposure; Chemical-resistant apron when cleaning equipment, mixing, or loading[83]. Agricultural Use/Engineering Controls: When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the Worker Protection Standard (WPS) for agricultural pesticides, 40 CFR 170.240 (d)(4-6), the handler PPE requirements may be reduced or modified as specified in the Worker Protection Standard. Firefighters should wear NIOSH approved SCBA and full protective clothing.

Respirator Selection: Where the neat (undiluted) test chemical is weighed and diluted, wear a NIOSH-approved half face respirator equipped with a combination filter cartridge, i.e., organic vapor/acid gas/HEPA (specific for organic vapors, HCl, acid gas, SO_2 and a high efficiency particulate filter)[88].

Storage: Color code-Blue: Health Hazard/Poison. Store in a tightly closed container in a dry, well -ventilated and secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Where possible, automatically transfer material from other storage containers to process containers. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN3082 Environmentally hazardous substances, liquid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required. UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen and carbon. As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 meters/150 feet for liquids and at least 25 meters/75 feet for solids. *Fire involving storage or vehicular tanks:* Isolate for 800 meters/0.5 mile in all directions; also, consider initial evacuation for 800 meters/0.5 mile in all directions. *On a small fire:* use dry chemical, CO_2, water spray or regular *foam. On a large fire:* use water spray, fog or regular foam. Do not scatter spilled material with high pressure streams of water. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal. *Fire involving tanks:* Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. Always stay away from tanks engulfed in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office. If this material cannot be disposed of according to label instructions, it may be dissolved or mixed with a combustible solvent and burned in a chemical incinerator equipped with an afterburner and scrubber. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers.

References

(31); (173); (101); (138); (100).

State of Washington, Department of Ecology, *Fact sheet for the fresh fruit packing general permit*, Lacey WA (July 2, 2009)

Pyriminil P:1350

Formula: $C_{13}H_{12}N_4O_3$

Synonyms: DLP787; DPL-87; *N*-(4-Nitrophenyl)-*N*′-(3-pyridinylmethyl)urea; 1-(4-Nitrophenyl)-3-(3-pyridinylmethyl) urea; nitrophenylurea; Pyrinuron; RH-787; Urea, *N*-(4-nitrophenyl)-*N'*-(3-pyridinylmethyl)-; Vacor

CAS Registry Number: 53558-25-1

HSDB Number: 6460

RTECS Number: YI9690000

UN/NA & ERG Number: UN2767/151; UN2588 (Pesticide, solid, poisonous, n.o.s.)/151

EC Number: 258-626-7

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Combustible, Poison, Diabetes hazard.

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 100 lb (45.4 kg).

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T+; Risk phrases: R10; R27/28; R50/53; Safety phrases: S13; S28; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Pyriminil is a yellow crystalline solid, resembling corn meal. Molecular weight = 272.29; Freezing/Melting point = 223°C (decomposition). Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0.

Potential Exposure: A potential danger to those involved in the application of this single-dose, acute rodenticide. No longer registered, produced or used in the United States There are more than 20 global suppliers[146].

Incompatibilities: A nitrated amine. Amines are combustible. Azo, diazo, azido compounds can detonate. This applies in particular to organic azides that have been sensitized by the addition of metal salts or strong acids. Toxic gases are formed by mixing materials of this class with acids, aldehydes, amides, carbamates, cyanides, inorganic fluorides, halogenated organics, isocyanates, ketones, metals, nitrides, peroxides, phenols, epoxides, acyl halides, and strong oxidizing or reducing agents. Flammable gases are formed by mixing materials in this group with alkali metals. Explosive combination can occur with strong oxidizing agents, metal salts, peroxides, and sulfides.

Permissible Exposure Limits in Air:

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 0.56 milligram per cubic meter

PAC-2: 6.2 milligram per cubic meter

PAC-3: 380 milligram per cubic meter

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Pyriminil may cause death by cardiovascular collapse and respiratory failure. Symptoms include nausea, vomiting, abdominal pain; chills, mental confusion; anorexia, aching, dilated pupils, dehydration, chest pain; urinary retention; irregular heartbeat; and muscular weakness. Exposure may also result in visual disturbances, CNS depression and tremors.

Long-Term Exposure: Pyriminil may damage the pancreas, causing diabetes. Human survivors of exposure regularly develop an insulin-deficient, ketosis-prone form of diabetes mellitus[72]. Also may affect the CNS.

Points of Attack: CNS.

Medical Surveillance: Blood sugar. Examination of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area. Where possible, automatically transfer material from drums or other storage containers to process containers.

Shipping: UN2767 Phenyl urea pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN2588 Pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Remove and isolate contaminated clothing at the site. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills:* absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills:* with clean shovel place material into clean, dry container and cover; move containers from spill area. *Large spills:* dike far ahead of spill for later disposal. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen and carbon. *Small fires:* dry chemical, carbon dioxide; water spray; or foam. *Large fires:* water spray, fog, or foam. Move container from fire area if you can do so without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Wear positive pressure breathing apparatus and special protective clothing. Remove and isolate contaminated clothing at the site. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Pyriminil, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Pyriminil, Trenton, NJ (May 2002)

Pyriproxyfen P:1360

Formula: $C_{20}H_{19}NO_3$

Synonyms: Archer; Dalar; Distance; Esteem; Nylar; 2-[1-Methyl-2-(4-phenoxyphenoxy)ethoxy] pyridine; 4-Phenoxyphenyl (*RS*)-2-(2-pyridyloxy)propyl ether; Pyridine, 2-[1-methyl-2-(4-phenoxyphenoxy)ethoxy]-; S-9318; S 31183; Sumilarv pyriproxyfen

CAS Number: 95737-68-1

HSDB Number: 7053

RTECS Number: UT5804000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 429-800-1

Regulatory Authority and Advisory Information

Carcinogenicity[83]: EPA Group E, Evidence of noncarcinogenicity for humans.

Hazard Alert: Environmental hazard.

EPA/OPP Oral reference dose (RfD) = 0.35 mg/kg/day. This RfD is based on a NOAEL of 35.1 mg/kg/day and an uncertainty factor (UF) of 100. The NOAEL was established from the combined chronic feeding/oncogenicity study in rats where the the LOAEL was 3,000 ppm, based on a 16.9% decrease in body weight gain in females when compared to controls[83].

Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: N; Risk phrases: R50/53; Safety phrases: S2; S29; S60; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Gray to white crystalline solid or powder. Also described as a pale yellow, waxy solid or liquid. Commercial product is available as an emulsifiable concentrate or wettable powders. Molecular weight = 321.37; Specific gravity (H_2O:1) = 1.23 @ 20°C; Boiling point = (decomposes); Freezing/Melting point = 49.7°C; Vapor pressure = 1×10^{-5} mmHg @ 25°C; Flash point = >90°C. Low solubility in water. Physical and toxicological properties may be affected by carrier solvents in commercial formulations.

Potential Exposure: Pyriproxyfen is an unclassified insect growth regulator, insecticide, veterinary medicine found in a number of household products as sprays, powders, baits, mists and shampoos for the control of fleas, ticks, mites, and flying insects on pets, in the air, and in carpets and rugs. It's a l larvicidal agent that mimics juvenile insect hormone.

Incompatibilities: This material is combustible. Dust may form an explosive mixture in air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Concentration in Water: Runoff from spills or fire control may cause water pollution.

Determination in Water: Octanol-water coefficient: Log $K_{ow} = >4.5$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Dermal contact, ingestion, eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: May cause irritation of the eyes, skin, and respiratory tract. Inhalation may cause mucous membrane and respiratory irritation. Ingestion may cause stomach irritation, nausea, cramps and vomiting. LD_{50} (oral, rat) = >5 g/kg.; LD_{50} (dermal, rat) = >2 g/kg.

Long-Term Exposure: Possible blood and liver toxin.

Points of Attack: Liver, blood.

Medical Surveillance:.CBC. Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Applicators and other handlers must wear: Coveralls worn over long-sleeved shirt and long pants; Chemical-resistant gloves such as DuPont Tychem suit fabrics, barrier laminate, or Viton; Chemical-resistant footwear plus socks; Protective eye wear; Chemical-resistant headgear for overhead exposure; Chemical-resistant apron when cleaning equipment, mixing, or loading[83]. Agricultural Use/Engineering Controls: When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the Worker Protection Standard (WPS) for agricultural pesticides, 40 CFR 170.240(d)(4-6), the handler PPE requirements may be reduced or modified as specified in the Worker Protection Standard. Firefighters should wear NIOSH approved SCBA and full protective clothing.

Respirator Selection: *At any detectable concentration:* SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code-Blue: Health Hazard/Possible Human Carcinogen: Store in a tightly closed container in a dry, well-ventilated and secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Where possible, automatically transfer material from other storage containers to process containers. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: For solids, *small spill*, isolate spill or leak area in all directions for at least 25 meters/75 feet. Increase, in the downwind direction, as necessary. For a *large spill* evacuate downwind at least 100 meters/330 feet. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Stop leak if you can do it without risk. Keep combustibles (wood, paper, oil, etc.) away from spilled material. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Stop leak if you can do it without risk. Do not allow water to get inside containers. *Small dry spill*: With clean shovel place material into clean, dry container and cover loosely; move containers from spill area. *Large spill*: Dike far ahead of liquid spill for later disposal. Following product recovery, flush area with water. Prevent entry into waterways, sewers, basements or confined areas. Cover with plastic sheet to prevent spreading. Absorb or cover with dry earth, sand or other noncombustible material and transfer to containers. Do not allow water to get inside containers. Prevent entry into waterways, sewers, basements or confined areas. Cover with plastic sheet to prevent spreading. Absorb or cover with dry earth, sand or other noncombustible material and transfer to containers.

Fire Extinguishing: Thermal decomposition products may include toxic oxides of nitrogen and carbon. As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 meters/150 feet for liquids and at least 25 meters/75 feet for solids. *Fire involving storage or vehicular tanks:* Isolate for 800 meters/0.5 mile in all directions; also, consider initial evacuation for 800 meters/0.5 mile in all directions. *On a small fire:* use dry chemical, CO_2, water spray or regular *foam. On a large fire:* use water spray, fog or regular foam. Do not scatter spilled material with high pressure streams of water. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal. *Fire involving tanks:* From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. Always stay away from tanks engulfed in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: It is the responsibility of chemical waste generators to determine the toxicity and physical properties and of a discarded chemical and to properly identify its classification and certification as a hazardous waste and to determine the disposal method. United States Environmental Protection Agency guidelines for the classification determination are listed in 40 CFR Parts 261.3. Additionally, waste generators must consult and follow all regional, national, state and local hazardous waste laws to ensure complete and accurate classification and disposal methods. Follow recommendations for the disposal of pesticides and pesticide containers. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Office of Pesticide Programs, Pesticide Residue Limits, “Pyriproxyfen,” 40 CFR 180.510, http://www.epa.gov/pesticides/food/viewtols.htm

Q

Quinoline Q:0050

Formula: C_9H_7N
Synonyms: 1-Azanaphthalene; B-500; 1-Benzazine; 1-Benzine; Benzo(*b*)pyridine; Benzopyridine; Chinoleine; Leucol; Leucoline; Leukol; Quinoleina (Spanish); Quinolin
CAS Registry Number: 91-22-5
HSDB Number: 121
RTECS Number: VA9275000
UN/NA & ERG Number: UN2656/154
EC Number: 202-051-6 [*Annex I Index No.*: 613-281-00-5]

Regulatory Authority and Advisory Information

Carcinogenicity: EPA: Likely to produce cancer in humans; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies; has not been identified as a carcinogen. Handle with caution as several related polynuclear aromatic hydrocarbons are known carcinogens. NIOSH has recommended that coal tar pitch volatiles, including polycyclic aromatic hydrocarbons (PAHs) be treated as potential human carcinogen.

California Proposition 65 Chemical[102]: (*Quinoline and its strong acid salts*) Cancer 10/24/1997

Hazard Alert: Poison, Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction), Environmental hazard, Preparative hazard.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; Section 307(a)(1) Toxic pollutant designated, pursuant to of the and is subject to effluent limitations as polycyclic aromatic hydrocarbons (PAHs)

United States National Primary Drinking Water Regulations: MCLG = 0 mg/L; MCL = 0.0002 mg/L as polycyclic aromatic hydrocarbons (PAHs).

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 5000 lb (2270 kg)

EPCRA Section 313 Form R de minimis concentration reporting level: 1.0%.

United States DOT Regulated marine pollutant (49CFR172.101, Appendix B) as naphthalenes

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects[293]. Toxic to aquatic life with long-lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R45; R21/22; R36/37/38; R68; R51/53; R62; safety phrases: S1/2; S29; S41; S45; S53; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Quinoline is a colorless liquid with a penetrating amine odor. Turns brown on exposure to light. Molecular weight = 129.16; specific gravity (H_2O:1) = 1.1 @ 15°C; boiling point = 237°C; freezing/melting point = −15°C; flash point = 101−107°C; autoignition temperature = 480°C. Explosive limits: LEL = 1.2%; 29,000 ppm[138]; UEL: 7%. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 2, reactivity 0. Insoluble in cold water; highly soluble in hot.

Potential Exposure: In manufacture of quinoline derivatives (dyes and pesticides); in synthetic fuel manufacture. Occurs in cigarette smoke.

Incompatibilities: Reacts, possibly violently, with strong oxidants, strong acids; perchromates, nitrogen tetroxide; and maleic anhydride. Keep away from moisture, steam, and light. Contact with hydrogen peroxide may cause explosion. Unpredictably violent, this substance has been the source of various plant accidents.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC) Ver. 29[138]
PAC-1: 0.003 ppm
PAC-2: 2.9 ppm
PAC-3: 17 ppm

The state of New York has set a guideline for quinoline in ambient air[60] of 0.03 μ/m^3.

Harmful Effects and Symptoms

Short-Term Exposure: Skin or eye contact can cause burns. Vapors can irritate the eyes and respiratory tract and may cause sore throat, nosebleeds, hoarseness, cough, phlegm, and/or tightness in the chest. High exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. High exposure can cause nausea, vomiting, gastrointestinal cramping; fever, dizziness, fatigue, rapid and irregular pulse, troubled breathing; collapse, and even death from paralysis of muscles needed for breathing. Liver damage may also occur.

Long-Term Exposure: May affect the liver and retina of the eyes. May cause liver damage. May lead to development of skin allergy with rash and itching. Very irritating substances may cause lung damage. This substance caused mutations and is possibly carcinogenic to humans.

Points of Attack: Nervous system, liver and kidneys, eyes.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon

Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens.
DOI: http://dx.doi.org/10.1016/B978-0-323-38968-6.00016-8

the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Eye examination. Liver and kidney function tests. Examination of the nervous system.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective butyl rubber gloves and protective clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Based on potential carcinogenicity the following is recommended by NIOSH: *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA-or European Standard EN 149-approved self-contained breathing apparatus (SCBA) that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-face-piece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration is not a danger. Store in a refrigerator under an inert atmosphere and protect from exposure to light, moisture, strong oxidants, strong acids; perchromates, nitrogen tetroxide; maleic anhydride. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gal or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN2656 Quinoline, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Use absorbent substance to pick up spilled material. Follow by washing surface well first with alcohol, then with soap and water. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; water spray or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(102); (31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile Draft Report: Quinoline, Washington, DC (December 29, 1983).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Quinoline, Trenton, NJ (June 2000).

Quinone Q:0100

Formula: $C_6H_4O_2$

Synonyms: Benzo-chinon (German); 1,4-Benzoquine; *p*-Benzoquinona (Spanish); *p*-Benzoquinone; 1,4-Benzoquinone; Benzoquinone; *p*-Chinon (German); Chinon (German); Chinone; Clyclohexadeinedione; 1,4-Cyclohexadienedione; 2,5-Cyclohexadiene-1,4-dione; 1,4-Cyclohexadiene dioxide; 1,4-Dioxybenzene; 1,4-Dioxybenzol; NCI-C55845; Quinona (Spanish); *p*-Quinone

CAS Registry Number: 106-51-4

HSDB Number: 1111

RTECS Number: DK2625000

UN/NA & ERG Number: UN2587/153

EC Number: 203-405-2 [*Annex I Index No.:* 606-013-00-3]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Inadequate Evidence; Human No Adequate Data, *not classifiable as carcinogenic to humans*, Group 3, 1999. United States Environmental Protection Agency Gene-Tox Program, Inconclusive: *D. melanogaster* sex-linked lethal.

Hazard Alert: Poison, Flammable solid, Oxidizer[101], Possible risk of forming tumors, Suspected reprotoxic hazard, Environmental hazard.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U197

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg)

EPCRA Section 313 Form R de minimis concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects[291]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T; risk phrases: R11; R20/21/22; R23/25; R36/37/38; R50; R63; safety phrases: S1/2; S16; S23; S26; S28; S29/35; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Quinone is a yellow, crystalline material or large yellow, monoclinic prisms. Pungent, irritating odor. Molecular weight = 108.10; specific gravity (H_2O:1) = 1.32 @ 25°C; boiling point = (sublimes) about 180°C; freezing/melting point = 115.6°C; 224°C (decomposes); vapor pressure = 0.1 mmHg @ 25°C; flash point (depending on humidity) = 38–93°C; 77°C[136]; autoignition temperature = 560°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, flammability 2, reactivity 0. Slightly soluble in water.

Potential Exposure: Due to this compound's ability to react with certain nitrogen compounds to form colored substances, quinone is widely used in the dye, textile, chemical, tanning, and cosmetic industries. It is used as an industrial chemical; laboratory reagent; and as an intermediate in chemical synthesis for hydroquinone and other chemicals.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, some combustible substances; reducing agents. Decomposes exothermically on warming above 60°C, when moist, producing carbon monoxide.

Permissible Exposure Limits in Air

NIOSH IDLH = 100 milligram per cubic meter

Conversion factor: 1 ppm = 4.42 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 0.1 ppm/0.4 milligram per cubic meter TWA

NIOSH REL: 0.1 ppm/0.4 milligram per cubic meter TWA

ACGIH TLV[1]: 0.1 ppm/0.44 milligram per cubic meter TWA

PAC Ver. 29[138]

PAC-1: 0.3 ppm

PAC-2: 11 ppm

PAC-3: 68 ppm

DFG MAK: Danger of skin sensitization; Carcinogen Category 3B; Germ Cell, Mutagen, Group 3B

Arab Republic of Egypt: TWA 0.1 ppm (0.4 milligram per cubic meter), 1993; Australia: TWA 0.1 ppm (0.4 milligram per cubic meter), 1993; Austria: MAK 0.1 ppm (0.4 milligram per cubic meter), 1999; Belgium: TWA 0.1 ppm (0.44 milligram per cubic meter), 1993; Denmark: TWA 0.1 ppm (0.4 milligram per cubic meter), 1999; Finland: TWA 0.1 ppm (0.4 milligram per cubic meter); STEL 0.3 ppm, [skin], 1999; France: VME 0.1 ppm (0.4 milligram per cubic meter), VLE 0.3 ppm (1.5 milligram per cubic meter), 1999; the Netherlands: MAC-TGG

0.4 milligram per cubic meter, 2003; the Philippines: TWA 5 ppm (15 milligram per cubic meter), 1993; Poland: TWA 0.1 milligram per cubic meter; STEL 0.4 milligram per cubic meter, 1999; Russia: STEL 0.05 milligram per cubic meter, 1993; Sweden: NGV 0.1 ppm (0.4 milligram per cubic meter), KTV 0.3 ppm (1.3 milligram per cubic meter), 1999; Switzerland: MAK-W 0.1 ppm (0.4 milligram per cubic meter), KZG-W 0.2 ppm (0.8 milligram per cubic meter), 1999; Turkey: TWA 0.1 ppm (0.4 milligram per cubic meter), 1993; United Kingdom: TWA 0.1 ppm (0.45 milligram per cubic meter); STEL 0.3 ppm (1.3 milligram per cubic meter), 2000; New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 0.1 ppm

Determination in Air: Use NIOSH II(4), Method #S-181, Quinone.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 0.21$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: The vapor irritates the eyes, skin, and respiratory tract; can cause nosebleeds, hoarseness, cough, phlegm, and/or tightness in the chest. Skin contact can cause severe irritation. Solid quinone in contact with skin or the lining of the nose and throat may produce discoloration, severe irritation; swelling; and the formation of ulcers, papules and vesicles. Prolonged contact with the skin may cause ulceration. quinone vapor is highly irritating to the eyes. Following prolonged exposure to vapor, brownish conjunctival stains may appear. These may be followed by corneal opacities and structural changes in the cornea and loss of visual acuity. The early pigmentary stains are reversible, while the corneal dystrophy tends to be progressive. Further effects reported[52] include vomiting, collapse, and coma.

Long-Term Exposure: Repeated or prolonged contact with skin may cause dermatitis. The substance may have effects on the skin and eyes, resulting in discoloration, inflammation and injury of the corneal epithelium; keratitis (inflammation of the cornea); reduced vision. Can cause lung irritation; bronchitis may develop. May cause kidney damage.

Points of Attack: Eyes, skin, lungs, kidneys.

Medical Surveillance: Ophthalmic examination. Careful examination of the eyes, including visual acuity and slit lamp examinations, should be done during placement and periodic examinations. Lung function tests. Kidney function tests. Also evaluate skin.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 10 milligram per cubic meter*: Sa:Cf (APF = 25)* (any supplied-air respirator operated in a continuous-flow mode). *Up to 20 milligram per cubic meter*: SCBAF (APF = 50) (any SCBA with a full facepiece); or, SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 100 milligram per cubic meter*: SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

*Substance causes eye irritation or damage; eye protection needed

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in a refrigerator or a cool, dry place. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN2587 Benzoquinone, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Dampen spilled material with alcohol to avoid dust, then transfer material to a suitable container. Use absorbent dampened with alcohol to pick up remaining material. Wash surfaces well with soap and water. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Controlled incineration (982°C, 2.0 seconds minimum).

References

(31); (100).

United States Environmental Protection Agency, Quinone, Health and Environmental Effects Profile No. 157, Washington, DC, Office of Solid Waste (April 30, 1980).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: p*-Benzoquinone, Trenton, NJ (June 2004).

Quintozene Q:0110

Formula: $C_6C_{15}NO_2$

Synonyms: Avicol (pesticide); Bartilex; Batrilex; Benzene, pentachloronitro-; Botrilex; Brassicol; Brassicol 75; Brassicol earthcide; Brassicol super; Chinozan; Fartox; Folosan; Fomac 2; Fungichlor; GC 3944-3-4; Kobu; Kobutol; KP2; Marisan forte; NCI-C00419; Nitropentachlorobenzene; Olipsan; Olpisan; PCNB; Pentachlornirtobenzol (German); Pentachloronitrobenzene; Pentagen; Phomasan; PKHNB; Quinosan; Quintocene; Quintoceno (Spanish); Quintozen; RTU 1010; Saniclor 30; Terrachlor; Terraclor; Terraclor 30G; Terrafun; Tilcarex; Tri-PCNB; Tritisan

CAS Registry Number: 82-68-8; (*alt.*) 39378-26-2

HSDB Number: 1749

RTECS Number: DA6550000

UN/NA & ERG Number: UN2588 (Pesticides, solid, toxic, n.o.s.)/151; UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 201-435-0 [*Annex I Index No.:* 609-043-00-5]

Regulatory Authority and Advisory Information

Carcinogenicity: NCI: Carcinogenesis Studies (feed); no evidence: mouse; NTP: Carcinogenesis Studies (feed); no evidence: mouse; IARC: Animal Limited Evidence; Human No Adequate Data, *not classifiable as carcinogenic to humans*, Group 3, 1987. United States Environmental Protection Agency Gene-Tox Program, Negative: Host-mediated assay; In vitro UDS-human fibroblast; Negative: TRP reversion; *S. cerevisiae-homozygosis*; Negative/limited: Carcinogenicity-mouse/rat; Inconclusive: *B. subtilis* rec assay; *E. coli polA* without S9; Inconclusive: Histidine reversion-Ames test; Inconclusive: *D. melanogaster* sex-linked lethal.

Hazard Alert: Poison, Combustible, Possible risk of forming tumors, Possible sensitization hazard, Suspected of causing genetic defects, Suspected reprotoxic hazard, Environmental hazard.

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U185 RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.055; Nonwastewater (mg/kg), 4.8

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)

EPCRA Section 313 Form R de minimis concentration reporting level: 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: Xi, N; Xi; risk phrases: R43; R50/53; R62; R63; safety phrases: S2; S13; S24; S29; S37; S60; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)]

Description: Quintozene is a colorless to cream-colored crystalline material. Musty, mothball odor. Technical-grade PCNB contains an average of 97.8% PCNB, 1.8% hexachlorobenzene (HCB), 0.4% 2,3,4,5-tetrachloronitrobenzene (TCNB), and less than 0.1% pentachlorobenzene. Musty odor. Molecular weight = 295.32; boiling point = 328°C;

freezing/melting point = 142−146°C; vapor pressure = 1×10^{-4} mbar @ 25°C. Insoluble in water.

Potential Exposure: Quintozene is used as a chemical intermediate, soil and seed fungicide; slime control in industrial waters; herbicide. A rebuttal presumption against registration was issued on October 13, 1977 by EPA on the basis of oncogenicity.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Thermal decomposition products may include nitrogen oxides and hydrogen chloride. Corrosive to unlined metal containers[101].

Permissible Exposure Limits in Air

ACGIH TLV[1]: 0.5 milligram per cubic meter TWA; not classifiable as a human carcinogen.

PAC Ver. 29[138]

PAC-1: 1.5 milligram per cubic meter

PAC-2: 28 milligram per cubic meter

PAC-3: 62 milligram per cubic meter

Denmark: TWA 0.5 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 0.5 milligram per cubic meter, 2003

Determination in Water: Fish Tox = 64.49856000 ppb (INTERMEDIATE)

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin and respiratory tract. Eye contact can cause corneal damage and permanent injury. High levels can interfere with the blood's ability to carry oxygen causing methemoglobinemia; cyanosis, with Blue color to the skin and lips. Higher levels can cause trouble breathing; collapse and even death. A chloromononitrobenzene, this chemical may have similar toxic effects as nitrobenzene.

Long-Term Exposure: May cause sensitization and skin allergy. May cause damage of the liver and kidneys. Human Tox = 2.10000 ppb (HIGH).

Points of Attack: Blood, skin, liver, kidneys.

Medical Surveillance: Blood methemoglobin levels. Evaluation by a qualified allergist. Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to Physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to this chemical above 0.5 milligram per cubic meter, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required. UN2588 Pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Soil Adsorption Index (K_{oc}) = 5000 (estimate).

Fire Extinguishing: This chemical is a combustible solid. Thermal decomposition products may include hydrogen chloride and oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dispose of contents/container to an approved waste disposal plant or consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform to EPA regulations governing storage, transportation, treatment, and waste disposal. In accordance with 40CFR165, follow recommendations for the disposal.

References

(31); (173); (101); (138); (80); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Chloronitrobenzenes (mixed isomers), Trenton, NJ (January 2007).

Quizalofop-ethyl Q:0130

Formula: $C_{19}H_{17}ClN_2O_4$

Synonyms: Assure; Caswell No. 215D; 2-[4-((6-Chloro-2-quinoxalinyl)oxy)phenoxy]ethyl propionate; 2-[4-((6-Chloro-2-quinoxalinyl)oxy)phenoxy]propionic acid, ethyl ester; DPX-Y 6202; Ethyl 2-[4-(6-chloro-2-quinoxalyloxy) phenoxy]propionate; FBC 32197; INY-6202; Leopard EC (*p*-isomer); Matador; MON 78746; NC-302; NCI-C99983; Pilot; Propanoic acid, 2-[4-((6-chloro-2-quinoxalinyl)oxy) phenoxy]-, ethyl ester; Quinofop-ethyl; Super matador (*p*-isomer); Targa; Ultra Targa (*p*-isomer); Xylofop-ethyl

CAS Number: 76578-14-8

HSDB Number: 6990

RTECS Number: UA2458255

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

Regulatory Authority and Advisory Information

Carcinogenicity[83]: EPA Group D, Not classifiable as a human carcinogen.

California Proposition 65 Chemical[102]: Male reproductive toxin, 12/24/1999.

Hazard Alert: Combustible, Suspected reprotoxic hazard (male, TRI); Possible endocrine disruptor, Environmental hazard, Agricultural chemical.

California EPA AB2588-Air Toxics "Hot Spots" Chemicals (CAL) as chlorophenoxy pesticides

EPCRA Section 313 Form R de minimis concentration reporting level: 1.0%

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) (severe)

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: Xn, N; risk phrases: R21/22; R50/53; R63; safety phrases: S22; 24/25; S29/35; S41; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: White crystalline solid or powder. Commercial product is available as an emulsifiable concentrate. Practically insoluble in water; solubility $\leq 2 \times 10^{-8}$ ppm. Molecular weight = 372.78; 372.80 (*p*-isomer); vapor pressure = 3×10^{-7} mmHg @ 20°C. Specific gravity (H_2O:1) = 1.35 @ 20°C; boiling point = 92°C; freezing/melting point = 92°C; 75°C *p*-isomer); vapor pressure = 3×10^{-7} mmHg @ 25°C; flash point = ~100°C. Practically insoluble in water; solubility = 0.5 mg/L @ 25°C. Physical and toxicological properties may be affected by carrier solvents in commercial formulations.

Potential Exposure: A chlorophenoxy/aryloxyphenoxypropionate herbicide

Determination in Water: Octanol–water coefficient: Log K_{ow} = > 4.0 (both isomers). Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, ingestion, absorption through the skin

Harmful Effects and Symptoms

Short-Term Exposure: Poisonous; may be fatal if inhaled, swallowed, or absorbed through skin. Severely irritates eyes, skin and respiratory tract, with burning sensation, pain, redness, and swelling. Metabolic stimulant. If inhaled, causes coughing, dilated pupils, headache, profuse perspiration, intense thirst, extreme fatigue, rapid pulse, high fever, clammy, flushed skin, rapid breathing, nausea, vomiting, cyanosis (bluish tint to skin and lips), anxiety and confusion, convulsions, risk of lung edema. If swallowed, face and lips turn bluish. Liver injury with associated jaundice, kidney failure, and cardiac arrhythmias are commonly noted. Nerve damage, which may be delayed, may include swelling of legs and feet, muscle twitch and stupor. Severe exposure can cause death from heart failure. Dust or liquid left in contact with the skin for several hours may be absorbed. This may result in severe delayed symptoms as listed above. These symptoms may last for months or years. LD_{50} (oral, rat) = 1500 mg/kg; 1200 mg/kg (*p*-isomer)]; LD_{50} (dermal, rat) = > 5 g/kg.

Long-Term Exposure: Workers exposed to chlorophenoxy compounds over a 5 to 10 year period at levels above

10 milligram per cubic meter complained of weakness, rapid fatigue, headache, and vertigo. Liver damage, low blood pressure and slowed heartbeat were also found. Based on animal tests, may affects human reproduction

Points of Attack: Eyes, skin, respiratory system, central nervous system (CNS), cardiovascular system, liver, kidney. A possible liver toxin.

Medical Surveillance: Preliminary medical exam to detect chronic diseases of CNS, liver, heart, kidneys, lung, and skin, as well as endocrinological or immunological disturbances, should protect susceptible individuals. Periodical medical exams of internal organs, skin and eyes are important to avoid chronic occupational intoxications. They should include lab and patch tests when necessary[83]. Comprehensive physical examination with emphasis on the genito-urinary tract including testicle size and consistency in males. Semen analysis to include sperm count, motility, and morphology. Other tests, such as serum testosterone, serum follicle stimulating hormone, and serum lutenizing hormone, may be carried out if, in the opinion of a physician, they are indicated. If symptoms develop or overexposure is suspected, the following may be useful: Liver and kidney function tests. Exam of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. *Do not induce vomiting when formulations containing petroleum solvents are ingested*. Otherwise, give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Applicators and other handlers must wear: Coveralls worn over long-sleeved shirt and long pants; Chemical-resistant gloves such as DuPont Tychem suit fabrics, barrier laminate, or Viton; Chemical-resistant footwear plus socks; Protective eye wear; Chemical-resistant headgear for overhead exposure; Chemical-resistant apron when cleaning equipment, mixing, or loading[83]. Agricultural Use/Engineering Controls: When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the Worker Protection Standard (WPS) for agricultural pesticides, 40 CFR 170.240(d)(4-6), the handler PPE requirements may be reduced or modified as specified in the WPS. Firefighters should wear NIOSH approved SCBA and full protective clothing.

Respirator Selection: *At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000): (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive pressure breathing apparatus). *Escape*: GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison. Store in a secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: First remove all sources of ignition. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Ventilate area of spill or leak. Use water spray to reduce vapor. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include hydrogen chloride and oxides of nitrogen and carbon. As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 m/150 ft for liquids and at least 25 m/75 ft for solids. *Fire involving storage or vehicular tanks:* Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. *On a small fire:* use dry chemical, CO_2, water spray or regular *foam. On a large fire:* use water spray, fog or regular foam. Do not scatter spilled material with high pressure streams of water. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal. *Fire involving tanks:* From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. Always stay away from tanks engulfed in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: It is the responsibility of chemical waste generators to determine the toxicity and physical properties and of a discarded chemical and to properly identify its classification and certification as a hazardous waste and to determine the disposal method. United States Environmental Protection Agency guidelines for the classification determination are listed in 40 CFR Parts 261.3. In addition, waste generators must consult and follow all regional, national, state, and local hazardous waste laws to ensure complete and accurate classification and disposal methods.

References

(102); (31); (173); (101); (138); (100).

United States Environmental Protection Agency, Office of Pesticide Programs, Pesticide Residue Limits, "Quizalofop-Ethyl," 40 CFR 180.441, http://www.epa.gov/pesticides/food/viewtols.htm.

Quinuclidinyl Benzilate (QNB-Agent BZ) Q:0120

Formula: $C_{21}H_{23}NO_3$

Synonyms: Agent 15; Agent-Buzz; 1-Azabicyclo(2,2,2) octan-3-ol, benzilate (ester); Benzeneacetic acid, α-hydroxy-α-phenyl-, 1-azabicyclo(2.2.2)oct-3-yl ester; Benzilic acid, 3-quinuclidinyl ester; BUZZ; BZ; 3-Chinuclidylbenzilate; 3-(2,2-Diphenyl-2-hydroxyethanoyloxy)-quinuclidine; Oksilidin; QNB; 3-Quinuclidinol benzilate; 3-Quinuclidinyl benzilate; Quinuclidinyl benzilate

Hydrochloride: 1-Azabicyclo(2.2.2)octan-3-ol, benzylate (ester), hydrochloride; Benzeneacetic acid, alpha-hydroxy-alpha -phenyl-, 1-azabicyclo(2.2.2)oct-3-yl ester, HCL; Benzilic acid, 3-quinuclidinyl ester, hydrochloride; CHEKB; HNB 3; 3-Quinuclidinyl benzilate hydrochloride; Quinuclidyl benzylate hydrochloride; Ro 2-3308

CAS Registry Number: 6581-06-2; 62869-69-6; 13004-56-3 (hydrochloride)

HSDB Number: 7533

RTECS Number: DD4639000; VD6300000 (hydrochloride)

UN/NA & ERG Number: UN2810 (Toxic liquids, organic, n.o.s.)/153

EC Number: Not established

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade).

Report any release of WMD to National Response Center 1-800-424-8802

While not a mandated "Federally listed" waste, BZ is more toxic than most RCRA listed chemicals. However, BZ is a "listed" hazardous waste in some states where it may have been stockpiled by the military.

Hazard Alert: Poison, Incapacitating agent, Combustible, Environmental hazard.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, Xn; risk phrases: R22; R26; R36/37/38; R34; R40; R45; R50/53; safety phrases: S1; S22; S26; S28; S36/37/39; S41; S45; S53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Quinuclidinol benzilate (QNB) aka BZ, is a white crystalline solid. Odorless to fruitlike. Molecular weight = 337.43; freezing/melting point = 167.5°C; also 164−165°C; boiling point = 320°C; solid density = 0.51 g/cm^3 (bulk); 1.33 g/cm^3 (crystal); vapor density = 11.6; vapor pressure = negligible, 2.38×10^{-10} @ 25°C; flash point = 246°C; hazard identification (based on NFPA-704 M Rating System): Health 3; flammability 0; reactivity 0. Slightly soluble in water.

History of the agent: QNB is an incapacitating agent and has been considered historically for use as a chemical warfare agent[92]. As a chemical weapon, QNB was mixed with a pyrotechnic mixture in small bombs designed for aerial delivery. Once exploded, the mixture produced a potentially dangerous aerosol of QNB. In the early 1960s at Pine Bluff Arsenal, Arkansas, the United States produced munitions containing QNB. Production ceased in the late 1960s and all stockpiles at every military installation were eventually destroyed by 1990. Iraq's "Agent 15" is believed to be identical to, or closely related to QNB. In general, the effectiveness of QNB as a WMD has proven both highly undependable and unpredictable.

Potential Exposure; Suspected reprotoxic hazard, drug; incapacitating agent. QNB is a glycolate anticholinergic compound that affects the CNS and peripheral nervous system (PNS) and is related to the drugs atropine, scopolamine, and hyoscyamine. QNB is nonirritating; symptoms are delayed for several hours. QNB can be used to contaminate water, food, and agricultural products. A highly potent drug and CNS depressant, QNB is a delayed-action incapacitating agent, usually dispersed as an aerosol, but it can also be used to penetrate skin when mixed with a solvent (such as DMSO), and to contaminate food and water. QNB appears to be widely used in pharmacologic research. The key to protection from QNB is prevention from entering the body with good quality aerosol filter and impermeable gloves and clothing. QMB is stable in most solvents, with a half-life of 3 to 4 weeks in moist air; it can be dispersed even with heat-producing munitions.

Incompatibilities: May form explosive mixture with air. Decomposes at about 170°C in air under prolonged heating. After 1 or 2 hours at 200°C, it is completely decomposed. Rate of decomposition is both temperature- and purity dependent. No effect on steel or stainless steel after 3 months @ 71°C. Aluminum and anodized aluminum are mildly attacked after 3 months @ 71°C. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Contact with metals may evolve flammable hydrogen gas

Persistence of Chemical Agent: QNB is very persistent in soil and water and on surfaces.

Permissible Exposure Limits in Air:

PAC* Ver. 29[138]

6581-06-2

PAC-1: 1.00E − 03 milligram per cubic meter

PAC-2: $\mathbf{0.011}_{\mathbf{A}}$ milligram per cubic meter

PAC-3: $\mathbf{0.21}_{\mathbf{A}}$ milligram per cubic meter

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

Determination in Air: No method is available for detecting QNB in environmental samples[92].

Determination in Water: No method is available for detecting QNB in environmental samples[92].

Routes of Entry: Respiratory system; ingestion, skin, or eye contact. Skin and eye absorption is possible, depending on liquid solvents that might be used to enhance absorption. Inhalation and ingestion of QNB are important routes of exposure for the solid[92].

Harmful Effects and Symptoms

QNB is nonirritating stunning agent. The onset of incapacitation is dose-dependent. Symptoms may occur as early as 1 hour following exposure and continue for 48 hours. The onset of incapacitation is dose-dependent. It might occur as early as 1 hour after exposure and continue from 48 hours to 4 days depending on level of exposure. An untreated casualty may require from three to four days to achieve full recovery from the effects of QNB intoxication. QNB affects a victim's ability to remember, solve problems, make sound decisions and judgments, pay attention to assigned tasks, and understand instructions. High levels of exposure can completely destroy a victim's ability to perform any tasks, military, and/or otherwise.

Short-Term Exposure: A very potent drug, QNB can cause confusion, dream-like state, hallucinations, and severe delirium; it also affects circulation, digestion, salivation, sweating, and vision. QNB causes dilation of the pupils, which is extremely uncomfortable to most people. QNB produces profound mental disturbances at a dose of 0.1 to 0.2 mg. Signs and symptoms of exposure include agitation, restlessness, dizziness, giddiness; failure to obey orders, confusion, erratic behavior; stumbling or staggering; vomiting. hallucinations; blurred vision; dry, flushed skin; urinary retention; ileus; tachycardia; hypertension; and elevated temperature (>101°F/38°C). QNB may cause short-term memory loss, and variable levels of side effects are experienced in different people. Impairments caused by QNB are generally temporary and unlikely to be fatal; however, they can be severe with high exposures[77]. QNB is an anticholinergic. LCt_{50} = High; estimated to be 200,000 mg min/m^3; ICt_{50} = 112 mg min/m^3. LD50 = (iv-mouse) 18 mg/kg[United States Army]; 25 mg/kg; TDLo (lowest published toxic dose) = (subcutaneous-human) 3 μg/kg[NIOSH].

Delayed effects of exposure: Widespread formation of clots in the blood vessels (disseminated intravascular coagulation) is a potential complication in a victim with marked agitation and/or exceptionally high body temperature (hyperthermia)[77].

Long-Term Exposure: Information is unavailable about the carcinogenicity, developmental toxicity, or reproductive toxicity from chronic or repeated exposure to QNB.

Points of Attack: CNS; PNS.

Medical Surveillance: In a victim with marked agitation and/or exceptionally high body temperature (hyperthermia) clotting studies e.g., prothrombin time, activated partial thromboplastin time, and international normalized ratio) are recommended. Urine tests.

Decontamination: Establish the decontamination corridor upwind and uphill of the hot zone. The warm zone should include two decontamination corridors. One decontamination corridor is used to enter the warm zone and the other for exiting the warm zone into the cold zone. The decontamination zone for exiting should be upwind and uphill from the zone used to enter. Decontamination area workers should wear appropriate PPE. A solution of detergent and water (which should have a pH value of at least 8 but should not exceed a pH value of 10.5) should be available for use in decontamination procedures. Soft brushes should be available to remove contamination from the PPE. Labeled, durable 6-mil polyethylene bags should be available for disposal of contaminated PPE.

INDIVIDUAL DECONTAMINATION: *Decontamination of First Responder:* Begin washing PPE of the first responder using soap and water solution and a soft brush. Always move in a downward motion (from head to toe). Make sure to get into all areas, especially folds in the clothing. Wash and rinse (using cold or warm water) until the contaminant is thoroughly removed. Remove PPE by rolling downward (from head to toe) and avoid pulling PPE off over the head. Remove the SCBA after other PPE has been removed. Place all PPE in labeled durable 6-mil polyethylene bags.

Decontamination of Patient/Victim: Remove the patient/victim from the contaminated area and into the decontamination corridor. Remove all clothing (at least down to their undergarments) and place the clothing in a labeled durable 6-mil polyethylene bag. Thoroughly wash and rinse (using cold or warm water) the contaminated skin of the patient/victim using a soap and water solution. Be careful not to break the patient/victim's skin during the decontamination process, and cover all open wounds. Cover the patient/victim to prevent shock and loss of body heat. Move the patient/victim to an area where emergency medical treatment can be provided.

First Aid: ***Eyes***: After removing patient/victim from the source of exposure, immediately wash eyes with large amounts of tepid water for at least 15 minutes. Do not allow the patient/victim to rub eyes. Monitor the patient/victim for signs of whole-body (systemic) effects; if signs appear, see the *Inhalation* section for treatment recommendations. Seek medical attention immediately. *Ingestion*: After removing patient/victim from the source of exposure, immediately ensure that the patient/victim has an unobstructed airway. *Do not induce vomiting.* See the *Inhalation* section for first aid recommendations. Seek medical attention immediately. *Inhalation*: After removing patient/victim from the source of exposure, immediately, evaluate respiratory function and pulse. Ensure that the patient/victim has an unobstructed airway. If shortness of breath occurs or breathing is difficult, administer oxygen. Assist ventilation as required. Always use a barrier or bag-valve-mask device. If breathing has ceased, provide artificial respiration. Monitor for exceptionally high body temperature. If body temperature is elevated above 102°F/39°C, initiate immediate and vigorous cooling (as for heatstroke), using 72° to 75°F/22° to 24°C water and air circulation (fanning), wet cloths and air circulation, or maximum exposure to air in a shaded area with maximum air circulation. Do not use ice for skin cooling. Give fluids sparingly. Manage dryness and coating of the mouth and lips using moist swabs and small amounts of petroleum jelly. Monitor for skin abrasions caused by repetitive movements. Remove potentially harmful items, including cigarettes, matches, medications, and small items that could be accidentally ingested, from the patient/victim's possession. Consider loose restraint of disoriented or agitated patient/victims. Consider separation of affected individuals into small groups to minimize potential crowd control problems. Seek medical attention immediately. *Skin*: After removing patient/victim from the source of exposure, immediately, see the *Decontamination* section (above). See the *Inhalation* section for first aid recommendations. Seek medical attention immediately.

Note to health professionals: Treatment of QNB intoxication largely consists of supportive care: use of intravenous fluids and appropriate cooling measures to address elevated core body temperature and judicious use of sedation using benzodiazepines. Severe toxicity may require the use of physostigmine in a hospital setting*[92].

Antidote: *Some military references suggest the use of physostigmine to temporarily increase synaptic acetylcholine concentrations. Physostigmine poses its own risks of side effects and interactions with other drugs and should be used. Only by physician or other medical personnel familiar with its safe use. Suggested dosages for physostigmine in the treatment of QNB (BZ) poisoning follow: *Test dose:* If the diagnosis is in doubt, a dose of 1 mg might be given. If a slight improvement occurs, routine dosing should be given. *Routine dosing:* Doses of about 45 μg/kg for adults have been recommended. This might be modified by the response. A mental status examination should be done every hour and the dose and time interval of dosing should be modified according to whether the mental status is improved or not. As the patient improves, the dosage requirement will decrease. *Routes of administration*: IM: 45 μg/kg in adults (20 mg/kg in children); IV: 30 μg/kg slowly (1 mg/min); PO: 60 μg/kg if patient is cooperative (because of bitter taste, consider diluting in juice). For each route, titrate about every 60 minutes to mental status[163].

Personal Protective Methods: F

General information: First responders should use a NIOSH-certified chemical, biological, radiological, nuclear (CBRN) SCBA with a level a protective suit when entering an area with an unknown contaminant or when entering an area where the concentration of the contaminant is unknown. Level a protection should be used until monitoring results confirm the contaminant and the concentration of the contaminant. *Note:* safe use of protective clothing and equipment requires specific skills developed through training and experience.

LEVEL A: (*RED ZONE*): Select when the greatest level of skin, respiratory, and eye protection is required. This is the maximum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than the AEGL-2. A NIOSH-certified CBRN full-face-piece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle. A totally encapsulating chemical protective (TECP) suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, and a hard hat worn under the TECP suit are optional items.

LEVEL B: (RED ZONE): Select when the highest level of respiratory protection is necessary but a lesser level of skin protection is required. This is the minimum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than AEGL-2. It differs from Level A in that it incorporates a nonencapsulating, splash-protective, chemical-resistant splash suit that provides Level A protection against liquids but is not airtight. A NIOSH-certified CBRN full-face-piece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL C: (YELLOW ZONE): Select when the contaminant and concentration of the contaminant are known and the respiratory protection criteria factors for using Air Purifying Respirators (APR) or Powered APR (PAPR) are met. This level is appropriate when decontaminating patient/victims. A NIOSH-certified CBRN tight-fitting APR with a canister-type gas mask or CBRN PAPR for air levels greater than AEGL-2. A NIOSH-certified CBRN PAPR with a loose-fitting face-piece, hood, or helmet and a filter or a combination organic vapor, acid gas, and particulate cartridge/filter combination or a continuous flow respirator for air levels greater than AEGL-1. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Escape mask, face shield, coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL D: (GREEN ZONE): Select when the contaminant and concentration of the contaminant are known and the concentration is below the appropriate occupational exposure limit or less than AEGL-1 for the stated duration times. Limited to coveralls or other work clothes, boots, and gloves.

Notes: Take all necessary precautions to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid, unless full facepiece respiratory protection is worn. Wear dust-proof goggles and face shield when working with powders or dust, unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to QNB, use a NIOSH-or European Standard EN 149-certified CBRN full facepiece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle.

Storage: Color code—Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. QNB is stable in most solvents, with a half-life of 3 to 4 weeks in moist air. Store at 2 to 8°C.

Shipping: UN2810 Toxic liquids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. Military driver shall be given full and complete information regarding shipment and conditions in case of emergency. AR 50-6 deals specifically with the shipment of chemical agents. Shipments of agent will be escorted in accordance with AR 740-32.

Spill Handling:

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 1.1/1.8

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 1000/300
Then: Protect persons downwind (mi/km)
Day 1.1/1.8
Night 2.8/4.5

QNB (BZ, Buzz), when used as a weapon

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 1.1/1.8

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 1250/381
Then: Protect persons downwind (mi/km) Day 1.4/2.3
Night 5.0/8.0

QNB aerosol is heavier than air. It will spread along the ground and collect and stay in poorly ventilated, low-lying, or confined areas e.g., sewers, basements, and tanks). Hazardous concentrations may develop quickly in enclosed, poorly ventilated, or low-lying areas. Keep out of these areas. Stay upwind. *Environment/spillage disposal*: Do not touch or walk through the spilled agent if at all possible. However, if you must, personnel should wear the appropriate PPE during environmental decontamination. See the PPE section of this record for detailed information. Keep combustibles (e.g., wood, paper, and oil) away from the spilled agent. Use water spray to reduce aerosols or divert aerosol cloud drift. Avoid allowing water runoff to contact the spilled agent. Do not direct water at the spill or the source of the leak. Stop the leak if it is possible to do so without risk to personnel. Prevent entry into waterways, sewers, basements, or confined areas. Isolate the area until aerosol has dispersed. Ventilate the area[77]. Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Spills must be contained by covering with vermiculite, diatomaceous earth; clay, fine sand; sponges, and paper or cloth towels. This containment is followed by treatment with copious amounts of aqueous sodium hydroxide solution (a minimum 10 wt.%). Scoop up all material and place in a fully removable head drum with a high density polyethylene liner. The decontamination solution must be treated with excess bleach to destroy the CN formed during hydrolysis. Cover the contents with additional bleach before affixing the drum head. After sealing the head, the exterior of the drum shall be decontaminated and then labeled in accordance with IAW, EPA, and DOT regulations. All leaking containers shall be over-packed with vermiculite placed between the interior and exterior containers. Decontaminate and label per IAW, EPA, and DOT regulations.

Fire Extinguishing: QNB (BZ) is combustible; it may burn but does not ignite readily. Thermal decomposition products may include oxides of nitrogen and carbon. QNB (BZ) might be transported in a molten form. QNB (BZ) may decompose upon heating producing corrosive and/or toxic gases. Containers may explode when heated. In case of fire, evacuate the area, including yourself. If there is some reason that you have to put out the fire—for example, there are things nearby that cannot be allowed to burn—use unattended equipment, then evacuate everyone immediately, including yourself. When heated, aerosols may form explosive mixture with air, presenting an explosion hazard indoors, outdoors, and in sewers. Containers may explode when heated. QNB (BZ) aerosol is heavier than air. It will spread along the ground and collect and stay in poorly ventilated, low-lying, or confined areas (e.g., sewers, basements, and tanks). Hazardous concentrations may develop quickly in enclosed, poorly ventilated, or low-lying areas. Keep out of these areas. Stay upwind. Fire may produce irritating, corrosive, and/or toxic gases.

If you must extinguish a QNB (BZ) fire—Small fires: Use dry chemical, carbon dioxide, or water spray. *Large fires*: Use dry chemical, carbon dioxide, alcohol-resistant foam, or water spray. Move containers from the fire area if it is possible to do so without risk to personnel. Dike fire control water for later disposal; do not scatter the material. For fire involving tanks or car/trailer loads, fight the fire from maximum distance or use unmanned hose holders or monitor nozzles. Do not get water inside containers. Cool containers with flooding quantities of water until well after the fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tanks. Always stay away from tanks engulfed in fire. Run-off from fire control or dilution water may be corrosive and/or toxic, and it may cause pollution. If the situation allows, control and properly dispose of run-off (effluent).

Disposal Method Suggested: Dispose of the material per IAW waste disposal methods provided below. Conduct general area monitoring with an approved monitor to confirm that the atmospheric concentrations do not exceed the airborne exposure limit. If 10 wt.% sodium hydroxide is not available then the following decontaminants may be used instead and are listed in order of preference: Decontaminating Solution No. 2 [DS2: (2% NaOH, 70% diethylenetriamine, 28% ethylene glycol monomethyl ether)], sodium carbonate and Supertropical Bleach Slurry (STB). Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

References

(31); (173); (101); (138); (85); (86); (87); (169); (93); (92); (94); (103); (105); (163); (175); (176); (186); (187); (80).

R

Radium and compounds R:0050

Formula: Ra; Cl_2Ra (radium chloride); Br_2Ra (radium bromate)
Synonyms: Actinium-X (^{226}Ra); ^{224}Ra; ^{226}Ra; ^{228}Ra; Radio (Spanish); Radium-224; Radium 226; Radium 228; Radium, isotope of mass 226; Radium, isotope of mass 228; Thorium-X (^{226}Ra)
Radium bromide: Radium (II) bromide; Radium dibromide
Radium chloride: Radium (II) chloride; Radium dichloride
CAS Registry Number: 7440-14-4 (Radium); 10031-23-9 (Radium bromide); 10025-66-8 (Radium chloride) *other radium compounds*:
Radium carbonate ($RaCO_3$) 7116-98-5
Radium fluoride (RaF_2) 20610-49-5
Radium hydroxide [Ra(OH)2] 98966-86-0
Radium nitrate (Ra_3NO_3) 10213-12-4
Radium sulfate ($RaSO_4$) 7446-16-4
HSDB Number: 2146 as radium, radioactive
RTECS Number: Not available
UN/NA & ERG Number: UN2915 (Radioactive material, Type A package nonspecial form, nonfissile or fissile-excepted)/163; UN3323/163
EC Number: 231-122-4 (Radium); 233-035-7 (Radium chloride); 233-086-5 (Radium bromide)
Regulatory Authority and Advisory Information
Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen (Ionizing radiation: Radon and its isotopic forms, radon-220 and radon-222); IARC: Known carcinogen; EPA and the National Academy of Sciences, Committee on Biological Effects of Ionizing Radiation: Radium is a known human carcinogen. Radium-224; Radium-226; Radium-228; Radon-222 and their decay products Category 1.
California Proposition 65 Chemical[102]: Cancer, 1/1/1989 as radionuclides. Hazard Alert: Dangerous radioactive hazard.
Radionuclides and Reportable Quantities (RQ) listed under CERCLA (see 40CFR Part 302, Table 302.4, Appendix B, for more information): Radium-223 RQ = 1 curies; Radium-224 RQ = 10 curies; Radium-225 RQ = 1 curies; Radium-226 RQ = 0.1 curies; Radium-227 RQ = 1000 curies; Radium-228 RQ = 0.1 curies; Radon-220 RQ = 1 curies; Radon-222 RQ = 1 curies.
United States National Primary Drinking Water Regulations: MCL = zero mg/L; MCL = 5pCi/L, Radium 226 & Radium 228 (combined); MCL = 15 pCi/L, (Ra-$_{226}$), as *alpha*-proton emitter.
The Clean Air Act authorizes EPA to establish annual limits, known as National Emission Standards for Hazardous Air Pollutants (NESHAP) for the maximum amount of radium and other radionuclides that may be released to the air. Radium = 10 m Rem.
Description: Radium (Ra) is a radioactive element, found naturally occurring in the environment. Ra is a silvery-white-metallic solid @ 25°C; it tarnishes black when exposed to air. It is an alkaline earth metal; there are 33 isotopes, all of them are unstable. Radium is commonly available as radium bromide ($RaBr_2$) or radium chloride (RaC_{12}). Atomic Weight = 226.025; Density = 5.5 g/cm^3 @ 28°C; Freezing/Melting Point = 700°C; Boiling Point = 1140°C; 1536°C; 1737°C[206]; Density = 5.3 g/cm^3 @ 26.85°C; Vapor Pressure = 327 Pa @ 700°C. *Radium bromide* is a white to brownish crystalline solid. Radioactive. Molecular weight = 395.83; Density = 5.79 @ 20°C; Specific gravity (H_2O:1) = (H_2O:1) 3.34; Freezing/Melting point = 728°C (decomposes); Boiling point = 900°C (sublimes). Soluble in cold water. *Radium chloride* is a yellowish-white or brownish crystalline solid. Radioactive. Molecular weight = 296.9 g/mol; Density = 4.91; Freezing/Melting point = 1000°C.
Potential Exposure: Radium is not available as a pure metal but is found in very small quantities in uranium and thorium ores. Uranium and thorium are found in small amounts in most rocks and soil; radium is formed when these elements break down in the environment. One ton of uranium ore yields only slightly more than 0.1 gm of radium. Radium is formed from the radioactive decay; and, as a by-product of refining these ores. Radium exists in several isotope forms. Two of the principal radium isotopes found in the environment are ^{226}Ra (radium-226) and ^{228}Ra (radium-228). Radium compounds, due to their geologically short half-life and intense radioactivity, are quite rare. A single gram of ^{226}Ra produces 10^{-4} mm of radon (Rn) a day. Radium's- 226, radium's most stable isotope has a half-life of about 1603 to 1620 years, and remains in the body for life. Radium, when used to produce radon gas, is used for treating various types of cancer; in radiography of metals; and combined with other metals, such as beryllium, as a neutron emitting source used in research and for calibrating radiation instruments. Until the 1960s, radium was a component in self-luminous paints used for watch, compass, and aircraft instrument dials and other aircraft and military instrumentation. A less dangerous radioactive source, ^{60}Co (cobalt-60), replaced radium in luminous paint. The greatest health risk from radium comes from exposure to its radioactive decay product, radon (Rn). Radon is common in many soils and can collect in buildings, including homes.
Incompatibilities: Metallic radium is highly chemically reactive. It forms compounds that are very similar to barium compounds, making separation of the two elements difficult[72]. On contact with water, radium forms flammable hydrogen gas. Radium bromate is a strong oxidizer; avoid contact with a combustible material (clothing, wood, paper, oil, etc.).

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Permissible Exposure Limits:

Recommended Occupational Annual Dose Limits (NCRP and NRC):

Whole body: 5 Rem (0.05 Sv)/1 year

Lens of eye: 15 Rem (0.15 Sv)

Skin: 50 Rem (0.5 Sv)

Hands or feet: 50 Rem (0.5 Sv)

Cumulative occupational limit: 1 Rem (0.01 Sv) x age

The limit for radiation exposure for a declared pregnant radiation worker is 500 mRem (0.005 Sv) for the entire gestation period. The separate limit for the fetus of 500 mRem (0.005 Sv) for the entire gestation; exposures to the fetus must be uniform, and must be maintained at or below 50 mRem (0.0005 Sv)/mo.

Radiological Dispersal Device (RDD) Incidents

Particulate sampling can be performed to measure the radioactivity of dust in the air and to further characterize exposures. Based on the sampling data, the respirator protection factor needed to meet the relevant exposure limits can be determined (see table below), and the specific type of respirator needed can be identified. According to the data, it may be possible to downgrade or remove requirements for respiratory protection. However, until exposures have been characterized, responders and support personnel should continue to utilize full-face air-purifying P100 respirators, or higher respiratory protection (e.g., SCBAs, PAPRs).

Guidance Matrix for Radiological Dispersal Device (RDD) Incidents

OSHA Occupational Exposure Rem (Sv)/calendar qtr.

Limits for Ionizing Radiation

29 CFR 1910.1096

Lens of Eye, or Gonads 1.25 (0.0125 Sv)

Feet and Ankles 18.75 (0.1875 Sv)

Skin of Whole Body 7.5 (0.075 Sv)

Minors (under age 18 workers) 10% of above limits

Over age 18 workers 3 Rem (0.3 Sv) may be permitted under conditions specified in 29CFR1910.1096 (b)

(2) *Note*: The Department of Homeland Security is currently chairing an interagency workgroup which is in the process of assessing the protective action guidance for response to an RDD event.

EPA Limits and advisory levels: United States, annual radiation exposure limits are found in Title 10, part 20 of the Code of Federal Regulations, and in equivalent state regulations.

Public dose limits due to licensed activities (NRC) 100 mRem (0.01 Sv)/year

Air: Radium NESHAP = 10 mRem (0.1 Sv)*

Water: ^{226}Ra & ^{228}Ra (combined radium) MCL = 5pCi/L; ^{224}Ra = 5pCi/L*

Indoor Air (advisory "action level"): 4pCi/L for Radon (Rn)

*Both the air and water standards limit the increased lifetime cancer risk to about two in 10,000.

Permissible Concentration in Water: Safe Drinking Water Act (47FR 9352): MCL = zero mg/L; MCL = 5pCi/L, Radium 226 & Radium 228 (combined); MCL = 15 pCi/L, (Ra-$_{226}$), as *alpha*-proton emitter.

Permissible Concentration in Soil: The United States Environmental Protection Agency has set a soil concentration limit for Radium-226 in uranium and thorium mill tailings of 5 pCi/g in the first 15 centimeters of soil and 15 pCi/g in deeper soil.

Routes of Entry: Inhalation, ingestion, external exposure to *alpha*-, *beta*-, and *gamma*-rays.

Harmful Effects and Symptoms

Radium is highly radioactive and its decay product, radon (Rn) gas, is also radioactive. Radium is over one million times more radioactive than the same mass of uranium. Since radium is chemically similar to calcium, it has the potential to cause great harm by replacing it in bones and teeth. The latter affects include an increase in cavities and broken teeth.

Short-Term Exposure: Inhalation, injection, ingestion, or body exposure to radium can cause cancer and other disorders. Exposure to high levels can increase the risk of bone, liver, and breast cancer. Radium emits several different kinds of radiation, in particular, *alpha* particles and *gamma* rays. *Alpha* particles are generally only harmful if emitted inside the body. However, both internal and external exposure to *gamma* radiation is harmful. *Gamma* rays can penetrate the body, so *gamma* emitters like radium can result in exposures even when the source is a distance away. *Radium bromate*: Very hazardous in case of skin contact (irritant), of eye contact (irritant), of ingestion, and of inhalation. Slightly hazardous in case of skin contact; prolonged contact may result in skin burns, inflammation (including reddening, itching, and scaling,), blistering, and ulcerations. Inhalation overexposure may cause respiratory irritation. Inflammation of the eye is characterized by redness, watering, and itching. Exposure from *gamma* rays is measured in units of roentgens (Rads); 100 Rads = 1 Gray (Gy) = 1joule/kilogram. For example: Radiation sickness = total body exposure of 100 rads (or 1 Gy). Radiation sickness and death in half the population = total body exposure of 400 Rads (or 4 Gy). Without medical treatment, nearly everyone who receives more than 400 Rads will die within 30 days. 100,000 rads causes almost immediate unconsciousness and death within an hour.[NYT]

Long-Term Exposure: Increased risk of cancer. Long-term exposure to radium increases the risk of developing several diseases. Inhaled or ingested radium increases the risk of developing lymphoma, bone cancer, and diseases that affect the formation of blood, such as leukemia and aplastic anemia. These effects usually take years to develop. External exposure to radium's *gamma* radiation increases the risk of cancer to varying degrees in all tissues and organs. Historically, Marie Curie's death due to aplastic anemia has been blamed on exposure and handling of radium. Patients who were injected with radium in Germany, from 1946 to 1950, for the treatment of certain diseases including tuberculosis were significantly shorter as adults than people who were not treated[92].

Points of Attack: Liver, blood (anemia), eyes (cataracts) and other organs, bones and teeth.

Medical Surveillance: There are tests that are used to determine exposure to radium or other radioactive substances. For example, a whole body count can measure the total amount of radioactivity in the body, and urine and feces can be tested for the presence of radionuclides. There is no test that can detect external exposure to radium's *gamma* radiation, unless the doses were very high, and cellular damage is detectable. Another test measures radon (Rn) in exhaled air [radon (Rn) is a breakdown product of radium]. None of these tests are routinely performed in a doctor's office; they require specialized laboratory equipment. These tests are unable to quantify exposure, nor can they be used to predict whether a patient will develop long-term or harmful health effects.

First Aid: Unless you are dressed in appropriate protective gear to prevent self-contaminating, do not provide medical attention. Evacuate the victim from area of exposure to a safe area as soon as possible. To stop ongoing contamination, have the victim remove clothing, if possible, and place clothing in a sealed garbage bag or container. Check the victim's breathing and pulse; start CPR, if necessary. *Skin*: If skin contamination has occurred, measure levels of contamination with a survey meter, record results, and begin decontamination by gentle washing with plenty of water (warm if possible) and nonabrasive and disinfecting soap, washing downwards towards extremities, not upwards. Dry body and cover the irritated skin with an emollient. If burns are obvious, do not use ointments. Wrap victim in a clean, soft blanket. Seek immediate medical attention; evacuate the victim to nearest emergency medical facility. *Eyes*: Check for and remove any contact lenses. Immediately flush eyes with cold water, Avoid the use of an eye ointment. Seek immediate medical attention; evacuate the victim to nearest emergency medical facility. *Inhalation*: Allow the victim to rest in a well-ventilated area. If breathing is difficult, administer oxygen. Seek immediate medical attention; evacuate the victim to nearest emergency medical facility. *Ingestion*: Do not induce vomiting. Loosen tight clothing such as a collar, tie, belt Seek immediate medical attention; evacuate the victim to nearest emergency medical facility.

Personal Protective Methods: *Radium bromate*: Engineering Controls: Use process enclosures, local exhaust ventilation, or other engineering controls to keep airborne levels below recommended exposure limits. If user operations generate dust, fume or mist, use ventilation to keep exposure to airborne contaminants below the exposure limit. Emergency responders to an explosion or the resulting fires will generally not know they are being exposed to radiation unless they utilize a radiation detecting device. There is no practical personal protective equipment (PPE) to protect First Responders against externally penetrating *gamma* radiation. Monitoring devices are the only means to ensure that responders do not enter an area where exposure to external *gamma* radiation is excessive. Personal protective equipment (PPE) to prevent skin contamination of particulates is very effective against particulate-borne radiation hazards (i.e., *alpha* and *beta* particles). Typical fire fighter "turn-out" gear, including an SCBA and radiation detection device or dosimeter, may be adequate for this purpose (depending on radiation level). The use of turn-out gear or any disposable protective clothing suitable for particulate exposure, should be followed by appropriate decontamination of personnel and equipment. *Personal Protection in Case of a Large Spill*: Splash goggles. Full suit. Dust respirator. Boots. Gloves. A self-contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling radioactive material.

Respirator Selection: Protection of internal organs from inhalation of radioactive particulates can be provided by wearing an appropriate particulate respirator. The SCBAs will provide the highest level of protection. Responders should utilize at least a full-face air-purifying respirator with a P100 or HEPA filter, as appropriate. Respiratory protection specifically approved by NIOSH for CBRN exposures is desirable. However, where specific CBRN-approved respirators are not available, the incident commander may allow alternative NIOSH-approved respirators, such as SCBAs, or full-face powered or nonpowered air-purifying respirators with P100 or HEPA filters, as appropriate. It should be noted that these recommendations for respiratory protection are designed ONLY for protection against inhalation of radioactive particulates, and do not consider protection that may be necessary for other contaminants, such as chemical or biological agents.

At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode).

Storage: Store in a ventilated area to prevent accumulation of radon (Rn).

Shipping: UN3323(does not appear in the 49CFR hazard materials tables[101]) Radioactive material, Type C package, nonfissile or fissile excepted. UN2915 Radioactive material, Type A package nonspecial form, nonfissile or fissile-excepted, Hazard class: 7-Radioactive material; Labels: None. *A1 and A2 values for Radium- 226 taken from §173.435 (see also Table A-1 in 10CFR71(Appendix A): A1 (SpecialForm*) 0.3 TBq (8.11Ci); A2 (NormalForm) 0.02TBq (0.541Ci))*

*Special form materials are limited to those materials which, if released from a package, would present a hazard due to direct *external radiation only*. Usually, due to the high physical integrity of a special form material, radioactive material contamination is not expected even under severe accident conditions. This high physical integrity is occasionally the result of *inherent natural* properties of the material, such as its being in nondispersible solid form. Most often, however, it is an *acquired characteristic*, resulting from being welded (encapsulated) into an extremely durable metal capsule.

The A1 and A2 quantities for each radionuclide are basically the maximum activity that can be transported in a type A package. For many radionuclides, the regulations allow substantially larger quantities of special form material to be placed in a Type A packaging than when the material is in "normal form," i.e., "nonspecial form". Special form radioactive material is defined in 49 CFR 173.403. Special form sources must have at least one external physical dimension which exceeds 5 mm (0.197″). The minimum dimension requirement makes the capsule easier to see and recover in the event of its release from the package during an accident. *Special form encapsulations are required to be constructed in a manner that they can only be opened by destroying the capsule*. This requirement prevents the inadvertent loosening or opening of the capsule, either during transport or following an accident. The testing requirements for determination of whether radioactive materials qualify as "special form" are found in 49CFR173.469, which describes tests for high temperature, impact, percussion, bending, and leakage.

Spill Handling: Notify authorities that spill has occurred. Do not touch spilled material. Cover with absorbent paper or dike with absorbent. Isolate the area to prevent unnecessary spread of the material and personnel exposures. Prevent entry into sewers, basements or confined areas; dike if needed. Using appropriate monitoring equipment, survey the spill site; evaluate the presence of contamination on an individual's skin and clothing and on lab equipment. If skin or clothing contamination is present, assume a MAJOR spill has occurred. Do not attempt to clean it up. Confine all potentially contaminated individuals in order to prevent the further spread of contamination. If possible, shield the source, but only if it can be done without significantly increasing radiation exposure to yourself or other personnel. Leave the affected room and lock the doors in order to prevent entry. Do what you can to prevent further spreading of contamination to unrestricted areas. Contact local and state authorities and the Department of Energy (DOE) Radiological Response Team. Call for assistance on disposal.

Fire Extinguishing: If "Radioactive material, Type A package nonspecial form" material is involved in a fire situation: First: Contact the Department of Energy (DOE) Radiological Response Team, as well as state and local authorities. Do not use water; use suitable dry powder, graphite, soda ash, powdered sodium chloride, or sand.

Disposal Method Suggested: Radioactive material considered waste and must be retained in containers for disposition by the authorizing institution. Drain disposal is prohibited. It is the responsibility of the operating institution to arrange for the proper disposal of all forms of any radioisotopes. The use, storage, transportation, labeling, and disposal of radioactive material are regulated through the Nuclear Regulatory Commission (NRC) using 10 CFR (Code of Federal Regulations) as the regulatory basis and 49 CFR (Transportation). (The CFR's are available at no cost on the internet at http://www.access.gpo.gov/nara/cfr/index.html.)

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(109); (102); (31); (92); (173); (101); (138).

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(173); (101); (138).

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Resmethrin R:0105

Formula: $C_{22}H_{26}O_3$

Synonyms: AI3-27474; Benzofuroline; Benzyfuroline; 5-Benzylfurfuryl chrysanthemate; (5-Benzyl-3-furyl)methyl chrysanthemate; 5-Benzyl-3-furylmethyl (±)-*cis-trans*-chrysanthemate; 5-Benzyl-3-furylmethyl(+)-trans-chrysanthemate; *d-trans*(5-Benzyl-3-furyl)methyl 2,2-dimethyl-3-(2-methylpropenyl) cyclopropanecarboxylate; 5-Benzyl-3-furylmethyl(1RS)-*cis,trans*-2,2-dimethyl-3-(2-methylprop-1- enyl)cyclopropanecarboxylate; 5-Benzyl-3-furylmethyl (1RS)-*(Z)*,*(E)*-2,2-dimethyl-3-(2-methylprop-1-enyl)cyclopropanecarboxylate; 5-Benzyl-3-furylmethyl (1RS,3RS; 1RS,3SR)-2,2-dimethyl-3-(2-methylprop-1-enyl)cyclopropanecarboxylate; (5-Benzyl-3-furyl)methyl 2,2-dimethyl-3-(2-methylpropenyl) cyclopropanecarboxylate; Bioresmethrin (*d-trans* isomer); Caswell No. 083E; Cyclopropanecar boxylic acid, 2,2-dimethyl-3-(2-methylpropenyl)-, (4-(2-benzyl)furyl) methyl ester; Cyclopropanecarboxylic acid, 2,2-dimethyl-3-(2-methylpropenyl)-, (5-benzyl-3-furyl) methyl ester (8CI); Cyclopropanecarboxylic acid, 2,2-dimethyl-3-(2-methyl-1-propenyl)-, (5-(phenylmethyl)-3-furanyl)methyl ester, *cis,trans*-(±)-; Cyclopropanecarboxylic acid, 2,2-dimethyl-3-(2-methyl-1-propenyl)-, [5-(phenylmethyl)-3-furanyl]methyl ester, *(Z),(E)*-(±)-; Cyclopropanecarboxylic acid, 2,2-dimethyl-3-(2-methyl-1-propenyl)-, [5-(phenylmethyl)-3-furanyl]methyl ester; Cyclopropanecarboxylic acid, 2,2-dimethyl-3-(2-methyl-1-propenyl)-(5-(phenylmethyl)-3-furanyl)methyl ester, (1R-*cis*)-; Dimethyl 3-(2-methyl-1-propenyl) cyclopropanecarboxylate; 2,2-dimethyl-3-(2-methyl-1-propenyl)cyclopropanecarboxylic acid; ENT 27474; NSC 195022; [5-(Phenylmethyl)-3-furanyl]methyl 2,2-dimethyl-3-furylmethyl-2,2-dimethyl-3-(2-methylpropenyl) cyclopropanecarboxylate; [5-(Phenylmethyl)- 3-furanyl]methyl 2,2-dimethyl-3-(2-methyl-1-propenyl)cyclopropanecarboxylate); 5-(Phenylmethyl)-3-(furanyl)methyl 2,2-dimethyl-3-(2-methyl-1-propenyl)cyclopropanecarboxylate; [5-(Phenylmethyl)-3-furanyl]methyl ester; Resmethrin, (±)-; Resmethrin, (+)-*trans,cis*-; Resmethrin, (+)-*(E),(Z)*-; BIORESMETHRIN (*d-trans*-isomer); CHRYSRON; CISMETHRIN (*cis*-isomer); CROSSFIRE; DERRINGER; FMC 17370; ISATHRIN; NRDC 107 (*d-trans*-isomer); NIA 26021® (*cis*-isomer); NIA-17370®; NIAGARA 18739 (*d-trans*-isomer); NIAGARA 26021 (*cis*-isomer); NRDC 119 (*cis* -isomer); OBLIQUE; PYNOSECT; PYRETHERM; RAID; RESPOND; RU-11484® (*d-trans*-isomer); SBP 1382 (*d-trans*-isomer); *d-trans*-SBP 1382 (*d-trans*-isomer); SBP-1390; S. B. PENICK 1382®; SCOURGE; SUN-BUGGER; SYNTHRIN; SYNTOX; VECTRIN; WHITMIRE PT-110

CAS Number: 10453-86-8; 28434-01-7 (*d-trans*-isomer); 35764-59-1 (*cis*-isomer); 33911-28-3 (−)-(*trans*-isomer)

HSDB Number: 1516

RTECS Number: GZ1310000

UN/NA & ERG Number: UN3352 (liquid)/151; UN3349 (pyrethroid pesticide, solid, toxic)/151

EC Number: 233-940-7 [*Annex I Index No.*:613-060-00-3]

Regulatory Authority and Advisory Information

Carcinogenicity[83]: EPA, Likely to be carcinogenic to humans.

California Proposition 65 Chemical[102]: Cancer (7/1/2008); Developmental/Reproductive toxin (7/1/2008).

Hazard Alert: Poison, Combustible, Reproductive toxin: Possible risk of gene damage/impaired fertility; possible endocrine disruptor, Environmental hazard.

EPA Acceptable Daily Intake (ADI): EPA Oral reference dose (RfD) = 0.03 mg/kg/day

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)

Permissible Exposure Limits for Chemical Contaminants (CAL/OSHA) as pyrethrum

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%

Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: Xn, N; Risk phrases: R22; R50/53; R62; Safety phrases: S1; S2; S29 S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Off-white to tan waxy solid or colorless crystals. Chrysanthemum-like odor. Commercial products may be dissolved in flammable organic solvents. Molecular weight = 338.48 (all isomers); Specific gravity (H_2O:1) = 0.96 @ 20°C; Boiling point = (decomposes); Freezing/Melting point = 56−57°C; Vapor pressure = 1×10^{-8} mmHg @ 20°C; Flash point = 129°C. Henry's Law constant = 1.3×10^{-7} atm-m^3/mol @ 25°C (est)[83]. Low solubility in water. Physical and toxicological properties may be affected by carrier solvents in commercial formulations.

Potential Exposure: Resmethrin is pyrethroid insecticide used for mosquito control (by aerial application) in the USA, and may can also be used in greenhouses to control white fly. Resmethrin is a synthetic Type I pyrethroid insecticide registered for control of insects in residential, commercial, and industrial settings, and in animal living areas. It is also registered for use in food handling establishments and as a restricted use pesticide when used in ULV spray to control adult mosquitoes in the interest of public health[83]. A United States Restricted Use Pesticide (RUP) when formulated for use in mosquito abatement and pest control treatments at nonagricultural sites. Restricted due to extreme fish toxicity.

Incompatibilities: Decomposed by air, light, alkaline media, and temperatures >175°C. May react violently with strong oxidizers, bromine, 90% hydrogen peroxide, phosphorus trichloride, silver powders or dust. Incompatible with silver compounds. Mixture with some silver compounds forms explosive salts of silver oxalate.

Permissible Exposure Limits in Air:

NIOSH(2) IDLH = 5,000 ppm

OSHA PEL: 5 milligram per cubic meter TWA

NIOSH REL: 5 milligram per cubic meter TWA

ACGIH TLV[1]: 5 milligram per cubic meter TWA

Determination in Air: Collection by impinger or fritted bubbler, analysis by gas liquid chromatography/ultraviolet. See NIOSH IV, Method #5008[18], pyrethrum.

Permissible Concentration in Water: EPA Acceptable Daily Intake (ADI) = 0.1250 mg/kg/day.

Determination in Water: Octanol-water coefficient: Log K_{ow} = > 5.0. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, ingestion, dermal contact.

Harmful Effects and Symptoms

Short-Term Exposure: Pyrethrins can affect you when breathed in and by passing through your skin. Irritates the eyes and respiratory tract. High exposure can affect the nervous system causing headache, nausea, vomiting, fatigue, restlessness, and rhinorrhea (discharge of thin nasal mucous). Potential thyroid toxin. LD50 (oral, rat) = >2 g/kg; LD50 (dermal, rat) = >3 g/kg.

Long-Term Exposure: High or repeated exposure can cause lung allergy (with cough, wheezing and/or shortness of breath) or hay fever symptoms (sneezing, runny or stuffy nose). Allergic "pneumonia" can also occur with cough, chest pain, breathing difficulty, and abnormal chest x-ray. Repeated attacks may lead to permanent scarring. Skin allergy may also develop with rash and itching, even with lower exposures. Dermal contact can cause rash with redness, blisters, and intense itching. A severe generalized allergy can occur with weakness and collapse.

Points of Attack: Respiratory system, skin, central nervous system; thyroid.

Medical Surveillance: Comprehensive physical examination with emphasis on the genitourinary tract analysis to include sperm count, motility, and morphology. Other tests, such as serum testosterone, serum follicle stimulating hormone (FSH), and serum luteinizing hormone (LH) may be carried out if, in the opinion of a physician, they are indicated. Before beginning employment and at regular times after that, the following are recommended: Employees should be screened for history of certain medical conditions which might place the employee at increased risk from pyrethroid exposure. Chronic respiratory disease: In persons with chronic respiratory disease, especially asthma, the inhalation of pyrethroids might cause exacerbation of symptoms due to its sensitizing properties. Lung function tests. These may be normal if the person is not having an attack at the time of the test. Consider chest x-ray if lung symptoms are present. Skin disease: Pyrethroids can cause dermatitis which may be allergic in nature. Persons with pre-existing skin disorders may be more susceptible to the effects of this agent. Evaluation by a qualified allergist, including exposure history and testing, may help diagnose allergy. Any employee developing the above-listed conditions should be referred for further medical examination[9].

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. *Do not induce vomiting when formulations containing petroleum solvents are ingested*. Otherwise, give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Applicators and other handlers must wear: Coveralls worn over long-sleeved shirt and long pants; Chemical-resistant gloves such as DuPont Tychem suit fabrics, barrier laminate, or Viton; Chemical-resistant footwear plus socks; Protective eye wear; Chemical-resistant headgear for overhead exposure; Chemical-resistant apron when cleaning equipment, mixing, or loading[83]. Agricultural Use/Engineering Controls: When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the Worker Protection Standard (WPS) for agricultural pesticides, 40 CFR 170.240 (d)(4−6), the handler PPE requirements may be reduced or modified as specified in the Worker Protection Standard. Firefighters should wear NIOSH approved self-contained breathing apparatus and full protective clothing.

Respirator Selection: NIOSH/OSHA *for pyrethrum*: *50 milligram per cubic meter*: CcrOv95 (APF = 10) [any air-purifying half-mask respirator equipped with an organic vapor cartridge(s) in combination with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *125 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOvHie (APF = 25) (any air-purifying full-facepiece respirator equipped with an organic vapor cartridge in combination with a high-efficiency particulate filter). *250 milligram per cubic meter*: CcrFOv100 (APF = 50) [any air-purifying full-facepiece respirator equipped with organic vapor cartridge(s) in combination with an N100, R100, or P100 filter]; or PaprTOvHie (APF = 50) [any powered, air-purifying respirator with a tight-fitting facepiece and organic vapor cartridge(s) in combination with a high-efficiency particulate filter]; or SCBAF (APF = 50) (any self-contained breathing apparatus with full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *5000 milligram per cubic meter*: SaF:Pd,Pp (APF = 2000) (any supplied- air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv100 (APF = 50) [any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, self-contained breathing apparatus). *Note*: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code-Blue: Health Hazard/Poison. Store in a secure poison location at temperature $<35°C$ and away from alkaline materials. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN3352 Pyrethroid pesticide, liquid toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN3349 Pyrethroid pesticide, solid toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous material

Spill Handling: First remove all sources of ignition. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Ventilate area of spill or leak. Use water spray to reduce vapor. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of carbon. As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 meters/150 feet for liquids and at least 25 meters/75 feet for solids. *Fire involving storage or vehicular tanks*: Isolate for 800 meters/0.5 mile in all directions; also, consider initial evacuation for 800 meters/0.5 mile in all directions. *On a small fire*: Use dry chemical, CO2, water spray, or regular *foam*. *On a large fire*: Use water spray, fog, or regular foam. Do not scatter spilled material with high pressure streams of water. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal. *Fire involving tanks*: From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. Always stay away from tanks engulfed in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration would be an effective disposal procedure where permitted. If an efficient incinerator is not available, the product should be mixed with large amounts of combustible material and contact with the smoke should be avoided. In accordance with 40CFR165. Follow recommendations for the disposal of pesticides and pesticide containers[83]. Bury in noncrop land away from water. It would be better to mix the product with lime. Incineration would be an effective disposal procedure where permitted. If an efficient incinerator is not available, the product should be mixed with large amount of combustible material. Recommendable methods: Hydrolysis, landfill, incineration, and open burning. *Not recommendable method*: Discharge to sewer. Mix with sawdust and burn at a remote place[UN].

References

(102); (31); (173); (101); (138); (100).

EXTOXNET, Extension Toxicology Network, “Pesticide Information Profile, Resmethrin,” Oregon State University, Corvallis, OR (June 1996). http://extoxnet.orst.edu/pips/resmethr.htm

United Nations, Treatment and Disposal Methods for Waste Chemicals (IRPTC File). Data Profile Series No. 5. P. 157, Geneva, Switzerland (December 1985)

Jackson, D.; Luukinen, B.; Buhl, K.; Stone, D., *Resmethrin Technical Fact Sheet*; National Pesticide Information Center, Oregon State University Extension Services, Corvallis OR (2008)

Reserpine R:0100

Formula: $C_{33}H_{40}N_2O_9$

Synonyms: Abesta; Abicol; Adelfan; Adelphane; Adelphin; Adelphin-esidrex-K; Alkarau; Alkaserp; Alserin; Anquil; Apoplon; Apsical; Arcum R-S; Ascoserp; Ascoserpina; Austrapine; Banasil; Banisil; Benazyl; Bendigon; Bioserpine; Brinderdin; Briserine; Broserpine; Butiserpazide-25; Butiserpazide-50; Butiserpine; Cardioserpin; Carditivo; Carrserp; Crystoserpine; Daerbon; Deserpine; Diupres; Diutensen-R; Drenusil-R; Dypertane compound; Eberpine; Eberspine; Ebserpine; Elerpine; Elfanex; Enipresser; ENT 50,146; Escaspere; Eserpine; Eskaserp; Gamaserpin; Gammaserpine; Gilucard; H 520; Helfoserpin; Hexaplin; Hiposerpil; Hiserpia; Hydromox R; Hydropres; Hydropreska; Hygroton-resperine; Hypercal B; Hypertane Forte; Hypertensan; Idoserp; Idsoserp; Interpina; Key-Serpine; Kitene; Klimanosid; ‘L,’ Carpserp; Lemiserp; Loweserp; Marnitension simple; Maviserpin; Mayserpine; Mephaserpin; Methylreserpate 3,4,5,-trimethoxybenzoic acid; Methylreserpate 3,4,5,-trimethoxybenzoic acid ester; Mio-pressin; Modenol; Naquival; NCI-C50157; Nembuserpin; Neo-antitensol; Neoserfin; Rau-sed; Rauwoleaf; Recipin; Regroton; Renese R; R-E-S; Resaltex; Resedin; Resedrex; Resedril; Reserpex; Reserpoid; Serpasil; Serpasil Apresoline; Serpine; 3,4,5-Trimethoxybenzoyl methyl reserpate; Yohimban-16-carboxylic acid derivative of benz(g)indolo(2,3-a)quinolizine; Yohimban-16-carboxylic acid, 11,17-Dimethoxy-18-(3,4,5-trimethoxybenxoyl)oxy-, methyl ester;

Yohimban-16-carboxylic acid, 11,17-dimethoxy-18-(3,4,5-trimethoxybenxoyl)oxy-, methyl ester, (3b,16b,17a,18b,20a)-

CAS Registry Number: 50-55-5

HSDB Number: 213

RTECS Number: ZG0350000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171; UN1544 (alkaloid, solid, n.o.s.)/151

EC Number: 200-047-9

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; NCI: Carcinogenesis studies (feed); clear evidence: Mouse, rat, 1980.

California Proposition 65 Chemical[102]: Cancer 10/1/1989

Hazard Alert: Poison, Combustible, Alkaloid drug, Suspected of causing genetic defects, Suspected reprotoxic hazard.

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U200

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 5000 lb (2270 kg).

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T, Xi, Xn; Risk phrases: R45; R10; R22; R36/37/37; R41; R50/53; R60; R61; R62; R63; R67; Safety phrases: S22; S26; S36/37/S39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Reserpine is a white to pale buff to slightly yellow crystalline substance that darkens on exposure to light. Molecular weight = 608.75; Freezing/Melting point = 264−265°C (decomposes). Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. May be combustible.

Potential Exposure: Reserpine, a pharmaceutical, is a naturally occurring substance that is isolated from the roots of the plant *rauwolfia serpentina*. Insoluble in water. Reserpine is used as a hypertensive for humans and animals; tranquilizer, and sedative. Permitted for use as an additive in food for human consumption, and the feed and drinking water of food-producing animals.

Incompatibilities: A weak acid; keep away from bases. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, and strong reducing agents such as hydrideds and active metals. Compounds of the carboxyl group react with all bases, both inorganic and organic (i.e., amines) releasing substantial heat, water, and a salt that may be harmful. Incompatible with arsenic compounds (releases hydrogen cyanide gas), diazo compounds, dithiocarbamates, isocyanates, mercaptans, nitrides, sulfides (releasing heat, toxic, and possibly flammable gases), thiosulfates, and dithionites (releasing hydrogen sulfate and oxides of sulfur).

Permissible Exposure Limits in Air

No standards or Protective Action Criteria (PAC) available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Routes of Entry: Ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Massive overexposure may cause decreased blood pressure, convulsions, and coma. Reserpine is highly toxic to man. In humans, 0.014 mg/kg produces psychotropic effects. Symptoms include nausea, diarrhea, excessive salivation; nasal stuffiness; drowsiness, nightmares, emotional depression, and other psychotropic effects; extra systoles; angina pain; edema and weight gain sometimes associated with frank congestive heart failure; thrombocytopenia; tremor, muscular stiffness; severe hypotension in conjunction with general anesthetic administration.

Long-Term Exposure: May be a human carcinogen. There is limited evidence that this chemical causes breast cancer in humans, and breast and testes cancer in animals. Reproductive activity; may also be a mutagen and teratogen. Reserpine may damage the developing fetus. People taking reserpine daily for medical purposes have developed nightmares, severe depression; cramps, diarrhea, and weight gain. It is unknown if these symptoms occur from repeated occupational exposure.

Points of Attack: Nervous system. *Cancer site*: Breast in humans; breast and testes in animals.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure. There is no special test for this chemical. If overexposure or illness is suspected, medical attention is recommended.

First Aid: *Skin Contact*: Flood all areas of body that have contacted the substance with water. Don't wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others[52]. *Eye Contact*: Remove any contact lenses at once. Immediately flush eyes well with copious quantities of water or normal saline for at least 20−30 minutes. Seek medical attention. *Inhalation*: Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing, or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion*: Contact a physician, hospital, or poison center at once. If the victim is unconscious or convulsing, do not induce vomiting or give anything by mouth. Assure that the patient's airway is open and lay him on his side with his head lower than his body and transport immediately to a medical facility. If conscious and not convulsing, give a glass of water to dilute the substance. Vomiting should not be induced without a physician's advice.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full-facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Specific engineering controls are required for drug manufacture by the Food and Drug Administration. Refer to 21CFR210, *FDA Regulation for Good Manufacturing Practices*.

Respirator Selection: *At any detectable concentration*: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA-or European Standard EN 149-approved self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full-facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in a refrigerator or in a cool, dry place. Protect from exposure to light and acids. Where possible, automatically transfer material from drums or other storage containers to process containers. A regulated, marked area should be established, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN1544 Alkaloids, solid, n.o.s. or Alkaloid salts, solid, Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources:[52] Remove all sources of ignition and dampen spilled material with toluene to avoid airborne dust, then transfer material to a suitable container. Ventilate the spill area and use absorbent dampened with toluene to pick up remaining material. Wash surfaces well with soap and water. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical may burn but does not easily ignite. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: It is inappropriate and possibly dangerous to the environment to dispose of expired or waste drugs and pharmaceuticals by flushing them down the toilet or discarding them to the trash. Household quantities of expired or waste pharmaceuticals may be mixed with wet cat litter or coffee grounds, double-bagged in plastic, discard in trash. Larger quantities shall carefully take into consideration applicable DEA, EPA, and FDA regulations. If possible return the pharmaceutical to the manufacturer for proper disposal being careful to properly label and securely package the material. Alternatively, the waste pharmaceutical shall be labeled, securely packaged and transported by a state licensed medical waste contractor to dispose by burial in a licensed hazardous or toxic waste landfill or incinerator. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(109); (102); (31); (173); (101); (138); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 4, 90–92 (1981)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Reserpine, Trenton, NJ (October 2001).

Resorcinol R:0110

Formula: $C_6H_6O_2$: 1,3-$C_6H_4(OH)_2$
Synonyms: Benzene, *m*-dihydroxy-; *m*-Benzenediol; 1,3-Benzenediol; C.I. 76505; C.I. Developer 4; C.I. Oxidation base 31; Developer O; Developer R; Developer RS; *m*-Dihydroxybenzene; 1,3-Dihydroxybenzene; *m*-Dioxybenzene; Durafur developer G; Fouramine RS; Fourrine 79; Fourrine EW; *m*-Hydroquinone; 3-Hydroxycyclohexadien-1-one; *m*-Hydroxyphenol; 3-Hydroxyphenol; Nako TGG; NCI-C05970; Pelagol grey RS; Pelagol RS; Phenol, *m*-hydroxy-; Resorcin; Resorcina (Spanish); Resorcine
CAS Registry Number: 108-46-3
HSDB Number: 722
RTECS Number: VG9625000
UN/NA & ERG Number: UN2876/153
EC Number: 203-585-2 [*Annex I Index No.*: 604-010-00-1]
Regulatory Authority and Advisory Information
Carcinogenicity: IARC: Animal Inadequate Evidence; Human No Adequate Data, *not classifiable as carcinogenic to humans*, Group 3, 1999; NCI: Carcinogenesis Studies (gavage); no evidence: Mouse, rat; NTP: Carcinogenesis Studies (gavagae); no evidence: Mouse, rat. United States Environmental Protection Agency Gene-Tox Program, Negative: *N crassa-aneuploidy*; Histidine reversion-Ames test; Inconclusive: Mammalian micronucleus.
Hazard Alert: Poison, Combustible, Endocrine disruptors (high), Possible risk of forming tumors, Possible sensitization (skin), Suspected of causing genetic defects, Primary irritant (w/o allergic reaction), FDA over the counter drug, Environmental hazard.
Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)
United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U201
RCRA, 40CFR261, Appendix 8 Hazardous Constituents
Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 5000 lb (2270 kg)
Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.
Hazardous to aquatic life or environment, with possible long lasting effects[291][194].
Hazard Symbols, Risk & Safety statements: Hazard Symbol: Xn, N, Xi; Risk phrases: R22; R36/37/38; R43; R51/53; R62; Safety phrases: S2; S26; S29; S41; S61 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.
Description: Resorcinol is a white crystalline solid with a characteristic odor and a sweetish taste. Turns pink on exposure to air or light, or contact with iron. Molecular weight = 110.1; Specific gravity (H2O:1) = 1.3 @ 20°C; Boiling point = 277°C; Freezing/Melting point = 109°C; Vapor pressure = 0.0002 mmHg @ 25°C; Flash point = 127.2°C (cc); Autoignition temperature = 607°C. Explosive limits: LEL = 1.4% @ 200°C. UEL-unknown. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity. Highly soluble in water; solubility = 110%.
Potential Exposure: Resorcinol is weakly antiseptic; resorcinol compounds are used in the production of resorcinol-formaldehyde adhesives; or as an intermediate; in pharmaceuticals and hair dyes for human use. Major industrial uses are as adhesives in rubber products and tires, wood adhesive resins, and as ultraviolet absorbers in polyolefin plastics. Resorcinol is also a by-product of coal conversion and is a component of cigarette smoke. Thus, substantial opportunity exists for human exposure.
Incompatibilities: Reacts with oxidizers, nitric acid; oil, ferric salts; methanol, acetanilide, albumin, antipyrene, alkalies, urethane, ammonia, amino compounds. Hygroscopic; absorbs moisture from the air.
Permissible Exposure Limits in Air
Conversion factor: 1 ppm = 4.50 milligram per cubic meter @ 25°C & 1 atm
OSHA PEL: None
NIOSH REL: 10 ppm/45 milligram per cubic meter TWA; 20 ppm/90 milligram per cubic meter STEL
ACGIH TLV[1]: 10 ppm/45 milligram per cubic meter TWA; 20 ppm/90 milligram per cubic meter STEL; not classifiable as a human carcinogen Protective Action Criteria (PAC) Ver. 29[138]
PAC-1: 20 ppm
PAC-2: 28 ppm
PAC-3: 170 ppm
DFG MAK: Danger of skin sensitization
Australia: TWA 10 ppm (45 milligram per cubic meter); STEL 20 ppm, 1993; Austria: MAK 10 ppm (45 milligram per cubic meter), 1999; Belgium: TWA 10 ppm (45 milligram per cubic meter); STEL 20 ppm, 1993; Denmark: TWA 10 ppm (45 milligram per cubic meter), 1999; EU OEL: TWA 10 ppm, 45 milligram per cubic meter; 2000; Finland: TWA 10 ppm (45 milligram per cubic meter); STEL 20 ppm (90 milligram per cubic meter), 1999; France: VME 10 ppm (45 milligram per cubic meter), 1999; Hungary: TWA 45 milligram per cubic meter; STEL 90 milligram per cubic meter, [skin], 1993; the Netherlands: MAC-TGG 45 milligram per cubic meter, 2003; Poland: MAC (TWA) 45 milligram per cubic meter; MAC (STEL) 90 milligram per cubic meter, 1999; Sweden: NGV 10 ppm (45 milligram per cubic meter), [skin], 1999; Switzerland: MAK-W 10 ppm (45 milligram per cubic meter), 1999; United Kingdom: TWA 10 ppm (46 milligram per cubic meter); STEL 20 ppm (92 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 20 ppm. Several states have set guidelines or standards for resorcinol in ambient air[60] ranging from 3.1 μ/m^3 (Massachusetts) to 450.0–900.0 μ/m^3 (North Dakota) to 750.0 μ/m^3 (Virginia) to 900.0 μ/m^3 (Connecticut, Florida, New York) to 1,071.0 μ/m^3 (Nevada).
Determination in Air: OSHA versatile sampler-7; Methanol; Gas chromatography/Flame ionization detection;

NIOSH Analytical Method (IV) #5701; OSHA Analytical Method: PV-2053.

Permissible Concentration in Water: Russia[35][43] set a MAC in water bodies used for domestic purposes of 0.1 mg/L and in water bodies used for fishery purposes of 0.004 mg/L. The state of Maine has set a guideline for drinking water of 140 μg/L[61].

Determination in Water: Octanol-water coefficient: Log $K_{ow} = < 1$. Unlikely to bioaccumulate in marine organisms.***Routes of Entry***: Inhalation, ingestion, eye and/or skin contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin, and respiratory tract. Skin contact causes a severe rash and blistering. Eye contact can cause burns and permanent damage. May affect the blood, causing formation of methemoglobin, cyanosis, convulsions; restlessness, increased heart rate; dyspnea (breathing difficulty), dizziness, drowsiness, hypothermia, hemoglobinuria. High exposure can cause kidney and/or liver damage. *Inhalation*: Humans occupationally exposed to 10 ppm showed no effects. Experiments with animals showed no toxic effects after 8 hour exposure to 625 ppm. *Skin*: Itching, irritation, redness, swelling, and chemical burns have been reported from contact with solutions of 3%−25% strength. Skin absorption is significant and leads to loss of oxygen carrying capacity of blood, convulsions, and death. *Eyes*: Animal tests suggest that 10% solution may cause irritation, pain, and corneal damage. Powdered resorcinol may cause chemical burns to the cornea resulting in blindness. *Ingestion*: May cause excessive sweating, low blood pressure; slowed breathing; tremors, breakdown of blood cells and death. One teaspoonful may cause death.

Long-Term Exposure: Repeated or prolonged contact may cause skin sensitization and allergy. Repeated exposure can cause lung damage. May cause kidney, liver, spleen damage.

Points of Attack: Eyes, skin, respiratory system; cardiovascular system; central nervous system; blood, spleen, liver, kidneys.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater, or significant skin contact), the following are recommended before beginning work and at regular times after that. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: Urine test for resorcinol. Tests for kidney and liver function. Methemoglobin level. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to Physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine. Emergency treatment and management is similar to phenol.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full-facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures *over 10* ppm; Use a NIOSH/MSHA (US) or EN149 (Europe)-approved full-facepiece respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. Where there is potential for high exposure exists, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous-flow mode; or use NIOSH/MSHA or European Standard EN 149-approved self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers, oil, ferric salts; methanol, acetanilide, albumin, antipyrine, and urethane. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN2876 Resorcinol, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Establish forced ventilation to keep levels below explosive limit. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Liquid solutions should be absorbed on sand or vermiculite and shoveled into suitable containers. Scrub spill area with soap and water. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Dissolve in a combustible solvent and incinerate.

References

(31); (101); (138); (100).

United States Environmental Protection Agency, Resorcinol, Health and Environmental Effects Profile No. 152, Office of Solid Waste, Washington, DC (April 30, 1980)

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 2, 58−59 (1980)

New York State Department of Health, *Chemical Fact Sheet*: Resorcinol, Bureau of Toxic Substance Assessment, Albany, NY (March 1986)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Resorcinol, Trenton, NJ (June 2001).

Rhodium R:0120

Formula: Rh; $O_3Rh2 \cdot xH2O$ [Rhodium(III) oxide, hydrate]

Synonyms: Elemental rhodium; Rhodium black; Rhodium-103

CAS Registry Number: 7440-16-6; 123542-79-0 [Rhodium (III) oxide, hydrate]; 12137-27-8 (Rhodium(IV) oxide); 12036-35-0 (Rhodium oxide, solids)

HSDB Number: 2534

RTECS Number: VI9069000 (metal)

UN/NA & ERG Number: UN3089 (metal powder, flammable, n.o.s.)/170

EC Number: 231-125-0; 234-846-9 [Rhodium(III) oxide, hydrate]

Regulatory Authority and Advisory Information

Hazard Alert: Flammable solid (powder, dust), Strong reducing agent, reactive hazard (known catalytic activity).

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%., elemental.

WGK[100] (German Aquatic Hazard Class): Nonhazard to water. (metal, particle size > 1 mm.)

Description: Rhodium, together with platinum, palladium, iridium, ruthenium, and osmium, is one of the platinum-group metals in Group VIII of the Periodic Table. Rhodium metal is a white, hard, ductile, malleable solid with a bluish-gray luster. Molecular weight = 103; Specific gravity [metal] (H2O:1) = 12.41 @ 25°C; Boiling point = 3727°C; Freezing/Melting point = 1966°C. Insoluble in water.

Potential Exposure: Rhodium has few applications by itself, as in rhodium plating of white gold jewelry or plating of electrical parts, such as commutator slip rings, but, mainly, rhodium is used as a component of platinum alloys. Rhodium-containing catalysts have been proposed for use in automotive catalytic converters for exhaust gas cleanup.

Incompatibilities: Flammable as a dust, fume, or powder may form explosive mixture with air. Incompatible with strong oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, bromine pentafluoride, and bromine trifluoride; chlorine trifluoride; oxygen difluoride.

Permissible Exposure Limits in Air

metal fume & insoluble compounds

OSHA PEL: 0.1 mg[Rh]/m^3 TWA

NIOSH REL: 0.1 mg[Rh]/m^3 TWA

ACGIH TLV[1] (*elemental*): 1 mg[Rh]/m^3; not classifiable as a human carcinogen

Protective Action Criteria (PAC) Ver. 29[138]

metal

NIOSH IDLH = 100 mg[Rh]/m^3

PAC-1: 3 milligram per cubic meter

PAC-2: 33 milligram per cubic meter

PAC-3: 200 milligram per cubic meter

DFG MAK: Carcinogen Category 3B

Australia: TWA 1 mg[Rh]/m^3, 1993; Belgium: TWA 1 mg [Rh]/m^3, 1993; Finland: TWA 0.1 mg[Rh]/m^3, 1999; France: VME 1 mg[Rh]/m^3, 1999; Norway: TWA 0.1 mg [Rh]/m^3, 1999; the Philippines: TWA 0.1 mg[Rh]/m^3, 1993; Switzerland: MAK-W 0.1 mg[Rh]/m^3, 1999; the Netherlands: MAC-TGG 0.1 mg[Rh]/m^3, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen

soluble compounds
NIOSH IDLH = 2 mg[Rh]/m^3
OSHA PEL: 0.001 mg[Rh]/m^3 TWA
NIOSH REL: 0.001 mg[Rh]/m^3 TWA
ACGIH TLV[1]: 0.01 mg[Rh]/m^3; not classifiable as a human carcinogen
DFG MAK (*inorganic only*): Carcinogen Category 3B
Several states have guidelines or standards for rhodium in ambient air[60] ranging from 0.16 μ/m^3 (Virginia) to 2.0 μ/m^3 (Connecticut), to 10.0 μ/m^3 (North Dakota) to 24.0 μ/m^3 (Nevada).

Determination in Air: Use NIOSH II(3) Method #S-188.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short-Term Exposure: May cause metal fume fever. Rhodium (III) chloride and its hydrate are extremely toxic. May cause serious eye damage.

Long-Term Exposure: Possible respiratory sensitization

Points of Attack: Respiratory system. Ingestion [Rhodium (III) chloride].

Medical Surveillance: Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Lung function tests. Consider chest X-ray following acute overexposure to metal fume or dust.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If metal fume fever develops, it may last less than 36 hours.

Note to Physician: In case of fume inhalation, treat for pulmonary edema. Give prednisone or other corticosteroid orally to reduce tissue response to fume. Positive pressure ventilation may be necessary. Treat metal fume fever with bed rest, analgesics and antipyretics.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full-facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 0.5 milligram per cubic meter*: Qm (APF = 25) (any quarter-mask respirator). *Up to 1 milligram per cubic meter*: 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators]. The following filters may also be used: N99, R99, P99, N100, R100, P100; or Sa (APF = 10) (any supplied-air respirator). *Up to 2.5 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *Up to 5 milligram per cubic meter*: 100F (APF = 50) (any air purifying, full-facepiece respirator with and N100, R100, or P100 filter); or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any self-contained breathing apparatus with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 100 milligram per cubic meter*: Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full-facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color code-Red (*powder*): Flammability Hazard: Store in a flammable materials storage area. Prior to working with this material all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers and sources of ignition. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Sipping: Flammable powder, Hazard Class: 4.1; Labels: 4.1-Flammable solid.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Powder is a flammable solid. Thermal decomposition products may include metal oxides. Use special mixtures of dry chemicals appropriate for extinguishing metal fires. *Do not use water*. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Recovery in view of the high economic value. Recovery techniques for recycling of rhodium in plating wastes and spent catalysts have been described in the literature.

References

(31); (173); (101); (138); (100).

Rhodium trichloride R:0130

Formula: Cl_3Rh; $RhCl_3 \cdot xH_2O$ (trihydrate)

Synonyms: Hydrated rhodium trichloride; Rhodium chloride; Rhodium(III) chloride (1:3); Rhodium chloride, trihydrate

CAS Registry Number: 10049-07-7; 13569-65-8 (trihydrate)

HSDB Number: 7121 as rhodium compounds

RTECS Number: VI9275000

UN/NA & ERG Number: UN3260 (Corrosive solid, acidic, inorganic, n.o.s.)/154

EC Number: 233-165-4 (trichloride)

Regulatory Authority and Advisory Information

Hazard Alert: Hygroscopic, Corrosive, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Superfund/EPCRA 302, Extremely Hazardous Substances: Dropped from listing in 1988.

United States National Primary Drinking Water Regulations: SMCL = 250 mg[Cl^-]/L as Chloride

Hazard Symbols, Risk & Safety statements: Hazard Symbol: C, Xn; Risk phrases: R22; R36/37/38; R41; R62; R63; Safety phrases: S16; S24; S26; S36/37/39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to waters.

Description: Rhodium trichloride is a red-brown or black, odorless solid or liquid. Molecular weight = 209.26; 263.32 (trihydrate); Boiling point = 775°C (sublimes); Freezing/Melting point = 400−500°C (decomposition). Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 1. Insoluble in water. *Rhodium trichloride trihydrate*, RhCl3 · xH2O, is a deep-red crystalline solid. Soluble in water.

Potential Exposure: Rhodium trichloride is used in hydrosilylation, hydrogenation, carbonylation, oxidation, arylation. See also "Rhodium Metal." In plating operations and in catalyst preparation, the metal will be used as the trichloride.

Incompatibilities: Sensitive to humidity. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides.

Permissible Exposure Limits in Air

NIOSH IDLH = 2 mg[Rh]/m^3

OSHA PEL: 0.001 mg[Rh]/m^3 TWA

NIOSH REL: 0.001 mg[Rh]/m^3 TWA

ACGIH TLV[1]: 0.01 mg[Rh]/m^3; not classifiable as a human carcinogen

Protective Action Criteria (PAC) not available

DFG MAK: Carcinogen Category 3B

Australia: TWA 1 mg[Rh]/m^3, 1993; Belgium: TWA 1 mg [Rh]/m^3, 1993; Denmark: TWA 0.001 mg[Rh]/m^3, 1999; Finland: TWA 0.001 mg[Rh]/m^3, [skin], 1999; France: VME 1 mg[Rh]/m^3, 1993; Norway: TWA 0.1 mg[Rh]/m^3, 1999; the Philippines: TWA 0.1 mg[Rh]/m^3, 1993; Switzerland: MAK-W 0.1 mg[Rh]/m^3, 1999; United Kingdom: TWA 0.001 mg[Rh]/m^3; STEL 0.003 mg[Rh]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Not classifiable as a human carcinogen. Several states have guidelines or standards for rhodium in ambient air[60] ranging from 0.16 μ/m^3 (Virginia); to 2.0 μ/m^3; (Connecticut); to 10.0 μ/m^3 (North Dakota); to 24.0 μ/m^3 (Nevada).

Determination in Air: Use NIOSH II(3), Method #S-189.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: This material is corrosive. May cause eye irritation, possible serious damage. Delayed effects of inhaling dust may cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. In animals: Irritation of the eyes; central nervous system damage. LD_{50} = (oral-rat) 1302 mg/kg.

Long-Term Exposure: May cause central nervous system damage. Tumorigenic and mutagenic effects have been reported in experimental lab animals.

Points of Attack: Eyes, central nervous system.

Medical Surveillance: Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Consider the point of attack in preplacement and periodic physical examinations.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full-facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 0.5 milligram per cubic meter*: Qm (APF = 25) (any quarter-mask respirator). *Up to 1 milligram per cubic meter*: 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators]. The following filters may also be used: N99, R99, P99, N100, R100, P100; or Sa (APF = 10) (any supplied-air respirator). *Up to 2.5 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *Up to 5 milligram per cubic meter*: 100F (APF = 50) (any air purifying, full-facepiece respirator with and N100, R100, or P100 filter); or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any self-contained breathing apparatus with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 100 milligram per cubic meter*: Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full-facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color code-White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers. Where possible, automatically transfer material from drums or other storage containers to process containers.

Shipping: UN3260 Corrosive solid, acidic, inorganic, n.o.s., Hazard class: 8; Labels: 8-Corrosive material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Thermal decomposition products may include hydrogen chloride and oxides of metal. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Recovery and reclaiming wherever possible in view of high economic value. See "Rhodium Metal."

References

(31); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Rhodium Trichloride, Washington, DC, Chemical Emergency Preparedness Program (October 31, 1985)

Ricin R:0135

Formula: None

Synonyms: African coffee tree; Castor; Castor bean; Castor oil; Ricine; Ricino (Spanish); Ricinus lectin; Ricinus agglutinin; Ricinus toxin; Lectin isolated from seeds of the castor bean; Ricinus communis protein/polypeptide; Steadfast

CAS Registry Number: 9009-86-3; (*alt.*) 9067-26-9; 96638-28-7 (Ricin, A chain)

HSDB Number: 3566

RTECS Number: VJ2625000

UN/NA & ERG Number: UN3172/153; UN3462/153

EC Number: None assigned.

Regulatory Authority and Advisory Information

Report any release of WMD to National Response Center 1-800-424-8802

Hazard Alert: Exposure can be lethal, Biotoxin, Environmental hazard, Suspected of causing genetic defects, Teratogen.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T+; Risk phrases: R26/27/28; R42/43; Safety phrases: S23; S28; S36/37; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class) No value assigned to these CAS numbers. *However, based on toxicity the following may apply*: 3-Severe hazard to water.

Description: Ricin is a lethal, delayed-action cytotoxin; it is persistent in the environment. Ricin is a white powder. Molecular weight = (approx.) 64,000−66,000 daltons; Volatility = negligible; Vapor Pressure = Negligible @ 20°C; Boiling point = decomposes; Ricin is detoxified in 10 minutes @80°C/176°F or in 1 hr at 50°C/122°F @ pH 7.8. Hazard Identification (based on NFPA-704 M Rating System): Health 4; Flammability 1; Reactivity 0[92]. Ricin is stable under ambient conditions and destroyed by heat and contact with solution household bleach. Michaelis constant (KM) = 0.1 ìmol/L for ribosomes; Enzymatic constant (*K*cat) = 1500/min. The toxin is soluble in water.

Detection: Various tests for the detection of Ricin are available, including "Pro-Strips" from Avant Technologies, the BIO-911™ test strip developed by Osborn Scientific Group, Lakeside AZ. This one-step test is reported to detect, within minutes, the presence of minute quantities of the toxin (less than 50 nanograms); the freeze-dried assay kit to detect crude Ricin called Ruggedized Advanced Pathogen Identification Device (Rapid)™, Rapid LT, and Razor instrument developed by Idaho Technologies, Inc. Ricin is detectable in urine, plasma, and environmental samples. *Instant Chek Abrin/Ricin Detection Kit*, Catalog Number: IC-RA-003-10 Kit Contents: 10 test units each test contains two tests (one Abrin and one Ricin) per unit, lyophilized reagent, reconstitution buffer, wash buffer, transfer pipettes, instruction booklet. Ey Laboratories, Inc, 107 N. Amphlett Blvd, San Mateo, CA. 94401 USA, Toll Free (North America)1-800-821-0044; Telephone: 1-650-342-3296, Option 2 or 3 Fax. +1 (650) 342 2648. Also, in 2009, researchers at Yeshiva University's Albert Einstein College of Medicine have developed an accurate test. Polymerase Chain Reaction (PCR) can detect castor bean DNA in most Ricin preparations. See also "Water Detection," below.

History of the material: Ricin is a lectin—a plant glycoprotein that binds and agglutinates animal cells. Ricin comes from the seeds (or beans) of the castor bean plant, *Ricinus communis*. The beans are processed to form castor oil, formerly used as a laxative and now used in industry as a lubricant. Annual worldwide processing of castor beans is approximately 1 million tons to produce castor oil; waste mash from this production is 3% to 5% Ricin by weight. Large-scale production and use of Ricin by an enemy is fairly difficult. It is estimated that a ton of Ricin would be required to produce a mass casualty biological weapon; therefore an enemy would have to produce a very large quantity in order to cover a large area of a battlefield. For centuries farmers have known the dangers to farm animals that have eaten castor beans. In fact, people found castor beans in 6000-year-old Egyptian tombs. Castor oil has been used for centuries as medicine, and scientist have known about Ricin's effect on stopping the body from making proteins since 1800. During WWII, the United States and Britain worked together on building bombs carrying Ricin, but the only reported military use was by Iraq in their war with Iran. The United States Army discovered large stores of Ricin in Al Qaeda caves in Afghanistan. This relatively inexpensive, accessible, natural source allows easy preparation of large quantities of Ricin; therefore, there is little motivation to produce it synthetically. Large-scale production of Ricin by recombinant DNA techniques is probably possible. Certain governments have successfully used Ricin to murder political enemies. In 1978, Georgi Markov, a Bulgarian journalist living in London, was assassinated when a Ricin pellet was injected into his leg using a specialized gun disguised as an umbrella. In February 2004, Ricin was found in the Senate mail room on Capitol Hill in Washington, D.C. No one became ill from that exposure. Since 1978, worldwide, there have been more than a dozen other known incidents involving Ricin. Although Ricin has the potential for use as a terrorist weapon, it is also being investigated as a treatment for cancer and AIDS.

Potential Exposure: Potentially Fatal. Ricin, a protein found in castor beans, is one of the most incredibly potent and lethal substances known to humankind − 500 μg (an amount capable of fitting on the head of a pin)—is capable of killing an adult within a few days. The castor plant, and their beans, is an important industrial plant and vast amounts of castor plants and beans are grown commercially. The castor plant, originally native to Africa, is an attractive plant that can be found in people's yards as ornamentals. If the flowers are removed before they produce seeds, the risk of accidents can be averted. Ricin poisoning can occur following accidental ingestion of castor beans. In some countries castor beans are used as beads on necklaces; both children and adults have eaten just a few beans and died from the poison. This invasive 8 to 10 foot tall plant can be found in more than 25 US states and other places, including Australia. The plants die in freezing weather. The beans are turned into important and valuable industrial products. After the castor oil is squeezed from the castor beans, about 5% of what's left is Ricin. Although people have used weak castor oil as a laxative, purgative, and general folk-medicine "cure all," pure Ricin kills in a few days. Ricin gets into the body's cells and inhibits protein synthesis. Once this essential mechanism is halted, within hours the body's systems begins to shut down and the body begins to die. Ricin poisoning is not contagious and does not spread from person to person. Because Ricin isn't a living thing but rather a chemical made by living things, it probably would NOT make as effective a military weapon as viruses or bacteria like the ebola virus or anthrax. Nevertheless, it would make an effective terrorist weapon because it's easy to make and easy to use. It is estimated that a ton of Ricin would be required to produce a mass casualty biological weapon. With no known antidote*, vaccine, or other effective therapy available for Ricin poisoning, the threat of this agent being released into the environment as an aerosol, or added to the food or water supply, could be catastrophic. Ricin is extremely hazardous when freeze-dried, forming a light, easily-dispersed powder. For this reason, research laboratory personnel are usually directed to avoid freeze-drying Ricin. **Note*: Various public and private sector organizations are working on the development of antibody therapy that shows promise in neutralizing Ricin in animals. If successful, this therapy could result in a vaccine for humans and potentially reduce the threat of Ricin being used as a terrorist weapon.

Incompatibilities: Product is considered stable at ambient temperature. Ricin and other protein toxins can be destroyed by exposure to 0.1% sodium hypochlorite solution (household bleach) for 10 minutes. The toxic portion of Ricin is heat stable at ambient temperatures and begins to decompose at 60°C/140°F. At 80°C/176°F most of the toxicity is lost in about 30 minutes. When heated to decomposition, Ricin emits toxic nitrogen oxides. Avoid contact with strong oxidizers.

Permissible Exposure Limits in Air:

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 8.20E-06

PAC-2: 9.00E-05

PAC-3: 5.40E-04

ChemWatch: 0.00006 milligram per cubic meter Ceiling limit (sensitizer)[92]

Determination in Air: No NIOSH or OSHA methods available.

Permissible Concentration in Water: Unknown.

Determination in Water:

Detecting Ricin in Water; Summary of Results

Technology	Contaminant Presence/ Absence	False Pos (+)/Neg(−) Responses	Consistency	Lowest Detectable Conc.
BADD Test Strips	9/21	0/0	100%	20 mg/L
BioVerify Test Kits	15/22	0/3	97%	0.0005 mg/L
RAMP Test	12/15	0/0	100%	5 mg/L
BioThreat Hazard Alert Test Strips[a]	15/15	2/1	100%	0.035 mg/L
Enzyme Linked Immunosorbent Assay (ELISA)	12/15	0/0	100%	0.0075 mg/L
QTL Biosensor	12/15	2/2	90%	0.25 mg/L

[a] *The most accurate results for Ricin using the Bio-Threat Alert test strips (Tetracore, Inc.) detected 15/15 for Ricin (2004−06).*

Source: EPA/Homeland Security (2004−06): See full report at: http://www.epa.gov/nhsrc/tte_immtestkitpandb.html

Routes of Entry: Can be absorbed by all routes of exposure. Ricin normally enters the body by ingestion. Aerosolized Ricin would enter the body by inhalation. The toxin attaches to cell surfaces of a variety of tissues, particularly the stomach lining if ingested or the moist, upper respiratory tissues if inhaled.

Harmful Effects and Symptoms

The symptoms depend on purity of the Ricin, the level of exposure, and route of exposure (inhalation, ingestion, or injection), the dose received. The LD_{50} = (oral-ingestion) 1 to 20 mg/kg (the equivalent of eight castor beans); (human-injection) 1 to 1.75 μg/kg; (human-inhalation) 21 to 42 μg/kg. As little as 500 μg of Ricin (about what might fit on the head of a pin; 1/228th of an aspirin tablet) may be enough to kill an adult. When Ricin toxins get inside the victim's body, they block protein synthesis (the body's ability to regenerate protein). Initial symptoms usually appear between 6 and 10 hours and 3 days. Clinical signs may appear as early as 45 minutes after ingestion if the victim has an empty stomach. Death can occur within 36−72 hours of exposure, depending on the route exposure and upon the dose received. Death from Ricin poisoning could take place within 36 to 48 hours of exposure, whether by injection, ingestion, or inhalation. Victims may linger for 10−12 days before death or recovery, also depending upon the level of exposure. However, if a person lives longer than 5 days after Ricin poisoning, without complications, they are less likely to die. Ricin is detoxified in 10 mins at 176°F (80°C) and in 1 hr at 122°F (50°C); it is stable under ambient conditions. Lethal dose = 1 mg/kg. Urinary excretion of ricin is probably slow and limited with the estimated half-life being about 8-days[92].

Short-Term Exposure:

The following lists do not convey prioritization or indicate specificity.

Inhalation: Within a few hours of inhaling significant amounts of Ricin, the likely symptoms would be respiratory distress, difficult or labored breathing; shortness of breath; chest tightness, hypoxemia, fever, cough, nausea, sweating, aching muscles. Heavy sweating may follow as noncardiogenic pulmonary edema develops.* This would make breathing even more difficult, and the skin might turn blue. Excess fluid in the lungs would be diagnosed by X-ray or by listening to the chest with a stethoscope. Finally, low blood pressure, Blue skin, multisystem organ failure, respiratory failure may occur, and possible death.

Skin: Its uncertain if Ricin can be absorbed through the skin. It is generally believed that the risk of toxicity is low from contact with unbroken skin; however, Ricin may be absorbed through irritated, damaged, abraded, wounded, or injured skin; or, through normal skin when Ricin is dissolved in a solvent carrier. If enough Ricin gets through the skin, the symptoms will be similar to those described for ingestion. If Ricin is injected, the muscles and lymph nodes near the injection site would die. This could lead to liver and kidney failure and death. *Eyes*: Tearing, swelling of the eye-lids, pain, redness, corneal injury. Urinary excretion of Ricin is probably slow and limited with the estimated half-life being about 8-days. LD50 = (humans) 1 mg/kg; a single seed can be fatal. LD50 = (oral-mice) about 3 μg/kg by injection or aerosol.

Ingestion: Generally within a few hours symptoms will appear, including nausea, vomiting, abdominal pain and cramping, diarrhea (possibly bloody), lowered blood pressure, hallucinations, and bloody urine, gastrointestinal bleeding, low or no urinary output, dilation of the pupils, fever, thirst, sore throat, headache, vascular collapse, and shock. Severe vomiting and diarrhea may result from severe dehydration and multisystem organ failure. In a few days, organs (liver, spleen, and kidneys) might stop working, and possible death.

**Note*: Ricin-induced pulmonary edema would be expected to occur much later (1−3 days post exposure) compared to other agents such as phosgene (about 6 hours post exposure).

Late phase complications: Ricin's cell killing (cytotoxic) effects on the liver, central nervous, kidneys, and adrenal glands, typically two to five days after exposure. The patient may be asymptomatic (showing no symptoms of exposure) during the preceding one to five days[92].

Pulmonary edema would be expected to occur much later (1−3 days post exposure) compared to that induced by other agents such as phosgene (about 6 hours post exposure).

Long-Term Exposure: Repeated exposures to Ricin may cause allergic/asthma-like symptoms with congestion of nose and throat; itchy, watery eyes; hives; tightness of the chest; and in acute cases, wheezing. May affect kidneys, liver, pancreas. Based on animal studies Ricin may be capable of causing severe lung damage in humans. Information about carcinogenicity, developmental toxicity, or reproductive toxicity from chronic or repeated exposure to Ricin is unknown at this time.

Points of Attack: Lungs, eyes, skin (primarily through cuts and bruises). The risk of toxicity from unbroken skin exposure to Ricin is low but there is still a danger of allergic skin reactions.

Medical Surveillance: Unfortunately Ricin symptoms resemble those that are similar to other diseases, especially the common flu. Laboratory testing might include metabolic acidosis; increased liver function tests; increased renal function tests; hematuria; leukocytosis (2-to-5-fold higher than normal).

First Aid: No antidote exists for Ricin. Make all exposed people go to the nearest hospital emergency department. Make all potentially exposed people shower and change clothes. In case you have gotten Ricin on your skin or your clothing, immediately shower and change clothes. See a doctor as soon as possible: Since it can take only a day and a half for symptoms to appear, all exposed persons should get to a doctor that same day. If exposure includes contact with Ricin, remove it off or out of the body as quickly as possible. Treatment needs to be provided in a hospital setting. Make the doctors and nurses aware of the potential for exposure so that they can protect themselves; and provide the most appropriate treatments and therapies. If you have to wait for medical assistance, make the victim comfortable. If Ricin has been ingested, the airway must be secured and stomach pumping (gastric lavage) may be considered. Vigorous gastric lavage is recommended only if it can be done shortly after ingestion (generally within 1 hour). Risk of aggravating injury to the lining of the gastrointestinal (GI) tract must be considered.

To minimize the effects of the poisoning and to keep the patient stable, Ricin poisoning is treated through supportive therapy. The types of supportive medical care would depend on several factors, such as the route by which victim(s) were poisoned (i.e., whether poisoning was by inhalation, ingestion, eye, or skin exposure). Do not induce vomiting. Rinse mouth, flush stomach with activated charcoal* (if the Ricin has been very recently ingested), washing out the victim's eyes with water, especially if the eyes are red and irritated. Supportive care could include intravenous fluid input and support of circulation and respiration; giving medications to treat conditions such as seizure and low blood pressure. Fluid input is critical, as fluid losses of up to 2-½ liters are probable. If individual is drowsy or unconscious, do not give anything by mouth. In the event of vomiting, lean patient forward or place on left side (head-down position, if possible) to maintain open airway and prevent aspiration. Fluid and electrolyte balance should be monitored and restored if abnormal. Early and aggressive IV fluid and electrolyte replacement. If the victim's lungs fill with fluid, you administer oxygen if his breathing is difficult or labored.

**Note*: Superactivated charcoal may be of little value for large molecules such as Ricin[163].

Decontamination: When Ricin symptoms appear and you know the location of the attack, the area should be decontaminated with responders wearing level A (Fully encapsulated suit with SCBA). Otherwise, stay away. Move as fast as possible; extra minutes before decontamination might make a big difference. If the Ricin attack was aerosolized (by small particles floating in the air), and you have the equipment, (*this is very important*) then you have to decontaminate as soon as possible. If you don't have the equipment and training, don't enter the hot zone to rescue and decontaminate victims. Even if you think you are not contaminated, be sure to thoroughly shower and change clothes as soon as you can after the incident. If possible, place all clothing in a labeled durable 6-mil polyethylene bags. If the victim can't move, decontaminate, if possible, without touching and without entering the hot zone. To prevent spreading the agent, be certain that victims are decontaminated as much as possible before allowing them to leave the area. During the decontamination process, be careful not to break the patient/victim's skin, and take care to cover all open wounds. The CDC recommends a decontamination procedure solution of detergent and water (with a pH value in the alkaline range of more than eight but less than 10.5). Soft brushes should be available to remove contamination from the personal protective equipment. Also recommended for cleanup of people and surfaces is household bleach. Use a fresh (made daily) solution of 0.5% sodium hypochlorite [diluted household bleach (10%, or one part bleach to nine parts water)]. Contact time: 15 minutes. Do not get bleach solution in the victim's eyes, open wounds (especially of the abdomen, spinal cord, or brain), or mouth. Wash off the diluted bleach solution after 15 minutes. Labeled, durable 6-mil polyethylene bags should be available for disposal of clothing and contaminated personal protective equipment. In the absence of pH adjusted solutions, wash the victim with lots of warm water with soap. Use clean water from any source; if possible, use a hose (spray or fog to prevent injury to the victim) or other system so that you won't have to touch the victim; don't even wait for soap or for the victim to remove clothing (at least down to undergarments), begin washing immediately. Immediate flush the eyes with water for at least 15 minutes. Wash—strip—wash—evacuate up wind and uphill: The idea is to immediately wash with water, then have the victim (not the responder) remove all the victim's clothing, then wash again (with soap if available) and then move away from the hot zone in an upwind and uphill direction.

Personal Protective Methods:

General information: First responders should use a NIOSH-certified chemical, biological, radiological, nuclear (CBRN) self-contained breathing apparatus (SCBA) with a level a protective suit when entering an area with an unknown contaminant or when entering an area where the concentration of the contaminant is unknown. Level a protection should be used until monitoring results confirm the contaminant and the concentration of the contaminant. *Note*: Safe use of protective clothing and equipment requires specific skills developed through training and experience.

LEVEL A: (RED ZONE): Select when the greatest level of skin, respiratory, and eye protection is required. This is the maximum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than the AEGL-2. A NIOSH-certified CBRN full-facepiece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle. A totally-encapsulating chemical protective (TECP) suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, and a hard hat worn under the TECP suit are optional items.

LEVEL B: (RED ZONE): Select when the highest level of respiratory protection is necessary but a lesser level of skin protection is required. This is the minimum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than AEGL-2. It differs from Level A in that it incorporates a nonencapsulating, splash-protective, chemical-resistant splash suit that provides Level A protection against liquids but is not airtight. A NIOSH-certified CBRN full-facepiece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL C: (YELLOW ZONE): Select when the contaminant and concentration of the contaminant are known and the respiratory protection criteria factors for using Air Purifying Respirators (APR) or Powered Air Purifying Respirators (PAPR) are met. This level is appropriate when decontaminating patient/victims. A NIOSH-certified CBRN tight- fitting APR with a canister-type gas mask or CBRN PAPR for air levels greater than AEGL-2. A NIOSH-certified CBRN PAPR with a loose-fitting facepiece, hood, or helmet and a filter or a combination organic vapor, acid gas, and particulate cartridge/filter combination or a continuous flow respirator for air levels greater than AEGL-1. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Escape mask, face shield, coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL D: (GREEN ZONE): Select when the contaminant and concentration of the contaminant are known and the concentration is below the appropriate occupational exposure limit or less than AEGL-1 for the stated duration times. Limited to coveralls or other work clothes, boots, and gloves.

Notes: Take all necessary precautions to prevent any reasonable probability of skin or eye contact. Recommenced protective clothing and materials may include Tychem BR or Responder CSM. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid, unless full-facepiece respiratory protection is worn. Wear dust-proof goggles and face shield when working with powders or dust, unless full-facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Safe use of protective clothing and equipment requires specific skills developed through training and experience.

Respirator Selection: Pressure demand, self-contained breathing apparatus [SCBA; Chemical, Biological, Radiological, Nuclear (CBRN)], [if available] is recommended in response to nonroutine emergency situations.

Storage: Color code-Blue: Health Hazard/Poison (Toxic): Store in a secure, locked poison location. Store in a cool, dry, and well-ventilated area and away from food stuff containers.

Shipping: UN3172 Toxins, extracted from living sources, liquid, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN3462 Toxins, extracted from living sources, solid, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling:

Initial isolation and protective action distances: Consider initial evacuation for 800 m/0.5 mi in all directions. This agent is not included in the DOT ERG 2004 Table of Initial Isolation and Protective Action Distances. In the DOT ERG 2004 orange-bordered section of the guidebook, there are public safety recommendations on how to immediately isolate a Ricin (Guide 153) spill or leak area for at least 50 m/150 ft for liquids and 25 m/75 ft for solids in all directions[190].

You must be careful! Avoid generating dust. Since a Ricin attack may be by small particles of Ricin floating in the air (aerosol), don’t breathe it or get it on you. Remember that the victim’s clothes or body may have Ricin; touch them and you can become a victim. If you think Ricin particles might be in the area, stay out until you are equipped with level A (Fully encapsulated suit with SCBA), proper personal protective equipment (PPE), including protective clothing and respiratory protection. Shut off heating, ventilation, and air conditioning (HVAC) systems to prevent the tiny aerosolized (floating in the air) Ricin droplets from spreading throughout the building. Keep the public away. Immediately call for medical assistance. For those contaminated by Ricin, don’t allow anyone to leave the hot zone. The Ricin chemical doesn’t dissipate quickly, and “survives” in clothing and bedding for long periods of time. Consequently, people as well as “things” must be quarantined and decontaminated. Don’t allow anyone leave until medical people examine them. Don’t breathe, touch, or eat anything that might be contaminated with Ricin. Notify the federal authorities, local health, and pollution/environmental agencies. See Decontamination.

Fire Extinguishing: Ricin is combustible. Thermal decomposition products may include nitrogen oxides. Ricin is not volatile, but it may be spread by efforts to extinguish the fire. Avoid generating dust. Use foam, dry chemical powder, BCF [bromochlorodiflouromethane (Halon 1211)] (where regulations permit), carbon dioxide, water spray, or fog (large fires only). If the situation allows, control and properly dispose of run-off (effluent). If a tank, rail car, or tank truck is involved in a fire, isolate it for 0.5 mi/800 m in all directions; also, consider initial evacuation for 0.5 mi/800 m in all directions. This agent is not included in the DOT ERG 2004 Table of Initial Isolation and Protective Action Distances. In the DOT ERG 2004 orange-bordered section of the guidebook, there are public safety recommendations on how to immediately isolate a ricin (Guide 153) spill or leak area for at least 150 ft/50 m for liquids and 75 ft/25 m for solids in all directions.

Disposal Method Suggested: Do not clean-up or dispose of Ricin, except under supervision of a specialist.

References

(31); (173); (77); (92); (173); (101); (104); (138); (103), (175); (190); (80); (100).

Defense Research and Development Canada *Unique Partnership Provides Promising Lead on Medical Countermeasures Against Ricin* http://www.css.drdc-rddc.gc.ca/crti/invest/stories-exemplaires/02_0007ta-eng.asp, Suffield, Albert, Canada, 2010

Tebbett, Ian, Grundmann, Oliver, *Forensics Magazine*: *Ricin on the Rise: Are we prepared?* http://www.forensicmag.com/article/ricin-rise-are-we-prepared?page = 0,1

Riddelliine R:0136

Formula: $C_{18}H_{23}NO_6$

Synonyms: Aids-020850; 13,19-Didehydro-12,18-dihydroxysenecionan-11,16-dione; *trans*-15-Ethylidene-12β-hydroxy-12α-hydroxymethyl-13-methylenesenec-1-enine; Riddeliin; Riddeliine; Senecionan-11,16-dione, 13,19-didehydro-12,18-dihydroxy-; Stereoisomer of 3-ethylidene-3,4,5,6,9,11,13,14,14α,14β-decahydro-6-hydroxy-6-(hydroxymethyl)-5-methylene(1,6)dioxacyclododecino[2,3,4-gh]-pyrrolizidine-2, 7-dione

CAS Registry Number: 23246-96-0

HSDB Number: 7147

RTECS Number: VJ3850000

UN/NA & ERG Number: UN1544 (alkaloid, solid, n.o.s.)/151

EC Number: Not found

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Human Inadequate Evidence, animal Sufficient Evidence, *possibly carcinogenic to humans*, Group 2B

California Proposition 65 Chemical[102]: Cancer, 12/3/2004

Hazard Alert: Poison, Alkaloid, Poison, Possible risk of forming tumors, Suspected of causing genetic defects.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: Risk phrases: R45; Safety phrases: S1; S29; S41 (see Appendix 4)

Description: Colorless to yellowish crystalline solid. Starts turning brown at approximately 165°C; turns blackish-brown at 187°C. Molecular weight = 349.40; Freezing/Melting point = (decomposes) >195°C. Practically insoluble in water; solubility = <1 mg/mL @ 25°C.

Potential Exposure: Riddelline is a natural alkaloid product used a laboratory chemical and reference standard.

Incompatibilities: Riddelline is sensitive to light, air, and heat, causing oxidation; reacts slowly with atmospheric oxygen. This chemical is probably combustible; dust mixed with air may be explosive. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides. Contact with alkalis and bases may cause hydrolysis.

Permissible Exposure Limits in Air: No standards or Protective Action Criteria (PAC) available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Routes of Entry: Ingestion

Harmful Effects and Symptoms

Short-Term Exposure: Symptoms of acute exposure to a mixture containing Riddelline include abdominal pain, hepatomegaly, emaciation, nausea, diarrhea and liver cirrhosis. Death occurred in several cases. Ingestion of mixtures in which Riddelline is a component has caused infant hepatic veno-occlusive disease and early death. LD_{50} = (oral-mouse) ~100 mg/kg.

Long-Term Exposure: Possible risk of forming tumors, Suspected of causing genetic defects

Points of Attack: Liver, Reproduction system.

Medical Surveillance: Riddelline is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure. Pregnant women should avoid contact. Employees should be notified by a physician that this chemical may affect the reproductive system. In addition to comprehensive initial medical and work histories emphasizing reproductive experience and menstrual history, patient should have physical examination and testing of genitourinary tract, sperm count, motility, and morphology. If required, other tests, such as serum testosterone, serum follicle stimulating hormone (FSH), and serum luteinizing hormone (LH) may be indicated.

First Aid: *Eyes*: First check the victim for contact lenses and remove if present. Flush victim's eyes with water or normal saline solution for 20−30 minutes while simultaneously calling a hospital or poison control center. Do not put any ointments, oils, or medication in the victim's eyes without specific instructions from a physician. *Immediately* transport the victim after flushing eyes to a hospital even if no symptoms (such as redness or irritation) develop. *Skin: Immediately* flood affected skin with water while removing and isolating all contaminated clothing. Gently wash all affected skin areas thoroughly with soap and water. If symptoms such as redness or irritation develop, *immediately* call a physician and be prepared to transport the victim to a hospital for treatment. *Inhalation: Immediately* leave the contaminated area; take deep breaths of fresh air. *Immediately* call a physician and be prepared to transport the victim to a hospital even if no symptoms (such as wheezing, coughing, shortness of breath, or burning in the mouth, throat, or chest) develop. Provide proper respiratory protection to rescuers entering an unknown atmosphere. Whenever possible, Self-Contained Breathing Apparatus (SCBA) should be used; if not available, use a level of protection greater than or equal to that advised under Protective Clothing. *Ingestion*: If the victim is conscious and not convulsing, give one or two glasses of water to dilute the chemical and *immediately* call a hospital or poison control center. Generally, the induction of vomiting is not recommended outside of a physician's care due to the risk of aspirating the chemical into the victim's lungs. However, if the victim is conscious and not convulsing and if medical help is not readily available, consider the risk of inducing vomiting because of the high toxicity of the chemical ingested. Ipecac syrup or salt water may be used in such an emergency. *Immediately* transport the victim to a hospital. If the victim is convulsing or unconscious, do not give anything by mouth, ensure that the victim's airway is open and lay the victim on his/her side with the head lower than the body. *Do not induce vomiting*. *Immediately* transport the victim to a hospital[101].

Personal Protective Methods:

Respirator Selection: *At any detectable concentration*: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA-or European Standard EN 149-approved self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full-facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, self-contained breathing apparatus)

Storage: Color code-Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. Protect Riddelline from exposure to light, air and heat. Keep the container tightly closed under an inert atmosphere (nitrogen), and store under refrigerated temperatures (15°C).

Shipping: UN1544 Alkaloids, solid, n.o.s. or Alkaloid salts, solid, n.o.s. poisonous, Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: *Small spills and leakage*: Should a spill occur while you are handling this chemical, *first remove all sources of ignition*, then you should dampen the solid spill material with 60%−70% ethanol and transfer the dampened material to a suitable container. Use absorbent paper dampened with 60%−70% ethanol to pick up any remaining material. Seal the absorbent paper, and any of your clothes, which may be contaminated, in a vapor-tight plastic bag for eventual disposal. Solvent wash all contaminated surfaces with 60%−70% ethanol followed by washing with a soap and water solution. Do not reenter the contaminated area until the Safety Officer (or other responsible person) has verified that the area has been properly cleaned. For a large spill increase, in the downwind direction, as necessary, the isolation distance shown below.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen and carbon (carbon monoxide and CO_2). This chemical is probably combustible. Fires involving this material can be controlled with a dry chemical, carbon dioxide or Halon extinguisher. As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 meters/150 feet for liquids and at least 25 meters/75 feet for solids. If tank, rail car or tank truck is involved in a fire, *isolate* for 800 meters/0.5 mile in all directions; also, consider initial evacuation for 800 meters/ 0.5 mile in all directions.

Disposal Method Suggested: It is inappropriate and possibly dangerous to the environment to dispose of expired or waste product such as lab chemicals by flushing them down the toilet or discarding them to the trash. Larger quantities shall carefully take into consideration applicable EPA, and FDA regulations. If possible return the lab chemicals to the manufacturer for proper disposal being careful to properly label and securely package the material. Alternatively, the waste lab chemicals shall be labeled, securely packaged and transported by a state licensed medical waste contractor to dispose by burial in a licensed hazardous or toxic waste landfill or incinerator.

References

(109); (102); (31); (173); (101); (138).

Ronnel R:0140

Formula: $C_8H_8Cl_3O_3PS$; $Cl_3C_6H_2OP(S)(OCH_3)_2$

Synonyms: Dermaphos; *O*,*O*-Dimethyl *O*-2,4,5-trichlorophenyl phosphorothioate; *O*,*O*-Dimethyl *O*-(2,4,5-trichlorophenyl) thiophosphate; Dimethyl trichlorophenyl thiophosphate; *O*,*O*-Dimethyl-*O*-(2,4,5-trichlorphenyl)-thionophosphat (German); Dow ET 14; Dow ET 57; Ectoral; ENT 23,284; ET 14; ET 57; Etrolene; Fenchlorfos; Fenchlorophos; Fenchlorphos; Karlan; Korlan; Korlane; Nanchor; Nanker; Nankor; Phosphorothioic acid, *O*,*O*-dimethyl *O*-(2,4,5-trichlorophenyl) ester; Thiophosphate de *O*,*O*-dimethyle et de *O*-(2,4,5-trichlorophenyle) (French); Trichlorometafos; 2,4,5-Trichlorophenol, *O*-ester with *O*,*O*-dimethyl phosphorothioate; *O*-(2,4,5-Trichlor-phenyl)-*O*,*O*-dimethyl-monothiophosphat (German); Trolen; Trolene; Viozene

CAS Registry Number: 299-84-3

HSDB Number: 667

RTECS Number: TG0525000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154; UN2783 (organophosphorus pesticides, solid, toxic)/152

EC Number: 206-082-6 [*Annex I Index No.*: 015-052-00-X]

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Possible cumulative neurotoxin, Suspected of causing genetic defects, Suspected reprotoxic hazard, Environmental hazard.

Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: Xn, N; Risk phrases: R21/22; R22; R33; R50/53; R62; R63; Safety phrases: S2; S25; S29; S36/37; S41; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)]

Description: Ronnel is a white to light tan crystalline solid. Molecular weight = 321.54; Specific gravity (H_2O:1) = 1.48 @ 25°C; Boiling point = (decomposes); Freezing/Melting point = 41°C. Practically insoluble in water; solubility = 0.004% @ 25°C.

Potential Exposure: Ronnel is both an organochlorine and organophosphorus compound; potential danger to those involved in manufacture, formulation and application of this insecticide for farm (livestock) and household uses. Degrades readily in the environment by hydrolysis and oxidation[101].

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides. Store at temperatures <25−30°C. Organothiophosphates are susceptible to formation of highly toxic and flammable phosphine gas in the presence of strong reducing agents such as hydrideds and active metals. Partial oxidation by oxidizing agents may result in the release of toxic phosphorus oxides[101].

Permissible Exposure Limits in Air

NIOSH IDLH = 300 milligram per cubic meter

OSHA PEL: 15 milligram per cubic meter TWA

NIOSH REL: 10 milligram per cubic meter TWA

ACGIH TLV[1]: 5 milligram per cubic meter TWA measured as inhalable fraction and vapor; not classifiable as a human carcinogen; BEI_A issued for Acetylcholinesterase inhibiting pesticides.

Protective Action Criteria (PAC) not available

Australia: TWA 10 milligram per cubic meter, 1993; Belgium: TWA 10 milligram per cubic meter, 1993; Denmark: TWA 5 milligram per cubic meter, 1999; France: VME 10 milligram per cubic meter, 1999; Norway: TWA 5 milligram per cubic meter, 1999; the Philippines: TWA 10 milligram per cubic meter, 1993; Russia: STEL 0.3 milligram per cubic meter, 1993; the Netherlands: MAC-TGG 10 milligram per cubic meter, 2003; United Kingdom: TWA 10 milligram per cubic meter, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Not classifiable as a human carcinogen

Several states have set guidelines or standards for ronnel in ambient air[60] ranging from 100 μ/m^3 (North Dakota) to 160 μ/m^3 (Virginia) to 200 μ/m^3 (Connecticut) to 238 μ/m^3 (Virginia).

Determination in Air: Use NIOSH Analytical Method (IV) Method #5600, Organophosphorus Pesticides; OSHA Analytical Method PV-2054.

Permissible Concentration in Water: Mexico[35] has set maximum permissible concentration of 50 μg/L in estuaries and 5 μg/L in coastal waters.

Determination in Water: Octanol-water coefficient: Log Kow = ~5. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

In varying degrees, organochlorines are absorbed from the gut and also by the lung and across the skin[72].

Short-Term Exposure: Irritates the eyes. Organic phosphorus insecticides are absorbed by the skin, as well as by the respiratory and gastrointestinal tracts. They are cholinesterase inhibitors. Symptoms of exposure include headache, giddiness; blurred vision; nervousness, weakness, nausea, cramps, diarrhea, and discomfort in the chest. Signs include sweating, tearing, salivation, vomiting, cyanosis, convulsions, coma, loss of reflexes, and loss of sphincter control.

Long-Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. There is limited evidence that ronnel may damage the developing fetus. May cause personality changes, such as depression, anxiety, and irritability. High or repeated exposure may cause nerve damage causing weakness, a feeling of "pins and needles" in the arms and legs; and poor coordination.

Points of Attack: Skin, central nervous system; blood plasma.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: Plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below pre-employment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider complete blood count. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates. Examination of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full-facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *Up to 100 milligram per cubic meter*: CcrOv95 (APF = 10) [Any air-purifying half-mask respirator with organic vapor cartridge(s) in combination with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *Up to 250 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOvHie (APF = 25) (any powered air-purifying respirator with an organic vapor cartridge in combination with a high-efficiency particulate filter). *Up to 300 milligram per cubic meter*: CcrFOv100 (APF = 50) [any air-purifying full-facepiece respirator equipped with organic vapor cartridge(s) in combination with an N100, R100, or P100 filter]; or GmFOv100 (APF = 50) [any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or PaprTOvHie (APF = 50) [any powered, air-purifying respirator with a tight-fitting facepiece and organic vapor cartridge(s) in combination with a high-efficiency particulate filter];* or SCBAF (APF = 50) (any self-contained breathing apparatus with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv100 (APF = 50) [any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, self-contained breathing apparatus). *Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Store at temperatures <25−30°C. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN2783 Organophosphorus pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: UN2811: Isolation Distance, Spill: 25meters/75 feet.(NJ). Isolation Distance, Fire: 800 meters/ 0.5 miles[70]. Organophosphorus compounds

Initial isolation and protective action distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.3/0.4
Night 0.8/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 600/200
Then: Protect persons downwind (miles/kilometers)
Day 1.4/2.3
Night 2.8/4.5

Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Thermal decomposition products may include oxides of phosphorus, sulfur, nitrogen, and carbon and trichlorophenol. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration with added flammable solvent in furnace equipped with afterburner and alkali scrubber[22]. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Ronnel, Trenton, NJ (August 2005).

Rotenone R:0150

Formula: $C_{23}H_{22}O_6$

Synonyms: Arol gordon dust; Barbasco; (1)Benzopyrano (3,4-b)furo(2,3-H)(1)benzopyran-6(6aH)-one, 1,2,12,12a-tetrahydro-8,9-dimethoxy-2-(1-methylethenyl), [2R-(2a, 6(a) a,12(a)a)]; Cenol garden dust; Chem fish; Chem-mite; Cube; Cube extract; Cube-pulver; Cube root; Cubor; Curex flea duster; Dactinol; Deril; Derrin; Derris; Dri-kil; ENT 133; Extrax; Fish-tox; Green cross warble powder; Haiari; Liquid derris; Mexide; NCI-C55210; Nicouline; Noxfish; Paraderil; Powder and root; Prentox; Pro-nox fish; Ro-Ko; Ronone; Rotefive; Rotefour; Rotenon; Rotenona (Spanish); Rotessenol; Rotocide; [2R-(2a,6aa,12aa)]-1,2,12,12a-Tetrahydro-8,9-dimethoxy-2-(1-methylethenyl) (1)-benzopyrano(3,4-b)furo(2,3-H) (1)-benzopyran-6(6aH)one; Tubatoxin

CAS Registry Number: 83-79-4; *(alt.)* 12679-58-2

HSDB Number: 1762

RTECS Number: DJ2800000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154; UN2588 (Pesticides, solid, toxic, n.o.s.)/151

EC Number: 201-501-9 [*Annex I Index No.*: 650-005-00-2]

Regulatory Authority and Advisory Information

Carcinogenicity: NCI: Carcinogenesis Studies (feed); equivocal evidence: Rat; no evidence: Mouse.

Hazard Alert: Poison, Combustible, Poison, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction), Environmental hazard.

Hazardous to aquatic life or environment, with possible long lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T, N; Risk phrases: R25; R36/37/38; R50/53; R62; R63; Safety phrases: S1/2; S22; S24/25; S29/35; S36; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to waters.

Description: Rotenone is a colorless to red odorless crystalline solid; a white crystalline solid when pure; oxidation will cause yellowing to bright red coloring. Odorless. Molecular weight = 394.45; Boiling point = (decomposes below BP); 210−220°C @ 0.5 mm; Freezing/Melting point = 165.6°C; Vapor pressure = 1×10^{-6} mmHg @ 20°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Practically insoluble in water; solubility = 10−12 ppm @ 100°C. Sprays may be dissolved in xylene or kerosene.

Potential Exposure: A potential danger to those involved in extraction from derris root, formulation or application of this insecticide. Rotenone is used as a pharmaceutical and veterinary drug.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, and alkalies.

Permissible Exposure Limits in Air

NIOSH IDLH = 2500 milligram per cubic meter

OSHA PEL: 5 milligram per cubic meter TWA

NIOSH REL: 5 milligram per cubic meter TWA

ACGIH TLV[1]: 5 milligram per cubic meter TWA; not classifiable as a human carcinogen

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 15 milligram per cubic meter

PAC-2: 420 milligram per cubic meter

PAC-3: 2500 milligram per cubic meter

DFG MAK: [skin]

Australia: TWA 5 milligram per cubic meter, 1993; Austria: MAK 5 milligram per cubic meter, 1999; Belgium: TWA 5 milligram per cubic meter, 1993; Denmark: TWA 5 milligram per cubic meter, 1999; Finland: TWA 5 milligram per cubic meter; STEL 10 milligram per cubic meter, 1993; the Philippines: TWA 5 milligram per cubic meter, 1993; the Netherlands: MAC-TGG 5 milligram per cubic meter, 2003; Turkey: TWA 5 milligram per cubic meter, 1993; United Kingdom: TWA 5 milligram per cubic meter; STEL 10 milligram per cubic meter, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Several states have set guidelines or standards for rotenone in ambient[60] ranging from 1.67 μ/m^3 (New York); to 50.0 μ/m^3 (Florida and South Carolina); to 50.0−100.0 μ/m^3 (North Dakota);to 80.0 μ/m^3 (Virginia); to 100.0 μ/m^3 (Connecticut); to 119.0 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #5007, Rotenone.

Permissible Concentration in Water: The state of Maine has set a guideline for rotenone in drinking water of 4.0 μg/L[61].

Determination in Water: Fish Tox = 1.49403000 ppb (HIGH); Octanol-water coefficient: Log K_{ow} = >4. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin, and respiratory tract. Eye contact can cause severe irritation and permanent damage. Exposure can cause numbness of the mucous membrane, nausea, vomiting, abdominal pain; muscular tremors; incoherence, colonic convulsions; stupor. May cause a severe drop in blood sugar. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: May affect the liver and kidneys. There is limited evidence that rotenone causes cancer of the liver and breast in animals, and damage to the developing fetus. There is limited evidence that this chemical is stored in breast milk and passed on to nursing infants. Repeated skin contact can cause severe rash. Human Tox = 28.00000 ppb (INTERMEDIATE).

Points of Attack: Central nervous system; eyes, respiratory system; liver and kidneys.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Lung function tests. Blood sugar. Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full-facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 50 milligram per cubic meter*: CcrOv95 (APF = 10) [any air-purifying half-mask respirator with organic vapor cartridge(s) in combination with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *Up to 125 milligram per cubic meter*: Sa: Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOvHie (APF = 25) (any powered air-purifying respirator with an organic vapor cartridge in combination with a high-efficiency particulate filter). *Up to 250 milligram per cubic meter*: CcrFOv100 (APF = 50) [any air-purifying full-facepiece respirator equipped with organic vapor cartridge(s) in combination with an N100, R100, or P100 filter]; or GmFOv100 (APF = 50) [any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or PaprTOvHie (APF = 50) [any powered, air-purifying respirator with a tight-fitting facepiece and organic vapor cartridge(s) in combination with a high-efficiency particulate filter]; or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or SCBAF (APF = 50) (any self-contained breathing apparatus with a full facepiece); or SaF (APF = 50) (any supplied- air respirator with a full facepiece). *Up to 2,500 milligram per cubic meter*: Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv100 (APF = 50) [any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in a refrigerator under an inert atmosphere and protect from prolonged exposure to light. Keep away from oxidizers and alkalis. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames are prohibited where this chemical is handled, used, or stored.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN2588 Pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Dampen spilled material with alcohol to avoid dust, then transfer material to a suitable container. Use absorbent dampened with alcohol to pick up remaining material. Wash surfaces well with soap and water. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Soil Adsorption Index (K_{oc}) = 10000 (estimate).

Fire Extinguishing: This chemical is a combustible solid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Rotenone is decomposed by light and alkali to less insecticidal products. It is readily detoxified by the action of light and air. It is also detoxified by heating; 2 hours @ 100°C results in 76% decomposition. Oxidation products are probably nontoxic. Incineration has been recommended as a disposal procedure. Burial with lime would also present minimal danger to the environment[22]. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Rotenone, Trenton, NJ (October 2000)

S

Saccharin S:0100

Formula: $C_7H_5NO_3S$
Synonyms: 550 Saccharine; Anhydro-*o*-sulfaminebenzoic acid; 3-Benzisothiazolinone 1,1-dioxide; 1,2-Benzisothiazolin-3-one, 1,1-dioxide, and salts; 1,2-Benzisothiazol-3(2*H*)-one 1,1-dioxide; *o*-Benzoic acid sulfimide; *o*-Benzoic sulfimide; Benzoic sulfimide; *o*-Benzoic sulfimide; Benzoicsulfimide; Benzoic sulfinide; *o*-Benzosulfimide; Benzo-2-sulfimide; Benzosulfimide; Benzosulfimide; *o*-Benzoyl sulfimide; 1,2-Dihydro-2-ketobenzisosulfonazole; 1,2-Dihydro-2-ketobenzisosulfonazole; 2,3-Dihydro-3-oxobenzisosulfonazole; 2,3-Dihydro-3-oxobenzisosulfonazole; 1,1-Dioxide-1,2-benzoisothiazol-3(2*H*)-one; Garantose; Glucid; Gluside; Glycophenol; Glycosin; Hermesetas; 3-Hydroxy-benzisothiazole-*S*,*S*-dioxide; Kandiset; Natreen; Neosaccarin; Sacarina (Spanish); Saccharimide; Saccharina; Saccharin acid; Saccharinol; Saccharinose; Saccharol; Saccharose; Saxin; Sucre Edulcor; Sucrette; *o*-Sulfobenzimide; *o*-Sulfobenzoic acid imide; 2-Sulfobenzoic imide; Sweeta; Sycorin; Sykose; Syncal; Zaharina
CAS Registry Number: 81-07-2; 128-44-9 (sodium)
HSDB Number: 669
RTECS Number: DE4200000
UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171
EC Number: 201-321-0 [1,2-benzisothiazol-3(2*H*)-one 1,1-dioxide]

Regulatory Authority and Advisory Information

Carcinogenicity: International Agency for Research on Cancer (IARC): Animal Inadequate Evidence; Human No Adequate Data, *not classifiable as carcinogenic to humans*, Group 3

California Proposition 65 Chemical[102]: *Delisted 4/6/01. Saccharin and Saccharin sodium*

Hazard Alert: Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U202

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 100 lb (45.4 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Hazard symbols, risk, & safety statements: Hazard symbol: T; risk phrases: R40; R51; R62; R63; R68; safety phrases: S24/25; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Saccharin is a crystalline solid with a sweet taste (500 times sweeter than sugar). Molecular weight = 183.19; freezing/melting point = 229°C (decomposes). Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 1, reactivity 0. Slightly soluble in water.

Potential Exposure: The information provided has to do, primarily, with the manufacturing of saccharin. Saccharin has been used as a nonnutritive sweetening agent. At one point the United States consumption pattern for all forms of saccharin has been estimated as 45% in soft drinks; 18% in tabletop sweeteners; 14% in fruits, juices, sweets, chewing gum, and jellies; 10% in cosmetics and oral hygiene products; 7% in drugs, such as coating on pills; 2% in tobacco; 2% in electroplating; and 2% for miscellaneous uses. Human exposure to saccharin occurs primarily through ingestion because of its use in many dietic foods and drinks and some personal hygiene products, including toothpastes and mouthwashes. The general public is exposed to saccharin, especially by persons required to reduce sugar intake.

Incompatibilities: Dust may form explosive mixture with air. Incompatible with strong oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides.

Permissible Exposure Limits in Air

Nuisance dusts; particulates not otherwise classified

Occupational Safety and Health Administration (OSHA) PEL: 5 milligram per cubic meter (15 mppcf) TWA

NIOSH REL: none

ACGIH TLV: 3 milligram per cubic meter (respirable particles)

Determination in Air: NIOSH Method 0600, Issue 3, *Particulates not otherwise regulated, respirable*.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: May cause skin irritation. Exposure to very high levels can cause loss of appetite; nausea, vomiting and diarrhea.

Long-Term Exposure: Saccharin in very high doses has been shown to cause bladder cancer in male rats. Other animal species have not shown this effect. High exposures in certain susceptible individuals may cause skin allergy.

Points of Attack: Bladder, skin.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following is recommended: Urine cytology (a special test for abnormal cells in the urine). Evaluation by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the

Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens.
DOI: http://dx.doi.org/10.1016/B978-0-323-38968-6.00018-1

skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and cardiopulmonary resuscitation (CPR) if heart action has stopped. Transfer promptly to a medical facility.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: At any exposure level, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure demand or other positive-pressure mode.

Storage: Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. A regulated, marked area should be established, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during clean-up. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical may burn but does not easily ignite. Thermal decomposition products may include oxides of nitrogen, sulfur, and carbon. Use extinguishers suitable for surrounding fires. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform to EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(102); (31); (173); (101); (138); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 2, No. 6, 18–21 (1982).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Saccharin, Trenton, NJ (June 2006).

Safrole S:0110

Formula: $C_{10}H_{10}O_2$

Synonyms: 5-Allyl-1,3-benzodioxole; Allylcatechol methylene ether; Allyldioxybenzene methylene ether; 1-Allyl-3,4-methylenedioxybenzene; 4-Allyl-1,2-(methylenedioxy)benzene; *m*-Allylpyrocatechinmethylene ether; Allylpyrocatechol methylene ether; Benzene, 4-allyl-1,2-(methylenedioxy)-; 1,3-Benzodioxole, 5-(2-propenyl)-; 3,4-Methylenedioxy-allylbenzene; 3-(3,4-Methylenedioxyphenyl)prop-1-ene; Methylene ester of allyl-pyrocatechol; 5-(2-Propenyl)-1,3-benzodioxole; Rhyuno oil; Safrene; Safrol (Spanish); Safrole MF; Shikimole; Shikomol

CAS Registry Number: 94-59-7

HSDB Number: 2653

RTECS Number: CY2800000

UN/NA & ERG Number: UN3082 (environmentally hazardous substances, liquid, n.o.s.)/171

EC Number: 202-345-4 [*Annex I Index No.:* 605-020-00-9]

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Human No Adequate Data, animal Sufficient Evidence, *possibly carcinogenic to humans*, Group 2B, 1987.

California Proposition 65 Chemical[102]: Cancer 1/1/1988

Hazard Alert: Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction).

List 1, DEA chemical code 8323 (Title 21 CFR1310.02)

Banned or Severely Restricted (US)[13]

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U203

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.081; Nonwastewater (mg/kg), 22

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xi; risk phrases: R45; R22; R36/37/38; R50/53; R62, R63, R68; safety phrases: S36/37/39; S41; S45; S53; S53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Safrole is a colorless to yellow liquid with an odor of camphor or sassafras. Molecular weight = 162; specific gravity (H_2O:1) = 1.1 @ 20°C; boiling point = 233°C; freezing/melting point = 11°C; vapor pressure = 1 mmHg @ 64°C; flash point = ~95°C. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 1, reactivity 0. Practically insoluble in water.

Potential Exposure: This compound has been used to flavor beverages and foods. It is also reported to be used in soap manufacture, perfumery, sleep aids, sedatives, and pesticides. The FDA estimated exposure to safrole of the general public through food consumption was extremely low since the Agency prohibited its used in food. Derived from oil of sassafras or camphor. Minimal exposure may occur through the use of edible spices, including nutmeg and mace, which contain low levels of naturally occurring safrole.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Safrole, an acetal, is readily hydrolyzed in acidic solution to give 4-allylpyrocatechol and formaldehyde (or formaldehyde polymers)[101].

Permissible Exposure Limits in Air

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 5.9 milligram per cubic meter

PAC-2: 64 milligram per cubic meter

PAC-3: 390 milligram per cubic meter

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin and respiratory tract. Contact can cause severe skin and eye irritation. Ingestion may cause abdominal burning, nausea and vomiting; diarrhea, dysuria, hematuria, unconsciousness, shallow respiration, and convulsions. Inhalation may cause dizziness; rapid and shallow breathing; tachycardia, bronchial irritation, and unconsciousness or convulsions. This compound can cause vomiting, shock, cyanosis, delirium and probably convulsions. Other effects may include circulatory collapse.

Long-Term Exposure: May be a carcinogen in humans.

First Aid: *Skin Contact:* Flood all areas of body that have contacted the substance with water. Don't wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others[52]. *Eye Contact:* Remove any contact lenses at once. Immediately flush eyes well with copious quantities of water or normal saline for at least 20−30 minutes. Seek medical attention. *Inhalation:* Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion:* Contact a physician, hospital or poison center at once. If the victim is unconscious or convulsing, do not induce vomiting or give anything by mouth. Assure that the patient's airway is open and lay him on his side with his head lower than this body and transport immediately to a medical facility. If conscious and not convulsing, give a glass of water to dilute the substance. Vomiting should not be induced without a physician's advice.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Green: General storage may be used. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in a refrigerator or a cool, dry place. Where possible, automatically transfer material from drums or other storage containers to process containers Sources of ignition, such as smoking and open flames are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established, or stored in compliance with OSHA Standard 1910.1045.

Shipping: Environmentally hazardous substances, liquid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources:[52] Remove all sources of ignition, ventilate the spill area, and use absorbent to pick up spilled material. Follow by washing surfaces well, first with 60% to 70% ethanol and water, then with soap and water. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform to EPA regulations governing storage, transportation, treatment, and waste disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(109); (102); (31); (173); (101); (138); (100).

Salicylic Acid S:0120

Formula: $C_7H_6O_3$; $C_6H_4(OH)COOH$

Synonyms: *o*-Hydroxybenzoic acid; 2-Hydroxybenzoic acid; Keralyt; Orthohydroxybenzoic acid; Retarder W; SA; SAx

CAS Registry Number: 69-72-7

HSDB Number: 672

RTECS Number: VO0525000

UN/NA & ERG Number: Not subject to regulation.

EC Number: 200-712-3

Regulatory Authority and Advisory Information

United States Environmental Protection Agency Gene-Tox Program, Positive: *S. cerevisiae*-reversion; Negative: Histidine reversion-Ames test.

Hazard Alert: Combustible, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction).

FDA-over the counter drug

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazard symbols, risk, & safety statements: Hazard symbol: Xn; risk phrases: R22; R36/37/38; R41; R62; R63; safety phrases: S16; S26; S36/37/39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Salicylic acid is a white to tan crystalline solid; needles. Molecular weight = 138.13; specific gravity (H_2O:1) = 1.4 @ 20°C; boiling point = 76°C (sublimes); freezing/melting point = 158°C; flash point = 157°C; autoignition temperature = 540°C. Explosive limits: LEL = 1.1% @ 200°C; UEL-unknown. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 0, reactivity 1. Practically insoluble in water; solubility = 1700 ppm @ 20°C; 2059 ppm @ 25°C.

Potential Exposure: Used as a topical keratolytic agent; in manufacture of aspirin, salicylates, resins, as a dyestuff intermediate; prevulcanization inhibitor; analytical reagent; fungicide, antiseptic, and food preservative.

Incompatibilities: iron salts; lead acetate; iodine. Forms an explosive mixture in air.

Permissible Exposure Limits in Air

PAC Ver. 27. No value in Ver. 29[138]

PAC-1: 0.11 milligram per cubic meter

PAC-2: 1.2 milligram per cubic meter

PAC-3: 180 milligram per cubic meter

Routes of Entry: Ingestion, inhalation, eyes and/or skin contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Overexposure may affect the central nervous system (CNS) and the body's acid–base balance, causing delirium and tremors. *Inhalation:* May cause ringing in the ears, confusion, rapid pulse, and breathing; headache, dizziness, nausea, and vomiting. *Skin:* May be very irritating and cause skin sores. May act as a systemic poison if applied to large areas of the skin. *Eyes:* Causes irritation; may be severe. *Ingestion:* 10 g may cause headache, dizziness, nausea, and vomiting. Ingestion of about 1 oz may be fatal.

Long-Term Exposure: Repeated large doses may cause, in addition to the symptoms listed above: abdominal pain; loss of appetite; heartburn, poor digestion; stomach ulcers; bleeding of the stomach; iron-deficiency anemia; restlessness, incoherent speech; tremor, kidney damage; coma, convulsions, and death. Repeated or prolonged contact with skin may cause acne-like skin sores.

Points of Attack: Skin, blood, kidneys.

Medical Surveillance: Complete blood count (CBC). Kidney function tests. Evaluation by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. *Skin contact*: remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to Physician: Induced emesis, gastric lavage; activated charcoal; or a combination of these, may be necessary to clear the gastrointestinal tract. Sodium bicarbonate (IV) with added potassium may be necessary for blood acidosis.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Green: General storage may be used. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area away from light.

Shipping: Not regulated.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Thermal decomposition products may include phenol and oxides of carbon. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New York State Department of Health, *Chemical Fact Sheet:* Salicylic Acid, Bureau of Toxic Substance Assessment, Albany, NY (April 1986).

Sarin (Agent GB) S:0130

Formula: $C_4H_{10}FO_2P$; $(CH_3)_2CHOP(CH_3)OF$

Synonyms: Fluoroisopropoxymethyl oxide; GB (military designation); IMPF; Isopropoxymethylphoryl, fluoride; Isopropyhyl methylphosphonofluoridate; Isopropyl methylfluorophosphate; *O*-Isopropyl methylphosphonofluoridate; Isopropyl methylphosphonofluoridate; Isopropyl-methylphosphoryl fluoride; Methylfluorophosphoric acid isopropyl ester; Methylfluorphosphorsaeureisopropylester (German); Methylphosphonofluoridic acid isopropyl ester; Methylphosphonofluoridic acid 1-methylethyl ester; MFI; Sarina (Spanish); Sarin II; T-144; T-2106; Tl 1618; Trilone 46

CAS Registry Number: 107-44-8; 50642-23-4

HSDB Number: 6382

RTECS Number: TA84000000

UN/NA & ERG Number: (PIH) UN2810 (toxic liquid, organic, n.o.s.)/153

EC Number: None found.

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity: *Theft hazard* CUM 100 g (*107-44-8; 1445-76-7 Chlorosarin, a precursor*).

Carcinogenicty: GB is not listed by the IARC; American Conference of Governmental Industrial Hygienists (ACGIH); OSHA; or National Toxicology Program (NTP) as a carcinogen.

Hazard Alert: Poison inhalation hazard: exposure can be lethal, Combustible, Danger! Nerve agent (deadly, quick acting nerve gas); Poor warning properties.

OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 100 lb (45 kg)

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 10 lb (4.54 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg)

United States Department of Transportation (DOT) 49CFR172.101, Inhalation Hazard Chemical *Note:* Army Regulation, AR 50-6, deals specifically with the shipment of chemical agents; must be escorted in accordance with Army Regulation, AR 740-32.

Hazard symbols, risk, & safety statements: Hazard symbol: T+; risk phrases: R27/28; R33; R50/53; safety phrases: S1; S13; S28; S41; S45 (see Appendix 4)

Description: Sarin (GB), a nerve agent, is one of the most toxic of the known chemical warfare agents. Exposure to sarin can cause death in minutes. A fraction of an ounce (1 to 10 mL) of GB on the skin can be fatal. GB is an odorless, colorless, tasteless, nonflammable liquid @ 15°C and 1 atm. *GB has no warning properties, especially when pure, and it can take away your sense of smell.* Molecular weight = 140.09; specific gravity (H_2O:1) = 1.080 @ 25°C; 1.10 @ 20°C; boiling point = 147°C; freezing/melting point = −57°C; vapor pressure = 2.86 mm @ 25°C; 2.1 mmHg @ 20°C; liquid density = 1.10 g/mL @ 20°C; relative vapor density (air = 1) = 4.86; vapor density = 4.9; volatility = 22,000 milligram per cubic meter @ 25°C. Flash point = > 280°C; 78°C (cc)[77]. Explosive limits: LEL = 10,000 ppm[138], UEL: unknown; Hazard identification (based on NFPA-704 M Rating System): Health 4, flammability 1, reactivity 0. Sinks in water; soluble in water and hydrolyzes, yielding hydrochloric acid, thiodiglycol, and nonvesicant arsenic compounds. The hydrolysis products are considerably less toxic than the material itself. *Note:* If it is used as a weapon, notify United States Department of Defense: Army. If a means of detection is available, use M-8 paper (detection: yellow) or M256-A1 Detector Kit (detection limit: 0.005 milligram per cubic meter). *Warning: A single drop on the skin can be fatal.* Damage and/or death may occur before chemical detection can take place.

Potential Exposure: GB is used as a quick-acting chemical warfare nerve agent; nerve gas. Both the liquid and the vapor can kill you. Very small amounts can hurt you in one minute or less, and can quickly lead to death. *A single drop, if vaporized, can kill everyone in a room*[136]! Sarin is 26 times more deadly than cyanide gas and 20 times more deadly than Potassium cyanide.

Persistence of Chemical Agent: Sarin (GB): Summer: 10 minutes to 24 hours; Winter: 2 hours to 3 days.

Incompatibilities: Attacks tin, magnesium, cadmium plated steel; and some aluminums. GB decomposes tin, magnesium, cadmium-plated steel, and aluminum. Slightly corrosive to brass, copper, and lead. No attack on 1020 steel, Inconel, and K-Monel. Hydrolyzed by water. In acid conditions, GB hydrolyzes, forming hydrofluoric acid (HF). Rapidly hydrolyzed by dilute aqueous sodium hydroxide (NaOH), or sodium carbonate, forming relatively nontoxic products of polymers and isopropyl alcohol. Contact with metals may evolve flammable hydrogen gas.

Permissible Exposure Limits in Air

IDLH: 0.1 milligram per cubic meter

STEL: 0.0001 milligram per cubic meter

107-44-8, GB

PAC* Ver. 29[138]

PAC-1: **4.80E-04**$_\mathbf{A}$ (0.00048A) ppm

PAC-2: **0.006**$_\mathbf{A}$ ppm

PAC-3: **0.022**$_\mathbf{A}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60-minute values.

Worker population limit: 0.00003 milligram per cubic meter

The suggested permissible airborne exposure concentration of Sarin (GB) for an 8-hour work-day or a 40-hour work-week is an 8-hour time weighted average (TWA) of 0.00003 milligram per cubic meter (2×10^{-5} ppm). This value is based on the TWA of GB as proposed in the USAEHA Technical Guide No. 169, *Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Nerve Agents GA, GB, GD, and VX.*

GPL (General population limit): 0.000001 milligram per cubic meter

Also, the general population limits (as recommended by the Surgeon General's Working Group, United States Department of Health): 0.000003 milligram per cubic meter. *Human Toxicity:* The human lethal dose (man) is approximately 0.01 mg/kg. LCt_{50} = 100 mg-min/m^3. LD_{50} [skin] = 1.7 g/70 kg [man] (*Medical Aspects of Chemical and Biological Warfare, Part I*, Walter Reed Medical Center, 1997)

Determination in Air: Available monitoring equipment for agent GB is the M8/M9 detector paper, detector ticket, Blue band tube, M256/M256A1 kits, bubbler, Depot Area Air Monitoring System; Automatic Continuous Air Monitoring System; Real Time Monitoring; Demilitarization Chemical Agent Concentrator; M8/M43, M8A1/M43A2, Hydrogen Flame Photometric Emission

Detector; CAM-M1, Miniature Chemical Agent Monitor; and the Real Time Analytical Platform. Real-time, low-level monitors (with alarm) are required for GB operations. In their absence, an IDLH atmosphere must be presumed. Laboratory operations conducted in appropriately maintained and alarmed engineering controls require only periodic low-level monitoring.

Determination in Water: Use M-272 Chemical Agent Water Testing Kit. Detection limit for nerve agents is 0.02 mg/L. Also, for cyanides, distillation followed by silver nitrate titration or colorimetric analysis using pyridine pyrazolone (or barbituric acid). *Food chain concentration potential:* sarin is soluble in water; bioconcentration in aquatic organisms is not expected to be an important fate process [United States Army Corps of Engineers. Special Report 86−38, Britton, K. B., *Low Temperature Effects on Sorption, Hydrolysis, and Photolysis of Organophosphates: A Literature Review, p. 23*. Washington DC, 1986]. Octanol−water coefficient: Log K_{ow} (estimated) = −1.4.

Water pollution: If used as a weapon, utilize an M272 Water Detection Kit (Detection limit: 0.02 mg/L). Dangerous to aquatic life in high concentrations. May be dangerous if it enters water intakes. Notify local health and pollution control officials. Notify operators of nearby water intakes. This material will be broken down in water quickly, but small amounts may evaporate. This material will be broken down in moist soil quickly. Small amounts may evaporate into the air or travel below the soil surface and contaminated groundwater.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Extremely toxic; vapor $LCt_{50} = 100$ mg min/m^3. Extremely active cholinesterase inhibitor. Toxic effects similar to, but more severe than those of parathion. Liquid, LD_{50} (skin) = 1.7 g/70 kg man; sarin: (mice) 200 μg/kg. A single drop on the skin can cause death. Death may occur within 15 minutes after fatal dose is absorbed. Symptoms of overexposure may occur within minutes or hours-depending upon dose. They include: miosis (constriction of pupils) and visual effects; headache and pressure sensation; runny nose and nasal congestion; salivation, tightness in the chest; nausea, vomiting, giddiness, anxiety, difficulty in thinking; difficulty sleeping, nightmares, muscle twitches, tremors, weakness, abdominal cramps; diarrhea, involuntary urination, and defecation.

Long-Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions and respiratory failure. Limited data suggest that chronic or repeated exposure to GB may result in a delayed postural sway and/or impaired psychomotor performance (neuropathy).

Points of Attack: Respiratory system; CNS; skin, eyes, plasma, and red blood cell cholinesterase. Liver and kidney damage.

Medical Surveillance: Patients/victims who have severe exposure should be evaluated for persistent CNS effects. Consider the points of attack in preplacement and periodic physical examinations. CBC. Evaluation of thyroid function. Lung function tests. CNS tests. Liver and kidney function tests.

First Aid: Administration of antidotes is a critical step in managing a patient/victim. However, this may be difficult to achieve in the Red Zone, because the antidotes may not be readily available, and procedures or policies for their administration in the Red Zone may be lacking. Do not administer antidotes preventatively; there is no benefit to doing so. Diazepam (or other benzodiazepines) should be administered when there is evidence of seizures, usually seen in cases of moderate to severe exposure to a nerve agent. Remember, physical findings of localized exposure often precede systemic exposure and physical findings[77]. *Inhalation*: Hold breath until respiratory protective mask is donned. If severe signs of agent exposure appear (chest tightens, pupil constriction; a lack of coordination; etc.), immediately administer, in rapid succession, all three Nerve Agent Antidote Kit(s), Mark I injectors (or atropine if directed by the local physician). Injections using the Mark I kit injectors may be repeated @ 5 to 20 minutes intervals if signs and symptoms are progressing until three series of injections have been administered. No more injections will be given unless directed by medical personnel. In addition, a record will be maintained of all injections given. If breathing has stopped, give artificial respiration. Mouth-to-mouth resuscitation should be used when approved mask-bag or oxygen delivery systems are not available. Do not use mouth-to-mouth resuscitation when facial contamination exists. If breathing is difficult, administer oxygen. *Seek medical attention immediately*. *Eye contact:* Immediately flush eyes with water for 10−15 minutes, then don respiratory protective mask. Although miosis (pinpointing of the pupils) may be an early sign of agent exposure, an injection will not be administered when miosis is the only sign present. Instead, the individual will be taken *immediately* to the medical treatment facility for observation. *Skin contact:* Don respiratory protective mask and remove contaminated clothing. Immediately wash contaminated skin with copious amounts of soap and water, 10% sodium carbonate solution, or 5% liquid household bleach. Rinse well with water to remove decontaminant. Administer an intramuscular injection with the *Mark I* Kit injectors only if local sweating and muscular twitching symptoms are observed. *Seek medical attention immediately*.

Ingestion: Do not induce vomiting. First symptoms are likely to be gastrointestinal. Immediately administer an intramuscular injection of the *Mark I* kit auto-injectors.

Medical Treatment: Electrocardiogram (ECG), and adequacy of respiration and ventilation, should be monitored. Supplemental oxygenation, frequent suctioning of secretions, insertion of a tube into the trachea (endotracheal intubation), and assisted ventilation may be required. Diazepam (5 to 10 mg in adults and 0.2 to 0.5 mg/kg in children) may be used to control convulsions. Lorazepam or other benzodiazepines may be used, but barbiturates, phenytoin, and other anticonvulsants are not effective. Administration of atropine (if not already given) should precede the administration of benzodiazepines in order to best control seizures. Patients/victims who have inhalation exposure and who complain of chest pain, chest tightness, or cough should be observed and examined periodically for 6 to 12 hours to detect delayed-onset inflammation of the large airways (bronchitis), inflammatory lung disease (pneumonia), accumulation of fluid in the lungs (pulmonary edema), or respiratory failure[77].

Decontamination: This is very important. The rapid physical removal of a chemical agent is essential. If you don't have the equipment and training, don't enter the hot or the warm zone to rescue and/or decontaminate victims. Medical personnel should wear the proper PPE. If the victim can't move, decontaminate without touching and without entering the hot or the warm zone. Nerve gasses stay in clothing; *do not* touch with bare skin—if possible, seal contaminated clothes and personal belongings in a sealed double bag. Use clean water from any source; if possible, use a hose (spray or fog to prevent injury to the victim) or other system to avoid touching the victim. Don't wait for soap or for the victim to remove clothing, begin washing immediately. Do not delay decontamination to obtain warm water; time is of the essence; use cold water instead. Immediately flush the eyes with water for at least 15 minutes. Use caution to avoid hypothermia in children and the elderly. Wash−strip−wash−evacuate up wind and uphill: Patients exposed to nerve agent by vapor only should be decontaminated by removing all clothing in a clean-air environment and shampooing or rinsing the hair to prevent vapor-off gassing; Patients exposed to liquid nerve agent should be decontaminated by washing in available clean water at least three times. Use liquid soap (dispose of container after use and replace), large amounts of water, and mild to moderate friction with a single-use sponge or washcloth in the first and second washes. Scrubbing of exposed skin with a brush is discouraged; skin damage may occur and may increase absorption. The third wash should be to rinse with large amounts of warm or hot water. Shampoo can be used to wash the hair. Decontaminate with diluted household bleach* (0.5%, or one part bleach to 200 parts water), but don't let any get in the victim's eyes, open wounds, or mouth. Wash off the diluted bleach solution after 15 minutes. Remember that the water you use to decontaminate the victims is dangerous. Be sure you've decontaminated the victims as much as you can before they are released from the area, so they don't spread the nerve gas. Rinse the eyes, mucous membranes; or open wounds with sterile saline or water and then move away from the hot zone in an upwind and uphill direction.

**Note*: The following can be used in addition to household bleach: (1) solids, powders, and solutions containing various types of bleach (NaOCl or $Ca(OCl)_2$); (2) DS2 (2% NaOH, 70% diethylenetriamine, 28% ethylene glycol monomethyl ether) (3) towelettes moistened with NaOH dissolved in water, phenol, ethanol, and ammonia. *Note:* Use 5% solution of common bleach (sodium hypochlorite) or calcium hypochlorite solution (48 oz per 5 gal of water) to decontaminate scissors used in clothing removal, clothes, and other items.

Personal Protective Methods:

General information: first responders should use a NIOSH-certified chemical, biological, radiological, nuclear (CBRN) SCBA with a level a protective suit when entering an area with an unknown contaminant or when entering an area where the concentration of the contaminant is unknown. Level a protection should be used until monitoring results confirm the contaminant and the concentration of the contaminant. *Note:* Safe use of protective clothing and equipment requires specific skills developed through training and experience.

LEVEL A: (*RED ZONE*): select when the greatest level of skin, respiratory, and eye protection is required. This is the maximum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than the AEGL-2. A NIOSH-certified CBRN full-face-piece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle. A totally encapsulating chemical protective (TECP) suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, and a hard hat worn under the TECP suit are optional items.

LEVEL B: (RED ZONE): Select when the highest level of respiratory protection is necessary but a lesser level of skin protection is required. This is the minimum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than AEGL-2. It differs from Level A in that it incorporates a nonencapsulating, splash-protective, chemical-resistant splash suit that provides Level A protection against liquids but is not airtight. A NIOSH-certified CBRN full-face-piece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL C: (YELLOW ZONE): Select when the contaminant and concentration of the contaminant are known and the respiratory protection criteria factors for using Air Purifying Respirators (APR) or Powered APR (PAPR) are met. This level is appropriate when decontaminating patient/victims. A NIOSH-certified CBRN tight-fitting APR with a canister-type gas mask or CBRN PAPR for air levels greater than AEGL-2. A NIOSH-certified CBRN PAPR with a loose-fitting face-piece, hood, or helmet and a filter or a combination organic vapor, acid gas, and particulate cartridge/filter combination or a continuous flow respirator for air levels greater than AEGL-1. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Escape mask, face shield, coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL D: (GREEN ZONE): Select when the contaminant and concentration of the contaminant are known and the concentration is below the appropriate occupational exposure limit or less than AEGL-1 for the stated duration times. Limited to coveralls or other work clothes, boots, and gloves.

Notes: Take all necessary precautions to prevent any reasonable probability of skin or eye contact. Wear protective "A-Level" PPE: rubber gloves, protective clothing; goggles, respirators. butyl rubber gloves M3 and M4, Norton chemical protective glove set; and Tyvek "F" decontamination suit provides barrier protection against chemical warfare agents. Airtight, impermeable clothing was developed for personnel who must enter heavily contaminated areas. This clothing is made of butyl rubber or a coated fabric, such as Tyvek "F" and provides barrier protection against liquid chemical warfare agents. Although resistant to liquid chemical agents, impermeable protective clothing may be penetrated after a few hours of exposure to heavy concentration of agent. Consequently, liquid contamination on the clothing must be neutralized or removed as soon as possible. If the proper equipment is not available, or if the rescuers have not been trained in its use, call for assistance from the United States Soldier and Biological Chemical Command—Edgewood Research Development and Engineering Center (from 0700-1630 EST call 410-671-4411, and from 1630-0700 EST call 410-278-5201; ask for the Staff Duty Officer). All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Swatch Test Results for Level A Suits and Chemical Protective Gloves for GB (Sarin)

Item	*Breakthrough*
25-mil Chemical protective gloves	>480 min
Kappler Suit Model 42483	350 min
TYCHEM 10,000 Pkg Style No. 12645	>480 min
Trellchem HPS suit	>480 min
Ready 1 Limited Use Suit: Model 91	>480 min
First Team XE HazMat suit	>480 min
Commander Ultrapro Suit, Style 79102	>480 min
Kappler Suit Model 50660	>480 min
TYCHEM Style No. 11645	>480 min
Trellchem TLU suit	>480 min
Chemturion Suit: Model 13	>480 min
Chempruf II BETEX Suit	225 min
Commander Brigade: F91	>480 min

Respirator Selection: *When used as a weapon, use SCBA Respirator Certified By NIOSH For CBRN Environments. Emergency or planned entry into unknown concentrations or* IDLH *conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *ESCAPE:* GmFOvHie [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister having a high efficiency particulate filter]; or SCBAE (any appropriate escape-type, SCBA). The United States Army standard M40 Series (which replaced the M17A1 protective mask) provides complete respiratory protection against all known military toxic chemical agents, but it cannot be used in an oxygen deficient environment and it does not afford protection against industrial toxics, such as ammonia and carbon monoxide. *It is not approved for civilian use.*

The following is taken from the Riegle Report:

Less than 0.0001 milligram per cubic meter: A full facepiece, chemical canister, air purifying protective mask will be on hand for escape. (The M9-, or M40-series masks are acceptable for this purpose). *0.0001 to 0.2 milligram per cubic meter:* A NIOSH/MSHA (US) or EN149 (Europe)-approved pressure demand full facepiece SCBA or supplied air respirator with escape air cylinder may be used. Alternatively, a full facepiece, chemical canister air purifying protective mask is acceptable for this purpose (for example, M9-, M17-, or M40-series mask or other mask certified as equivalent) is acceptable. *Greater than 0.2 milligram per cubic meter or unknown concentration:* NIOSH/MSHA or European Standard EN 149-approved pressure demand full facepiece SCBA suitable for use in high agent concentrations with protective ensemble.

Storage: Color code—Blue: Health Hazard/Toxics/Poisons: Store in a secure, locked, well-marked, poison location. In handling, the buddy system will be incorporated. No smoking, eating, and drinking in areas containing agent is permitted. Containers should be periodically inspected for leaks (either visually or by a detector kit). Stringent control over all personnel practices must be exercised. Decontamination equipment shall be conveniently located. Exits must be designed to permit rapid evacuation. Chemical showers, eye-wash stations, and personal cleanliness facilities must be provided. Wash hands before meals and each worker will shower thoroughly with special attention given to hair, face, neck, and hands, using plenty of soap before leaving at the end of the work-day.

Shipping: UN2810 Toxic liquids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poison Inhalation Hazard, Technical Name Required. Driver shall be given full and complete information regarding shipment and conditions in case of emergency. AR 50-6 deals specifically with the shipment of chemical agents. Shipments of agent will be escorted in accordance with AR 740-32. Passenger aircraft/rail: FORBIDDEN; Cargo aircraft only: FORBIDDEN. The packaging and shipping of samples are subject to strict regulations established by the Department of Transportation (DOT), Center for Disease Control, United States Postal Service, OSHA, and International Air Transport Association). Military driver shall be given full and complete information regarding shipment and conditions in case of emergency. AR 50-6 deals specifically with the shipment of chemical agents. Shipments of agent will be escorted in accordance with AR 740-32.

Spill Handling:
UN2810 Toxic liquids, organic, n.o.s.
Initial isolation and protective action distances
Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)
First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 0.7/1.2

Large spills (From a large package or from many small packages)
First: Isolate in all directions (ft/m) 1000/300
Then: Protect persons downwind (mi/km)
Day 1.1/1.8
Night 2.8/4.5

GB when used as a weapon
Small spills (From a small package or a small leak from a large package)
First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.3/0.5
Night 0.7/1.3

Large spills (From a large package or from many small packages)
First: Isolate in all directions (ft/m) 1250/400
Then: Protect persons downwind (mi/km)
Day 1.3/2.0
Night 3.0/4.8

Spills must be contained by covering with vermiculite, diatomaceous earth; clay, fine sand; sponges, and paper or cloth towels. Decontaminate with copious amounts of aqueous NaOH solution (a minimum 10 wt.%). Scoop up all material and place in a fully removable head drum with a high density polyethylene liner. Cover the contents of the drum with decontaminating solution as above before affixing the drum head. After sealing the head, the exterior of the drum shall be decontaminated and then labeled in accordance with IAW, EPA, and DOT regulations. All leaking containers shall be over-packed with vermiculite placed between the interior and exterior containers. Decontaminate and label in accordance with IAW, EPA, and DOT regulations. Dispose of material used to decontaminate exterior of drum. Conduct general area monitoring with an approved monitor to confirm that the atmospheric concentrations do not exceed the airborne exposure limit. If 10 wt.% aqueous NaOH solution is not available then the following decontaminants may be used instead and are listed in the order of preference: Decontaminating Solution No. 2 [DS2: (2% NaOH, 70% diethylenetriamine, 28% ethylene glycol monomethyl ether)], sodium carbonate; and Super-tropical Bleach Slurry (STB).

Fire: If tank, rail car, or tank truck is involved in fire, isolate for at least 800 m (1/2 mi) in all directions; also, consider initial evacuation for 800 m (1/2 mi) in all directions. Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Rapidly hydrolyzed by dilute aqueous NaOH or sodium carbonate forming relatively nontoxic products. Water alone removes the fluorine atom producing a nontoxic acid. Decontaminants include bleach slurry; dilute alkali; hot soapy water; steam, and ammonia. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. See also above "Determination in Water." Soil: 2 to 24 hours @ 5−25°C.

Fire Extinguishing: Highly volatile poison! (organophosphate). Breathing the vapor, skin [A single drop on the skin can be fatal] or eye contact, or swallowing the material can kill you; symptoms may be delayed for several hours. Thermal decomposition products may include fluorides and oxides of phosphorus and carbon. If exposure occurs, remove and isolate gear immediately and thoroughly decontaminate personnel. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. Vapors are heavier than air and will collect and stay in low areas. *Combustion products are less deadly than the material itself.* Toxic products of combustion may include carbon monoxide, fluorine, and phosphorus oxide. GB will react with steam or water to produce toxic & corrosive vapors. All persons not engaged in extinguishing the fire should be evacuated. Fires involving GB should be contained to prevent contamination to uncontrolled areas. When responding to a fire alarm in buildings or areas containing agents, firefighting personnel clothing (without TAP clothing) during chemical agent firefighting and fire rescue operations. Respiratory protection is required. Positive pressure, full facepiece, NIOSH-approved SCBA will be worn where there is danger of oxygen deficiency and when directed by the fire chief or chemical accident/incident (CAI) operations officer. In cases where firefighters are responding to a CAI for rescue/reconnaissance purposes, they will wear appropriate levels of protective clothing. Complete protection required; have available decontaminants (bleach, alkali) and atropine. Use dry chemical, carbon dioxide; or foam extinguishers. Vapors are heavier than air and will collect in low areas. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156.

Disposal Method Suggested: Principles and methods for destruction of chemical weapons: "Destruction of chemical weapons" means a process by which chemicals are converted in an essentially irreversible way to a form unsuitable for production of chemical weapons, and which in an irreversible manner renders munitions and other devices unusable as such. Each nation shall determine how it shall destroy chemical weapons, except that the following processes may not be used: dumping in any body of water, land burial, or open-pit burning. It shall destroy chemical weapons only at specifically designated and appropriately designed and equipped facilities. Each nation shall ensure that its chemical weapons destruction facilities are constructed and operated in a manner to ensure the destruction of the chemical weapons; and that the destruction process can be verified under the provisions of this Convention (Organization for the Prohibition of Chemical Weapons; Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and Their Destruction). Open pit burning or burying of GB or items containing or contaminated with GB in any quantity is prohibited. The detoxified GB using procedures above can be thermally destroyed by incineration in an EPA approved incinerator in accordance with appropriate provisions of federal, state and local RCRA regulations. A minimum of 56 g of decon solution is required for each gram of GB. A minimum of 65 g of decontamination fluid per gram of HD is allowed to agitate for a minimum of 1 hour. Agitation is not necessary following the first hour. At the end of the 1 hour, the resulting solution should be adjusted to a pH greater than 11.5. If the pH is below 11.5, NaOH should be added until a pH above 11.5 can be maintained for 60 minutes. An alternate solution for the decontamination of GB is 10% wt. Sodium carbonate in place of the 10% NaOH solution above. Continue with 56 g of decon to 1 g of agent. Agitate for 1 hour but allow 3 hours for the reaction. The final pH should be adjusted to above 10. It is also permitted to substitute 5.25% sodium hypochlorite or 25 wt.% monoethylamine (MEA) for the 10% NaOH solution above. MEA must be completely dissolved in water prior to addition of the agent. Continue with 56 g of decon for each gram of GB and provide agitation for 1 hour. Continue with same ratios and time stipulations. Scoop up all material and place in a fully removable head drum with a high density polyethylene liner. Cover the contents of the drum with decontaminating solution as above before affixing the drum head. After sealing the head, the exterior of the drum shall be decontaminated and then labeled per IAW, EPA, and DOT regulations. All leaking containers shall be over-packed with vermiculite placed between the interior and exterior containers. Decontaminate and label per IAW, EPA and DOT regulations. Dispose of the material per IAW waste disposal methods provided below. Dispose of material used to decontaminate exterior of drum in accordance with IAW, Federal, state, and local regulations. Conduct general area monitoring with an approved monitor to confirm that the atmospheric concentrations do not exceed the airborne exposure limit.

References

(31); (173); (101); (138); (85); (86); (87); (169); (93); (94); (103); (105); (163); (176).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Sarin, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

Sethoxydim S:0205

Formula: $C_{17}H_{29}NO_3S$
Synonyms: Aljaden; Alloxol S; ARD 34/02; BASF 9052; Caswell No. 072A; Checkmate; Conclude; 2-Cyclohexen-1-one, 2-[1-(ethoxyimino)butyl]-5-[2-(ethylthio)propyl]-3-hydroxy-; Cyethoxydim; (±)-2-[1-(Ethoxyimino)butyl]-5-[2-(ethylthio)propyl]-3-hydroxy-2-cyclohexen-1-one; 2-[1-(Ethoxyimino) butyl]-5-[2-(ethylthio)propyl]-3-hydroxyl-2-cyclohexen-1-one; 2-[1-(Ethoxyimino)butyl]-5-[2-(ethylthio)propyl]-3-hydroxy-2-cyclohexen-1-one; 2-[1-(Ethoxyimino)butyl]-5-[2-(ethylthio)propyl]-3-hydroxyl-2-cyclohexen-1-one; (*ZE*)-2-(1-Ethoxyiminobutyl)-5-[2-(ethylthio)propyl]-3-hydroxycyclohex-2-enone; Expand; Fervinal; Grasidim; Grassout; Nabu; NP-55; Poast; Sethoxydim cyclohexanone herbicide; Tritex-extra; Ultima; Vantage
CAS Number: 74051-80-2
HSDB Number: 7342
RTECS Number: GW7191000
UN/NA & ERG Number: UN3082 (environmentally hazardous substances, liquid, n.o.s.)/171
EC Number: 277-682-3
Regulatory Authority and Advisory Information
Carcinogenicity[83]: EPA Not likely to be carcinogenic to humans.
Hazard Alert: Combustible, Suspected reprotoxic hazard, Reproductive toxin[138]
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%
Hazard symbols, risk, & safety statements: Hazard symbol: T; risk phrases: R23/25; R33; R51/53; safety phrases: S1/2; S20/21; S28; S41; S45 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.
Description: Oily, amber liquid. Odorless. Flammable. Commercial product is available as an emulsifiable concentrate. Molecular weight = 327.53; specific gravity (H_2O:1) = 1.04 @ 20°C; vapor pressure = 1.6×10^{-7} mmHg @ 20°C. Hazard identification (based on NFPA-704M Rating System): Health 2, flammability 2, reactivity 0. Highly soluble in water. Henry's Law constant = 2.2×10^{-11} atm m^3/mol @ 25°C (est)[83]. Highly soluble in water. Physical and toxicological properties may be affected by carrier solvents in commercial formulations.
Potential Exposure: A selective postemergence cyclohexadione/cyclohexenone herbicide used to control both annual and perennial grass weeds in broad-leaved vegetables, field crops, fruit, ornamentals, and indoor applications.
Incompatibilities: Incompatible with strong acids, oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.). Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Incompatible with all copper compounds.
Permissible Concentration in Air:
PAC Ver. 29[138]
PAC-1: 9.6 milligram per cubic meter
PAC-2: 110 milligram per cubic meter
PAC-3: 630 milligram per cubic meter
Determination in Water: Octanol–water coefficient: Log K_{ow} = > 4.0 @ (pH = 5). Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.
Routes of Entry: Ingestion, inhalation, dermal and/or eye contact. May be absorbed through the unbroken skin.
Harmful Effects and Symptoms
Short-Term Exposure: Contact may burn eyes, skin, and respiratory tract. Toxic if ingested. If swallowed, this chemical may cause pulmonary edema and other lung damage. LD_{50} (oral, rat) = 3145 mg/kg [FR48128(8/5/1998)]; LD_{50} (dermal, rat) = > 5 g/kg[9].
Long-Term Exposure: May cause liver, thyroid, bladder, or bone marrow damage. Reproductive and fetal effects.
Points of Attack: Liver, bladder, thyroid, lungs, bone marrow; reproductive cells.
Medical Surveillance: Preliminary medical exam to detect chronic diseases of CNS, liver, heart, kidneys, lung and skin, as well as endocrinological or immunological disturbances, should protect susceptible individuals. Periodical medical exams of internal organs, skin and eyes are important to avoid chronic occupational intoxications. They should include lab and patch tests when necessary[83]. Consult a physician if poisoning is suspected or if redness, itching, or burning of the eyes or skin develop. CBC. Thyroid and liver function tests.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. *Do not induce vomiting when formulations containing petroleum solvents are ingested.* Otherwise, give large quantities of water and induce vomiting. Do not make an unconscious person vomit.
Personal Protective Methods: Applicators and other handlers must wear: Coveralls worn over long-sleeved shirt and long pants; Chemical-resistant gloves such as DuPont Tychem suit fabrics, barrier laminate, or Viton; Chemical-resistant footwear plus socks; Protective eye wear; Chemical-resistant headgear for overhead exposure; Chemical-resistant apron when cleaning equipment, mixing, or loading[83]. Agricultural Use/Engineering Controls:

When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the Worker Protection Standard (WPS) for agricultural pesticides, 40 CFR 170.240(d)(4-6), the handler PPE requirements may be reduced or modified as specified in the WPS. Firefighters should wear NIOSH approved SCBA and full protective clothing.

Respirator Selection: SCBA >9.6 milligram per cubic meter. Wherever and whenever workplace conditions warrant respirator use, a respiratory protection program must be followed that meets one or more of the following government standards: OSHA's 29 CFR 1910.134, ANSI Z88.2, or European Standard EN 149.

Shipping: UN3082 Environmentally hazardous substances, liquid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include toxic oxides of nitrogen, sulfur, and carbon. As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 m/150 ft for liquids and at least 25 m/75 ft for solids. *Fire involving storage or vehicular tanks:* Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. *On a small fire:* use dry chemical, CO_2, water spray or regular *foam. On a large fire:* use water spray, fog or regular foam. Do not scatter spilled material with high pressure streams of water. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal. *Fire involving tanks:* From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. Always stay away from tanks engulfed in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: It is the responsibility of chemical waste generators to determine the toxicity and physical properties and of a discarded chemical and to properly identify its classification and certification as a hazardous waste and to determine the disposal method. United States Environmental Protection Agency guidelines for the classification determination are listed in 40 CFR Parts 261.3. In addition, waste generators must consult and follow all regional, national, state, and local hazardous waste laws to ensure complete and accurate classification and disposal methods. Follow recommendations for the disposal of pesticides and pesticide containers. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Office of Pesticide Programs, Pesticide Residue Limits, "*Sethoxydim*," 40 CFR 180.412, http://www.epa.gov/pesticides/food/viewtols.htm.

EXTOXNET, Extension Toxicology Network, "Pesticide Information Profile, Sethoxydim," Oregon State University, Corvallis, OR (June 1996). http://extoxnet.orst.edu/pips/sethoxyd.htm.

Siduron S:0208

Formula: $C_{14}H_{20}N_2O$

CAS Number: 1982-49-6

Synonyms: Greenfield; Gro-tone; H-1318; 1-(2-Methylcyclohexyl)-3-phenylurea; *N*-(2-Methylcyclohexyl)-*N*′-phenylurea; Trey; Tupersan; Urea, *N*-(2-methylcyclohexyl)-*N*′-phenyl-

CAS Registry Number: 1982-49-6

HSDB Number: 1764

RTECS Number: YT7350000

UN/NA & ERG Number: UN2767 (solid)/151; UN3002 (liquid)/151

EC Number: 217-844-2

Regulatory Authority and Advisory Information.

Hazard Alert: Poison, Suspected reprotoxic hazard, Environmental hazard.

Potential Ground water Pollutant [California FAC Section 13145(d)/12811, active]

Hazardous to aquatic life or environment, with possible long-lasting effects[291]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xi, N; risk phrases: R36/37/38; R51/53; R63; safety phrases: S2; S26; S29/35; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Colorless or white crystalline solid or powder. Odorless. Commercial product is available as an emulsifiable concentrate. Molecular weight = 232.33; specific gravity (H_2O:1) = 1.08 @ 20°C; boiling point = (decomposes); freezing/melting point = 136°C; vapor pressure = 4×10^{-9} mmHg @ 20°C. Low solubility in water; solubility = 18.3 ppm @ 25°C. Henry's Law constant = 6.8×10^{-11} atm m^3/mol @ 25°C (est)[83]. Physical and toxicological properties may be affected by carrier solvents in commercial formulations.

Potential Exposure: A phenyl urea preemergence herbicide used to control annual grasses (e. g., crabgrass, foxtail, and barnyard grass) and on newly seeded or established turf and lawn grasses and as bare soil treatment following spring seeding.

Determination in Water: Octanol−water coefficient: Log K_{ow} = > 3.5. Values above 3.0 are likely to bioaccumulate in marine organisms.

Determination in Air: Filter; none; Gravimetric; NIOSH IV [Particulates NOR; #0500 (total), #0600 (respirable)][18].

Harmful Effects and Symptoms

Short-Term Exposure: Contact with eyes or skin may cause irritation or injury. Inhalation should be avoided; use NIOSH- or CEN (UK)-approved APR for pesticides. May be harmful if swallowed. Dermal contact may cause severe irritation or burns. LD_{50} (oral, rat) = >5 g/kg; LD_{50} (dermal, rat) = > 5 g/kg.

Long-Term Exposure: May cause skin sensitization. May cause reproductive and fetal effects.

Points of Attack: Skin. Reproductive cells.

Medical Surveillance: Evaluation by a qualified allergist, including exposure history and testing, may help diagnose allergy. Preliminary medical exam to detect chronic diseases of CNS, liver, heart, kidneys, lung, and skin, as well as endocrinological or immunological disturbances, should protect susceptible individuals. Periodical medical exams of internal organs, skin, and eyes are important to avoid chronic occupational intoxications. They should include lab and patch tests when necessary[83].

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions) if breathing has stopped, and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water. Do not induce vomiting when formulations containing petroleum solvents are ingested. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of dermal and/or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where the neat (undiluted) test chemical is weighed and diluted, wear a NIOSH-approved half face respirator equipped with a combination filter cartridge, i.e., organic vapor/acid gas/HEPA (specific for organic vapors, HCl, acid gas, SO_2, and a high efficiency particulate filter)[88].

Storage: Color code—Blue: Health Hazard/Poison. Store in a tightly closed container in a dry, well-ventilated and secure poison location. Prior to working with this chemical all handlers should be trained on its proper handling and storage. Where possible, automatically transfer material from other storage containers to process containers. Store pesticides in original containers, complete with labels listing ingredients, use directions, and first aid. Keep them away from areas where flooding is possible or where they might leak into wells, drains, ground water, basements, or surface water.

Shipping: UN2767 Phenyl urea pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN3002 Phenyl urea pesticides, liquid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: First remove all sources of ignition. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Do not touch spilled material; stop leak if you can do it without risk. Use water spray to reduce vapors. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. *Large spills:* dike far ahead of spill for later disposal. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen and carbon. As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 m/150 ft for liquids and at least 25 m/75 ft for solids. *Fire involving storage or vehicular tanks:* Isolate for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m (1/2 mi) in all directions. *On a small fire:* use dry chemical, CO_2, water spray or regular *foam. On a large fire:* use water spray, fog or regular foam. Do not scatter spilled material with high pressure streams of water. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal. *Fire involving tanks:* From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. Always stay away from tanks engulfed in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incinerate in a unit with effluent gas scrubbing. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (100).

National Institutes of Health, Hazardous Substance Data Bank (HSDB), Toxicology Data Network, Bethesda, MD (2016).

Pesticide Management Education Program, "Siduron (Tupersan) Herbicide Profile 2/85," Cornell University, Ithaca, NY (February 1985). http://pmep.cce.cornell.edu/profiles/herb-growthreg/sethoxydim-vernolate/siduron/herb-prof-siduron.html.

Selenium S:0140

Formula: Se

Synonyms: C.I. 77805; Colloidal selenium; Elemental selenium; Selenate; Selenio (Spanish); Selenium (collodial); Selenium alloy; Selenium base; Selenium dust; Selenium elemental; Selenium homopolymer; Selenium powder

CAS Registry Number: 7782-49-2

HSDB Number: 4493

RTECS Number: VS7700000

UN/NA & ERG Number: UN3283/151

EC Number: 231-957-4 [*Annex I Index No.:* 034-001-00-2]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Inadequate Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1987; EPA: Not Classifiable as to human carcinogenicity.

Hazard Alert: Combustible Possible risk of forming tumors, Suspected of causing genetic defects, Environmental hazard.

Banned or Severely Restricted (in agriculture) (Germany, U.K.) (UN)[13]

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/1992); 40CFR401.15 Section 307 Toxic Pollutants

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): D010

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA Toxicity Characteristic (Section 261.24), Maximum Concentration of Contaminants, regulatory level, 1.0 mg/L

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.82; Nonwastewater (mg/L), 0.16 TCLP

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L); total dust 6010 (750); 7740 (20); 7741 (20)

United States National Primary Drinking Water Regulations: MCLG = 0.05 mg[Se]/L; MCL = 0.05 mg[Se]/L as selenium

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazardous to aquatic life or environment, with possible long-lasting effects[195]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R23/25; R33; R51/53; R62; safety phrases: S1/2; S20/21; S28; S29; S41; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Selenium exists in three forms: a red amorphous powder, a gray form, and red crystals. Occurs as an impurity in most sulfide ores. Selenium, along with tellurium, is found in the sludges and sediments from electrolytic copper refining. It may also be recovered in flue dust from burning pyrites in sulfuric acid manufacture. Molecular weight = 78.96; specific gravity (H_2O:1) = 4.28 @ 25°C; 4.81 @ 20°C; boiling point = 685°C; freezing/melting point = 221°C (red crystalline form); 217°C (gray crystalline form). Hazard identification (based on NFPA-704 M Rating System): (powder) Health 3, flammability 1, reactivity 1. Insoluble in water.

Potential Exposure: Most of the selenium produced is used in the manufacture of selenium rectifiers. It is also utilized as a pigment for ruby glass, paints, and dyes; as a vulcanizing agent for rubber; a decolorizing agent for green glass; a chemical catalyst in the Kjeldahl test; as an insecticide; in the manufacture of electrodes, selenium photocells, selenium cells, and semiconductor fusion mixtures; in photographic toning bathes; and for dehydrogenation of organic compounds. It is also used in veterinary medicine and in antidandruff shampoos. Se is used in radioactive scanning for the pancreas and for photostatic and X-ray xerography. It may be alloyed with stainless steel; copper, and cast steel. Selenium is a contaminant in most sulfide ores of copper, gold, nickel, and silver; and exposure may occur while removing selenium from these ores.

Incompatibilities: Reacts violently with strong acids and strong oxidizers, chromium trioxide; potassium bromate;

cadmium. Reacts with incandescence on gentle heating with phosphorous and metals, such as nickel, zinc, sodium, potassium, platinum. Reacts with water @ 50°C forming flammable hydrogen and selenious acids.

Permissible Exposure Limits in Air

NIOSH IDLH = 1 mg[Se]/m^3

The PEL and REL also apply to other selenium compounds (as Se) except selenium hexafluoride; the MAK applies to Se and its inorganic compounds.

OSHA PEL: 0.2 mg[Se]/m^3 TWA

NIOSH REL (*except selenium hexafluoride*): 0.2 mg[Se]/m^3 TWA

ACGIH TLV[1]: 0.2 mg[Se]/m^3 TWA

PAC Ver. 29[138]

PAC-1: 0.6 milligram per cubic meter

PAC-2: 6.6 milligram per cubic meter

PAC-3: 40 milligram per cubic meter

DFG MAK (*metal and inorganic compounds*): 0.05 mg [Se]/m^3, inhalable fraction TWA; Peak Limitation Category II(4); Carcinogen Category 3B; Pregnancy Risk Group C

Arab Republic of Egypt: TWA 0.2 milligram per cubic meter, 1993; Australia: TWA 0.2 mg[Se]/m^3, 1993; Austria: MAK 0.1 milligram per cubic meter, 1999; Belgium: TWA 0.2 milligram per cubic meter, 1993; Denmark: TWA 0.1 milligram per cubic meter, 1999; Finland: TWA 0.1 milligram per cubic meter; STEL 0.3 milligram per cubic meter, 1999; Hungary: STEL 0.1 milligram per cubic meter, 1993; the Netherlands: MAC-TGG 0.1 mg[Se]/m^3, 2003; the Philippines: TWA 0.2 milligram per cubic meter, 1993; Poland: MAC (TWA) 0.1 milligram per cubic meter; MAC (STEL) 0.3 milligram per cubic meter, 1999; Sweden: NGV 0.1 milligram per cubic meter, 1999; Switzerland: MAK-W 0.1 milligram per cubic meter, 1999; Turkey: TWA 0.2 milligram per cubic meter, 1993; United Kingdom: TWA 0.1 milligram per cubic meter, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 0.2 mg[Se]/m^3. Russia[43] set a MAC in workplace air of 2.0 milligram per cubic meter. Several states have set guidelines or standards for selenium compounds as selenium in ambient air[60] ranging from 0.26−1.57 μ/m^3 (Montana) to 0.27 μ/m^3 (Massachusetts) to 0.66 μ/m^3 (New York) to 2.0 μ/m^3 (Florida and North Dakota) to 3.5 μ/m^3 (Virginia) to 4.0 μ/m^3 (Connecticut) to 5.0 μ/m^3 (Nevada).

Determination in Air: NIOSH(IV) Methods #7300, Elements; #7301; #7303; #9102; NIOSH II(7), Method #S190; OSHA Analytical Method ID-121 and ID-125G.

Permissible Concentration in Water: Safe Drinking Water Act (47FR 9352): MCLG = 0.05 mg[Se]/L; MCL = 0.05 mg[Se]/L as selenium. State Drinking Water Standards: Arizona 10 μg[Se]/L; New York 10 μg[Se]/L; State Drinking Water Guidelines: Arizona 45 μg[Se]/L; Connecticut 10 μg[Se]/L; Maine 35 μg[Se]/L; Minnesota 30 μg[Se]/L.

Determination in Water: Digestion followed by atomic absorption gives total selenium. Dissolved selenium is determined by 0.45 μ filtration prior to the above analysis.

Routes of Entry: Inhalation of dust or vapor, percutaneous absorption of liquid, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

The normal dietary intake of selenium, about 50−150 μg/day, is sufficient to meet the daily nutritional requirement for this essential nutrient. Selenium compounds can be toxic. However, at levels of daily intake that are only moderately higher than the nutritional requirement. The severity of the toxic effects of selenium would depend upon how much selenium was eaten and how often. Swallowing a quantity of concentrated sodium selenate or sodium selenite (for example, part of a bottle of sodium selenate designed to be administered to a flock of sheep, or large numbers of selenium supplement pills) would be life-threatening without immediate treatment. If amounts of selenium that were moderately higher than the daily nutritional requirement were eaten over long periods of time, several health effects could occur, including brittle hair, deformed nails; and in extreme causes, numbness and a lack of coordination in arms and legs. These health effects have been observed in people living in several villages in the People's Republic of China who were exposed to foods that were high in selenium for months to years. There have been no reports of populations in the United States exhibiting these symptoms of extreme chronic selenium poisoning.

Short-Term Exposure: Selenium can affect you when breathed in. Fumes can irritate the eyes and the respiratory tract. Contact can burn the eyes and skin. Inhalation of fume may cause symptoms of asphyxiation, chills and fever, and bronchitis. High levels can cause troubled breathing; lung irritation (pneumonitis) and headaches. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Symptoms of exposure can cause visual disturbance; headache, chills, fever, dyspnea (breathing difficulty), bronchitis, metallic taste; garlic breath; gastrointestinal disturbance. Tellurium compounds are both an oral and dermal toxic hazard. The material is toxic by ingestion. Oral ingestion of tellurium compounds is generally regarded as extremely toxic. The probable oral lethal dose is 5−50 mg/kg or between seven drops and one teaspoonful for a 70 kg (150 lb) person. Tellurium compounds are regarded as super toxic for skin exposures.

Long-Term Exposure: Hair or fingernail loss; numbness in fingers or toes; circulatory problems. Long-term exposure to selenium compounds may be a cause of amyotrophic lateral sclerosis in humans. Repeated or prolonged contact may cause skin dermatitis. May affect the CNS; blood, teeth, and bones. May cause nervousness, depression, pallor, digestive disturbances. Kidney and liver damage may occur. Daily ingestion of 25 mg of sodium selenite, containing 4−5 selenium; after 11 days showed signs of hair and fingernail loss, fatigue, nausea, vomiting, and garlic-breath.

Points of Attack: Eyes, skin, respiratory system; liver, kidneys, blood, spleen. In animals: anemia, liver necrosis; cirrhosis, kidney, spleen damage.

Medical Surveillance: NIOSH lists the following tests: Body Hair/Nail; whole blood (chemical/metabolite); blood plasma; blood serum; liver function tests; urine (chemical/metabolite); urine (chemical/metabolite), 24-hour collection; urinalysis; white blood cell count/differential. Urine test for selenium (normal is less than 100 μg/L of urine). If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pneumonitis or pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Note to physician: For severe poisoning, *do not* use BAL (British Anti-Lewisite), dimercaprol, dithiopropanol ($C_3H_8OS_2$) as it is contraindicated or ineffective in poisoning from selenium.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *1 milligram per cubic meter:* Q_m (APF = 25) (any quarter-mask respirator); or 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or PAPRDM if not present as a fume (any powered, air-purifying respirator with a dust and mist filter); or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter); or Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Selenium must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine) and strong acids (such as hydrochloric, sulfuric, and nitric), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from water.

Shipping: UN3283 Selenium compound, solid, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Thermal decomposition products may include oxides of metal, selenium. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Powdered selenium: dispose in a chemical waste landfill. When possible, recover selenium and return to suppliers[22].

References

(31); (173); (100); (173); (101); (138).

National Academy of Sciences, Selenium, Washington, DC (1976). (Also issued by EPA Health Effects Res. Lab. as Report EPA-600/1-76-014, Research Triangle Park, NC).

United States Environmental Protection Agency, Selenium: Ambient Water Quality Criteria, Washington, DC (1980).

United States Environmental Protection Agency, Selenium, Health and Environmental Effects Profile No. 153, Office of Solid Waste, Washington, DC (April 30, 1980).

United States Public Health Service, "Toxicological Profile for Selenium," Atlanta, Georgia, agency for Toxic Substances and Disease Registry (December 1988).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Selenium, Trenton, NJ (September 2002).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 3, 75−78 (1981).

Selenium Dioxide S:0150

Formula: O_2Se; SeO_2

Synonyms: Dioxido de selenio (Spanish); Selenious acid anhydride; Selenious anhydride; Selenium(IV) dioxide; Selenium oxide; Selenium(IV) oxide

CAS Registry Number: 7446-08-4

HSDB Number: 677

RTECS Number: VS8575000

UN/NA & ERG Number: UN3283/151; UN2811 (toxic solid, organic, n.o.s.)/154 (selenium oxide)

EC Number: 231-194-7

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Strong oxidizer, Suspected reprotoxic hazard, Suspected of causing genetic defects, Environmental hazard.

United States National Primary Drinking Water Regulations: MCLG = 0.05 mg[Se]/L; MCL = 0.05 mg[Se]/L as selenium

Clean Water Act: Section 311 Hazardous Substances/RQ same as CERCLA; Section 313 Water Priority Chemicals (57FR41331, 9/9/1992) as selenium oxide; 40CFR 401.15 Section 307 Toxic Pollutants as selenium and compounds

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U204

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500 lb (227 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: O, T, N, Xn; risk phrases: R5; R8; R20/21/22; R23/25; R33; R36/38; R44; R49; R51/53; R62; R63; safety phrases: S17; S20/21; S26; S28; S29/35; S36/37/39; S45; S53; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Selenium dioxide is white to slightly reddish crystalline solid or yellow liquid which forms a yellow-green vapor. It has a sour and pungent odor. Odor threshold in air = 0.0002 milligram per cubic meter. Molecular weight = 110.96; sublimation point = 315°C. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 0, ₩reactivity 0 **OX**. Soluble in water; solubility = 40%. Readily soluble; reacts with water forming corrosive selenious acid.

Potential Exposure: Selenium dioxide is used in the manufacture of selenium compounds, a reagent for alkaloids; an oxidizing agent; in paint and ink pigments; in metal "blueing" and etching; as a chemical catalyst; in photographic toners; in electric and photoelectric components; and others.

Incompatibilities: Selenium dioxide is and inorganic oxidizer; reacts, possibly violently, with reducing agents such as hydrides, nitrides, alkali metals, and sulfides. Contact with strong acids may cause release of toxic hydrogen selenide gas. Water solution is a medium-strong acid (selenious acid). Rapidly absorbs dry hydrogen fluoride, hydrogen bromide, hydrogen chloride, to form corresponding selenium oxohalides. Reacts with many substances producing toxic selenium vapors. Attacks many metals in presence of water.

Permissible Exposure Limits in Air

NIOSH IDLH = 1 mg[Se]/m^3

OSHA PEL: 0.2 mg[Se]/m^3 TWA

NIOSH REL: 0.2 mg[Se]/m^3 TWA

ACGIH TLV[1]: 0.2 mg[Se]/m^3 TWA

PAC Ver. 29[138]

PAC-1: 0.84 milligram per cubic meter

PAC-2: 1.6 milligram per cubic meter

PAC-3: 9.5 milligram per cubic meter

DFG MAK: 0.05 mg[Se]/m^3, inhalable fraction TWA; Peak Limitation Category II(4); Carcinogen Category 3B; Pregnancy Risk Group C

Arab Republic of Egypt: TWA 0.2 mg[Se]/m^3, 1993; Australia: TWA 0.2 mg[Se]/m^3, 1993; Austria: MAK 0.1 mg[Se]/m^3, 1999; Belgium: TWA 0.2 mg[Se]/m^3, 1993; Denmark: TWA 0.1 mg[Se]/m^3, 1999; Finland: TWA

0.1 mg[Se]/m^3; STEL 0.3 mg[Se]/m^3, 1999; Hungary: STEL 0.1 mg[Se]/m^3, 1993; Japan: 0.1 mg[Se]/m^3, 1999; Norway: TWA 0.1 mg[Se]/m^3, 1999; the Philippines: TWA 0.2 mg[Se]/m^3, 1993; Poland: MAC (TWA) 0.1 mg[Se]/m^3; MAC (STEL) 0.3 mg[Se]/m^3, 1999; Sweden: NGV 0.1 mg [Se]/m^3, 1999; Switzerland: MAK-W 0.1 mg[Se]/m^3, 1999; Turkey: TWA 0.2 mg[Se]/m^3, 1993; United Kingdom: TWA 0.1 mg[Se]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 0.2 mg[Se]/m^3. Russia[43] set a MAC in ambient air in residential areas of 0.1 μ/m^3 on a momentary basis and 0.05 μ/m^3 on a daily average basis.

Determination in Air: Use NIOSH(IV) Methods #7300, Elements; #7301; #7303; #9102; NIOSH II(7), Method #S190; OSHA Analytical Method ID-121 and ID-125G.

Permissible Concentration in Water: Safe Drinking Water Act (47FR 9352): MCLG = 0.05 mg[Se]/L; MCL = 0.05 mg[Se]/L as selenium. State Drinking Water Standards: Arizona 10 μg[Se]/L; New York 10 μg[Se]/L; State Drinking Water Guidelines: Arizona 45 μg[Se]/L; Connecticut 10 μg[Se]/L; Maine 35 μg[Se]/L; Minnesota 30 μg[Se]/L.

Determination in Water: Digestion followed by atomic absorption gives total selenium. Dissolved selenium is determined by 0.45 μ filtration prior to the above analysis.

Routes of Entry: Inhalation, ingestion, skin, and/or eyes. Absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Corrosive to the eyes, skin, and respiratory tract. *Inhalation:* Low level exposures may cause garlic breath and metallic taste in the mouth. Tiredness, pallor and indigestion have been reported. Unknown high levels have caused intense irritation of nose, throat, and lungs, with coughing, sneezing, congestion, dizziness, and headache. Inhalation may cause chemical pneumonitis. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. *Skin:* May cause dermatitis with itchy red bumps forming. Chemical burns may also occur. Intense pain will occur if selenium oxide penetrates under the fingernail. *Eyes:* May cause pain and irritation. Eyelids may become puffy, an allergic reaction known as "rose eye." *Ingestion:* No information specific to selenium oxide. Based on other selenium compounds, may cause nausea, vomiting, abdominal pain; diarrhea, metallic taste, and garlic odor on breath. Animal studies suggest that the lethal dose for an adult may be as low as 1/200 oz.

Long-Term Exposure: Hair or fingernail loss; numbness in fingers or toes; circulatory problems. Allergic sensitization may occur resulting in onset of skin rash and rose eye at very low levels. Discoloration of hair and nails may also affect the many organ systems. Animal feeding studies suggest that liver, spleen, and kidney damage is possible. Nasopharyngeal irritation, gastrointestinal distress, and persistent garlic breath may also occur. Long-term exposure to selenium compounds may be a cause of amyotrophic lateral sclerosis in humans. Repeated or prolonged contact may cause skin dermatitis. May affect the CNS; blood, teeth, and bones. May cause nervousness, depression, pallor, digestive disturbances. Kidney and liver damage may occur. Daily ingestion of 25 mg of sodium selenite, containing 4−5 selenium, after 11 days showed signs of hair and fingernail loss, fatigue, nausea, vomiting, and garlic-breath.

Points of Attack: Skin, eyes, liver, kidneys, spleen.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Note to Physician: Inhalation: bronchodilators, decongestants, and oxygen may be used if necessary. Corticosteroids are useful for treating pneumonitis.

Note to Physician: 10% sodium thiosulfate solutions, creams and eye ointments will rapidly convert selenium oxide to less harmful red selenium. Urinary selenium may be useful indicator of degree of exposure. Liver function tests are suggested.

Note to physician: For severe poisoning, *do not* use BAL, dimercaprol, dithiopropanol ($C_3H_8OS_2$) as it is contraindicated or ineffective in poisoning from selenium.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid, unless full facepiece respiratory protection is worn. Wear dust-proof goggles and face shield when working with powders or dust, unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin

is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *1 milligram per cubic meter:* Q_m (APF = 25) (any quarter-mask respirator); or 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or PAPRDM if not present as a fume (any powered, air-purifying respirator with a dust and mist filter); or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter); or Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Check oxygen content prior to entering storage area. Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store away from acids and water. Where possible, automatically transfer material from drums or other storage containers to process containers Sources of ignition, such as smoking and open flames are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Store in a cool, well-ventilated area away from incompatible materials listed above. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage.

Shipping: UN3283Selenium compound, solid, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous material, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft (NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during clean-up. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. For liquids, absorb on sand or vermiculite and shovel slurry into sealed container. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include selenium and oxygen which may increase intensity of fire. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform to EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31).

New York State Department of Health, *Chemical Fact Sheet:* Selenium Oxide, Bureau of Toxic Substance Assessment, (100) Albany, NY (April 1986 and Version 2).

Selenium Hexafluoride S:0160

Formula: F_6Se; SeF_6

Synonyms: Selenium fluoride

CAS Registry Number: 7783-79-1

HSDB Number: 676

RTECS Number: VS9450000

UN/NA & ERG Number: (PIH) UN2194/125

EC Number: [*Annex I Index No.:* 034-002-00-8]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Theft hazard* 15 (≥1.67% concentration).

Carcinogenicity: IARC: Animal Inadequate Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3

Hazard Alert: Poison inhalation hazard, Corrosive (resp.), Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated.

CLEAN WATER ACT: Section 307 Toxic Pollutants as selenium and compounds.

RCRA Section 261 Hazardous Constituents., as selenium compounds, n.o.s.

EPCRA Section 313: Includes any unique chemical substance that contains selenium as part of that chemical's infrastructure. Form R *de minimus* concentration reporting level: 1.0%. Form R Toxic Chemical Category Code: N725

OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 1000 lb (450 kg)

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

United States National Primary Drinking Water Regulations: MCLG = 0.05 mg[Se]/L; MCL = 0.05 mg[Se]/L as Selenium; MCLG = 4 mg[F]/L; MCL = 4 mg[F]/L; SMCL = 2.0 mg[F]/L, as Fluoride.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: T, C: risk phrases: R5; R21; R23/25; R33; R34; safety phrases: S1/2; S9; S20/21; S24; S25; S28; S33; S38; S41; S45, S60 (see Appendix 4).

Description: Selenium hexafluoride is a nonflammable, colorless gas. Repulsive odor. Molecular weight = 192.95; specific gravity (H_2O:1) = 7.9 @ 20°C; boiling point = −34.4°C (Sublimation point = −46°C); freezing/melting point = −50.5°C[77]; vapor pressure = 750 mmHg @ −47°C; relative vapor density (air = 1) = 6.66. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 1. Insoluble in water; slow reaction.

Potential Exposure: Selenium hexafluoride, a gas, is utilized as a gaseous electric insulator.

Incompatibilities: Hydrolyzes very slowly in cold water. Decomposes on heating, producing hydrogen fluoride, fluoride, and selenium. Contact with metal or acid will produce toxic gaseous hydrogen selenide.

Permissible Exposure Limits in Air

NIOSH IDLH = 2 ppm

Conversion factor = 1 ppm = 7.89 milligram per cubic meter

OSHA PEL: 0.05 ppm/0.4 mg[Se]/m^3 TWA

NIOSH REL: 0.05 ppm TWA

ACGIH TLV[1]: 0.05 ppm/0.4 mg[Se]/m^3 TWA

Protective Action Criteria PAC* Ver. 29[138]

PAC-1: **0.053**$_{\mathbf{A}}$ ppm

PAC-2: **0.087**$_{\mathbf{A}}$ ppm

PAC-3: **0.26**$_{\mathbf{A}}$ ppm

*AEGLs are marked with a subscript "**A**" and correspond to 60-minute values.

Australia: TWA 0.05 ppm (0.2 milligram per cubic meter), 1993; Austria: MAK 2.5 mg[F]/m^3, 1999; MAK 0.1 mg[Se]/m^3, 1999; Belgium: TWA 0.05 ppm (0.16 milligram per cubic meter), 1993; Denmark: TWA 0.05 ppm (0.4 milligram per cubic meter), 1999; Finland: TWA 0.05 ppm (0.4 milligram per cubic meter); STEL 0.15 ppm (1.2 milligram per cubic meter), 1999; France: VME 0.05 ppm (0.2 milligram per cubic meter), 1999; Japan 0.1 mg[Se]/m^3, 1999; the Netherlands: MAC-TGG 0.2 mg[Se]/m^3, 2003; Norway: TWA 0.05 ppm (0.4 milligram per cubic meter), 1999; the Philippines: TWA 0.05 ppm (0.4 milligram per cubic meter), 1993; Poland: MAC (TWA) 1 mg[HF]/m^3, 1999; Sweden: NGV 2 mg[F]/m^3, 1999; Switzerland: MAK-W 0.05 ppm (0.4 milligram per cubic meter), 1999; United Kingdom: TWA 0.1 mg [Se]/m^3, 2000; TWA 2.5 mg[F]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 0.05 ppm. Several states have set guidelines or standards for SeF6 in ambient air[60] ranging from 2 μ/m^3 (North Dakota); to 3.5 μ/m^3 (Virginia); to 4.0 μ/m^3 (Connecticut); to 5.0 μ/m^3 (Nevada).

Determination in Air: Collection by impinger or fritted bubbler, analysis by atomic absorption spectrometry.

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guidelines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg [F]/L. Safe Drinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg[F]/L; SMCL = 2 mg/F/L, as Fluoride.

Routes of Entry: Inhalation, skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Inhalation can be fatal. Highly corrosive to the eyes and respiratory tract. Can cause permanent damage and possible blindness. Inhalation can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Contact with the liquid can cause frostbite.

Long-Term Exposure: Repeated or prolonged contact may cause skin sensitization. May affect the CNS; liver and kidneys.

Points of Attack: Respiratory system, liver, kidneys, skin. In animals: pulmonary irritation, edema.

Medical Surveillance: NIOSH lists the following tests: Blood Gas Analysis; chest X-ray, ECG, pulmonary function tests: forced vital capacity, forced expiratory volume (1 second); sputum cytology; urinalysis (routine); white blood cell count/differential. Urine test for selenium (should not exceed 100 μg/L of urine). Lung function tests. Consider chest X-ray following acute overexposure. Liver and kidney function tests. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Examination of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the

skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water, or milk. Do not induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticoste roid spray. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water. *Note to physician:* For severe poisoning, *do not* use BAL, dimercaprol, dithiopropanol ($C_3H_8OS_2$) as it is contraindicated or ineffective in poisoning from selenium.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 0.5* ppm*:* Sa (APF = 10) (any supplied-air respirator). *Up to 1.25* ppm*:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *Up to 2* ppm*:* SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-, mounted canister providing protection against the compound of concern]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Check oxygen content prior to entering storage area. Poison gas. (1) Color code—Blue: Health Hazard/ Poison: Store in a secure poison location. This gas is highly toxic. Even slight exposure to these gasses can cause death. Store outdoors in a secure, restricted area that containing warning signs. This area must be roofed and shaded with the cylinders stored off the ground and separated from all other products assigned to other hazard categories and radiant heat sources on nonwooden floors. If indoors, store in a well-ventilated areas in temperatures not to exceed 50°C. (2) Color code—White stripe: Contact Hazard; Store separately; not compatible with materials in solid white category. Prior to working with this chemical, personnel should be trained on its proper handling and storage. High concentrations cause a deficiency of oxygen with the risk of unconsciousness or death. Check that oxygen content is at least 19% before entering storage or spill area. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: Selenium hexafluoride, Hazard Class: 2.3; Labels: 2.3-Poisonous gas, 8-Corrosive material Inhalation, Hazard Zone A. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling:

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 600/200
Then: Protect persons downwind (mi/km)
Day 0.7/1.1
Night 2.3/3.6

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 2500/800
Then: Protect persons downwind (mi/km)
Day 3.1/5.0
Night 7.0 + /11.0 + *

* + means distance can be larger in certain atmospheric conditions.

If in a building, evacuate building and confine vapors by closing doors and shutting down HVAC systems. Restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak to disperse the gas. Wear chemical protective suit with SCBA to combat spills. Stay upwind and use water spray to "knock down" vapor; contain runoff. Stop the flow of gas, if it can be done safely from a distance. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place; and repair leak or allow cylinder to empty. Keep this chemical out of confined spaces, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include hydrogen fluoride, fluoride and metal oxides of selenium (fumes). Extinguish fire using agent suitable for type of surrounding fire. The material itself does not burn or burns with difficulty. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. If possible, convert selenium compounds to an insoluble form with SO_2 before landfill or solidification.

References

(31); (173); (101); (138); (122).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Selenium Hexafluoride, Trenton, NJ (September, 2001).

Selenium Oxychloride S:0170

Formula: Cl_2OSe; $SeOCl_2$

Synonyms: Seleninyl chloride; Selenium chloride oxide; 9Seleninyl dichloride

CAS Registry Number: 7791-23-3

HSDB Number: 678

RTECS Number: VS7000000

UN/NA & ERG Number: UN2879/157

EC Number: 232-244-0

Regulatory Authority and Advisory Information

Hazard Alert: Human Data, Violently reactive with water, Environmental hazard.

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as selenium and compounds

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, as selenium compounds, n.o.s., waste number not listed

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500 lb (227 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 500 lb (227 kg)

EPCRA Section 313: Includes any unique chemical substance that contains selenium as part of that chemical's infrastructure. Form R *de minimus* concentration reporting level: 1.0%. Form R Toxic Chemical Category Code: N725.

United States National Primary Drinking Water Regulations: MCLG = 0.05 mg[Se]/L; MCL = 0.05 mg[Se]/L as selenium; SMCL = 250 mg[Cl^-]/L as Chloride

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R14; R20/22; R23/25; R29; R33; R35; R50/53; R61; R62; safety phrases: S20/21; S26; S29; S36/37/39; S28; S45; S53; S60; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Selenium oxychloride is a colorless to yellowish liquid. Fumes in air. Molecular weight = 165.86; specific gravity (H_2O:1) = 2.42 @ 22°C; boiling point = 176.3°C; freezing/melting point = 11°C; vapor pressure = 2.5 mmHg @ 25°C;. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 0, reactivity 1₩. Violent reaction with water forming hydrochloric acid and selenious acid.

Potential Exposure: This material is used as a solvent for many substances, including metals and as a chlorinating agent; and resin plasticizer; as an ionizing solvent; for monochlorination of ketones.

Incompatibilities: Water and air reactive releasing strong acids. The aqueous solution is a strong acid and oxidizer.

Reacts violently with bases, reducing agents, hydrides, powdered antimony, red, and white phosphorus, disilver oxide, lead oxide; powdered metals, and potassium. *Note: Never* pour water into this substance; when dissolving or diluting always add it slowly to the water.

Permissible Exposure Limits in Air

NIOSH IDLH = 1 mg[Se]/m^3

OSHA PEL: 0.2 mg[Se]/m^3 TWA

NIOSH REL: 0.2 mg[Se]/m^3 TWA

ACGIH TLV[1]: 0.2 mg[Se]/m^3 TWA

PAC Ver. 29[138]

PAC-1: 1.3 milligram per cubic meter

PAC-2: 10 milligram per cubic meter

PAC-3: 60 milligram per cubic meter

DFG MAK: 0.05 mg[Se]/m^3, inhalable fraction TWA; Peak Limitation Category II(4); Carcinogen Category 3B; Pregnancy Risk Group C

Arab Republic of Egypt: TWA 0.2 mg[Se]/m^3, 1993; Australia: TWA 0.2 mg[Se]/m^3, 1993; Belgium: TWA 0.2 mg[Se]/m^3, 1993; Denmark: TWA 0.1 mg[Se]/m^3, 1999; Finland: TWA 0.1 mg[Se]/m^3; STEL 0.3 mg[Se]/m^3, 1999; Hungary: STEL 0.1 mg[Se]/m^3, 1993; Norway: TWA 0.1 mg[Se]/m^3, 1999; the Philippines: TWA 0.2 mg [Se]/m^3, 1993; Poland: MAC (TWA) 0.1 mg[Se]/m^3, 1993; Sweden: NGV 0.1 mg[Se]/m^3, 1999; Switzerland: MAK-W 0.1 mg[Se]/m^3, 1999; Turkey: TWA 0.2 mg[Se]/m^3, 1993; United Kingdom: TWA 0.1 mg[Se]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 0.2 mg[Se]/m^3. Several states have set guidelines or standards for selenium compounds as selenium in ambient air[60] ranging from 0.26−1.57 μ/m^3 (Montana); to 0.27 μ/m^3 (Massachusetts); to 0.66 μ/m^3 (New York); to 2.0 μ/m^3 (Florida and North Dakota); to 3.5 μ/m^3 (Virginia); to 4.0 μ/m^3 (Connecticut); to 5.0 μ/m^3 (Nevada).

Determination in Air: NIOSH(IV) Methods #7300, Elements; #7301; #7303; #9102; NIOSH II(7), Method #S190; OSHA Analytical Method ID-121 and ID-125G.

Permissible Concentration in Water: Safe Drinking Water Act (47FR 9352): MCLG = 0.05 mg[Se]/L; MCL = 0.05 mg[Se]/L as selenium. State Drinking Water Standards: Arizona 10 μg[Se]/L; New York 10 μg[Se]/L; State Drinking Water Guidelines: Arizona 45 μg[Se]/L; Connecticut 10 μg[Se]/L; Maine 35 μg[Se]/L; Minnesota 30 μg[Se]/L.

Determination in Water: Digestion followed by atomic absorption gives total selenium. Dissolved selenium is determined by 0.45 μ filtration prior to the above analysis.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: This material is very toxic and may cause death or permanent injury after very short exposures to small quantities. Inhalation of small quantities may be corrosive and irritating to the respiratory tract. Effects may include severe pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. It can burn and severely irritate the skin and eyes and cause burns to the mouth, esophagus, and stomach when ingested. Inhalation of this material may cause garlic breath, odor, nausea, vomiting, indigestion, fever, headache, lassitude, irritability, and unstable blood pressure.

Long-Term Exposure: Long-term exposure to selenium compounds may be a cause of amyotrophic lateral sclerosis in humans. Repeated or prolonged contact may cause skin dermatitis. May affect the CNS; blood, teeth, and bones. May cause nervousness, depression, pallor, digestive disturbances. Kidney and liver damage may occur. Daily ingestion of 25 mg of sodium selenite, containing 4−5 selenium, after 11 days showed signs of hair and fingernail loss, fatigue, nausea, vomiting, and garlic-breath.

Points of Attack: Skin, lungs, liver.

Medical Surveillance: Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. NIOSH lists the following tests: Blood Gas Analysis; chest X-ray, ECG, pulmonary function tests: forced vital capacity, forced expiratory volume (1 second); sputum cytology; urinalysis (routine); white blood cell count/differential. Urine test for selenium (should not exceed 100 μg/L of urine).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water, or milk. Do not induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Note to physician: For severe poisoning, *do not* use BAL, dimercaprol, dithiopropanol ($C_3H_8OS_2$) as it is contraindicated or ineffective in poisoning from selenium.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/ manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All

protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *1 milligram per cubic meter:* DM if not present as a fume (any dust and mist respirator); or any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100; or 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or PAPRDM if not present as a fume (any powered, air-purifying respirator with a dust and mist filter); or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter); or Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: (1) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. (2) Color code—Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Where possible, automatically pump liquid from drums or other storage containers to process containers Sources of ignition, such as smoking and open flames are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gal or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN2879 Selenium oxychloride, Hazard class: 8; Labels: 8-Corrosive material, 6.1-Poisonous material.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include hydrogen chloride and metal oxides of selenium. Stay upwind; keep out of low areas. Wear positive pressure breathing apparatus and special protective clothing. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Selenium Oxychloride, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

Selenium Sulfides S:0180

Formula: SSe; Se_4S_4; SeS_2; Se_2S_6; SeS; Se_4S_4; SeS_2; Se_2S_6

Synonyms: 7446-34-6 *(monosulfide):* NCI-C50033; Selenium monosulfide; Selenium sulfide; Selenium sulfide; Selensulfide (German); Sulfur selenide

7788-56-4 *(disulfide):* Exsel; Selenium(IV) disulfide (1:2); Selenium disulfide; Selenium sulfide; Sulfuro de selenio; Selsun

CAS Registry Number: 7488-56-4 [Selenium(IV) disulfide (SeS_2)]; 7446-34-6 (monosulfide, SeS)

HSDB Number: 6367

RTECS Number: VT0525000 (SeS); VS8925000 (SeS_2)

UN/NA & ERG Number: UN2657 (SeS_2)/153

EC Number: 231-303-8 [*Annex I Index No.:* 034-002-00-8] (selenium disulfide)

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen (Selium sulfide); IARC: Animal Inadequate Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3; EPA: Sufficient evidence from animal studies; inadequate evidence or no useful data from epidemiologic studies; NCI: Carcinogenesis Studies (gavage); clear evidence: rat, mouse; NCI: Carcinogenesis Bioassay (dermal); no evidence: mouse

California Proposition 65 Chemical[102]: Cancer 10/1/1989

Hazard Alert: Poison, Probably combustible[101], Environmental hazard, Suspected of causing genetic defects (selenium (IV) disulfide).

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as selenium and compounds

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U205

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

EPCRA Section 313: Includes any unique chemical substance that contains selenium as part of that chemical's infrastructure. Form R *de minimus* concentration reporting level: 1.0%. Form R Toxic Chemical Category Code: N725

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg)

United States National Primary Drinking Water Regulations: MCLG = 0.05 mg[Se]/L; MCL = 0.05 mg[Se]/L as Selenium

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%, selenium (IV) disulfide (SeS_2).

Hazardous to aquatic life or environment, with possible long-lasting effects[192]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N: risk phrases: R23/25; R33; R50/53; R62; safety phrases: S20/21; S28; S29; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: There are various selenium sulfides: Selenium monosulfide, SeS, is orange-yellow powder or tablets, Molecular weight = 111.02; specific gravity (H_2O:1) = 3.1 @ 20°C; boiling point = (decomposes) 118−119°C; freezing/melting point = 111.06°C. Selenium disulfide, SeS_2 which is a bright red to yellow material; freezing/melting point ≤100°C. Se_2S_6 which is a light orange crystalline solid. Freezing/Melting point = 121.5°C. Se_4S_4 is a red crystalline solid. Molecular weight = 143.08; freezing/melting point = 113°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 1, reactivity 0. Slightly soluble in water.

Potential Exposure: Selenium sulfide is used for the treatment of seborrhea, especially in shampoos. The chemical is available over the counter as Selsun, a stabilized buffered suspension. FDA reports that selenium sulfide is an active ingredient in some drug products used for the treatment of dandruff and certain types of dermatitis. A dandruff shampoo containing 1% selenium sulfide is available without a prescription and is recommended for use once or twice a week. By prescription, selenium sulfide is available in a 2.5% shampoo or lotion, with the recommended application limited to 10 minutes for 7 days to avoid the possibility of acute toxic effects. Selenium sulfide is also used topically in veterinary medicine for eczemas and dermatomycoses.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Violent reaction with silver oxide.

Permissible Exposure Limits in Air

NIOSH IDLH = 1 mg[Se]/m^3

OSHA PEL: 0.2 mg[Se]/m^3 TWA

NIOSH REL: 0.2 mg[Se]/m^3 TWA

ACGIH TLV[1]: 0.2 mg[Se]/m^3 TWA

PAC Ver. 29[138]

7446-34-6, monosulfide

PAC-1: 0.84 milligram per cubic meter

PAC-2: 1.3 milligram per cubic meter

PAC-3: 7.5 milligram per cubic meter

7488-56-4, disulfide

PAC-1: 1.1 milligram per cubic meter

PAC-2: 4.6 milligram per cubic meter

PAC-3: 27 milligram per cubic meter

DFG MAK: 0.05 mg[Se]/m^3, inhalable fraction TWA; Peak Limitation Category II(4); Carcinogen Category 3B; Pregnancy Risk Group C

Several states have set guidelines or standards for selenium compounds as selenium in ambient air[60] ranging from 0.26−1.57 μ/m^3 (Montana); to 0.27 μ/m^3 (Massachusetts); to 0.66 μ/m^3 (New York); to 2.0 μ/m^3 (Florida and North Dakota); to 3.5 μ/m^3 (Virginia); to 4.0 μ/m^3 (Connecticut); to 5.0 μ/m^3 (Nevada).

Determination in Air: NIOSH(IV) Methods #7300, Elements; #7301; #7303; #9102; NIOSH II(7), Method #S190; OSHA Analytical Method ID-121 and ID-125G.

Permissible Concentration in Water: Safe Drinking Water Act (47FR 9352): MCLG = 0.05 mg[Se]/L; MCL = 0.05 mg[Se]/L as selenium. State Drinking Water Standards: Arizona 10 μg[Se]/L; New York 10 μg[Se]/L; State Drinking Water Guidelines: Arizona 45 μg[Se]/L; Connecticut 10 μg[Se]/L; Maine 35 μg[Se]/L; Minnesota 30 μg[Se]/L.

Determination in Water: Digestion followed by atomic absorption gives total selenium. Dissolved selenium is determined by 0.45 μ filtration prior to the above analysis. Hazardous to the aquatic environment. Do not allow release to the environment unless proper permits are obtained from the federal government.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact. Absorbed by the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Eye contact can cause irritation. The dust irritates the respiratory tract. Higher exposure can cause headaches, troubled breathing; and pneumonitis. Symptoms of exposure include irritation of the skin (dermatitis), eyes, and mucous membranes; eye injury; hair loss; discoloration of hair; garlic odor of the breath; depression, languor, giddiness, emotional instability; excess dental caries; pallor, nervousness; digestive disturbances, and nausea[52].

Long-Term Exposure: A probable carcinogen in humans, it has been shown to cause liver and lung cancer in animals. Long-term exposure to selenium compounds may be a cause of amyotrophic lateral sclerosis in humans. Repeated or prolonged contact may cause skin dermatitis. May affect the CNS; blood, teeth, and bones. May cause nervousness, depression, pallor, digestive disturbances. Kidney and liver damage may occur. Daily ingestion of 25 mg of sodium selenite, containing 4−5 selenium, after 11 days showed signs of hair and fingernail loss, fatigue, nausea, vomiting, and garlic-breath.

Points of Attack: Liver.

Medical Surveillance: NIOSH lists the following tests: Blood Gas Analysis; chest X-ray, ECG, pulmonary function tests: forced vital capacity, forced expiratory volume (1 second); sputum cytology; urinalysis (routine); white blood cell count/differential. Urine test for selenium (should not exceed 100 μg/L of urine).

First Aid: *Skin Contact:* Flood all areas of body that have contacted the substance with water. Don't wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others[52]. *Eye Contact:* Remove any contact lenses at once. Immediately flush eyes well with copious quantities of water or normal saline for at least 20−30 minutes. Seek medical attention. *Inhalation:* Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion:* Contact a physician, hospital or poison center at once. If the victim is unconscious or convulsing, do not induce vomiting or give anything by mouth. Assure that the patient's airway is open and lay him on his side with his head lower than his body and transport immediately to a medical facility. If conscious and not convulsing, give a glass of water to dilute the substance. Vomiting should not be induced without a physician's advice.

Note to Physician: Inhalation: Bronchodilators, decongestants and oxygen may be used if necessary. Corticosteroids are useful for treating pneumonitis.

Note to physician: For severe poisoning, *do not* use BAL, dimercaprol, dithiopropanol ($C_3H_8OS_2$) as it is contraindicated or ineffective in poisoning from selenium.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in a refrigerator or a cool dry place. Where possible, automatically transfer material from drums or other storage containers to process containers Sources of ignition, such as smoking and open flames are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2657 Selenium disulfide, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Thermal decomposition products may include hydrogen sulfide, hydrogen selenide, and oxides of sulfur. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(109); (102); (31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Selenium Sulfide, Trenton, NJ (October 2001).

Selenous Acid S:0190

Formula: H_2O_3Se; H_2SeO_3

Synonyms: Acide selenieux (French); Acido selenioso (Spanish); Hydrogen selenite; Monohydrated selenium dioxide; Selenious acid; Selenium dioxide

CAS Registry Number: 7783-00-8; *(alt.)* 11140-60-6

HSDB Number: 6065

RTECS Number: VS7175000

UN/NA & ERG Number: UN3283 (solid)/151; UN3440 (liquid)/151

EC Number: 231-974-7

Regulatory Authority and Advisory Information

Carcinogenicity: EPA: Not Classifiable as to human carcinogenicity.

Hazard Alert: Exposure can be lethal, Strong oxidizer, Suspected reprotoxic hazard, Sensitization hazard, Environmental hazard.

United States National Primary Drinking Water Regulations: MCLG = 0.05 mg[Se]/L; MCL = 0.05 mg[Se]/L as Selenium

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as selenium and compounds

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U204

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, as selenium compounds, n.o.s.

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 1000/10,000 lb (454/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg)

EPCRA Section 313: Includes any unique chemical substance that contains selenium as part of that chemical's infrastructure. Form R *de minimus* concentration reporting level: 1.0%. Form R Toxic Chemical Category Code: N725

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T +, N, Xi; risk phrases: R8; R20/21/22; R23/25; R33; R36/38; R43; R44; R49; R50/53; R63; safety phrases: S17; S20/21; S26; S28; S29/35; S36/37/39; S45; S53; S45; S60; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Selenious acid is a colorless, crystalline solid. Molecular weight = 128.98; freezing/melting point = 70°C (decomposition). Hazard identification (based on NFPA-704 M Rating System): Health 4, flammability 0, reactivity 1 (Oxidizer). Soluble in water; solution forms a strong acid.

Potential Exposure: Selenious acid is used as a reagent for alkaloids and as an oxidizing agent. Isotope is used in labeling radiopharmaceuticals.

Incompatibilities: A strong oxidizer. Reacts exothermically with many reducing agents including hydroiodic acid, sulfurous acid, sodium hyposulfite, hydroxylamine salts, hydrazine salts, hypophosphorous acid, phosphorous acid[206, 136]. Incompatible combustibles, organic material, oxidizable materials, strong acids, strong bases. Contact with acids produce toxic and gaseous hydrogen selenide. Attacks metals.

Permissible Exposure Limits in Air

NIOSH IDLH = 1 mg[Se]/m^3

OSHA PEL: 0.2 mg[Se]/m^3 TWA

NIOSH REL: 0.2 mg[Se]/m^3 TWA

ACGIH TLV[1]: 0.2 mg[Se]/m^3 TWA

PAC Ver. 29[138]

PAC-1: 23 milligram per cubic meter

PAC-2: 250 milligram per cubic meter

PAC-3: 1500 milligram per cubic meter

DFG MAK: 0.05 mg[Se]/m^3, inhalable fraction TWA; Peak Limitation Category II(4); Carcinogen Category 3B; Pregnancy Risk Group C

Arab Republic of Egypt: TWA 0.2 mg[Se]/m^3, 1993; Australia: TWA 0.2 mg[Se]/m^3, 1993; Austria: MAK 0.1 mg[Se]/m^3, 1999; Belgium: TWA 0.2 mg[Se]/m^3, 1993; Denmark: TWA 0.1 mg[Se]/m^3, 1999; Finland: TWA 0.1 mg[Se]/m^3; STEL 0.3 mg[Se]/m^3, 1999; Hungary: STEL 0.1 mg[Se]/m^3, 1993; Norway: TWA 0.1 mg[Se]/m^3, 1999; the Philippines: TWA 0.2 mg[Se]/m^3, 1993; Poland: MAC (TWA) 0.1 mg[Se]/m^3, 1993; Sweden: NGV 0.1 mg [Se]/m^3, 1999; Switzerland: MAK week 0.1 mg[Se]/m^3, 1999; Turkey: TWA 0.2 mg[Se]/m^3, 1993; United Kingdom: TWA 0.1 mg[Se]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 0.2 mg[Se]/m^3. Several states have set guidelines or standards for selenium compounds as selenium in ambient air[60] ranging from 0.26−1.57 μ/m^3 (Montana); to 0.27 μ/m^3 (Massachusetts); to 0.66 μ/m^3 (New York); to 2.0 μ/m^3 (Florida and North Dakota); to 3.5 μ/m^3 (Virginia); to 4.0 μ/m^3 (Connecticut); to 5.0 μ/m^3 (Nevada).

Determination in Air: NIOSH(IV) Methods #7300, Elements; #7301; #7303; #9102; NIOSH II(7), Method #S190; OSHA Analytical Method ID-121, and ID-125G.

Permissible Concentration in Water: Safe Drinking Water Act (47FR 9352): MCLG = 0.05 mg[Se]/L; MCL = 0.05 mg[Se]/L as selenium. State Drinking Water Standards: Arizona 10 μg[Se]/L; New York 10 μg[Se]/L; State Drinking Water Guidelines: Arizona 45 μg[Se]/L; Connecticut 10 μg[Se]/L; Maine 35 μg[Se]/L; Minnesota 30 μg[Se]/L.

Determination in Water: Digestion followed by atomic absorption gives total selenium. Dissolved selenium is determined by 0.45 μ filtration prior to the above analysis.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Selenious acid and its salts are capable of penetrating the skin and can produce acute poisonings. Corrosive to the eyes, skin, and respiratory tract. May affect the eyes, resulting in "rose-eye," an allergic-type reaction of the eyelids. It is highly toxic orally. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Inorganic selenium compounds may cause dermatitis. Toxic effects are similar to those of selenium and other selenium compounds. Garlic odor of breath is a common symptom. Pallor, nervousness, depression, and digestive disturbances have been reported in cases of chronic exposure. The most common industrial injuries are irritations and burns of the skin.

Long-Term Exposure: Repeated or prolonged contact may cause skin dermatitis. May affect the CNS; blood, teeth, and bones. May cause nervousness, depression, pallor, digestive disturbances. Kidney and liver damage may occur. Daily ingestion of 25 mg of sodium selenite, containing 4−5 selenium, after 11 days showed signs of hair and fingernail loss, fatigue, nausea, vomiting, and garlic-breath.

Points of Attack: Skin, eyes, liver, kidneys, nervous system.

Medical Surveillance: NIOSH lists the following tests: Blood Gas Analysis; chest X-ray, ECG, pulmonary function tests: forced vital capacity, forced expiratory volume (1 second); sputum cytology; urinalysis (routine); white blood cell count/differential. Urine test for selenium (should not exceed 100 μg/L of urine). Examination of the nervous system. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Note to physician: For severe poisoning, *do not* use BAL, dimercaprol, dithiopropanol ($C_3H_8OS_2$) as it is contraindicated or ineffective in poisoning from selenium.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Check oxygen content prior to entering storage area. Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from reducing agents; acids, combustibles. Where possible, automatically transfer material from drums or other storage containers to process containers. Store in a cool, well-ventilated area away from incompatible materials listed above. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage.

Shipping: UN3283Selenium compound, solid, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous material, Technical Name Required. UN3440 Selenium compound, liquid, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Liquid containing selenium inorganic compounds should be absorbed in vermiculite, dry sand; earth or similar material. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Thermal decomposition products may include toxic oxides of metal. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform to EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Selenious Acid, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Selenious Acid, Trenton, NJ (September, 1999).

Semicarbazide Hydrochloride S:0200

Formula: CH_6ClN_3O; $H_2NNHCONH_2 \cdot HCl$

Synonyms: Amidourea hydrochloride; Aminourea hydrochloride; Carbamylhydrazine hydrochloride; CH; Clorhidrato de semicarbazide (Spanish); Hydrazinecarboxamide monohydrochloride

CAS Registry Number: 563-41-7; 18396-65-1

HSDB Number: 5197

RTECS Number: VT3500000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 209-247-0

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Sufficient Evidence; Human Inadequate Evidence*, not classifiable as carcinogenic to humans*, Group 3, 1987

Hazard Alert: Poison, Combustible, Poison, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Agricultural chemical.

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 1000/10,000 lb (454/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1000 lb (454 kg).

Hazardous to aquatic life or environment, with possible long-lasting effects[291]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xn; risk phrases: R22; R23/24/25; R36/37/38; R34; R40; R45; R50; R62; R63 Safety phrases: S1; S22; S24/25; S26; S36/37/39; S41; S45; S53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water. (mfg.)

Description: Semicarbazide hydrochloride is a white crystalline solid. Molecular weight = 111.55; freezing/melting point = (decomposes) 172−175°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 1, reactivity 0. Soluble in water.

Potential Exposure: This material is used as a reagent for ketones and aldehydes with which it affords crystalline compounds having characteristic freezing/melting points. Also used in isolation of hormones and certain fractions from essential oils.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. May ignite combustible materials (wood, oil, paper).

Permissible Exposure Limits in Air

PAC Ver. 29[138]

563-41-7

PAC-1: 9.1 milligram per cubic meter

PAC-2: 100 milligram per cubic meter

PAC-3: 600 milligram per cubic meter

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Contact can irritate the eyes and skin. Toxic by ingestion. Symptoms of exposure include convulsions, irritation of skin, eyes, and mucous membranes; gastroenteric disturbances; and anemia. High level of exposure may affect the nervous system.

Long-Term Exposure: There is limited evidence that this chemical causes lung cancer in animals. High or repeated exposure may cause nerve damage with weakness, a feeling of "pins and needles," and loss of coordination in the limbs.

Points of Attack: Nervous system.

Medical Surveillance: Examination of the nervous system.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in a refrigerator and protect from oxidizers, combustible materials; moisture. Where possible, automatically transfer material from drums or other storage containers to process containers Sources of ignition, such as smoking and open flames are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft (NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include hydrogen chloride and oxides of nitrogen and carbon. This material may burn, but does not ignite readily. For small fires use dry chemical, carbon dioxide; water spray; or alcohol resistant foam. For large fires, use water spray, fog, or foam. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Semicarbazide Hydrochloride, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

Semustine S:0205

Formula: $C_{10}H_{18}ClN_3O_2$

Synonyms: 1-(2-Chloroethyl)-3-(4-methylcyclohexyl-1-nitrosourea); 1-(2-Chloroethyl)-3-(4-methylcyclohexyl)-1-nitroso-; 1-(2-Chloroethyl)-3-(trans-4-methyl-cyclohexyl)-1-nitrosourea; *N*-(2-Chloroethyl)-N′-(*trans*-4-methylcyclohexyl)-*N*-nitrosourea; ICIG-1110; Lomustine, methyl-; ME-CCNU; Methyl-CCNU; *trans*-Methyl-CCNU; NCI-C04955; NSC-95441; SeMustine; Urea, 1-(2-chloroethyl)-3-(4-methylcyclohexyl)-1-nitroso-; Urea, *N*-(2-chloroethyl)-*N*′-(4-methylcyclohexyl)-*N*-nitroso-

CAS Registry Number: 13909-09-6

HSDB Number: 7760

RTECS Number: YS500000

UN/NA & ERG Number: UN3249 (Medicine, solid, toxic, n.o.s.)/151

Regulatory Authority and Advisory Information

Carcinogenicty: NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen.

California Proposition 65 Chemical[102]: Cancer 10/1/1988

Hazard Alert: Poison, Possible risk of forming tumors, Suspected of causing genetic defects.

Hazard symbols, risk, & safety statements: Hazard symbol: T; risk phrases: R45; R23/24/25; R33; R36/37/39; R46; R62; safety phrases: S22; S26; S36/37/39; S41; S45; S53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: A crystalline solid or light yellow powder. Molecular weight = 247.76; freezing/melting point = (decomposes) ~64°C; vapor pressure = 5.6×10^{-6} mmHg @ 25°C (est.)[72]; Henry's Law constant = 2.5×10^{-10} atm m^3/mol @ 25°C (est)[72]. Low solubility in water; solubility = 38 mg/L @ 25°C (est.)[72].

Potential Exposure: Semustine is chemotherapy agent; an antineoplastic agent which functions as an alkylating agent[NIH].

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from strong acids, alkaline materials, strong bases. Semustine, an organic amide, reacts with azo and diazo compounds, releasing toxic gases. Amides are very weak bases but they can react as acids, forming salts. Contact with reducing agents can release flammable gases. Mixing amides with dehydrating agents such as such as phosphorus pentoxide or thionyl chloride generates the corresponding nitrile.

Permissible Exposure Limits in Air:

Determination in Air: No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Determination in Water: Octanol–water coefficient: Log K_{ow} => 3. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Ingestion, inhalation, through the unbroken skin.

Harmful Effects and Symptoms

Short-Term Exposure: Highly toxic, may be fatal if inhaled, swallowed or absorbed through skin. Avoid any skin contact or eye. Effects of contact or inhalation may be delayed. May be fatal if inhaled. Toxic if absorbed through skin. Causes skin, eye, and respiratory tract irritation. Symptoms of exposure to this compound may include delayed bone marrow depression, nausea, and vomiting.

Long-Term Exposure: Possible risk of forming tumors, Mutagen. Abnormalities of renal function, including three cases of renal failure, were noted some patients. Pulmonary fibrosis is a serious side effect of nitrosourea. Possible leukemia or preleukemia.

Points of Attack: Lungs, kidneys, lymph nodes, bone marrow.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method* if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed.

Personal Protective Methods: Wear positive pressure SCBA. Wear chemical protective clothing that is specifically recommended by the manufacturer. It may provide little or no thermal protection. Structural firefighters' protective clothing provides limited protection in fire situations ONLY; it is not effective in spill situations where direct contact with the substance is possible.

Respirator Selection: *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA)

Storage: Color code—Blue: Health Hazard/Toxics/Poisons: Store in a secure, dry, poison location. Protect from moisture. Prior to working with this chemical, personnel should be trained on its proper handling and storage.

Shipping: UN3249 Medicine, solid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials. PG II.

Spill Handling: As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 m/150 ft for liquids and at least 25 m/75 ft for solids. Keep unauthorized personnel away. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Stay upwind. Keep out of low areas. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Stop leak if you can do it without risk. Prevent entry into waterways, sewers, basements, or confined areas. Cover with plastic sheet to prevent spreading. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include hydrogen chloride and oxides of nitrogen and carbon. Noncombustible, substance itself does not burn but may decompose upon heating to produce corrosive and/or toxic fumes. Containers may explode when heated. Runoff from fire control or dilution water may be corrosive and/or toxic and may cause pollution. Runoff may pollute waterways. If tank, rail car, or tank truck is involved in a fire, ISOLATE for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. Small Fire: Use dry chemical, CO_2 or water spray. *Large Fire*: Water spray, fog or regular foam. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal; do not scatter the material. Use water spray or fog; do not use straight streams. *Fire involving Tanks or Car/Trailer Loads:* Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Do not get water inside containers. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. *Always* stay away from tanks engulfed in fire. For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn. *Do not* get water inside containers.

Disposal Method Suggested: It is inappropriate to dispose of expired or waste drugs and pharmaceuticals by flushing them down the toilet or discarding them to the trash. Household quantities of expired or waste pharmaceuticals may be mixed with wet cat litter or coffee grounds, double-bagged in plastic, discard in trash. Larger quantities shall carefully take into consideration applicable DEA, EPA, and FDA regulations. If possible return the pharmaceutical to the manufacturer for proper disposal being careful to properly label and securely package the material. Alternatively, the waste pharmaceutical shall be labeled, securely packaged and transported by a state licensed medical waste contractor to dispose by burial in a licensed hazardous or toxic waste landfill or incinerator.

References

(109); (102); (31); (173); (101); (138); (100).

DHHS/National Toxicology Program; Eleventh Report on Carcinogens: Semustine (1-(2-Chloroethyl)-3-(4-methylcyclohexyl)-1-nitrosourea) (13909-09-6) (January 2005).

Silane S:0210

Formula: H_4Si; SiH_4

Synonyms: Monosilane; Silano (Spanish); Silicane; Silicon tetrahydride

CAS Registry Number: 7803-62-5

HSDB Number: 6351

RTECS Number: VV1400000

UN/NA & ERG Number: UN2203/116

EC Number: 232-263-4

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Hazard Alert: Extremely flammable gas, Strong reducing agent, Pyrophoric hazard, Water reactive, Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated, Suspected reprotoxic hazard.

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: F+, Xn; risk phrases: R5; R12; R17; R20; R21; safety phrases: S1; S9; S16; S33; S36/37/39; S38 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Silane is a colorless, pyrophoric gas with a repulsive odor. Molecular weight = 32.13; boiling point = −169°C; specific gravity (H_2O:1) = 1.31 @ 25°C; boiling point = −185; freezing/melting point = −111.7°C; flash point = −236°C. Relative vapor density (air = 1) = 1.11. Explosive limits: LEL = 1.37%; UEL: 100%. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 4, reactivity 3₩. Slight solubility in water; slowly decomposes forming silicon hydroxides and flammable hydrogen gas.

Potential Exposure: Silane is used as a doping agent for solid-state devices; as a source of silicon for semiconductors; and in the production of amorphous silicon.

Incompatibilities: An extremely flammable gas. Forms explosive mixture with air; may spontaneously ignite in air. A strong reducing agent. Reacts slowly with water forming silicon hydroxides and flammable hydrogen gas. Reacts with oxidizing agents; halogens [bromine, chlorine, carbonyl chloride; antimony pentachloride; tin(IV) chloride], potassium hydroxide solution. Explodes in oxygen. Decomposes on heating or on burning producing silicon and hydrogen.

Permissible Exposure Limits in Air

OSHA PEL: None

NIOSH REL: 5 ppm/7 milligram per cubic meter TWA

ACGIH TLV[1]: 5 ppm/6.6 milligram per cubic meter TWA

Protective Action Criteria PAC* Ver. 29[138]

PAC-1: **100**$_{\mathbf{A}}$ ppm

PAC-2: **130**$_{\mathbf{A}}$ ppm

PAC-3: **270**$_{\mathbf{A}}$ ppm

*AEGLs are marked with a subscript "**A**" and correspond to 60-minute values.

Australia: TWA 5 ppm (7 milligram per cubic meter), 1993; Belgium: TWA 5 ppm (6.6 milligram per cubic meter), 1993; Denmark: TWA 0.5 ppm (0.7 milligram per cubic meter), 1999; Finland: TWA 0.5 ppm (0.7 milligram per cubic meter); STEL 1.5 ppm (2.0 milligram per cubic meter), 1999; France: VME 5 ppm (7 milligram per cubic meter), 1999; Japan: 100 ppm (130 milligram per cubic meter), 1999; Norway: TWA 0.5 ppm (0.7 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 0.7 milligram per cubic meter, 2003; United Kingdom: TWA 0.5 ppm (0.67 milligram per cubic meter); STEL 1 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 5 ppm. Several states have set guidelines or standards for silane in ambient air[60] ranging from 70 μ/m^3 (North Dakota); to 140 μ/m^3 (Connecticut); to 167 μ/m^3 (Nevada).

Determination in Air: No method available.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Silicon tetrahydride can affect you when breathed in. Irritates the eyes, skin, and respiratory tract. Skin or eye contact with the liquid may cause frostbite. Not much is known about the effects of exposure to high levels, but somewhat similar chemicals cause severe irritation of the eyes, skin and lungs.

Long-Term Exposure: Unknown at this time.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures *over 5 ppm*; Use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Check oxygen content prior to entering storage area. Flammable gas. (1) Color code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. This gas is spontaneously flammable. Store in an area that is roofed, shaded, and well ventilated with the cylinders stored off the ground, separated from all other products assigned to other hazard categories, and radiant heat sources on nonwooden floors. If indoors, store in a well-ventilated areas in temperatures not to exceed 50°C. (2) Color code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Silicon tetrahydride must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine), since violent reactions occur. Silicon tetrahydride should be stored and used under a blanket of inert gas as it explodes on contact with air. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames are prohibited where silicon tetrahydride is handled, used, or stored. Use only nonsparking tools and equipment, especially when opening and closing containers of silicon tetrahydride. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: UN2203 Silane, Hazard Class: 2.1; Labels: 2.1-Flammable gas. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit and to disperse the gas. Stop the flow of gas if it can be done safely. If source of leak is a cylinder and the leak cannot be stopped in place, remove leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. Keep this chemical out of confined space, such as a sewer because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is an extremely flammable and unstable gas. *Use extreme caution*. Thermal decomposition products may include silicon and explosive hydrogen. For small fires, use dry chemical or CO_2 extinguishers. Avoid halons. Do not use CO_2 extinguishers on large fires; use water spray or fog. Dolomite powder or graphite is recommended dry chemical agents[24]. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Dispose by controlled burning or seal cylinders and return to suppliers[24].

References

(31); (173); (101); (138); (170); (100).

National Institute for Occupational Safety and Health (NIOSH), Profiles on Occupational Hazards for Criteria Document Priorities: Silicon and its Compounds, Report PB-270,073, Cincinnati, Ohio, pp. 55−61 (1977).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Silicon Tetrahydride, Trenton, NJ (August 2001).

Silica, Amorphous S:0220

Formula: O_2Si; SiO_2

Synonyms: *diatomaceous earth:* Amorphous silica; Celite; Chromosorb; D.E.; Diatomaceous earth, natural; Diatomaceous silica; Diatomite; Infusorial earth; Kieselguhr; Silica, amorphous-diatomaceous earth (uncalcined); Snowfloss

Silica, amorphous hydrated: Amorphous fumed silica; Silica aerogel; Silica gel; Silica xerogel; Silicic acid; Silicid anhydride

CAS Registry Number: 7631-86-9 (amorphous hydrated); *(alt.)* 50926-93-7; *(alt.)* 67256-35-3; 112945-52-5 (amorphous fumed); 69012-64-2 (fume); 60676-86-0 (fused); 61790-53-2 (diatomaceous earth, uncalcined); *(alt.)* 12750-99-1; *(alt.)* 29847-98-1; *(alt.)* 37337-67-0; *(alt.)* 54511-18-1; *(alt.)* 56748-40-4; *(alt.)* 67016-73-3; 68855-54-9 (diatomaceous earth); 112926-00-8 (precipitated silica and silica gel); 7699-41-4

HSDB Number: 7168 (crystalline silica); 682 (amorphous silica)

RTECS Number: VV73100000 (fumed); VV7311000 (diatomaceous earth)

EC Number: 231-545-4

Regulatory Authority and Advisory Information

Carcinogenicity: see S:0230: NTP 13th Report on Carcinogens, 2014: *Silica, crystalline (respirable size).* Known to be a human carcinogen; IARC: Animal Inadequate Evidence; Human Inadequate Evidence*, not classifiable as carcinogenic to humans*, Group 3, 1997; NIOSH (*Silica, amorphous silica, fused*): Potential occupational carcinogen.

Hazard Alert: Possible risk of forming tumors, Sensitization hazard, Environmental hazard.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects[291]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: Xn, Xi; risk phrases: R22; R36/37/38; R43; R52/53; safety phrases: S26; S29/35; S36/37/39; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): Nonhazard to water.

Description: Amorphous silica, the noncrystalline form of SiO_2, is a transparent to gray, odorless, amorphous powder. *Hydrated*: Molecular weight = 60.08; specific gravity (H_2O:1) = 2.2 @ 20°C; boiling point = 2230°C; 4046°C (fume); freezing/melting point = 1710°C; 3110°C (fume). Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 0, reactivity 0. Insoluble in water. *Fumed:* Molecular weight = 60.09.

Potential Exposure: Amorphous fumed silica is used as a mineral, natural or synthetic fiber. A potential danger to those involved in the production and handling of fumed silica for paint pigments or catalysts. Diatomaceous earth is used in clarifying liquids, in manufacture of fire brick and heat insulators; used as a filtering agent; as a filler in construction materials; pesticides, paints, and varnishes. A potential danger to those involved in mining of diatomaceous earth or fabrication of products there from.

Incompatibilities: Silica, amorphous is a noncombustible solid. Generally unreactive chemically. Incompatible with fluorine, oxygen difluoride, chlorine trifluoride. Soluble in molten alkalis and reacts with most metallic oxides at high temperature[101].

Permissible Exposure Limits in Air

Silica, amorphous silica, fused

OSHA PEL: 30 milligram per cubic meter total dust/ divided by the value "%SiO_2 +2" TWA; *either one* of the following methods: 250 mppcf respirable dust/divided by the value "%SiO_2 +5" *or* 10 milligram per cubic meter respirable dust/divided by the value "%SiO_2 + 2"

NIOSH REL: 0.05 milligram per cubic meter, respirable dust TWA; See *NIOSH Pocket Guide*, Appendix A

ACGIH TLV[1]: withdrawn.

DFG MAK (*CAS: 60676-86-0 & 7699-41-4*): 0.3 milligram per cubic meter respirable fraction; Pregnancy Risk Group C.

Silica, amorphous precipitated and gel & diatomaceous earth, uncalcined

NIOSH IDLH = 3000 milligram per cubic meter

OSHA PEL*: either one of the methods:* 20 mppcf [millions of particles per cubic foot of air, based on impinger samples counted by light-field techniques] *or* 80 milligram per cubic meter divided by the value "%SiO_2," TWA

NIOSH REL: 6 milligram per cubic meter TWA

ACGIH TLV[1]: withdrawn for the following: silica amorphous, precipitated and gel; silica fume; silica fused; diatomaceous earth, calcined.

PAC Ver. 29[138]

7631-86-9, amorphous hydrated

PAC-1: 18 milligram per cubic meter

PAC-2: 740 milligram per cubic meter

PAC-3: 4500 milligram per cubic meter

112945-52-5, amorphous fumed

PAC-1: 18 milligram per cubic meter

PAC-2: 100 milligram per cubic meter

PAC-3: 630 milligram per cubic meter

DFG MAK (*diatomaceous earth, uncalcined)*: 4 milligram per cubic meter, inhalable fraction; Pregnancy Risk Group C.

Austria: MAK 4 milligram per cubic meter, 1999; Norway: TWA 1.5 milligram per cubic meter (respirable dust), 1999; Switzerland: MAK-W 4 milligram per cubic meter, 1999; Thailand: TWA 80 milligram per cubic meter, 1993; United Kingdom: TWA 6 milligram per cubic meter, total dust, 2000; United Kingdom: TWA 1.2 milligram per cubic meter, (respirable dust), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 3 milligram per cubic meter (respirable fraction, for particulate matter containing no asbestos and <1% crystalline silica). Russia[43] set a MAC of 2 milligram per cubic meter in work-place air.

PAC Ver. 29[138]

69012-64-2, silica amorphous fume

PAC-1: 45 milligram per cubic meter

PAC-2: 500 milligram per cubic meter

PAC-3: 3000 milligram per cubic meter

Determination in Air: Use NIOSH(IV) Method #7501 (any form); OSHA Analytical method ID-125G (fumed)

Routes of Entry: Inhalation, skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Amorphous fused silica can affect you when breathed in. Exposure can cause a very serious lung disease called silicosis, with cough and shortness of breath. Very high exposures can cause this problem to develop in a few weeks, or with lower exposures it may occur over many years. Silicosis can cause death. If silicosis develops, chances of getting tuberculosis are increased. The disease may progress, with or without continued exposure. If it does, this can be crippling or even fatal.

Points of Attack: Eyes, respiratory system.

Medical Surveillance: The fused material is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure. For those with frequent or potentially high exposure (half the TLV or greater) the following are recommended before beginning work and at regular times after that. Lung function tests. Chest X-ray every 1 to 3 years. If abnormal chest X-ray develops, the following should be done periodically: skin test for TB.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. If this chemical has been inhaled, remove from exposure. Transfer promptly to a medical facility.

Personal Protective Methods: All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *Up to 30 milligram per cubic meter:* Q_m (APF = 25) (any quarter-mask respirator). *Up to 60 milligram per cubic meter:* 95XQ (APF = 10) [Any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator).*Up to 150 milligram per cubic meter:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *Up to 300 milligram per cubic meter:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 3000 milligram per cubic meter:* Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Prior to working with this chemical, personnel should be trained on its proper handling and storage. Amorphous fused silica must be stored to avoid contact with powerful oxidizers including fluorine, oxygen difluoride; chrome trifluoride; and manganese trioxide; since violent reactions occur.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Amorphous fused silica itself does not burn. Thermal decomposition products may include oxides of metal. Extinguish fire using an agent suitable for type of surrounding fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Sanitary landfill.

References

(109); (31); (173); (101); (138); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 6, 94 (1981).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Silica, amorphous-Dimataceous Earth, Trenton, NJ (May 1999).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Silica, amorphous (Fume), Trenton, NJ (April 2003).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Silica, amorphous Fused, Trenton, NJ (April 2002).

Silica, Crystalline S:0230

Formula: O_2Si; SiO_2

Synonyms: *cristobalite:* Calcined diatomite; Silica, cristobalite; Silica, crystalline-cristobalite

Silica, quartz: Agate; Amethyst; Chalcedony; Cherts; Flint; Onyx; Pure quartz; Quartz; Rose quartz; Sand; Silica flour (powdered crystalline silica); Silicic anhydride

Tridymite: Christensenite; Silica, crystalline-tridymite; Tridimite (French); α-Tridymite; Tridymite; Tridymite 118

Tripoli: Finely ground silica; Silica flour

CAS Registry Number: 14808-60-7 (crystalline quartz); 14464-46-1 (cristobalite); *(alt.)* 1317-48-2; 105269-70-3 (cristobalite); 15468-32-3; *(alt.)* 1317-94-8; 12414-70-9 (tridymite); 1317-95-9 (tripoli)

HSDB Number: 7168 (crystalline); 682 (amorphous)

RTECS Number: VV7325000 (cristobalite); VV7330000 (quartz); VV7335000 (tridymite); VV7336000 (tripoli)

EC Number: 215-684-8; 238-878-4; 238-455-4 (cristobalite); 239-487-1 (tridymite)

Regulatory Authority and Advisory Information

Carcinogenicity: IARC (*cristobalite, tridymite, tripoli & quartz*): Human Sufficient Evidence; Animal Sufficient Evidence, *carcinogenic to humans*, Group 1, 1997; NTP (*respirable cristobalite, tridymite, tripoli & quartz*): NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen; NIOSH (*cristobalite, tridymite, tripoli & quartz*): Potential occupational carcinogen.

California Proposition 65 Chemical[102]: Cancer [Silica, crystalline (airborne particles of respirable size)] 10/1/1988

Hazard Alert: Cristobalite: Possible risk of forming tumors. Quartz: Possible risk of forming tumors, Suspected of causing genetic defects, Organometallic. Tridymite: Possible risk of forming tumors, Suspected of causing genetic defects.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%, all forms.

Hazard symbols, risk, & safety statements: Hazard symbol: Xn; risk phrases: R40; R36/37/38; R48/20; safety phrases: S22; S24/25; S26 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): Nonhazard to water.

Description: Silicon dioxide/crystalline silica is a component of many mineral dusts and materials which melts to a glass at very high temperature. Molecular weight = 60.09; specific gravity (H_2O:1) = 2.65; 2.3 (cristolbalite); boiling point (quartz) = 2950°C; freezing/melting point (quartz) = 573°C; 1722°C (cristobalite). Explosive limits (SiO_2): LEL = 13,700 ppm[138]; 11,000 ppm[138]; UEL: unknown; Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 0, reactivity 0. Insoluble in water.

Potential Exposure: Cristobalite is used in the manufacture of water glass, refractories, abrasives, ceramics and enamels. Quartz is used as a mineral, natural or synthetic fiber. Tridymite is used as a filtering and insulating media and as a refractory material for furnace linings. Workers are potentially exposed to crystalline silica in such industries as granite quarrying and cutting, foundry operations; metal, coal, dentistry, painting, and nonmetallic mining; and manufacture of clay and glass products.

Incompatibilities: Violent reactions with powerful oxidizers: fluorine, chlorine trifluoride; manganese trioxide; oxygen difluoride, hydrogen peroxide, etc.; acetylene; ammonia.

Permissible Exposure Limits in Air

OSHA PEL: (*silica, crystalline α-quartz, CAS: 14808-60-7 & Silica, crystalline tripoli CAS: 1317-95-9*): 30 milligram per cubic meter total dust/divided by the value "%SiO_2 +2" TWA; *either one* of the following methods: 250 mppcf respirable dust/divided by the value "%SiO_2 +5" *or* 10 milligram per cubic meter respirable dust/divided by the value "% SiO_2 + 2; For Silica crystalline, tridymite, CAS: 15468-32-3 & Silica, crystalline cristobalite, CAS 14464-46-1 use 1/2 the values calculated above using the count or mass formula for quartz. See also Table Z-3 of 29 CFR 1910.1000

NIOSH REL (*silica, crystalline, all forms*): 0.05 milligram per cubic meter, respirable dust TWA; Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A

ACGIH TLV[1] (*Silica, crystalline α-quartz, CAS: 14808-60-7 & Crystalline cristobalite, CAS 14464-46-1*): 0.025 milligram per cubic meter TWA, Respirable fraction of dust; Suspected Human Carcinogen

NIOSH IDLH = (*cristobalite & tridymite*) 25 milligram per cubic meter (*quartz & tripoli*) 50 milligram per cubic meter

PAC Ver. 29[138]

14808-60-7 Silica, crystalline-quartz (Silicon dioxide); 14464-46-1 (cristobalite)

PAC-1: 0.075 milligram per cubic meter

PAC-2: 33 milligram per cubic meter

PAC-3: 200 milligram per cubic meter

DFG MAK (*silica, crystalline, all forms*): respirable; Carcinogen Category 1

Austria: MAK 0.15 milligram per cubic meter, 1999; Belgium: TWA

0.05 milligram per cubic meter, 1993; Finland: TWA 0.1 milligram per cubic meter, 1999; France: VME 10/(2X + 2), 1999; Norway: TWA 0.05 milligram per cubic meter (respirable dust), 1999; Russia: STEL 1 milligram per cubic meter (total dust), 1993; the Netherlands: MAC-TGG 0.075 milligram per cubic meter, 2003; Switzerland: MAK-W 0.15 milligram per cubic meter, 1999; Thailand: TWA 10 milligram per cubic meter, 1993; United Kingdom: TWA0.3 milligram per cubic meter, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 0.05 milligram per cubic meter (respirable dust)

Determination in Air: Use: Use NIOSH Analytical Method (cristobalite), #7500, Silica, crystalline, by XRD; #7601, by VIS; #7602, by IR; #7603, Silica, crystalline in coal mine dust, by IR; OSHA Analytical Method ID-142 (revised October 2015); 125-G.

Routes of Entry: Inhalation of dust, skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes. Inhalation can cause cough, dyspnea (breathing difficulty), wheezing.

Long-Term Exposure: Can cause decreased pulmonary function, progressive respiratory symptoms; fibrosis (silicosis). A potential occupational carcinogen. Silicosis is a very serious lung disease that can cause cough and shortness of breath. Silicosis can develop in a few weeks at very high exposures, or it may occur over many years with lower exposures. Silicosis can cause death. If silicosis develops, risk of developing tuberculosis is increased. The disease may progress with or without continued exposure. If it does, this can be crippling or even fatal. Very fine silica, or "silica flour" is even more hazardous.

Points of Attack: Eyes, respiratory system. Cancer site in animals: lung cancer.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that. Lung function tests. Chest X-ray every 1 to 3 years. Chest X-rays should be read by a "B-reader," a doctor with special training for reading X-rays of the lungs. If abnormal chest X-ray develops, the following should be done periodically, skin test for tuberculosis.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Specific engineering controls are recommended in the NIOSH document CT-112-23b, *Control Technology for Bag Filling Operations at Manville Products Corporation, Lompoc, CA.* NIOSH recommends that *silica sand* or materials containing *more than 1% free silica* be prohibited as abrasive substances in abrasive blasting and cleaning operations. The New Jersey Department of Health and Senior Services document, *Stop Silicosis in Sandblasters; Use Silica Substitutes* recommends the substitution of less toxic *alumina* in pottery, and *quartz free grit* in abrasive blasting for silica, cristobalite. Follow OSHA regulations (OSHA Standard 1910.94) for abrasive blasting operations.

Respirator Selection: NIOSH: *Up to 0.5 milligram per cubic meter:* 95XQ (APF = 10) (any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100). *Up to 1.25 milligram per cubic meter:* PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter); or Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *Up to 2.5 milligram per cubic meter:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter). *Up to 25 milligram per cubic meter:* Sa:Pd, Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp:ASCBA (APF =
10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Prior to working with this chemical, personnel should be trained on its proper handling and storage. Silica must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine), since violent reactions occur. A regulated, marked area should be established, or stored in compliance with OSHA Standard 1910.1045.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during clean-up. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Silica itself does not burn. Thermal decomposition may include oxides of metal. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Sanitary landfill.

References

(109); (102); (31); (173); (101); (138); (2); (100).

National Institute for Occupational Safety and Health (NIOSH), "Criteria for a Recommended Standard: Occupational Exposure to Crystalline Silica", NIOSH Document Number 75-120, Cincinnati OH (1974).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Silica, Quartz, Trenton, NJ (April 2002).
New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Silica, Tripoli, Trenton, NJ (April 2002).
New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Silica Cristobalite, Trenton, NJ (April 2002).

Silicon S:0240

Formula: Si
Synonyms: Defoamer S-10; Elemental silicon; Silicon, amorphous powder
CAS Registry Number: 7440-21-3
HSDB Number: 5033
RTECS Number: VW0400000
UN/NA & ERG Number: UN1346 (powder, amorphous)/170
EC Number: 231-130-8

Regulatory Authority and Advisory Information
Hazard Alert: Highly flammable (dust, powder only), Primary irritant (w/o allergic reaction)
Hazard symbols, risk, & safety statements: Hazard symbol: T, F (powder); risk phrases: R11; safety phrases: S7; S16; S26; S36/37; S41; S45 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): Nonhazard to water.

Description: Silicon is a nonmetallic element which is known as silicon metal. Not occur freely in nature, but is found in silicon dioxide (silica) and in various silicates[77]. It is a steel-gray crystalline solid or a black-brown amorphous material. Molecular weight = 28.09; specific gravity (H_2O:1) = 2.33; boiling point = 3265°C[138]; freezing/melting point = 1414°C. Minimum Explosive Concentration = $160\ g/m^3$. Ignition temperature of dust cloud = Unknown; minimum explosive concentration = $0.11\ oz/ft^3$[209]. Relative explosion hazard of dust: Strong. Hazard identification (based on NFPA-704 M Rating System): [powder] Health 1, flammability 2, reactivity 1. Nearly insoluble in water. Does not occur free in nature, but is found in silicon dioxide (silica) and in various silicates.

Potential Exposure: Silicon may be used in the manufacture of silanes, silicon tetrachloride, ferrosilicon, silicones. It is used in purified elemental form in transistors and photovoltaic cells.

Incompatibilities: Dust or powder may form explosive mixture with air. A strong reducing agent. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, calcium, carbonates, chlorine, fluorine, oxidizers, cesium carbide; alkaline carbonates.

Permissible Exposure Limits in Air
OSHA PEL: 15 milligram per cubic meter TWA, total dust; 5 milligram per cubic meter TWA, respirable fraction
NIOSH REL: 10 milligram per cubic meter TWA, total dust; 5 milligram per cubic meter TWA, respirable fraction
ACGIH TLV[1]: withdrawn
PAC Ver. 29[138]
PAC-1: 45 milligram per cubic meter
PAC-2: 100 milligram per cubic meter
PAC-3: 630 milligram per cubic meter
Australia: TWA 10 milligram per cubic meter, 1993; Belgium: TWA 10 milligram per cubic meter, 1993; Denmark: TWA 10 milligram per cubic meter, 1999; France: VME 10 milligram per cubic meter, 1999; Norway: TWA 10 milligram per cubic meter, 1999; Switzerland: MAK-W 4 milligram per cubic meter, 1999; United Kingdom: TWA $10\ mg/m^2$, total inhalable dust, 2000; the Netherlands: MAC-TGG 10 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 10 milligram per cubic meter

Determination in Air: Filter; none; Gravimetric; NIOSH IV, Particulates NOR: Method #0500, total dust; Method #0600 (respirable dust).

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms
Short-Term Exposure: Causes irritation of the eyes, skin, and upper respiratory system; cough. Silicon dust does not produce significant organic disease or toxic effect when exposures are kept under reasonable control. Unpleasant deposits may be caused in eyes, ears and nasal passages, and injury to the skin and mucous membranes may be caused by the dust itself or by cleansing procedures used for its removal.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: Lung function test. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure. Transfer promptly to a medical facility.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when

skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.
Storage: Color code—Red Stripe: Flammability Hazard: Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Store flammable solids up to maximum allowable quantity per control area in an approved flammable storage area. Do not store in a basement. Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers and other incompatible materials.
Shipping: UN1346 Silicon powder, amorphous requires, Hazard Class: 4.1; Labels: 4.1-Flammable solid.
Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.
Fire Extinguishing: This chemical is a combustible solid. Thermal decomposition products may include silicon oxide. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.
References
(31); (173); (101); (138); (100).

Silicon Carbide S:0250

Formula: CSi; SiC
Synonyms: Carbon silicide; Carborundum, Crystolon, Carbonite, Electrolon; Silicon monocarbide
CAS Registry Number: 409-21-2; *(alt.)* 12504-67-5; *(alt.)* 66039-27-8
HSDB Number: 681
RTECS Number: VW0450000
EC Number: 206-991-8
Regulatory Authority and Advisory Information
Hazard Alert: Combustible (dust. Powder), Possible risk of forming tumors.
Hazard symbols, risk, & safety statements: Hazard symbol: Xi; risk phrases: R36/37; safety phrases: S16; S26; S36/37/39 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.
Description: Silicon carbide is a yellow to green to bluish-black, iridescent crystalline substance. Colorless when pure. Molecular weight = 40.1; specific gravity (H_2O:1) = 3.23; 3.16[138]; boiling point = (sublimes); freezing/melting point = (sublimes with decomposition) 2700°C; 2830°C[138]. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 1, reactivity 0. Insoluble in water.
Potential Exposure: A potential danger to those involved in the manufacture of silicon carbide abrasives, refractories, and semiconductors. Silicon carbide fibers are also produced in fibrous form as reinforcing fibers for composite materials.
Incompatibilities: Dust may form explosive mixture with air. Sublimes with decomposition @ 2700°C.
Permissible Exposure Limits in Air
OSHA PEL: 15 milligram per cubic meter TWA, total dust; 5 milligram per cubic meter TWA, respirable fraction
NIOSH REL: 10 milligram per cubic meter TWA, total dust; 5 milligram per cubic meter TWA, respirable fraction
ACGIH TLV[1]: *nonfibrous:* 10 milligram per cubic meter TWA, inhalable fraction; particulate matter containing no asbestos and <1% crystalline silica; 3 milligram per cubic meter TWA, respirable fraction, for particulate matter containing no asbestos and <1% crystalline silica; *fibrous (including whiskers):* 0.1 f/cc, TWA, respirable fibers; length >5 μm; aspect ratio ≥3:1, as determined by the membrane filter method @ 400−450× magnification (4-mm objective), using phase-contrast illumination; Suspected Human Carcinogen
PAC Ver. 29[138]
PAC-1: 45 milligram per cubic meter
PAC-2: 500 milligram per cubic meter
PAC-3: 3000 milligram per cubic meter
DFG MAK: 1.5 milligram per cubic meter, respirable fraction (previously "fine dust"); 4 milligram per cubic meter, inhalable fraction; Pregnancy Risk Group C.

Australia: TWA 10 milligram per cubic meter, 1993; Austria: MAK 4 milligram per cubic meter, 1999; Belgium: TWA 10 milligram per cubic meter, 1993; France: VME 10 milligram per cubic meter, 1999; Switzerland: MAK-W 4 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 10 milligram per cubic meter, 2003; United Kingdom: TWA 4 milligram per cubic meter, (respirable dust), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Suspected Human Carcinogen

Determination in Air: Use NIOSH IV Method #0500, total dust, Method #0600 (respirable dust), Particulates NOR.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin, upper respiratory system; cough.

Long-Term Exposure: Silicon carbide can alter the course of inhalation tuberculosis leading to extensive fibrosis and progressive disease.

Points of Attack: Respiratory system.

Medical Surveillance. Lung function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure. Transfer promptly to a medical facility.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Green: General storage may be used. Prior to working with this chemical, personnel should be trained on its proper handling and storage.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Thermal decomposition products may include oxides of silicon and carbon. Use any extinguishing agent suitable for surrounding fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Landfill.

References

(173); (31); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Silicon carbide, Trenton, NJ (February 2007).

Silicon Tetrafluoride S:0255

Formula: SiF_4

Synonyms: Perfluorosilane; Silicon fluoride; Silicon tetrafluoride, compressed; Tetrafluorosilane

CAS Registry Number: 7783-61-1

HSDB Number: 684

RTECS Number: VW2327000

UN/NA & ERG Number: (PIH) UN1859/125

EC Number: 232-015-5

Regulatory Authority and Advisory Information

Carcinogenicity: ACGIH A4 Not classifiable as a human carcinogen, as fluorides

Hazard Alert: Poison inhalation hazard, Corrosive, Dangerously water reactive, Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated.

United States National Primary Drinking Water Regulations: MCLG = 4 mg[F]/L; MCL = 4 mg[F]/L; SMCL = 2.0 mg[F]/L, as Fluoride.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. As fluoride compounds

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Hazard symbols, risk, & safety statements: Hazard symbol: T+, C; risk phrases: R6; R14; R26/27/28; R29; R31; R34;

R35; R37; R51/53; safety phrases: S7/9; S23; S24/25; S26; S36/37/39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [2-Hazard to waters (est.)]

Description: A colorless, nonflammable, corrosive and toxic gas. Sharp, pungent suffocating odor, similar to hydrogen chloride. Vapor is heavier than air; density = 3.6. Molecular weight = 104.09; specific gravity (H_2O:1) = 1.66 @ 20°C; boiling point = −86°C; freezing/melting point = −90°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 2₩. Dangerous reaction with water, releasing silicon dioxide, silicic acid, and hydrofluoric acid.

Potential Exposure: Silicon tetrafluoride is not used in industry but may be a discharge byproduct of certain processes, including ore refining and smelting operations. It has been used in the manufacture of silane and fluosilicic acid, and pure electronic silicon.

Incompatibilities: Water and air reactive Fluorides form explosive gases on contact with strong acids, acid fumes, and sodium. Water and air reactive. Corrosive. Fumes in air. Decomposed exothermically by water, alcohols, or moisture in the air to hydrofluoric acid and silicic acid, forming flammable and potentially explosive hydrogen gas. Attacks many metals in the presence of moisture.

Permissible Exposure Limits in Air:

NIOSH IDLH = 250 mg[F]/m^3

OSHA PEL: 3 ppm/2.5 mg[F]/m^3 TWA

NIOSH REL: 3 ppm/2.5 mg[F]/m^3 TWA; 6 ppm/5 mg[F]/m^3, 15 minutes Ceiling Concentration

ACGIH TLV[1]: 2.5 mg[F]/m^3 TWA; not classifiable as a human carcinogen; Biological Exposure Index (BEI): 3 mg [F]/g creatinine in urine *prior* to end-of-shift; 10 mg[F]/g creatinine in urine end-of-shift.

DFG MAK: 1 mg[F]/m^3, inhalable fraction [skin]; Peak Limitation Category II(4); Pregnancy Risk Group C; BAT: 7.0 mg[F]/g creatinine in urine at end-of-shift; 4.0 mg[F]/g creatinine in urine at the beginning of the next shift

Australia: TWA 2.5 mg[F]/m^3, 1993; Austria: MAK 2.5 mg [F]/m^3, 1999; Belgium: TWA 2.5 mg[F]/m^3, 1993; Finland: TWA 2.5 mg[F]/m^3, 1999; France: VME 2.5 mg[F]/m^3, 1999; Hungary: TWA 1 mg[F]/m^3; STEL 2 mg[F]/m^3, 1993; Norway: TWA 0.6 mg[F]/m^3, 1999; the Philippines: TWA 2.5 mg[F]/m^3, 1993; Poland: MAC (TWA) 1 mg[HF]/m^3, MAC (STEL) 3 mg[HF]/m^3, 1999; Russia: STEL 0.5 ppm (2.5 milligram per cubic meter), 1993; Sweden: NGV 2 mg [F]/m^3, 1999; Switzerland: MAK-W 1.8 ppm (1.5 mg[F]/m^3), KZG-W 3.6 ppm (3.0 mg[F]/m^3), 1999; Thailand: TWA 2.5 mg[F]/m^3, 1993; United Kingdom: TWA 2.5 mg[F]/m^3, 2000; LTEL 2.5 mg[F]/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen

Several states have set guidelines or standards for fluorides in ambient air[60] ranging from 2.85 μ/m^3 (Iowa) to 25.0 μ/m^3 (North Dakota) to 34.0 μ/m^3 (Massachusetts) to 40.0 μ/m^3 (Virginia).

PAC* Ver. 29[138]

PAC-1: $\mathbf{0.05_A}$ ppm

PAC-2: $\mathbf{3.3_A}$A ppm

PAC-3: $\mathbf{10_A}$ ppm

*AEGLs are marked with a subscript "**A**" and correspond to 60-minute values.

Exposure Period AEGL-1/AEGL-2/AEGL-3 (NAC/NRC)

10 minutes 0.05 ppm/6.3 ppm/19 ppm

30 minutes 0.05 ppm/4.3 ppm/13 ppm

60 minutes 0.05 ppm/3.3 ppm/10 ppm

4 hours 0.05 ppm/0.87 ppm/2.6 ppm

8 hours 0.05 ppm/0.43 ppm/1.3 ppm

Determination in Air: Gaseous fluorides collected by impinger using caustic; particulates by filter. Analysis is by ion-specific electrode per NIOSH Analytical Method 7902[18].

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guidelines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg [F]/L. Safe Drinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg[F]/L; SMCL = 2 mg[F]/L.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short-Term Exposure: Very toxic and irritating by inhalation and ingestion. Corrosive to the eyes and respiratory system.

LD$_{50}$ (oral-rat) = < 3 g/kg; (rat, inhalation) = 450 ppm.

Long-Term Exposure: Repeated high exposures to fluorides may affect kidneys. Repeated high exposures can cause deposits of fluorides in the bones (fluorosis) that may cause pain, disability, and mottling of the teeth. Repeated exposure can cause nausea, vomiting, loss of appetite; diarrhea, or constipation. Nosebleeds and sinus problems may also occur.

Eyes, respiratory system; CNS; skeleton, kidneys, skin.

Medical Surveillance: For those with frequent or potentially high exposure to fluorides (half the TLV or greater), the following are recommended before beginning work and at regular times after that. Lung function tests. Fluoride level in urine (use NIOSH #8308). Levels higher than 4 mg/L may indicate overexposure. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Kidney function tests.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method* if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with liquefied gas, thaw frosted parts with lukewarm water. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. Keep victim warm and quiet. Keep victim under observation Effects of contact or inhalation may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water, or milk. Do not induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: *Caution*: Liquids with this reactive group classification have been known to react with the following absorbents: Cellulose-Based Absorbents, Mineral-Based & Clay-Based Absorbents, Dirt/Earth[101]. In addition to positive pressure SCBA, wear chemical protective clothing that is specifically recommended by the manufacturer. It may provide little or no thermal protection. Structural firefighters' protective clothing provides limited protection in fire situations only; it is not effective in spill situations where direct contact with the substance is possible.

Respirator Selection: NIOSH/OSHA *12.5 milligram per cubic meter:* Q_m (APF = 25) (any quarter-mask respirator). *25 milligram per cubic meter:* 95XQ (APF = 10)* [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or SA* (any supplied-air respirator). *62.5 milligram per cubic meter:* Sa:Cf (APF = 25)*+ (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25)* *if not present as a fume* (any powered, air-purifying respirator with a high-efficiency particulate filter). *125 milligram per cubic meter:* 100F (APF = 50)$^+$ [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *250 milligram per cubic meter:* Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50)$^+$ [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or SCBAE (any appropriate escape-type, SCBA). *Substance reported to cause eye irritation or damage; may require eye protection. *May need acid gas sorbent.

Storage: Poison inhalation chemical (PIH); check oxygen content prior to entering storage area. (1) Color code—Blue: Health Hazard/Poison: Store in tightly closed containers in a secure poison location. This gas is highly toxic. Even slight exposure to this gas can cause death. Store outdoors in a secure, restricted area that containing warning signs. This area must be roofed and shaded with the cylinders stored off the ground and separated from all other products assigned to other hazard categories and radiant heat sources on nonwooden floors. If indoors, store in a well-ventilated areas in temperatures not to exceed 50°C. (2) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association

Shipping: UN1859 Silicon tetrafluoride, Hazard Class: 2.3; Labels 2.3-Poisonous gas; 8-Corrosive material; Inhalation Hazard Zone B. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling:

Silicon tetrafluoride

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)
First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.5/0.8
Large spills (From a large package or from many small packages)
First: Isolate in all directions (ft/m) 300/90
Then: Protect persons downwind (mi/km)
Day 0.4/0.6
Night 1.6/2.5

If in a building, evacuate building and confine vapors by closing doors and shutting down HVAC systems. Restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Stop the release if it can be done safely from a distance. Ventilate confined area if it can be done without placing personnel at risk Wear chemical protective suit with SCBA to combat spills. Stay upwind and use water spray to "knock down" vapor; contain runoff. Stop the flow of gas, if it can be done safely from a distance. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place; and repair leak or allow cylinder to empty. Keep this chemical out of confined spaces, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include toxic fumes of hydrogen fluoride. This gas is under pressure; containers may rupture and explode when heated. Noncombustible, poisonous and corrosive. Water reactive. Thermal decomposition products may include toxic fumes of hydrogen fluoride. Under prolonged exposure to heat the containers may rupture violently and rocket. Stop the release if it can be done safely from a distance. *Small fire:* Use *dry* chemical, CO_2. Large fire: Use water spray, fog, or regular foam. *If tanks are involved or in case of Large fire*: Fight fire from maximum distances or use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn. Cool exposed containers with large quantities of water from unattended equipment until well after fire is out, or remove intact containers if it can be done safely. Damaged cylinders should be handled only by specialists. Do not direct water at source of leak or safety devices; icing may occur. If cooling streams are ineffective (*venting sound increases in volume and pitch, tank discolors or shows signs of deforming*), withdraw immediately to a secure location. Always stay away from ends of tanks, especially when engulfed in flames. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156.

Disposal Method Suggested: For laboratory quantities, transfer into an evaporating dish containing sodium bicarbonate, spray with ammonia (6M NH_4OH)/6 M-ammonium hydroxide/while stirring and then spread with crushed ice. Continue spraying with ammonia until the smoke of ammonium chloride partly subsides and add iced water while stirring. Neutralize and slowly transfer the mixture into a drain with running water.

References

(31); (173); (101); (138); (122); (100).
National Institute for Occupational Safety and Health (NIOSH), "Criteria for a Recommended Standard: Occupational Exposure to Inorganic Fluorides", NIOSH Document Number 76-103, Cincinnati, OH (1976).
National Academy of Sciences, Medical and Biologic Effect of Environmental Pollutants: Fluoride, Washington, DC (1971).
New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Fluoride, Trenton, NJ (January 1986).
United Nations Environmental Programme*, Treatment and Disposal Methods for Waste Chemicals*, Data Profile Series No. 5, p. 279, Geneva, Switzerland, December, 1985.

Silver S:0260

Formula: Ag
Synonyms: Argentum; C.I. 77820; Elemental silver; Shell silver; Silber (German); Silver metal
soluble compounds: Silver acetate; Silver bromate; Silver bromide; Silver carbonate; Silver chloride; Silver chromate; Silver cyanide; Silver cichromate; Silver hydroxide; Silver iodate; Silver iodide; Silver nitrite; Silver oxalate; Silver sulfate; Silver sulfide; Silver thiocyanate
CAS Registry Number: 7440-22-4
HSDB Number: 5034
RTECS Number: VW3500000
UN/NA & ERG Number: Not regulated in bulk. UN3089 Metal powders, flammable, n.o.s., Hazard Class: 4.1; Labels: 4.1-Flammable solid.
EC Number: 231-131-3
Regulatory Authority and Advisory Information
Carcinogenicity (*metal*): EPA: Not Classifiable as to human carcinogenicity.
Hazard Alert: (powder/dust): Combustible, Highly reactive with known catalytic activity.
United States National Primary Drinking Water Regulations: SMCL = 0.10 mg[Ag]/L as Silver
Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/1992); 40CFR401.15 Section 307 Toxic Pollutants as *silver and compounds*
United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): D011
RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed
RCRA Toxicity Characteristic (Section 261.24), Maximum Concentration of Contaminants, regulatory level, 5.0 mg/L

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.43; Nonwastewater (mg/L), 0.30 TCLP

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 6010 (70); 7760 (100)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1000 lb (454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0% (includes any unique chemical substance that contains silver as part of that chemical's infrastructure).

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xn; risk phrases: R40; R10 (powder); R20/21; R22; R23/24/25; R34; R38; safety phrases: S24/25; S36/37/39 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water. (*metal with a particle size >= 1 mm*); 3-Severe hazard to water. (*colloidal*)

Description: Silver is a white lustrous metal that is extremely ductile and malleable. Molecular weight = 107.87; specific gravity (H_2O:1) = 10.5 (metal); boiling point = 2212°C; 2162°C[138]; freezing/melting point = 962°C. Hazard identification (based on NFPA-704 M Rating System) (*powder*): Health 0, flammability 0, reactivity 1 Insoluble in water but soluble in hot sulfuric and nitric acids. Perhaps the most common soluble silver compounds are silver nitrate, $AgNO_3$ and silver cyanide, AgCN.

Potential Exposure: Silver may be alloyed with copper, aluminum, cadmium, lead, or antimony. The alloys are used in the manufacture of silverware, jewelry, coins, ornaments, plates, commutators, scientific instruments; automobile bearing; and grids in storage batteries. Silver is used in chrome-nickel steels, in solders and brazing alloys; in the application of metallic films on glass and ceramics, to increase corrosion resistance to sulfuric acid, in photographic films, plates and paper; as an electroplated undercoating for nickel and chrome; as a bactericide for sterilizing water; fruit juices; vinegar, etc.; in bus bars and windings in electrical plants; in dental amalgams; and as a chemical catalyst in the synthesis of aldehydes. Because of its resistance to acetic and other food acids, it is utilized in the manufacture of pipes, valves, vats, pasteurizing coils and nozzles for the milk, vinegar, cider, brewing, and acetate rayon silk industries.

Incompatibilities: Dust may form explosive mixture with air. Powders are incompatible with strong oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides May react and/or form dangerous or explosive compounds, with acetylene, ammonia, halogens, hydrogen peroxide; bromoazide, concentrated or strong acids, oxalic acid, tartaric acid, chlorine trifluoride, ethyleneimine.

Permissible Exposure Limits in Air

Silver metal dust and fume

NIOSH IDLH = 10 mg[Ag]/m^3

OSHA PEL: 0.01 mg[Ag]/m^3 TWA

NIOSH REL: 0.01 mg[Ag]/m^3 TWA

ACGIH TLV[1]: *silver metal dust and fume*: 0.1 mg[Ag]/m^3 TWA; *silver salts*: 0.01 mg[Ag]/m^3 TWA

PAC Ver. 29[138]

PAC-1: 0.3 milligram per cubic meter

PAC-2: 170 milligram per cubic meter

PAC-3: 990 milligram per cubic meter

DFG MAK: *silver metal dust and fume*: 0.1 mg[Ag]/m^3, inhalable fraction TWA; Peak Limitation Category II(8); Pregnancy Risk Group D. *silver salts:* 0.01 mg[Ag]/m^3, inhalable fraction TWA; Peak Limitation Category I(2); Pregnancy Risk Group D

Australia: TWA 0.1 milligram per cubic meter, 1993; Austria: MAK 0.01 milligram per cubic meter, 1999; Belgium: TWA 0.1 milligram per cubic meter, 1993; Denmark: TWA 0.01 milligram per cubic meter, 1999; Finland: TWA 0.1 milligram per cubic meter, 1999; France: VME 0.1 milligram per cubic meter, 1999; Japan: 0.01 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 0.1 milligram per cubic meter, 2003; Norway: TWA 0.01 milligram per cubic meter, 1999; Russia: STEL 1 milligram per cubic meter, 1993; Sweden: NGV 0.1 milligram per cubic meter, 1999; Switzerland: MAK-W 0.01 milligram per cubic meter, 1999; United Kingdom: TWA 0.1 milligram per cubic meter, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 0.1 milligram per cubic meter *silver metal dust*. Several states have set guidelines or standards for silver in ambient air[60] ranging from 0.01−0.08 μ/m^3 (Montana); to 0.2 μ/m^3 (Connecticut and Nevada); to 1.0 μ/m^3 (North Dakota); to 16,000 μ/m^3 (Virginia).

As silver soluble compounds

OSHA PEL: 0.01 milligram per cubic meter TWA

NIOSH REL: 0.01 milligram per cubic meter TWA

ACGIH TLV[1]: 0.01 milligram per cubic meter TWA

Determination in Air: NIOSH Analytical Method #7300 Elements by ICP; #8005, Elements in blood or tissue, #8310 Metals in urine; OSHA Analytical Method ID-121.

Permissible Concentration in Water: United States National Primary Drinking Water Regulations: SMCL = 0.10 mg[Ag]/L as silver Federal Drinking Water Guidelines: EPA 100 μg[Ag]/L; State Drinking Water Standards: Connecticut 50 μg[Ag]/L; State Drinking Water Guidelines: Arizona 50 μg[Ag]/L; Maine 35 μg[Ag]/L; Minnesota 30 μg[Ag]/L. Wisconsin 50 μg[Ag]/L.

Determination in Water: Digestion followed by atomic absorption, or colorimetric determination (with Dithizone); or by inductively coupled plasma (ICP) optical emission spectrometry. This gives total silver. Dissolved silver may be determined by these same methods preceded by 0.45 μ filtration.

Routes of Entry: Inhalation of fumes or dust; ingestion of solutions or dust, eye and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Causes irritation of the eyes, skin and respiratory tract. Ingestion of dust can cause gastrointestinal disturbance.

Long-Term Exposure: Silver can affect you when breathed in. Repeated exposure to fine silver dust or fumes can cause blue-gray staining of the eyes, mouth, throat, internal organs, and skin. This occurs slowly and may take years to develop. Once present, it does not go away. It can be very disfiguring. Skin contact can cause silver to become imbedded in small cuts in the skin, forming a permanent tattoo. Can cause sores on the inner lining of the nose and may cause perforation of the nasal septum.

Points of Attack: Nasal septum, skin, eyes.

Medical Surveillance: NIOSH lists the following tests: whole blood (chemical/metabolite); blood serum; biologic tissue/biopsy; Pigmentation Evidence; urine (chemical/metabolite). Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: Slit lamp exam by an eye doctor. Exam of the skin, nose, and throat. If symptoms develop or overexposure is suspected, the following may be useful: kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *0.25 milligram per cubic meter:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *0.5 milligram per cubic meter:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *10 milligram per cubic meter:* SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode. *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance causes eye irritation or damage; eye protection needed.

Storage: Color code—Green (*solid metal*): General storage may be used. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Silver is highly reactive and must be stored to avoid contact with incompatible materials such as acetylene, ammonia, hydrogen peroxide; or ethyleneimine; since violent reactions could result.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible bulk solid, but flammable in the form of dust or powder. Thermal decomposition products may include metal oxides. Use dry chemical, metal extinguishers, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Recovery, wherever possible, in view of economic value of silver. Techniques for silver recovery from photoprocessing and electroplating wastewaters have been developed and patented.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Silver: Ambient Water Quality Criteria, Washington, DC (1980).

United States Environmental Protection Agency, Silver, Health and Environmental Effects Profile No. 154, Washington, DC, Office of Solid Waste (April 30, 1980).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 1, 52−55 (1980).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Silver, Trenton, NJ (October 2002).

Silver Cyanide S:0270

Formula: CAgN

Synonyms: Cianuro de plata (Spanish); Cyanure d'argent (French)

CAS Registry Number: 506-64-9

HSDB Number: 6058

RTECS Number: VW3850000

UN/NA & ERG Number: UN1684/151

EC Number: 208-048-6

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Combustible, Primary irritant (w/o allergic reaction), Environmental hazard.

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as silver and compounds

United States National Primary Drinking Water Regulations: SMCL = 0.10 mg[Ag]/L as Silver; 0.2 mg [CN^-]/L; MCL = 0.2 mg[CN^-]/L as cyanide

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P104

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg)

EPCRA (Section 313): Includes any unique chemical substance that contains silver as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: 1.0%. Section 313 Category Code N740 (silver compounds)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.; National Pollutant Release Inventory (NPRI); CEPA Priority Substance List, Ocean dumping prohibited, as cyanides.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, N; risk phrases: R23/24/25; R32; R33; R26/27/28; R36/37/38; R41; R50/53; R52/53; safety phrases: S7; S26; S28; S29; S36/37/39; S45; S60; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Silver cyanide is a white or grayish, odorless powder which darkens when exposed to light. Molecular weight = 133.89; specific gravity (H_2O:1) = 3.95; freezing/melting point = 320°C (decomposition). Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 1, reactivity 0. Practically insoluble in water.

Potential Exposure: It is primarily used in silver plating.

Incompatibilities: Acetylene, ammonia, and hydrogen peroxide (H_2O_2). Contact with moisture, CO_2, acid and acid fumes release hydrogen cyanide. Contact with fluorine is violently explosive at normal temperatures. Incompatible with phosphorus cyanide.

Permissible Exposure Limits in Air

NIOSH IDLH = 25 mg[CN]/m^3

OSHA PEL: 5 mg[CN]/m^3/4.7 ppm TWA

NIOSH REL: 5 mg[CN]/m^3/4.7 ppm/10 min, Ceiling Concentration

ACGIH TLV[1]: 5 mg[CN]/m^3 [skin] Ceiling Concentration

PAC Ver. 29[138]

PAC-1: 0.37 milligram per cubic meter

PAC-2: 4.1 milligram per cubic meter

PAC-3: 24 milligram per cubic meter

DFG MAK: 2 mg[CN]/m^3, inhalable fraction TWA; Peak Limitation Category II(1) [skin]; Pregnancy Risk Group: C

Silver salts

DFG MAK*:* 0.01 mg[Ag]/m^3, respirable fraction TWA; Peak Limitation Category I(2); Pregnancy Risk Group D

NIOSH IDLH = 10 mg[Ag]/m^3

Determination in Air: Use NIOSH Analytical Method #7904; #6010, cyanides. See also entry for Silver.

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 200 μg[CN]/L; State Drinking Water Standards: California 150 μg[CN]/L; State Drinking Water Guidelines: Arizona 220 μg[CN]/L; Maine. 140 μg [CN]/L; Minnesota 100 μg[CN]/L. United States Army field drinking-water standards for cyanide: 2 mg[CN]/L assuming a water consumption of 15 L/day and 6 mg[CN]/L assuming a water consumption of 5 L/day. United States Army field drinking-water standards for cyanide, long term consumption 0.5 mg[CN]/L; Short-term consumption; Raw water constituents (maximum) 20 mg[CN]/L. The Clean Water Act ambient water quality criterion for silver and silver compounds is recommended to be 50 μg[Ag]/L. Federal Drinking Water Standards: EPA 100 μg[Ag]/L; State Drinking Water Standards: Connecticut 50 μg[Ag]/L; State Drinking Water Guidelines: Arizona 50 μg[Ag]/L; Maine 35 μg[Ag]/L; Minnesota 30 μg[Ag]/L; Wisconsin 50 μg[Ag]/L.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Silver cyanide can affect you when breathed in and by passing through your skin. Heating releases deadly cyanide gas. Skin or eye contact can cause irritation. A deadly poison if ingested.

Long-Term Exposure: Repeated exposure can slowly cause the eyes, inner nose, throat, skin, and body organs to turn a blue-gray color. This may take years to develop but is permanent. High or repeated exposure may cause kidney damage.

Points of Attack: Kidneys, skin.

Medical Surveillance: To detect early changes in body color, careful periodic exams of the eyes, inner nose, throat, and skin are useful. Persons with high or frequent exposure should consider periodic tests for kidney function. If cyanide exposure is suspected, immediate medical attention is recommended. Consider urine test for thiocyanates to detect cyanide exposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. *Note:* Use amyl nitrate capsules if symptoms develop. All area employees should be trained regularly in emergency measures for cyanide poisoning and in CPR. A cyanide antidote kit should be kept in the immediate work area and must be rapidly available. Kit ingredients should be replaced every 1–2 years to ensure freshness. Persons trained in the use of this kit; oxygen use, and CPR must be quickly available.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *0.25 milligram per cubic meter:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *0.5 milligram per cubic meter:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *10 milligram per cubic meter:* SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode. *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance causes eye irritation or damage; eye protection needed.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from acetylene, ammonia, and hydrogen peroxide. Protect from light. Silver cyanide and fluorine are violently explosive at normal temperatures.

Shipping: UN1684 Silver cyanide, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Thermal decomposition products may include hydrogen cyanide and oxides of nitrogen, metal, and carbon. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform to EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (173); (101); (138); (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Silver Cyanide, Trenton, NJ (June 2000).

Silver Nitrate S:0280

Formula: $AgNO_3$

Synonyms: Lunar caustic; Nitrate d'argent (French); Nitrato de plata (Spanish); Nitric acid, silver(1+) salt; Nitric acid, silver(I) salt; Silbernitrat (German); Silver(1+) nitrate; Silver(I) nitrate

CAS Registry Number: 7761-88-8

HSDB Number: 685

RTECS Number: VW4725000

UN/NA & ERG Number: UN1493/140

EC Number: 231-853-9 [*Annex I Index No.:* 047-001-00-2]

Regulatory Authority and Advisory Information.

Hazard Alert: Strong oxidizer, Corrosive (skin), Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction), Environmental hazard, FDA over the counter drug.

United States National Primary Drinking Water Regulations: SMCL = 0.10 mg[Ag]/L as Silver; MCLG = 10 mg[N]/L; MCL = 10 mg[N]/L nitrate measured as Nitrogen.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR 41331, 9/9/1992)

40CFR401.15 Section 307 Toxic Pollutants as silver and compounds

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, as silver compounds, n.o.s., waste number not listed

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg)

EPCRA (Section 313): Includes any unique chemical substance that contains silver as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: 1.0%. Section 313 Category Code N740 (silver compounds)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: O, C, N; risk phrases: R8; R34; R50/53; R62; R63; safety phrases: S1/2; S17; S26; S29; S36/37/39; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Silver nitrate is a colorless to dark gray, odorless, crystalline solid. Molecular weight = 169.9; specific gravity (H_2O:1) = 4.35 @ 20°C; boiling point = 444°C (decomposes); freezing/melting point = 210°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 0, reactivity 3 OX. Soluble in water.

Potential Exposure: Silver nitrate is used in photography, silver plating; as an antiseptic; in chemical reactions; and mirror manufacturing; as starting material in production of other silver compounds.

Incompatibilities: A strong oxidizer. Reacts violently with combustible and reducing materials. Reacts with acetylene forming a shock-sensitive explosive. Reacts with alkalis, antimony salts; ammonia, arsenites, bromides, carbonates, chlorides, iodides, hydrogen peroxide; thiocyanates, ferrous salts; oils, hypophosphites, morphine salts; creosote, phosphates, tannic acid; tartarates, halides, vegetable extracts, and others. Attacks some forms of plastics, rubber, and coatings.

Permissible Exposure Limits in Air

As silver soluble compounds

NIOSH IDLH = 10 mg[Ag]/m^3

OSHA PEL: 0.01 milligram per cubic meter TWA

NIOSH REL: 0.01 milligram per cubic meter TWA

ACGIH TLV[1]: 0.01 milligram per cubic meter TWA

PAC Ver. 29[138]

PAC-1: 0.47 milligram per cubic meter

PAC-2: 0.9 milligram per cubic meter

PAC-3: 5.4 milligram per cubic meter

DFG MAK: *silver salts:* 0.01 mg[Ag]/m^3, respirable fraction TWA; Peak Limitation Category I(2); Pregnancy Risk Group D

Arab Republic of Egypt: TWA 0.01 mg[Ag]/m^3, 1993; Australia: TWA 0.01 mg[Ag]/m^3, 1993; Belgium: TWA 0.01 mg[Ag]/m^3, 1993; Denmark: TWA 0.01 mg[Ag]/m^3, 1999; Finland: TWA 0.01 mg[Ag]/m^3; STEL 0.03 mg[Ag]/m^3 [skin], 1999; France: VME 0.01 mg[Ag]/m^3, 1999; Japan: 0.01 mg[Ag]/m^3, 1999; Norway: TWA 0.01 mg[Ag]/m^3, 1999; the Philippines: TWA 0.01 mg[Ag]/m^3, 1993; Poland: MAC (TWA) 0.01 mg[Ag]/m^3, 1999; Sweden: NGV 0.01 mg [Ag]/m^3, 1999; Switzerland: TWA 0.01 mg[Ag]/m^3, 1999; United Kingdom: TWA 0.01 mg[Ag]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 0.01 mg[Ag]/m^3

Determination in Air: NIOSH Analytical Method #7300 Elements by ICP; #8005, Elements in blood or tissue, #8310 Metals in urine; OSHA Analytical Method ID-121.

Permissible Concentration in Water: United States National Primary Drinking Water Regulations: SMCL = 0.10 mg[Ag]/L as silver Federal Drinking Water

Guidelines: EPA 100 μg[Ag]/L; State Drinking Water Standards: Connecticut 50 μg[Ag]/L; State Drinking Water Guidelines: Arizona 50 μg[Ag]/L; Maine 35 μg[Ag]/L; Minnesota 30 μg[Ag]/L. Wisconsin 50 μg[Ag]/L.

Harmful Effects and Symptoms

Short-Term Exposure: Corrosive to the eyes, skin, and respiratory tract. May affect the blood, causing formation of methemoglobin. *Inhalation:* May cause irritation of the nose, throat, and lungs. *Skin:* May cause irritation. Concentrated solutions may cause burns, sores, and discoloration of skin. Solid materials will cause chemical burns especially if skin is wet. *Eyes:* May cause irritation which can be severe. Solid material may cause chemical burns and permanent damage.

Ingestion: May cause burns to mouth and throat, abdominal pain; diarrhea and dizziness. Shock and convulsions may develop. Estimated lethal dose is 2 g or 1/14 oz for a 150 lb adult.

Long-Term Exposure: All forms of silver accumulate and are excreted very slowly. Blue-gray discoloration (argyreia) of eyes, nose, throat and, skin may occur. This discoloration is likely to be permanent. May affect the blood causing formation of methemoglobin. Very irritating substances can cause lung effects. High or repeated exposure may cause kidney damage. Infants below the age of 6 months who drink water containing nitrate in excess of the MCL could become seriously ill and, if untreated, may die. Symptoms include shortness of breath and blue-baby syndrome.

Points of Attack: Skin, kidneys, blood.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended. Lung function tests. Exam of the eyes, nose, throat, and skin for changes in color. If symptoms develop or overexposure is suspected, the following may be useful: kidney function tests. Test for blood methemoglobin level.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water, or milk. Do not induce vomiting.

Note to Physician: If swallowed, perform gastric lavage, using 1%−2% sodium chloride water every 15 minutes, followed by saline catharsis. Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with solutions containing silver nitrate. Wear dust-proof goggles and face shield when working with powders or dust, unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *0.25 milligram per cubic meter:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *0.5 milligram per cubic meter:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *10 milligram per cubic meter:* SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode. *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance causes eye irritation or damage; eye protection needed.

Storage: Check oxygen content prior to entering storage area. Color code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially organic materials, flammables and combustibles, and other incompatible materials. Oxidizers, including oxidizing gases, should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Silver nitrate must be stored to avoid contact with oils and fuels, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers and alkalis. Silver nitrate should not be stored in plastic containers. Store in a cool, well-ventilated area away from incompatible materials listed above. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA

1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage.

Shipping: UN1493 Silver nitrate, Hazard Class: 5.1; Labels: 5.1-Oxidizer.

Spill Handling: Solid material: evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Liquid: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen and metal. Nonflammable but is a strong oxidizer capable of increasing the intensity of an existing fire and the flammability of combustible, organic, or other oxidizable materials. Use type of extinguisher appropriate to other burning materials. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (80); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 1, 52−53 (1980).

New York State Department of Health, *Chemical Fact Sheet:* Silver Nitrate, Bureau of Toxic Substance Assessment, Albany, NY (April 1986 and Version 2).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Silver Nitrate, Trenton, NJ (May 2000).

Silver Picrate S:0290

Formula: $C_6H_2AgN_3O_7$; $C_6H_2(NO_2)_3OAg$

Synonyms: Picragol; Picrotol; 2,4,6-Trinitro-phenol silver (1+) salt; 2,4,6-Trinitrophenolate

CAS Registry Number: 146-84-9

RTECS Number: TJ7891000

UN/NA & ERG Number: UN1347 (wetted with not <30% water, by mass)/113

EC Number: 205-682-5

Regulatory Authority and Advisory Information

Hazard Alert: Explosive (dried material only)

Silver compounds:

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as silver and compounds

United States National Primary Drinking Water Regulations: SMCL = 0.10 mg[Ag]/L as Silver

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, as silver compounds, n.o.s., waste number not listed

EPCRA (Section 313): Includes any unique chemical substance that contains silver as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: 1.0%. Section 313 Category Code N740 (silver compounds)

EPCRA Section 313: Includes any unique chemical substance that contains silver as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. as silver, soluble compounds.

Description: Silver picrate is a yellow powder or crystalline material which turns brown when heated or exposed to light.

Commercial product is a white to light tan solid paste. Contains about 35% water, which reduces its tendency toward rapid decomposition or explosion. Considered safe for storage, handling and shipping, but should be treated as an explosive[101]. Molecular weight = 335.98. Soluble in water.

Potential Exposure: Used in antibacterial medicines.

Incompatibilities: Organics or other oxidizable materials. Dried out material is unstable and a severe explosion risk; protect from shock, light, and vibration.

Permissible Exposure Limits in Air

As silver soluble compounds

NIOSH IDLH = 10 mg[Ag]/m^3

OSHA PEL: 0.01 milligram per cubic meter TWA

NIOSH REL: 0.01 milligram per cubic meter TWA

ACGIH TLV[1]: 0.01 milligram per cubic meter TWA

PAC not available

DFG MAK: *silver salts:* 0.01 mg[Ag]/m^3, respirable fraction TWA; Peak Limitation Category I(2); Pregnancy Risk Group D

Determination in Air: NIOSH Analytical Method #7300 Elements by ICP; #8005, Elements in blood or tissue, #8310 Metals in urine; OSHA Analytical Method ID-121.

Permissible Concentration in Water: United States National Primary Drinking Water Regulations: SMCL = 0.10 mg[Ag]/L as silver Federal Drinking Water Guidelines: EPA 100 μg[Ag]/L; State Drinking Water Standards: Connecticut 50 μg[Ag]/L; State Drinking Water Guidelines: Arizona 50 μg[Ag]/L; Maine 35 μg[Ag]/L; Minnesota 30 μg[Ag]/L. Wisconsin 50 μg[Ag]/L.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact. Absorbed by the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Silver picrate can affect you when breathed in and by passing through your skin. Eye contact can cause burns with possible damage. Skin contact can cause severe irritation or burns.

Long-Term Exposure: Repeated exposure can slowly cause the eyes, inner nose, throat, skin, and body organs to turn a blue-gray color. This usually takes years to develop but is permanent. High or repeated exposure can cause kidney damage.

Points of Attack: Skin, eyes, kidneys.

Medical Surveillance: To detect early changes in body color, careful periodic exams of the eyes, inner nose, throat, and skin are useful. Persons with high or frequent exposure should consider periodic tests for kidney function.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *0.25 milligram per cubic meter:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *0.5 milligram per cubic meter:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *10 milligram per cubic meter:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode. *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance causes eye irritation or damage; eye protection needed.

Storage: Treat as an explosive material. Color code—Red Stripe: Flammability Hazard: Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8–10 m or a 1-hour fire wall from flammable or reactive materials. Store flammable solids up to maximum allowable quantity per control area in an approved flammable storage area. Do not store in a basement. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from organics or other readily oxidizable material. Protect from shock, light, and vibration. Sources of ignition, such as smoking and open flames, are prohibited where silver picrate is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Wherever silver picrate is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1347 Silver picrate, wetted with not <30 % water, by mass, Hazard Class: 4.1; Labels: 4.1-Flammable solid.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. Keep silver picrate out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Silver picrate is a flammable material; may be ignited by heat, sparks, or flames. Thermal decomposition products may include oxides of nitrogen, metal, and carbon. Containers may explode if exposed to heat, flame, or shock. Cover with sand, earth, or water spray, and keep it wet. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Silver Picrate, Trenton, NJ (May 2000).

Simazine S:0310

Formula: $C_7H_{12}ClN_5$

Synonyms: A 2079; AI3-51142; Aktinit S; Aquazine; Batazina; 2,4-Bis(aethylamino)-6-chlor-1,3,5-triazin (German); 2,4-Bis(ethylamino)-6-chloro-*s*-triazine; Bitemol; Bitemol S-50; Cat (Japan); CDT; Cekusan; Cekuzina-S; Cet; 1-Chloro-3,5-bis(ethylamino)-2,4,6-triazine; 2-Chloro-4,6-bis(ethylamino)-*s*-triazine; 2-Chloro-4,6-bis(ethylamino)-1,3,5-triazine; 6-Chloro-*N*,*N*′-diethyl-1,3,5-triazine-2,4-diamine; 6-Chloro-N^2, N^4-diethyl-1,3,5-triazine-2,4-diamine; 6-Chloro-*N*,*N*′-diethyl-1,3,5-triazine-2,4-diyldiamine; Framed; G 27692; Geigy 27692; Gesaran; Gesatop; Gesatop-50; H 1803; Herbazin 50; Herbex; Herboxy; Hungazin DT; NSC 25999; Premazine; Primatel S; Primatol S; Princep 80W; Simadex; Simanex; Simazina (Spanish); Simazine 80W; Tafazine; Tafazine 50-W; Taphazine; Triazine A 384; *s*-Triazine, 2-chloro-4,6-bis(ethylamino)-; 1,3,5-Triazine-2,4-diamine, 6-chloro-*N*,*N*′-diethyl-; W 6658; Weedex; Zeapur

CAS Registry Number: 122-34-9

HSDB Number: 1765

RTECS Number: XY5250000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171; UN2763 (triazine pesticide, solid, toxic)/151

EC Number: 204-535-2 [*Annex I Index No.:* 612-088-00-3]

Regulatory Authority and Advisory Information

Carcinogenicity: EPA, Not Likely to be Carcinogenic to Humans. IARC: Animal Inadequate Evidence; Human Inadequate Evidence*, not classifiable as carcinogenic to humans*, Group 3.

Hazard Alert: Poison, Combustible, Environmental hazard.

United States National Primary Drinking Water Regulations: MCLG = 0.004 mg/L; MCL = 0.004 mg/L

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: Xn, N; risk phrases: R50/53; safety phrases: S2; S29; S36/37; S41; S46; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Simazine is a combustible, white crystalline solid. Practically odorless. Molecular weight = 201.68. Freezing/Melting point = (decomposes) 225°C; vapor pressure = 2.2×10^{-8} mmHg 20°C. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 1, reactivity 0. Practically insoluble in water; solubility = 4 ppm @ 20°C.

Potential Exposure: A potential danger to those involved in the manufacture, formulation, and application of this preemergence herbicide. Pesticide not in use; TRI and/or IUR indicates importers or manufacturers are unlikely[88]. Banned for use in the EU.

Incompatibilities: Powder may form explosive mixture with air. Incompatible with strong oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air Russia set a MAC for simazine in work-place air[35] of 2.0 milligram per cubic meter and a MAC for ambient air in residential areas of 0.02 milligram per cubic meter both on a momentary and a daily average basis.

Permissible Concentration in Water: Safe Drinking Water Act (47FR 9352): MCL, 0.004 mg/L; MCLG, 0.004 mg/L. A lifetime health advisory of 35 μg/L has been developed by EPA. Various states have developed guidelines for simazine in drinking water[61] ranging from 150 μg/L (California); to 430 μg/L (Maine); to 2150 μg/L (Wisconsin).

Determination in Water: Analysis of simazine is by a gas chromatographic (GC) method applicable to the determination of certain nitrogen-phosphorus-containing pesticides in water samples. In this method, approximately 1 L of sample is extracted with methylene chloride. The extract is concentrated and the compounds are separated using capillary column GC. Measurement is made using a nitrogen−phosphorus detector. The method detection limit has not been determined for this compound but it is estimated that the detection limits for the method analytes are in the range of 0.1−2 μg/L. Fish Tox = 1732.04831000 ppb (VERY LOW). Octanol−water coefficient: Log $K_{ow} = 2.1$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: May cause skin or eye irritation. Moderately poisonous if ingested. Approximate lethal dose = 1.5 cupful/150 lb man. No case of poisoning in humans from simazine has been reported, although exposure to simazine has caused acute and subacute dermatitis in Russia, characterized by erythema, slight edema; moderate pruritus; and burning lasting 4−5 days.

Long-Term Exposure: Problems with blood; repeated exposure may cause weight loss and reduced red blood cell count. *Chronic Toxicity*-simazine fed to rats for 2 years @ 1.0, 10, and 100 ppm produced no difference between treated and control animals in gross appearance or behavior. The rats fed 100 ppm had approximately twice as many thyroid and mammary tumors as the control animals, but it was stated that these were not attributable to simazine. A 2-year chronic-feeding study of simazine in dogs with simazine 80 W fed @ 15, 150, and 1500 ppm showed only a slight thyroid hyperplasia @ 1500 ppm and slight increases in serum alkaline phosphatase and serum glutamic oxalacetic transaminase in several of the dogs fed 1500 ppm. Human Tox = 4.00000 ppb (HIGH).

Points of Attack: Blood.

Medical Surveillance: CBC.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required. UN2763 Triazine pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Soil Adsorption Index (K_{oc}) = 130.

Fire Extinguishing: This chemical pesticide is a combustible solid. Thermal decomposition products may include hydrogen chloride and oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Strong acid or alkaline hydrolysis leads to complete degradation of simazine. However, large quantities of simazine should be incinerated in a unit operating @ 850°C equipped with off-gas scrubbing equipment[22]. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 7, No. 4, 109−113 (1987).

United States Environmental Protection Agency, "Alert: Simazine, Washington, DC, Office of Drinking Water (August 1987).

Soapstone S:0320

Formula: $H_2Mg_3O_{12}Si4$; $3MgO \cdot 4SiO_2 \cdot H_2O$

Synonyms: Massive talc; Silicate soapstone; Soapstone silicate; Soapstone superfine powder; Steatite; Talc

CAS Registry Number: None listed or assigned.

HSDB Number: 830 as Talc

RTECS Number: VV8780000

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human Inadequate Evidence (talc not containing asbestiform fibers); Sufficient (for talc containing asbestiform fibers)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Description: Soapstone is an odorless gray-white crystalline solid. Molecular weight = 351.31; specific gravity (H_2O:1) = 2.7−2.8 @ 25°C; freezing/melting point = 900−1000°C. Negligible solubility in water.

Potential Exposure: Soapstone is used as a pigment in paints, varnishes, rubber, and soap. It is used in lubricating molds and machinery. In massive form, it is used as a heat insulator.

Incompatibilities: fine powder can form explosive mixture with air. Silicates can react violently with lithium.

Permissible Exposure Limits in Air

NIOSH IDLH = 3000 milligram per cubic meter

OSHA PEL: 20 mppcf TWA

NIOSH REL: 6 milligram per cubic meter, total dust TWA; 3 milligram per cubic meter (respirable dust) TWA

ACGIH TLV[1]: 6 milligram per cubic meter (for particulate matter containing no asbestos and $<1\%$ crystalline silica) TWA; 3 milligram per cubic meter (respirable fraction, for particulate matter containing no asbestos and $<1\%$ crystalline silica) TWA

Talc, superfine powder

PAC Ver. 28, no listing in Ver. 29[138]

PAC-1: 6 milligram per cubic meter

PAC-2: 66 milligram per cubic meter

PAC-3: 400 milligram per cubic meter

DFG MAK: *for talcum* suspended 2004; Carcinogen Category 3B

The Netherlands: MAC-TGG 5 milligram per cubic meter (total dust); 2.5 milligram per cubic meter (respirable dust), 2003

Determination in Air: Filter; none; Gravimetric; NIOSH Analytical Method (IV) #0500, Particulates NOR, total dust.

Routes of Entry: Inhalation, eye, and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes and respiratory tract causing coughing, wheezing.

Long-Term Exposure: Pneumoconiosis: cough, dyspnea (breathing difficulty); digital clubbing; cyanosis, basal crackles; or pulmonale.

Points of Attack: Respiratory system, cardiovascular system.

Medical Surveillance: NIOSH lists the following tests: chest X-ray; pulmonary function tests: forced vital capacity, forced expiratory volume (1 second). Consider the points of attack in preplacement and periodic physical examinations. Lung function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *Up to 30 milligram per cubic meter:* Q_m (APF = 25) (any quarter-mask respirator). *Up to 60 milligram per cubic meter*: 95 XQ [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *Up to 150 milligram per cubic meter:* PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *Up to 300 milligram per cubic meter:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTHie (APF = 50)* (any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter);* or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 3000 milligram per cubic meter:* SaF:Pd, Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd, Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode. *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA). *Note:* *Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—Green: General storage may be used. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in a cool, dry place.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Dampen spilled material with water to avoid airborne dust then transfer material to a suitable container for disposal. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include oxides of silicon and metal. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Sanitary landfill.

References

(31); (173); (101); (138).

Sodium S:0330

Formula: Na

Synonyms: Elemental sodium; Natrium; Sodio (Spanish); Sodium element; Sodium, metal liquid alloy; Sodium metal

CAS Registry Number: 7440-23-5

HSDB Number: 687

RTECS Number: VY0686000

UN/NA & ERG Number: UN1428/138

EC Number: 231-132-9 [*Annex I Index No.:* 011-001-00-0]

Regulatory Authority and Advisory Information

Hazard Alert: Pyrophoric hazard, Highly flammable, Strong reducing agent, Violent, possibly explosive, Violently reactive with water.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg).

Hazard symbols, risk, & safety statements: Hazard symbol: F, C; risk phrases: R11; R14/15; R29; R34; safety phrases: S1/2; S5 (If appropriate); S8; S21; S43; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Sodium is a soft silvery white metallic element. Pyrophoric solid or molten liquid. Odorless. Molecular weight = 22.99; specific gravity (H_2O:1) = 0.97; boiling point = 883°C; freezing/melting point = 98°C; Autoignition temperature ≥ 115°C (in dry air). Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 3, reactivity 2₩. Violent reaction with water, forming corrosive NaOH fume and explosive decomposition.

Potential Exposure: A potential danger to those involved in tetra-alkyl lead manufacture using lead-sodium alloy as a reactant; those using sodium as a liquid metal coolant, as a catalyst, or in the manufacture of sodium hydride, borohydride, or peroxide.

Incompatibilities: A strong reducing agent. A dangerous fire hazard when exposed to heat and moisture. Violent reaction with water, forming NaOH. Violent reaction with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. halogenated hydrocarbons; phosphorus and phosphorus compounds; sulfur and sulfur compounds; and many other chemicals.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 13 milligram per cubic meter

PAC-2: 140 milligram per cubic meter

PAC-3: 870 milligram per cubic meter

Permissible Concentration in Water: The metal reacts with water. Sodium ion limit is 10 mg/L as desirable in drinking water; 200 mg/L may be injurious to humans.

Russia[43] set a MAC in water bodies used for domestic purposes of 120 mg/L. Several states have set guidelines for sodium in drinking water[61] ranging from 20 mg/L (Massachusetts); to 100 mg/L (Kansas).

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: *Inhalation:* Contact with water, including perspiration, causes the formation of NaOH fumes which are highly irritating to skin, eyes, nose, and throat. May cause sneezing and coughing. Very severe exposures may result in difficult breathing; coughing, and chemical bronchitis. High exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. *Skin:* Contact may cause itching, tingling, thermal and caustic burns, and may cause permanent damage. *Eyes:* May cause tearing, very painful irritation; and burns. Contact with eyes may result in permanent damage and loss of sight. *Ingestion:* Causes immediate intense burning sensation in mouth, throat, and stomach, followed by salivation, vomiting, rapid breathing; symptoms of shock; diarrhea, loss of consciousness, and death.

Long-Term Exposure: Very irritating substances may affect the lungs. It is not known; however, if sodium causes lung damage.

Points of Attack: Lungs.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposure to sodium metal, the following are recommended. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. Wipe the chemical off the skin with a dry cloth. Then quickly remove contaminated clothing. Immediately wash area with large amounts of water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposure to sodium, use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: (1) Color code—Red Stripe: Store material under an inert gas blanket. Dangerous when wet materials release flammable gases on contact with water. Do not store this material in a room protected by water sprinkler systems. Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Do not store in a basement. (2) Color code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Sodium must be stored to avoid contact with water, halogenated hydrocarbons; phosphorus and phosphorus compounds; and sulfur and sulfur compounds; since violent reactions occur. Protect storage containers from physical damage. Keep in an inert atmosphere or under oil. Requires special precautions to avoid contact with moisture, including condensation from other objects and perspiration. Store in a dry, fire resistive room exclusively for sodium storage. Sprinkler systems should not be used, so keep combustibles away. Remove only the amount of sodium needed for immediate use and place dry in a friction top metal can under a layer of oil. Transport in a special container with a tight fitting cover. Where sodium is used, handled, manufacture, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1428 Sodium, Hazard Class: 4.3; Labels: 4.3-Dangerous when wet material. *Note:* Finely divided sodium is pyrophoric.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until

clean-up is complete. Remove all ignition sources. Put on proper protective equipment. Blanket with appropriate inert material. Scoop up and place in a suitable, sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. A severe fire risk on contact with water or moisture. Thermal decomposition products may include sodium oxide. Blanket with dry soda-ash, graphite, salt, dry limestone, or other approved dry powder. *Do not use water*, carbon dioxide or halogenated extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration with absorption of oxide fumes.

References

(31); (173); (101); (138); (170); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 8, 85−88 (1981).

Sittig, M., *Sodium, Its Manufacture, Properties and Uses*, American Chemical Monograph No. 133, New York, Reinhold Publishing Corp. (1956).

New York State Department of Health, *Chemical Fact Sheet:* Sodium, Bureau of Toxic Substance Assessment, Albany, NY (May 1986).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Sodium, Trenton, NJ (April 2001).

Sodium Aluminate S:0340

Formula: $AlNaO_2$: $NaAlO_2$ ($Na_2O \cdot Al_2O_3$)

Synonyms: β-Alumina; *beta*-Alumina; Aluminum sodium oxide; J 242; Maxifloc 8010; Monofrax H; Nalco 680; Sodium aluminum oxide; Sodium polyaluminate; VSA 45

CAS Registry Number: 1302-42-7 (solid); 11138-49-1 (solution)

HSDB Number: 5023

RTECS Number: BD1600000

UN/NA & ERG Number: UN2812 (solid)/154; UN1819 (solution)/154.

EC Number: 234-391-6

Regulatory Authority and Advisory Information

Hazard Alert: Corrosive, Water reactive.

United States National Primary Drinking Water Regulations: SMCL = 0.05 to 0.2 mg[Al]/L as aluminum.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: C; risk phrases: R20/21/22; R35; R34; R36/37/38; safety phrases: S26; S36/37/39; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Sodium aluminate is a white crystalline solid or solution. Molecular weight = 82.1; specific gravity (H_2O:1) = 1.6 @ 20°C; freezing/melting point = 1650°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 1. Soluble in water, may generate heat.

Potential Exposure: Used in water and waste treatment; papermaking industry; in printing on fabrics; in the manufacture of pigments, milk glass, and soap; hardening building stone; sizing paper; as a water softener.

Incompatibilities: The aqueous solution is a strong base. Reacts violently with acid. Incompatible with organic anhydrides; isocyanates, alkylene oxides; epichlorohydrin, aldehydes, alcohols, glycols, caprolactum, chlorocarbons. Corrosive to metals; attacks copper, tin, aluminum, and zinc.

Permissible Exposure Limits in Air

OSHA PEL: None

NIOSH REL: 2 mg[Al]/m^3 TWA

ACGIH TLV[1]: 2 mg[Al]/m^3 TWA as soluble salts and alkyls, n.o.s.

PAC Ver. 29[138]

PAC-1: 18 milligram per cubic meter

PAC-2: 200 milligram per cubic meter

PAC-3: 1200 milligram per cubic meter

Australia: TWA 2 mg[Al]/m^3, 1993; Belgium: TWA 2 mg [Al]/m^3, 1993; Denmark: TWA 2 mg[Al]/m^3, 1999; France: VME 2 mg[Al]/m^3, 1999; Norway: TWA 2 mg[Al]/m^3, 1999; Russia: TWA 2 mg[Al]/m^3, 1993; Sweden: NGV 2 mg[Al]/m^3, 1999; Switzerland: MAK-W 2 mg[Al]/m^3, 1999; United Kingdom: TWA 10 milligram per cubic meter, total dust inhalable dust; TWA 4 mg.m^3, respirable dust, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 2 mg[Al]/m^3

Determination in Air: Use NIOSH #7013 Aluminum; #7300, Elements; #7303; OSHA Analytical Method ID-121.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Sodium aluminate can affect you when breathed in. Sodium aluminate solution is a corrosive chemical. Skin or eye contact can cause severe irritation or burns, with possible damage. Breathing sodium aluminate dust can irritate the air passages. This may cause cough with phlegm and/or shortness of breath. Inhalation of dust may cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Corrosive on ingestion.

Long-Term Exposure: Irritating substances may affect the lungs. It is not known whether sodium aluminate causes lung damage.

Points of Attack: Lungs.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended. Lung function tests. consider chest X-ray following acute overexposure.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid, unless full facepiece respiratory protection is worn. Wear dust-proof goggles and face shield when working with powders or dust, unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Respirator Selection: Where there is potential exists for exposure to solid sodium aluminate, use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece respirator with a high efficiency particulate filter. Greater protection is provided by a PAPR. Where there is potential for high exposures or liquid sodium aluminate exists, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilate area away from incompatible materials. Where possible, automatically transfer material from drums or other storage containers to process containers.

Shipping: UN2812 Sodium aluminate, solid, Hazard class: 8; Labels: 8-Corrosive material. UN1819 Sodium aluminate, solution, Hazard class: 8; Labels: 8-Corrosive material.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material is nonflammable. Use agent suitable for surrounding fire. Thermal decomposition products may include oxides of nitrogen and metal. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Sodium Aluminate, Trenton, NJ (October 1986).

New York State Department of Health, *Chemical Fact Sheet:* Sodium Aluminate, Bureau of Toxic Substance Assessment, Albany, NY (April 2000).

Sodium Aluminum Fluoride S:0350

Formula: AlF_6Na_3; Na_3AlF_6

Synonyms: Aluminum sodium fluoride; Cryolite; ENT 24,984; Kryolith (German); Natriumaluminumfluorid (German); Natriumhexafluoroaluminate (German); Sodium aluminofluoride; Sodium fluoaluminate; Sodium hexafluoroaluminate; Trisodium hexafluoroaluminate; Villiaumite

CAS Registry Number: 15096-52-3; 13775-53-6 (synthetic)

HSDB Number: 1548

RTECS Number: WA9625000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 239-148-8 [*Annex I Index No.:* 009-016-00-2]

Regulatory Authority and Advisory Information

Hazard Alert: Suspected reprotoxic hazard, Environmental hazard.

United States National Primary Drinking Water Regulations: MCLG = 4 mg[F]/L; MCL = 4 mg[F]/L; SMCL = 2 mg[F]/L, as fluorides; SMCL = 0.05 to 0.2 mg [Al]/L as aluminum.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects[293]. Toxic to aquatic life with long-lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard Symbol (*natural and synthetic*): T, N; risk phrases: R20/22; R48/23/25; R50/53; safety phrases: S1/2; S22; S29; S37; S41; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Sodium aluminum fluoride is a snow-white crystalline solid, powder or vitreous mass. The crystalline solid (natural product (cryolite) may be colored reddish or brown or even black but loses this discoloration on heating); synthetic product is an amorphous powder. Odorless. Molecular weight = 209.9; boiling point = (decomposes); freezing/melting point = 995−1000°C. Very slightly soluble in water; solubility = 0.4%[77].

Potential Exposure: Sodium aluminum fluoride is used in making pesticides, ceramics, glass, and polishes; in refining reduction of aluminum, flux, glass, and enamel.

Incompatibilities: Incompatible with strong acids such as sulfuric, strong oxidizers, hydrogen fluoride.

Permissible Exposure Limits in Air

NIOSH IDLH = 250 mg[F]/m^3

As fluorides [F]

OSHA PEL: 3 ppm/2.5 mg[F]/m^3 TWA

NIOSH REL: 3 ppm/2.5 mg[F]/m^3 TWA

ACGIH TLV: 2.5 mg[F]/m^3 TWA; Excursion Limit Recommendation: Excursions in worker exposure levels may exceed three times the TLV-TWA for no more than a total of 30 minutes during a work day, and under no circumstances should they exceed five times the TLV-TWA, provided that the TLV-TWA is not exceeded. BEI: Determinant: fluorides in urine; Sampling Time: prior to shift; BEI: 3 mg/g creatinine. Determinant: fluorides in urine; Sampling Time: end of shift; BEI: 10 mg/g creatinine. The determinant may be present in biological specimens collected from subjects who have not been occupationally exposed, at a concentration which could affect interpretation of the result. Such background concentrations are incorporated in the BEI value. The determinant is nonspecific, since it is also observed after exposure to other chemicals.

As aluminum, soluble salts

OSHA PEL: None

NIOSH REL: 2 mg[Al]/m^3 TWA

ACGIH TLV: 1 milligram per cubic meter [Al] (soluble fraction) TWA; Excursion Limit Recommendation: Excursions in worker exposure levels may exceed three times the TLV-TWA for no more than a total of 30 minutes during a work day, and under no circumstances should they exceed five times the TLV-TWA, provided that the TLV-TWA is not exceeded.

PAC not available

Australia: TWA 2 mg[Al]/m^3, 1993; Belgium: TWA 2 mg [Al]/m^3, 1993; Denmark: TWA 2 mg[Al]/m^3, 1999; France: VME 2 mg[Al]/m^3, 1993; Russia: TWA 2 mg[Al]/m^3, 1993; Sweden: NGV 2 mg[Al]/m^3, 1999; Switzerland: MAK-W 2 mg[Al]/m^3, 1999; United Kingdom: LTEL 2 mg [Al]/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 2 mg[Al]/m^3

As fluoride

OSHA PEL: 3 ppm/2.5 mg[F]/m^3 TWA

NIOSH REL: 3 ppm/2.5 mg[F]/m^3 TWA

Australia: TWA 2.5 mg[F]/m^3, 1993; Austria: MAK 2.5 mg [F]/m^3, 1999; Belgium: TWA 2.5 mg[F]/m^3, 1993; Finland: TWA 2.5 mg[F]/m^3, 1999; France: VME 2.5 mg[F]/m^3, 1999; Hungary: TWA 1 mg[F]/m^3; STEL 2 mg[F]/m^3, 1993; Norway: TWA 0.6 mg[F]/m^3, 1999; the Philippines: TWA 2.5 mg[F]/m^3, 1993; Poland: MAC (TWA) 1 mg [HF]/m^3, MAC (STEL) 3 mg[HF]/m^3, 1999; Russia: STEL 0.5 ppm (2.5 milligram per cubic meter), 1993; Sweden: NGV 2 mg[F]/m^3, 1999; Switzerland: MAK-W 1.8 ppm (1.5 mg[F]/m^3), KZG-W 3.6 ppm (3.0 mg[F]/m^3), 1999; Thailand: TWA 2.5 mg[F]/m^3, 1993; United Kingdom: TWA 2.5 mg[F]/m^3, 2000; LTEL 2.5 mg[F]/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New

Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen
Determination in Air: Use NIOSH Analytical Method (IV) #7902, Fluoride; for aluminum, soluble salts, use NIOSH #7013 Aluminum; #7300, Elements; #7303; OSHA Analytical Method ID-121.
Permissible Concentration in Water: Drinking water, *aluminum* guidelines[61] are 1.43 mg/L in Massachusetts and 5.0 mg/L in Kansas. *Fluoride*: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guidelines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg[F]/L. Safe Drinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg[F]/L; SMCL = 2 mg[F]/L.
Routes of Entry: Inhalation, ingestion; skin and/or eye contact.
Harmful Effects and Symptoms
Short-Term Exposure: Sodium aluminum fluoride can affect you when breathed in. Eye contact can cause severe irritation, burns with possible loss of vision. Skin contact can cause irritation and even burns, especially if prolonged. Breathing can irritate the nose, throat and air passages. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Exposure can cause nausea, abdominal pain; diarrhea; salivation, thirst, sweating
Long-Term Exposure: Repeated exposure can cause stiff spine; calcification of ligaments of ribs, pelvis. Repeated or high exposures may cause permanent lung damage.
Points of Attack: Eyes, skin, lungs, skeletal system.
Medical Surveillance: NIOSH lists the following tests: chest X-ray, ECG, pulmonary function tests: forced vital capacity, forced expiratory volume (1 second); pelvic X-ray; sputum cytology; urine (chemical/metabolite); urine (chemical/metabolite) pre- and postshift; urinalysis (routine); CBC/differential. Urine fluoride test (levels above 3−4 mg/L at the end of exposure represent increased exposure).
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water, or milk. Do not induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.
Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Specific engineering controls are recommended in NIOSH Criteria Document #76−103: *Inorganic fluorides*.
Respirator Selection: NIOSH/OSHA *12.5 milligram per cubic meter:* Q_m (APF = 25) (any quarter-mask respirator). *25 milligram per cubic meter:* 95XQ (APF = 10)* [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or SA* (any supplied-air respirator). *62.5 milligram per cubic meter:* Sa:Cf (APF = 25)$^{*+}$ (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25)* *if not present as a fume* (any powered, air-purifying respirator with a high-efficiency particulate filter). *125 milligram per cubic meter:* 100F (APF = 50)$^{+}$ [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *250 milligram per cubic meter:* Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50)$^{+}$ [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or SCBAE (any appropriate escape-type, SCBA). *Substance reported to cause eye irritation or damage; may require eye protection. *May need acid gas sorbent.
Storage: Color code—Green: General storage may be used. Prior to working with this chemical, personnel should be

trained on its proper handling and storage. Sodium aluminum fluoride must be stored to avoid contact with strong acids (such as hydrochloric, sulfuric, and nitric), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material is not flammable. Thermal decomposition products may include hydrogen fluoride and oxides of sodium and metal. Use dry chemicals appropriate for metal fires. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR 165 recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (2); (80); (122); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Sodium Aluminum Fluoride, Trenton, NJ (April 2000).

Sodium Aluminum Hydride S:0360

Formula: AlH_4Na; $NaAlH_4$

Synonyms: Aluminate(1-), tetrahydro-, sodium, (*t*-4)-; Aluminum sodium hydride; Sah 22; Sodium aluminum tetrahydride; Sodium tetrahydroaluminate(1-)

CAS Registry Number: 13770-96-2

HSDB Number: 690

RTECS Number: BD0180000

UN/NA & ERG Number: UN2835/138

EC Number: 237-400-1

Regulatory Authority and Advisory Information

Hazard Alert: Highly flammable, Corrosive (skin), Pyrophoric hazard, Dangerously water reactive, Strong reducing agent.

United States National Primary Drinking Water Regulations: SMCL = 0.05 to 0.2 mg[Al]/L as aluminum.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: F, C, Xn; risk phrases: R11; R14/15; R17; R19; R22; R29; R34; R36/37/38; R40; safety phrases: S16; S26; S33; S36/37; S36/37/39; S43; S45; S7/8; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Sodium aluminum hydride is a white crystalline solid. Molecular weight = 54.01; specific gravity (H_2O:1) = 1.24 @ 20°C; freezing/melting point = (decomposes) 183°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 1, reactivity ₩. Reaction with water can be violent/dangerous, releasing NaOH and flammable hydrogen gas plus heat, which may cause ignition.

Potential Exposure: Used in chemical synthesis.

Incompatibilities: A strong reducing agent. Very sensitive to moisture; reaction with water may cause fire or explosion. Also incompatible with iron, aluminum, and zinc in the presence of water. Hydrides are incompatible with acids, alcohols, amines, and aldehydes. Violent reaction, possibly explosive, on contact with water, air, oxidizers, acids, alcohols, and ethers. May ignite spontaneously in moist air. Does not react in dry air at room temperature. Reacts with water to form corrosive NaOH and flammable hydrogen gas. The heat of reaction may be sufficient to ignite[101].

Permissible Exposure Limits in Air

13770-96-2

PAC Ver. 29[138]

PAC-1: 1.2 milligram per cubic meter

PAC-2: 13 milligram per cubic meter

PAC-3: 80 milligram per cubic meter

The limits for "aluminum pyro powders" may be applicable (NJ).

OSHA PEL: None

NIOSH REL: 5 mg[Al]/m^3 TWA

ACGIH TLV[1]: 5 mg[Al]/m^3 TWA

The limits for aluminum soluble salts, for reference

OSHA PEL: None

NIOSH REL: 2 mg[Al]/m^3 TWA

ACGIH TLV[1]: 2 mg[Al]/m^3 TWA as soluble salts and alkyls, n.o.s.

Determination in Air: Use NIOSH #7300; #7301; #7303.

Permissible Concentration in Water: This material reacts vigorously with water so this category is not pertinent.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Sodium aluminum hydride can affect you when breathed in. Exposure can irritate the eyes, skin, and respiratory tract. If wet, sodium aluminum hydride may cause burns and permanent damage.

Long-Term Exposure: May cause lung injury; pulmonary fibrosis.

Points of Attack: Skin, respiratory system.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that. Lung function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures *over 5 milligram per cubic meter*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece respirator with a high efficiency particulate filter. Greater protection is provided by a PAPR. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Dangerous if any form of moisture is present. (1) Color code—Red Stripe: Store under inert gas. Dangerous when wet materials release flammable gases on contact with water. Do not store this material in a room protected by water sprinkler systems. Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Do not store in a basement. (2) Color code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard: Store under inert gas. Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Sodium aluminum hydride must be stored to avoid contact with water, air, oxidizers, acids, alcohols, and ethers, since violent reactions occur. Sources of ignition, such as smoking and open flames, are prohibited where sodium aluminum hydride is handled, used, or stored. Use only nonsparking tools and equipment, especially when opening and closing containers of sodium aluminum hydride. Wherever sodium aluminum hydride is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN2835 Sodium aluminum hydride, Hazard Class: 4.3; Labels: 4.3-Dangerous when wet material.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include sodium oxides and flammable hydrogen gas. Sodium aluminum hydride is a flammable solid. It can ignite spontaneously in moist air. The flame may be invisible. *Do not use water*. Use dry chemical, soda ash; or lime extinguishers. Fires may restart after it has been extinguished. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (170); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Sodium Aluminum Hydride, Trenton, NJ (May 2002).

Sodium Arsenate S:0370

Formula: $AsH_3Na_xO_4$; $AsHNa_2O_4$; $Na_xH_3AsO_4$; HNa_2AsO_4

Synonyms: Arsenite de sodium (French); Arsenito sodico (Spanish); Arsenous acid, sodium salt; Atlas A; Chem Pels C; Chem-Sen 56; Disodium arsenate heptahydrate; Kill-All; Penite; Prodalumnol; Sodanit; Sodium metaarsenite

Dibasic: Arsenic acid disodium salt; Disodium arsenate; Disodium hydrogen arsenate; Sodium arsenate, dibasic

Heptahydrate: Dibasic sodium arsenate heptahydrate; Disodium arsenate, heptahydrate; Sodium acid arsenate, heptahydrate; Sodium arsenate, dibasic, heptahydrate; Sodium arsenate heptahydrate; Sodium arseniate heptahydrate

CAS Registry Number: 7631-89-2; 7778-43-0 (dibasic; disodium hydrogenarsenate); *(alt.)* 55957-14-7; 10048-95-0 (heptahydrate)

HSDB Number: 1675

RTECS Number: CG1225000; CG0875000 (dibasic); CG0900000 (heptahydrate)

UN/NA & ERG Number: UN1685/151

EC Number: 231-547-5; 231-902-4 [*Annex I Index No.:* 033-005-00-1] (*dibasic; disodium hydrogenarsenate*)

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 15,000 (≥1.00% concentration).

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen: Arsenic and inorganic arsenic compounds; IARC: Human Sufficient Evidence, 1980; Animal Limited Evidence*, carcinogenic to humans*, Group 1, 1987.

California Proposition 65 Chemical[102]: Carcinogen (as arsenic) 2/27/1987.

Hazard Alert: Poison, Water reactive, Suspected of causing genetic defects, Possible risk of forming tumors, Suspected reprotoxic hazard, Environmental hazard.

United States National Primary Drinking Water Regulations: MCLG = 0 mg[As]/L; MCL = 0.010 mg[As]/L as Arsenic.

Clean Water Act: Section 311 Hazardous Substances/RQ (same as CERCLA); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 1000/10,000 lb (454/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%. sodium arsenate; 1% [disodium hydrogen arsenate (dibasic)]

Canada: Priority Substance List & Restricted Substances/ Ocean Dumping FORBIDDEN (CEPA), NPRI arsenic compounds.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R45; R14/15; R23/25; R29; R50/53; R62; R63; safety phrases: S1/2; S20/21; S28; S29; S45; S60; S61; (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Sodium arsenate and sodium arsenate, dibasic are both white crystalline, odorless solids. Molecular weight = 203; 185.91 (dibasic); 427.00 (heptahydrate); boiling point = 180°C (decomposition); freezing/melting point = 86°C; 57°C (dibasic). Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 0₩. Soluble in water; reacts forming flammable hydride of arsenic.

Potential Exposure: (dibasic): Sodium arsenate is used in dyeing and printing; making other arsenates; as a germicide; in dyeing with turkey-red oil.

Incompatibilities: Sodium arsenate reacts with moisture, steam, and water; forming flammable and toxic arsenic hydride. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Sodium arsenate is a weak oxidizing agent that may react with reducing agents, including hydrides. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, chemically active metals. Arsine, a very deadly gas, can be released in the presence of acid, acid mists; or hydrogen gas. Attacks many metals (such as aluminum, iron, and zinc) in presence of moisture producing arsenic and arsine fumes.

Permissible Exposure Limits in Air

Inorganic arsenic compounds

NIOSH IDLH = 5 mg[As]/m^3, potential occupational carcinogen.

OSHA PEL: 0.010 mg[As]/m^3 TWA; cancer hazard that can be inhaled. See [1910.1018]

NIOSH REL: 0.002 mg[As]/m^3 15 min. Ceiling Concentration. A potential occupational carcinogen. Limit exposure to lowest feasible concentration; See Appendix A.

ACGIH TLV[1]: 0.01 mg[As]/m^3 TWA; Confirmed Human Carcinogen

PAC Ver. 29[138]

PAC-1: 4.1 milligram per cubic meter

PAC-2: 45 milligram per cubic meter

PAC-3: 270 milligram per cubic meter

DFG TRK: 0.10 mg[As]/m^3; BAT: 1.30 μg[As]/L in urine/ end-of-shift; Carcinogen Category 1

Arab Republic of Egypt: TWA 0.2 milligram per cubic meter, 1993; Australia: TWA 0.05 milligram per cubic meter, carcinogen, 1993; Belgium: TWA 0.2 milligram per cubic meter, 1993; Denmark: TWA 0.05 milligram per cubic meter, 1999; Finland: carcinogen, 1993; France: VME 0.2 milligram per cubic meter, 1993; Hungary: STEL 0.5 milligram per cubic meter, carcinogen, 1993; India: TWA 0.2 milligram per cubic meter, 1993; Norway: TWA 0.02 milligram per cubic meter, 1999; the Philippines: TWA 0.5 milligram per cubic meter, 1993; Poland: MAC (TWA) 0.01 milligram per cubic meter, 1999; Sweden: NGV 0.03 milligram per cubic meter, carcinogen, 1999; Switzerland: TWA 0.1 milligram per cubic meter, carcinogen, 1999; Thailand: TWA 0.5 milligram per cubic meter, 1993; Turkey: TWA 0.5 mg(As)/m^3, 1993; Turkey: TWA 0.5 milligram per cubic meter, 1993; United Kingdom: TWA 0.1 milligram per cubic meter, carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH: TLV: Confirmed Human Carcinogen. Russia[43] set a MAC of 0.003 milligram per cubic meter on an average daily basis for residential areas. Several states have set guidelines or standards for arsenic in ambient air:[60] 0.06 milligram per cubic meter (California Prop. 65), 0.0002 μ/m^3 (Rhode Island), 0.00023 μ/m^3 (North Carolina), 0.024 μ/m^3 (Pennsylvania), 0.05 μ/m^3 (Connecticut), 0.07−0.39 μ/m^3 (Montana), 0.67 μ/m^3 (New York), 1.0 μ/m^3 (South Carolina), 2.0 μ/m^3 (North Dakota), 3.3 μ/m^3 (Virginia), 5 μ/m^3 (Nevada).

Determination in Air: NIOSH Analytical Methods (inorganic arsenic): #7300, #7301,#7303, #7900, #9102; OSHA Analytical Methods ID-105. The American Conference of Government Industrial Hygienists (ACGIH) Method 803 measures total particulate arsenic in air.

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 10 μg[As]/L; State Drinking Water Guidelines: Arizona 10 μg[As]/L; Connecticut 10 μg[As]/L EPA Maximum Contaminant Level (MCL): 0.010 mg[As]/L [40 CFR 141.62]. Canadian Drinking Water Standards: IMAC 0.025 [As] mg/L.

Determination in Water: *For arsenic:* The atomic absorption graphite furnace technique is often used for measurement of total arsenic in water. It also has been standardized by EPA. Total arsenic may be determined by digestion followed by silver diethyldithiocarbamate; an alternative is atomic absorption; another is ICP optical emission spectrometry. See OSHA Method #ID-105 for arsenic[58]

Routes of Entry: Inhalation, ingestion; skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin, and respiratory tract. May affect the CNS; digestive tract; circulatory system, causing loss of fluids and electrolytes; collapse, shock, and death. Exposure at low level may result in death. Death can occur due to a severe decrease in blood pressure. Thickening of skin on palms and soles following chronic low-level exposures. Symptoms of exposure include a feeling of constriction of throat, difficulty in swallowing; abdominal discomfort with pain, vomiting, watery diarrhea; sweetish metallic taste; garlicky odor of breath and stools; and dizziness with frontal headaches. Symptoms usually appear one-half to 1 hour after ingestion but may be delayed many hours.

Long-Term Exposure: Arsenic can cause skin damage or problems with circulatory systems, and may have increased risk of cancer. Repeated or prolonged contact may cause skin sensitization and dermatitis. May affect the peripheral nervous system; skin, mucous membranes; causing neuropathy, skin thickening and pigmentation disorders; ulcers and perforation of nasal septum; and liver cirrhosis. Nerve damage may include "pins and needles," burning, numbness, and later weakness in the limbs. This substance is carcinogenic to humans. A probable teratogen in humans.

Points of Attack: Skin, nervous system; liver.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure. Before first exposure and every 6 to 12 months thereafter, a medical history and exam are recommended, including: exam of the nose, skin eyes, nails, and nervous system. Test for urine arsenic (may not be accurate within 2 days of eating shellfish or fish; most accurate at the end of a work-day). At NIOSH recommended exposure levels, urine arsenic should not be greater than 100 μg/g creatinine in the urine. Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give a slurry of activated charcoal in water to drink and induce vomiting. Do not make an unconscious person vomit.

Antidotes and Special Procedures: For severe poisoning, BAL have been used. For milder poisoning, penicillamine (*not penicillin*) has been used, both with mixed success. Side effects occur with such treatment and it is never a substitute for controlling exposure. It can only be done under strict medical care.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Eye protection is included in the recommended respiratory protection. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Specific engineering controls are required under OSHA 1910.1018, *Inorganic Arsenic*. See also NIOSH Criteria Document #75−149, *Inorganic Arsenic*.

***Respirator Selection*: Requirements for Respiratory Protection for Inorganic Arsenic Particulate *Except for Those With Significant Vapor Pressure*:** $<$ or $= 100\ \mu g/m^3$ (micrograms per cubic meter) (1) Half-mask air-purifying respirator equipped with high-efficiency filter*; or (2) Any half-mask supplied air respirator. $<$ or $= 500\ \mu g/m^3$ (1) Full facepiece air-purifying respirator equipped with high-efficiency filter*; (2) Any full-facepiece supplied-air respirator; or (3) Any full-facepiece SCBA. $<$ or $= 10{,}000\ \mu g/m^3$ (1) Powered air-purifying respirators in all inlet face coverings with high-efficiency filters*; or (2) Half-mask supplied-air respirators operated in positive-pressure mode. $<$ or $= 20{,}000\ \mu g/m^3$ Supplied-air respirator with full facepiece, hood, or helmet or suit, operated in positive-pressure mode. $>20{,}000\ \mu g/m^3$, unknown concentrations, or firefighting. Any full-facepiece SCBA operated in positive-pressure mode.* A high-efficiency filter means a filter that is at least 99.97% efficient against monodispersed particles of 0.3 μm (micrometers) in diameter or higher. Or, *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA-or European Standard EN 149-approved SCBA that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-face-piece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Sodium arsenate must be stored to avoid contact with chemically active metals (such as potassium, sodium, magnesium, and zinc), since violent reactions occur. Sodium arsenate must be stored to avoid contact with acids. Store in tightly closed containers in a cool, well-ventilated area away from heat. A regulated, marked area should be established, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN1685 Sodium arsenate, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Do not touch spilled material; stop leak if you can do so without risk. *Small spills:* absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills:* with clean shovel place material into clean, dry container and cover; move containers from spill area. *Large spills:* dike far ahead of spill for later disposal. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Sodium arsenate itself does not burn. Thermal decomposition products may include oxides of sodium and arsenic fumes. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve in minimum quantity of concentrated, reagent hydrochloric acid. Filter if necessary. Dilute with water until white precipitate forms. Add just enough 6M HCl to redissolve. Saturate with hydrogen sulfide. Filter, wash the precipitate; dry, package, and ship to the supplier. (Sax, DPIMR see below).

References

(109); (102); (31); (173); (101); (138); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 2, No. 6, 71−73 (1982).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Sodium Arsenate, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Sodium Arsenate, Trenton, NJ (April 2000).

Sodium Arsenite S:0380

Formula: AsO_2Na; $NaAsO_2$

Synonyms: Arsenite de sodium (French); Arsenito sodico (Spanish); Arsenous acid, sodium salt; Atlas A; Chem Pels C; Chem-Sen 56; Disodium arsenate heptahydrate; Kill-All; Penite; Prodalumnol; Sodanit; Sodium *m*-arsenite; Sodium metaarsenite

CAS Registry Number: 7784-46-5
HSDB Number: 693
RTECS Number: CG3675000
UN/NA & ERG Number: UN2027 (solid)/151; UN1686 (solution)/154
EC Number: 232-070-5

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen: Arsenic and inorganic arsenic compounds; IARC: Human Sufficient Evidence, 1980; Animal Limited Evidence, *carcinogenic to humans*, Group 1, 1987

California Proposition 65 Chemical[102]: Carcinogen (as arsenic) 2/27/1987

Hazard Alert: Poison, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard. Agricultural chemical, Environmental hazard.

United States National Primary Drinking Water Regulations: MCLG = 0 mg[As]/L; MCL = 0.010 mg[As]/L as Arsenic.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%.

Canada: Priority Substance List & Restricted Substances/Ocean Dumping FORBIDDEN (CEPA), NPRI (arsenic compounds).

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R45; R21; R22; R23/24/25; R34 R50/53; R62; R63; safety phrases: S20/21; S26; S28; S29; S36/37/39; S45; S53; S60; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Sodium arsenite is a white or grayish-white powder or flakes. Molecular weight = 129.9; freezing/melting point = 615°C; boiling point = decomposes. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 0. Highly soluble in water.

Potential Exposure: This material is used in manufacturing of arsenical soap for use on skin; treating vines against certain scale diseases; wood preservation; as a reagent in preparation of Methylene iodide; corrosion inhibitor; and for herbicidal and pesticidal purposes.

Incompatibilities: Chemically active metals. Arsine, a very deadly gas, can be released in the presence of acid, acid mists, or hydrogen gas.

Permissible Exposure Limits in Air

NIOSH IDLH = 5 mg[As]/m^3, potential occupational carcinogen.

OSHA PEL: 0.010 mg[As]/m^3 TWA; cancer hazard that can be inhaled. See [1910.1018]

NIOSH REL: 0.002 mg[As]/m^3 [15 min] Ceiling Concentration. A potential occupational carcinogen. Limit exposure to lowest feasible concentration; See *NIOSH Pocket Guide*, Appendix A.

ACGIH TLV[1]: 0.01 mg[As]/m^3 TWA; Confirmed Human Carcinogen

PAC Ver. 29[138]

PAC-1: 0.91 milligram per cubic meter

PAC-2: 10 milligram per cubic meter

PAC-3: 170 milligram per cubic meter

DFG TRK: 0.10 mg[As]/m^3; BAT: 1.30 μg[As]/L in urine/end-of-shift; Carcinogen Category 1

Arab Republic of Egypt: TWA 0.2 milligram per cubic meter, 1993; Australia: TWA 0.05 milligram per cubic meter, carcinogen, 1993; Belgium: TWA 0.2 milligram per cubic meter, 1993; Denmark: TWA 0.05 milligram per cubic meter, 1999; Finland: carcinogen, 1993; France: VME 0.2 milligram per cubic meter, 1993; Hungary: STEL 0.5 milligram per cubic meter, carcinogen, 1993; India: TWA 0.2 milligram per cubic meter, 1993; Norway: TWA 0.02 milligram per cubic meter, 1999; the Philippines: TWA 0.5 milligram per cubic meter, 1993; Poland: MAC (TWA) 0.01 milligram per cubic meter, 1999; Sweden: NGV 0.03 milligram per cubic meter, carcinogen, 1999; Switzerland: TWA 0.1 milligram per cubic meter, carcinogen, 1999; Thailand: TWA 0.5 milligram per cubic meter, 1993; Turkey: TWA 0.5 mg(As)/m^3, 1993; Turkey: TWA 0.5 milligram per cubic meter, 1993; United Kingdom: TWA 0.1 milligram per cubic meter, carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH: TLV: Confirmed Human Carcinogen. Russia[43] set a MAC of 0.003 milligram per cubic meter on an average daily basis for residential areas. Several states have set guidelines or standards for arsenic in ambient air:[60] 0.06 milligram per cubic meter (California Prop. 65), 0.0002 μ/m^3 (Rhode Island), 0.00023 μ/m^3 (North Carolina), 0.024 μ/m^3 (Pennsylvania), 0.05 μ/m^3 (Connecticut), 0.07−0.39 μ/m^3 (Montana), 0.67 μ/m^3 (New York), 1.0 μ/m^3 (South Carolina), 2.0 μ/m^3 (North Dakota), 3.3 μ/m^3 (Virginia), 5 μ/m^3 (Nevada).

Determination in Air: NIOSH Analytical Methods (inorganic arsenic): #7300, #7301,#7303, #7900, #9102; OSHA Analytical Methods ID-105. The American Conference of Government Industrial Hygienists (ACGIH) Method 803 measures total particulate arsenic in air.

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 10 μg[As]/L; State Drinking Water Guidelines: Arizona 10 μg[As]/L; Connecticut 10 μg[As]/L EPA Maximum Contaminant Level (MCL): 0.010 mg[As]/L [40 CFR 141.62]. Canadian Drinking Water Standards: IMAC 0.025 [As] mg/L.

Determination in Water: *For arsenic:* The atomic absorption graphite furnace technique is often used for measurement of total arsenic in water. It also has been standardized by EPA. Total arsenic may be determined by digestion followed by silver diethyldithiocarbamate; an alternative is atomic absorption; another is ICP optical emission spectrometry. See OSHA Method #ID-105 for arsenic[58]

Routes of Entry: Inhalation, ingestion; skin and/or eye contact. Absorbed by the skin

Harmful Effects and Symptoms

Short-Term Exposure: Sodium arsenite may irritate or burn the skin, eyes, and mucous membranes. Skin contact can cause burning sensation; itching, and rash. Extremely toxic: probable oral lethal dose (human) 5−50 mg/kg, between seven drops and one teaspoon for 70 kg person (150 lb). Poisonous if swallowed or inhaled. Signs and symptoms of acute exposure to sodium arsenite may be severe and include headache, vomiting, stomach pain; vomiting, cough, dyspnea (shortness of breath), Hypotension (low blood pressure), and chest pain. Gastrointestinal effects include difficulty in swallowing; intense thirst; generalized abdominal pain; vomiting, and painful diarrhea; blood may be noted in the vomitus and feces. A weak pulse, cyanosis (blue tint to the skin and mucous membranes), and cold extremities may also be observed. Neurological effects include giddiness, delirium, mania, stupor, weakness, headache, dizziness, and fainting. Convulsions, paralysis, and coma may occur.

Long-Term Exposure: Arsenic can cause skin damage or problems with circulatory systems, and may have increased risk of cancer. Repeated or prolonged contact may cause skin sensitization and dermatitis. May affect the peripheral nervous system; skin, mucous membranes; causing neuropathy; skin thickening and pigmentation disorders; ulcers and perforation of nasal septum, and liver cirrhosis. Nerve damage may include “pins and needles,” burning, numbness, and later weakness in the limbs. This substance is carcinogenic to humans. A probable teratogen in humans.

Points of Attack: Liver, kidneys, skin, lungs, lymphatic system.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater, or significant skin contact), the following are recommended before beginning work and at regular times after that: exam of the nose, skin, eyes, nails, and nervous system. Test for urine arsenic (may not be accurate within 2 days of eating shellfish or fish; most accurate at the end of a work-day). At NIOSH recommended exposure levels, urine arsenic should not be greater than 100 μg/g creatinine in the urine.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy. *Antidotes and Special Procedures:* For severe poisoning, BAL has been used. For milder poisoning penicillamine (*not penicillin*) has been used, both with mixed success. Side effects occur with such treatment and it is never a substitute for controlling exposure. It can only be done under strict medical care.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Eye protection is included in the recommended respiratory protection. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Specific engineering controls are required under OSHA 1910.1018, *Inorganic Arsenic.* See also NIOSH Criteria Document #75−149, *Inorganic Arsenic.*

Respirator Selection**: Requirements for Respiratory Protection for Inorganic Arsenic Particulate *Except for Those With Significant Vapor Pressure*:** < or = 100 μg/m^3 (1) Half-mask air-purifying respirator equipped with high-efficiency filter*; or (2) Any half-mask supplied air respirator. < or = 500 μg/m^3 (1) Full facepiece air-purifying respirator equipped with high-efficiency filter*; (2) Any full-facepiece supplied-air respirator; or (3) Any full-facepiece SCBA. < or = 10,000 μg/m^3 (1) Powered air-purifying respirators in all inlet face coverings with high-efficiency filters*; or (2) Half-mask supplied-air respirators operated in positive-pressure mode. < or = 20,000 μg/m^3 Supplied-air respirator with full facepiece, hood, or helmet or suit, operated in positive-pressure mode. >20,000 μg/m^3, unknown concentrations, or firefighting. Any full-facepiece SCBA operated in positive-pressure mode.

* A high-efficiency filter means a filter that is at least 99.97% efficient against monodispersed particles of 0.3 μm in diameter or higher.

Shipping: UN2027 Sodium arsenite, solid, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN1686 Sodium arsenite, aqueous solutions, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is

complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of arsenic sodium. Extinguish fire using an agent suitable for type of surrounding fire. Sodium arsenite itself does not burn. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: The arsenic may be precipitated as calcium arsenite. It should be stored until recycled[22]. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(109); (102); (31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Sodium Arsenite, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Sodium Arsenite, Trenton, NJ (March 2002).

Sodium Azide S:0390

Formula: N_3Na; NaN_3

Synonyms: AI3-50436; Axium; Azida sodico (Spanish); Azide; Azium; Azoture de sodium (French); Dazoe; Hydrazoic acid, Sodium salt; Kazoe; Natriumazid (German); NCI-C06462; Smite; Sodium salt of hydrazoic acid

CAS Registry Number: 26628-22-8; *(alt.)* 12136-89-9

HSDB Number: 695

RTECS Number: VY8050000

UN/NA & ERG Number: UN1687/153

EC Number: 247-852-1 [*Annex I Index No.:* 011-004-00-7]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Theft hazard* 400 (Commercial grade).

Carcinogenicity: NCI: Carcinogenesis Studies (gavage); no evidence: rat; (EPA) Gene-Tox Program: Inconclusive: Carcinogenicity: mouse/rat. United States Environmental Protection Agency Gene-Tox Program, Inconclusive: Carcinogenicity-mouse/rat; Positive: L5178Y cells In vitro-TK test; Positive: *D. melanogaster* sex-linked lethal; Positive: *S. cerevisiae* gene conversion; Positive: *S. cerevisiae*-forward mutation; *S. cerevisiae*-reversion; Negative: In vitro cytogenetics-human lymphocyte; Negative: Sperm morphology-mouse; In vitro UDS-human fibroblast; Negative: TRP reversion; TRP reversion.

Hazard Alert: Poison, High acute toxicity, Systemic agent, Explosive, Unstable chemical (heat sensitive), Possible risk of forming tumors, Suspected of causing genetic defects, Environmental hazard.

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P105

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500 lb (227 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1000 lb (454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, N; risk phrases: R28; R31; R32; R50/53; R62; safety phrases: S1/2; S28; S29; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Sodium azide is a colorless to white, odorless, crystalline solid. Combustible solid above 300°C. Molecular weight = 65.02; specific gravity (H_2O:1) = 1.85 @ 25°C; boiling point = (decomposes); freezing/melting point = (the solid crystals decompose with the evolution of nitrogen gas, leaving a residue of sodium oxide) 275°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 3. Soluble in water; reaction; solubility = 42% @ 17°C.

Potential Exposure: Sodium azide is used as preservative and diluent. It has been used for a wide variety of military, laboratory, medicine, and commercial purposes. It is used extensively as an intermediate in the production of lead azide, commonly used in detonators, and other explosives. Reported to be used in automobile air-bag inflation. One of the largest potential exposure is that to automotive workers, repairmen, and wreckers, if sodium azide is used as the inflation chemical. Commercial applications include use as a fungicide, nematocide, and soil sterilizing agent and as a preservative for seeds and wine. The lumber industry has used sodium azide to limit the growth of enzymes responsible for formation of brown stain on sugar pine, while the Japanese beer industry used it to prevent the growth of a fungus which darkens its product. The chemical industry has used sodium azide as a retarder in the manufacture of sponge rubber, to prevent coagulation of styrene and butadiene latexes stored in contact with metals; and to decompose nitrites in the presence of nitrates.

Incompatibilities: Reacts explosively and/or forms explosive and/or shock sensitive compounds with acids and many metals. Contact with water forms hydrazoic acid. Combustible solid (if heated above 275°C). May explode when heated above its melting point, especially if heating is rapid. Reacts with acids; producing toxic, shock-sensitive, and explosive hydrogen azide. It forms explosive compounds with phosgene, brass, zinc, trifluoroacrylol fluoride, and nitrogen-diluted bromine vapor. Reacts with benzoyl chloride and potassium hydroxide, bromine, carbon disulfide; copper, lead, nitric acid; barium carbonate; sulfuric acid; chromium (II) hypochlorite; dimethyl sulfate; dibromomalononitrile, silver, mercury. Over a period of time, sodium azide may react with copper, lead, brass, or solder in plumbing systems to form an accumulation of the *highly explosive* and shock-sensitive compounds of lead azide and copper azide.

Permissible Exposure Limits in Air

OSHA PEL: Vacated 1989 OSHA PEL:0.1 ppm Ceiling Limit [skin] (as HN_3); 0.3 milligram per cubic meter Ceiling Limit [skin] (as NaN_3) designation is still enforced in some states.

NIOSH REL: 0.1 ppm (as HN_3) [skin] Ceiling Concentration; 0.3 milligram per cubic meter (as NaN_3) [skin] Ceiling Concentration

ACGIH TLV[1]: 0.11 ppm (as HN_3) [skin] Ceiling Concentration; 0.29 milligram per cubic meter (as NaN_3) [skin] Ceiling Concentration; not classifiable as a human carcinogen

PAC Ver. 29[138]

PAC-1: 0.026 milligram per cubic meter

PAC-2: 0.29 milligram per cubic meter

PAC-3: 5.3 milligram per cubic meter

DFG MAK: 0.2 milligram per cubic meter, inhalable fraction TWA; Peak Limitation Category I(2); Pregnancy Risk Group D

Australia: TWA 0.1 ppm (0.3 milligram per cubic meter), 1993; Austria: MAK 0.07 ppm (0.2 milligram per cubic meter), 1999; Belgium: STEL 0.11 ppm (0.3 milligram per cubic meter), 1993; Denmark: TWA 0.3 milligram per cubic meter, 1999; Finland: TWA 0.1 ppm (0.3 milligram per cubic meter); STEL 0.3 ppm (0.9 milligram per cubic meter), 1999; France: VLE 0.1 ppm (0.3 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 0.1 milligram per cubic meter [skin], 2003; Switzerland: MAK-W 0.07 ppm (0.2 milligram per cubic meter), 1999; United Kingdom: STEL 0.3 mg [NaN_3], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Ceiling Concentration 0.29 milligram per cubic meter. Several states have set guidelines or standards for sodium azide in ambient air[60] ranging from 0.7 μ/m³ (Nevada); to 2.5 μ/m³ (Virginia); to 3.0 μ/m³ (North Dakota).

Determination in Air: Use OSHA Analytical Method ID-121.

Permissible Concentration in Water: No criteria set. (Sodium azide reacts with water to produce hydrazoic acid).

Routes of Entry: Inhalation, ingestion, skin contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Severely irritates the eyes, skin, and respiratory tract. Contact of skin causes redness and pain. Contact with eyes causes redness, pain, and blurred vision; may cause loss of vision. Inhalation or ingestion causes dizziness, weakness; blurred vision; slight shortness of breath; Hypotension, slowed heart rate; abdominal pain and spasms. Serious cases of exposure may result in convulsions, unconsciousness, and death. Exposure slightly above the exposure limits in air can cause death by affecting the CNS. Azides can cause blood pressure to drop and thus have action similar to cyanides and nitrites. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Sodium azide is a broad-spectrum, metabolic poison that interferes with oxidation enzymes and inhibits nuclear phosphorylation. Although the effects in these systems are complex, there is general agreement that azide causes a dissociation of phosphorylation and cellular respiration. For this reason parallels have been drawn to other metabolic inhibitors, such as cyanide, malonitrile, and fluoride.

Long-Term Exposure: May cause kidney damage. Sodium azide is a potent mutagen in barley, peas, rice, and soybeans. It is also a very effective mutagen in bacteria. However, several studies have been performed to determine whether it is carcinogenic but results were negative.

Points of Attack: Brain, eyes, skin, CNS; cardiovascular system, kidneys.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: exam of the nervous system and vision (including visual fields). Lung function tests. Consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water, or milk. Do not induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods:

General information: first responders should use a NIOSH-certified CBRN SCBA with a level a protective suit when entering an area with an unknown contaminant or when entering an area where the concentration of the contaminant is unknown. Level a protection should be used until monitoring results confirm the contaminant and the concentration of the contaminant. *Note:* Safe use of protective clothing and equipment requires specific skills developed through training and experience.

LEVEL A: (*RED ZONE*): select when the greatest level of skin, respiratory, and eye protection is required. This is the maximum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than the AEGL-2. A NIOSH-certified CBRN full-face-piece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle. A TECP suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, and a hard hat worn under the TECP suit are optional items.

LEVEL B: (RED ZONE): Select when the highest level of respiratory protection is necessary but a lesser level of skin protection is required. This is the minimum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than AEGL-2. It differs from Level A in that it incorporates a nonencapsulating, splash-protective, chemical-resistant splash suit that provides Level A protection against liquids but is not airtight. A NIOSH-certified CBRN full-face-piece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL C: (YELLOW ZONE): Select when the contaminant and concentration of the contaminant are known and the respiratory protection criteria factors for using APR or PAPR are met. This level is appropriate when decontaminating patient/victims. A NIOSH-certified CBRN tight-fitting APR with a canister-type gas mask or CBRN PAPR for air levels greater than AEGL-2. A NIOSH-certified CBRN PAPR with a loose-fitting face-piece, hood, or helmet and a filter or a combination organic vapor, acid gas, and particulate cartridge/filter combination, or a continuous flow respirator for air levels greater than AEGL-1. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Escape mask, face shield, coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL D: (GREEN ZONE): Select when the contaminant and concentration of the contaminant are known and the concentration is below the appropriate occupational exposure limit or less than AEGL-1 for the stated duration times. Limited to coveralls or other work clothes, boots, and gloves.

Notes: Take all necessary precautions to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof goggles and face shield when working with powders or dust, unless full facepiece respiratory protection is worn. Where sodium azide may be present in solution, wear splash-proof chemical goggles and face shield, unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures over 0.1 ppm as a dust, fume or mist, use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece respirator with a high efficiency particulate filter. Greater protection is provided by a powered-air purifying respirator. *Where there is potential for high exposures exists*, or for exposures to hydrazoic acid vapor, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Sodium azide must be stored to avoid contact with benzoyl chloride; potassium hydroxide; bromine, copper and lead, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from water, heat and acids. On contact with water it forms hydrazoic acid which is explosive. Danger of explosion exists from friction, heat or contamination. Where possible, automatically transfer material from drums or other storage containers to process containers Sources of ignition, such as smoking and open flames are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1687 Sodium azide, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills:* absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills:* with clean shovel place material into clean, dry container and cover; move containers from spill area. *Large spills:* dike far ahead of spill for later disposal. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is an unstable combustible solid. Rapid heating above 275°C can cause rapid decomposition and explosion. Thermal decomposition products may include sodium and oxides of nitrogen. May form toxic hydrazoic acid fumes in fire. Containers may explode in fire. If material is on fire or involved in fire, use water in flooding quantities as fog. Use foam, carbon dioxide or dry chemical. *Small fires:* dry chemical, carbon dioxide; water spray; or foam. *Large fires:* water spray, fog, or foam. Move container from fire area if you can do so without risk. For massive fire in cargo area, use unmanned hose holder or monitor nozzles; if this is impossible, withdraw from area and let fire burn. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform to EPA regulations governing storage, transportation, treatment, and waste disposal. Disposal may be accomplished by reaction with sulfuric acid solution and sodium nitrate in a hard rubber vessel. Nitrogen dioxide is generated by this reaction and the gas is run through a scrubber before it is released to the atmosphere. Controlled incineration is also acceptable (after mixing with other combustible wastes) with adequate scrubbing and ash disposal facilities.

References

(31); (173); (100).

National Institute for Occupational Safety and Health (NIOSH), Profiles on Occupational Hazards for Criteria Document Priorities: Sodium Azide, Report PB-274,073, Cincinnati, Ohio, pp. 306−308 (1977).

(173); (101); (138).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Sodium Azide, Washington, DC (August 1, 1977).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 2, No. 6, 74−78 (1982).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Sodium Azide, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Sodium Azide, Trenton, NJ (October 1998).

Sodium Benzoate S:0400

Formula: $C_7H_5NaO_2$: C_6H_5COONa

Synonyms: Antimol; Benzoate of soda; Benzoate sodium; Benzoesaeure (Na-salz) (German); Benzoic acid, sodium salt; Sobenate; Sodium benzoic acid

CAS Registry Number: 532-32-1

HSDB Number: 696

RTECS Number: DH6650000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 208-534-8

Regulatory Authority and Advisory Information.

United States Environmental Protection Agency Gene-Tox Program, Negative: TRP reversion.

Hazard Alert: Poison, Combustible, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction).

Hazard symbols, risk, & safety statements: Hazard symbol: T; risk phrases: R62; R63; safety phrases: S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Sodium benzoate is a white crystalline solid. It is odorless and nonflammable. Molecular weight = 144.11; decomposes @ 120°C; freezing/melting point = > 300°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 2, reactivity 1. Soluble in water.

Potential Exposure: Sodium benzoate is used as a food and feed additive, flavor, packaging material; pharmaceutical; preservative for food products and tobacco; anti-fungal agent; antiseptic, rust, and mildew inhibitor; intermediate in the manufacture of dyes. Used as a human hygiene biocidal product.

Incompatibilities: Dust may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 61 milligram per cubic meter

PAC-2: 680 milligram per cubic meter

PAC-3: 810 milligram per cubic meter

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: An eye and skin irritant. The accumulation of dust in the eyes, ears, nose, throat, and lungs may be sufficiently unpleasant and distracting to make work near machinery hazardous. Irritation may result from abrasion or chemical action. Sodium benzoate can cause allergic reactions. Sodium benzoate has been given GRAS status by the Food and Drug Administration at the levels currently being used as a food preservative. Ingestion of 8−10 g (1/3 oz) may cause nausea and vomiting. 12 g has caused gastric pain and loss of appetite. These symptoms disappear when exposure stops. LD_{50}(oral-rat) = 27 mg/kg.

Long-Term Exposure: Sodium benzoate may produce an allergic reaction and, in addition, may intensify the symptoms of allergies to other substances.

Points of Attack: Skin, lungs.

Medical Surveillance: Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Lung function tests.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Avoid prolonged skin contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers. Where possible, automatically transfer material from drums or other storage containers to process containers Sources of ignition, such as smoking and open flames are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft (NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Sodium benzoate is combustible. It may emit acrid fumes when heated to decomposition (@ 120°C/248°F). Thermal decomposition products may include oxides of sodium and carbon. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (80); (100).

New York State Department of Health, *Chemical Fact Sheet:* Sodium Benzoate, Bureau of Toxic Substance Assessment, Albany, NY (March 1986).

Sodium Bisulfite S:0410

Formula: $HNaO_3S$; $NaHSO_3$

Synonyms: Amersite 2; Bisulfite de sodium (French); Bisulfito sodico (Spanish); Hydrogen sulfite sodium; Sodium acid sulfite; Sodium hydrogen sulfite; Sodium hydrogen sulfite; Sodium pyrosulfite; Sodium metabisulfite; Sodium sulhydrate; Sulfurous acid, monosodium salt

CAS Registry Number: 7631-90-5; *(alt.)* 57414-01-4; *(alt.)* 69098-86-8; *(alt.)* 89830-27-3; *(alt.)* 91829-63-9

HSDB Number: 724

RTECS Number: VZ2000000

UN/NA & ERG Number: UN2693 (solution)/154; UN3260 (solid)/154

EC Number: 231-548-0 [*Annex I Index No.:* 016-064-00-8]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Inadequate Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1992. United States Environmental Protection Agency Gene-Tox Program, Negative: Rodent dominant lethal; Rodent heritable translocation; Negative: Mouse specific locus; TRP reversion.

Hazard Alert: Strong reducing agent, Corrosive, Sensitization hazard, Possible risk of forming tumors, Suspected reprotoxic hazard.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 5000 lb (2270 kg)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: Xn; risk phrases: R22; R31; R41; R63; safety phrases: S2; S25; S26; S31; S39; S46 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Sodium bisulfite is a white crystalline solid. Slight odor of sulfur dioxide and a disagreeable taste. Slowly oxidized to the sulfate on exposure to air. Molecular weight = 104.06; specific gravity (H_2O:1) = 1.48 @ 25°C; boiling point = (decomposes). Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 0, reactivity 0. Soluble in water.

Potential Exposure: Sodium bisulfite is used in the digestion of wood pulp, in the tanning of leather; in the dyeing of textiles; as a photographic reducing agent; as a food preservative; as an additive in electroplating; as disinfectant, bleach, antioxidant, and as inhibitor of yeast and bacteria in winemaking.

Incompatibilities: Aqueous solution is a weak acid. Incompatible with strong mineral acids forming a toxic sulfur dioxide gas. A strong reducing agent, sodium bisulfite is incompatible with oxidizers, such as perchlorates, peroxides, permanganates, chlorates, and nitrates. Reacts with bases forming sulfate. Slowly oxidizes to sulfate in air. Heat causes decomposition. Slowly oxidized to the sulfate on exposure to air. Contact with oxidizers or acids forms sulfur dioxide gas. Attacks some metals in the presence of moisture.

Permissible Exposure Limits in Air

OSHA PEL: None

NIOSH REL: 5 milligram per cubic meter TWA

ACGIH TLV[1]: 5 milligram per cubic meter TWA; not classifiable as a human carcinogen

PAC Ver. 29[138]

PAC-1: 15 milligram per cubic meter

PAC-2: 66 milligram per cubic meter

PAC-3: 400 milligram per cubic meter

DFG MAK: Sensitizing substances as sulfites

Australia: TWA 5 milligram per cubic meter, 1993; Belgium: TWA 5 milligram per cubic meter, 1993; Denmark: TWA 5 milligram per cubic meter, 1999; France: VME 5 milligram per cubic meter, 1999; Norway: TWA 5 milligram per cubic meter, 1999; Switzerland: MAK-W 5 milligram per cubic meter, 1999; United Kingdom: TWA 5 milligram per cubic meter, 2000; the Netherlands: MAC-TGG 5 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Several states have set guidelines or standards for sodium bisulfite in ambient air[60] ranging from 5.0 μ/m^3 (North Dakota); to 80.0 μ/m^3 (Virginia); to 100.0 μ/m^3 (Connecticut); to 119.0 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #0500, Particulates NOR, total dust.

Permissible Concentration in Water: Maryland[61] has set a guideline for sodium bisulfite in drinking water of 70.0 μg/L.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Corrosive can cause severe skin and eye irritation and burns. Irritates the respiratory tract causing cough, wheezing, and shortness of breath. Ingestion may cause irritation to mouth, throat, and stomach. Allergic response may occur. This could include itching of ears and legs, nausea, cough, tightening of throat, and reddening of the skin.

Long-Term Exposure: An asthma-like allergy may develop after repeated exposure. Skin allergy may develop. May irritate the lungs, causing bronchitis to develop with cough, phlegm, and/or shortness of breath.

Points of Attack: Lungs, skin, eyes.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater) the following are recommended before beginning work and at regular times after that. Lung function tests. Evaluation by a qualified allergist.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Note to Physician: Converted to sulfuric acid in stomach. Acute obstruction of alimentary canal may occur Up to 3 weeks following ingestion.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures *over 5 milligram per cubic meter*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, proved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full operated in pressure-demand or other positive-pressure mode.

Storage: Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a dark, cool, well-ventilated area away from strong acids, such as hydrochloric and nitric; and oxidizers, such as perchlorates, peroxides, permanganates, chlorates, and nitrates.

Shipping: UN2693 Bisulfites, inorganic, aqueous solutions, n.o.s., Hazard class: 8; Labels: 8-Corrosive material. UN3260 Bisulfites, inorganic, solid, n.o.s., Hazard class: 8; Labels: 8-Corrosive material.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during clean-up. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Cover spilled liquid with soda ash, absorb on vermiculite, or other inert material. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is noncombustible. Extinguish fire using an agent suitable for type of surrounding fire. Sodium bisulfite itself does not burn. Thermal decomposition products may include sulfur dioxide and oxides of carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dump into water, add soda ash, then neutralize with HCl; flush to sewer with large volumes of water.

References

(31); (173); (101); (138); (2); (80); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Sodium Bisulfite, Trenton, NJ (August 1998).

New York State Department of Health, *Chemical Fact Sheet:* Sodium Bisulfite, Bureau of Toxic Substance Assessment, Albany, NY (April 1986).

Sodium Bromate S:0415

Formula: $NaBrO_3$; $BrO_3 \cdot Na$; $BrHO_3 \cdot Na$[NLM]
Synonyms: Bromate de sodium (French); Bromic acid, sodium salt; Dyetone; Neutralizer K-126; Neutralizer K-140; Neutralizer K-938
CAS Registry Number: 7789-38-0
HSDB Number: 2185
RTECS Number: EF8750000
UN/NA & ERG Number: UN1494/141; UN1450/141
EC Number: 223-160-4

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human Inadequate Evidence, animal Sufficient Evidence, *possibly carcinogenic to humans*, Group 2B, 1999; EPA: Likely to produce cancer in humans (inhalation, as bromates); Available data are inadequate for an assessment of human carcinogenic potential (oral route, as bromates); Limited evidence of carcinogenicity based on epidemiologic studies[72].

California Proposition 65 Chemical[102]: Carcinogen (as bromate) 5/31/2002

Hazard Alert: Strong oxidizer, Narcotic, Possible risk of forming tumors,

United States National Primary Drinking Water Regulations: MCLG = 0 mg[BrO_3^-]/L; MCL = 0.010 mg [BrO_3^-]/L, as bromates/bromate ion

Hazard symbols, risk, & safety statements: Hazard symbol: O, Xi, Xn; risk phrases: R8; R20/21/22; R36/37/38; R45; R50; safety phrases: S17; S22; S26; S36/37/39; S41; S45; S53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Sodium bromate is a colorless or white crystalline solid. Odorless. Molecular weight = 150.90; specific gravity (H_2O:1) = 3.34 @ 20°C; boiling point = 1390°C; freezing/melting point = (decomposes) 381°C; flash point = 381°C. Soluble in water; solubility = 35 g/100 g @ 20°C.

Potential Exposure: Used for research and development; as an analytical reagent; for separating gold from ores; making vat dyes; boiler cleaning.

Incompatibilities: Dust may form explosive mixture with air. A strong oxidizer capable of increasing the intensity of an existing fire. Can react, possibly violently, with combustible, organic, or other oxidizable materials, alcohols, glycols, reducing agents, strong acids, finely divided metals, especially aluminum. Contamination with carbon, organic matter, and finely divided metal can cause sodium bromate become shock-sensitive. Decomposes at 381°C. Sodium bromate may explode in heat of fire.

Permissible Exposure Limits in Air:
PAC* Ver. 29[138]
PAC-1: 0.46 milligram per cubic meter
PAC-2: 5.1 milligram per cubic meter
PAC-3: 30 milligram per cubic meter

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 10 μg/L as bromate ion. Safe Drinking Water Act (47FR 9352): MCLG = 0 mg/L; MCL = 0.010 mg/L, as bromates

Routes of Entry: Inhalation, ingestion, dermal, or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritation of the skin, eyes, and respiratory tract. Toxic by ingestion. Inhalation of dust is toxic Contact with substance may cause severe burns to skin and eyes. Acute effects: Hematological effects (unspecified). Narcotic, brain, CNS; nervous system toxin; kidney. A respiratory toxin-acute effects other than severe or moderate irritation; gastrointestinal tract[138]. LD_{50}(oral-mouse) = 140 mg/kg.

Long-Term Exposure: Bromates may cause an increased risk of cancer. May cause tumors, kidney, and nervous system problems.

Points of Attack: Brain, nervous system, CNS, kidney, gastrointestinal tract.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. Contaminated clothing may be a fire risk when dry. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. Keep victim warm and quiet. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves.

Personal Protective Methods: Wear chemical protective clothing that is specifically recommended by the manufacturer. It may provide little or no thermal protection. Structural firefighters' protective clothing will only provide limited protection. Wear positive pressure SCBA. Wear chemical protective clothing that is specifically recommended by the manufacturer. It may provide little or no thermal protection. Structural firefighters' protective clothing will only provide limited protection.

Respirator Selection: *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA-or European Standard EN 149-approved SCB that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-face-piece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Check oxygen content prior to entering storage area. Color code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially organic materials, flammables and combustibles, and other incompatible materials. Oxidizers, including oxidizing gases, should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Store in a cool, well-ventilated area away from incompatible materials listed above. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage.

Shipping: UN1494 Sodium bromate, Hazard Class: 5.1; Labels: 5.1-Oxidizer. UN1450 Bromates, inorganic, n.o.s., Hazard Class: 5.1; Labels: 5.1-Oxidizer, Technical Name Required.

Spill Handling: *Caution:* Incompatible absorbents: Cellulose-Based Absorbents, Expanded Polymeric Absorbents[101]. As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 m/150 ft for liquids and at least 25 m/75 ft for solids. Keep unauthorized personnel away. Stay upwind. Keep out of low areas. Ventilate closed spaces before entering. *Evacuation*: *Large Spill*: Consider initial downwind evacuation for at least 100 m/330 ft. Fire: If tank, rail car or tank truck is involved in a fire, ISOLATE for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. Keep combustibles (wood, paper, oil, etc.) away from spilled material. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Stop leak if you can do it without risk. Small Dry Spill: With clean shovel place material into clean, dry container and cover loosely; move containers from spill area. Large Spill: Dike far ahead of spill for later disposal.[31]

Fire Extinguishing: Thermal decomposition products may include hydrogen bromide gas. A strong oxidizer. Sodium bromate may explode in heat of fire. Oxidizers will accelerate burning when involved in a fire. May explode from heat or contamination. Some may burn rapidly. Some will react explosively with hydrocarbons (fuels). May ignite combustibles (wood, paper, oil, clothing, etc.). Containers may explode when heated. Runoff may create fire or explosion hazard. *Small Fire*: Use water. Do not use dry chemicals or foams. CO_2 or Halon may provide limited control. *Large Fire*: Flood fire area with water from a distance. Do not move cargo or vehicle if cargo has been exposed to heat. Move containers from fire area if you can do it without risk. Fire involving Tanks or Car/Trailer Loads: Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Cool containers with flooding quantities of water until well after fire is out. ALWAYS stay away from tanks engulfed in fire. For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn.

Disposal Method Suggested: SRP: The most favorable course of action is to use an alternative chemical product with less inherent propensity for occupational exposure or environmental contamination. Recycle any unused portion of the material for its approved use or return it to the manufacturer or supplier. Ultimate disposal of the chemical must consider: the material's impact on air quality; potential migration in soil or water; effects on animal, aquatic, and plant life; and conformance with environmental and public health regulations. See also Sigma-Aldridge data sheet (Sodium Bromate >99%).

References

(102); (31); (173); (101); (138). (100).

Sodium Cacodylate S:0420

Formula: $C_2H_6AsNaO_2$: $(CH_3)_2AsOONa$

Synonyms: Alkarsodyl; Ansar 160; Arsecodile; Arsycodile; Bolls-Eye; Cacodilato sodico (Spanish); Cacodylate de sodium (French); Cacodylic acid sodium salt; Chemaid; Dimethylarsinic acid, sodium salt; [(Dimethylarsino)oxy] sodium-arsenic-oxide; [(Dimethylarsino)oxy]sodium As-oxide; Dutch-treat; Hydrodimethylarsine oxide, sodium salt; Kakodylan Dodny; Phytar 560; Rad-E-Cate; Rad-E-Cate 16; Rad-E-Cate-25; Rad-E-Cate-35; Silvisar; Sodium dimethylarsinate; Sodium dimethyl arsonate; Sodium salt of cacodylic acid

CAS Registry Number: 124-65-2; 6131-99-3 (trihydrate)

HSDB Number: 731

RTECS Number: CH7890000

UN/NA & ERG Number: UN1688/152; UN3465 (organoarsenic compound, solid, n.o.s.)/151

EC Number: 204-708-2

Regulatory Authority and Advisory Information

Carcinogenicity: EPA, classification: D; not classifiable as to human carcinogenicity. Basis for classification: No human data and inadequate data in animals.

Hazard Alert: Poison, Environmental hazard, Suspected reprotoxic hazard.

Banned or Severely Restricted (Portugal) (UN)[13]

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)

As arsenic compounds:

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) as arsenic compounds

Clean Water Act: Toxic Pollutant (Section 401.15) as arsenic and compounds

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, D004 (arsenic compounds)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg)

EPCRA (Section 313): Includes any unique chemical substance that contains arsenic as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: organics 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B) as arsenates, liquid, n.o.s.; arsenates, solid, n.o.s.; arsenical pesticides liquid, toxic, flammable, n.o.s.

Canada: Priority Substance List & Restricted Substances/ Ocean Dumping FORBIDDEN (CEPA), NPRI (arsenic compounds).

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R23/25; R50/53; R63; safety phrases: S29; S53; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)]

Description: Sodium cacodylate is a white crystalline solid which occurs as the trihydrate. It liquefies in the water of hydration @ 60°C and becomes anhydrous @ 120°C. Molecular weight = 159.99. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 0. Soluble in water.

Potential Exposure: This material has been used as a non-selective herbicide and for general weed control.

Incompatibilities: Incompatible with oxidizers, strong bases; acids, active metals (iron, aluminum, zinc). Contact with acids react to form highly toxic dimethylarsine gas. Attacks some metals.

Permissible Exposure Limits in Air

Arsenic, organic compounds

OSHA PEL: 0.5 mg[As]/m^3 TWA

NIOSH REL: Not established. See NIOSH Pocket Guide, Appendix A

ACGIH TLV[1]: 0.01 mg[As]/m^3 TWA; Confirmed Human Carcinogen; BEI established.

124-65-2

PAC Ver. 29[138]

PAC-1: 3.2 milligram per cubic meter

PAC-2: 86 milligram per cubic meter

PAC-3: 510 milligram per cubic meter

Determination in Air: Filter; Reagent: Ion chromatography/hydride atomic absorption: NIOSH IV [#5022, Arsenic, organo-][18].

Permissible Concentration in Water: EPA[6] recommends a zero concentration of arsenic for human health reasons. Federal Drinking Water Guidelines: EPA 10 μg/L; State Drinking Water Guidelines: Arizona 10 μg/L; Connecticut 10 μg/L. Toxic pollutant designated pursuant to section 307 (a) (1) of the Clean Water Act and is subject to effluent limitations (arsenic and inorganic and organic arsenic) [40 CFR 401.15 (7/1/1987)]. Canadian Drinking Water Standards: IMAC 0.025 [As] mg/L. Runoff from spills or fire control may cause water pollution.

Determination in Water: See OSHA Analytical Method ID-105 for arsenic. The atomic absorption graphite furnace technique is often used for measurement of total arsenic in water. It also has been standardized by EPA. Total arsenic may be determined by digestion followed by silver diethyldithiocarbamate; an alternative is atomic absorption; another is ICP optical emission spectrometry.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Sodium cacodylate is corrosive to the skin, eyes, and mucous membranes. Moderately toxic; probable oral lethal dose in humans is 0.5−5 g/kg or between 1 oz and 1 pt (or 1 lb) for a 70 kg (150 lb) person. It may cause disturbances of the blood, kidneys, and nervous system. Acute exposure to sodium cacodylate may be fatal. Headache, red-stained eye; and a garlicky odor of the breath may be the first effects noticed. Other signs and symptoms include generalized weakness, intense thirst; muscle cramping; seizures, toxic delirium; and shock. Nausea, vomiting, anorexia, abdominal pain; and diarrhea may occur. Hypotension (low blood pressure), tachycardia (rapid heart rate), pulmonary edema; ventricular fibrillation; and other cardiac abnormalities are usually found following severe exposure.

Long-Term Exposure: Repeated exposure may cause ulcers and hole in the nasal septum. Hoarseness and sore eyes also occur. Repeated contact may cause thickened skin, pigmentation changes. May cause liver damage and nerve damage causing sensation of "pins and needles," weakness and loss of coordination in the limbs. May cause gastrointestinal tract and reproductive effects. Repeated exposures can cause metallic taste; poor appetite; nausea, vomiting, diarrhea and stomach pain; seizures and death.

Points of Attack: Skin, respiratory system; kidneys, CNS; liver, gastrointestinal tract; reproductive system.

Medical Surveillance: Examination of the nose, skin, eyes, and nails. Examination of the nervous system. Liver function tests. Test for urine arsenic. NIOSH recommended exposure levels should not exceed 100 μg/L of creatinine in the urine. Results may be accurate within 2 days of eating shellfish or fish (which may increase arsenic levels); they are most accurate at the end of a work-day.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give a slurry of activated charcoal in water to drink and induce vomiting. Do not make an unconscious person vomit. Obtain authorization and/or further instructions from the local hospital for administration of an antidote or performance of other invasive procedures. Rush to health care facility.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Note to physician: For severe poisoning, BAL, Dimercaprol, dithiopropanol ($C_3H_8OS_2$) has been used to treat toxic symptoms of certain heavy metals poisoning—including arsenic. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5). For milder poisoning *penicillamine (not penicillin)* has been used, both with mixed success. Side effects occur with such treatment and it is never a substitute for controlling exposure. It can only be done under strict medical care. Specific engineering controls are required under OSHA 1910.1018, *Inorganic Arsenic.* See also NIOSH Criteria Document #75-149, *Inorganic Arsenic.*

Respirator Selection: *at any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFAg100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted acid gas canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage.

Shipping: UN1688 Sodium cacodylate Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN3465 Organoarsenic compound, solid, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required

Spill Handling:

Organoarsenic compound, solid or liquid

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.5/0.8

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 500/60
Then: Protect persons downwind (mi/km)
Day 1.1/1.8
Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Stay upwind; keep out of low areas. Wear self-contained (positive pressure if available) breathing apparatus and full protective clothing. Do not touch spilled material; stop leak if you can do it without risk. *Small liquid spills:* take up with sand or other noncombustible absorbent material into clean, dry container and cover; move containers from spill area. *Large spills:* dike far ahead of spill for later disposal. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Sodium cacodylate itself does not burn. Thermal decomposition products may include arsenic hydride and oxides of arsenic and carbon. Poisoning potential is high when heated to decomposition, or on contact with acids or acid fumes, because it emits highly toxic fumes of arsenic. Avoid water solution in contact with active metals such as iron, aluminum, zinc[101]. Use any agent suitable for surrounding fire. Stay upwind; keep out of low areas. Wear SCBA and full protective clothing. Move container from fire area, if you can do so without risk. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: For cacodylic acid, precipitate as calcium arsenate and calcium arsenite by treatment with excess lime water. Recycle if possible. If not, put in secure storage for possible disposal in leach-proof dumps[22]. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Sodium Cacodylate, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

(173); (101); (138).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Sodium Cacodylate, Trenton, NJ (August 1999).

Sodium Chlorate S:0430

Formula: $ClNaO_3$; $NaClO_3$

Synonyms: Asex; Atlacide; Atratol B-herbatox; Chlorate of soda; Chlorate salt of sodium; Chlorax; Chloric acid, Sodium salt; Chlorsaure (German); De-Fol-Ate; Desolet; Drexel defol; Drop leaf; Evau-superfall; Grain sorghum harvest aid; Granex OK; Harvest-aid; Klorex; Kusa-tohru-kusatol; Lorex; Natriumchlorat (German); Ortho C-1 defoliant & weed killer; Oxycil; Rasikal; Shed-α-leaf; Shed-α-leaf "L"; Soda chlorate; Sodium (chlorate de) (French); Travex; Tumbleaf; United Chemical defoliant No. 1; Val-Drop

CAS Registry Number: 7775-09-9; *(alt.)* 11096-45-0

HSDB Number: 732

RTECS Number: FO0525000

UN/NA & ERG Number: UN1495 (solid)/140; UN2428 (solution)/140

EC Number: 017-005-00-9

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Theft hazard* 400 (Commercial grade).

United States Environmental Protection Agency, FIFRA, 1998 Status of Pesticides: Supported.

Hazard Alert: Strong oxidizer, Highly Reactive Substance, Explosive World bank[15]. Agricultural chemical, Possible risk of forming tumors, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction), Environmental hazard.

Hazardous to aquatic life or environment, with possible long-lasting effects[293]. Toxic to aquatic life with long-lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: O, E, Xn, N; risk phrases: R8; R9; R22; R51/53; R62; safety phrases: S1; S13; S17; S29/35; S46; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Sodium chlorate is a white crystalline solid. Molecular weight = 106.44; Decomposes below boiling point @ ca. 300°C; freezing/melting point = 248°C (also listed @ 255°C and 264°C). Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 0, reactivity, reactivity 2 (Oxidizer). Soluble in water.

Potential Exposure: Sodium chlorate is used to manufacture dyes, explosives, in paper pulp processing and as a weed killer; used as a constituent of atratol and pramitol.

Incompatibilities: A strong oxidizer. Potentially explosive. Reacts violently with combustibles, sulfuric acid; and reducing materials. Reacts with strong acids giving off carbon dioxide. Explosions may be caused by contact with ammonia salts; ammonium thiosulfate; antimony sulfide; arsenic, carbon, charcoal, organic matter; organic acids; thiocyanates, chemically active metals; oils, metal sulfides; nitrobenzene, powdered metals; sugar. Reacts with some organic contaminants forming shock-sensitive mixtures. Decomposes on heating above 300°C or on burning, producing oxygen and toxic chlorine fumes. Attacks zinc, magnesium, and steel.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 3.6 milligram per cubic meter

PAC-2: 40 milligram per cubic meter

PAC-3: 240 milligram per cubic meter

Permissible concentration in Water: *Chlorates:* State Drinking Water Guidelines: California 800 μg/L; Maine 7 μg/L.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Sodium chlorate can affect you when breathed in. Eye or skin contact can cause severe irritation and even burns. Breathing sodium chlorate, especially dust or mist, can irritate the nose and throat. It can also cause cyanosis, causing the skin to turn Blue (methemoglobinemia), because it interferes with the blood's ability to carry oxygen. Damage to red blood cells (hemolytic anemia) can also occur. If severe or repeated, this can cause kidney damage. Ingestion can cause kidney damage. The effects may be delayed.

Long-Term Exposure: Repeated or prolonged contact with skin may cause dermatitis. Kidney damage can occur from severe or repeated damage to red blood cells resulting from exposure. Very irritating substances may cause lung damage.

Points of Attack: Kidneys, lungs, skin.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: CBC. Test for methemoglobin if skin is blue.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim under medical observation.

Antidotes and Special Procedures: Do not use Methylene Blue to treat methemoglobinemia from sodium chlorate as it can cause increased toxicity.

Note to Physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposure to sodium chlorate, use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Check oxygen content prior to entering storage area. Oxidizer. Potentially explosive. Color code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially organic materials, flammables and combustibles, and other incompatible materials. Oxidizers, including oxidizing gases, should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Sodium chlorate must be stored to avoid contact with ammonium thiosulfate, antimony sulfide; arsenic, carbon, charcoal, organic matter; organic acids; sulfuric acid; thiocyanates and chemically active metals (such as potassium, sodium, magnesium, and zinc), since violent reactions occur. Protect storage containers against physical damage. Store in tightly closed containers in a cool, well-ventilated area away from sources of heat. Store in a cool, well-ventilated area away from incompatible materials listed above. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage.

Shipping: UN1495 Sodium chlorate, Hazard Class: 5.1; Labels: 5.1-Oxidizer. UN2428 Sodium chlorate, aqueous solution, Hazard Class: 5.1; Labels: 5.1-Oxidizer.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. Keep sodium chlorate out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Sodium chlorate may burn, but does not readily ignite. Thermal decomposition products may include oxides of chlorine, sodium and carbon. Heat above 300°C produces oxygen which can increase the intensity of fire and may ignite other combustible materials. Flood areas with water unless that is incompatible with other materials in the fire area. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR 165 recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (80); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 3, No. 1, 28–32 (1983).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Sodium Chlorate, Trenton, NJ (February 2001).

Sodium Chloroplatinate S:0440

Formula: $Cl_6Pt \cdot 2Na \cdot 4H_2O$

Synonyms: Platinate(2-), hexachlorodisodium, tetrahydrate; Platinic sodium chloride; Sodium hexachloroplatinate(IV); Sodium platinic chloride; Sodium platinic chloride

CAS Registry Number: 1307-82-0; 16923-58-3

EC Number: 240-983-5 [*Annex I Index No.:* 078-006-00-8]

Regulatory Authority and Advisory Information

Hazard Alert: Sensitization hazard (skin, resp.), Corrosive.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1% as platinum, water-soluble salts.

Hazard symbols, risk, & safety statements: Hazard symbol: T, C; risk phrases: R20/21/22; R25; R27/28; R41; R42/43; safety phrases: S22; S26; S36/37/39; S45 (see Appendix 4)

Description: Sodium chloroplatinate is a yellow-orange or red-brown crystalline solid. Odorless. Molecular weight = 561.9; freezing/melting point = loses water @ 100°C; vapor pressure = essentially zero. Soluble in water; solubility = 50 g/100 g @ 20°C.

Potential Exposure: Used as a catalyst.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

NIOSH IDLH = 4 mg[Pt]/m^3

OSHA PEL: 0.002 mg[Pt]/m^3 TWA

NIOSH REL: 0.002 mg[Pt]/m^3 TWA

ACGIH TLV[1]: 10.002 mg[Pt]/m^3 TWA

PAC not available

DFG MAK: No numerical value established. Data may be available; however, 2 μg[Pt]/m^3 peak should not be exceeded; danger of skin and airway sensitization, as chloroplatinates

Several states have set limits on platinum in ambient air[60] as well. See the entry on platinum for details.

Determination in Air: Use NIOSH II(7) Method #S-19 (soluble salts)

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Chloroplatinates can affect you when breathed in. Severe allergy can develop to chloroplatinates. Symptoms include asthma (with cough, wheezing, and/or shortness of breath); runny nose, and/or skin rash, sometimes with hives. If allergy develops, even small future exposure can trigger significant symptoms. Some persons exposed to this type of chemical have developed lung scarring. Family members can develop allergy to dust carried home on work clothing. It may irritate the eyes, nose, and throat. High exposure may cause irritability and even seizures.

Long-Term Exposure: May cause skin sensitization and dermatitis and/or asthma-like allergy. Repeated exposures can cause sores or ulcers in the lining of the nose. Tetrachloroplatinates are mutagens.

Points of Attack: Skin, lungs.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended. Lung function tests. These may be normal if the person is not having an attack at the time of the test. If symptoms develop or overexposure is suspected, the following may be useful: chest X-ray every 3 years should be considered if above tests are not normal. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek

medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: (for soluble Pt salts): *Up to 0.05 milligram per cubic meter:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *Up to 0.1 milligram per cubic meter:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 4 milligram per cubic meter:* SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full facepiece respirator with an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance cause eye irritation and damage; eye protection needed.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers. Where possible, automatically transfer material from drums or other storage containers to process containers.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical may burn but does not easily ignite. Thermal decomposition products may include hydrogen chloride and oxides of sodium and metal. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Sodium Chloroplatinate, Trenton, NJ (April 2000).

Sodium Chromates S:0445

Formula: $CrO_4 \cdot 2Na$; $Cr_2O_7 \cdot 2Na$ (dihydrate); $CrO_4 \cdot 2Na \cdot 10H_2O$ (decahydrate)

Synonyms: Chromate of soda; Chromium disodium oxide; Chromium sodium oxide; Cromato sodico (Spanish); Disodium chromate; Neutral sodium chromate; Sodium chromate(VI)

Bichromate: Bichromate of soda; Bichromate de sodium (French); Chromic acid, disodium salt; Chromium sodium oxide; Disodium dichromate; Natriumdichromat (German); Sodium bichromate; Sodium chromate; Sodium dichromate de (French); Sodium dichromate (dihydrate); Sodium dichromate(VI)

Decahydrate: Chromic acid, disodium salt, decahydrate; Sodium chromate decahydrate

CAS Registry Number: 10588-01-9 (disodium dichromate); 7775-11-3 (disodium chromate); 7789-12-0 (dihydrate); 13517-17-4 (decahydrate); 10034-82-9 (tetrahydrate)

HSDB Number: 737 (10588-01-9); 2962 (7775-11-3)

RTECS Number: GB2955000; GB2957000 (decahydrate)

UN/NA & ERG Number: UN3087 (oxidizing solid, toxic, n.o.s.)/141; UN3085 (oxidizing solid, corrosive, n.o.s.),/140

EC Number: 231-889-5 [*Annex I Index No.:* 024-018-00-3]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human Sufficient Evidence; Animal Sufficient Evidence, *carcinogenic to humans*, Group 1, 1997; NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen; EPA *(inhalation)*: Known human carcinogen; EPA *(oral)*: Not Classifiable as to human carcinogenicity; NTP: Known to be a human carcinogen. United States Environmental Protection Agency Gene-Tox Program, Positive/dose response: TRP reversion.

California Proposition 65 Chemical[102]: (*hexavalent chromium*) Cancer 2/27/1987; Developmental/Reproductive toxin (male, female) 12/19/2008.

Hazard Alert: Poison, Strong oxidizer, Sensitization hazard, Possible risk of forming tumors, Reproductive toxin: possible risk of gene damage/impaired fertility; Suspected reprotoxic hazard, Environmental hazard.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg)

As chromium compounds:

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

United States National Primary Drinking Water Regulations: MCLG = 0.01 mg[Cr]/L; MCL = 0.1 mg[Cr]/L as Chromium

Clean Water Act: Toxic Pollutant (Section 401.15); 40CFR401.15 Section 307 Toxic Pollutants as chromium and compounds.

EPA Acceptable daily intake (ADI): Chromium(VI) = 0.175 mg/day/man. EPA estimated adequate and safe intake (EASI) levels for chromium: **Infants:** age 0.0−0.5 years: 0.01−0.04 mg/day; age 0.5−1.0 years: 0.02−0.06 mg/day. **Children** age 1−3 years: 0.02−0.08 mg/day; age 4−6 years: 0.03−0.12 mg/day; age 7−10 years: 0.05−0.20 mg/day; age > or = to 11 years: 0.05−0.20 mg/day. **Adults:** 0.05−0.20 mg/day.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, D007 (chromium compounds)

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: O, T+, N, Xi; risk phrases: R45; R8; R21; R25; R26; R34; R42/43; R46; R48/23; R50/53; R60; R61; R62; R63; safety phrases: S29; S41; S45; S53; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Sodium chromate, including the hexahydrate, is yellow crystalline solids that can also be used in solution. Disodium dichromate (10588-01-9): Molecular weight = 161.98; specific gravity (H_2O:1) = 2.4 @ 13°C; freezing/melting point = 357°C. Soluble in water. The dichromate is a red or red-orange crystalline solid. Molecular weight = 161.98; freezing/melting point = 357°C (decomposes @ 400°C). Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 0, reactivity 0. Soluble in water. Dihydrate (7789-12-0): Molecular weight = 298; specific gravity (H_2O:1) = 2.35 @ 13°C. Disodium chromate (7775-11-3): Molecular weight = 161.97; specific gravity (H_2O:1) = 2.7; freezing/melting point = 794°C. Decahydrate (13517-17-4): Molecular weight = 342.18. Tetrahydrate (10034-82-9): Molecular weight = 303.

Potential Exposure: Used to make dyes, inks, pigments, and other chromates; in leather tanning, a corrosion inhibitor in circulating water systems; metal treatment; a drilling mud additive; chemical intermediate for chromium catalysts; colorimetry, oxidizing agent; bleaching agent; an algicide, fungicide, insecticide; in wood preservation.

Incompatibilities: Aqueous solution in a base. A strong oxidizer. Violent reaction with reducing agents; combustibles, strong acids; organic materials.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

10588-01-9, disodium dichromate

PAC-1: 0.38 milligram per cubic meter
PAC-2: 6.5 milligram per cubic meter
PAC-3: 39 milligram per cubic meter

7775-11-3, dichromate

PAC-1: 0.47 milligram per cubic meter
PAC-2: 8.2 milligram per cubic meter
PAC-3: 49 milligram per cubic meter

7789-12-0, dihydrate

PAC-1: 0.43 milligram per cubic meter
PAC-2: 7.5 milligram per cubic meter
PAC-3: 45 milligram per cubic meter

13517-17-4, decahydrate

PAC-1: 0.99 milligram per cubic meter
PAC-2: 17 milligram per cubic meter
PAC-3: 100 milligram per cubic meter

10034-82-9, tetrahydrate

PAC-1: 0.87 milligram per cubic meter
PAC-2: 15 milligram per cubic meter
PAC-3: 91 milligram per cubic meter

As chromium(VI) inorganic soluble compounds

NIOSH IDLH = 15 mg[Cr(VI)]/m^3

OSHA PEL: 0.005 mg[Cr(VI)]/m^3 TWA Concentration. See 29CFR1910.1026

NIOSH REL: 0.001 mg[Cr]/m^3 TWA, potential carcinogen, limit exposure to lowest feasible level. NIOSH considers all Cr(VI) compounds (including chromic acid, *tert*-butyl chromate, zinc chromate, and chromyl chloride) to be potential occupational carcinogens. See *NIOSH Pocket Guide*, Appendix A & C.

ACGIH TLV[1]: 0.05 mg[Cr]/m^3 TWA, Confirmed Human Carcinogen; BEI issued
DFG MAK: Danger of skin sensitization; Carcinogen Category 1; TRK: 0.05 mg[Cr]/m^3; 20 μg/L [Cr] in urine at end-of-shift. United Kingdom: carcinogen, 2000. The former USSR-UNEP/IRPTC joint project[43] gives a MAC in work-place air of 0.01 milligram per cubic meter. Connecticut[60] has set a guideline for chromium trioxide in ambient air of 0.25 μ/m^3.

Determination in Air: Use NIOSH Analytical Methods #7600,#7604, #7605, #7703, #9101; OSHA Analytical Methods ID-103, ID-215, W-4001.

Permissible Concentration in Water: The EPA[6] has designated chromium as a priority toxic pollutant. State Drinking Water Guidelines: California 10 μg[Cr(VI)]/L; Maine 35 μg[Cr(VI)]/L.

Determination in Water: Total chromium may be determined by digestion followed by atomic absorption, or by colorimetry, (diphenylcarbazide); or by ICP optical emission spectrometry. Chromium(VI) may be determined by extraction and atomic absorption or colorimetry (using diphenylhydrazide). Dissolved total Cr or Cr(VI) may be determined by 0.45 μ filtration followed by the above-cited methods[49].

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Sodium chromate can affect you when breathed in. It can also pass into inner layers of the skin. A corrosive. Eye contact can cause severe damage with possible loss of vision. Irritation of nose, throat and bronchial tubes can occur; with cough and/or wheezing. Skin contact can cause severe irritation, deep ulcers; or an allergic skin rash.

Long-Term Exposure: Chromium may cause allergic dermatitis. Sodium chromate is a human carcinogen. Sodium chromates can cause a sore or perforated nasal septum, with bleeding, discharge or crusting. May cause skin allergy with eczema-like rash. Can cause lung irritation or allergy; bronchitis may develop. May cause kidney damage.

Points of Attack: Skin, lungs, kidneys. *Cancer site:* throat and lungs.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure. NIOSH lists the following tests: Blood gas analysis, CBC; chest X-ray, ECG, liver function tests; pulmonary function tests; sputum cytology, urine (chemical/metabolite), urinalysis (routine), white blood cell count/differential. Exam of the nose and skin. If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Also check your skin daily for little bumps or blisters, the first sign of "chrome ulcers." If not treated early, these can last for years after exposure. Urine test for chromates. This test is most accurate shortly after exposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water, or milk. Do not induce vomiting.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Prevent skin contact (as chromic acid and chromates) **8 hours** (more than 8 hours of resistance to breakthrough >0.1 μg/cm/min): polyethylene gloves, suits, boots; polyvinyl chloride gloves, suits, boots; Saranex coated suits; **4 hours** (At least 4 but <8 hours of resistance to breakthrough >0.1 μg/cm^2/min): butyl rubber gloves, suits, boots; Viton gloves, suits. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid, unless full facepiece respiratory protection is worn. Wear dust-proof goggles and face shield when working with powders or dust, unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Specific engineering controls are recommended in NIOSH criteria document #76-129 [Chromium(VI)].

Respirator Selection: NIOSH: *at any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Check oxygen content prior to entering storage area. (1) Color code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Oxidizers, including oxidizing gases, should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. (2) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. (3) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from combustibles, organics, or other easily oxidized materials. Where possible, automatically transfer material from drums or other storage containers to process containers. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Store in a cool, well-ventilated area away from incompatible materials listed above. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage.

Shipping: UN3087 Oxidizing solid, toxic, n.o.s., Hazard Class: 5.1; Labels: 5.1-Oxidizer, 6.1-Poisonous materials, Technical Name Required. UN3085 Oxidizing solid, corrosive, n.o.s., Hazard Class: 5.1; Labels: 5.1-Oxidizer, 8-Corrosive material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical may burn but does not easily ignite. Thermal decomposition products may include oxides of chromium oxide and sodium. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(109); (102); (31); (173); (101); (138); (2); (80); (122); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Sodium Dichromate, Trenton, NJ (April 2000).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Sodium Chromate*, Trenton, NJ (October 2001).

United States Environmental Protection Agency, *Health Assessment Document: Chromium,* EPA 600/8-83-014F, Washington, DC (1984).

Sodium Cyanide S:0450

Formula: NaCN

Synonyms: Cianuro sodico (Spanish); Cyanide of sodium; Cyanobrik; Cyanogran; Cyanure de sodium (French); Cymag; Hydrocyanic acid, sodium salt; Prussiate of soda; Sodium cyanide, solid; Sodium cyanide, solution

CAS Registry Number: 143-33-9; 10034-82-9 (tetrahydrate)

HSDB Number: 734

RTECS Number: VZ7530000

UN/NA & ERG Number: UN1689/157; UN1935

EC Number: 205-599-4

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade).

Hazard Alert: Poison, Systemic agent, High acute toxicity, Water reactive, Corrosive, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Environmental hazard.

United States National Primary Drinking Water Regulations: MCLG = 0.2 mg[CN^-]/L; MCL = 0.2 mg [CN^-]/L as cyanide.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P106

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg)

EPCRA Section 313: See cyanide compounds

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%. NPRI; CEPA Priority Substance List, Ocean dumping prohibited.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, C, N; risk phrases: R15; R26/27/28; R32; R34; R48/25; R50/53; R62; R63; safety phrases: S1/2; S7; S28; S29/35; S45, S60, S41; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

As cyanide compounds:

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants, as cyanide, total

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P030 as cyanides soluble salts and complexes, n.o.s.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, as cyanides, soluble salts, and complexes, n.o.s.

Description: Sodium cyanide is found as white granules, flakes or lumps. Sodium cyanide is shipped as pellets or briquettes. Odorless when dry. It absorbs water from air (is hygroscopic or deliquescent). Hydrogen cyanide gas released by sodium cyanide has a distinctive mild, bitter almond odor, but a large proportion of people cannot detect it; the odor does not provide adequate warning of hazardous concentrations. Molecular weight = 49.01; boiling point = 1496°C; freezing/melting point = 564°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 0₩. Soluble in water forming a strong base. Sodium cyanide releases highly flammable and toxic hydrogen cyanide gas on contact with acids or water.

Potential Exposure: Sodium cyanide is used as a solid or in solution to extract metal ores, in electroplating and metal cleaning baths; in metal hardening; in treatment of rabbit and rat burrows and holes and termite nests; in insecticides.

Incompatibilities: Sodium cyanide decomposes on contact with acids, acid salts, water, moisture, alcohols, and carbon dioxide, releasing highly toxic and flammable hydrogen cyanide gas. Aqueous solution is a strong base; it reacts violently with acid and is corrosive. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Absorbs moisture from the air forming a corrosive syrup. Corrosive to active metals, such as aluminum, copper, and zinc. Under acid conditions, sarin hydrolyzes to form hydrofluoric acid.

Permissible Exposure Limits in Air

NIOSH IDLH = 25 mg[CN]/m^3

OSHA PEL: 5 mg[CN]/m^3 TWA

NIOSH REL: 4.7 ppm/5 mg[CN]/m^3 [10 min] Ceiling Concentration

ACGIH TLV[1]: 5 mg[CN]/m^3 [skin] Ceiling Concentration

PAC* Ver. 29[138]

PAC-1: **4.0**$_{\mathbf{A}}$ milligram per cubic meter

PAC-2: **14**$_{\mathbf{A}}$ milligram per cubic meter

PAC-3: **30**$_{\mathbf{A}}$ milligram per cubic meter

*AEGLs are marked with a subscript "**A**" and correspond to 60-minute values.

DFG MAK: 3.8 mg[CN]/m^3, inhalable fraction TWA; Peak Limitation Category II(1) [skin]; Pregnancy Risk Group: C

Skin contact may contribute significantly in overall exposure.

Australia: TWA 5 milligram per cubic meter [skin], 1993; Austria: MAK 5 mg[CN]/m^3 [skin], 1999; Denmark: TWA 5 milligram per cubic meter [skin], 1999; France: VME 5 mg [CN]/m^3 [skin], 1999; Poland: TWA 0.3 mg[CN]/m^3, ceiling 10 mg[CN]/m^3, 1999; Switzerland: MAK-W 5 milligram per cubic meter, KZG-W 10 milligram per cubic meter [skin], 1999; United Kingdom: TWA 5 mg[CN]/m^3 [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Ceiling Concentration 5 milligram per cubic meter [skin]. Russia[43] has set MAC values for ambient air in residential areas of 0.009 milligram per cubic meter on a momentary basis and 0.004 milligram per cubic meter on an average daily basis. Several states have set guidelines or standards for cyanides in ambient air[60] ranging from 16.7 μ/m^3 (New York); to 50.0 μ/m^3 (Florida and North Dakota); to 80.0 μ/m^3 (Virginia); to 100 μ/m^3 (Connecticut and South Dakota); to 125 μ/m^3 (South Carolina); to 119.0 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #7904, Cyanides. See also Method #6010, Hydrogen cyanide[18].

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 200 μg[CN$^-$]/L; Federal Drinking Water Guidelines: EPA 200 μg[CN$^-$]/L; State Drinking Water Standards: California 150 μg[CN$^-$]/L; State Drinking Water Guidelines: Arizona 220 μg[CN$^-$]/L; Maine 140 μg[CN$^-$]/L; Minnesota 100 μg[CN$^-$]/L.

Determination in Water: Distillation followed by silver nitrate titration or colorimetric analysis using pyridine pyrazolone (or barbituric acid). Octanol−water coefficient: Log K_{ow} (estimated) = −1.69.

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Sodium cyanide releases hydrogen cyanide gas, a highly toxic chemical asphyxiant that interferes with the body's ability to use oxygen. Exposure to sodium cyanide can be rapidly fatal. It has whole-body (systemic) effects, particularly affecting those organ systems most sensitive to low oxygen levels: the CNS (brain), the cardiovascular system (heart and blood vessels), and the pulmonary system (lungs)[77].

Short-Term Exposure: Sodium cyanide can be absorbed through the skin, thereby increasing exposure. Sodium cyanide is corrosive to the eyes, skin, and respiratory tract. Contact can cause skin and eye burns, and possible permanent eye damage. Inhalation can cause lung irritation with coughing, sneezing, and difficult breathing; slow gasping respiration. Corrosive if swallowed. These substances may affect the CNS. Symptoms include headaches; confusion; nausea, pounding heart, weakness, and unconsciousness.

Long-Term Exposure: Repeated or prolonged contact with sodium cyanide may cause thyroid gland enlargement and interfere with thyroid function. May cause nosebleed and sores in the nose; changes in blood cell count. May cause CNS damage with headache, dizziness, confusion; nausea, vomiting, pounding heart, weakness in the arms and legs, unconsciousness and death. May affect liver and kidney function. Repeated lower exposures can cause sores in the nose with nosebleeds.

Points of Attack: Liver, kidneys, skin, cardiovascular system; CNS; thyroid gland.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Urine thiocyanate levels. Blood cyanide levels. CBC. Evaluation of thyroid function. Liver function tests. Kidney function tests. CNS tests. EKG. Smokers may have somewhat higher blood cyanide and urine thiocyanate levels.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Use amyl nitrate capsules if symptoms develop. All area employees should be trained regularly in emergency measures for cyanide poisoning and in CPR. A cyanide antidote kit should be kept in the immediate work area and must be rapidly available. Kit ingredients should be replaced every 1−2 years to ensure freshness. Persons trained in the use of this kit; oxygen use, and CPR must be quickly available.

Personal Protective Methods:

General information: first responders should use a NIOSH-certified CBRN SCBA with a level a protective suit when entering an area with an unknown contaminant or when entering an area where the concentration of the contaminant is unknown. Level a protection should be used until monitoring results confirm the contaminant and the concentration of the contaminant. *Note:* Safe use of protective clothing and equipment requires specific skills developed through training and experience.

LEVEL A: (*RED ZONE*): select when the greatest level of skin, respiratory, and eye protection is required. This is the maximum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than the AEGL-2. A NIOSH-certified CBRN full-face-piece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle. A TECP suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, and a hard hat worn under the TECP suit are optional items.

LEVEL B: (RED ZONE): Select when the highest level of respiratory protection is necessary but a lesser level of skin protection is required. This is the minimum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than AEGL-2. It differs from Level A in that it incorporates a nonencapsulating, splash-protective, chemical-resistant splash suit that provides Level A protection against liquids but is not airtight. A NIOSH-certified CBRN full-face-piece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL C: (YELLOW ZONE): Select when the contaminant and concentration of the contaminant are known and the respiratory protection criteria factors for using APR or PAPR are met. This level is appropriate when decontaminating patient/victims. A NIOSH-certified CBRN tight-fitting APR with a canister-type gas mask or CBRN PAPR for air levels greater than AEGL-2. A NIOSH-certified CBRN PAPR with a loose-fitting face-piece, hood, or helmet and a filter or a combination organic vapor, acid gas, and particulate cartridge/filter combination or a continuous flow respirator for air levels greater than AEGL-1. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Escape mask, face shield, coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL D: (GREEN ZONE): Select when the contaminant and concentration of the contaminant are known and the concentration is below the appropriate occupational exposure limit or less than AEGL-1 for the stated duration times. Limited to coveralls or other work clothes, boots, and gloves.

Notes: Take all necessary precautions to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. *Polyethylene (for sodium cyanide, less than 30%, only) is among the recommended protective materials.* All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid, unless full facepiece respiratory protection is worn. Wear dust-proof goggles and face shield when working with powders or dust, unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH (*as cyanides*): *25 milligram per cubic meter*: Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern and having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA). *When used as a weapon, use SCBA Respirator Certified By NIOSH For CBRN Environments. Up to 25 milligram per cubic meter:* Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFS100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern and having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong acids, acid salts; oxidizers, light, and moisture. Where possible, automatically transfer material from drums or other storage containers to process containers.

Shipping: UN1689 Sodium cyanide, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling:
(*Initial isolation and protective action distances*
Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

When spilled in water: large amounts of hydrogen cyanide may be produced
First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.1/0.2
Large spills (From a large package or from many small packages)
First: Isolate in all directions (ft/m) 300/90
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 0.96/1.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Eliminate all ignition sources (no smoking, flares, sparks, or flames in immediate area). All equipment used when handling the product must be grounded. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Stop leak if you can do it without risk. A vapor-suppressing foam may be used to reduce vapors. *Do not get water inside containers*. Use water spray to reduce vapors or divert vapor cloud drift. Avoid allowing water runoff to contact spilled material. Prevent entry into waterways, sewers, basements, or confined areas. *Small spill*: Cover with DRY earth, DRY sand or other noncombustible material followed with plastic sheet to minimize spreading or contact with rain. Use clean, nonsparking tools to collect material and place it into loosely covered plastic containers for later disposal. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: If a tank, rail car, or tank truck is involved in a fire, isolate it for 0.5 mi/800 m in all directions; also consider initial evacuation for 0.5 mi/800 m in all directions. *Small spills/when spilled in water*: First isolate in all directions: 200 ft/60 m. Then protect persons downwind during the day: 0.1 mi/0.2 km. Then protect persons downwind during the night: 0.4 mi/0.7 km). Large spills (when spilled in water). First isolate in all directions: 1300 ft/390 m. Then protect persons downwind during the day: 0.8 mi/1.3 km). Then protect persons downwind during the night: 3.0 mi/4.9 km. Material does not burn. Thermal decomposition products may include hydrogen cyanide and oxides of nitrogen. NaCN decomposes in the presence of water, damp air, or carbon dioxide, producing highly toxic and flammable hydrogen cyanide gas and oxides of nitrogen. *NO* acidic dry chemical extinguishers; *NO* hydrous agents; *NO* water; *NO* carbon dioxide directly on material. Fight surrounding fire with an agent appropriate for the burning material. Vapors are heavier than air and may collect in low areas. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. Do not allow water to enter open containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform to EPA regulations governing storage, transportation, treatment, and waste disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office. Add strong alkaline hypochlorite and react for 24 hours. Then flush to sewer with large volumes of water[22].

References

(31); (173); (101); (138); (2); (80); (100).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet: Sodium Cyanide*, Trenton, NJ (August 2006).

Sodium Dichloroisocyanurate S:0460

Formula: $C_3HCl_2N_3O_3 \cdot Na$

Synonyms: ACL 60; CDB 63; Dichloroisocyanuric acid sodium salt; Dikonit; Dimanin C; FI Clor 60S; OCI 56; SDIC; Simpla; Sodium dichlorisocyanurate; Sodium dichlorocyanurate; Sodium dichloroisocyanurate; Sodium-1,3-dichloro-1,3,5-triazine-2,4-dione-6-oxide; 1-Sodium-3,5-dichloro-*s*-triazine-2,4,6-trione; 1-Sodium-3,5-dichloro-1,3,5-triazine-2,4,6-trione; Sodium dichloro-*s*-triazinetrione, dry, containing more than 39% available chlorine; Sodium salt of dichloro-*s*-triazinetrione

CAS Registry Number: 2893-78-9

HSDB Number: 4235

RTECS Number: XZ1900000

UN/NA & ERG Number: UN2465/140

EC Number: 220-767-7 [*Annex I Index No.:* 613-030-00-X]

Regulatory Authority and Advisory Information

Hazard Alert: Powerful Oxidize, Water reactive, Thermally unstable, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction), Environmental hazard.

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: Xn, N; risk phrases: R8; R22; R31; R36/37/38; R51/53; R62; safety phrases: S2; S8; S17; S26; S29; S41; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Dichloroisocyanuric acid, sodium salt, is a white crystalline powder. Chlorine odor. Thermally unstable. Molecular weight = 220.96; specific gravity (H_2O:1) = 1.10 @ 25°C; freezing/melting point = (decomposes) 230°C. NFPA 704M Hazard identification (anhydrous): Health 2, flammability 0, reactivity 2 OX₩. Soluble in water; solubility = 25% (reactive).

Potential Exposure: Dichloroisocyanuric acid salts, are used in cleaning; making dry bleaches, detergents, sanitizers, and disinfectants; in swimming pool and sewage treatment.

Incompatibilities: A powerful oxidizer. Dust may form explosive mixture with air. Violent reaction with reducing agents; organic matter; easily chlorinated or oxidized materials. Isocyanates are highly flammable and reactive with many compounds, even with themselves. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Reaction with moist air, water or alcohols may form amines and insoluble polyureas and react exothermically, releasing toxic, corrosive or flammable gases, including carbon dioxide; and, at the same time, may generate a violent release of heat increasing the concentration of fumes in the air. Incompatible with amines, aldehydes, alkali metals, ammonia, carboxylic acids, caprolactum, alkaline materials, glycols, ketones, mercaptans, hydrides, organotin catalysts, phenols, strong acids, strong bases, strong reducing agents such as hydrides, urethanes, ureas. Elevated temperatures or contact with acids, bases, tertiary amines, and acyl-chlorides may cause explosive polymerization. Contact with metals may evolve flammable hydrogen gas. Attacks some plastics, rubber and coatings.

May accumulate static electrical charges, and may cause ignition of its vapors. Incompatible with ammonium salts, amines forming nitrogen trichloride.

Permissible Exposure Limits in Air

No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Contact can cause severe eye and permanent damage. Skin contact can cause severe irritation especially if skin is moist or material is in solution. Inhalation can cause irritation of the respiratory tract. The dry material is less irritating to the skin. A strong poison and corrosive if ingested; may cause liver damage.

Long-Term Exposure: Highly irritating substances may affect the lungs.

Points of Attack: Lungs, eyes, skin, liver.

Medical Surveillance. Lung function tests. Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water, or milk. Do not induce vomiting.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid, unless full facepiece respiratory protection is worn. Wear dust-proof goggles and face shield when working with powders or dust, unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Check oxygen content prior to entering storage area. Color code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially organic materials, flammables and combustibles, and other incompatible materials. Oxidizers, including oxidizing gases, should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from ammonium compounds, hydrated salts; moisture and combustible materials. Where possible, automatically transfer material from drums or other storage containers to process containers. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Store in a cool, well-ventilated area away from incompatible materials listed above. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage.

Shipping: UN2465 Dichloroisocyanuric acid, dry or Dichloroisocyanuric acid salts, Hazard Class: 5.1; Labels: 5.1-Oxidizer.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Keep water away from release. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid but it is a powerful oxidizer and may increase the activity of an existing fire. May burn rapidly. Thermal decomposition products may include hydrogen chloride and oxides of sodium, metal, and carbon. Use flooding quantities of water, from a distance. Do *NOT* use extinguishers containing ammonia. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Sodium Dichloro-Isocyanate, Trenton, NJ (May 2002).

Sodium Dimethyldithiocarbamate S:0465

Formula: $C_3H_7NS_2 \cdot Na$; $C_3H_7NNaS_2$

Synonyms: Aceto-SDD40; 40 Alcobam NM; Amersep MP 3R; Brogdex 555; Carbam S; Dimethyldithiocarbamic acid, sodium salt; *N,N*-Dimethyldithiocarbamate sodium salt; MSL (carbamate); Sodium *N,N*-dimethyldithiocarbamate; Sodium dimethyl dithiocarbamate; Sodium dimethyldithiocarbamate dihydrate; SDMC; Stafresh 615; Steriseal liquid No. 40; Thiostop N; Vinditat; Vinstop; Vulnopol-NM; Wing stop B

CAS Registry Number: 128-04-1

HSDB Number: 6811

RTECS Number: FD3500000

UN/NA & ERG Number: UN2771(solid)/151; UN3077 (environmentally hazardous substances, solid, n.o.s.)/171; UN3082 (environmentally hazardous substances, liquid, n.o.s.)/171

EC Number: 204-876-7

Regulatory Authority and Advisory Information

Carcinogenicity: EPA, Likely to be Carcinogenic to Humans.

California Proposition 65 Chemical[102]: Developmental/Reproductive toxin 3/30/1999.

Hazard Alert: Poison, Possible thyroid effects, Environmental hazard, Water reactive, Reproductive toxin: Suspected of causing genetic defects, Agricultural chemical, Drug.

EPCRA (Section 313): Includes any unique chemical substance that contains arsenic as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: organics 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects[291]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, N, Xn; risk phrases: R45; R22; R29; R36; R50/53; R60; R61; safety phrases: S26; S29; S41; S46; S61 (see Appendix 4).

R62; WGK (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Sodium dimethyldithiocarbamate is a clear yellow liquid or yellow crystalline solid. Molecular weight = 143.12; specific gravity (H_2O:1) = 1.17 @ 20°C; freezing/melting point = (decomposes) 121°C; flash point = 127°C (oc)[NFPA]. Becomes anhydrous at 130°C. ₩ Soluble in water; slowly decomposes in water, forming carbon disulfide and various amines, including methylamine.

Potential Exposure: The slow release of poisonous gases from hydrolysis of many thio and dithiocarbamates requires the use of respirators during handling. Used as an antimicrobial/fungicidal agent in paints, water treatment; a registered biocide for cutting oils and aqueous systems in industries such as leather tanning and paper manufacturing. Used in the rubber industry as a vulcanization accelerator for making synthetic and natural rubbers (i.e., butadiene rubber, latex). Used as a fungicide on melons (tolerance set as 25 ppm). Also used as an indirect food additive for use only as a component of adhesives[72].

Incompatibilities: Slowly decomposes in water, forming carbon disulfide, oxides of sulfur and nitrogen, hydrogen sulfide, ammonia, and amines, including methylamine; this decomposition is accelerated in the presence of acids. Flammable gases are generated by the combination with aldehydes, nitrides, and hydrides. Incompatible with acids, peroxides, and acid halides. Thiocarbamate esters are combustible. They react violently with powerful oxidizers such as calcium hypochlorite. Poisonous gases are generated by the thermal decomposition of thiocarbamate compounds, including carbon disulfide, oxides of sulfur, oxides of nitrogen, hydrogen sulfide, ammonia, and methylamine. Thio and dithiocarbamates slowly decompose in aqueous solution to form carbon disulfide and methylamine or other amines. Such decompositions are accelerated by acids. Flammable gases are generated by the combination of thiocarbamates with aldehydes, nitrides, and hydrides. Thiocarbamates are incompatible with carboxylic acid acids, peroxides, and acid halides.

Permissible Exposure Limits in Air: No OELs have been established. However this chemical is a suspected carcinogen and a reproductive/developmental hazard. Exposure should be reduced to the lowest possible level.

Permissible Concentration in Water: Acute hazard to the aquatic environment. Do not allow release to the environment unless proper permits are obtained from the federal government.

Determination in Water: EPA EMSLC Method 630. The determination of dithiocarbamate pesticides in municipal and industrial wastewater by UV-VIS spectrophotometry. Log K_{ow} = 1.50 (est)[72]. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Poisoning can occur by inhalation, ingestion, and absorption through the unbroken skin.

Harmful Effects and Symptoms

Short-Term Exposure: The slow release of poisonous gases from hydrolysis of many thio- and dithiocarbamates requires the use of respirators during handling. Highly toxic, may be fatal if inhaled, swallowed, or absorbed through skin. Avoid any skin contact or eye. Effects of contact or inhalation may be delayed. LD_{50}(oral-rat) = <1 g/kg; (dermal-rat) = >5 g/kg.

Long-Term Exposure: Suspected carcinogen. Developmental/reproductive hazard. Thyroid effects.

Points of Attack: Thyroid function (may cause goiter).

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure. Thyroid function tests.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method* if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed.

Personal Protective Methods: Wear positive pressure SCBA. Wear chemical protective clothing that is specifically recommended by the manufacturer. It may provide little or no thermal protection. Structural firefighters' protective clothing provides limited protection in fire situations ONLY; it is not effective in spill situations where direct contact with the substance is possible.

Respirator Selection: *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved SCBA that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-face-piece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA)

Storage: Color code—Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location.

Shipping: UN2771 Dithiocarbamate and Thiocarbamate pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.UN3082 Environmentally hazardous substances, liquid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 m/150 ft for liquids and at least 25 m/75 ft for solids. Keep unauthorized personnel away. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Stay upwind. Keep out of low areas. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Stop leak if you can do it without risk. Prevent entry into waterways, sewers, basements, or confined areas. Cover with plastic sheet to prevent spreading. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen, sulfur, sodium, and carbon. Containers may explode when heated. Runoff from fire control or dilution water may be corrosive and/or toxic and may cause pollution. Runoff may pollute waterways. If tank, rail car or tank truck is involved in a fire, ISOLATE for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. Small Fire: Use dry chemical, CO_2 or water spray. *Large Fire*: Water spray, fog or regular foam. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal; do not scatter the material. Use water spray or fog; do not use straight streams. *Fire involving Tanks or Car/Trailer Loads:* Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Do not get water inside containers. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. *Always* stay away from tanks engulfed in fire. For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn. *Do not* get water inside containers.

Disposal Method Suggested: Dispose of contents and container to an approved waste disposal plant. All federal, state, and local environmental regulations must be observed.

References

(102); (31); (173); (101); (138).

HSDB NLM, NFPA (Fire Protection Guide to Hazardous Materials. 13 ed. Quincy, MA: National Fire Protection Association, 2002, p. 325−84.

Sodium Fluoride S:0470

Formula: NaF
Synonyms: Alcoa sodium fluoride; Antibulit; Cav-trol; Checkmate; Chemiflour; Credo; Disodium Difluoride; F1-Tabs; FDA 0101; Floridine; Florocid; Flour-O-kote; Flozenges; Fluoral; Fluorident; Fluorigard; Fluorineed; Fluorinse; Fluoritab; Fluorure de sodium (French); Fluoruro sodico (Spanish); Flura-gel; Flurcare; Fungol B; Gel II; Gelution; Iradicav; Karidium; Karigel; Kari-rinse; Lea-cov; Lemoflur; Luride; Nafeen; Natrium fluoride; NCI: C55221; Nuflour; Ossalin; Ossin; Pediaflor; Pedident; Pennwhite; Pergantene; Phos-flur; Point two; Pro-portion; Rafluor; Rescue squad; Roach salt; Sodium hydrofluoride; Sodium monofluoride; So-Flo; Stay-Flo; Studaflour; Super-Dent; T-Fluoride; the ra-flur-N; Trisodium trifluoride; Villiaumite; Zendium
CAS Registry Number: 7681-49-4; *(alt.)* 39287-69-9
HSDB Number: 1766
RTECS Number: WB0350000
UN/NA & ERG Number: UN1690/154
EC Number: 231-667-8 [*Annex I Index No.:* 009-004-00-7]
Regulatory Authority and Advisory Information
Carcinogenicity: NCI: Carcinogenesis Studies (water); equivocal evidence: rat; no evidence: mouse; IARC: Animal Inadequate Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1987.
United States Environmental Protection Agency Gene-Tox Program, Positive: *D. melanogaster*-whole sex chrom. loss; Negative: *D. melanogaster*-nondisjunction; *N. crassa-aneuploidy*; Negative: In vivo SCE-nonhuman; *S. cerevisiae* gene conversion; Inconclusive: *D. melanogaster*-partial sex chrom. Loss; Inconclusive: Histidine reversion-Ames test; Inconclusive: *D. melanogaster* sex-linked letha.
Hazard Alert: Poison, High acute toxicity, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction), FDA-over the counter drug.
United States National Primary Drinking Water Regulations: MCLG = 4 mg[F]/L; MCL = 4 mg[F]/L; SMCL = 2.0 mg[F]/L, as Fluoride.
Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)
Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1000 lb (454 kg).
Hazard symbols, risk, & safety statements: Hazard symbol: T+, Xi; risk phrases: R25; R32; R36/38; R62; R63; safety phrases: S1/2; S22; S36; S41; S45 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.
Description: Sodium fluoride is a white powder or colorless crystals. Often used in a solution. Odorless. Pesticide grade is often dyed blue. Molecular weight = 41.99; specific gravity (H_2O:1) = 2.78 @ 25°C; boiling point = 1703.9°C; freezing/melting point = 992.8°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 0. Slightly soluble in water; solubility = 4%.
Potential Exposure: Widely used in the chemical industry; in water treatment and fluoridation of drinking water; as an insecticide, fungicide, and rodenticide; chemical cleaning; electroplating, glass manufacture; vitreous enamels; preservative for adhesives; toothpastes, disinfectant, dental prophylaxis; also used orally in the treatment of various bone diseases to increase bone density and to relieve bone pain.
Incompatibilities: Contact with acids release toxic gas. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.
Permissible Exposure Limits in Air
NIOSH IDLH: 250 mg[F]/m^3
OSHA PEL: 3 ppm/2.5 mg[F]/m^3 TWA
NIOSH REL: 3 ppm/2.5 mg[F]/m^3 TWA; 6 ppm/5 mg[F]/m^3, 15 minutes Ceiling Concentration
ACGIH TLV[1]: 2.5 mg[F]/m^3 TWA; not classifiable as a human carcinogen; BEI: 3 mg[F]/g creatinine in urine *prior* to end-of-shift; 10 mg[F]/g creatinine in urine end-of-shift
PAC Ver. 29[138]
PAC-1: 17 milligram per cubic meter
PAC-2: 90 milligram per cubic meter
PAC-3: 1100 milligram per cubic meter
DFG MAK: 1 mg[F]/m^3, inhalable fraction [skin]; Peak Limitation Category II(4); Pregnancy Risk Group C; BAT: 7.0 mg[F]/g creatinine in urine at end-of-shift; 4.0 mg[F]/g creatinine in urine at the beginning of the next shift
Australia: TWA 2.5 mg[F]/m^3, 1993; Austria: MAK 2.5 mg [F]/m^3, 1999; Belgium: TWA 2.5 mg[F]/m^3, 1993; Finland: TWA 2.5 mg[F]/m^3, 1999; France: VME 2.5 mg[F]/m^3, 1999; Hungary: TWA 1 mg[F]/m^3; STEL 2 mg[F]/m^3, 1993; Norway: TWA 0.6 mg[F]/m^3, 1999; the Philippines: TWA 2.5 mg[F]/m^3, 1993; Poland: MAC (TWA) 1 mg [HF]/m^3, MAC (STEL) 3 mg[HF]/m^3, 1999; Russia: STEL 0.5 ppm (2.5 milligram per cubic meter), 1993; Sweden: NGV 2 mg[F]/m^3, 1999; Switzerland: MAK-W 1.8 ppm (1.5 mg[F]/m^3), KZG-W 3.6 ppm (3.0 mg[F]/m^3), 1999; Thailand: TWA 2.5 mg[F]/m^3, 1993; United Kingdom: TWA 2.5 mg[F]/m^3, 2000; LTEL 2.5 mg[F]/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Several states have set limits for fluoride in ambient air[60] ranging from as low as 2.85 μ/m^3 (Iowa); to as high as 60,000 μ/m^3 (Kentucky).
Determination in Air: Use NIOSH Analytical Method (IV) #7902, Fluorides; #7906; OSHA Analytical Method ID-110.
Permissible Concentration in Water: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guidelines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware

2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg [F]/L. Safe Drinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg[F]/L; SMCL = 2 mg[F]/L.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact. Liquid can be absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Sodium fluoride can affect you when breathed in. Inhalation of dust or mist can cause severe irritation and burns of the eyes and skin. Irritates the eyes and respiratory system. May cause permanent eye damage. Exposure can cause nausea, abdominal pain; diarrhea, salivation, thirst, sweating.

Long-Term Exposure: Repeated or prolonged industrial contact can cause dermatitis. Repeated exposure can cause fluoride to build-up in the body. Can irritate the lungs; bronchitis may develop. Repeated exposure can cause fluoride to build up in the body causing stiffness, brittle bones; stiff spine; calcification of ligaments of ribs, pelvis; and crippling. Repeated exposures can cause weakness and muscle twitching; tremors, convulsions, coma and even death. May cause kidney damage. Prolonged contact can cause sores in the nose and perforated septum. High concentrations can damage the developing fetus. These effects *Do NOT* occur when sodium fluoride is used in drinking water for dental cavity prevention.

Points of Attack: Eyes, skin, respiratory system; CNS; skeleton, kidneys.

Medical Surveillance: NIOSH lists the following tests: chest X-ray, ECG, pulmonary function tests: forced vital capacity, forced expiratory volume (1 second); pelvic X-ray; sputum cytology; urine (chemical/metabolite); urine (chemical/metabolite) pre- and postshift; urinalysis (routine); CBC/differential.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA *12.5 milligram per cubic meter:* Q_m (APF = 25) (any quarter-mask respirator). *25 milligram per cubic meter:* 95XQ (APF = 10)* [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or SA* (any supplied-air respirator). *62.5 milligram per cubic meter:* Sa:Cf (APF = 25)$^{*+}$ (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25)* *if not present as a fume* (any powered, air-purifying respirator with a high-efficiency particulate filter). *125 milligram per cubic meter:* 100F (APF = 50)$^{+}$ [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *250 milligram per cubic meter:* Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50)$^{+}$ [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or SCBAE (any appropriate escape-type, SCBA). *Substance reported to cause eye irritation or damage; may require eye protection. *May need acid gas sorbent.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage.

Shipping: UN1690 Sodium fluoride, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include hydrogen fluoride. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (80); (122). (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Sodium Fluoride, Trenton, NJ (November 2004).

Sodium Fluoroacetate S:0480

Formula: $C_2H_2FNaO_2$: FCH_2COONa

Synonyms: 1080; Acetic acid, fluoro-, sodium salt; AI3-08434; Compound 1080; Fluoacetato sodico (Spanish); Fluorakil 3; Fluoressigsaeure (German); Fluoroacetic acid, sodium salt; Fratol; Furatol; Monofluoressigsaure, natrium (German); Natriumfluoracetat (German); NSC 77690; Ratbane 1080; SMFA; Sodium fluoacetate; Sodium fluoacetic acid; Sodium fluoracetate; Sodium fluoracetate de (French); Sodium monofluoroacetate; Ten-Eighty; TL 869; Yasoknock

CAS Registry Number: 62-74-8

HSDB Number: 743

RTECS Number: AH9100000

UN/NA & ERG Number: UN2629/151

EC Number: 200-548-2 [*Annex I Index No.:* 607-169-00-5]

Regulatory Authority and Advisory Information

California Proposition 65 Chemical[102]: Cancer; Developmental/Reproductive toxin 11/6/1998

Hazard Alert: Exposure can be lethal, Highly poisonous (all routes), Reproductive toxin: possible risk of gene damage/impaired fertility; Suspected reprotoxic hazard, Environmental hazard.

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P058

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 10/10,000 lb (4.54/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects[291]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, N; risk phrases: R26/27/28; R50; R62; R63; safety phrases: S1/2; S13; S22; S29; S36/37; S41; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Sodium fluoroacetate is a fluffy, colorless, odorless, hygroscopic solid (sometimes dyed black). Molecular weight = 100.03; boiling point = (decomposes); freezing/melting point = 200°C (decomposes below MP). Hazard identification (based on NFPA-704 M Rating System): Health 4, flammability 0, reactivity 0. Soluble in water.

Potential Exposure: A potential danger to those involved in the manufacture, formulation, and application of this highly toxic, immediate-action rodenticide.

Incompatibilities: Incompatible with alkaline metals and carbon disulfide[24]. Avoid decomposing heat[101].

Permissible Exposure Limits in Air

NIOSH IDLH = 2.5 milligram per cubic meter

OSHA PEL: 0.05 milligram per cubic meter TWA [skin]

NIOSH REL: 0.05 milligram per cubic meter TWA; 0.15 milligram per cubic meter STEL [skin]

ACGIH TLV[1]: 0.05 milligram per cubic meter TWA [skin]

PAC Ver. 29[138]

PAC-1: 0.15 milligram per cubic meter

PAC-2: 0.5 milligram per cubic meter

PAC-3: 5 milligram per cubic meter

DFG MAK: 0.05 milligram per cubic meter, inhalable fraction TWA; Peak Limitation Category II(4) [skin]; Pregnancy Risk Group C

Arab Republic of Egypt: TWA 0.05 milligram per cubic meter, 1993; Australia: TWA 0.05 milligram per cubic meter; STEL 0.15 milligram per cubic meter [skin], 1993; Austria: MAK 0.05 milligram per cubic meter [skin], 1999; Belgium: TWA 0.05 milligram per cubic meter; STEL

0.15 milligram per cubic meter [skin], 1993; Denmark: TWA 0.05 milligram per cubic meter [skin], 1999; Finland: TWA 0.05 milligram per cubic meter, STEL 0.15 milligram per cubic meter [skin], 1993; France: VME 0.05 milligram per cubic meter [skin], 1999; the Netherlands: MAC-TGG 0.05 milligram per cubic meter [skin], 2003; Norway: TWA 0.05 milligram per cubic meter, 1999; the Philippines: TWA 0.05 milligram per cubic meter [skin], 1993; Switzerland: MAK-W 0.05 milligram per cubic meter, KZG-W 1 milligram per cubic meter [skin], 1999; Turkey: TWA 0.05 milligram per cubic meter [skin], 1993; United Kingdom: TWA 0.05 milligram per cubic meter; STEL 0.15 milligram per cubic meter [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 0.05 milligram per cubic meter [skin]

Determination in Air: Use NIOSH II(5) Method #S-301.

Routes of Entry: Inhalation, skin absorption; ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: May affect the cardiovascular system and CNS; causing cardiac disorders and respiratory failure. Exposure may result in death. This material is super toxic. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. The probable oral lethal dose in humans is less than 5 mg/kg, or a taste (less than seven drops) for a 150 lb person. Symptoms include nausea, vomiting; apprehension, auditory hallucinations; facial paresthesia; twitching face muscle; pulsus altenans; ectopic heartbeat; ventricular fibrillation. Symptoms are usually seen within one-half hour of exposure, but severe effects may be delayed as long as 20 hours. A rebuttable presumption against registration of sodium fluoroacetate for pesticidal uses was issued on December 1, 1976 by the United States Environmental Protection Agency. On the basis of reductions in nontarget and endangered species and because there is no human antidote.

Long-Term Exposure: May cause liver and kidney damage. Affects the CNS causing epileptiform convulsive seizures that may be followed by severe depression.

Points of Attack: Cardiovascular system, lungs, kidneys, liver, CNS.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Liver and kidney function tests. Lung function tests. Consider chest X-ray following acute overexposure. Examination of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *When used as a weapon, use SCBA Respirator Certified By NIOSH For CBRN Environments. Up to 0.25 milligram per cubic meter:* Q_m (APF = 25) (any quarter-mask respirator). *Up to 0.5 milligram per cubic meter:* 95QX [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *Up to 1.25 milligram per cubic meter:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *Up to 2.5 milligram per cubic meter:* 100SaT (100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Where possible, automatically transfer material from drums or other storage containers to process containers Sources of ignition, such as smoking and open flames are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN2629 Sodium fluorosilicate, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Thermal decomposition products may include hydrogen fluorine and oxides of sodium metal and carbon. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform to EPA regulations governing storage, transportation, treatment, and waste disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office. This compound is unstable at temperatures above 110°C and decomposes @ 200°C. Thus, careful incineration has been suggested as a disposal procedure. According to their procedure, the produce should be mixed with large amounts of vermiculite, sodium bicarbonate, and sand-soda ash. Slaked lime should also be added to the mixture. Two incineration procedures for this mixture are suggested. The better of these procedures is to burn the mixture in a closed incinerator equipped with an afterburner and an alkali scrubber. The other procedure suggests that the mixture be covered with scrap wood and paper in an open incinerator. (The incinerator should be lighted by means of an excelsior train)[22].

References

(102); (31); (173); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Sodium Fluoroacetate, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

Sodium Hexafluorosilicate S:0490

Formula: F_6Na_2Si; Na_2SiF_6

Synonyms: Destruxol applex; (2-)-Disodium hexafluorosilicate; Disodiumsilicofluoride; Ens-zem weevil bait; ENT 1501; Fluosilicate de sodium; Natriumsilicofluorid (German); Ortho earwig bait; Ortho weevil bait; Prodan; PSC Co-Op weevil bait; Safsan; Salufer; Silicon sodium fluoride; Sodium fluorosilicate; Sodium fluosilicate; Sodium silicofluoride; Super prodan

CAS Registry Number: 16893-85-9; *(alt.)* 1310-02-7; *(alt.)* 39413-34-8

HSDB Number: 770

RTECS Number: VV8410000

UN/NA & ERG Number: UN2674/154

EC Number: 240-934-8 [*Annex I Index No.:* 009-012-00-0]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Inadequate Evidence; Human Inadequate Evidence*, not classifiable as carcinogenic to humans*, Group 3, 1987.

Hazard Alert: Poison, Possible risk of forming tumors, Primary irritant (w/o allergic reaction).

United States National Primary Drinking Water Regulations: MCLG = 4 mg[F]/L; MCL = 4 mg[F]/L; SMCL = 2 mg[F]/L, as fluorides.

Banned or Severely Restricted (In U.K.) (UN)[13]

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xi; risk phrases: R23/24/25; safety phrases: S1/2; S26; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Sodium hexafluorosilicate is a white crystalline solid. Molecular weight = 188.1; specific gravity (H_2O:1) = 2.7 @ 20°C;. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 0, reactivity 0. Practically insoluble in water.

Potential Exposure: Sodium hexafluorosilicate is as a rodenticide; as an intermediate in production of synthetic cyrolite; as an insecticide in delousing and in mothproofing of woolens.

Incompatibilities: Reacts with acids to produce hydrogen fluoride, a highly corrosive and poisonous gas.

Permissible Exposure Limits in Air

NIOSH IDLH = 250 mg[F]/m^3

OSHA PEL: 3 ppm/2.5 mg[F]/m^3 TWA

NIOSH REL: 3 ppm/2.5 mg[F]/m^3 TWA; 6 ppm/5 mg[F]/m^3, 15 min. Ceiling Concentration
ACGIH TLV[1]: 2.5 mg[F]/m^3 TWA; not classifiable as a human carcinogen; BEI: 3 mg[F]/g creatinine in urine *prior* to end-of-shift; 10 mg[F]/g creatinine in urine end-of-shift
PAC Ver. 29[138]
PAC-1: 12 milligram per cubic meter
PAC-2: 140 milligram per cubic meter
PAC-3: 820 milligram per cubic meter
DFG MAK: 1 mg[F]/m^3, inhalable fraction [skin]; Peak Limitation Category II(4); Pregnancy Risk Group C; BAT: 7.0 mg[F]/g creatinine in urine at end-of-shift; 4.0 mg[F]/g creatinine in urine at the beginning of the next shift
Australia: TWA 2.5 mg[F]/m^3, 1993; Austria: MAK 2.5 mg [F]/m^3, 1999; Belgium: TWA 2.5 mg[F]/m^3, 1993; Finland: TWA 2.5 mg[F]/m^3, 1999; France: VME 2.5 mg[F]/m^3, 1999; Hungary: TWA 1 mg[F]/m^3; STEL 2 mg[F]/m^3, 1993; Norway: TWA 0.6 mg[F]/m^3, 1999; the Philippines: TWA 2.5 mg[F]/m^3, 1993; Poland: MAC (TWA) 1 mg [HF]/m^3, MAC (STEL) 3 mg[HF]/m^3, 1999; Russia: STEL 0.5 ppm (2.5 milligram per cubic meter), 1993; Sweden: NGV 2 mg[F]/m^3, 1999; Switzerland: MAK-W 1.8 ppm (1.5 mg[F]/m^3), KZG-W 3.6 ppm (3.0 mg[F]/m^3), 1999; Thailand: TWA 2.5 mg[F]/m^3, 1993; United Kingdom: TWA 2.5 mg[F]/m^3, 2000; LTEL 2.5 mg[F]/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen

Determination in Air: Use NIOSH Analytical Method (IV) #7902, Fluorides; #7906.

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guidelines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg [F]/L. Safe Drinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg[F]/L; SMCL = 2 mg/F/L, as Fluoride.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: *Inhalation:* May cause difficult breathing and burning of the mouth, throat and nose which may result in bleeding. These may be felt @ 7.5 milligram per cubic meter. Nausea, vomiting, profuse sweating, and excess thirst may occur at higher levels. *Skin:* May cause rash, itching and burning of skin. Solutions of 1% strength may cause sores if not removed promptly. *Eyes:* May cause severe irritation. *Ingestion:* Most reported instances of fluoride toxicity are due to accidental ingestion and it is difficult to associate symptoms with dose. Five to 40 mg may cause diarrhea and vomiting. More severe symptoms of burning and painful abdomen, sores in mouth, throat and digestive tract; tremors, convulsions, and shock will occur around a dose of 1 g. Death may result by ingestion of 2−5 g.

Long-Term Exposure: Fluoride may increase bone density, stimulate new bone growth or cause calcium deposits in ligaments. This may become a problem at levels of 20−50 milligram per cubic meter or higher. May cause mottling of the bones or teeth at this level, resulting in fluorosis. May cause lung damage.

Points of Attack: Bones, lungs.

Medical Surveillance. Lung function tests. DEXA bone densitometry scan.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA *12.5 milligram per cubic meter:* Q_m (APF = 25) (any quarter-mask respirator). *25 milligram per cubic meter:* 95XQ (APF = 10)* [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or SA* (any supplied-air respirator). *62.5 milligram per cubic meter:* Sa:Cf (APF = 25)*$^+$ (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25)* *if not present as a fume* (any powered, air-purifying respirator with a high-efficiency particulate filter). *125 milligram per cubic meter:* 100F (APF = 50)$^+$ [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *250 milligram per cubic meter:* Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50)$^{+}$ [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or SCBAE (any appropriate escape-type, SCBA). *Substance reported to cause eye irritation or damage; may require eye protection. *May need acid gas sorbent.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in a cool, dry area that is well-ventilated. Protect from damage and acids.

Shipping: UN2674/Sodium fluorosilicate, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Enter spill area only with protective clothing and devices. Treat with soda ash or slaked lime. Use an industrial vacuum cleaner to remove the spill. Clean up with soap and water is allowed only if exposure and contamination are not increased to above the recommended levels. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material is nonflammable. Use agents suitable to surrounding fire. Thermal decomposition products may include hydrogen fluoride and silicon tetrafluoride. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138) (122); (100).

New York State Department of Health, Chemical Fact Sheet: *Sodium Hexafluorosilicate*, Bureau of Toxic Substance Assessment, Albany, NY (February 1986 and Version 2).

Sodium Hydroxide S:0500

Formula: HNaO; NaOH

Synonyms: Caustic soda; Caustic soda, bead; Caustic soda, dry; Caustic soda, flake; Caustic soda, granular; Caustic soda, solid; Hidroxido sodico (Spanish); Hydroxyde of sodium (French); Lewis Red Devil Lye; Lye; Lye solution; Natriumhydroxid (German); Pels soda lye; Sodium hydrate; Sodium hydrate solution; NaOH, bead; NaOH caustic soda solution; NaOH, dry; NaOH, flake; NaOH, granular; NaOH liquid; NaOH, solid; NaOH solution; Sodium (hydroxide de) (French); White caustic; White caustic, solution

CAS Registry Number: 1310-73-2; *(alt.)* 8012-01-9

HSDB Number: 229

RTECS Number: WB4900000

UN/NA & ERG Number: UN1823 (dry, solid)/154; UN1824 (solution)/154

EC Number: 215-185-5 [*Annex I Index No.:* 011-002-00-6]

Regulatory Authority and Advisory Information.

Hazard Alert: Corrosive, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction).

United States Environmental Protection Agency Gene-Tox Program, Negative: Cell transformation-SA7/SHE

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1000 lb (454 kg)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: C, Xi; risk phrases: R22; R35; R52/53; R62; safety phrases: S24/25; S36/37/39; S45; S53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: NaOH is a white, odorless, deliquescent material sold as pellets, flakes, lumps, or sticks. Aqueous solutions are known as soda lye. Molecular weight = 40.00; specific gravity (H_2O:1) = 2.13 @ 25°C; boiling point = 1390°C; freezing/melting point = 318.3°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 1. Highly soluble in water; solubility = 111%.

Potential Exposure: NaOH is utilized to neutralize acids and make sodium salts in petroleum refining, viscose rayon; cellophane, plastic production; and in the reclamation of solutions of their salts. It is used in the manufacture of mercerized cotton, paper, explosives, and dyestuffs in metal cleaning; electrolytic extraction of zinc; tin plating; oxide coating; laundering, bleaching, dishwashing; and it is used in the chemical industries.

Incompatibilities: A strong base and a strong oxidizer. Violent reaction with acid. Incompatible with water; flammable liquids; organic halogens, nitromethane, and nitrocompounds, combustibles. Rapidly absorbs carbon dioxide and water from air. Contact with moisture or water may generate heat. Corrosive to metals. Contact with zinc, aluminum, tin and lead in the presence of moisture, forming explosive hydrogen gas. Attacks some forms of plastics, rubber or coatings.

Permissible Exposure Limits in Air

NIOSH IDLH = 10 milligram per cubic meter

OSHA PEL: 2 milligram per cubic meter

NIOSH REL: 2 milligram per cubic meter Ceiling Concentration

ACGIH TLV[1]: 2 milligram per cubic meter Ceiling Concentration

PAC* Ver. 29[138]

PAC-1: $\mathbf{0.5_E}$ milligram per cubic meter

PAC-2: $\mathbf{5_E}$ milligram per cubic meter

PAC-3: $\mathbf{50_E}$ milligram per cubic meter

*ERPG [Emergency Response Planning Guidelines] are marked with a subscript "**E**."

DFG MAK: No numerical value established.

Australia: TWA 2 milligram per cubic meter, 1993; Austria: MAK 2 milligram per cubic meter, 1999; Belgium: STEL 2 milligram per cubic meter, 1993; Denmark: TWA 2 milligram per cubic meter, 1999; Finland: TWA 2 milligram per cubic meter, 1999; France: VME 2 milligram per cubic meter, 1999; Japan: 2 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 2 milligram per cubic meter, 2003; Norway: TWA 2 milligram per cubic meter, 1999; the Philippines: TWA 2 milligram per cubic meter, 1993; Poland: MAC (TWA) 0.5 milligram per cubic meter; MAC (STEL) 1 milligram per cubic meter, 1999; Sweden: TGV 2 milligram per cubic meter, 1999; Switzerland: MAK-W 2 milligram per cubic meter, KZG-W 4 milligram per cubic meter, 1999; Thailand: TWA 2 milligram per cubic meter, 1993; Turkey: TWA 2 milligram per cubic meter, 1993; United Kingdom: STEL 2 milligram per cubic meter, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Ceiling Concentration 2 milligram per cubic meter. Russia has set 10 μ/m^3 as a MAC for ambient air in residential areas on a once-daily basis. Several states have set guidelines or standards for NaOH in ambient air[60] ranging from 16.0 μ/m^3 (Virginia); to 20.0 μ/m^3 (North Dakota and South Carolina); to 40.0 μ/m^3 (Connecticut and South Dakota); to 48.0 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #7401, alkaline Dusts; OSHA Analytical Method ID-121.

Permissible Concentration in Water: NaOH is designated as a hazardous substance under section 311(b)(2) (A) of the Federal Water Pollution Control Act and further regulated by the Clean Water Act Amendments of 1977 and 1978. These regulations apply to discharges of this substance. This designation includes any isomers and hydrates, as well as any solutions and mixtures containing this substance. To protect freshwater aquatic life: pH 6.5−9.0; to protect saltwater aquatic life: pH 6.5−8.5; and to protect humans' drinking water-pH 5−9.

Routes of Entry: Inhalation of dust or mist, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Highly corrosive to the eyes, skin, and the respiratory tract. *Inhalation:* Can cause severe irritation of the nose and throat and inflammation of the lungs. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. *Skin:* Can cause severe irritation and deep burns. *Eyes:* Can cause severe irritation, corneal burns, and blindness. *Ingestion:* Can cause burning of the mouth and throat, nausea, vomiting, abdominal pains, and diarrhea (occasionally with blood). Can also cause swelling of the larynx and subsequent suffocation, holes in stomach and intestines; heart failure; coma. Death has resulted from swallowing less than 1/3 oz of the solid.

Long-Term Exposure: Skin irritation may develop from repeated exposure to the solid or low concentrations of the liquid. Irritation to the lungs, nose, throat and mouth may occur if exposed to low levels for long periods of time. May cause temporary loss of hair.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: NIOSH lists the following tests: chest X-ray; pulmonary function tests.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation.

For 30−70% solution: Sealed chemical materials with good to excellent resistance: butyl rubber; natural rubber; Neoprene, nitrile rubber; polyethylene, PVC, Teflon, Viton, Viton/chlorobutyl rubber; Saranex, Silvershield, Sol-vex nitrile.

For less than 30%. solution: Viton + chlorobutyl rubber, Silvershield, polyvinyl chloride; polyethylene, Nitrile + polyvinyl chloride; and chlorinated polyethylene are among the recommended protective materials. Neoprene + Natural rubber and polyethylene.

All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid, unless full facepiece respiratory protection is worn. Wear dust-proof goggles and face shield when working with powders or dust, unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 10 milligram per cubic meter:* Sa:Cf[£] (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or PaprHie[£] (APF = 25) (any powered air-purifying respirator with a high-efficiency particulate filter[£]); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode. *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

[£] *Note:* Substance causes eye irritation or damage; eye protection needed.

Storage: (1) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location; keep acids away from bases and red, yellow, and blue-coded chemicals.(2) Color code—White stripe: Contact Hazard; Store separately; not compatible with materials in solid white category. Prior to working with this chemical, personnel should be trained on its proper handling and storage. NaOH must be stored to avoid contact with water, acids, flammable liquids; organic halogen compounds; metals, or nitro compounds; because violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from water. Where possible, automatically transfer material from drums or other storage containers to process containers Sources of ignition, such as smoking and open flames are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1823 NaOH, solid, Hazard class: 8; Labels: 8-Corrosive material. UN1824 NaOH, solution, Hazard class: 8; Labels: 8-Corrosive material.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Wear protective clothing. For the solid, sweep into large vessel containing a large amount of water. Neutralize with weak hydrochloric acid. For solution, neutralize with weak hydrochloric acid. Pick up with mop or water vacuum. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. NaOH itself does not burn, but it is a strong oxidizer and may ignite combustibles, such as wood, paper, oil, etc. Thermal decomposition products may include sodium oxide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Discharge into tank containing water, neutralize, then flush to sewer with water.

References

(31); (173); (2); (173); (101); (138); (80); (100).

National Institute for Occupational Safety and Health (NIOSH), *Criteria for a Recommended Standard: Occupational Exposure to* NaOH, NIOSH Document Number 76-105, Cincinnati, OH (1976).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 4, No. 3, 85−89 (1984).

New York State Department of Health, *Chemical Fact Sheet:* NaOH, Bureau of Toxic Substance Assessment, Albany, NY (February 1986 and Version 3).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* NaOH, Trenton, NJ (May 2001).

Sodium Methanearsonate S:0505

Formula: $CH_5AsO_3 \cdot Na$
Synonyms: Ansar-6.6; Ansar-70L; Ansar-170; Ansar-529-HC; Arsonate; Arsenic acid, methyl-, monosodium salt; Bueno; Bueno 6; Daconate; Daconate 6; Dal-E-Rad; Dal-E-Rad-120; Gepiron; Herb-All; Merge; Merge 823; Mesamate; Mesamate-400; Mesamate-600; Mesamate concentrate; Mesamate-HC; Methanearsonic acid, monosodium salt; Methylarsonic acid, sodium salt; Methylarsonat monosodny; Monate; Monosodium acid methanearsonate; Monosodium acid metharsonate; Monosodium methanearsonate; Monosodium methanearsonic acid; Monosodium methylarsonate; MSMA; NCI-C60071; Phyban; Phyban H.C.; Silvisar 550; Sodium acid methanearsonate; Target MSMA; Transvert; Weed-108; Weed Hoe-108
CAS Registry Number: 2163-80-6; 5967-62-4 (hexahydrate)
HSDB Number: 754
RTECS Number: PA2625000
UN/NA & ERG Number: UN2994 (liquid)/151; UN3465 (Organoarsenic compound, solid, n.o.s.)/151
EC Number: 218-495-9
Regulatory Authority and Advisory Information
Carcinogenicity: EPA, Not likely to be carcinogenic to humans
Hazard Alert: Poison, Suspected reprotoxic hazard, Agricultural chemical, Environmental hazard.
CLEAN AIR ACT: Hazardous Air Pollutants (Title I, Part A, Section 112) as arsenic compounds.
CLEAN WATER ACT: Toxic Pollutant (Section 401.15) as arsenic and compounds.
RCRA Section 261 Hazardous Constituents, RCRA Section 261 Hazardous Constituents, waste number D004 (arsenic compounds)
EPCRA Section 304 RQ: CERCLA, 1 lb (0.454 kg).
EPCRA (Section 313): Includes any unique chemical substance that contains arsenic as part of that chemical's infrastructure. Form R *de minimus* concentration reporting level: (inorganics) 0.1%.; organics 1.0%. Form R, Toxic Chemical Category Code: N020
United States DOT Regulated marine pollutant (49CFR172.101, Appendix B) as arsenates, liquid, n.o.s.; arsenates, solid, n.o.s.; arsenical pesticides liquid, toxic, flammable, n.o.s.
Hazardous to aquatic life or environment, with possible long-lasting effects[291]. Do not allow release to the environment unless proper permits are obtained from the federal government.
Hazard symbols, risk, & safety statements: Hazard symbol: T, N, Xn; risk phrases: R22; R23/25; R31; R50/53; R63; safety phrases: S2; S20/21; S28; S29/35; S45; S46; S60; S61; S41 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]
Description: Colorless solid or colorless to red or green solution. Odorless. Specific Gravity: (DSMA) 1.0 @ 20°C; (MSMA solutions) 1.4−1.6 @ 20°C (liquid); molecular weight: 161.96; boiling point: Decomposes; melting point: 235 to 241F (NTP, 1992). Solid may float or sink in water; solid; solutions mix with water; solubility: greater than or equal to 100 mg/mL @ 25°C.
Potential Exposure: Those exposed to this organometallic, selective pesticide used for postemergence control of grasses, sedges, and weeds.
Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Incompatible with reducing agents.
Permissible Exposure Limits in Air:
Arsenic, organic compounds
OSHA PEL: 0.5 mg[As]/m^3 TWA
NIOSH REL: Not established. See NIOSH Pocket Guide, Appendix A
ACGIH TLV[1]: 0.01 mg[As]/m^3 TWA; Confirmed Human Carcinogen; BEI established.
PAC Ver. 27, no values found in Ver. 29[138]
PAC-1: 1.1 milligram per cubic meter
PAC-2: 4 milligram per cubic meter
PAC-3: 510 milligram per cubic meter
Determination in Air: Filter; Reagent: Ion chromatography/hydride atomic absorption: NIOSH IV [#5022, Arsenic, organo-][18].
Permissible Concentration in Water: EPA[6] recommends a zero concentration of arsenic for human health reasons. Federal Drinking Water Guidelines: EPA 10 μg/L; State Drinking Water Guidelines: Arizona 10 μg/L; Connecticut 10 μg/L. Toxic pollutant designated pursuant to section 307 (a) (1) of the Clean Water Act and is subject to effluent limitations (arsenic and inorganic and organic arsenic) [40 CFR 401.15 (7/1/1987)]. Canadian Drinking Water Standards: IMAC 0.025 [As] mg/L. Runoff from spills or fire control may cause water pollution.
Determination in Water: See OSHA Analytical Method ID-105 for arsenic. The atomic absorption graphite furnace technique is often used for measurement of total arsenic in water. It also has been standardized by EPA. Total arsenic may be determined by digestion followed by silver diethyldithiocarbamate; an alternative is atomic absorption; another is ICP optical emission spectrometry.
Routes of Entry: Ingestion, inhalation, skin or eye contact.
Harmful Effects and Symptoms
Short-Term Exposure: Toxic, may be fatal if inhaled, swallowed, or absorbed through skin. Avoid any skin or eye contact. Effects of contact or inhalation may be delayed. LD_{50}(oral-rat) = 700 mg/kg.
Long Term Exposure; Suspected reprotoxic hazard.
Points of Attack: Eye and skin irritant.
Medical Surveillance: Test for urine arsenic (may not be accurate within 2 days of eating shellfish or fish; most

accurate at the end of a work-day). Levels should not be greater than 100 μg/g of creatinine in the urine. Examine the skin for abnormal growths. Liver and kidney function tests. Before first exposure and every 6−12 months thereafter, a medical history and exam are recommended, including: exam of the nose, skin eyes, nails, and nervous system. Employees shall be counseled by the physician to ensure that employee is aware that this chemical may affect the reproductive system. In addition to comprehensive initial medical and work histories emphasizing reproductive experience and menstrual history, patient should have physical examination and testing of genito-urinary tract, sperm count, motility and morphology. If required, other tests, such as serum testosterone, serum follicle stimulating hormone, and serum luteinizing hormone (LH) may be indicated.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: For severe poisoning, BAL, Dimercaprol, dithiopropanol ($C_3H_8OS_2$) has been used to treat toxic symptoms of certain heavy metals poisoning—including arsenic. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5). For milder poisoning *penicillamine (not penicillin)* has been used, both with mixed success. Side effects occur with such treatment and it is never a substitute for controlling exposure. It can only be done under strict medical care.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Eye protection is included in the recommended respiratory protection. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Specific engineering controls are required under OSHA 1910.1018, *Inorganic Arsenic.* See also NIOSH Criteria Document #75-149, *Inorganic Arsenic.*

Respirator Selection: *At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFAg100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with arsenic compounds all handlers should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Store in tightly closed containers in a cool, well-ventilated area away from oxidizing agents; chemically active metals; strong bases; moisture, fertilizers, seeds, insecticides, and fungicides.

Shipping: UN2994 Arsenical pesticides, liquid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN3280 Organoarsenic compound, liquid, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required, Potential Inhalation Hazard (Special Provision 5).

Spill Handling:

Organoarsenic compound, solid or liquid

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30

Then: Protect persons downwind (mi/km)

Day 0.1/0.2

Night 0.5/0.8

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 500/60

Then: Protect persons downwind (mi/km)

Day 1.1/1.8
Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Stay upwind; keep out of low areas. Wear self-contained (positive pressure if available) breathing apparatus and full protective clothing. Do not touch spilled material; stop leak if you can do it without risk. *Small liquid spills:* take up with sand or other noncombustible absorbent material into clean, dry container and cover; move containers from spill area. *Large spills:* dike far ahead of spill for later disposal. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area of spill or leak after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Noncombustible, substance itself does not burn but may decompose upon heating to produce corrosive and/or toxic fumes, including arsenic and oxides of carbon. Containers may explode when heated. Runoff from fire control or dilution water may be corrosive and/or toxic and may cause pollution. Runoff may pollute waterways. If tank, rail car or tank truck is involved in a fire, ISOLATE for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. Small Fire: Use dry chemical, CO_2 or water spray. *Large Fire*: Water spray, fog or regular foam. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal; do not scatter the material. Use water spray or fog; do not use straight streams. *Fire involving Tanks or Car/Trailer Loads:* Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Do not get water inside containers. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. *Always* stay away from tanks engulfed in fire. For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn. *Do not* get water inside containers.

Disposal Method Suggested: Disposal of unused product must be undertaken by qualified personnel who are knowledgeable in all applicable regulations and follow all pertinent safety precautions including the use of appropriate protective equipment. For proper handling and disposal, always comply with federal, state, and local regulations.

References

(31); (173); (101); (138). (100).

Sodium Metabisulfite S:0510

Formula: $O_5S_2 \cdot 2Na$; $Na_2S_2O_5$

Synonyms: Disodium disulfite; Disodium disulfite; Disodium pyrosulfite; Disulfurous acid, disodium salt; Pyrosulfurous acid, sodium salt; Sodium disulfite; Sodium metabisulfite; Sodium metabisulfite; Sodium pyrosulfite

CAS Registry Number: 7681-57-4; *(alt.)* 7757-74-6; *(alt.)* 15771-29-6

HSDB Number: 378

RTECS Number: UX8225000

UN/NA & ERG Number: UN1759/154; UN2693 (solution)/154

EC Number: 231-673-0 [*Annex I Index No.:* 016-063-00-2] (disodium disulfite)

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Inadequate Evidence; Human Inadequate Evidence*, not classifiable as carcinogenic to humans*, Group 3, 1992. United States Environmental Protection Agency Gene-Tox Program, Negative: TRP reversion.

Hazard Alert: Possible risk of forming tumors, Sensitization hazard, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction).

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: Xn; risk phrases: R22; R31; R32; R36; R41; R43; R62; R63; safety phrases: S2; S25; S26; S39; 46 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Sodium metabisulfite is a white crystalline powder. Sulfur dioxide odor. It may be considered the anhydride of 2 molecules of sodium disulfite. Molecular weight = 190.1; specific gravity (H_2O:1) = 1.40 @ 25°C; boiling point = (decomposes); freezing/melting point = (decomposes) $\geq 150°C$. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 0, reactivity 0₩. Soluble in water; solubility = 54%; forms a corrosive acid with water.

Potential Exposure: Sodium metabisulfite is used as an antioxidant in pharmaceutical preparations and as a preservative in foods. People with asthma have a greater chance of having an allergic reaction with this chemical. Individuals allergic to *sodium bisulfite* (a food preservative found in some wine, fresh shrimp; packaged foods; and restaurant salads and potatoes) may have a severe reaction when exposed to sodium metabisulfite.

Incompatibilities: A strong reducing agent. Keep away from oxidizers. Mixtures with water forms a strong corrosive. Contact with acids releases toxic fumes. Heat causes decomposition. Slowly oxidized to the sulfate on exposure to air and moisture. Attacks metals.

Permissible Exposure Limits in Air
OSHA PEL: None
NIOSH REL: 5 milligram per cubic meter TWA
ACGIH TLV[1]: 5 milligram per cubic meter TWA; not classifiable as a human carcinogen
PAC Ver. 29[138]
PAC-1: 15 milligram per cubic meter
PAC-2: 64 milligram per cubic meter
PAC-3: 390 milligram per cubic meter
DFG MAK: Sensitizing substances as sulfites
Australia: TWA 5 milligram per cubic meter, 1993; Belgium: TWA 5 milligram per cubic meter, 1993; Denmark: TWA 5 milligram per cubic meter, 1999; France: VME 5 milligram per cubic meter, 1999; Norway: TWA 5 milligram per cubic meter, 1999; Switzerland: MAK-W 5 milligram per cubic meter, 1999; United Kingdom: TWA 5 milligram per cubic meter, 2000; the Netherlands: MAC-TGG 5 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Several states have set guidelines or standards for sodium metabisulfite in ambient air[60] ranging from 50.0 μ/m^3 (North Dakota); to 80.0 μ/m^3 (Virginia); to 100.0 μ/m^3 (Connecticut); to 119.0 μ/m^3 (Nevada).

Determination in Air: Filter; none; Gravimetric; NIOSH Analytical Method (IV) #0500, Particulates NOR, total dust.

Routes of Entry: Inhalation, skin and/or eye contact, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Sodium metabisulfite can affect you when breathed in. Exposure can irritate the nose, throat and sinuses. It can also irritate the lungs, causing coughing, wheezing, and shortness of breath. Very severe general (anaphylactic) reactions can also occur in those allergic to sodium metabisulfite that can be fatal. Contact can irritate the skin.

Long-Term Exposure: Sodium metabisulfite may cause an asthma-like allergy. Future exposures can cause asthma attacks with cough, shortness of breath; wheezing, and/or chest tightness. Can cause lung irritation; bronchitis may develop.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater) the following are recommended before beginning work and at regular times after that. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose lung or skin allergy.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures *over 5 milligram per cubic meter*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand, or other positive-pressure mode.

Storage: (1) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. (2) Color code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from combustible materials, such as wood and paper. DOT requires sodium metabisulfite to be packed in earthenware; glass, metal, or plastic during transport.

Shipping: UN1759 Corrosive solids, n.o.s., Hazard class: 8; Labels: 8-Corrosive material, Technical Name required. UN2693 Bisulfites, inorganic, aqueous solutions, n.o.s., Hazard class: 8; Labels: 8-Corrosive material.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Sodium metabisulfite may burn, but does not readily ignite. Thermal decomposition products may include sulfur and sodium oxides. Use dry chemical, CO_2, water spray; or foam extinguishers. Sodium metabisulfite may ignite nearby combustible materials. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Sodium Metabisulfite, Trenton, NJ (August 2005).

Sodium Pentachlorophenate S:0520

Formula: C_6Cl_5NaO; C_6Cl_5ONa

Synonyms: AI3-16418; Dow dormant fungicide; Dowicide G; Dowicide G-ST; GR 48-11PS; GR 48-32S; Napclor-G; PCP-sodium; PCP sodium salt; Pentachlorophenate sodium; Pentachlorophenol, sodium salt; Pentachlorophenoxy sodium; Pentaclorofenato sodico (Spanish); Pentaphenate; Phenol, pentachloro-, sodium salt; Phenol, pentachloro-, sodium salt, monohydrate; PKHFN; Santobrite; Santobrite D; Sodium PCP; Sodium pentachlorophenol; Sodium pentachlorophenolate; Sodium pentachlorophenoxide; Sodium, (pentachlorophenoxy)-; Sodium pentachlorphenate; Weedbeads

CAS Registry Number: 131-52-2

HSDB Number: 761

RTECS Number: SM6490000

UN/NA & ERG Number: UN2567/154

EC Number: 205-025-2 [*Annex I Index No.:* 604-003-00-3]

Regulatory Authority and Advisory Information

United States Environmental Protection Agency Gene-Tox Program, Positive: *Bacillus subtilis* rec assay; Inconclusive: *D. melanogaster* sex-linked lethal.

Hazard Alert: Poison, Suspected of causing genetic defects, Suspected reprotoxic hazard, Environmental hazard.

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): F027

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, N; risk phrases: R24/24; R26; R36/37/38; R40; R50/53; R62; R63; safety phrases: S1/2; S28; S28; S52; S41; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Sodium pentachlorophenate is a crystalline solid. Phenolic odor. Molecular weight = 288.3. Soluble in water; solubility = 33% @ 25°C.

Potential Exposure: Uses include: wood preservative; as a fungicide in water-based latex paints; preservation of cellulose products, textiles, adhesives, leather, pulp, paper, and industrial waste systems; a contact and preemergence herbicide; general disinfectant and control of the intermediate snail host of schistosomiasis. The technical grade of sodium pentachlorophenate usually contain toxic micro-contaminants including polychlorinated dibenzodioxins and dibenzofurans (132-64-9, and others).

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 0.22 milligram per cubic meter

PAC-2: 2.4 milligram per cubic meter

PAC-3: 8.4 milligram per cubic meter

Russia[43] set a MAC of 0.1 milligram per cubic meter in work-place air and MAC values for ambient air in residential areas as follows: 0.005 milligram per cubic meter on a momentary basis and 0.001 milligram per cubic meter on a daily average basis.

Determination in Air: No method available.

Permissible Concentration in Water: Russia[43] a MAC in water bodies used for domestic purposes of 5 milligram per cubic meter and in water bodies used for fishery purposes of 0.0005 mg/L.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Exposure to fine dusts or sprays cause burning in eyes and painful irritation in upper respiratory tract. If inhaled, it will induce violent coughing and sneezing. Skin irritation results from brief exposures, causing a burning sensation or rash. Symptoms of severe systemic intoxication include loss of appetite; respiratory difficulties; anesthesia, fever, sweating, difficulty in breathing, and rapidly progressive coma. Severe intoxications, including fatalities, have been reported from uncontrolled use. This compound causes inflamed gastric mucosa, congestion of the lungs; edema in the brain; cardiac dilatation; degeneration of the liver and kidneys. Individuals suffering from kidney and liver diseases have a lowered resistance and should not be exposed.

Long-Term Exposure: May cause skin allergy. May cause anemia. May damage the liver and kidneys. Repeated exposure can cause headache, weakness, sweating, fever, muscle twitching; dizziness, confusion, and death.

Points of Attack: Skin. blood, liver, kidneys.

Medical Surveillance: CBC. Liver and kidney function tests. Evaluation by a qualified allergist.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Where possible, automatically transfer material from drums or other storage containers to process containers Sources of ignition, such as smoking and open flames are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN2567 Sodium pentachlorophenate, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Ventilate area of spill. Collect spilled material in most convenient manner and deposit in sealed containers for later disposal. Liquids should be absorbed in vermiculite, dry sand; earth, or similar material. Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Do not touch spilled material; stop leak if you can do so without risk. *Small spills:* absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills:* with clean shovel, place material into clean, dry container and cover; move containers from spill area. *Large spills:* dike far ahead of spill for later disposal. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. It is noncombustible. Thermal decomposition products may include hydrogen chloride, chlorine and oxides of sodium and carbon. *For small fires*, use dry chemical, carbon dioxide; water spray; or foam. *For large fires*, use water spray, fog, or foam. Wear self-contained (positive pressure) breathing apparatus and full protective clothing. Move container from fire area if possible. Runoff from fire control or dilution water may cause pollution. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any

signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform to EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (173); (101); (138); (80); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 6, N0. 2, 5−30 (1986).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Sodium Pentachlorophenate, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Sodium Pentachlorophenate, Trenton, NJ (August 1999).

Sodium Permanganate S:0525

Formula: $MnO_4 \cdot Na$; $NaMnO_4$

Synonyms: Permanganato de sodio (Spanish); Permanganate de sodium (French); Permanganic acid, sodium salt; Sodium manganate

CAS Registry Number: 10101-50-5

HSDB Number: 762

RTECS Number: SD6650000

UN/NA & ERG Number: UN1503/140

EC Number: 233-251-1

Regulatory Authority and Advisory Information

Hazard Alert: Strong oxidizer, Neurotoxic (cumulative) as Mn, Environmental hazard.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112), as manganese compounds

List 2, DEA chemical code 6588 (Title 21 CFR1310.02)

Safe Drinking Water Act (47FR 9352): SMCL = 0.05 mg/L

EPA TSCA CHEMICAL INVENTORY Section 8(b) as manganese

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%, manganese compounds, Form R Toxic Chemical Category Code: N450

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. as manganese compounds, n.o.s.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: O, C, N; risk phrases: R8; R17; R34; R50/53; safety phrases: S17; S26; S29; S36/37/39; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: A reddish-black or purple crystalline solid. Molecular weight = 141.93; specific gravity (H_2O:1) = 1.972 @ 20°C. Soluble in water; solubility = > 850 g/L @ 20°C.

Potential Exposure: Used in medicine, as a disinfectant, and for many other uses: an oxidizer in reaction for making other chemicals, etchant for electronic boards; an antidote drug for chemical poisons

Incompatibilities: Oxidizers accelerates the burning of combustible material. Some may decompose explosively when heated or involved in a fire. May ignite combustibles: wood, paper, oil, organic matter, clothing, etc. Contact with finely divided metal may by explosive. May spontaneously ignite in contact with liquid combustible materials, hydrocarbons, benzene, fuels, diethyl ether, carbon disulfide. Incompatible with acetic anhydride, acetic acid. Contact with sulfuric acid may cause fires or explosions. Heat or contamination may cause explosion.

Permissible Exposure Limits in Air:

10101-50-5

PAC Ver. 29[138]

PAC-1: 7.8 milligram per cubic meter

PAC-2: 13 milligram per cubic meter

PAC-3: 78 milligram per cubic meter

Manganese:

NIOSH IDLH = 500 mg[Mn]/m^3

OSHA PEL: 5 mg[Mn]/m^3 Ceiling Concentration (inorganic compounds and fume)

NIOSH REL: 1 mg[Mn]/m^3 TWA; 3 mg[Mn]/m^3 STEL

ACGIH TLV[1] 0.02 mg[Mn]/m^3, respirable fraction; 0.1 mg[Mn]/m^3, inhalable fraction; not classifiable as a human carcinogen.

DFG MAK (*inorganic compounds and fume*): 0.5 mg[Mn]/m^3 inhalable fraction (Mn and its inorganic compounds); Pregnancy Risk Group C

Determination in Air: ***Manganese:*** Use NIOSH Analytical Method, Elements by ICP, #7300; #7301; #7303; #9102; Elements in blood or tissue, #8005; Metals in urine, #8310; OSHA Analytical Method, ID-125G or ID121.

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 50 μg[Mn]/L; State Drinking Water Standards: New York: 300 μg[Mn]/L; State Drinking Water Guidelines: California 500 μg[Mn]/L; Connecticut: 500 μg [Mn]/L; Maine: 500 μg[Mn]/L; Minnesota: 300 μg[Mn]/L; New Hampshire: 100 μg[Mn]/L. World Health Organization (WHO) limit: 400 μg(Mn)/L

Determination in Water: The manganese detection limit by direct flame atomization is 2 μg/L. However, solvent extraction is used for many determinations. Analytic conditions are more critical for the extraction of manganese than for most other metals, because many manganese-chelate complexes are unstable in solution. With pH control and immediate analysis after extraction, accurate determinations are possible. When the graphite furnace is used to increase sample atomization, the detection limit is lowered to 0.01 μg/L or ng/L according to NAS/NRC.

Routes of Entry: Inhalation, ingestion, eye and, skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: A severe skin, eye, and respiratory irritant. Inhalation, ingestion or skin or eyes contact with vapors or substance may cause severe injury, burns, or death. Hematological effects-acute, unspecified; Gastrointestinal tract-acute effects; Nervous system toxin-acute effects; Respiratory toxin-acute effects other than severe or moderate irritation; Respiratory irritant-acute, severe, or moderate but not mild irritant effects; Eye irritant-severe; Skin irritant-severe; Kidney-acute effects.

Long-Term Exposure: See manganese M:0250

Points of Attack: Respiratory system; CNS; lungs, blood, kidneys.

Medical Surveillance: NIOSH lists the following tests: whole blood (chemical/metabolite); biologic tissue/biopsy; CBC; chest X-ray; pulmonary function tests; urine (chemical/metabolite); urinalysis (routine). For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: A complete exam of the nervous system. CBC. Lung function tests. These may be normal if the person is not having an attack at the time of the test. Kidney function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. The symptoms of metal fume fever may be delayed for 4−12 hours following exposure: it may last less than 36 hours. Medical observation is recommended.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 10 milligram per cubic meter:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *Up to 25 milligram per cubic meter:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); PaprHie (APF = 25) (any powered air-purifying respirator with a high-efficiency particulate filter). *Up to 50 milligram per cubic meter:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 500 milligram per cubic meter:* Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); SCBA (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Check oxygen content prior to entering storage area. Color code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially organic materials, flammables and combustibles, and other incompatible materials. Oxidizers, including oxidizing gases, should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from ammonium compounds, hydrated salts; moisture and combustible materials. Where possible, automatically transfer material from drums or other storage containers to process containers. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Store in a cool, well-ventilated area away from incompatible materials listed above. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage.

Shipping: UN1503 Sodium Permanganate, Hazard Class: 5.1; Labels: 5.1-Oxidizer. PG2

Spill Handling: As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 m/150 ft for liquids and at least 25 m/75 ft for solids. *Large spill:* Consider initial downwind evacuation for at least 100 m/330 ft. Stay upwind and uphill. Isolate the area of release or fire and deny entry. Keep material away from combustible materials, fuels, etc. Remove all ignition sources. If material or contaminated runoff from fire control enters waterways, notify downstream users of potentially contaminated water. Keep combustibles (wood, paper, oil, etc.) away from spilled material. *Small dry spill:* Use clean shovel to collect material and place material into loosely covered *dry* containers for later disposal. *Small Liquid Spill:* Use noncombustible material like vermiculite, sand, or earth to soak up material and place in a container for later disposal. *Large Spill:* Dike far ahead of spill for later disposal. Following product recovery, flush with water. Prevent material and runoff from entering sewers and waterways if it can be done safely well ahead of the release. Ventilate confined area if it can be done without placing personnel at risk.

Fire Extinguishing: Thermal decomposition products may include oxides of sodium and manganese metal. If tank, rail car or tank truck is involved in a fire, ISOLATE for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. Containers may explode when heated. Runoff from fire control or dilution water may cause pollution) may create fire/explosion hazard or pollution. *Small fire*: Use water. Do not use dry chemicals or foams. CO_2 or Halon may provide limited control. *Large fire*: Flood area with water from a distance. Move containers from fire area it can be done without risk. Do not move cargo or vehicle if cargo has been exposed to heat. If material is not leaking, cool exposed containers with large quantities of water from unattended equipment or remove intact containers if it can be done safely. *Do not allow water to get inside containers*. If cooling streams are ineffective (*venting sound increases in volume and pitch, tank discolors or shows signs of deforming*), withdraw immediately to a secure location. Always stay away from ends of tanks, especially when engulfed in flames. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156.

Disposal Method Suggested: Generators of waste (equal to or greater than 100 kg/mo) containing this contaminant, EPA hazardous waste number N450, must conform to USEPA regulations for storage, transportation, treatment and disposal of waste. Dispose of waste material as hazardous waste using a licensed disposal contractor to an approved landfill. Dispose of contents and container to an approved waste disposal plant. Containers must be disposed of properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office. All federal, state, and local environmental regulations must be observed. Do not discharge into drains or sewers.

References

(31); (173); (101); (138). (2); (100).

Sodium Selenite S:0530

Formula: Na_2O_3Se; Na_2SeO_3

Synonyms: Disodium selenite; Natriumselenit (German); Selenious acid, Disodium salt; Selenito sodico (Spanish)

CAS Registry Number: 10102-18-8

HSDB Number: 768

RTECS Number: VS73500000

UN/NA & ERG Number: UN2630/151

EC Number: 233-267-9 [*Annex I Index No.:* 034-003-00-3]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Inadequate Evidence Group 3, 1987. United States Environmental Protection Agency Gene-Tox Program, Positive: Histidine reversion-Ames test; Positive/dose response: In vitro SCE-human lymphocytes; Positive/dose response: In vitro SCE-human; Positive/dose response: In vitro UDS-human fibroblast.

Hazard Alert: Poison, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Sensitization hazard, Environmental hazard.

NTP: Toxicity studies, Report TOX-38, October, 2000

United States National Primary Drinking Water Regulations: MCLG = 0.05 mg[Se]/L; MCL = 0.05 mg[Se]/L as selenium

CLEAN WATER ACT: Section 307 Toxic Pollutants as selenium and compounds.

RCRA Section 261 Hazardous Constituents., as selenium compounds, n.o.s.

EPCRA Section 313: Includes any unique chemical substance that contains selenium as part of that chemical's infrastructure. Form R *de minimus* concentration reporting level: 1.0%. Form R Toxic Chemical Category Code: N725

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg)[72]

Hazardous Substance RQ = 100 lb (45.4 kg)[4]

Priority Toxic Pollutant (EPA)[6]

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects[293]. Toxic to aquatic life with long-lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, N, Xi; risk phrases: R23; R28; R31; R43; R51/53; R62; R63; safety phrases: S1/2; S28; S29/35; S36/37; S45; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Sodium selenite is a white crystalline substance. Molecular weight = 172.94; freezing/melting point = (decomposes) 320°C; 710°C[138]. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 0. Highly soluble in water; solubility = > 80% @ 20°C.

Potential Exposure: Sodium selenite is used in glass manufacturing and as an alkaloidal reagent; for removing green color from glass during its manufacture; alkaloidal reagent; reagent in bacteriology; testing germination of seeds; decorating porcelain; as a livestock feed additive.

Incompatibilities: The aqueous solution is a medium strong base. Reacts with water, strong acids; hot surfaces; causing decomposition and a toxic hazard.

Permissible Exposure Limits in Air
NIOSH IDLH = 1 mg [Se]/m^3
OSHA PEL: 0.2 mg[Se]/m^3 TWA
NIOSH REL: 0.2 mg[Se]/m^3 TWA
ACGIH TLV[1]: 0.2 mg[Se]/m^3 TWA
PAC Ver. 29[138]
PAC-1: 1.3 milligram per cubic meter
PAC-2: 2.3 milligram per cubic meter
PAC-3: 3.1 milligram per cubic meter
DFG MAK: 0.05 mg[Se]/m^3 inhalable fraction; Carcinogen Category 3; Pregnancy Risk Group C

Arab Republic of Egypt: TWA 0.2 mg[Se]/m^3, 1993; Australia: TWA 0.2 mg[Se]/m^3, 1993; Austria: MAK 0.1 mg[Se]/m^3, 1999; Belgium: TWA 0.2 mg[Se]/m^3, 1993; Denmark: TWA 0.1 mg[Se]/m^3, 1999; Finland: TWA 0.1 mg[Se]/m^3; STEL 0.3 mg[Se]/m^3, 1999; Hungary: STEL 0.1 mg[Se]/m^3, 1993; Norway: TWA 0.1 mg[Se]/m^3, 1999; the Philippines: TWA 0.2 mg[Se]/m^3, 1993; Poland: MAC (TWA) 0.1 mg[Se]/m^3, 1993; Sweden: NGV 0.1 mg [Se]/m^3, 1999; Switzerland: MAK-W 0.1 mg[Se]/m^3, 1999; Turkey: TWA 0.2 mg[Se]/m^3, 1993; United Kingdom: TWA 0.1 mg[Se]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 0.2 mg[Se]/m^3. Russia[43] set a MAC in ambient air in residential areas of 0.1 μ/m^3 on a momentary basis and 0.05 μ/m^3 on a daily average basis.

Permissible Concentration in Water: Safe Drinking Water Act (47FR 9352): MCLG = 0.05 mg[Se]/L; MCL = 0.05 mg[Se]/L as selenium. State Drinking Water Standards: Arizona 10 μg[Se]/L; New York 10 μg[Se]/L; State Drinking Water Guidelines: Arizona 45 μg[Se]/L; Connecticut 10 μg[Se]/L; Maine 35 μg[Se]/L; Minnesota 30 μg[Se]/L.

Routes of Entry: Inhalation, ingestion, eye, and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin, and the respiratory tract. Inhalation of the dust can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. May affect the liver, kidneys, heart, nervous system, and gastrointestinal tract. *Inhalation:* Dust or fumes can cause irritation of the nose, throat, and lungs; nausea, vomiting, intestinal disturbance; garlic odor on breath; headache, fatigue and irritability. *Skin:* Can cause irritation, burning, and red or yellow discoloration. *Eyes:* Can cause irritation and injury. *Ingestion:* Can cause nausea, vomiting, abdominal pain; diarrhea, metallic taste, and garlic odor on breath. Elemental selenium has low acute systemic toxicity, but dust or fumes can cause serious irritation of the respiratory tract. In humans, a concentration of 5 ppm in food or 0.5 ppm in milk or water has been estimated to be dangerous (selenium compounds). Animal studies suggest that the lethal dose for an adult may be as low as 1/200 oz.

Long-Term Exposure: Long-term exposure to selenium compounds may be a cause of amyotrophic lateral sclerosis in humans. Repeated or prolonged contact may cause skin dermatitis. May affect the CNS; blood, teeth, and bones. May cause nervousness, depression, pallor, digestive disturbances. Kidney and liver damage may occur. Daily ingestion of 25 mg of sodium selenite; containing 4−5 selenium, after 11 days showed signs of hair and fingernail loss, fatigue, nausea, vomiting, and garlic-breath.

Points of Attack: Liver, kidneys, heart, nervous system; gastrointestinal tract.

Medical Surveillance: Urine test for selenium (should be less than 100 μg/L of urine). Liver and kidney function tests. Examination of the nervous system. EKG.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Wear protective gloves when inducing vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Note to physician: For severe poisoning, *do not* use BAL, dimercaprol, dithiopropanol ($C_3H_8OS_2$) as it is contraindicated or ineffective in poisoning from selenium.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Change gloves frequently. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: For levels Up to 2 milligram per cubic meter use a respirator with full facepiece and dust and mist filters. For levels Up to 7.5 milligram per cubic meter use a powered air-purifying respirator with dust and mist filters or supplied-air respirator operated in continuous flow mode. For levels Up to 10 milligram per cubic meter use a high-efficiency particulate filter respirator with a full facepiece. For levels Up to 100 milligram per cubic meter use a Type C supplied-air respirator with a full facepiece operated in a positive-pressure mode. For levels above 100 milligram per cubic meter or use in areas of unknown concentrations use a self-contained Type C supplied-air respirator with an auxiliary SCBA, both with full facepiece and operated in a positive-pressure mode. For firefighting use a SCBA with a full facepiece operated in a positive-pressure mode. For escape from a contaminated area use a high-efficiency particulate filter respirator with a full facepiece or an escape SCBA with a full facepiece.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store at room temperature in water tight containers. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2630 Selenates or Selenites, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: May burn but will not ignite readily. Thermal decomposition products may include oxides of sodium and metal. *Small fires:* dry chemical carbon dioxide, water spray, or foam. *Large fires:* water spray, fog, or foam. Thermal decomposition products may include selenium and sodium oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Liquid or solid: make a strongly acidic solution using hydrochloric acid. Slowly add sodium sulfite to the cold solution. Stir mixture producing sulfur dioxide. Heat, forming dark-gray selenium and black tellurium. Let stand overnight. Filter and dry. Ship to supplier.

References

(31); (173); (101); (138); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 3, No. 0. 6, 75–77 (1983).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Sodium Selenite, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

New York State Department of Health, *Chemical Fact Sheet:* Sodium Selenite, Bureau of Toxic Substance Assessment, Albany, NY (April 1986 and Version 2).

Sodium Sulfate S:0540

Formula: Na_2O_4S; Na_2SO_4

Synonyms: Disodium sulfate; Glaubers salt; Natriumsulfat (German); Salt cake; Sodium sulfate; Sulfuric acid, Disodium salt; Trona

CAS Registry Number: 7757-82-6

HSDB Number: 5042

RTECS Number: WE1650000

EC Number: 231-820-9

Regulatory Authority and Advisory Information.

Hazard Alert: Poison, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard.

United States National Primary Drinking Water Regulations: SMCL = 250 mg[SO_4^{-2}]/L as Sulfate

Hazard symbols, risk, & safety statements: Hazard symbol: T; risk phrases: R62; R63;?; safety phrases: (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Sodium sulfate is a white crystalline solid. It frequently is found as the decahydrate. Molecular weight = 142.04; specific gravity(H_2O:1) = 2.7 @ 20°C; freezing/melting point = 888°C. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 0, reactivity 1. Soluble in water.

Potential Exposure: Sodium sulfate is used in the manufacture of glass; as a precipitating agent in the manufacture of silver emulsions; as an analytical reagent; in making ultramarine and paper pulp; in ceramic glazes and pharmaceuticals; as a food additive; and a filler in synthetic detergents.

Incompatibilities: Violent reaction with aluminum, magnesium. Attacks metals in the presence of moisture.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 9.8 milligram per cubic meter

PAC-2: 110 milligram per cubic meter

PAC-3: 650 milligram per cubic meter

Permissible Concentration in Water: Maryland[61] has set a guideline of 210 μg/L for sodium sulfate in drinking water.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: *Inhalation:* May cause irritation of nose and throat at high dust levels. *Skin:* No information found. *Eyes:* May cause irritation of nose and throat at high dust levels. *Ingestion:* Irritation of the digestive tract; vomiting and diarrhea may result from ingestion of 1/2 oz.

Long-Term Exposure: No information found.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/ manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Wear a dust mask if necessary.

Storage: Color code—Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Keep tightly closed in a cool place. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN2630 Selenates or Selenites, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. Thermal decomposition products may include sulfur oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Do not discharge waste sodium sulfate directly into sewers or surface waters. Recovered sodium sulfate may be disposed of by burial in a landfill.

References

(31); (173); (101); (138); (80); (100).

New York State Department of Health, *Chemical Fact Sheet:* Sodium Sulfate, Bureau of Toxic Substance Assessment, Albany, NY (March 1986).

Sodium Sulfite S:0550

Formula: Na_2O_3S; Na_2SO_3

Synonyms: Disodium sulfite; Sodium sulfite (2:1); Sodium sulfite, anhydrous; Sulftech; Sulfurous acid, Sodium salt (1:2)

CAS Registry Number: 7757-83-7; *(alt.)* 10579-83-6; 68135-69-3
HSDB Number: 5043
RTECS Number: WE2150000
UN/NA & ERG Number: UN3260/154
EC Number: 231-821-4

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human Inadequate Evidence; Animal Inadequate Evidence Group 3, 1992. United States Environmental Protection Agency Gene-Tox Program, Positive: *S. cerevisiae*-reversion.

Hazard Alert: Strong reducing agent, Sensitization hazard, Possible risk of forming tumors, Suspected reprotoxic hazard.

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xn; risk phrases: R22; R31; R36/37/38; R43; R63; safety phrases: S22; S24/25; S26; S36; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Sodium sulfite is a white crystalline solid. Molecular weight = 126.04; specific gravity (H_2O:1) = 2.63 @ 20°C; freezing/melting point = (decomposes) 538°C. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 0, reactivity 0. Highly soluble in water; aqueous solution is basic.

Potential Exposure: Sodium sulfite is used as a reducing agent; in boiler water treatment; food applications; in photographic developers and fixers; in bleaching of wool, paper, textiles, straw and silk; manufacture of dyes; dechlorination; preservation of meat, fruit and egg products; silvering of glass.

Incompatibilities: A strong reducing agent. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases. Reacts with strong acids producing toxic sulfur dioxide.

Permissible Exposure Limits in Air

PAC Ver. 29[138]
PAC-1: 11 milligram per cubic meter
PAC-2: 120 milligram per cubic meter
PAC-3: 710 milligram per cubic meter

Permissible Concentration in Water: Maryland[61] has set a guideline for sodium sulfite in drinking water of 100 μg/L.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: *Inhalation:* May cause asthmatic reactions Animal studies indicate that levels of 1 milligram per cubic meter may cause slight swelling of lung tissue and irritation. *Skin:* Corrosive. Causes irritation and burns. *Eyes:* Corrosive. Causes severe irritation and burns. *Ingestion:* Solutions cause gastric irritation by the liberation of sulfurous acid. Because of rapid oxidation to sulfate, sulfites are well tolerated until large doses are reached; then violent colic and diarrhea, circulatory disturbances; central nervous depression; and death can occur. Increased dosage will result in sudden, violent colic and diarrhea, circulatory disturbances; slowed breathing; fainting, rapid pulse; and death. The lethal dose may be about 10 g (about 1/3 oz).

Long-Term Exposure: Repeated or prolonged contact may cause skin sensitization. Repeated or prolonged inhalation exposure may cause asthma.

Points of Attack: Skin, lungs.

Medical Surveillance: Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: (1) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. (2) Color code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in a cool, dry location in closed containers.

Shipping: UN3260 Corrosive solid, acidic, inorganic, n.o.s., Hazard class: 8; Labels: 8-Corrosive material.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Nonflammable. Use agents suitable for surrounding fire. Decomposes at >538°C. Thermal decomposition products may include sulfur dioxide and oxides of sodium. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (80); (100).

New York State Department of Health, *Chemical Fact Sheet:* Sodium Sulfite, Bureau of Toxic Substance Assessment, Albany, NY (March 1986).

Sodium Tellurite S:0560

Formula: Na_2O_3Te; Na_2TeO_3

Synonyms: Sodium tellurate(IV); Telluric acid, disodium salt; Tellurous acid, disodium salt; Telurito sodico (Spanish)

CAS Registry Number: 10102-20-2

HSDB Number: 6441

RTECS Number: WY24500000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154; UN3284 (tellurium compound, n.o.s.)/151

EC Number: 233-268-4

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Reducing agent, Suspected of causing genetic defects

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 500 lb (227 kg)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T; risk phrases: R23/24/25; R62; safety phrases: S22; S36/37/39; S45 (see Appendix 4)

Description: Sodium tellurite is a white crystalline solid. Molecular weight = 221.6. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 0, reactivity 0. Slightly soluble in water.

Potential Exposure: Used in bacteriology and medicine. Formerly used as pesticide.

Incompatibilities: A weak reducing agent. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, cadmium, halogens. Reaction with oxidizers may generate heat and products that may be flammable, combustible, or otherwise reactive[101].

Permissible Exposure Limits in Air

NIOSH IDLH = 25 mg[Te]/m^3 OSHA PEL: 0.1 mg[Te]/m^3 TWA

NIOSH REL: 0.1 mg[Te]/m^3 TWA

ACGIH TLV[1]: 0.1 mg[Te]/m^3 TWA

PAC Ver. 29[138]

PAC-1: 1.8 milligram per cubic meter

PAC-2: 20 milligram per cubic meter

PAC-3: 120 milligram per cubic meter

DFG MAK: 0.1 mg[Te]/m^3, inhalable fraction

Australia: TWA 0.1 milligram per cubic meter, 1993; Austria: MAK 0.1 milligram per cubic meter, 1999; Belgium: TWA 0.1 milligram per cubic meter, 1993; Denmark: TWA 0.1 milligram per cubic meter, 1999; Finland: TWA 0.1 milligram per cubic meter, STEL 0.3 milligram per cubic meter, 1999; France: VME 0.1 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 0.1 mg[Te]/m^3, 2003; the Philippines: TWA 0.1 milligram per cubic meter, 1993; Poland: MAC (TWA) 0.01 milligram per cubic meter; MAC (STEL) 0.03 milligram per cubic meter, 1999; Sweden: NGV 0.1 milligram per cubic meter, 1999; Switzerland: MAK-W 0.1 milligram per cubic meter, KZG-W 0.5 milligram per cubic meter, 1999; Turkey: TWA 0.1 milligram per cubic meter, 1993; United Kingdom: TWA 0.1 milligram per cubic meter, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 0.1 mg[Te]/m^3. Several states have set guidelines or standards for tellurium in ambient air[60] ranging from 1.0 μ/m^3 (North Dakota); to 1.6 μ/m^3 (Virginia); to 2.0 μ/m^3 (Connecticut and Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #7900. See also #7300, Elements; #7301; #7303; #9102; OSHA Analytical Method ID-121.

Permissible Concentration in Water: EPA[32] has suggested a permissible ambient goal of 1.4 μg/L based on health effects. Russia[43] set a MAC for tellurium in water bodies used for domestic purposes of 0.01 mg/L.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the skin and eyes. Irritates the respiratory tract causing cough and wheezing. Tellurium compounds are both an oral and dermal toxic hazard. The material is toxic by ingestion. Oral ingestion of tellurium compounds is generally regarded as extremely toxic. The probable oral lethal dose is 5−50 mg/kg or between seven drops and one teaspoonful for a 70 kg (150 lb) person. Tellurium compounds are regarded as super toxic for skin exposures. Symptoms of exposure are as follows: sleepiness, fatigue, stupor; loss of appetite; nausea, vomiting, stomach pain; metallic taste; garlic odor of the breath and sweat; dryness of the mouth or excessive salivation; renal pain; bronchitis, irregular breathing; cyanosis, fatty degeneration of the liver; and unconsciousness.

Long-Term Exposure: Repeated or prolonged exposure to tellurium compounds may cause reproductive damage; liver and kidney damage; lung irritation. Bronchitis may develop with cough, phlegm, and/or shortness of breath.

Points of Attack: Liver, kidneys, lungs.

Medical Surveillance: Lung function tests, liver and kidney function tests.

First Aid: *Skin Contact:* Flood all areas of body that have contacted the substance with water. Don't wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others[52]. *Eye Contact:* Remove any contact lenses at once. Immediately flush eyes well with copious quantities of water or normal saline for at least 20−30 minutes. Seek medical attention. *Inhalation:* Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion:* If unconscious or convulsing, do not induce vomiting or give anything by mouth. Assure that victim's airway is open and lay him on his side with his head lower than his body and transport at once to a medical facility. If conscious and not convulsing, give a glass of water to dilute the substance. If medical advice is not readily available, consider inducing vomiting of this toxic material. Transport at once to a medical facility.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/ manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 0.5 milligram per cubic meter:* Q_m (APF = 25) (any quarter-mask respirator). *Up to 1 milligram per cubic meter:* 95QX [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *Up to 2.5 milligram per cubic meter:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *Up to 5 milligram per cubic meter:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 25 milligram per cubic meter:* Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in a refrigerator or a cool, dry place.

Shipping: UN3284 Tellurium compound, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling:

UN2811: *Isolation Distance, Spill*: 25 m/75 ft (NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during clean-up. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Thermal decomposition products including metal oxides of tellurium and sodium. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. Do not use halogens. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Sodium Tellurite, Washington, DC,(2). Chemical Emergency Preparedness Program (November 30, 1987).

(173); (101); (138).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Sodium Tellurite, Trenton, NJ (August 1999).

Soman (Agent GD) S:0565

Formula: $C_7H_{16}FO_2P$; $CH_3P(O)(F)OCH(CH_3)C(CH_3)_3$

Synonyms: EA 1210; Fluoromethylpinacolyloxyphosphine Oxide; GD (military designation); Methyl-fluoropinacolylphosphonate; Methyl-pinacolyloxyfluorophosphine oxide; Methyl-pinacolyloxyphosphonyl flouride; PFMP; Phosphonofluoridic acid, methyl-, 1,2,2-trimethylpropyl ester; Pinacolyl methylphosphonofluoridate; Pinacolyl methanefluorophosphonate; Pinacolyl methylfluorophosphonate; Pinacolyloxymethylphosphonyl flouride; Somain; Thickened GD; TGD; 1,2,2-Trimethylpropylmethylphosphonofluoridate; 1,2,2,-Trimethylpropoxyfluoromethyl phosphine oxide; Zoman

Chlorosoman

O-Pinacolyl methylphosphonochloridate; méthylphosphonochloridate de O-pinacolyle (French)

CAS Registry Number: 96-64-0; 50642-24-5; 7040-57-5 (Chlorosoman); 89254-46-6 (C−)−Soman)

HSDB Number: 6764

RTECS Number: TA8753000 (C−)−Soman)

UN/NA & ERG Number: (PIH) UN2810 (toxic liquid, organic, n.o.s.)/153

EC Number: Not assigned

Regulatory Authority

Department of Homeland Security Screening Threshold Quantity: *Theft hazard* CUM 100 g (*96-64-0; 7040-57-5 chloro-soman*).

Carcinogenicty: GD is not listed by the IARC, ACGIH, OSHA, or NTP as a carcinogen.

Hazard Alert: Poison inhalation hazard, Extremely toxic inhalation hazard, Dangerous nerve agent, Combustible, Dangerously water reactive, Possible Environmental hazard. Information on GD is limited.

United States DOT 49CFR172.101, Inhalation Hazard Chemical.

WGK[100] (German Aquatic Hazard Class): No value found. *Note*: Hydrolyzed by water forming hydrogen fluoride and the nontoxic phosphonic acid derivative.

Description: Soman (GD), a fluorinated organophosphorus compound. Exposure to soman can cause death in minutes. A fraction of an ounce (1 to 10 mL) of soman on the skin can be fatal[77]. When pure, GD is a colorless liquid with fruity odor. With impurities, or upon aging, GD is an amber to dark brown oily liquid with an odor of rotten fruit or camphor (like Vicks Vapo-Rub). *Do not rely on odor for detection; not everyone can smell low concentrations of this chemical.* Molecular weight = 182.2; boiling point = 198°C; 167−200°C; specific gravity (h20 = 1) = 1.022 @ 20°C; melting point: − 42°C; vapor pressure = 0.4 mmHg @ 25°C; vapor density (air = 1) = 6.3; volatility = 3900 milligram per cubic meter @ 25°C; flash point = 121°C (oc). Flammability limits: Unknown. Hazard identification (based on NFPA-704 M Rating System): Health 4, flammability 1, reactivity 0 ₩. Slightly soluble in water; reacts with (hydrolyzed by) water to form hydrofluoric acid and the nontoxic phosphonic acid derivative.

Thickened agent GD [TGD] is essential the same as GD except for viscosity. Viscosity = (approximately) 1180 centistokes uses "K125" (acryloid copolymer, 5%) to create TGD. K125 is not known to be a hazardous material except in a finely divided, powder form[92]. *Chlorosoman*: Molecular weight = 198.63.

Potential Exposure: Agent GD, an organic fluoride compound, is a quick-acting chemical warfare nerve agent (nerve gas). Medical treatment of soman is difficult because it permanently binds to receptors in the body in minutes. Large amounts of the vapor or liquid can hurt you in minutes, and can quickly lead to death.

Persistence of Chemical Agent: Soman (GD): Summer: 10 minutes to 24 hours; Winter: 2 hours to 3 days.

Incompatibilities: Hydrolyzed by water to form hydrogen fluoride and the nontoxic phosphonic acid derivative. It is rapidly hydrolyzed by dilute aqueous NaOH[101] Stable after storage in steel for 3 months @ 65°C. Raising the pH increases the rate of decomposition significantly. GD decomposes slowly in water; will hydrolyze to form HF-H-H-O-CH_3 and $(CH_3)_3$-C-C-O-P-OH. GD reacts readily with bases and weak acids. Under acid conditions, GD hydrolyzes, forming hydrofluoric acid (HF). Flammable hydrogen gas produced by the corrosive vapors reacting with metals, concrete, etc., may be present. Corrosive to steel and possibly other ferrous metals. GD corrodes steel at the rate of 1×10^{-5} in/month. When heated to decomposition or on contact with steam, it emits very toxic fumes of fluorides and oxides of phosphorus.

Permissible Exposure Limits in Air

IDLH: 0.05 milligram per cubic meter [United States Army]

PAC* Ver. 29[138]

96-64-0, Soman, GD; 7040-57-5, Chlorosoman

PAC-1: $\mathbf{0.00018_A}$ (1.80E − 04) ppm

PAC-2: $\mathbf{0.0022_A}$ ppm

PAC-3: $\mathbf{0.017_A}$ ppm

*AEGLs are marked with a subscript "**A**" and correspond to 60 minutes values.

Acute Exposure Guideline Level s (AEGLs)

Level 1-potential minor discomfort or noticeable effects; reversible

10 minutes—0.00049 ppm
30 minutes—0.00028 ppm
1 hour—0.0002 ppm
4 hours—0.0001 ppm
8 hours—0.00050 ppm

Level 2-potentially impacting functional abilities or ability to escape; potential delayed recovery

10 minutes—0.0062 ppm
30 minutes—0.0035 ppm
1 hours—0.0024 ppm
4 hours—0.0013 ppm
8 hours—0.00091 ppm

Level-3-Life threatening; level of potential initial fatalities

10 minutes—0.053 ppm
30 minutes—0.027 ppm
1 hours—0.018 ppm
4 hours—0.0098 ppm
8 hours—0.0071 ppm

The suggested permissible airborne exposure concentration of Soman (GD) for an 8 hours work-day or a 40 hours work week is an 8 hours TWA of 0.00003 milligram per cubic meter (2×10^{-5} ppm). This value is based on the TWA of GB as proposed in the USAEHA Technical Guide No. 169, *Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Nerve Agents GA, GB, GD, and VX*. Also, the general population limits (as recommended by the Surgeon General's Working Group, United States Department of Health): 0.000003 milligram per cubic meter.

Determination in Air: Available monitoring equipment for soman (GD) is the Automatic Chemical Agent Detector Alarm (ACADA), bubblers (GC method), and Chemical Agent Monitor (CAM).

Determination in Water: Octanol−water coefficient: Log K_{ow} (estimated) = 1.02:Log $K_{benzene\text{-}water}$ = 1.61. Soman dissolves in water and remains very dangerous. To prevent anyone from drinking water mixed with soman, notify local health and pollution control officials. Also, notify operators of nearby water intakes and advise shutting water intakes. Hydrolysis by acidic, neutral, and basic mechanisms; giving fluoride and pinacolyl methylphosphonate. Rapidly hydrolyzed in basic solutions e.g., Na_2CO_3, NaOH, or KOH) with a half-life of approximately 1 minute at pH 11 @ 25°C. Soman and its hydrolysis products exhibit no significant phototransformations in sunlight. Soman and its hydrolysis products are thermally stable at temperatures less than 49°C. Use M272 Chemical Agent Water Testing Kit. Detection limit for nerve agents is 0.02 mg/L. Bleaching powder (chlorinated lime) destroys soman but gives rise to cyanogen chloride (CAS: 506-77-4). See table of contents or name index for location of entry for: "Cyanogen chloride."

Routes of Entry: Skin absorption, absorption through eyes; and inhalation.

Harmful Effects and Symptoms

Soman (military designation GD) is one of the nerve agents, which are the most toxic of the known chemical warfare agents. It has an odor like camphor or rotting fruit. Exposure to soman can cause death in minutes. A fraction of an ounce (1 to 10 mL) of soman on the skin can be fatal. Nerve agents are chemically similar to organophosphate pesticides and exert their effects by interfering with the normal function of the nervous system[77].

Short-Term Exposure: Soman (GD) is a lethal anticholinesterase agent with the median lethal dose in humans being: LCt_{50} (inhalation) = 70 mg min/m^3 (t = 10 min); LD_{50} (PC, bare skin) = 0.35 g/man (70 kg). *One to several minutes following overexposure to airborne Soman (GD)* the following acute symptoms appear: *Local effects* (lasting 1−15 days, increase with dose): *Eyes:* Miosis (constriction of pupils); redness, pressure sensation on eyes. *Inhalation:* Rhinorrhea (runny nose), nasal congestion, tightness in chest; wheezing, salivation, nausea, vomiting. *Systemic effects* (increases with dose): When inhaled soman (GD) will cause excessive secretion causing coughing/breathing difficulty: salivation and sweating: vomiting, diarrhea, stomach cramps; involuntary urination/defecation; generalized muscle twitching/muscle cramps; CNS depression including anxiety, restlessness, giddiness, insomnia, excessive dreaming, and nightmares. With more severe exposure, also headache, tremor, drowsiness, concentration difficulty; memory impairment; confusion, unsteadiness on standing or walking; and progressing to death. After exposure to liquid soman (GD), the following acute symptoms appear: *Local effects*: *Eyes:* Miosis (constriction of pupils); redness, pressure sensation on eyes. *Ingestion:* salivation, anorexia, nausea, vomiting, abdominal cramps; diarrhea, involuntary defecation; heartburn. *Skin:* Sweating, muscle twitching. If recovery from nerve agent poisoning occurs, it will be complete unless anoxia or convulsions have gone unchecked so long that irreversible CNS changes due to anoxemia have occurred.

Long-Term Exposure: Limited data suggest delayed neuropathy (postural sway, psychomotor performance). Miosis has been noted Up to 62 days[92]. Chronic exposure to soman (GD) causes forgetfulness, thinking difficulty; vision disturbances; muscular aches/pains. Mild or moderately exposed people usually recover completely. Severely exposed people are not likely to survive. Unlike some organophosphate pesticides, nerve agents have not been associated with neurological problems lasting more than 1 to 2 weeks after the exposure. Although certain organophosphate pesticides have been shown to be teratogenic in animals, these effects have not been documented in carefully controlled toxicological evaluations for soman (GD). The inhibition of cholinesterase enzymes throughout the body by nerve agents is more or less irreversible so that their effects are prolonged. Until the tissue cholinesterase enzymes are restored to normal activity, probably by very slow regeneration over a period of weeks or 2 to 3 months if damage is severe, there is a period of increased susceptibility to the effects of another exposure to any nerve agent. During this period the effects of repeated exposures are cumulative; after a single exposure, daily exposure to concentrations of a nerve agent insufficient to produce symptoms may result in the onset of symptoms after several days. Continued daily exposure may be followed by increasingly severe effects. After symptoms subside, increased susceptibility persists for one to several days. The degree of exposure required to produce recurrence of symptoms, and the severity of these symptoms, depend on duration of exposure and time intervals between exposures. Increased susceptibility is not limited to the particular nerve agent initially absorbed. Agent GD is not listed by the IARC; ACGIH; OSHA; or NTP as a carcinogen.

Points of Attack: Respiratory system, lungs, CNS; cardiovascular system, skin, eyes, plasma, and red blood cell cholinesterase. Liver, kidneys.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Urine thiocyanate levels. CBC. Evaluation of thyroid function. Liver function tests. Kidney function tests. CNS tests. EKG.

First Aid: *Inhalation:* Hold breath until respiratory protective mask is donned. If severe signs of agent exposure appear (chest tightens; pupil constriction; a lack of coordination; etc.); immediately administer, in rapid succession, all three Nerve Agent Antidote Kit(s); Mark I injectors (or atropine if directed by the local physician). Injections using the Mark I kit injectors may be repeated @ 5 to 20 minute intervals if signs and symptoms are progressing until three series of injections have been administered. No more injections will be given unless directed by medical personnel. In addition, a record will be maintained of all injections given. If breathing has stopped, give artificial respiration. Mouth-to-mouth resuscitation should be used when approved mask-bag of oxygen delivery systems are not available. Do not use mouth-to-mouth resuscitation when facial contamination exists. If breathing is difficult, administer oxygen. Seek medical attention *Immediately*.

Eye contact: Immediately flush eyes with water for 10−15 minutes, then don respiratory protective mask. Although miosis (pinpointing of the pupils) may be an early sign of agent exposure, an injection will not be administered when miosis is the only sign present. Instead, the individual will be taken *immediately* to the medical treatment facility for observation. *Skin contact:* Don respiratory protective mask and remove contaminated clothing. Immediately wash contaminated skin with copious amounts of soap and water; 10% sodium carbonate solution, or 5% liquid household bleach. Rinse well with water to remove decontaminant. Administer nerve agent antidote kit, Mark I, only if local sweating and muscular twitching symptoms are present. Seek medical attention *Immediately*. *Ingestion:* Do not induce vomiting. First symptoms are likely to be gastrointestinal. *Immediately* administer Nerve Agent Antidote kit, Mark I. Seek medical attention immediately. If there is no apparent breathing, artificial resuscitation will be started immediately, but *do not* use mouth-to-mouth resuscitation when facial contamination exists; in this case, use mechanical resuscitator. The situation will dictate method of choice. When appropriate and trained personnel are available, CPR may be necessary.

Notes for physician and qualified medical personnel: An individual who has received a known agent exposure or who exhibits definite signs or symptoms of agent exposure shall be given an intramuscular injection immediately with the MARK I kit auto-injectors. Some of the early symptoms of a *vapor exposure* may be rhinorrhea (runny nose) and/or tightness in the chest with shortness of breath (bronchial constriction). Some of the early symptoms of a *percutaneous exposure* may be local muscular twitching or sweating at the area of exposure followed by nausea or vomiting. Although myosis (pin-pointing of the pupils) may be an early sign of agent exposure, an injection shall not be administered when myosis is the only sign present. Instead, the individual shall be taken immediately to the medical facility for observation. Injections using the MARK I kit injectors (or atropine only if directed by the local physician) may be repeated @ 5 to 20 minutes intervals if signs and symptoms are progressing until three series of injections have been administered. No more injections will be given unless directed by medical personnel. In addition, a record will be maintained of all injections given. Administer, in rapid succession, all three MARK I kit injectors (or atropine if directed by the local physician) in the case of SEVERE signs of agent exposure. If indicated, CPR should be started immediately. Mouth-to-mouth resuscitation should be used when approved mask-bag or oxygen delivery systems are not available. Do not use mouth-to-mouth resuscitation when facial contamination exists. *CAUTION:* atropine does not act as a prophylactic and shall not be administered until an agent exposure has been ascertained.

Medical treatment: ECG, and adequacy of respiration and ventilation, should be monitored. Supplemental oxygenation, frequent suctioning of secretions, insertion of a tube into the trachea (endotracheal intubation), and assisted ventilation may be required. Diazepam (5 to 10 mg in adults and 0.2 to 0.5 mg/kg in children) may be used to control convulsions. Lorazepam or other benzodiazepines may be used, but barbiturates, phenytoin, and other anticonvulsants are not effective. Administration of atropine (if not already given) should precede the administration of benzodiazepines in order to best control seizures. Patients/victims who have inhalation exposure and who complain of chest pain, chest tightness, or cough should be observed and examined periodically for 6 to 12 hours to detect delayed-onset inflammation of the large airways (bronchitis), inflammatory lung disease (pneumonia), accumulation of fluid in the lungs (pulmonary edema), or respiratory failure.

Decontamination: This is very important. The rapid physical removal of a chemical agent is essential. If you don't have the equipment and training, don't enter the hot or the warm zone to rescue and/or decontaminate victims. Medical personnel should wear the proper PPE. If the victim can't move, decontaminate without touching and without entering the hot or the warm zone. Nerve gasses stay in clothing; *do not* touch with bare skin—if possible, seal contaminated clothes and personal belongings in a sealed double bag. Use clean water from any source; if possible, use a hose (spray or fog to prevent injury to the victim) or other system to avoid touching the victim. Don't wait for soap or for the victim to remove clothing; begin washing immediately. Do not delay decontamination to obtain warm water; time is of the essence; use cold water instead. Immediately flush the eyes with water for at least 15 minutes. Use caution to avoid hypothermia in children and the elderly. Wash−strip−wash−evacuate up wind and uphill: Patients exposed to nerve agent by vapor only. should be decontaminated by removing all clothing in a clean-air environment; and shampooing or rinsing the hair to prevent vapor-off gassing; patients exposed to liquid nerve agent should be decontaminated by washing in available clean water at least three times. Use liquid soap (dispose of container after use and replace), large amounts of water, and mild to moderate friction with a single-use sponge or washcloth in the first and second washes. Scrubbing of exposed skin with a brush is discouraged; skin damage may occur and may increase absorption. The third wash should be to rinse with large amounts of warm or hot water. Shampoo can be used to wash the hair. Decontaminate with diluted household bleach* (0.5%, or one part bleach to 200 parts water), but don't let any get in the victim's eyes, open wounds, or mouth. Wash off the diluted bleach solution after 15 minutes. Remember that the water you use to decontaminate the victims is dangerous. Be sure you've decontaminated the victims as much as you can before they are released from the area, so they don't spread the nerve gas. Rinse the eyes, mucous membranes; or open wounds with sterile saline or water and then move away from the hot zone in an upwind and uphill direction.

**Note*: The following can be used in addition to household bleach: (1) solids, powders, and solutions containing various types of bleach (NaOCl or $Ca(OCl)_2$); (2) DS2 (2% NaOH, 70% diethylenetriamine, 28% ethylene glycol monomethyl ether); (3) towelettes moistened with NaOH (NaOH) dissolved in water, phenol, ethanol, and ammonia. *Note:* Use 5% solution of common bleach (sodium hypochlorite) or calcium hypochlorite solution (48 oz per 5 gal of water) to decontaminate scissors used in clothing removal, clothes, and other items.

Personal Protective Methods: *Protective gloves*: Butyl Glove M3 and M4; Norton chemical protective glove set. *Eye protection*: chemical goggles. For splash hazards use goggles and faceshield. *Other protective equipment*: Full protective clothing will consist of M9 mask and hood; butyl rubber suit (M3), M2A1 butyl boots; M3 and M4 gloves; unimpregnated underwear; or demilitarization protective ensemble (DPE). For laboratory operations; wear lab coats and have a protective mask readily available.

Respirator Selection: *When used as a weapon, use SCBA Respirator Certified By NIOSH For CBRN Environments.* Positive pressure, full facepiece, NIOSH/MSHA or European Standard EN 149-approved SCBA will be worn where there is danger of oxygen deficiency and when directed by the fire chief or CAI operations officer. The M9 or M17 series mask may be worn in lieu of SCBA when there is no danger of oxygen deficiency. In cases where firefighters are responding to a CAI for rescue/reconnaissance purposes they will wear appropriate levels of protective clothing.

From the Riegle Report

Less than 0.00003 milligram per cubic meter: M9, M17, or M40 series mask shall be available for escape as necessary. 0.00003 *milligram per cubic meter* to 0.06 *milligram per cubic meter:* M9 or M40 series mask with Level A or Level B ensemble. *Greater than 0.06 milligram per cubic meter:* or DPE or TAPES used with prior approval from AMC Field Safety Activity. *Note:* When DPE or TAPES is not available, the M9 or M40 series mask with Level A protective ensemble can be used. However, use time shall be restricted to the extent operationally feasible, and may not exceed 1 hour. As an additional precaution, the cuffs of the sleeves and the legs of the M3 suit shall be taped to the gloves and boots respectively to reduce aspiration.

Local Exhaust: Mandatory. Must be filtered or scrubbed to limit exit conc. to <0.00001 *milligram per cubic meter* (averaged over 8 hours/day, indefinitely).
Special: Chemical laboratory hoods shall have an average inward face velocity of 100 linear feet per minute (l fpm) + 10% with the velocity at any point not deviating from the average face velocity by more than 20%. Laboratory hoods shall be located such that cross-drafts do not exceed 20% of the inward face velocity. A visual performance test utilizing smoke-producing devices shall be performed in assessing the ability of the hood to contain agent GD. Emergency back-up power necessary: Hoods should be tested semi-annually or after modification or maintenance operations. Operations should be performed 20 cm inside hood face. *Other:* Recirculation of exhaust air from agent areas is prohibited. No connection between agent areas and other areas through ventilation system is permitted.

Storage: Color code—Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. In handling soman (GD), the "buddy system" will be incorporated. No smoking, eating, or drinking is permitted in areas containing agent GD. Containers should be periodically inspected for leaks (either visually or by a detector kit) and prior to transferring the containers from storage to work areas. Stringent control over all personnel practices must be exercised. Decontamination equipment shall be conveniently located. Exits must be designed to permit rapid evacuation. Chemical showers, eyewash stations, and personal cleanliness facilities shall be provided. Wash hands before meals and each worker will shower thoroughly with special attention given to hair, face, neck, and hands, using plenty of soap before leaving at the end of the work-day. *Other precautions:* Agent GD must be double-contained in liquid and vapor-tight containers when in storage or when outside of the ventilation hood.

Shipping: UN2810 Toxic liquids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poison Inhalation Hazard, Technical Name Required. Military driver shall be given full and complete information regarding shipment and conditions in case of emergency. AR 50-6 deals specifically with the shipment of chemical agents. Shipments of agent will be escorted in accordance with AR 740-32.

Spill Handling:
UN2810 Toxic liquids, organic, n.o.s.
Initial isolation and protective action distances
Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).
Small spills (From a small package or a small leak from a large package)
First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 0.7/1.2
Large spills (From a large package or from many small packages)
First: Isolate in all directions (ft/m) 1000/300
Then: Protect persons downwind (mi/km)
Day 1.1/1.8
Night 2.8/4.5
GD (when used as a weapon)
Small spills (From a small package or a small leak from a large package)
First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.3/0.5
Night 0.5/0.8
Large spills (From a large package or from many small packages)
First: Isolate in all directions (ft/m) 1000/300
Then: Protect persons downwind (mi/km)
Day 1.1/1.8
Night 1.7/2.7
Warn pollution control authorities and advise shutting water intakes. Spills must be contained by covering with vermiculite, diatomaceous earth; clay, fine sand; sponges and paper or cloth towels. This containment is followed by treatment with copious amounts of aqueous NaOH solution (a minimum of 10%). Scoop up all material and place in a fully removable head drum with a high density polyethylene liner. Cover the contents of the drum with decontaminating solution as above before affixing the drum head. After sealing the head, the exterior of the drum shall be decontaminated and then labeled in accordance with IAW EPA, and DOT regulations. All leaking containers shall be overpacked with vermiculite placed between the interior and exterior containers. Decontaminate and label in accordance with IAW, EPA, state, and DOT regulations. Dispose of material used to decontaminate exterior of drum in accordance with IAW Federal, state, and local regulations. Contaminated clothing will be placed in a fully removable head drum with a high density polyethylene liner and the contents shall be covered with decontaminating solution as above before affixing the drum head. Conduct general area monitoring to confirm that the atmospheric concentrations do not exceed the exposure limits (see Section 8). If 10% wt. aqueous NaOH solution is not available then the following decontaminants may be used instead and are listed in the order of preference: Decontaminating Solution No. 2 [DS2: (2% NaOH, 70% diethylenetriamine, 28% ethylene glycol monomethyl ether)], sodium carbonate, and STB.

Fire Extinguishing: Thermal decomposition products may include very toxic fumes of fluorides and oxides of phosphorus. When heated, vapors may form explosive mixture with air, presenting an explosion hazard indoors, outdoors, and in sewers. Containers may explode when heated. Fires involving soman (GD) should be contained to prevent contamination of uncontrolled areas. All persons not engaged in extinguishing the fire should be evacuated immediately. Contact with soman (GD) or its vapors can be fatal. When responding to a fire alarm in buildings or areas containing nerve agents, firefighting personnel should wear full firefighter protective clothing (without TAP clothing) during chemical agent firefighting and fire rescue operations. Respiratory protection is required. Positive pressure, full facepiece, NIOSH/MSHA or European Standard EN 149-approved SCBA will be worn where there is danger of oxygen deficiency and when directed by the fire chief or CAI operations officer. The M9 or M17 series mask may be worn in lieu of SCBA when there is no danger of oxygen deficiency. In cases where firefighters are responding to a CAI for rescue/reconnaissance purposes they will wear appropriate levels of protective clothing.

Disposal Method Suggested: Principles and methods for destruction of chemical weapons: "Destruction of chemical weapons" means a process by which chemicals are converted in an essentially irreversible way to a form unsuitable for production of chemical weapons, and which in an irreversible manner renders munitions and other devices unusable as such. Each nation shall determine how it shall destroy chemical weapons, except that the following processes may not be used: dumping in any body of water, land burial, or open-pit burning. It shall destroy chemical weapons only at specifically designated and appropriately designed and equipped facilities. Each nation/shall ensure that its chemical weapons destruction facilities are constructed and operated in a manner to ensure the destruction of the chemical weapons; and that the destruction process can be verified under the provisions of this Convention [Organization for the Prohibition of Chemical Weapons; Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and Their Destruction]. A minimum of 55 g of decontamination solution is required per gram of soman (GD). A minimum of 65 g of decontamination fluid per gram of soman (GD) is allowed to agitate for a minimum of 1 hour. Agitation is not necessary following the first hour provided a single phase is obtained. At the end of the first hour the pH should be checked and adjusted Up to 11.5 with additional NaOH as required. An alternate solution for the decontamination of soman (gd) is 10% sodium carbonate in place of the 10% NaOH solution above. Continue with 55 g of decon per gram of gd. Agitate for 1 hour and allow to react for 3 hours. At the end of the third hour, adjust the pH to above 10. It is also permitted to substitute 5.25% sodium hypochlorite for the 10% NaOH solution above. Continue with 55 g of decon per gram of soman (GD). Agitate for 1 hour and allow to react for 3 hours, then adjust the pH to above 10. Scoop up all material and place in a fully removable head and a high density polyethylene liner. Cover the contents with additional decontaminating solution before affixing the drum head. After sealing the head, the exterior of the drum shall be decontaminated and then labeled in accordance with IAW EPA, and DOT regulations. All contaminated clothing will be placed in a fully removable head drum with a high density polyethylene liner. Cover the contents of the drum with decontaminating solution as above before affixing the drum head. After sealing the head, the exterior of the drum shall be decontaminated and then labeled per IAW EPA, and DOT regulations. All leaking containers shall be overpacked with vermiculite placed between the interior and exterior containers. Decontaminate and label in accordance with IAW EPA, and DOT regulations. Conduct general area monitoring to confirm that the atmospheric concentrations do not exceed the exposure limits. *Waste disposal method*: Open pit burning or burying of soman (GD) or items containing or contaminated with soman (GD) in any quantity is prohibited. The detoxified soman (GD) (using procedures above) can be thermally destroyed by incineration in an EPA approved incinerator in accordance with appropriate provisions of federal, state and local RCRA regulations. *NOTE:* Several states define decontaminated surety material as a RCRA Hazardous Waste.

References

(31); (173); (101); (138); (85); (86); (87); (169); (92); (93); (94); (103); (105); (163); (176); (186); (187); (80); (100).

Stannic Chloride, Hydrated S:0570

Formula: $Cl_4H_{10}O_5Sn$; $SnCl_4 \cdot 5H_2O$

Synonyms: Stannic chloride pentahydrate; Tetrachlorostannane pentahydrate

CAS Registry Number: 7646-78-8; 10026-06-9 (hydrated)

HSDB Number: 781(7646-78-8)

RTECS Number: XP8870000

UN/NA & ERG Number: UN2440/154

EC Number: 050-001-00-5

Regulatory Authority and Advisory Information

Hazard Alert: Corrosive, Water and air reactive.

United States National Primary Drinking Water Regulations: SMCL = 250 mg[Cl^-]/L as Chloride

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: C; risk phrases: R22; R34; R35; R36/37/38; R40; R42; R50/53; R67; safety phrases: S7/8; S23; S36/37/39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Stannic chloride is a white to yellow powder with a faint odor of HCl. Molecular weight = 350.59; boiling point = 114°C; freezing/melting point = −33°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 1. ₩ Soluble in water; dangerously reactive releasing hydrochloric acid and dense white fumes.

Potential Exposure: Hydrated stannic chloride is used for fixing certain textile dyes, and for treating silk to give weight to the fabric.

Incompatibilities: Reacts violently with water, forming corrosive hydrochloric acid and tin oxide fumes. Reacts with turpentine, alcohols, and amines, causing fire and explosion hazard. Attacks many metals; some forms of plastics, rubber, and coatings. Reacts with moist air to form hydrochloric acid and dense white fume.

Permissible Exposure Limits in Air

NIOSH IDLH = 100 mg[Sn]/m^3
OSHA PEL: 2 mg[Sn]/m^3 TWA
NIOSH REL: 2 mg[Sn]/m^3 TWA
ACGIH TLV[1]: 2 mg[Sn]/m^3 TWA
DFG MAK: *tin, inorganic compounds:* No numerical value established. Data may be available.
PAC* Ver. 29[138]
7646-78-8, stannic chloride (for reference only), see also T:0550
PAC-1: 13 milligram per cubic meter
PAC-2: 150 milligram per cubic meter
PAC-3: 880 milligram per cubic meter

Permissible Concentration in Water: State Drinking Water Guidelines: Minnesota 4000 μg[Sn]/L.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Hydrated stannic chloride can affect you when breathed in. Corrosive the eyes, skin, and respiratory tract. Eye damage may be permanent. Breathing hydrated stannic chloride can irritate the throat and bronchial tubes, causing cough and/or difficulty breathing. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: Changes may occur on chest X-ray with repeated exposure; resulting in impaired lung functions. Tin may interfere with the body's ability to absorb iron from the diet or from vitamins, contributing to iron deficiency anemia.

Points of Attack: Lungs, blood.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended. Lung function tests. CBC. Hemoglobin or hematocrit. If acute breathing exposure to heated hydrated stannic chloride with chlorine gas is suspected, also consider chest X-ray.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA *Up to 10 milligram per cubic meter:* Q_m (APF = 25) (any quarter-mask respirator). *Up to 20 milligram per cubic meter:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa* (APF = 10) (any supplied-air respirator). *Up to 50 milligram per cubic meter:* Sa:Cf (APF = 25)* (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25)* (any powered air-purifying respirator with a high-efficiency particulate filter). *Up to 100 milligram per cubic meter:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter. Click here for information on selection of N, R, or P filters); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SAF:PD,PP:ASCBA (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Hydrated stannic chloride must be stored to avoid contact with water, moisture, chlorine, turpentine, ethylene oxide, and alkyl nitrates, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from flammable and combustible materials. Keep hydrated stannic chloride dry and out of direct sunlight. Hydrated stannic chloride can attack some plastics, rubbers, and coatings.

Shipping: UN2440 Stannic chloride, pentahydrate, Hazard class: 8; Labels: 8-Corrosive material.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Hydrated stannic chloride itself does not burn. Thermal decomposition products may include hydrogen chloride, chlorine, and tin. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Stannic Chloride, Hydrated, Trenton, NJ (September 2002).

Stannous Chloride S:0580

Formula: Cl_2Sn; $Cl_2Sn \cdot 2H_2O$ (dihydrate); $SnCl_2$

Synonyms: C.I. 77864; NCI-C02722; Stannochlor; Tin(II) chloride; Tin dichloride; Tin protochloride

Dihydrate: Stannous dichloride dihydrate; Stannochlor; Stannous chloride dihydrate; Tin(II) chloride, dihydrate (1:2:2)

CAS Registry Number: 7772-99-8; 10025-69-1 (dihydrate)

HSDB Number: 582

RTECS Number: XP8700000; XP8850000 (dihydrate)

UN/NA & ERG Number: UN3260/154

EC Number: 231-868-0

Regulatory Authority and Advisory Information

Carcinogenicity: NCI: Carcinogenesis Studies (feed); equivocal evidence: rat; no evidence: mouse. United States Environmental Protection Agency Gene-Tox Program, Negative: *B. subtilis* rec assay; TRP reversion; Negative/limited: Carcinogenicity-mouse/rat.

Hazard Alert: Possible risk of forming tumors, Suspected of causing genetic defects. *Dihydrate*: Suspected of causing genetic defects, Suspected reprotoxic hazard.

Air Pollutant Standard Set: ACGIH[1]; DFG[3]; OSHA[58]

United States National Primary Drinking Water Regulations: SMCL = 250 mg[Cl^-]/L as Chloride

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T; risk phrases: R62; R63;?; safety phrases: (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Stannous chloride is a white crystalline solid. Molecular weight = 189.59; 222.63 (dihydrate); specific gravity (H_2O:1) = 2.7 @ 20°C; boiling point = (decomposes) 652°C; 623°C; freezing/melting point = 246°C; 38°C (dihydrate). Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 0, reactivity 0. Soluble in water; solubility = 90% @ 20°C.

Potential Exposure: Stannous chloride is used as a dye, pigment, and printing ink; in making chemicals; chemical preservatives; food additives; polymers, textiles, glass, silvering mirrors.

Incompatibilities: A strong reducing agent. Reacts violently with oxidants. Reacts violently with bromine trifluoride; potassium, hydrazine hydrate, sodium, sodium peroxide; ethylene oxide; and nitrates. Keep away from moisture, sources of oxygen, and combustible materials.

Permissible Exposure Limits in Air

Includes dihydrate

NIOSH IDLH = 100 mg[Sn]/m^3

OSHA PEL: 2 mg[Sn]/m^3 TWA

NIOSH REL: 2 mg[Sn]/m^3 TWA

ACGIH TLV[1]: 2 mg[Sn]/m^3 TWA

PAC Ver. 29[138]

7772-99-8

PAC-1: 9.6 milligram per cubic meter

PAC-2: 65 milligram per cubic meter

PAC-3: 640 milligram per cubic meter

10025-69-1, dihydrate

PAC-1: 11 milligram per cubic meter

PAC-2: 20 milligram per cubic meter

PAC-3: 760 milligram per cubic meter

EUR OEL: 2 mg[Sn]/m^3 as TWA

DFG MAK: *tin, inorganic compounds:* No numerical value established. Data may be available.

Australia: TWA 2 mg[Sn]/m^3, 1993; Austria: MAK 2 milligram per cubic meter, 1999; Belgium: TWA 2 mg

[Sn]/m^3, 1993; Denmark: TWA 2 mg[Sn]/m^3, 1999; Finland: TWA 2 mg[Sn]/m^3, 1999; Hungary: TWA 1 mg [Sn]/m^3; STEL 2 mg[Sn]/m^3 [skin], 1993; Norway: TWA 2 mg[Sn]/m^3, 1999; the Philippines: TWA 2 mg[Sn]/m^3, 1993; Poland: TWA 2 mg[Sn]/m^3, 1999; Switzerland: MAK-W 2 mg[Sn]/m^3, KZG-W 4 mg[Sn]/m^3, 1999; Thailand: TWA 2 mg[Sn]/m^3, 1993; United Kingdom: TWA 2 mg[Sn]/m^3; STEL 4 mg[Sn]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 2 mg[Sn]/m^3

Permissible Concentration in Water: State Drinking Water Guidelines: Minnesota 4000 μg[Sn]/L.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Stannous chloride can affect you when breathed in. Contact can cause skin and eye burns. Breathing stannous chloride dust or mist can irritate the throat and bronchial tubes, causing cough and/or difficulty breathing. May affect the CNS; blood when ingested.

Long-Term Exposure: Effects on the liver following ingestion. Changes may also occur on chest X-ray with repeated exposures; reduced lung function has been reported. Tin may interfere with the body's ability to absorb iron from the diet or from vitamins, contributing to iron deficiency anemia.

Points of Attack: Lungs, blood, liver.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that. Lung function tests. CBC; hemoglobin or hematocrit. Liver function tests.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Neoprene and polyvinyl chloride are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA *Up to 10 milligram per cubic meter:* Q_m (APF = 25) (any quarter-mask respirator). *Up to 20 milligram per cubic meter:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa* (APF = 10) (any supplied-air respirator). *Up to 50 milligram per cubic meter:* Sa:Cf (APF = 25)* (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25)* (any powered air-purifying respirator with a high-efficiency particulate filter). *Up to 100 milligram per cubic meter:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter. Click here for information on selection of N, R, or P filters); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SAF; PD,PP:ASCBA (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: (1) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. (2) Color code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Stannous chloride must be stored to avoid contact with bromine trifluoride; nitrates, potassium hydrazine hydrate, sodium peroxide, ethylene oxide, and hydrogen peroxide, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from moisture, sources of oxygen and combustible materials. Sources of ignition, such as smoking and open flames are prohibited where stannous chloride is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN3260 Corrosive solid, acidic, inorganic, n.o.s., Hazard class: 8; Labels: 8-Corrosive material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Stannous chloride itself does not burn. Stannous chloride may ignite combustible materials. Thermal decomposition products may include chlorine and stannous sulfate. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Stannous Chloride, Trenton, NJ (August 2001).

Stannous Fluoride S:0590

Formula: F_2Sn**:** SnF_2

Synonyms: Fluoristan; Stannous fluoride; Tin bifluoride; Tin difluoride

CAS Registry Number: 7783-47-3

HSDB Number: 783

RTECS Number: XQ3450000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154; UN2923 (corrosive solids, toxic, n.o.s.)/154 (corrosive solids, toxic, n.o.s.)

EC Number: 231-999-3

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Inadequate Evidence; Human Inadequate Evidence*, not classifiable as carcinogenic to humans*, Group 3, 1987. United States Environmental Protection Agency Gene-Tox Program, Negative: *N. crassa-aneuploidy.*

Hazard Alert: Poison, OTC Drug[FDA], Possible risk of forming tumors, Poison[101], Suspected reprotoxic hazard.

United States National Primary Drinking Water Regulations: MCLG = 4 mg[F]/L; MCL = 4 mg[F]/L; SMCL = 2 mg[F]/L, as fluorides.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, C, Xn; risk phrases: R22; R36/37/38; R34; R40; R41; R50-52; R60; 61; safety phrases: S22; S26; S36/37/39; S45; S53; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water [mfg]. 3-Severe hazard to water[lit]. *Note*: see "Permissible Concentration in Water" for Sn and F.

Description: Stannous fluoride is a white crystalline solid with a bitter, salty taste. Molecular weight = 156.69; boiling point = 849°C; freezing/melting point = 213°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 0, reactivity 0. Soluble in water; 30% @ 20°C.

Potential Exposure: Stannous fluoride is used in dental caries (tooth decay); as an ingredient of cavity-preventing toothpastes.

Incompatibilities: A strong reducing agent. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Reacts with acids, forming hydrogen fluoride fumes. Reacts violently with chlorine and metal nitrates. Reacts with metals releasing flammable hydrogen gas.

Permissible Exposure Limits in Air

NIOSH IDLH = 100 $mg[Sn]/m^3$

As tin, inorganic compounds

OSHA PEL: 2 $mg[Sn]/m^3$ TWA

NIOSH REL: 2 $mg[Sn]/m^3$ TWA

ACGIH TLV[1]: 2 $mg[Sn]/m^3$ TWA

DFG MAK: *tin, inorganic compounds:* No numerical value established. Data may be available.

NIOSH IDLH = 100 $mg[Sn]/m^3$

PAC not available

As fluorides

NIOSH IDLH = 250 $mg[F]/m^3$

OSHA PEL: 3 ppm/2.5 $mg[F]/m^3$ TWA

NIOSH REL: 3 ppm/2.5 $mg[F]/m^3$ TWA

ACGIH TLV[1]: 2.5 $mg[F]/m^3$ TWA; not classifiable as a human carcinogen; BEI: 3 mg[F]/g creatinine in urine *prior* to end-of-shift; 10 mg[F]/g creatinine in urine end-of-shift

DFG MAK: 1 $mg[F]/m^3$, inhalable fraction [skin]; Peak Limitation Category II(4); Pregnancy Risk Group C; BAT: 7.0 mg[F]/g creatinine in urine at end-of-shift; 4.0 mg[F]/g creatinine in urine at the beginning of the next shift

Australia: TWA 2 $mg[Sn]/m^3$, 1993; Australia: TWA 2.5 $mg[F]/m^3$, 1993; Austria: MAK 2.5 $mg[F]/m^3$, 1999; Austria: MAK 2 milligram per cubic meter, 1999; Belgium: TWA 2 $mg[Sn]/m^3$, 1993; Belgium: TWA 2.5 $mg[F]/m^3$, 1993; Denmark: TWA 2.5 $mg[F]/m^3$, 1999; Denmark: TWA

2 mg[Sn]/m^3, 1999; Finland: TWA 2 mg[Sn]/m^3, 1999; Finland: TWA
2.5 mg[F]/m^3, 1999; France: VME 2.5 mg[F]/m^3, 1999; Hungary: TWA 1 mg[F]/m^3; STEL 2 mg[F]/m^3, 1993; Hungary: TWA 1 mg[Sn]/m^3; STEL 2 mg[Sn]/m^3 [skin], 1993; Norway: TWA 0.6 mg[F]/m^3, 1999; Norway: TWA 2 mg[Sn]/m^3, 1999; the Philippines: TWA 2 mg[Sn]/m^3, 1993; the Philippines: TWA 2.5 mg[F]/m^3, 1993; Poland: MAC (TWA) 1 mg[HF]/m^3; MAC (STEL) 3 mg[HF]/m^3, 1999; Poland: TWA 2 mg[Sn]/m^3, 1999; Sweden: NGV 2 mg [F]/m^3, 1999; Switzerland: MAK-W 1.8 ppm (1.5 mg[F]/m^3), KZG-W 3.6 ppm (3.0 mg[F]/m3), 1999; Switzerland: MAK-W 2 mg[Sn]/m^3, KZG-W 4 mg[Sn]/m^3, 1999; Thailand: TWA 2 mg[Sn]/m^3, 1993; Thailand: TWA 2.5 mg[F]/m^3, 1993; Turkey: TWA 2.5 mg[F]/m^3, 1993; United Kingdom: TWA 2.5 mg[F]/m^3, 2000; United Kingdom: TWA 2 mg[Sn]/m^3; STEL 4 mg[Sn]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Not classifiable as a human carcinogen

Determination in Air: Filter; Acid; Hydride generation atomic absorption spectrometry; NIOSH Analytical Method (IV) #7900. See also #7300, Elements.

Permissible Concentration in Water: *Tin*: State Drinking Water Guidelines: Minnesota 4000 μg[Sn]/L. The EPA has set 4 mg/L as a standard for fluoride[61] *Fluoride*: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guidelines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg[F]/L. Safe Drinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg[F]/L; SMCL = 2 mg/F/L, as Fluoride.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Stannous fluoride can affect you when breathed in. Corrosive to the eyes. Irritates the skin and respiratory tract. Prolonged skin contact can cause burns. Breathing stannous fluoride can irritate the throat and bronchial tubes, causing cough and/or difficulty breathing. Changes may also occur on chest X-ray with repeated exposures. When heated, toxic fluorine gas can be released, causing pulmonary edema (fluid in the lungs), a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. If swallowed, may affect the gastrointestinal tract; causing shock.

Long-Term Exposure: May affect the teeth and bones. Repeated exposure, usually after years, may cause changes in the chest X-ray; reduced lung function has been reported. Tin released by stannous fluoride may interfere with the body's ability to absorb iron, contributing to iron deficiency anemia.

Points of Attack: Lungs, blood.

Medical Surveillance: Before beginning employment and at regular times after that, the following is recommended. Lung function tests. For person exposed to levels 1/2 the TLV or greater, the following is recommended: hemoglobin or hematocrits. If acute breathing overexposure to heated stannous fluoride with fluorine gas is suspected, also consider chest X-ray.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. For heated stannous fluoride exposure medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy. If swallowed, watch for symptoms of shock.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA *Up to 10 milligram per cubic meter:* Q_m (APF = 25) (any quarter-mask respirator). *Up to 20 milligram per cubic meter:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa* (APF = 10) (any supplied-air respirator). *Up to 50 milligram per cubic meter:* Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25)* (any powered air-purifying respirator with a high-efficiency particulate filter). *Up to 100 milligram per cubic meter:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter. Click here for information on selection of N, R, or P filters); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SAF; PD,PP:ASCBA (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: (1) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location; keep acids away from bases and red, yellow, and blue-coded chemicals. (2) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Stannous fluoride must be stored to avoid contact with chlorine and turpentine, since violent reactions occur.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN2923 Corrosive solids, toxic, n.o.s., Hazard class: 8; Labels: 8-Corrosive material, 6.1-Poisonous material, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25 m/75 ft (NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Use dry chemical or CO_2 extinguishers. Poisonous fluorine gas is produced in fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(173); (101); (138); (31); (173); (122); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Stannous Fluoride, Trenton, NJ (August 2002).

Stibine S:0600

Formula: H_3Sb; SbH_3

Synonyms: Antimonwasserstoffes (German); Antimony hydride; Antimony trihydride; Hydrogen antimonide

CAS Registry Number: 7803-52-3

HSDB Number: 785

RTECS Number: WJ0700000

UN/NA & ERG Number: (PIH) UN2676/119; UN3260

EC Number: 232-179-8 [*Annex I Index No.:* 051-003-00-9]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Theft hazard* 15 (≥0.67% concentration).

OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 500 lb (227 kg)

Hazard Alert: Poison inhalation hazard: exposure can be lethal, Extremely flammable, Corrosive, Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated, Possible hematological effects.

WGK[100] (German Aquatic Hazard Class): No value found. [2-Hazard to waters (est.)]

As antimony compounds:

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Clean Water Act: Toxic Pollutant (Section 401.15)

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed, as antimony compounds, n.o.s.

Safe Drinking Water Act (47FR 9352): MCL 0.006 mg/L; MCLG, 0.006 mg/L

EPCRA Section 313: Includes any unique chemical substance that contains antimony as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: 0.1%.

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects[293]. Toxic to aquatic life with long-lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, F+, Xn, N: risk phrases: R5; R12; R20/22; R21; R51/53; safety phrases: S1; S2; S9; S33; S41; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [2-Hazard to waters (est.)]

Description: Stibine is a colorless gas. Characteristic disagreeable odor. It is produced by dissolving zinc/antimony or magnesium-antimony in hydrochloride acid. Molecular weight = 124.78; boiling point = −18°C; freezing/melting point = −88°C; flash point = flammable gas; relative vapor density (air = 1) = 4.31; vapor pressure => 1 mmHg

@ 25°C; 2.26 mmgHg @ − 25°C[138]. Hazard identification (based on NFPA-704 M Rating System): Health 4, flammability 4, reactivity 2. Poor solubility in water.

Potential Exposure: Stibine is used as a fumigating agent. Exposure to stibine usually occurs when stibine is released from antimony-containing alloys during the charging of storage batteries, when certain antimonial drosses are treated with water or acid, or when antimony-containing metals come in contact with acid. Operations generally involved are metallurgy, welding or cutting with blow torches; soldering, filling of hydrogen balloons; etching of zinc; and chemical processes.

Incompatibilities: A highly flammable gas. Incompatible with acids, halogenated hydrocarbons; oxidizers, moisture, chlorine, ammonia. Reacts violently with chlorine, concentrated nitric acid or ozone. Decomposes in air. Thermally unstable: quick decomposition >190°C producing metallic antimony and explosive hydrogen gas.

Permissible Exposure Limits in Air

NIOSH IDLH = 5 ppm
Conversion factor = 1 ppm = 5.10 mg/m.
OSHA PEL: 0.1 ppm/0.5 milligram per cubic meter TWA
NIOSH REL: 0.1 ppm/0.5 milligram per cubic meter TWA
ACGIH TLV[1]: 0.1 ppm/0.5 milligram per cubic meter TWA
PAC Ver. 29[138]
PAC-1: 0.3 ppm
PAC-2: $\mathbf{1.5_A}$ ppm
PAC-3: $\mathbf{9.6_A}$ ppm
*AEGLs are marked with a subscript "**A**" and correspond to 60-minute values

Austria: MAK 0.1 ppm (0.5 milligram per cubic meter), 1999; Denmark: TWA 0.05 ppm (0.25 milligram per cubic meter), 1999; France: VME 0.1 ppm (0.5 milligram per cubic meter), 1999; Norway: TWA 0.05 ppm (0.25 milligram per cubic meter), 1999; Poland: MAC (TWA) 0.2 milligram per cubic meter; MAC (STEL) 1.5 milligram per cubic meter, 1999; Sweden: TWA 0.05 ppm (0.3 milligram per cubic meter), 1999; United Kingdom: TWA 0.1 ppm (0.52 milligram per cubic meter; STEL 0.3 ppm, 2000; the Netherlands: MAC-TGG 0.5 mg[Sb]/m^3. Several states have set guidelines or standards for stibine in ambient air[60] ranging from 5.0 μ/m^3 (North Dakota); to 8.0 μ/m^3 (Virginia); to 10.0 μ/m^3 (Connecticut); to 12.0 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #6008, Stibine.

Permissible Concentration in Water: See regulatory section.

Routes of Entry: Inhalation of gas.

Harmful Effects and Symptoms

Short-Term Exposure: Stibine can affect you when breathed in. May be fatal if absorbed through the skin or inhaled. A strong sensitizer. May cause severe allergic respiratory reaction. Exposure can cause rapid, fatal poisoning, with symptoms of headaches, nausea, dark or bloody urine; pain in the back and abdomen; slowed breathing and death. Exposure can also irritate the lungs and may lead to a build-up of fluid (pulmonary edema); a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Stibine destroys red blood cells and can also cause liver and kidney damage.

Long-Term Exposure: Stibine destroys red blood cells (hemolysis). May affect the kidneys, liver; hemoglobinuria, hematuria (blood in the urine), hemolytic anemia; jaundice. May affect the CNS. Antimony may cause an increase in blood cholesterol; a decrease in blood sugar.

Points of Attack: Blood, liver, kidneys, respiratory system; CNS.

Medical Surveillance: Antimony can be measured in the urine, feces, and blood[76]. NIOSH lists the following tests: liver function tests; red blood cells/count, RBC Hemolysis; urine (chemical/metabolite), Hemoglobin; urinalysis (routine); white blood cell count/differential. For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Examination of the CNS. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 1 ppm:* Sa (APF = 10) (any supplied-air respirator). *Up to 2.5 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *Up to 5 ppm:* SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus). *Escape:* GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Check oxygen content prior to entering storage area. Poison gas. (1) Color code—Blue: Health Hazard/ Poison: Store in a secure poison location. This gas is highly toxic. Even slight exposure to these gasses can cause death. Store outdoors in a secure, restricted area that containing warning signs. This area must be roofed and shaded with the cylinders stored off the ground and separated from all other products assigned to other hazard categories and radiant heat sources on nonwooden floors. If indoors, store in a well-ventilated areas in temperatures not to exceed 50°C. (2) Color code—Red: Flammability Hazard: Store in a flammable (liquid or solid materials) storage area or approved cabinet away from sources if ignition. (3) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Stibine must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates); strong acids (such as hydrochloric, sulfuric, and nitric) and halogenated hydrocarbons, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat, sparks and flames. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. The storage area for flammable toxic gases should have electrical equipment conforming to Article 500 of the National Electrical Code.

Shipping: UN2676 Stibine, Hazard Class: 2.3; Labels: 2.3-Poisonous gas, 2.1-Flammable gas, Hazard Zone A. UN3260 Corrosive solid, acidic, inorganic, n.o.s., Hazard class: 8; Labels: 8-Corrosive material, Technical Name Required. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling:

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 1.1/1.8

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 1000/300
Then: Protect persons downwind (mi/km)
Day 1.2/1.9
Night 4.0/6.6

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of leak to disperse the gas. Stop the flow of gas if it can be done safely. If source of leak is a cylinder and the leak cannot be stopped in place, remove leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. Keep this chemical out of confined space, such as a sewer because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable gas. Evolves hydrogen and Thermal decomposition products may include antimony. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Use flooding quantities of water. Do not use halogenated extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies.

From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Dissolve in hydrochloric acid; add water to produce precipitate; add acid to dissolve again; precipitate with H_2S; filter and dry precipitate and return to supplier.

References

(31); (173); (101); (138); (2); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 2, No. 4, 17−18 (1982).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Stibine, Trenton, NJ (August 2001).

Stoddard Solvent S:0610

Formula: C_9H_{20}

Synonyms: Cleaning solvent; Dry cleaner naphtha; Mineral spirits; Mineral spirits, 85% nonane, &15% trimethyl benzene; Naphtha safety solvent; Petroleum solvent; Spotting solvent; Varnoline; White spirits

CAS Registry Number: 8052-41-3

HSDB Number: 7171

RTECS Number: WJ8925000

UN/NA & ERG Number: UN1268/128; UN1993 (flammable liquids, n.o.s.)/128

EC Number: 232-489-3 [*Annex I Index No.:* 649-345-00-4]

Regulatory Authority and Advisory Information

Hazard Alert: Combustible liquid, Primary irritant (w/o allergic reaction).

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xi; risk phrases: R36/37/38; R45; R46; R65; safety phrases: S53; S45. (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Stoddard solvent is a refined petroleum solvent containing >65% C10 or higher hydrocarbons (mineral spirits, 85% nonane & 15% trimethylbenzene)[138]. Stoddard solvent is a colorless liquid. Kerosene-like odor. Molecular weight can vary = 140−160; specific gravity (H_2O:1) = 0.765−0.795 @ 25°C; 0.75−0.85 mmHg (no temp.)[138]; boiling point = 154−202°C[1]; 130−230°C; freezing/melting point = −70°C; vapor pressure = 1.5 mmHg @ 25°C; flash point = 39−60°C; but, may vary from 21−60°C based on composition; autoignition temperature 229−240°C; but may vary based on composition. Explosive limits: LEL = 0.6%; UEL: 8.0%. Hazard identification (based on NFPA-704 M Rating System): Health20, flammability 2, reactivity 0. Insoluble in water. See also "Naphthas" for related materials.

Potential Exposure: Stoddard solvent is used as a diluent in paints, coatings, and waxes; as a paint thinner; as a dry-cleaning agent; as a degreaser for metal parts; as a herbicide.

Incompatibilities: May form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Attacks some forms of plastics, rubber, and coatings.

Permissible Exposure Limits in Air

NIOSH IDLH = 20,000 milligram per cubic meter

Odor threshold = 1 ppm(NY)−30 ppm.

OSHA PEL: 500 ppm/2900 milligram per cubic meter TWA

NIOSH REL: 350 milligram per cubic meter TWA; 1800 milligram per cubic meter [15-minutes] Ceiling Concentration

ACGIH TLV[1]: 100 ppm/525 milligram per cubic meter TWA

PAC Ver. 29[138]

PAC-1: 300 ppm

PAC-2: 1800 ppm

PAC-3: 29,500 ppm

Australia: TWA 790 milligram per cubic meter, 1993; Belgium: TWA 100 ppm (525 milligram per cubic meter), 1993; Denmark: TWA 25 ppm (140 milligram per cubic meter), 1999; the Philippines: TWA 200 ppm (1150 milligram per cubic meter), 1993; the Netherlands: MAC-TGG 575 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 100 ppm. Several states have set guidelines or standards for Stoddard solvent in ambient air[60] ranging from 5.25−10.50 milligram per cubic meter (North Dakota); to 7.0 milligram per cubic meter (Connecticut); to 12.5 milligram per cubic meter (Nevada).

Determination in Air: Use NIOSH Analytical Method 1550, Naphthas; OSHA Analytical Method 48.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 3.2−7.1. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: *Inhalation:* Causes irritation of the eyes and respiratory tract. Exposure to levels above 2400 milligram per cubic meter may cause headache, dizziness, nose, and throat irritation. More severe exposures may cause nausea and vomiting, a feeling of intoxication;

weakness, muscle twitches; and in extreme cases, convulsions, unconsciousness and death. *Skin:* Contact with liquid may cause irritation and drying of skin. This can result in dermatitis. *Eyes:* Contact with liquid or vapor levels of 900−2400 milligram per cubic meter may cause irritation and tearing. *Ingestion:* Small amounts may cause headache, dizziness, nausea, vomiting, intoxication, weakness, muscle twitches; convulsions and unconsciousness. May cause aspiration into the lungs and chemical pneumonia. As little as 3 oz may be fatal. If liquid is breathed into the lungs, as little as 1 oz may cause death due to respiratory failure.

Long-Term Exposure: Prolonged or repeated contact with liquid may cause defatting of the skin with drying, irritation, and skin ulcers. Exposure to vapor may cause eye, nose, and throat irritation; fatigue, headaches, anemia, jaundice, and damage to the liver and bone marrow. In animals: kidney damage. Repeated exposure may cause a rare reaction in some people that destroys blood cells (aplastic anemia). This can be fatal. Many petroleum-based solvents have been shown to cause brain and/or nerve damage. Effects may include reduced memory and concentration, personality changes; fatigue, sleep disturbances; reduced coordination; effects on the autonomic nerves and/or nerves to the limbs.

Points of Attack: Eyes, skin, respiratory system; CNS; liver, kidneys.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: CBC. Evaluation for brain effects. Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Do *NOT* induce vomiting.

Note to Physician: Treat symptomatically for CNS depression. Supportive treatment for pulmonary edema using oxygen may be needed when aspiration of liquids or massive exposure to vapors has occurred.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Some of these manufacturers recommend *nitrile* or *polyvinyl alcohol* as a protective material. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. For engineering controls see "Criteria for a Recommended Standard: Occupational Exposure to Refined Petroleum", NIOSH Document Number 77-192

Respirator Selection: NIOSH: *Up to 3500 milligram per cubic meter:* CcrOv* (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)]; or Sa* (APF = 10) (any supplied-air respirator). *Up to 8750 milligram per cubic meter:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode);* or PaprOv* (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]. *Up to 17,500 milligram per cubic meter:* CcrFOv (APF = 50) [any chemical cartridge respirator with a full facepiece and organic vapor cartridge (s)]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or PaprTOv (APF = 50) [any powered, air-purifying respirator with a tight-fitting facepiece and organic vapor cartridge(s)];* or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 20,000 milligram per cubic meter:* SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd, Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

*Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Stoddard solvent must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where Stoddard solvent is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gal or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1993 Flammable liquids, n.o.s., Hazard Class: 3; Labels: 3-Flammable liquid, Technical Name Required.

UN1268 Petroleum distillates, n.o.s. or Petroleum products, n.o.s., Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (100).

National Institute for Occupational Safety and Health (NIOSH), "Criteria for a Recommended Standard: Occupational(2). Exposure to Refined Petroleum", NIOSH Document Number 77-192, Cincinnati OH (1977).

(173); (101); (138).

New York State Department of Health, *Chemical Fact Sheet:* Stoddard Solvent, Bureau of Toxic Substance Assessment, Albany, NY (March 1986 and Version 2).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Stoddard Solvent, Trenton, NJ (August 1998).

Strontium Chromate S:0630

Formula: CrO_4Sr; $SrCrO_4$

Synonyms: Chromic acid, stontium salt (1:1); Chromic acid, strontium salt; C.I. Pigment yellow 32; Cromato de estronicio (Spanish); Deep lemon yellow; Strontium chromate; Strontium chromate(VI); Strontium chromate 12170; Strontium chromate A; Strontium chromate X-2396; Strontium yellow

CAS Registry Number: 7789-06-2; *(alt.)* 54322-60-0

HSDB Number: 2546

RTECS Number: BG3240000

UN/NA & ERG Number: UN3086/141

EC Number: 232-142-6 [*Annex I Index No.:* 024-009-00-4]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human Sufficient Evidence; Animal Sufficient Evidence, *carcinogenic to humans*, Group 1, 1990; NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen; NIOSH: Potential occupational carcinogen. United States Environmental Protection Agency Gene-Tox Program, Positive: Carcinogenicity-mouse/rat.

California Proposition 65 Chemical[102]: (*hexavalent chromium*) Cancer 2/27/1987; Developmental/Reproductive toxin (male, female) 12/19/2008.

Hazard Alert: Poison, Strong oxidizer, Possible risk of forming tumors, Suspected reprotoxic hazard, Sensitization hazard (skin), environmental hazard.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) as chromium compounds.

United States National Primary Drinking Water Regulations: MCLG = 0.01 mg[Cr]/L; MCL = 0.1 mg[Cr]/L as Chromium; MCLG = mg/L; MCL = 4 millirems/yr, as *beta*-proton emitter (Sr_{89}, and Sr_{90} only)

Clean Water Act: 40CFR116.4 Hazardous Substances; RQ 40CFR117.3 (same as CERCLA); 40CFR423, Appendix A, Priority Pollutants

EPA Acceptable daily intake (ADI): Chromium(VI) = 0.175 mg/day/man. EPA EASI levels for chromium: **Infants:** age 0.0−0.5 years: 0.01−0.04 mg/day; age 0.5−1.0 years: 0.02−0.06 mg/day. **Children:** age 1−3 years: 0.02−0.08 mg/day; age 4−6 years: 0.03−0.12 mg/day;

age 7−10 years: 0.05−0.20 mg/day; age > or = to 11 years: 0.05−0.20 mg/day. **Adults**: 0.05−0.20 mg/day.

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg)

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: O, T, N, Xi; risk phrases: R45; R8; R22; R23/24; R43; R50/53; R62; R63; safety phrases: S17; S29/35; S45; S53; S41; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to waters.

Description: Strontium chromate a light yellow crystalline solid or powder. Molecular weight = 203.62. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 0, reactivity 1. Slightly soluble in water.

Potential Exposure: Strontium chromate is used as a metal protective coating to prevent corrosion, in wash primers; and aluminum flake coatings; colorant in polyvinyl chloride resins and pyrotechnics.

Incompatibilities: Violent reaction with strong oxidizers, hydrazine. Incompatible with combustible, organic, or other readily oxidizable materials, such as paper, wood, sulfur, aluminum powder. Attacks plastics and coatings.

Permissible Exposure Limits in Air

NIOSH IDLH = 15 mg[Cr(VI)]/m^3

OSHA PEL: 0.005 mg[Cr]/m^3 TWA

NIOSH REL: 0.001 mg[Cr]/m^3 TWA, potential carcinogen, limit exposure to lowest feasible level. See *NIOSH Pocket Guide*, Appendix A & C.

ACGIH TLV[1]: 0.0005 mg[Cr]/m^3 TWA, Suspected Human Carcinogen

PAC not available

DFG MAK: [skin] Danger of skin sensitization; Carcinogen Category 1; TRK: 0.05 mg[Cr]/m^3; 20 μg/L [Cr] in urine at end-of-shift

Arab Republic of Egypt: TWA 0.5 milligram per cubic meter, 1993; Australia: TWA 0.5 milligram per cubic meter, 1993; Austria: carcinogen, 1999; Belgium: TWA 0.5 milligram per cubic meter, 1993; Denmark: TWA 0.001 mg[Cr]/m^3, 1999; Finland: TWA 0.5 milligram per cubic meter; carcinogen, 1999; France: VME 0.05 mg[Cr]/m^3, 1999; [skin], 1993; India: TWA 0.5 milligram per cubic meter, 1993; Japan: 0.01 mg[Cr]/m^3, 1999; Norway: TWA 0.02 mg [CrO3]/m^3, 1999; the Philippines: TWA 0.5 milligram per cubic meter, 1993; Poland: TWA 0.5 milligram per cubic meter, 1999; Sweden: NGV 0.02 milligram per cubic meter, carcinogen, 1999; Switzerland: MAK-W 0.05 mg[Cr]/m^3, 1999; Thailand: TWA 1 milligram per cubic meter, 1993; United Kingdom: TWA 0.05 mg[Cr]/m^3, carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 0.0005 mg[Cr]/m^3. The former USSR-UNEP/IRPTC joint project[43] gives a MAC in work-place air of 0.01 milligram per cubic meter. Connecticut[60] has set a guideline for chromium trioxide in ambient air of 0.25 μ/m^3.

Determination in Air: Use NIOSH Analytical Methods #7600,#7604, #7605, #7703, #9101; OSHA Analytical Methods ID-103, ID-215, W-4001. Permissible Concentration in Water: *Chromium:* The EPA[6] has designated chromium as a priority toxic pollutant. State Drinking Water Guidelines: California 10 μg[Cr(VI)]/L; Maine 35 μg[Cr(VI)]/L. *Strontium*: A suggested maximum ambient environmental level for strontium in potable water was set at 10 mg[Sr]/L. Federal Drinking Water Guidelines: EPA 4000 μg[Sr]/L; State Drinking Water Guidelines: Florida 4200 μg[Sr]/L; Maine 4200 μg[Sr]/L. Runoff from spills or fire control may cause water pollution.

Determination in Water: Total chromium may be determined by digestion followed by atomic absorption, or by colorimetry, (diphenylcarbazide); or by ICP optical emission spectrometry. Chromium(VI) may be determined by extraction and atomic absorption or colorimetry (using diphenylhydrazide). Dissolved total Cr or Cr(VI) may be determined by 0.45 μ filtration followed by the above-cited methods[49].

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Strontium chromate can affect you when breathed in. Strontium chromate is a carcinogen; handle with extreme caution. Contact may burn the skin and eyes. The vapor or dust may irritate the mouth, nose, and air passages.

Long-Term Exposure: Chromium may cause allergic dermatitis. Repeated or prolonged exposure (at 20 milligram per cubic meter) may damage the lungs, heart, liver, kidneys, and affect the nervous system. May affect the blood and brain, resulting in changes in white and red blood cells and neurovegetative disorders. Strontium chromate accumulates in the body with repeated exposure and effects can persist after exposure. Repeated or prolonged contact with skin may cause skin sensitization, dermatitis or ulcers. Lungs may be affected or asthma may develop from repeated or prolonged exposure; and with some chromate exposures, nasal septim perforation has occurred. This substance is possibly carcinogenic to humans.

Points of Attack: Kidneys, liver, nervous system; heart, lungs, skin.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure. NIOSH lists the following tests: blood gas analysis, CBC; chest X-ray, ECG, liver function tests; pulmonary function tests; sputum cytology, urine (chemical/metabolite), urinalysis (routine), white blood cell count/differential. For those with frequent or potentially high exposure (half the TLV or greater, or significant skin contact), the following are recommended before beginning work and at regular times after that: tests for kidney and liver function. Exam of the nervous system. Evaluation by a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and demulcents and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Eye protection is included in the recommended respiratory protection. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH, as chromates: *at any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Check oxygen content prior to entering storage area. (1) Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Oxidizers, including oxidizing gases, should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. (2) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Strontium chromate must be stored to avoid contact with strong oxidizers (such as chlorine, bromine and fluorine), since violent reactions occur. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Store in a cool, well-ventilated area away from incompatible materials listed above. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage.

Shipping: UN3086 Toxic solids, oxidizing, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, 5.1-Oxidizer. Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Thermal decomposition products may include oxides of metal. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. *Inhaling the hot fumes may cause cyanosis.* If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(109); (102); (31); (173); (101); (138); (2); (122); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 7, 74−76 (1981)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Strontium Chromate, Trenton, NJ (August 1998)

United States Environmental Protection Agency, *Health Assessment Document: Chromium,* EPA 600/8-83-014F, Washington, DC (1984).

Strontium Nitrate S:0640

Formula: N_2O_6Sr; $Sr(NO_3)_2$
Synonyms: Nitrate de strontium (French); Nitric acid, strontium salt; Strontium(II) nitrate (1:2)
CAS Registry Number: 10042-76-9
HSDB Number: 787
RTECS Number: WK98000000
UN/NA & ERG Number: UN1507/140
EC Number: 233-131-9
Regulatory Authority and Advisory Information
Hazard Alert: Strong oxidizer, Environmental hazard.
As nitrate compounds (water dissociable):
United States National Primary Drinking Water Regulations: MCLG 10 mg[N]/L; MCL = 10 mg[N]/L nitrate measured as Nitrogen; MCLG = mg/L; MCL = 4 millirems[Sr_{90}]/yr, as *beta*-proton emitter.
EPCRA Section 313: Reportable only when in aqueous solution. Form R *de minimis* concentration reporting level: 1.0%.
United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), as nitrates, inorganic, n.o.s.
Hazard symbols, risk, & safety statements: Hazard symbol: O, Xi, Xn; risk phrases: R8, R36/37/38; R41; safety phrases: S17; S25; S26; S36/37/39; S41; S45 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.
Description: Strontium nitrate is a white crystalline solid. Molecular weight = 211.6; specific gravity (H_2O:1) = 3 @ 20°C; boiling point = 645°C; freezing/melting point = 570°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 2 (Oxidizer). Soluble in water.
Potential Exposure: Strontium nitrate is used in matches, pyrotechnics, marine signals; and railroad flares.
Incompatibilities: A strong oxidizer. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Violent reaction with reducing agents; combustibles, organics, or other readily oxidizable materials. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.
Permissible Exposure Limits in Air
PAC Ver. 29[138]
PAC-1: 5.7 milligram per cubic meter
PAC-2: 62 milligram per cubic meter
PAC-3: 370 milligram per cubic meter
Russia[43] set a MAC in work-place air of 1.0 milligram per cubic meter.
Permissible Concentration in Water: Safe Drinking Water Act (47FR 9352): MCLG = 10 mg[N]/L; MCL = 10 mg [N]/L nitrate measured as Nitrogen. A suggested maximum ambient environmental level for strontium in potable water was set at 10 mg[Sr]/L. Federal Drinking Water Guidelines: EPA 4000 μg[Sr]/L; State Drinking Water Guidelines: Florida 4200 μg[Sr]/L; Maine 4200 μg[Sr]/L. Runoff from spills or fire control may cause water pollution.
Routes of Entry: Inhalation, ingestion; skin and/or eye contact.
Harmful Effects and Symptoms
Short-Term Exposure: Strontium nitrate can affect you when breathed in. Contact may burn the skin and eyes. The vapor or dust can irritate eyes, mouth, nose, and air passages. Higher levels may cause a chemical pneumonia.
Long-Term Exposure: Repeated exposures (at 50 milligram per cubic meter) has caused damage to the lungs, heart muscle, liver, kidneys, and blood forming organs; and affect the nervous system in animals. Strontium nitrate accumulates in the body with repeated exposure and effects can persist after exposure stops. Infants below the age of 6 months who drink water containing nitrate in excess of the MCL could become seriously ill and, if untreated, may die. Symptoms include shortness of breath and blue-baby syndrome.
Points of Attack: Liver, kidneys, nervous system; blood
Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: tests for kidney and liver function. Exam of the nervous system. CBC. If respiratory symptoms are present, lung function tests are recommended. Persons on low calcium diets may be at greater risk of absorbing more strontium nitrate.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 hours in case chemical pneumonia or other respiratory symptoms are present.
Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: Where there is potential exists for exposure to strontium nitrate, use a NIOSH/MSHA (US) or

EN149 (Europe)-approved full facepiece respirator with a high efficiency particulate filter. Greater protection is provided by a PAPR. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Check oxygen content prior to entering storage area. Color code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially organic materials, flammables and combustibles, and other incompatible materials. Oxidizers, including oxidizing gases, should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Strontium nitrate must be stored to avoid contact with combustible, organic or other readily oxidizable materials, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from sources of heat. Store in a cool, well-ventilated area away from incompatible materials listed above. Store in a cool, well-ventilated area away from incompatible materials listed above. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage.

Shipping: UN1507 Strontium nitrate, Hazard Class: 5.1; Labels: 5.1-Oxidizer.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. Keep strontium nitrate out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Thermal decomposition products may include oxides of nitrogen and metal. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Strontium Nitrate, Trenton, NJ (March 2000).

Strychnine S:0650

Formula: $C_{21}H_{22}N_2O_2$; $C_{21}H_{22}N_2O_2 \cdot \frac{1}{2}H_2O_4S$ (sulfate)

Synonyms: Boomer-Rid; Certox; Dolco mouse cereal; Estricnina (Spanish); Gopher bait; Gopher-gitter; Hare-rid; Kwik-kil; Mole death; Mouse-nots; Mouse-rid; Mouse-tox; Nux vomica; Pied piper mouse seed; Ro-Dex; Sanaseed; Strychnidin-10-one; Strychnin (German); Strychnos

Strychnine, sulfate (2:1): Antivampire; Strychinium sulfate; Strychnidin-10-one, sulfate (2:1); Strychnine hemisulfate; Strychnine sulfate; Vampirol

CAS Registry Number: 57-24-9; 60-41-3 (sulfate)

HSDB Number: 2001

RTECS Number: WL2275000; WL2550000 (sulfate)

UN/NA & ERG Number: UN1692/151

EC Number: 200-319-7 [*Annex I Index No.:* 614-003-00-5]; 200-477-7 (strychnine sulfate)

Regulatory Authority and Advisory Information

Hazard Alert: Combustible, Suspected of causing genetic defects, Environmental hazard. *sulfate*: Drug.

Banned or Severely Restricted (several countries) (UN)[13]

FDA-over the counter drug

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P108

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0% *(Strychnine and salts)*

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

European/International Regulations *(Strychnine and salts)*: Hazard symbol: T+, N; risk phrases: R27/28; R50/53; R62; safety phrases: S1/2; S29/35; S36/37; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Strychnine is a colorless crystalline prisms or white powder. It is odorless; with a bitter taste. Molecular weight = 333.45; 383.49 (sulfate); specific gravity (H_2O:1) = 1.36 @ 25°C; boiling point = (decomposes) 270°C @ 5 mmHg; freezing/melting point = 267.8°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 1, reactivity 0. Slightly soluble in water; solubility = 0.02%.

Potential Exposure: Classified in the United States as a restricted use pesticide, requiring a certified applicator. Strychnine is an alkaloid compound that has been widely used as a rodenticide/bait to kill rodents; a medicine, respiratory stimulant. A potential danger to those involved in the extraction the seeds of the *Strychnos nux* vomica, *Strychnos ignatii* (*S. sancta* Ingnatius), and *Strychnos tiente* (Upas tree); formulation or application of this rodent poison. The sulfate is used to kill gophers and moles. A common adulterant in illicit street drugs. Listed as a potential WMD biotoxin[77].

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Dangerous when heated; forms toxic fumes, including nitrogen oxides. In the body, caffeine may increase the strychnine effect.

Permissible Exposure Limits in Air

NIOSH IDLH = 3 milligram per cubic meter

OSHA PEL: 0.15 milligram per cubic meter TWA

NIOSH REL: 0.15 milligram per cubic meter TWA

ACGIH TLV[1]: 0.15 milligram per cubic meter TWA

PAC Ver. 29[138]

57-24-9

PAC-1: 0.45 milligram per cubic meter

PAC-2: 0.5 milligram per cubic meter

PAC-3: 3 milligram per cubic meter

Australia: TWA 0.15 milligram per cubic meter, 1993; Austria: MAK 0.15 milligram per cubic meter, 1999; Belgium: TWA 0.15 milligram per cubic meter, 1993; Belgium: TWA 0.15 milligram per cubic meter, 1999; Finland: TWA 0.15 milligram per cubic meter; STEL 0.45 milligram per cubic meter, 1999; France: VME 0.15 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 0.15 milligram per cubic meter, 2003; the Philippines: TWA 0.15 milligram per cubic meter, 1993; Poland: MAC (TWA) 0.15 milligram per cubic meter, 1999; Switzerland: MAK-W 0.15 milligram per cubic meter, KZG-W 0.3 milligram per cubic meter, 1999; Turkey: TWA 0.15 milligram per cubic meter, 1993; United Kingdom: TWA 0.15 milligram per cubic meter; STEL 0.45 milligram per cubic meter, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 0.15 milligram per cubic meter. Several states have set guidelines or standards for strychnine in ambient air[60] ranging from 1.5 μ/m^3 (North Dakota); to 2.5 μ/m^3 (Virginia); to 3.0 μ/m^3 (Connecticut); to 4.0 μ/m^3 (Nevada).

PAC Ver. 29[138]

60-41-3, sulfate

PAC-1: 0.45 milligram per cubic meter

PAC-2: 5 milligram per cubic meter

PAC-3: 30 milligram per cubic meter

Determination in Air: Use NIOSH Analytical Method (IV) #5016.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 1.68. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation of dust, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Affects the CNS; causing convulsions; muscle contractions; and respiratory failure. Super toxic; probable oral lethal dose in humans is less than 5 mg/kg, a taste (less than seven drops) for a 70 kg (150 lb) person. It causes violent generalized convulsions. Death results from respiratory arrest as the respiratory muscles are in sustained spasm. The lowest lethal oral dose reported for humans if 30 mg/kg. Respiratory paralysis and arrest are likely to occur following severe exposure to strychnine. Signs and symptoms of acute exposure generally involve excitation of all portions of the CNS. Convulsions, bilateral horizontal nystagmus (rapid, synchronous, horizontal, oscillations of the eyeballs); agitation, restlessness, apprehension; and abrupt, jerking movements of the extremities may occur. Victims may also experience stiffness, painful muscle cramping (especially in the legs); and opisthotonos (spasm in which the spine and extremities are bent with convexity forward, the body resting on the head and heels). Vomiting and renal failure; as well as cyanosis (blue tint to skin and mucous membranes) and rhabdomyolysis (destruction of skeletal muscle), may be found.

Long-Term Exposure: Chronic allergen if inhaled or ingested.

Points of Attack: CNS.

Medical Surveillance: Be aware of possible convulsions. Consider the points of attack in preplacement and periodic physical examinations. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: Remove victims from exposure. Emergency personnel should avoid self-exposure to strychnine. Warning-Any unnecessary sensory input may induce seizures. Isolate the victims from any avoidable distractions. Rush to a health care facility! Evaluate vital signs including pulse and respiratory rate, and note any trauma. If no pulse is detected, provide CPR. If not breathing, provide artificial respiration. If breathing is labored, administer oxygen or other respiratory support. Remove contaminated clothing as soon as possible. If eye exposure has occurred, remove any contact lenses at once;

eyes must be flushed with lukewarm water for at least 15 minutes. Wash exposed skin areas thoroughly with soap and water. Obtain authorization and/or further instructions from the local hospital for administration of an antidote or performance of other invasive procedures.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 0.75 milligram per cubic meter:* Q_m (APF = 25) (any quarter-mask respirator). *Up to 1.5 milligram per cubic meter:* 95 XQ [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *Up to 3 milligram per cubic meter:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode.); or PaprHie (APF = 25) (any powered, air-purifying respirator with a dust and mist filter); or 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode. *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers and heat. Where possible, automatically transfer material from drums or other storage containers to process containers Sources of ignition, such as smoking and open flames are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1692 Strychnine or strychnine salts, Hazard Class: 6.1; Labels: 6.1-Poisonous material.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Do not touch spilled material; stop leak if you can do so without risk. *Small spills:* absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills:* with clean shovel place material into clean, dry container and cover; move containers from spill area. *Large spills:* dike far ahead of spill for later disposal. Avoid breathing dusts, and fumes from burning materials. Keep upwind. Avoid bodily contact with the material. *Do Not* handle broken packages without protective equipment. Wash away any material which may have contacted the body with copious amounts of water or soap and water. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using agent suitable for type of surrounding fire; material itself does not burn or burns with difficulty. Use water in flooding quantities as fog. Use alcohol foam, carbon dioxide; or dry chemical. Thermal decomposition products may include oxides of nitrogen and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform to EPA regulations governing storage, transportation, treatment, and waste disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office. Careful incineration has been recommended for disposal. Two procedures are suggested[1]. Pour or sift onto a thick layer of sand and soda ash mixture (90-10). Mix and shovel into a heavy paper box with much paper packing Burn in incinerator. Fire may be augmented by adding excelsior and scrap wood. Stay on the upwind side[2]. Waste may be dissolved in flammable solvent (alcohols, benzene, etc.) and sprayed into fire box of an incinerator with afterburner and scrubber[22].

References

(31); (173); (101); (138); (2); (80); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 2, No. 2, 63−65 (1982) and 8, No. 1, 78−83 (1988).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Strychnine, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Strychnine Sulfate, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

Styrene S:0660

Formula: C_8H_8; $C_6H_5CH{=}CH_2$

Synonyms: Annamene; Benzene, ethenyl-; Benzene, vinyl-; Cinnamene; Cinnamenol; Cinnamol; Diarex HF 77; Estireno (Spanish); Ethylbenzene; Ethylene, phenyl-; NCI-C02200; Phenethylene; Phenylethene; Phenylethylene; Styrene monomer; Styrene monomer, inhibited; Styrol (German); Styrole; Styrolene; Styron; Styropol; Styropol SO; Styropor; Vinylbenzene; Vinylbenzol

CAS Registry Number: 100-42-5; *(alt.)* 79637-11-9

HSDB Number: 171

RTECS Number: WL3675000

UN/NA & ERG Number: UN2055/128 (P)

EC Number: 202-851-5 [*Annex I Index No.:* 601-026-00-0]

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Human Limited Evidence, animal Sufficient Limited Evidence, *possibly carcinogenic to humans*, Group 2B, 2002; NCI: Carcinogenesis Bioassay (gavage); inadequate studies: mouse, rat Note: Do not confuse with *Styrene polymer* (CAS: 9003-53-6; RTECS: WL6475000): IARC: Animal Inadequate Evidence; Human No Adequate Data, *not classifiable as carcinogenic to humans*, Group 3, 1987. United States Environmental Protection Agency Gene-Tox Program, Positive: *In vivo* cytogenetics-human lymphocyte; Host-mediated assay; Positive: In vitro human lymphocyte micronucleus; Positive: Histidine reversion-Ames test; Positive: *D. melanogaster* sex-linked lethal; Positive: *S. cerevisiae* gene conversion; Positive/limited: Carcinogenicity-mouse/rat; Negative: Cell transformation-SA7/SHE; In vitro UDS-human fibroblast; Negative: V79 cell culture-gene mutation; Inconclusive: *S. pombe*-forward mutation

Hazard Alert: Highly flammable, Polymerization hazard (nonstabilized), Endocrine disruptor (high), Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction), Environmental hazard.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8020 (1); 8240 (5)

United States National Primary Drinking Water Regulations: MCLG = 0.1 mg/L; MCL = 0.1 mg/L

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1000 lb (454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Hazard symbols, risk, & safety statements: Hazard symbol: Xn; risk phrases: R10; R20; R36/38; R62; R63; safety phrases: S2; S23; S41 (see Appendix 4).

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, F+, Xn; risk phrases: R11; R19; R20; R22; R23/24/25; R36/37/38; R39; R40; R51; R61; R62; safety phrases: S7; S16; S21; S23; S26; S36/37; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Styrene is a colorless to yellowish, very refractive, oily liquid with a penetrating odor. Molecular weight = 104.15; specific gravity (H_2O:1) = 0.9 @ 20°C; boiling point = 145°C; freezing/melting point = −30.7°C; vapor pressure = 7.5 mmHg @ 29°C; flash point = 31°C; autoignition temperature 490°C. Explosive limits: LEL = 0.9%;UEL: 6.8%. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 3, reactivity 2. Practically insoluble in water; solubility = 0.03%.

Potential Exposure: Styrene is used in the production of plastics and polystyrene resins. It is also used in combination with 1,3-butadiene or acrylonitrile to form copolymer elastomers, butadiene-styrene rubber; and acrylonitrile-butadiene-styrene. It is also used in the manufacture of protective coatings; resins, polyesters; in making insulators and in drug manufacture.

Incompatibilities: Styrene May form explosive mixture with air. A storage hazard above 31°C. Upon heating to 200°C, styrene polymerizes to form polystyrene, a plastic. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in a cool, dry area away from oxidizers, catalysts for vinyl polymers; peroxides, strong acids; aluminum chloride. May polymerize if contaminated, subjected to heat; under the influence of light; and on contact with many compounds, such as oxygen, oxidizing agents;

peroxides and strong acids. Usually contains an inhibitor, such as *tert*-butylcatechol. Corrodes copper and copper alloys. Attacks some plastics, rubber, and coatings.

Permissible Exposure Limits in Air

NIOSH IDLH = 700 ppm

Conversion factor: 1 ppm = 4.26 milligram per cubic meter @ 25°C & 1 atm

The Odor Threshold = 0.02−0.47 ppm.

OSHA PEL: 100 ppm TWA; 200 ppm Ceiling Concentration; 600 ppm [5-min. max peak in any 3 hours]

NIOSH REL: 50 ppm/215 milligram per cubic meter TWA; 100 ppm/425 milligram per cubic meter STEL

ACGIH TLV[1]: 20 ppm/85 milligram per cubic meter TWA; 40 ppm/170 milligram per cubic meter STEL, not classifiable as a human carcinogen. BEI: 800 mg[mendelic acid]/g creatinine in urine/end-of-shift; 300 mg[mendelic acid]/g creatinine in urine, prior to next shift; 240 mg [phenylglyoxylic acid]/g creatinine in urine/end-of-shift; 100 mg[phenylglyoxylic acid]/g creatinine in urine, prior to next shift; 0.55 mg[styrene]/L in blood/end-of-shift; 0.02 mg[styrene]/L in blood, prior to next shift.

PAC* Ver. 29[138]

PAC-1: $\mathbf{20}_{\mathbf{A}}$ ppm

PAC-2: $\mathbf{130}_{\mathbf{A}}$ ppm

PAC-3: $\mathbf{1100}_{\mathbf{A}}$ ppm

*AEGLs are marked with a subscript "**A**" and correspond to 60-minute values.

DFG MAK: 20 ppm/86 milligram per cubic meter TWA; Peak Limitation Category II(2); Carcinogen Category 5; Pregnancy Risk Category C; BAT: 600 mg[mendelic acid plus phenyl glyoxylic acid]/g creatinine in urine/end-of-shift; for long term exposures: after several shifts.

Australia: TWA 50 ppm (215 milligram per cubic meter); STEL 100 ppm, 1993; Austria: MAK 20 ppm (85 milligram per cubic meter), 1999; Denmark: TWA 25 ppm (105 milligram per cubic meter) [skin], 1999; Finland: TWA 20 ppm (85 milligram per cubic meter); STEL 100 ppm (420 milligram per cubic meter), 1999; France: VME 50 ppm (215 milligram per cubic meter), 1999; Hungary: STEL 50 milligram per cubic meter, carcinogen, 1993; Japan: 50 ppm (210 milligram per cubic meter), 2B carcinogen, 1999; the Netherlands: MAC-TGG 107 milligram per cubic meter, 2003; Norway: TWA 25 ppm (105 milligram per cubic meter), 1999; the Philippines: TWA 100 ppm (420 milligram per cubic meter), 1993; Poland: MAC (TWA) 50 milligram per cubic meter; MAC (STEL) 200 milligram per cubic meter, 1999; Sweden: NGV 20 ppm (90 milligram per cubic meter), KTV 50 ppm (200 milligram per cubic meter) [skin], 1999; Switzerland: MAK-W 50 ppm (215 milligram per cubic meter), KZG-W 100 ppm (430 milligram per cubic meter), 1999; Thailand: TWA 100 ppm; STEL 200 ppm, 1993; Turkey: TWA 100 ppm (420 milligram per cubic meter), 1993; United Kingdom: TWA 100 ppm (430 milligram per cubic meter); STEL 250 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 40 ppm. Also, values for styrene in ambient air in residential areas vary. The Czech Republic[35] has set 0.015 milligram per cubic meter, both on a momentary and a daily average basis. Russia has set 0.003 milligram per cubic meter both on a daily average and momentary basis[43] but values are also given[35] as 0.04 milligram per cubic meter on a once-daily basis and 0.002 milligram per cubic meter on a daily average basis. Several states have set guidelines or standards for styrene in ambient air[60] ranging from zero (North Carolina); to 3.45 μ/m^3 (Indiana); to 30.0 μ/m^3 (Rhode Island); to 34.48 μ/m^3 (Kansas); to 39.0 μ/m^3 (Massachusetts); to 716.0 μ/m^3 (New York); to 2150.0−4250.0 μ/m^3 (North Dakota); to 3600.0 μ/m^3 (Virginia); to 4300.0 μ/m^3 (Connecticut); to 5119.0 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #1501, Aromatic hydrocarbons; #3800. OSHA Analytical Method 9 or 89.

Permissible Concentration in Water: Safe Drinking Water Act (47FR 9352): MCL, 0.1 mg/L; MCLG, 0.1 mg/L. A lifetime health advisory of 140 μg/L has been determined by EPA[48]. Russia set a MAC in water bodies used for domestic purposes of 100 μg/L[43]. This same limit applies to water bodies used for fishery purposes. Several states have set guidelines for styrene in drinking water[61] ranging from 10.0 μg/L (Wisconsin); to 140 μg/L (Arizona and Minnesota); to 270 μg/L Maine.

Determination in Water: Styrene may be determined by a purge-and-trap GC procedure[48]. Octanol−water coefficient: Log K_{ow} = > 3. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, ingestion; skin, and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Irritates the eyes, skin, and respiratory tract. *Inhalation:* At or above 100 ppm, styrene causes immediate eye and nose irritation; persistent metallic taste; headache, fatigue, slight muscular weakness; loss of appetite; drowsiness, feelings of drunkenness, decreased coordination; depression, unconsciousness; inflammation of the lung, kidney and liver damage, and death. *Skin:* Can cause drying cracking, itching burning and sores. Absorption is moderate and can cause symptoms described above. *Eyes:* Can cause severe itching, tearing and injury to the surface of the eye. *Ingestion:* Symptoms are same as inhalation. Additional symptoms may include severe irritation of the mouth, throat, and stomach. Swallowing the liquid may cause chemical pneumonitis.

Long-Term Exposure: Liver, kidney, and/or circulatory system problems. Repeated exposure to low levels can cause concentration problems, memory problems, hearing disability, slowed reflexes; reduced coordination and manual dexterity; trouble with balance; nausea, headache, fatigue and a feeling of drunkenness. Continued exposures to levels near 400 ppm can cause eye and throat irritation, and slight impairment of coordination and balance. At higher air concentrations; nasal, eye, throat and skin irritation becomes pronounced. Prolonged inhalation of vapors may cause respiratory tract obstruction. Very high levels may affect brain function and cause liver damage and death. Cases of liver damage have been found in workers employed for over five years in polystyrene plants and exposed to a concentration of 20−150 ppm Styrene has been found to produce lung tumors in mice and cause changes in the genetic material of laboratory organisms. Whether it does so in humans is not known.

Points of Attack: Eyes, skin, respiratory system; CNS; liver, reproductive system.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure. NIOSH lists the following tests: whole blood (chemical/metabolite); whole blood (chemical/metabolite), end-of-shift; whole blood (chemical/metabolite), end-of-work-week; whole blood (chemical/metabolite), prior to next shift; whole blood (chemical/metabolite), Prior to Shift, expired air, Expired Air, During Exposure. For those with frequent or potentially high exposure (half the TLV or grater, or significant skin contact) the following are recommended before beginning work and at regular times after that: exam of the nervous system. If symptoms develop or overexposure is suspected, the following may be useful: EEG (brain wave study).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to Physician: Inhalation: bronchodilators, decongestants and oxygen may be used if necessary. Corticosteroids are useful for treating pneumonitis.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Safety equipment manufacturers and styrene manufacturers recommend Teflon, Viton/chlorobutyl rubber, chlorinated polyethylene; and polyvinyl alcohol as the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Before entering a confined space where styrene monomer is present, check the oxygen level (at least 19% must be present) and that explosive concentration does not exist.

Respirator Selection: NIOSH: *500* ppm*:* CcrOv* [any chemical cartridge respirator with organic vapor cartridge(s)]; or SA* (any supplied-air respirator). *700* ppm*:* Sa:Cf (APF = 25)* (any supplied-air respirator operated in a continuous-flow mode); or CcrFOv (APF = 50) [any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s)]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or PaprOv* [any powered, air-purifying respirator with organic vapor cartridge(s)]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA). *Note:* *Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. A storage hazard above 31°C. Before entering a confined space where styrene monomer is present, check the oxygen level (at least 19% must be present) and that explosive concentration does not exist. Styrene monomer must be stored to avoid contact with oxidizing agents; and catalysts for vinyl polymerization, such as peroxides, strong acids (such as hydrochloric, sulfuric, and nitric); and aluminum chlorides; since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames are prohibited where styrene monomer is handled, used, or stored. Metal containers involving the transfer of 5 gal or more of styrene monomer should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of styrene monomer. Wherever styrene monomer is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Styrene monomer will corrode copper and copper alloys and dissolve rubber. Styrene monomer must be stored with an inhibitor to prevent explosive reactions. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2055 Styrene monomer, stabilized, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include styrene oxides. Use dry chemical, carbon dioxide; or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed. In some cases, recovery and recycle of styrene monomer is economic and the technology is available.

References

(109); (31); (173); (101); (138); (2); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 8, 92−95 (1981), 2, No. 6, 60−64 (1982), 6, No. 2, 110−115 (1986), 8, No. 3, 10−44 (1988).

New York State Department of Health, *Chemical Fact Sheet:* Styrene, Bureau of Toxic Substance Assessment, Albany, NY (Version 3, June 1984).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Styrene Monomer, Trenton, NJ (August 2006).

Styrene Oxide S:0670

Formula: C_8H_8O

Synonyms: Benzene, (epoxyethyl)-; Epoxyethylbenzene; (Epoxyethyl)benzene; 1,2-Epoxyethylbenzene; Epoxystyrene; α,β-Epoxystyrene; Ethane, 1,2-epoxy-1-phenyl-; Oxido de estireno (Spanish); Oxirane, phenyl-; Phenethylene oxide; 1-Phenyl-1,2-epoxyethane; Phenylethylene oxide; 2-Phenyloxirane; Phenyloxirane; Styrene epoxide; Styrene 7,8-oxide; Styryl oxide

CAS Registry Number: 96-09-3; *(alt.)* 62497-63-6

HSDB Number: 2646

RTECS Number: CZ9625000

UN/NA & ERG Number: UN2810 (toxic liquid, organic, n.o.s.)/153 (P)

EC Number: 202-476-7 [*Annex I Index No.:* 603-084-00-2]

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen (Styrene 7,8-oxide); IARC: Animal, Sufficient Evidence, 1997; Human, Inadequate Evidence, Group 2A, 1994; NTP: Carcinogenesis Studies (gavage); clear evidence: mouse, rat. United States Environmental Protection Agency Gene-Tox Program, Positive: Host-mediated assay; Positive: In vitro human lymphocyte micronucleus; Positive: Histidine reversion-Ames test; Positive: *D. melanogaster* sex-linked lethal; Positive: In vitro UDS-human fibroblast; Positive: V79 cell culture-gene mutation; Positive: *S. cerevisiae* gene conversion; Weakly Positive: *S. pombe*-forward mutation; Positive/dose response: TRP reversion; Positive/limited: Carcinogenicity-mouse/rat; Negative: Rodent dominant lethal; Inconclusive: Mammalian micronucleus

California Proposition 65 Chemical[102]: Cancer 10/1/1988.

Hazard Alert: Poison, Flammable, Polymerization hazard (above flash point), Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard; Skin allergy.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, F; risk phrases: R10; R19; R45; R21; R36; R50/53; R62; R63; safety phrases: S53; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Styrene oxide is a colorless to pale straw-colored liquid. Pleasant, sweet odor. Molecular weight = 120.16; specific gravity (H2O:1) = 1.05 @ 25°C; boiling point = 194°C; freezing/melting point = −37°C; vapor pressure = mmHg 0.3 @ 20°C; flash point = 76°C; autoignition temperature 498°C. Explosive limits: LEL = 1%; UEL: 22%. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 2, reactivity 0. Slightly soluble in water.

Potential Exposure: Styrene oxide is used as a reactive intermediate, especially to produce styrene glycol and its derivatives. Substantial amounts are also used in the epoxy resin industry as a diluent. It may also have applications in the preparation of agricultural and biological chemicals, cosmetics, and surface coatings and in the treatment of textiles and fibers. Styrene oxide is made in quantities in excess of a million pounds per year, and further, is a presumed metabolite of styrene which is produced in much greater quantities.

Incompatibilities: Vapors may form explosive mixture with air. May polymerize on heating above 200°C, under the influence of strong acids, strong bases; oxidizers, metal salts; such as aluminum chloride; catalysts for vinyl polymers. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 0.33 ppm

PAC-2: 3.6 ppm

PAC-3: 21 ppm

Austria: carcinogen, 1999; France: carcinogen, 1993.

Determination in Air: NIOSH Analytical Method (IV) #1501, aromatic Hydrocarbons

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Toxic by ingestion, inhalation, and skin absorption. May be corrosive. Irritates the skin, eyes, and mucous membranes. If inhaled, irritation to mucosal surfaces; headache, fatigue, weakness, nausea, vomiting, diarrhea, CNS depression; unsteadiness or feeling of drunkenness; peripheral neuropathies and hepatic. May cause you to pass out.

Long-Term Exposure: Repeated or prolonged contact may cause skin sensitization and skin allergy, with drying and cracking. May cause liver damage. Probable carcinogen in humans; has been shown to cause stomach and liver cancer in animals. May cause decreased fertility in females.

Points of Attack: Skin, liver.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure. Liver function tests. Evaluation by a qualified allergist. Drinking alcohol may increase the liver damage caused by styrene oxide.

First Aid: *Skin Contact:* Flood all areas of body that have contacted the substance with water. Don't wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others[52]. *Eye Contact:* Remove any contact lenses at once. Immediately flush eyes well with copious quantities of water or normal saline for at least 20−30 minutes. Seek medical attention. *Inhalation:* Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion:* If unconscious or convulsing, do not induce vomiting or give anything by mouth. Assure that victim's airway is open and lay him on his side with his head lower than his body and transport at once to a medical facility. If conscious and not convulsing, give a glass of water to dilute the substance. If medical advice is not readily available, do not induce vomiting, and rush the victim to the nearest medical facility.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Polyvinyl alcohol is recommended by some safety equipment manufacturers. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration (suspected carcinogen):* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved SCBA that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-face-piece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

NIOSH as *styrene monomer*: *500 ppm:* CcrOv* [any chemical cartridge respirator with organic vapor cartridge(s)]; or SA* (any supplied-air respirator). *700 ppm:* Sa:Cf (APF = 25)* (any supplied-air respirator operated in a continuous-flow mode); or CcrFOv (APF = 50) [any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s)]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or PaprOv* [any powered, air-purifying respirator with organic vapor cartridge(s)]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA). *Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in a cool, dry place. A fireproof area separated from strong acids is recommended[57]. Where possible, automatically pump liquid from drums or other storage containers to process containers Sources of ignition, such as smoking and open flames are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gal or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2810 Toxic liquids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling:

UN2810 Toxic liquids, organic, n.o.s.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 0.7/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 1000/300
Then: Protect persons downwind (mi/km)
Day 1.1/1.8
Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Follow by washing surfaces well, first with 60%−70% ethanol, then with soap and with 60%−70% ethanol. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include styrene oxide. Use dry chemical, carbon dioxide; alcohol foam; or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(109); (102); (31); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Styrene Oxide, Washington, DC (March 9, 1978).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Styrene Oxide, Trenton, NJ (December 1999).

Subtilisins S:0680

Formula: None listed.

Synonyms: Alcalase; Alk; *Bacillus subtilis*; *Bacillus subtilis* BPN; Bacillus *subtilis* Carlsburg; BPN; Fungosin; Maxatase; Protease 150; Proteolytic enzymes; *subtilis*in BPN; *subtilis*in Carlsburg

CAS Registry Number: 9014-01-1 (*subtilis*in); 1395-21-7 (BPN)

HSDB Number: 7921

RTECS Number: CO9450000 (BPN); CO9550000 (Carlsburg)

EC Number: 232-752-2 [*Annex I Index No.:* 647-012-00-8] (*subtilis*in)

Regulatory Authority and Advisory Information

Hazard Alert: (BPN): Primary irritant (w/o allergic reaction); (Carlsburg). Primary irritant (w/o allergic reaction). Sensitization hazard (resp.), Environmental hazard.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%. Carcinogen), BPN CAS 1395-21-7.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: Xn, N; risk phrases: R22; R36/37/39; R41; R42; R51; safety phrases: S2; S22; S23; S24; S26; S29/35; S36/37/39; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water[mfg]; 2-Hazard to water[lit.].

Description: These are proteolytic enzymes which take the form of light-colored, free-flowing powders. A protein containing numerous amino acids. Molecular weight = 28,000 (approx).

Potential Exposure: These commercial proteolytic enzymes are used in laundry detergent formulations.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

OSHA PEL: None

NIOSH REL: 0.00006 milligram per cubic meter [60-minute] STEL

ACGIH TLV[1] (*as crystalline active enzyme*): 0.00006 milligram per cubic meter Ceiling Concentration

PAC not available

DFG MAK: Danger of airway sensitization

(*BPN*) Australia: TWA 0.00006 milligram per cubic meter, 1993; Denmark: TWA 0.00006 milligram per cubic meter, 1999; Norway: TWA 0.00006 milligram per cubic meter, 1999; Switzerland: MAK-W 0.00006 milligram per cubic meter, 1999; United Kingdom: LTEL 0.00006 milligram per cubic meter; STEL 0.00006 milligram per cubic meter, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Ceiling Concentration 0.00006 milligram per cubic meter

(*Carlsberg*) Sweden: TWA 1 glycine unit/m^3, ceiling 3 glycine units/m^3, 1999; United Kingdom: LTEL 0.00006 milligram per cubic meter; STEL 0.00006 milligram per cubic meter, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Ceiling Concentration 0.00006 milligram per cubic meter. Several states have set guidelines or standards for *subtilis*ins in ambient air[60] ranging from zero (North Dakota); to 0.1 μ/m^3 (Nevada); to 1000.0 μ/m^3 (Virginia).

Determination in Air: No method available.

Routes of Entry: Inhalation of dust.

Harmful Effects and Symptoms

Short-Term Exposure: *Subtilis*ins can affect you when breathed in. Irritates the eyes, skin, and respiratory tract. Exposure can cause runny nose; congestion, sore throat; sweating, headache, chest pain; flu-like symptoms; cough, breathlessness, wheezing. Prolonged exposure may lead to chronic lung damage.

Long-Term Exposure: *Subtilis*ins may cause respiratory sensitization and enzyme asthma. Future exposures can cause asthma attacks with shortness of breath; wheezing, cough, and/or chest tightness. Contact can irritate the skin, especially in sweaty areas. Prolonged exposure may lead to chronic lung damage.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended. Lung function tests. These may be normal if the person is not having an attack at the time of the test. If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the

skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures *over 0.00006 milligram per cubic meter*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator with a high efficiency particulate filter. More protection is provided by a full facepiece respirator than by a half-mask respirator, and even greater protection is provided by a powered-air purifying respirator. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed.

Where there is potential for high exposures exists, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide; water spray; or foam extinguishers. Thermal decomposition products may include harmful and irritating gases. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Subtilis*ins, Trenton, NJ (March 2003).

Sulfallate S:0700

Formula: $C_8H_{14}ClNS_2$

Synonyms: CDEC; Chlorallyl diethyldithiocarbamate; 2-Chlorallyl diethyldithiocarbamate; 2-Chlorallyl-*N,N*-diethyldithiocarbamate; 2-Chloroallyl-*N,N*-diethyldithiocarbamate; 2-Chloro-2-propene-1-thiol diethyldithiocarbamate; 2-Chloro-2-propenyl-diethylcarbamodithioate; CP 4572; Diethylcarbamodithioic acid 2-chloro-2-propenyl ester; Diethyldithiocarbamic acid-2-chloroallyl ester; NCI-COO453; Thioallate; Vegadex; Vegadex super

CAS Registry Number: 95-06-7

HSDB Number: 1538

RTECS Number: EZ5075000

UN/NA & ERG Number: UN2771 (solid)/151; UN3082 (environmentally hazardous substances, liquid, n.o.s.)/171

EC Number: 202-388-9 [*Annex I Index No.:* 006-038-00-4]

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Animal Sufficient Evidence, *possibly carcinogenic to humans*, Group 2B, 1983; NCI: Carcinogenesis Studies (feed); clear evidence: rat, mouse, 1978

California Proposition 65 Chemical[102]: Cancer 1/1/1988.

Hazard Alert: Poison, Possible thyroid effects, Combustible, Environmental hazard.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R45; R22; R50/53; safety phrases: S29/35; S53; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)]

Description: Sulfallate is an amber liquid. Molecular weight = 223.80; boiling point = 128−130°C under 1.0 mm pressure; flash point = 88°C. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 1, reactivity 0. Slightly soluble in water.

Potential Exposure: A dithiocarbamate. The major use for sulfallate in the United States is as a preemergent selective herbicide to control certain annual grasses and broadleaf weeds around vegetable and fruit crops. Sulfallate has also been used for weed control among shrubbery and ornamental plants. Some dithiocarbamates have been used as rubber components.

Incompatibilities: Dithiocarbamate esters are combustible. They react violently with powerful oxidizers such as calcium hypochlorite. Poisonous gases are generated by the thermal decomposition of dithiocarbamate compounds, including carbon disulfide, oxides of sulfur, oxides of nitrogen, hydrogen sulfide, ammonia, and methylamine.Thio and dithiocarbamates slowly decompose in aqueous solution to form carbon disulfide and methylamine or other amines. Such decompositions are accelerated by acids. Flammable gases are generated by the combination of dithiocarbamate with aldehydes, nitrides, and hydrides. Dithiocarbamate are incompatible with acids, peroxides, and acid halides.

Permissible Exposure Limits in Air

DFG MAK: Danger of skin sensitization (dithiocarbamates used as rubber components).

Routes of Entry: Poisoning can occur by inhalation, ingestion and absorption through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes and skin. High exposure may cause fatigue, sleepiness, headache, dizziness, upset stomach; severe rash and personality changes; muscle weakness and collapse may result. LD_{50}(oral-rat) = 850 mg/kg (slightly toxic).

Long-Term Exposure: Thyroid effects. Repeated or prolonged skin contact may cause rash from irritation. A probable carcinogen in humans. Repeated exposure may cause kidney damage. Sulfallate, a chlorinated dithiocarbamate, administered in the feed, was carcinogenic to Osborne-Mendel rats and to B6C3F1 mice, inducing mammary gland tumors in females of both species, tumors of the fore stomach in male rats; and lung tumors in male mice.

Points of Attack: Skin, eyes, kidneys, plasma and thyroid function (possible goiter). Cancer site in animals: stomach, lungs.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider CBC. Kidney function tests. Consider chest X-ray following acute overexposure.

First Aid: *Skin Contact:* Flood all areas of body that have contacted the substance with water. Don't wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others[52]. *Eye Contact:* Remove any contact lenses at once. Flush eyes well with copious quantities of water or normal saline for at least 20−30 minutes. Seek medical attention. *Inhalation:* Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion:* If convulsions are not present, give a glass or two of water or milk to dilute the substance. Assure that the person's airway is unobstructed and contact a hospital or poison center immediately for advice on whether or not to induce vomiting.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in a refrigerator or in a cool, dry regulated area. Where possible, automatically transfer material from drums or other storage containers to process containers Sources of ignition, such as smoking and open flames are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2771 Dithiocarbamate and Thiocarbamate pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN3082 Environmentally hazardous substances, liquid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include nitrogen oxides; sulfur oxides; and chlorine. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Small amounts may be decomposed by strong oxidizing agent. Large amounts should be incinerated in a unit with effluent gas scrubbing[22].

References

(109); (102); (31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Sulfallate, Trenton, NJ (October 2001).

Sulfolane S:0710

Formula: $C_4H_8O_2S$; $C_4H_8SO_2$

Synonyms: Bondelane A; Bondolane A; Cyclic tetramethylene sulfone; Cyclotetramethylene; Dihydrobutadiene sulfone; 1,1-Dioxidetetrahydrothiofuran; 1,1-Dioxidetetra hydrothiophene; Dioxothiolan; 1,1-Dioxothiolan; Sulfalone; Sulfolan; Sulfolane; Sulfoxaline; Tetrahydrothiofen-1,1-dioxide; Tetrahydrothiophene dioxide; Tetrahydrothiophene 1,1-dioxide; 2,3,4,5-Tetrahydrothiophene-1,1-dioxide; Tetramethylene sulfone; Thiacyclopentane dioxide; Thiocyclopentane-1,1-dioxide; Thiolane-1,1-dioxide; Thiophane dioxide; Thiophan sulfone

CAS Registry Number: 126-33-0

HSDB number: 122

RTECS Number: XN0700000

UN/NA & ERG Number: UN3334/171 (cameo)

EC Number: 204-783-1 [*Annex I Index No.:* 016-031-00-8]

Regulatory Authority and Advisory Information

Hazard Alert: Combustible, Primary irritant (w/o allergic reaction).

Hazard symbols, risk, & safety statements: Hazard symbol: Xn; risk phrases: R22; R36/37; safety phrases: S2; S25; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Sulfolane is a colorless oily liquid. Molecular weight = 120.18; specific gravity (H_2O:1) = 1.26 @ 20°C Boiling point = 285°C; freezing/melting point = 27°C; flash point = 176°C. Explosive limits: LEL = 67,000 ppm, UEL: unknown; Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 1, reactivity 0. Soluble in water.

Potential Exposure: Sulfolane is used primarily as a process solvent for extraction of aromatics and for purification of acid gases. Used as a curing agent for epoxy resins, in medicine ash an antibacterial; fractionation of wood tars, tall oil, and other fatty acids; a component of hydraulic fluid; in textile finishing.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Contact with nitronium tetrafluoroborate(1-) is potentially explosive.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 4.1 milligram per cubic meter

PAC-2: 45 milligram per cubic meter

PAC-3: 400 milligram per cubic meter

Routes of Entry: Inhalation, ingestion; skin, and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Irritating to the eyes. Lethality data indicate that sulfolane is not highly acutely toxic. Oral LD

50 values in the rat range 1846−2500 mg/kg. Symptoms of neurotoxicity have been observed in rats, dogs, and monkeys; after ingestion, injection, inhalation or dermal application of sulfolane. These effects include convulsions, hyperactivity, tremors and ataxia. Other effects of acute exposure to sulfolane include alterations in stomach, intestines, lungs and liver following ingestion; and lung and liver inflammation following inhalation.

Long-Term Exposure: Sulfolane is neither a dermal sensitizer nor irritant in the guinea pig, but it does cause eye injuries in rabbits. Subchronic inhalation exposure to sulfolane has resulted in a reduction in the white blood cell count in rats and monkeys. No information was found on the carcinogenicity or teratogenicity of sulfolane. The compound was not found to be mutagenic.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective gloves and clothing. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Green: General storage may be used. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN3334 Aviation regulated liquid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material. Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include sulfur oxides. Use dry chemical, carbon dioxide; or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Sulfolane, Washington, DC, Office of Toxic Substances (June 21, 1984).

(173); (101); (138).

Sulfotep S:0720

Formula: $C_8H_{20}O_5P_2S_2$

Synonyms: ASP 47; Bay E-393; Bayer-E-393; bis-*O*,*O*-Diethylphosphorothionic anhydride; Bladafum; Bladafume; Bladafun; Dithio; Dithiodiphosphoric acid, tetraethyl ester;

Dithiofos; Dithion; Dithione; Dithiophos; Di(thiophosphoric) acid, tetraethyl ester; Dithiopyrophosphate de tetraethyle (French); Dithiotep; E393; ENT 16,273; Ethyl thiopyrophosphate; Lethalaire G-57; Pirofos; Plant dithio aerosol; Plantfume 103 smoke generator; Pyrophosphorodithioic acid, tetraethyl ester; Pyrophosphorodithioic acid, *O*,*O*,*O*,*O*-tetraethyl ester; Sulfatep; TEDP; TEDTP; Tetraethyldithiopyrophosphate; *O*,*O*,*O*,*O*-Tetraethyldithiopyrophosphate; Tetraethyl dithiopyrophosphate; Thiotepp

CAS Registry Number: 3689-24-5

HSDB Number: 380

RTECS Number: XN4375000

UN/NA & ERG Number: (PIH) UN1704/153

EC Number: 222-995-2 [*Annex I Index No.:* 015-027-00-3]

Regulatory Authority and Advisory Information

Hazard Alert: Poison inhalation hazard: exposure can be lethal, Combustible, Suspected reprotoxic hazard, Environmental hazard.

Banned or Severely Restricted (former USSR) (UN)[13]

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P109

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10)

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500 lb (227 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

United States DOT 49CFR172.101, Inhalation Hazardous Chemical (PIH).

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, N; risk phrases: R27/28; R33; R50/53; R62; safety phrases: S1/2; S23; S28; S29/35; S36/37; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Sulfotep is a yellow mobile liquid. Garlic-like odor. Molecular weight = 322.34; specific gravity (H_2O:1) = 1.20 @ 25°C; boiling point = (decomposes) 131−135°C @ 2 mmHg; vapor pressure = 0.0002 mmHg. Hazard identification (based on NFPA-704 M Rating System): Health 4, flammability 1, reactivity 1. Practically insoluble in water; solubility = 0.0007%. A pesticide that may be absorbed on a solid carrier or mixed in a more flammable liquid which will change the physical properties listed here.

Potential Exposure: Sulfotep is used in greenhouse fumigant formulations for control of aphids, spider mites; thrips, whiteflies, etc.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Hydrolyzes very slowly in aqueous solution. Attacks some forms of plastic, rubber and coating. Corrosive to iron.

Permissible Exposure Limits in Air

NIOSH IDLH = 10 milligram per cubic meter

Conversion factor: 1 ppm = 13.18 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 0.2 milligram per cubic meter TWA [skin]

NIOSH REL: 0.2 milligram per cubic meter TWA [skin]

ACGIH TLV[1]: 0.2 milligram per cubic meter, measured as inhalable fraction and vapor TWA [skin] not classifiable as a human carcinogen

PAC Ver. 29[138]

PAC-1: 0.32 milligram per cubic meter

PAC-2: 3.5 milligram per cubic meter

PAC-3: 35 milligram per cubic meter

DFG MAK: 0.0075 ppm/0.1 milligram per cubic meter TWA; Peak Limitation Category II(2) [skin]; Pregnancy Risk Group C

EEC OEL: 0.1 milligram per cubic meter [skin]

Australia: TWA 0.2 milligram per cubic meter [skin], 1993; Austria: MAK 0.015 ppm (0.2 milligram per cubic meter) [skin], 1999; Belgium: TWA 0.2 milligram per cubic meter [skin], 1993; Denmark: TWA 0.015 ppm (0.2 milligram per cubic meter) [skin], 1999; France: VME 0.2 milligram per cubic meter [skin], 1999; Norway: TWA 0.015 ppm (0.2 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 0.1 milligram per cubic meter [skin], 2003; Switzerland: MAK-W 0.015 ppm (0.2 milligram per cubic meter) [skin], 1999; Turkey: TWA 0.2 milligram per cubic meter [skin], 1993; United Kingdom: TWA 0.2 milligram per cubic meter [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen

Several states have set guidelines or standards for sulfotep in ambient air ranging from 3.5 μ/m^3 (Virginia); to 4.0 μ/m^3 (Connecticut); to 5.0 μ/m^3 (Nevada); to 20.0 μ/m^3 (North Dakota).

Determination in Water: Octanol−water coefficient: Log $K_{ow} = \sim 4$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes and skin. Can cause rapid, fatal, poisoning. Contact may cause eye pain, blurred vision. May affect the nervous system. Symptoms of exposure include: lacrimation (discharge of tears); rhinorrhea (discharge of thin nasal mucous); headache, cyanosis, anorexia, nausea, vomiting, diarrhea, localized sweating; weakness, twitching, paralysis, Cheyne−Stokes respiration; convulsions, low blood pressure; cardiac irregular/irregularities; respiratory failure and death. Super toxic;

probable oral lethal dose in humans is less than 5 mg/kg, or a taste (less than seven drops) for a 70 kg (150 lb) person. It is a cholinesterase inhibitor. Material is similar to parathion in symptomatology, including nausea followed by vomiting; abdominal cramps; diarrhea, excessive salivation; headache, giddiness, dizziness, weakness, tightness in chest; blurring of vision; tearing, slurring of speech; confusion, troubled breathing; convulsions, coma and even death.

Long-Term Exposure: A cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. Repeated exposure may cause personality changes of depression, anxiety, or irritability.

Points of Attack: Eyes, skin, respiratory system; CNS; cardiovascular system, blood cholinesterase.

Medical Surveillance: NIOSH lists the following tests: Blood serum; cholinesterase, red blood cells/count. Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1–2 weeks while red blood cell levels may be reduced for 1–3 months. When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above test as soon as possible and get an exam of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Effects may be delayed. Keep under medical observation.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash- or dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 2 milligram per cubic meter:* Sa (APF = 10) (any supplied-air respirator). *Up to 5 milligram per cubic meter:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *Up to 10 milligram per cubic meter:* SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers and moisture. Where possible, automatically transfer material from drums or other storage containers to process containers Sources of ignition, such as smoking and open flames are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1704 (Sulfotep) Tetraethyl dithiopyrophosphate, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Remove and isolate contaminated clothing at the site. Do not touch spilled material; stop leak if you can do it without risk. Use water spray to reduce vapors. *Small spills:* absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. *Large spills:* dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Sulfotep may burn, but does not readily ignite. Use dry chemical, CO_2, water spray, or foam extinguishers. Thermal decomposition products may include oxides of phosphorus and sulfur, and phosphoric acid mist. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office. Incineration with added flammable solvent in furnace equipped with afterburner and alkaline scrubber[22].

References

(31); (173); (101); (138); (80); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Sulfotep, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Sulfotep,* Trenton, NJ (December 2000).

Sulfur S:0730

Formula: S

Synonyms: Brimstone

CAS Registry Number: 7704-34-9; *(alt.)* 12673-82-4; *(alt.)* 12767-24-7; *(alt.)* 56591-09-4; *(alt.)* 56645-30-8; *(alt.)* 57035-13-9; *(alt.)* 63705-05-5

HSDB Number: 5166

RTECS Number: WS4250000

UN/NA & ERG Number: UN1350 (solid)/133; UN2448 (molten)/155

EC Number: 231-722-6 [*Annex I Index No.:* 016-094-00-1]

Regulatory Authority and Advisory Information

Hazard Alert: Combustible, Primary irritant (w/o allergic reaction).

FDA-over the counter and proprietary drug

Hazard symbols, risk, & safety statements: Hazard symbol: Xi; risk phrases: R38; safety phrases: S2; S46 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): Nonwater polluting agent (*metal*); 1-Low hazard to water. (*colloidal*).

Description: Sulfur is a yellow crystalline solid or powder. Often transported in the molten state. Molecular weight = 32.06; 256.5 (S_8); boiling point = 445°C; freezing/melting point = 113−120°C (amorphous); 115°C (β-sulfur); 107°C (r-sulfur); flash point = 207°C; 160°C (cc); autoignition temperature 232°C. Explosive limits: LEL = 35% (1400 g/m^3). Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 2, reactivity 0. Insoluble in water.

Potential Exposure: Widely used in manufacture of sulfuric acid; carbon bisulfide; drugs, fungicides, gunpowder, wood pulp; rubber, and other products.

Incompatibilities: Combustible solid. Liquid forms sulfur dioxide with air. Violent reaction with strong oxidizers, halogen compounds; phosphorus, sodium, tin, uranium, metal carbides and other compounds. Forms explosive, shock-sensitive or pyrophoric mixtures with ammonia, ammonium nitrate; bromates, calcium carbide; charcoal, chlorates, hydrocarbons, iodates, iron. Attacks steel when moist.

Permissible Exposure Limits in Air

PAC Ver. 28, no value in Ver. 29[138]

PAC-1: 30 milligram per cubic meter

PAC-2: 330 milligram per cubic meter

PAC-3: 2000 milligram per cubic meter

Russia set a MAC for work-place air of 6.0 milligram per cubic meter of elemental sulfur.

Determination in Air: Filter; Acid; ICP; NIOSH Analytical Method (IV) #7300, Elements.

Permissible Concentration in Water: Mexico[35] set a MAC of 0.5 mg/L of sulfides in estuaries.

Routes of Entry: Inhalation, ingestion; skin, and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Sulfur can affect you when breathed in. Irritates the eyes, skin and respiratory tract. Exposure can cause inflammation of the nose and irritate the lungs.

Long-Term Exposure: Repeated exposures may cause chronic bronchitis to develop with cough, phlegm, and/or shortness of breath. Contact can irritate the skin and may cause a skin allergy. Repeated exposure to sulfur dust may cause permanent eye damage (clouding of the eye lens and chronic irritation).

Points of Attack: Skin, respiratory tract.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended. Lung function tests. Eye examination. If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash or dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures to sulfur, use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears and replaced as needed. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Red Stripe: Flammability Hazard: Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Store flammable solids up to maximum allowable quantity per control area in an approved flammable storage area. Do not store in a basement. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store solid sulfur in tightly closed containers in a cool, well-ventilated area away from oxidizers (such as perchlorates, peroxides, permanganates, chlorates and nitrates); chemically active metals (such as potassium, sodium lithium and zinc); charcoal, phosphorus, metal nitrates (such as potassium nitrate) and metal halogenates (such as zinc bromate). Molten sulfur must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates and nitrates); chemically active metals (such as potassium, sodium, lithium and zinc) and metal carbides (such as calcium carbide), since violent reactions occur. Sources of ignition, such as smoking and open flames, are prohibited where sulfur is used, handled or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN1350 Sulfur, Hazard Class: 4.1; Labels: 4.1-Flammable solid (International). NA1350 Sulfur, Hazard class: 9; Labels: 9-Miscellaneous hazardous material (Domestic). UN2448 Sulfur, molten, Hazard Class: 4.1; Labels: 4.1-Flammable solid (International). NA 2448 Sulfur, molten Hazard class: 9; Labels: 9-Miscellaneous hazardous material (Domestic).

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during clean-up. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Sulfur is a combustible solid. Use dry chemical, water spray; or foam extinguishers. Fire may restart after it has been extinguished. Dust or vapor (from molten sulfur) forms explosive mixture with air. Thermal decomposition products may include sulfur oxides. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Salvage for reprocessing or dump to landfill.

References

(31); (173); (101); (138); (80); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 2, No. 2, 65−68 (1982), New York, Van Nostrand Reinhold Co. (1982).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Sulfur, Trenton, NJ (August 2002).

Sulfur Chloride S:0740

Formula: Cl_2S_2; S_2Cl_2
Synonyms: Chloride of sulfur; Cloruro de azufre (Spanish); Chlorosulfane; Disulfur dichloride; Monocloruro de azufe (Spanish); Sulfur monochloride (di-); Sulfur subchloride; Sulfur chloride (di-); Thiosulfurous dichloride
CAS Registry Number: 10025-67-9
HSDB Number: 826
RTECS Number: WS4300000
UN/NA & ERG Number: (PIH) UN1828/137
EC Number: 233-036-2 [*Annex I Index No.:* 016-012-00-4]
Regulatory Authority and Advisory Information
Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade).
Hazard Alert: Poison inhalation hazard, Combustible, Environmental hazard.
Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)
Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1000 lb (454 kg)
United States DOT 49CFR172.101, Inhalation Hazardous Chemical
United States National Primary Drinking Water Regulations: SMCL = 250 mg[Cl^-]/L as Chloride
Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.
Hazardous to aquatic life or environment, with possible long-lasting effects[291]. Do not allow release to the environment unless proper permits are obtained from the federal government.
Hazard symbols, risk, & safety statements: Hazard symbol: C; risk phrases: R14; R20; R25; R29; R35; R50; safety phrases: S1/2; S26; S29/35; S36/37/39; S41; S45; S61 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.
Description: Sulfur chloride is a fuming, oily liquid with a yellowish-red to amber color and a suffocating odor. It has an added hazard since it oxidizes and hydrolyzes to sulfur dioxide and hydrogen chloride. Molecular weight = 135.02; specific gravity (H_2O:1) = 1.7 @ 16°C; boiling point = 138°C; freezing/melting point = −77°C; vapor pressure = 10 mmHg @ 28°C; flash point = 118°C (cc)[17]. Autoignition temperature = 234°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 1, reactivity 1₩. Reacts with water (decomposes).
Potential Exposure: Sulfur chloride finds use as a chlorinating agent, catalyst, and as an intermediate in the manufacture of organic chemicals; carbon tetrachloride; sulfur dyes; insecticides, synthetic rubber; and pharmaceuticals. Exposure may also occur during the extraction of gold, purification of sugar juice; finishing and dyeing textiles; processing vegetable oils; hardening wood; and vulcanization of rubber. Has been used as a military poison.
Incompatibilities: Decomposes violently in water, forming hydrochloric acid, sulfur dioxide; sulfur, sulfite, thiosulfate, and hydrogen sulfide. Reacts with oxidizers, strong bases; peroxides, phosphorus oxides; organics, antimony, antimony sulfide; arsenic sulfide; mercury oxide; tin, alkenes, terpenes, unsaturated glycerides; chromyl chloride; methyl sulfoxide; dimethylformamide, acetone, and other compounds; causing fire and explosion hazard. Corrosive to many metals in presence of water. Attacks some plastics, rubber and coatings.
Permissible Exposure Limits in Air
NIOSH IDLH = 5 ppm
Conversion factor 1 ppm = 5.52 milligram per cubic meter
OSHA PEL: 1 ppm/6 milligram per cubic meter TWA
NIOSH REL: 1 ppm/6 milligram per cubic meter Ceiling Concentration
ACGIH TLV[1]: 1 ppm/5.5 milligram per cubic meter Ceiling Concentration
PAC* Ver. 29[138]
PAC-1: $\mathbf{0.53}_{\mathbf{A}}$ ppm
PAC-2: $\mathbf{6.4}_{\mathbf{A}}$ ppm
PAC-3: $\mathbf{15}_{\mathbf{A}}$ ppm
*AEGLs are marked with a subscript "**A**" and correspond to 60-minute values.
Australia: TWA 1 ppm (6 milligram per cubic meter), 1993; Austria: MAK 1 ppm (6 milligram per cubic meter), 1999; Belgium: STEL 1 ppm (5.5 milligram per cubic meter), 1993; Denmark: TWA 1 ppm (6 milligram per cubic meter), 1999; Finland: TWA 1 ppm (6 milligram per cubic meter); STEL 2 ppm (12 milligram per cubic meter) [skin], 1999; Hungary: STEL 5 milligram per cubic meter, 1993; Japan: 1 ppm (5.5 milligram per cubic meter), 1999; the Netherlands: MAC 6 milligram per cubic meter, 2003; Norway: TWA 1 ppm (6 milligram per cubic meter), 1999; the Philippines: TWA 6 milligram per cubic meter, 1993; Poland: MAC (TWA) 5 milligram per cubic meter; MAC (STEL) 15 milligram per cubic meter, 1999; Russia: STEL 1 ppm (0.3 milligram per cubic meter) [skin], 1993; Switzerland: MAK-W 1 ppm (6 milligram per cubic meter), KZG-W 2 ppm (12 milligram per cubic meter), 1999; United Kingdom: STEL 1 ppm (5.6 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Ceiling Concentration 1 ppm.
Several states have set guidelines or standards for sulfur monochloride in ambient air[60] ranging from 50.0 μ/m^3 (Virginia); to 60.0 μ/m^3 (North Dakota); to 120.0 μ/m^3 (Connecticut); to 143.0 μ/m^3 (Nevada).

Determination in Air: No method available.
Determination in Water: Violent reaction.
Routes of Entry: Inhalation of vapor, ingestion; skin and/or eye contact.
Harmful Effects and Symptoms
Short-Term Exposure: A lacrimator and corrosive. Fumes can cause severe irritation to eyes, skin, and mucous membranes of the upper respiratory tract. Contact can cause severe irritation, burns and permanent eye damage. Corrosive on ingestion. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Exposure can cause headache, nausea, and dizziness. Although this compound is capable of producing severe pulmonary irritation, few serious cases of industrial exposure have been reported. This may be due to the pronounced irritant effects of sulfur chloride which serve as an immediate warning signal when concentration of the gas approaches a hazardous
Long-Term Exposure: May cause lung damage; bronchitis may develop. Repeated exposure can cause drying and cracking of the skin.
Points of Attack: Respiratory system, skin, eyes, lungs.
Medical Surveillance: Preemployment and periodic examinations should give special emphasis to the skin, eyes, and respiratory system. Pulmonary function tests may be useful. Lung function tests. Consider chest X-ray following acute overexposure. Exposures may also include sulfur dioxide and hydrochloric acid. See also these compounds.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water, or milk. Do not induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.
Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.
Respirator Selection: *5 ppm:* CcrFS (APF = 50) [any chemical cartridge respirator with a full facepiece and cartridge(s) providing protection against the compound of concern]; or GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern]; or PaprS (APF = 25) [any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode. *Escape:* GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern]; or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.
Storage: (1) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. (2) Color code—Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Keep containers well closed and upright, away from heat. Do not allow water to get into container as this material reacts violently with water when in a closed vessel. Provisions should be made for washing down spills with large quantities of water. Vapor-tight electrical equipment is recommended to reduce corrosion. Separate from oxidizing materials. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gal or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.
Shipping: UN1828 Sulfur chlorides, Hazard class: 8; Labels: 8-Corrosive material, Potential Inhalation Hazard (Special Provision 5)

Spill Handling:
Sulfur chlorides
Initial isolation and protective action distances
Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).
Small spills (From a small package or a small leak from a large package)
When spilled on land
First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.1/0.2
Large spills (From a large package or from many small packages)
First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.5/0.8
Night 0.8/1.3
When spilled in water
First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.1/0.2
Large spills (From a large package or from many small packages)
First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 0.8/1.3
Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Avoid contact with liquid and vapor. Keep people away. Wear goggles, SCBA, and rubber overclothing (including gloves). Stop discharge if possible to do so without harm. Call fire department. Isolate and remove discharged material. Notify local health and pollution control agencies. Remove all ignition sources. Ventilate area of spill or leak. The aqueous solution is a strong acid that can be neutralized with lime or soda ash. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include hydrogen chloride; hydrogen sulfide; sulfur oxides. *Do not use water*. Use chemical extinguishers. Decomposes on contact with water to produce heat and toxic and corrosive fumes. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Wearing protective equipment, spray carefully onto sodium ash/slaked lime mixture. Then spray with water, dilute, neutralize and flush to drain.

References
(31); (173); (101); (138); (100).
Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 5, No. 6, 90−92 (1985).
New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Sulfur Chloride, Trenton, NJ (October 1999).

Sulfur Dioxide S:0750

Formula: O_2S; SO_2
Synonyms: Bisulfite; Dioxido de azufe (Spanish); Fermenicide; Schwefelddioxyd (German); Sulfurous acid anhydride; Sulfurous anhydride; Sulfurous oxide; Sulfur dioxide; Sulfurous anhydride; Sulfurous oxide
CAS Registry Number: 7446-09-5; *(alt.)* 8014-94-6; *(alt.)* 12396-99-5; *(alt.)* 83008-56-4; *(alt.)* 89125-89-3
HSDB Number: 228
RTECS Number: WS4550000
UN/NA & ERG Number: (PIH) UN1079/125
EC Number: 231-195-2 [*Annex I Index No.:* 016-011-00-9]
Regulatory Authority and Advisory Information
Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 5000 (≥1.00%

concentration). (≥1.00% concentration); *Theft hazard* 500 (≥84.00% concentration).

Carcinogenicity: IARC: Human Inadequate Evidence; Animal Limited Evidence*, not classifiable as carcinogenic to humans*, Group 3, 1992.

California Proposition 65 Chemical[102]: developmental toxin (July 29, 2011).

Hazard Alert: Poison inhalation hazard, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated, Primary irritant (w/o allergic reaction).

OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 1000 lb (450 kg)

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 5000 lb (2270 kg)

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500 lb (227 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 500 lb (227 kg)

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T; risk phrases: R5; R21; R23; R34; R62; R63; safety phrases: S1/2; S9; S26; S33; S36/37/39; S38; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Sulfur dioxide is a noncombustible colorless gas at ambient temperatures with a characteristic, strong, suffocating odor. The Odor Threshold is 1.1ppm. Shipped as a liquefied compressed gas. Molecular weight = 64.06; specific gravity (H_2O:1) = 2.6 @ 20°C; boiling point = −10°C; freezing/melting point = −76°C; relative vapor density (air = 1) = 2.26. Vapor pressure = 3.2 atm; 750 mmHg @ 10.3°C;. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 0, reactivity 0. Soluble in water; solubility = 10%.

Potential Exposure: Sulfur dioxide is used in the manufacture of sodium sulfite, sulfuric acid; sulfuryl chloride; thionyl chloride; organic sulfonates; disinfectants, fumigants, glass, wine, ice, industrial and edible protein; and vapor pressure thermometers. It is also used in the bleaching of beet sugar, flour, fruit, gelatin, glue, grain, oil, straw, textiles, wicker ware; wood pulp; and wool; in the tanning of leather; in brewing and preserving; and in the refrigeration industry. Exposure may also occur in various other industrial processes as it is a by-product of ore smelting, coal and fuel oil combustion; paper manufacturing and petroleum refining.

Incompatibilities: Reacts with water to form sulfurous acid, a medium-strong acid. Reacts violently with ammonia, acrolein, acetylene; alkali metals; such as sodium, potassium, magnesium, and zinc; chlorine, ethylene oxide; amines, butadiene. Attacks many metals including aluminum, iron, steel, brass, copper, nickel; especially in presence of water or steam. Incompatible with halogens. Attacks plastics, rubber and coatings.

Permissible Exposure Limits in Air

NIOSH IDLH = 100 ppm

Conversion factor: 1 ppm = 2.62 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 5 ppm/13 milligram per cubic meter

NIOSH REL: 2 ppm/5 milligram per cubic meter TWA; 5 ppm/13 milligram per cubic meter STEL

ACGIH TLV[1]: 0.25 ppm/0.65 milligram per cubic meter STEL; not classifiable as a human carcinogen

PAC Ver. 29[138]

PAC-1: $\mathbf{0.20_A}$ ppm

PAC-2: $\mathbf{0.75_A}$ ppm

PAC-3: $\mathbf{30_A}$ ppm

*AEGLs are marked with a subscript "**A**" and correspond to 60-minute values.

DFG MAK: 0.5 ppm/1.3 milligram per cubic meter TWA; Peak Limitation Category I(1); a momentary Ceiling Concentration value of 1 mL/m^3/2.7 milligram per cubic meter should not be exceeded; Pregnancy Risk Group C

Arab Republic of Egypt: TWA 5 ppm (13 milligram per cubic meter), 1993; Australia: TWA 2 ppm (5 milligram per cubic meter); STEL 5 ppm, 1993; Austria: MAK 2 ppm (5 milligram per cubic meter), 1999; Belgium: TWA 2 ppm (5.2 milligram per cubic meter); STEL 5 ppm (13 milligram per cubic meter), 1993; Denmark: TWA 2 ppm (5 milligram per cubic meter), 1999; Finland: TWA 2 ppm (5 milligram per cubic meter); STEL 5 ppm (13 milligram per cubic meter), 1999; France: VME 2 ppm (5 milligram per cubic meter), VLE 5 ppm (10 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 5 milligram per cubic meter, 2003; Japan: 1999; Norway: TWA 2 ppm (5 milligram per cubic meter), 1999; the Philippines: TWA 5 ppm (13 milligram per cubic meter), 1993; Poland: MAC (TWA) 2 milligram per cubic meter; MAC (STEL) 5 milligram per cubic meter, 1999; Russia: STEL 10 milligram per cubic meter [skin], 1993; Sweden: NGV 2 ppm (5 milligram per cubic meter), TKV 5 ppm (13 milligram per cubic meter), 1999; Switzerland: MAK-W 2 ppm (5 milligram per cubic meter), KZG-W 4 ppm (10 milligram per cubic meter), 1999; Thailand: TWA 5 ppm (13 milligram per cubic meter), 1993; Turkey: TWA 5 ppm (13 milligram per cubic meter), 1993; United Kingdom: TWA 2 ppm (5.3 milligram per cubic meter); STEL 5 ppm (13 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam; ACGIH TLV: STEL 5 ppm. Russia[43] set a MAC for ambient air in residential areas of 0.5 milligram per cubic meter on a momentary basis and 0.05 milligram per cubic meter on a daily average basis. Several states have set guidelines or standards for sulfur dioxide in ambient air[60] ranging from 1.2 μ/m^3 (Tennessee); to 80.0−1300.0 μ/m^3 (Arizona); to 119.0 μ/m^3 (Nevada); to 1300.0 μ/m^3 (Connecticut).

Determination in Air: Use NIOSH Analytical Method (IV) #6004, Sulfur dioxide; OSHA Analytical Methods ID-200, ID-104 (for impinger).

Routes of Entry: Inhalation of gas; direct contact of gas or liquid phase on skin and mucous membranes.

Harmful Effects and Symptoms

Short-Term Exposure: *Inhalation:* Causes irritation of the eyes, nose, throat. Nose and throat irritation may be let @ 6−12 ppm. Between 10−50 ppm for 5−15 minutes, runny nose (rhinorrhea); difficult breathing; coughing and choking; reflex bronchoconstriction may occur. Levels of 50−100 ppm may only be tolerated for 30−60 minutes, and 400 ppm and above may immediately cause swelling and accumulation of fluid in throat and lungs (pulmonary edema), breathing stoppage; pneumonia, and death. Pulmonary edema is a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. *Skin:* Levels of 1% (10,000 ppm) may be irritating to moist skin. Liquid may cause frostbite and chemical burns. *Eyes:* Irritation may occur @ 20 ppm and above. Liquid may cause frostbite, and permanent damage leading to blindness. *Ingestion:* Liquid may cause frostbite and chemical burns to mouth.

Long-Term Exposure: Repeated or prolonged inhalation exposure may cause asthma. May cause chronic irritation of the eyes and respiratory tract; loss of the sense of smell; burning and dryness. Stomach problems may also occur. May cause permanent lung damage. Repeated exposure to 10 ppm may cause irritation to throat and lungs and an increased occurrence of nosebleeds. There is limited animal evidence that sulfur dioxide causes lung cancer in animals. There is limited evidence that sulfur dioxide may damage the developing fetus. *Note:* Persons with asthma, subnormal pulmonary function, or cardiovascular disease are at greater risk. Sulfur dioxide may irritate the eyes and respiratory tract. Signs and symptoms of acute exposure to sulfur dioxide may be severe and include coughing, choking, dyspnea (shortness of breath), sneezing, wheezing, and chest discomfort. Upper airway edema (swelling) or obstruction, bronchoconstriction, pneumonia, pulmonary edema; and respiratory paralysis may occur. Fatigue may be noted. Gastrointestinal effects may include nausea, vomiting, and abdominal pain. Cyanosis (blue tint to skin and mucous membranes) may be noted following exposure to sulfur dioxide. It may cause death or permanent injury after very short exposure to small quantities. 1000 ppm causes death in from 10 minutes to several hours by respiratory depression.

Points of Attack: Respiratory system, skin, eyes.

Medical Surveillance: NIOSH lists the following tests: chest X-ray, ECG, pulmonary function tests: forced vital capacity, forced expiratory volume (1 second); sputum cytology; white blood cell count/differential. Preplacement and periodic medical examinations should be concerned especially with the skin, eyes and respiratory tract. Lung function tests. Examination of the eyes, nose, and throat. Consider chest X-ray following acute overexposure. Pulmonary function should be evaluated, as well as smoking habits, and exposure to other pulmonary irritants.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *20 ppm:* CcrS (APF = 10) [any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern]; or Sa (APF = 10) (any supplied-air respirator). *50 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprS (APF = 25) [any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern]. *100 ppm:* CcrFS (APF = 50) [any chemical cartridge respirator with a full facepiece and cartridge(s) providing protection against the compound of concern]; or GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern]; or PaprTS (APF = 50) [any powered, air-purifying respirator with a tight-fitting facepiece and cartridge(s) providing protection against the compound of concern]; or SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode) *Escape:* GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern]; or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Check oxygen content prior to entering storage area. Poisonous and corrosive gas. (1) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. This gas is highly toxic. Even slight exposure to these gasses can cause death. Store outdoors in a secure, restricted area that containing warning signs. This area must be roofed and shaded with the cylinders stored off the ground and separated from all other products assigned to other hazard categories and radiant heat sources on nonwooden floors. If indoors, store in a well-ventilated areas in temperatures not to exceed 50°C. (2) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Keep temperature <54°C/130°F, protect containers from damage. Outdoor, ventilated, fireproof storage preferred. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169 with the recommendations of the Compressed Gas Association.

Shipping: UN1079 Sulfur dioxide, Hazard Class: 2.3; Labels: 2.3-Poisonous gas, 8-Corrosive material, Inhalation Hazard Zone C. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner

Spill Handling:

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 300/90
Then: Protect persons downwind (mi/km)
Day 0.4/0.6
Night 1.7/2.7

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 3000/1000
Then: Protect persons downwind (mi/km)
Day 3.5/5.5
Night 7.0 + /11.0 + *

* + means distance can be larger in certain atmospheric conditions.

****Attention:*** If dealing with a large spill from the following containers: (1) Rail tank car, (2) Highway tank truck or trailer, (3) Multiple ton cylinders or (4) Multiple small cylinders or single ton cylinder see the following: "ERG Table 3: Initial Isolation and Protective Action Distances for Different Quantities of Six Common Toxic-by-Inhalation Gases." This chart shows isolation protective distances for the transport containers listed above (numbers 1 through 4) and various wind conditions: Low wind (<6 mph); Moderate wind (6 to 12 mph); High wind (> 12 mph).

Rail tank car (isolate, all directions) 3000 ft; **Day:** (Lo)7 + mi./(Med) 7 + mi./(Hi) 4.4 mi.; **Night:** (Lo)7 + mi./(Med) 7 + mi./(Hi) 6.1 mi.

Highway tank truck or trailer (isolate, all directions) 3000 ft; **Day:** (Lo)7 + mi./(Med) 3.6 mi./(Hi) 3.1 mi.; **Night:** (Lo)7 + mi./(Med) 5 mi./(Hi) 3.8 mi.

Multiple ton cylinders (isolate, all directions) 1500 ft; **Day:** (Lo)3.2 mi./(Med) 1.5 mi./(Hi) 1.1 mi.; **Night:** (Lo) 4.7 mi./(Med) 2.5 mi./(Hi) 1.7 mi.

Multiple small cylinders or single ton cylinder (isolate, all directions) 600 ft; **Day:** (Lo)1.9 mi./(Med) 0.9 mi./(Hi) 0.7 mi.; **Night:** (Lo) 3.5 mi./(Med) 1.5 mi./(Hi) 0.9 mi.

If in a building, evacuate building and confine vapors by closing doors and shutting down HVAC systems. Restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak to disperse the gas. Wear chemical protective suit with SCBA to combat spills. Stay upwind and use water spray to "knock down" vapor; contain runoff. Stop the flow of gas, if it can be done safely from a distance. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place; and repair leak or allow cylinder to empty. Keep this chemical out of confined spaces, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Not flammable. Extinguish fires with dry chemical, carbon dioxide; water spry, fog or foam. Wear SCBA and full protective clothing. Move container from fire area. Stay away from ends of tanks. Cool containers that are exposed to flames with water from the side until well after the fire is out. Isolate area until gas has dispersed. Keep unnecessary people away. Containers may explode in heat of fire, or they may rupture and release irritating toxic sulfur dioxide. Sulfur dioxide has explosive properties when it comes in contact with sodium hydride; potassium chlorate at elevated temperatures; ethanol; ether; at very cool temperatures (−15°C); fluorine; chlorine trifluoride and chlorates. It will react with water or steam to produce toxic and corrosive fumes. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Pass into soda ash solution, then add calcium hypochlorite; neutralize and flush to sewer with water (A-38).

References

(102); (31); (173); (100).

National Institute for Occupational Safety and Health (NIOSH), "Criteria for a Recommended Standard: Occupational(2). Exposure to Sulfur Dioxide", NIOSH Document Number 74-111, Cincinnati, OH (1974).

(173); (101); (138).

World Health Organization, Sulfur Oxides and Suspended Particulate Matter, Environmental Health Criteria No. 8, Geneva, Switzerland (1979).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 3, 78−79 (1981).

United States Environmental Protection Agency, Chemical Hazard Information Profile: *Sulfur Dioxide*, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

New York State Department of Health, *Chemical Fact Sheet: Sulfur Dioxide*, Bureau of Toxic Substance Assessment, Albany, NY (March 1986 and Version 2).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Sulfur Dioxide*, Trenton, NJ (June 2000).

Sulfur Hexafluoride S:0760

Formula: F_6S; SF_6

Synonyms: Hexafluorure de soufre (French); Sulfur fluoride

CAS Registry Number: 2551-62-4

HSDB Number: 825

RTECS Number: WS4900000

UN/NA & ERG Number: UN1080/126

EC Number: 219-854-2

Regulatory Authority and Advisory Information

Hazard Alert: Suffocation/asphyxiation hazard, Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated.

United States National Primary Drinking Water Regulations: MCLG = 4 mg[F]/L; MCL = 4 mg[F]/L; SMCL = 2.0 mg[F]/L, as Fluoride.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: Xi; risk phrases: R5; R21; R37; safety phrases: S9; S33; S38; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): Nonhazard to water.

Description: Sulfur hexafluoride is a colorless, odorless gas. Shipped as a liquefied compressed gas. Molecular weight = 146.06; specific gravity (H_2O:1) = 1.7 @ 20°C; boiling point = (sublimes) − 64°C; freezing/melting point = (sublimes) − 51°C; relative vapor density (air = 1): 5.11; vapor pressure = 21.5 atm. Condenses directly to a solid upon cooling. Practically insoluble in water; solubility = 0.003% @ 25°C.

Potential Exposure: May contain highly toxic sulfur pentafluoride as an impurity. SF6 is used in various electric power applications as a gaseous dielectric or insulator. The most extensive use is in high-voltage transformers. SF6 is also used in waveguides, linear particle accelerators; Van de Graaff generators; chemically pumped continuous-wave lasers; transmission lines; and power distribution substations. Nonelectrical applications include use as a protective atmosphere for casting of magnesium alloys and use as a leak detector or in tracing moving air masses. Several sources note that vitreous substitution of SF6 in owl monkeys results in a greater ocular vascular permeability than that caused by saline. This implies that SF_6 could have an important use in retinal surgery.

Incompatibilities: May contain impurities that cause it to hydrolyze on contact with water, forming corrosive and toxic hydrogen fluoride. Vigorous reaction with disilane.

Permissible Exposure Limits in Air
Conversion factor: 1 ppm = 5.98 milligram per cubic meter @ 25°C & 1 atm
OSHA PEL: 1000 ppm/6000 milligram per cubic meter TWA
NIOSH REL: 1000 ppm/6000 milligram per cubic meter TWA
ACGIH TLV[1]: 1000 ppm/5970 milligram per cubic meter TWA
PAC Ver. 29[138]
PAC-1: 3000 ppm
PAC-2: 33,000 ppm
PAC-3: 200E + 05 ppm
DFG MAK: 1000 ppm/6100 milligram per cubic meter TWA; Peak Limitation Category II(8); Pregnancy Risk Group D
Australia: TWA 1000 ppm (6000 milligram per cubic meter), 1993; Austria: MAK 1000 ppm (6000 milligram per cubic meter), 1999; Belgium: TWA 1000 ppm (5970 milligram per cubic meter), 1993; Denmark: TWA 1000 ppm (6000 milligram per cubic meter), 1999; Finland: TWA 1000 ppm (6000 milligram per cubic meter); STEL 1250 ppm (7500 milligram per cubic meter), 1999; France: VME 1000 ppm (6000 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 6000 milligram per cubic meter, 2003; the Philippines: TWA 1000 ppm (6000 milligram per cubic meter), 1993; Poland: MAC (TWA) 1 mg[HF]/m^3; MAC (STEL) 3 mg[HF]/m^3, 1999; Russia: STEL 5000 milligram per cubic meter, 1993; Sweden: NGV 2 mg[F]/m^3, 1999; Switzerland: MAK-W 1000 ppm (6000 milligram per cubic meter), 1999; Turkey: TWA 1000 ppm (6000 milligram per cubic meter), 1993; United Kingdom: TWA 1000 ppm (6070 milligram per cubic meter); STEL 1250 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 1000 ppm. Several states have set guidelines or standards for sulfur hexafluoride in ambient air[60] ranging from 60.0 milligram per cubic meter (North Dakota); to 100.0 milligram per cubic meter (Virginia); to 120.0 milligram per cubic meter (Connecticut); to 142.857 milligram per cubic meter (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #6602.

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guidelines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg [F]/L. Safe Drinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg[F]/L; SMCL = 2 mg/F/L, as Fluoride.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = 1.68$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, skin absorption; ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: Contact with the liquid may cause frostbite. Symptoms of exposure include asphyxia; increase(d) breathing rate; pulse rate; slight muscle incoordination; emotional upset; fatigue, nausea, vomiting. SF_6 is considered to be physiologically inert in the pure state. In high concentrations. However, pure SF_6 can act as a simple asphyxiant by displacing the necessary oxygen. Ordinarily, however, SF_6 does not exist in the pure state. It contains variable quantities of sulfur fluorides. In the presence of water, these sulfur fluorides can hydrolyze to yield hydrogen fluoride (HF) and oxygluoride compounds, such as sulfuryl fluoride (SO_2F_2) and thionyl fluoride (SOF_2). These compounds have much more toxic health effects. Sulfur hexafluoride may also be contaminated with more toxic sulfur compounds, such as S_2F_{10}.

Long-Term Exposure: Repeated high exposures can cause deposits of fluorides in the bones (fluorosis) that may cause pain, disability, and mottling of the teeth. Repeated exposure can cause nausea, vomiting, loss of appetite; diarrhea or constipation. Nosebleeds and sinus problems can also occur.

Points of Attack: Respiratory system, skeleton

Medical Surveillance: Fluoride level in urine (use NIOSH #8308). Levels higher than 4 mg/L may indicate overexposure.

First Aid: *Eye:* If eye tissue is frozen, seek medical attention immediately; if tissue is not frozen, immediately and thoroughly flush the eyes with large amounts of water for at least 15 minutes, occasionally lifting the lower and upper eyelids. If irritation, pain, swelling, lacrimation, or photophobia persist, get medical attention as soon as possible. *Skin:* If frostbite has occurred, seek medical attention immediately; do NOT rub the affected areas or flush them with water. In order to prevent further tissue damage, do NOT attempt to remove frozen clothing from frostbitten areas. If frostbite has NOT occurred, immediately and thoroughly wash contaminated skin with soap and water. Breathing: If a person breathes large amounts of this chemical, move the exposed person to fresh air at once. If breathing has stopped, perform mouth-to-mouth resuscitation. Keep the affected person warm and at rest. Get medical attention as soon as possible[190].

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *(fluorides) 12.5 milligram per cubic meter:* Q_m (APF = 25) (any quarter-mask respirator). *25 milligram per cubic meter:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or SA* (any supplied-air respirator). *62.5 milligram per cubic meter:* Sa:Cf (APF = 25)* (any supplied-air respirator operated in a continuous-flow mode); or PAPRDM^{*+} *if not present as a fume* (any powered, air-purifying respirator with a dust and mist filter). *125 milligram per cubic meter:* HieF^{+} (any air-purifying, full facepiece respirator with a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *250 milligram per cubic meter:* Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* HieF^{+} (any air-purifying, full facepiece respirator with a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA). *Note:* *Substance reported to cause eye irritation or damage; may require eye protection. $^{+}$May need acid gas sorbent.

Storage: Check oxygen content prior to entering storage area. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Outdoor, ventilated, fireproof storage preferred. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169 with the recommendations of the Compressed Gas Association.

Shipping: UN1080 Sulfur hexafluoride, Hazard Class: 2.2; Labels: 2.2-Nonflammable compressed gas. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: As an immediate precautionary measure, isolate spill or leak area for at least 100 m/330 ft in all directions. *Large spill*: Consider initial downwind evacuation for at least 500 m/1/3 mi. If in a building, evacuate building and confine vapors by closing doors and shutting down HVAC systems. Restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak to disperse the gas. Wear chemical protective suit with SCBA to combat spills. Stay upwind and use water spray to “knock down” vapor; contain runoff. Stop the flow of gas, if it can be done safely from a distance. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place; and repair leak or allow cylinder to empty. Keep this chemical out of confined spaces, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a nonflammable gas. Thermal decomposition products may include hydrogen fluoride and oxides of sulfur. If tank, rail car or tank truck is involved in a fire, *isolate* for 800 m/0.5 mi. in all directions; also, consider initial evacuation for 800 m/0.5 mi. in all directions[31]. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Seal unused cylinders and return to suppliers.

References

(31); (173); (101); (138); (122); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: *Sulfur Hexafluoride*, Washington, DC (July 10, 1978).

Sulfuric Acid S:0770

Formula: H_2O_4S; H_2SO_4

Synonyms: Acido sulfurico (Spanish); Acide sulfurique (French); BOV; Dihydrogen sulfate; Dipping acid; Hydrogen sulfate; Hydroot; Matting acid; Nordhausen acid; Oil of vitriol; Schwefelsaeureloesungen (German); Spirit of sulfur; Sulfuric acid; Vitriol brown oil; Vitriol, oil of-

CAS Registry Number: 7664-93-9; *(alt.)* 119540-51-1; *(alt.)* 127529-01-5; 8014-95-7 (fuming sulfuric acid; Oleum)

HSDB Number: 1811

RTECS Number: WS5600000; WS5605000 (fuming)

UN/NA & ERG Number: UN1830/137; UN1831 (fuming)/137; UN1832 (spent)/137

EC Number: 231-639-5

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration). (*Oleum*)

Carcinogenicity (*strong inorganic acid mists containing sulfuric acid*): NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen; IARC: Human Sufficient Evidence*, carcinogenic to humans*, Group 1, 1992

California Proposition 65 Chemical[102]: Cancer (Strong inorganic acid mists containing sulfuric acid) 4/14/2003.

Hazard Alert: Corrosive, Strong oxidizer, Dangerously water reactive, Know catalytic activity, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction).

List II, DEA chemical code 6552 (Title 21 CFR1310.02)

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1000 lb (454 kg)

EPCRA Section 313 (acid aerosols including mists, vapors, gas, fog, and other airborne species of any particle size) Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: C, O, T, Xi; risk phrases: R8, R35; R36/37; R62; R63; safety phrases: S1; S17; S24/25; S26; S27; S30; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Sulfuric acid is a colorless to dark brown, odorless, oily liquid which is commercially sold @ 93% to 98% H_2SO_4, the remainder being water. Molecular weight = 98.08; specific gravity (H_2O:1) = 1.8 @ 25°C; boiling point = (decomposes) 340°C; freezing/melting point = 10.6°C; vapor pressure = 0.001 mmHg. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 2₩. Fuming sulfuric acid (oleum) gives off free SO_2. Soluble in water; violent reaction.

Potential Exposure: Used as a chemical feedstock in the manufacture of acetic acid, hydrochloric acid; citric acid; phosphoric acid; aluminum sulfate; ammonium sulfate; barium sulfate; copper sulfate; phenol, superphosphates, titanium dioxide; as well as synthetic fertilizers, nitrate explosives; artificial fibers; dyes, pharmaceuticals, detergents, glue, paint, and paper. It finds use as a dehydrating agent for esters and ethers due to its high affinity for water; as an electrolyte in storage batteries; for the hydrolysis of cellulose to obtain glucose; in the refining of mineral and vegetable oil; and in the leather industry. Other uses include fur and food processing; carbonization of wool fabrics; gas drying; uranium extraction from pitchblende; and laboratory analysis. Sulfuric acid is among the highest-volume produced chemical in the United States.

Incompatibilities: A strong acid and oxidizer. Reacts violently with water with dangerous spattering and evolution of heat. Reacts violently with combustible and reducing materials; bases, organic materials; chlorates, carbides, picrates, fulminates, water, powdered metals. Corrosive to most common metals forming explosive hydrogen gas.

Permissible Exposure Limits in Air

NIOSH IDLH = 15 milligram per cubic meter

OSHA PEL: 1 milligram per cubic meter TWA

NIOSH REL: 1 milligram per cubic meter TWA

ACGIH TLV[1]: 0.2 milligram per cubic meter (measured as thoracic fraction of the aerosol) TWA; Suspected Human Carcinogen; H_2SO_4 contained in strong inorganic acid mists

PAC* Ver. 29[138]

includes oleum

PAC-1: **0.20**$_{\mathbf{A}}$ milligram per cubic meter

PAC-2: **8.7**$_{\mathbf{A}}$ milligram per cubic meter

PAC-3: **160**$_{\mathbf{A}}$ milligram per cubic meter

*AEGLs are marked with a subscript "**A**" and correspond to 60-minute values.

DFG MAK: 0.1 milligram per cubic meter, inhalable fraction TWA; Peak Limitation Category I(1), a momentary Ceiling value of 0.2 milligram per cubic meter should not be exceeded; Carcinogen Category 4; Pregnancy Risk Group C

Arab Republic of Egypt: TWA 1 milligram per cubic meter, 1993; Australia: TWA 1 milligram per cubic meter, 1993; Austria: MAK 1 milligram per cubic meter, 1999; Belgium: TWA 1 milligram per cubic meter; STEL 3 milligram per cubic meter, 1993; Denmark: TWA 1 milligram per cubic meter, 1999; Finland: TWA 1 milligram per cubic meter; STEL 3 milligram per cubic meter [skin], 1999; France: VME 1 milligram per cubic meter, VLE 3 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 1 milligram per cubic meter, 2003; Japan: 1 milligram per cubic meter, 1999; Norway: TWA 1 milligram per cubic meter, 1999; Poland: MAC (TWA) 1 milligram per cubic meter; MAC (STEL) 3 milligram per cubic meter, 1999; Russia: STEL 1 milligram per cubic meter [skin], 1993; Sweden: NGV 1 milligram per cubic meter, TKV 3 milligram per cubic meter, 1999; Switzerland: MAK-W 1 milligram per cubic meter, KZG-W 2 milligram per cubic meter, 1999; Thailand: TWA 1 milligram per cubic meter, 1993; Turkey: TWA 1 milligram per cubic meter, 1993; United Kingdom: TWA 1 milligram per cubic meter, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 3 milligram per cubic meter. Several states have set guidelines or standards for sulfuric acid in ambient air[60] ranging from 2.381 μ/m^3 (Kansas); to 10.0 μ/m^3 (South Carolina); to 14.0 μ/m^3 (Massachusetts); to 16.0 μ/m^3 (Virginia); to 12.0−100.0 μ/m^3 (North Carolina); to 20.0 μ/m^3 (Connecticut); to 24.0 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #7903, Inorganic Acids; OSHA Analytical Method ID-113.

Permissible Concentration in Water: A guideline of 250 μg/L of sulfate has been recommended for drinking water by the EEC[35] and the state of Kansas[61].

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: *Inhalation:* May cause irritation of nose and throat at levels of 5 milligram per cubic meter. Swelling of the throat and lungs and inflammation of the bronchial membranes may occur at levels of 12−35 milligram per cubic meter. A few drops in the lung air passages may be fatal. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. *Skin:* May cause severe irritation, burns and ulceration. *Eyes:* May cause severe irritation, damage to the cornea and blindness. *Ingestion:* May cause damage to teeth, burning of the mouth, throat, and stomach; nausea, vomiting of blood and eroded tissue; holes in the stomach and intestines, shock and kidney damage. Death may occur from as little as 1 oz. Signs and symptoms of acute ingestion of sulfuric acid may be severe and include salivation, intense thirst; difficulty in swallowing; pain, and shock. Oral, esophageal, and stomach burns are common. Vomitus generally has a coffee-ground appearance. The potential for circulatory collapse is high following ingestion of sulfuric acid. Acute inhalation exposure may result in sneezing, hoarseness, choking, laryngitis, dyspnea (shortness of breath); respiratory tract irritation; and chest pain. Bleeding of nose and gums, ulceration of the nasal and oral mucosa; pulmonary edema; chronic bronchitis; and pneumonia may also occur. If the eyes have come in contact with sulfuric acid, irritation, pain, swelling, corneal erosion; and blindness may result. Dermal exposure may result in severe burns, pain, and dermatitis (red, inflamed skin).

Long-Term Exposure: Can cause chronic runny nose; tearing of the eyes; nose bleeding; and stomach upset. Risk of tooth erosion and pitting from repeated or prolonged exposure to the aerosol. Lungs may be affected by repeated or prolonged exposure to the aerosol; bronchitis may develop. Exposure to amounts greater than 3.0 milligram per cubic meter may cause all of the above symptoms in greater severity.

Points of Attack: Eyes, skin, respiratory system; teeth.

Medical Surveillance: NIOSH lists the following tests: chest X-ray; pulmonary function tests: forced vital capacity, forced expiratory volume (1 second). For those with frequent or potentially high exposure (half the TLV or greater) the following are recommended before beginning work and at regular times after that. Lung function tests. Exam of the teeth. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water, or milk. Do not induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Polyethylene, Teflon, Saranex, Neoprene/natural rubber, Viton are among the recommended protective materials for *sulfuric acid solution of more than 70%.* All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. for engineering controls see NIOSH Criteria Document #74-128, *Exposure to Sulfuric Acid.*

Respirator Selection: *Up to 15 milligram per cubic meter:* Sa:Cf (APF = 25)$^{\pounds}$ (any supplied-air respirator operated in a continuous-flow mode); or PaprAgHie (APF = 25) (APF = 25)$^{\pounds}$ (any powered, air-purifying respirator with acid gas cartridge(s) in combination with a high-efficiency particulate filter); or CcrFAg100 (APF = 50) [Any chemical cartridge respirator with a full facepiece and acid gas cartridge(s) in combination with an N100, R100, or P100 filter]; or GmFAg100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister having an N100, R100, or P100 filter]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF; PDPP (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SAF:PD,PP:ASCUBA (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus). *Escape:* GmFAg100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA). *Note:* Substance causes eye irritation or damage; eye protection needed.

Storage: Check oxygen content prior to entering storage area. **(1)** Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. (2) Color code—Yellow: Reactive Hazard; Store in a location separate from other materials, especially organic materials, flammables and combustibles, and other incompatible materials. Oxidizers, including oxidizing gases, should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Sulfuric acid must be stored to avoid contact with water, chlorates, chromates, carbides, fulminates, nitrates, picrates, and powdered metals; since violent reactions occur. Store in tightly closed containers in a cool, dry well-ventilated area away from sunlight and in an area with an acid resistant cement floor. Sources of ignition, such as smoking and open flames are prohibited where sulfuric acid is used, handled, or stored in a manner that could create a potential fire or explosion hazard. always add acid to water, never the reverse. Sulfuric acid is extremely corrosive; handle with care and use proper equipment and practices. Wherever sulfuric acid is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Contact of sulfuric acid with metal drums may cause the release of flammable, explosive hydrogen gas; therefore, storage drums should be coated with acid resistant material.

Shipping: UN1830 Sulfuric acid with >51% acid or sulfuric acid with not >51% acid, Hazard class: 8; Labels: 8-Corrosive material. UN1831 Sulfuric acid, fuming with 30% or more free sulfur trioxide and Sulfuric acid, fuming, with <30% free sulfur trioxide, Hazard class: 8; Labels: 8-Corrosive material. UN1832 Sulfuric acid, spent, Hazard class: 8; Labels: 8-Corrosive material.

Spill Handling:

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Sulfuric acid, fuming;***Sulfuric acid, fuming, with not less than 30% free Sulfur trioxide***

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 300/90
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 0.5/0.8

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 1250/400
Then: Protect persons downwind (mi/km)
Day 1.8/2.9
Night 3.5/5.6

Extremely hazardous to health; areas may be entered with extreme care. Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. No skin surface should be exposed. Keep all sources of ignition away from containers because explosive mixtures of hydrogen may be produced during storage. Ventilate area of spill or leak. *Small spills:* cover area with sodium bicarbonate or soda ash/slaked lime. Shovel neutralized residues into containers for disposal, or (if not available) cover area with sand or earth and shovel into disposal containers. Other neutralizing agents are calcinated dolomite; calcium oxide and hydroxide; sodium carbonate. Place sulfuric acid absorbed in vermiculite in sealed containers. Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Notify proper authorities in case of water pollution. Do not touch spilled material. Use water spray to reduce vapor; do not get water inside container. Dike for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include sulfur oxides are produced in fire or on contact with water. Contact with metal releases flammable and explosive hydrogen gas. Use carbon dioxide or dry chemical. Use water on combustibles burning in vicinity of this material, but use extreme care as water applied directly to this acid results in generation of heat and causes splattering. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Add slowly to solution of soda ash and slaked lime with stirring; flush to drain with large volumes of water. Recovery and reuse of spent sulfuric acid may be a viable alternative to disposal, and processes are available.

References

(109); (102); (31); (173); (101); (138); (80); (2); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 5, 80−83 (1981) and 5, No. 3, 70−74 (1985).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Sulfuric Acid, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

New York State Department of Health, *Chemical Fact Sheet:* Sulfuric Acid, Bureau of Toxic Substance Assessment, Albany, NY (March 1988 and Version 2).

Fuming sulfuric acid or oleum

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Sulfuric Acid Fuming*, Trenton, NJ (January 1986).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Sulfuric Acid Fuming*, Trenton, NJ (June 2002).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Sulfuric Acid*, Trenton, NJ (June 2002).

Sulfur Pentafluoride S:0790

Formula: $F_{10}S_2$; S_2F_{10}

Synonyms: Disulfur decafluoride; Disulfur decafluoride; Sulfur decafluoride

CAS Registry Number: 5714-22-7

HSDB Number: 7922

RTECS Number: WS4480000

UN/NA & ERG Number: UN3287/151

EC Number: 227-204-4 (disulfur decafluoride)

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Strong oxidizer, Highly toxic gas, Corrosive, Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated.

OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 250 lb (114 kg)

United States National Primary Drinking Water Regulations: MCLG = 4 mg[F]/L; MCL = 4 mg[F]/L; SMCL = 2.0 mg [F]/L, as Fluoride.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xi; risk phrases: R5; R21; R26/27/28; 34; R41; safety phrases: S1/2; S9; S26; S33; S36/37/39; S38; S41; S45 (see Appendix 4).

Description: Sulfur pentafluoride is a colorless liquid or gas (above 29°C). Odor like sulfur dioxide. Noncombustible liquid and nonflammable gas. Molecular weight = 254.12; specific gravity (H_2O:1) = 2.1 @ 0°C Boiling point = 26.7°C; freezing/melting point = −53°C; vapor pressure = mmHg 561 @ 25°C; relative vapor density (air = 1) = 8.77. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 0, reactivity 0. Insoluble in water.

Potential Exposure: Sulfur pentafluoride is encountered as a by-product in the manufacture of sulfur hexafluoride, which is made by the direct fluorination of sulfur or sulfur dioxide.

Incompatibilities: Violent reaction with many compounds, including reducing agents; chemically active metals; combustible materials, strong acids, alkaline earth sulfides, aluminum carbides, aluminum, amines, calcium sulfide, carbides, chlorine trifluoride, glycerin, hydrides, hydrochloric acid, hydrogen peroxide, hydrogen sulfide, hydroxylamine, magnesium, metal powders, metal sulfides, molybdenum, phenylhydrazine, phosphorous red/friction, phosphorous trichloride, silicon, sulfides, sulfur, sulfur dioxide, sulfur/friction, sulfuric acid, tungsten, hydrogen trisulfide. Fluorides form explosive and toxic gases on contact with strong acids and acid fumes. Reacts with strong caustics. Decomposed in temperatures above 400°C forming toxic and corrosive fumes of sulfur oxides and sulfur fluorides; as this chemical decomposes, it acts as both a strong oxidizer and a fluorinating agent.

Permissible Exposure Limits in Air

NIOSH IDLH = 1 ppm

Conversion factor: 1 ppm = 10.39 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 0.025 ppm/0.25 milligram per cubic meter TWA

NIOSH REL: 0.01 ppm/0.1 milligram per cubic meter Ceiling Concentration

ACGIH TLV[1]: 0.01 ppm/0.10 milligram per cubic meter Ceiling Concentration

PAC Ver. 29[138]
PAC-1: 9.10E-04 ppm
PAC-2: 0.01 ppm
PAC-3: 1 ppm
DFG MAK: No numerical value established. Data may be available.
Australia: TWA 0.01 ppm (0.1 milligram per cubic meter), 1993; Austria: MAK 0.025 ppm (0.25 milligram per cubic meter), 1999; Belgium: STEL 0.01 ppm (0.1 milligram per cubic meter), 1993; Denmark: TWA 0.01 ppm (0.1 milligram per cubic meter), 1999; Finland: TWA 0.025 ppm, STEL 0.075 ppm [skin], 1999; Norway: TWA 0.01 ppm (0.1 milligram per cubic meter), 1999; the Philippines: TWA 0.025 ppm (0.25 milligram per cubic meter), 1993; the Netherlands: MAC-TGG 0.1 milligram per cubic meter, 2003; Sweden: NGV 2 mg[F]/m^3, 1999; Switzerland: MAK-W 0.01 ppm (0.1 milligram per cubic meter), KZG-W 0.02 ppm (0.2 milligram per cubic meter), 1999; Turkey: TWA 0.025 ppm (0.25 milligram per cubic meter), 1993; United Kingdom: TWA 0.025 ppm (0.26 milligram per cubic meter), STEL 0.075 ppm, 2000: Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Ceiling Concentration 0.01 ppm. Several states have set guidelines or standards for sulfur pentafluoride in ambient air[60] ranging from 0.8 μ/m^3 (Virginia); to 1.0 μ/m^3 (North Dakota); to 5.0 μ/m^3 (Connecticut); to 6.0 μ/m^3 (Nevada).

Determination in Air: Gaseous fluorides collected by impinger using caustic; particulates by filter. Analysis is by ion-specific electrode per NIOSH Analytical Method 7902[18].

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guidelines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg [F]/L. Safe Drinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg[F]/L; SMCL = 2 mg/F/L, as Fluoride.

Routes of Entry: Inhalation, ingestion; skin, and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Highly toxic when inhaled. Irritates the eyes, skin, and respiratory tract. Fluorides can irritate and may damage the eyes. Skin contact can cause irritation, rash or burning sensation. High repeated exposure can cause nausea, vomiting, loss of appetite; and bone and teeth changes. Extremely high levels could be fatal. Breathing can irritate the nose and throat, and cause nausea, headaches and nosebleeds. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Very high exposure can cause fluoride poisoning with stomach pain; weakness, convulsions, collapse and death. These effects do not occur at the level of fluorides used in water for preventing cavities in teeth. In animals: pulmonary edema, hemorrhage.

Long-Term Exposure: Repeated high exposures can cause deposits of fluorides in the bones (fluorosis) that may cause pain, disability and mottling of the teeth. May cause lung and kidney damage.

Points of Attack: Respiratory system; CNS.

Medical Surveillance: NIOSH lists the following tests: chest X-ray; ECG; pulmonary function tests: forced vital capacity, forced expiratory volume (1 second); sputum cytology; white blood cell count/differential. Also consider kidney function tests. Fluoride level in urine (use NIOSH #8308). Levels higher than 4 mg/L may indicate overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and do not induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash- or gas-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *Up to 0.1 ppm:* Sa (APF = 10) (any supplied-air respirator). *Up to 0.25 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *Up to 0.5 ppm:* SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 1 ppm:* Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd, Pp (APF = 10,000) (any SCBA that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFAg (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Check oxygen content prior to entering storage area. Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Fluorides must be stored to avoid contact with strong acids (such as hydrochloric, sulfuric, and nitric); since violent reactions occur. Fluorides form explosive gases on contact with nitric acid. Store in tightly closed containers in a cool, well-ventilated area away from water. Where possible, automatically transfer material from drums or other storage containers to process containers Sources of ignition, such as smoking and open flames are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Store in a cool, well-ventilated area away from incompatible materials listed above. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage.

Shipping: UN3287 Toxic liquids, inorganic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Toxic liquids, inorganic, n.o.s.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.4/0.6
Night 1.2/1.9

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 1000/300
Then: Protect persons downwind (mi/km)
Day 1.8/2.9
Night 4.0/6.6

Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources and dampen spilled material with toluene to avoid airborne dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a nonflammable gas. Decomposed in temperatures above 400°C. Thermal decomposition products may include sulfur oxides and sulfur fluorides; as this chemical decomposes, it acts as a strong oxidizer which can increase the intensity of a fire. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Nonrefillable cylinders should be disposed of in accordance with local, state and federal regulations. Allow remaining gas to vent slowly into atmosphere in an unconfined area or exhaust hood. Refillable-type cylinders should be returned to original supplier with any valve caps and outlet plugs secured and valve protection caps in place.

References

(31); (173); (101); (138); (122).

Sulfur Tetrafluoride S:0800

Formula: F_4S; SF_4
Synonyms: Sulfur fluoride (SF_4),(*t*-4)-; Sulfur fluoride; Sulfur tetrafluoride; Tetraflurosulfurane; Tetrafluoruro de azufre (Spanish); Tétrafluorure de soufre (French)
CAS Registry Number: 7783-60-0
HSDB Number: 6339
RTECS Number: WT4800000
UN/NA & ERG Number: (PIH) UN2418/125
EC Number: 232-013-4
Regulatory Authority and Advisory Information
Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 2500 (≥1.00% concentration); *Theft hazard* 15 (≥1.33% concentration).
Hazard Alert: Poison inhalation hazard, Corrosive, Dangerously water/moisture reactive, Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated.
OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 250 lb (114 kg)
United States National Primary Drinking Water Regulations: MCLG = 4 mg[F]/L; MCL = 4 mg[F]/L; SMCL = 2.0 mg[F]/L, as Fluoride.
Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 2500 lb (1135 kg)
Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg)
Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)
OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 250 lb (114 kg)
United States DOT 49CFR172.101, Inhalation Hazardous Chemical
Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.
Hazard symbols, risk, & safety statements: Hazard symbol: T+, C; risk phrases: R5; R14; R21; R26; R34; R37; R41; R50/53; safety phrases: S1/2; S9; S33; S38; S26; S36/37/39; S38; S41; S45 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]
Description: Sulfur tetrafluoride is a colorless gas with an odor like sulfur dioxide. Shipped as a liquefied compressed gas. Molecular weight = 108.06; specific gravity (H_2O:1) = 10.5 @ 21°C; 1.95 @ −78°C; boiling point = −38°C; freezing/melting point = −121°C; relative vapor density (air = 1) = 3.78; vapor pressure = 10.5 atm @ 25°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 2. ₩ Highly soluble. Reacts violently, with water forming toxic and corrosive hydrofluoric acid and thionyl fluoride.
Potential Exposure: Sulfur tetrafluoride is used as a selective fluorinating agent in making water-repellent and oil-repellent materials and lubricity improvers. It is also used as a pesticide intermediate.
Incompatibilities: Keep away from moisture, concentrated sulfuric acid, dioxygen difluoride. Reacts vigorously with water, alcohols and acids releasing toxic fluoride, sulfur oxide fumes and forming a corrosive acid solution. Readily hydrolyzed by moisture, forming hydrofluoric acid, thionyl fluoride. Attacks glass, ceramic, concrete.
Permissible Exposure Limits in Air
NIOSH IDLH = Not determined.
Conversion factor: 1 ppm = 4.42 milligram per cubic meter @ 25°C & 1 atm
OSHA PEL: None
NIOSH REL: 0.1 ppm/0.4 milligram per cubic meter Ceiling Concentration
ACGIH TLV[1]: 0.1 ppm/0.44 milligram per cubic meter Ceiling Concentration
PAC Ver. 29[138]
PAC-1: 0.091 ppm
PAC-2: 0.1 ppm
PAC-3: 0.82 ppm
Australia: TWA 0.1 ppm (0.4 milligram per cubic meter), 1993; Austria: MAK 2.5 mg[F]/m^3, 1999; Belgium: STEL 0.1 ppm (0.44 milligram per cubic meter), 1993; Denmark: TWA 0.1 ppm (0.4 milligram per cubic meter), 1999; Finland: TWA 0.1 ppm (0.4 milligram per cubic meter), STEL 0.3 ppm [skin], 1999; Norway: TWA 0.1 ppm (0.4 milligram per cubic meter), 1999; Poland: MAC (TWA) 1 mg[HF]/m^3; MAC (STEL) 2 mg[HF]/m^3, 1999; the Netherlands: MAC 0.4 milligram per cubic meter, 2003; United Kingdom: TWA 0.1 ppm (0.45 milligram per cubic meter), STEL 0.3 ppm (1.3 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam; ACGIH TLV: Ceiling Concentration 0.1 ppm. Several states have set guidelines or standards for sulfur tetrafluoride in ambient air[60] ranging from 3.5 μ/m^3 (Virginia); to 4.0 μ/m^3 (North Dakota); to 8.0 μ/m^3 (Connecticut); to 10.0 μ/m^3 (Nevada).
Determination in Air: Bubbler; NaOH; Ion-specific electrode; OSHA Analytical Method. #ID11.
Permissible Concentration in Water: No criteria set. (SF_4 reacts violently with water to give SO_2 and HF). Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guidelines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg[F]/L. Safe Drinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg[F]/L; SMCL = 2 mg/F/L, as Fluoride.
Routes of Entry: Inhalation, ingestion; skin, and/or eye contact.
Harmful Effects and Symptoms
Short-Term Exposure: Exposure can severely irritate the nose, throat, and lungs. May cause skin burns (from SF_4 releasing hydrofluoric acid on exposure to moisture). High

levels can cause a build-up of fluid in the lungs (pulmonary edema) with cough and shortness of breath. This can lead to death. Contact with liquid may cause frostbite. Sulfur tetrafluoride is about as toxic as phosgene. It is a strong irritant. The toxic effects are attributed largely to fluorine which is released upon hydrolysis. In animals: dyspnea (breathing difficulty), weakness, rhinorrhea (discharge of thin nasal mucous).

Long-Term Exposure: May cause lung damage. Repeated high exposures can cause deposits of fluorides in the bones (fluorosis) that may cause pain, disability and mottling of the teeth. May cause kidney damage.

Points of Attack: Eyes, skin, respiratory system, bones, teeth.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that: lung function testing. Urine test for fluoride level (should not be above 4 mg/L). If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *fluorides: 12.5 milligram per cubic meter*: Q_m (APF = 25) (any quarter-mask respirator). *25 milligram per cubic meter*: Any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100; or SA* (any supplied-air respirator). *62.5 milligram per cubic meter:* Sa:Cf (APF = 25)* (any supplied-air respirator operated in a continuous-flow mode); or PAPRDM^{*+} *if not present as a fume* (any powered, air-purifying respirator with a dust and mist filter). *125 milligram per cubic meter:* HieF$^+$ (any air-purifying, full facepiece respirator with a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *250 milligram per cubic meter:* Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape:* HieF$^+$ (any air-purifying, full facepiece respirator with a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA). *Substance reported to cause eye irritation or damage; may require eye protection. *May need acid gas sorbent.

Storage: Check oxygen content prior to entering storage area. Poison gas. (1) Color code—Blue: Health Hazard/ Poison: Store in a secure poison location. This gas is highly toxic. Even slight exposure to these gasses can cause death. Store outdoors in a secure, restricted area that containing warning signs. This area must be roofed and shaded with the cylinders stored off the ground and separated from all other products assigned to other hazard categories and radiant heat sources on nonwooden floors. If indoors, store in a well-ventilated areas in temperatures not to exceed 50°C. (2) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location; keep acids away from bases and red, yellow, and blue-coded chemicals. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Sulfur tetrafluoride must be stored to avoid contact with water, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from water, steam or acids to avoid the production of toxic fumes. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: UN2418 Sulfur tetrafluoride, Hazard Class: 2.3; Labels: 2.3-Poisonous gas, 8-Corrosive material, Inhalation Hazard Zone A. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner. Forbidden to be transported by any aircraft or by rail tank car.

Spill Handling:

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 300/100
Then: Protect persons downwind (mi/km)
Day 0.4/0.6
Night 1.6/2.5

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 2000/200
Then: Protect persons downwind (mi/km)
Day 2.2/3.6
Night 5.9/9.5

If in a building, evacuate building and confine vapors by closing doors and shutting down HVAC systems. Restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak to disperse the gas. Wear chemical protective suit with SCBA to combat spills. Stay upwind and use water spray to "knock down" vapor; contain runoff. Stop the flow of gas, if it can be done safely from a distance. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place; and repair leak or allow cylinder to empty. Keep this chemical out of confined spaces, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include sulfur dioxide and hydrogen fluoride may be released in fire. This chemical is a nonflammable gas but containers may rupture and explode when exposed to heat. *Do not use water*. For small fires use dry chemical or carbon dioxide. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Nonrefillable cylinders should be disposed of in accordance with local, state and federal regulations. Allow remaining gas to vent slowly into atmosphere in an unconfined area or exhaust hood. Refillable-type cylinders should be returned to original supplier with any valve caps and outlet plugs secured and valve protection caps in place.

References

(31); (173); (101); (138); (122); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: *Sulfur Tetrafluoride*, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Sulfur Tetrafluoride, Trenton, NJ (February 2000).

Sulfur Trioxide S:0810

Formula: O_3S; SO_3

Synonyms: Sulfan; Sulfuric anhydride; Sulfuric oxide; Sulfur trioxide, stabilized; Sulfur trioxide; Trioxido de azufre (Spanish); Trioxyde de soufre (French)

CAS Registry Number: 7446-11-9

HSDB Number: 6338

RTECS Number: WT4830000

UN/NA & ERG Number: (PIH) UN1829/137

EC Number: 231-197-3

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 ($\geq$1.00% concentration).

Hazard Alert: Poison inhalation hazard, Strong oxidizer, Corrosive irritant, Possible risk of forming tumors, Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated.

OSHA 29CFR1910.119, Appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 1000 lb (450 kg)

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg)

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg). This material is a reactive solid. The TPQ does not default to 10,000 lb for nonpowder, nonmolten, nonsolution form.

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)

United States DOT 49CFR172.101, Inhalation Hazardous Chemical (PIH).

Hazard symbols, risk, & safety statements: Hazard symbol: T+, O, C; risk phrases: R45; R5; R8; R14; R21; R26; R34; R35; R37; R41; safety phrases: S1/2; S8; S9; S17; S25; S26; S30; S33; S36/37/39; S38; S41; S45; S53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Sulfur trioxide is a crystalline solid which has 3 forms: *alpha-, beta*-, and *gamma*-; and can also exist as a gas or liquid. Molecular weight = 80.06; boiling point = 45°C (all forms); freezing/melting point = 17°C (*gamma*-); 32.5°C (*beta*-); 62°C (*alpha*-); vapor pressure = 433 mmHg @ 250°C. An explosive increase in vapor pressure occurs when the *alpha*-form melts. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 2. ₩. Reacts with water forming hydrosulfuric acid.

Potential Exposure: Sulfur trioxide is used as a sulfating and sulfonating agent for detergent, lubricating oil additives, and other organic compounds; in solar energy collectors. It is also used as an intermediate in sulfuric acid manufacture and in making explosives.

Incompatibilities: Combustible and Corrosive. A strong oxidizer. Reacts violently with water, steam or moisture, releasing corrosive hydrosulfuric acid. Violent reactions occur on contact with strong bases; strong acids, chemically active metals; reducing agents; finely divided metal; cyanides, nitrates, picrates, fulminates, chlorates, sulfides, carbides, phosphorus, dioxygen difluoride, barium oxide; lead oxide; diphenyl mercury; alcohols, nitryl chloride; acetonitrile, dioxane, tetrafluoroethylene.

Permissible Exposure Limits in Air

PAC* Ver. 29[138]

PAC-1: **0.20**$_{\mathbf{A}}$ milligram per cubic meter

PAC-2: **8.7**$_{\mathbf{A}}$ milligram per cubic meter

PAC-3: **160**$_{\mathbf{A}}$ milligram per cubic meter

*AEGLs are marked with a subscript "**A**" and correspond to 60-minute values.

Finland: STEL 1 ppm (3 milligram per cubic meter) [skin], 1999; Hungary: STEL 1 milligram per cubic meter, 1993; Poland: MAC (TWA) 1 milligram per cubic meter; MAC (STEL) 3 milligram per cubic meter, 1999; Russia: STEL 1 milligram per cubic meter [skin], 1993

Routes of Entry: Inhalation, ingestion; skin, and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: This material is highly toxic and corrosive. Contact can severely irritate and burn the skin and eyes with possible permanent eye damage. It is an irritant and corrosive to mucous membranes. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Poisonous if inhaled or swallowed. Contact causes severe burns to skin and eyes. This material may cause coughing, choking, and severe discomfort at a concentration of 1 ppm.

Long-Term Exposure: Repeated exposure can cause lung irritation; bronchitis may develop.

Points of Attack: Lungs, eyes, skin.

Medical Surveillance: Lung function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water, or milk. Do not induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: PIH; check oxygen content prior to entering storage area. (1) Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. (2) Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from all forms of moisture and incompatible materials listed above. Where possible, automatically transfer material from drums or other storage containers to process containers Sources of ignition, such as smoking and open flames are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Outdoor, ventilated, fireproof storage preferred. Store in a cool, well-ventilated area away from incompatible materials listed above. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage.

Shipping: UN1829 Sulfur trioxide, stabilized, Hazard class: 8; Labels: 8-Corrosive material, 6.1-Poisonous Inhalation Hazard, Inhalation Hazard Zone B.

Spill Handling:

Sulfur trioxide, stabilized

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Sulfur trioxide, used as a weapon−not listed in current DOT tables

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 300/90
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 0.5/0.8

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 1250/400
Then: Protect persons downwind (mi/km)
Day 1.8/2.9
Night 3.5/5.6

Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Avoid inhalation. Do not touch spilled material. Keep combustibles (wood, paper, oil, etc.) away from spilled material. Dike spill for later disposal; do not apply water unless directed to so. Clean up only under supervision of an expert. Remove all ignition sources. *Solid:* Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate and wash area after clean-up is complete. *Gas:* Ventilate area of leak to disperse gas. Stop flow of gas if it can be done without harm to personnel. If the source of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Toxic and corrosive gases are produced in fire, including sulfur oxides and hydrogen fluoride. Sulfur trioxide may burn but does not easily ignite. *Do not use water.* Use dry chemical or carbon dioxide extinguishers. *Small fires:* dry chemical or carbon dioxide. Spray cooling water on containers that are exposed to flames until well after fire is out. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Containers may explode in fire. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Nonrefillable cylinders should be disposed of in accordance with local, state and federal regulations. Allow remaining gas to vent slowly into atmosphere in an unconfined area or exhaust hood. Refillable-type cylinders should be returned to original supplier with any valve caps and outlet plugs secured and valve protection caps in place.

References

(31); (173); (101); (138); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 5, 83−84 (1981).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Sulfur Trioxide, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Sulfur Trioxide, Trenton, NJ (September 1999).

Sulfuryl Chloride S:0813

Formula: SO_2Cl_2

Synonyms: Cloruro de sulfurilo (Spanish); Sulfonyl chloride; Sulfuric dichloride; Sulfuric oxychloride; Sulfuryl chloride

CAS Registry Number: 7791-25-5

HSDB Number: 827

RTECS Number: WT4870000

UN/NA & ERG Number: (PIH) UN1834/137

EC Number: 232-245-6 [*Annex I Index No.:* 016-016-00-6]

Regulatory Authority and Advisory Information

Hazard Alert: Poison inhalation hazard, Lacramator, Violently water reactive, Hygroscopic, Air reactive, Possible risk of forming tumors.

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

United States National Primary Drinking Water Regulations: SMCL = 250 mg$[Cl^-]$/L as Chloride

Hazard symbols, risk, & safety statements: Hazard symbol: T+, C; risk phrases: R14; R15/29; R29; R34; R37; R40; R51; safety phrases: S26; S36/37/39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: A colorless to light yellow fuming liquid. Pungent acrid odor. Molecular weight = 134.965; specific gravity (H_2O:1) = 1.67 @ 20°C; boiling point = 69°C @ 760 mmHg; freezing/melting point = ~ −50C; vapor pressure = 135 mmHg @ 25°C; relative vapor density (air = 1) = 4.6[136]; flash point = Not flammable. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 2 ₩. Mixes with water; decomposes exothermically, releasing heat, hydrogen chloride and sulfur dioxide gas and sulfuric acid.

Potential Exposure: Sulfuryl chloride is used to make other chemicals, including chlorophenol and chlorothymol, disinfectants, pharmaceuticals, phosphate insecticides, heterocyclic herbicides, fungicides, dyestuffs, and some plastics; as a solvent and catalyst; as a chlorosulfonating agent in organic synthesis. Also used as a dehydrating agent, as cathode material and in lithium batteries; as a wool treatment to prevent shrinkage[NLM].

Incompatibilities: Water and air reactive. When spilled in water, hydrogen chloride, sulfur dioxide and sulfuric acid are produced. Forms corrosive mixture with air (NFPA Fire Rating: 0). Reacts exothermically with moisture in air, water or steam, releasing heat and yielding sulfuric acid and HCl vapors. Reacts violently with bases, amines, amides, inorganic hydroxides; alkalis, alkali metals, dimethyl sulfoxide, dinitrogen pentoxide, lead dioxide (explosive reaction); *N*-methylformamide, red phosphorus. Reacts, possibly violently, with oxidizers, organic substances, strong acids, alcohols, amines, ethers e.g., diethyl ether, diisopropyl ether, especially if trace amounts of metal salts are present); glycols, peroxides. Attacks metals in the presence of moisture, forming flammable hydrogen gas. Acid formed by reaction with water can be neutralized by limestone, lime, or soda ash.

Permissible Exposure Limits in Air:

PAC* Ver. 29[138]

PAC-1: 0.3 ppm

PAC-2: 3.7 ppm

PAC-3: 11 ppm

Routes of Entry: Inhalation, ingestion, skin and eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Corrosive and poisonous. Breathing the vapor can cause death; skin or eye contact causes severe burns, impaired vision, or blindness. Highly toxic by inhalation. Vapors are corrosive to body tissues, skin, eyes, and respiratory system. Poisonous if ingested; can cause severe burns of mouth and stomach. Exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Poisonous if inhaled or swallowed.

Long-Term Exposure: Repeated small exposure can cause lung irritation; bronchitis may develop. May cause tumors to develop.

Points of Attack: Lungs, eyes, skin.

Medical Surveillance: Lung function tests. Consider chest X-ray following acute overexposure.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Removal of solidified molten material from skin requires medical assistance. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Do not put yourself in danger by entering a contaminated area to rescue a victim. Wear positive pressure SCBA. Wear chemical protective clothing that is specifically recommended by the manufacturer. It may provide little or no thermal protection. Structural firefighters' protective clothing provides limited protection in fire situations ONLY; it is not effective in spill situations where direct contact with the substance is possible. Fully encapsulating, vapor protective clothing should be worn for spills and leaks with no fire. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing.

Respirator Selection: *(sulfuric acid) Up to 15 milligram per cubic meter:* Sa:Cf (APF = 25)$^{\pounds}$ (any supplied-air respirator operated in a continuous-flow mode); or PaprAgHie (APF = 25) (APF = 25)$^{\pounds}$ (any powered, air-purifying respirator with acid gas cartridge(s) in combination with a high-efficiency particulate filter); or CcrFAg100 (APF = 50) [Any chemical cartridge respirator with a full facepiece and acid gas cartridge(s) in combination with an N100, R100, or P100 filter]; or GmFAg100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister having an N100, R100, or P100 filter]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF; PDPP (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SAF; PD,PP: ASCUBA (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus).

Escape: GmFAg100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: PIH; check oxygen content prior to entering storage area. (1) Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. (2) White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from all forms of moisture and incompatible materials listed above. Outdoor, ventilated, fireproof storage preferred.

Shipping: UN1834 Sulfuryl chloride, Hazard Class: 6.1; Labels: 6.1-Poison Inhalation Hazard; 8-Corrosive material; Inhalation Hazard Zone A. STN: 4930260; Sulfuryl chloride.

Spill Handling:

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

When spilled on land

First: Isolate in all directions (ft/m) 100/30

Then: Protect persons downwind (mi/km)

Day 0.1/0.2

Night 0.4/0.6

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 300/90

Then: Protect persons downwind (mi/km)

Day 0.6/1.0

Night 1.3/2.0

When spilled in water *Note:* When spilled in water, large amounts of Hydrogen chloride (HCl) may be produced.

First: Isolate in all directions (ft/m) 100/30

Then: Protect persons downwind (mi/km)

Day 0.1/0.2

Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 200/60

Then: Protect persons downwind (mi/km)

Day 0.3/0.5

Night 1.1/1.8

Fully encapsulating, vapor protective clothing should be worn for spills and leaks with no fire. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Stop leak if you can do it without risk. Use water spray to reduce vapors; do not put water directly on leak, spill area or inside container. Keep combustibles (wood, paper, oil, etc.) away from spilled material. *Small spills:* Cover with DRY earth, DRY sand, or other noncombustible material followed with plastic sheet to minimize spreading or contact with rain. Use clean nonsparking tools to collect material and place it into loosely covered plastic containers for later disposal. Prevent entry into waterways, sewers, basements, or confined areas. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Decomposes in fire, releasing corrosive and toxic gases, including chlorine, hydrogen chloride, and oxides of sulfur. Nonflammable. If tank, rail car or tank truck is involved in a fire, ISOLATE for 800 m (1/2 mi) in all directions; also, consider initial evacuation for 800 m (1/2 mi) in all directions. When material is not involved in fire: do not use water on material itself. *Small fires:* Dry chemical or CO_2. Move containers from fire area if you can do it without risk. *Large Fires*: Flood fire area with large quantities of water, while knocking down vapors with water fog. If insufficient water supply: knock down vapors only. Fire involving tanks or car/trailer loads: Cool containers with flooding quantities of water until well after fire is out. Do not get water inside containers. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. *Always* stay away from tanks engulfed in fire. May ignite combustibles (wood, paper, oil, clothing, etc.). Substance will react with water (some violently), releasing corrosive and/or toxic gases. Flammable/toxic gases may accumulate in confined areas (basement, tanks, hopper/tank cars etc.). Containers may explode when heated or if contaminated with water. Substance may be transported in a molten form. Runoff from fire control or dilution water may cause pollution. Contact with metals may evolve flammable hydrogen gas.

Disposal Method Suggested: Wear nitrile rubber gloves, laboratory coat, eye protection and, if necessary, a SCBA. Cover the spill with a 1:1:1 mixture by weight of sodium carbonate or calcium carbonate, clay cat litter (bentonite) and sand. When the sulfuryl chloride has been absorbed, scoop the mixture into a plastic pail of cold water. Allow to stand for 24 hours. Test the pH of the solution and neutralize if necessary with sodium carbonate. Decant the solution to the drain flushing with 50 times its volume of water. Treat the solid residue as normal refuse[CRC].

References

(31); (173); (101); (138); (100).

Sulfuryl Fluoride S:0820

Formula: F_2O_2S; SO_2F_2

Synonyms: Fluorure de sulfuryle (French); Fluoruro de sulfurilo (Spanish); Sulfonyl fluoride; Sulfur difluoride dioxide; Sulfuric oxyfluoride; Sulfuryl fluoride; Sulfuryl difluoride; Vikane; Vikane fumigant

CAS Registry Number: 2699-79-8

HSDB Number: 828

RTECS Number: WT5075000

UN/NA & ERG Number: (PIH) UN2191/123

EC Number: 220-281-5 [*Annex I Index No.:* 009-015-00-7]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade).

Hazard Alert: Poison inhalation hazard, Corrosive, Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated, Suspected of causing genetic defects.

United States National Primary Drinking Water Regulations: MCLG = 4 mg[F]/L; MCL = 4 mg[F]/L; SMCL = 2.0 mg[F]/L, as Fluoride.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Hazardous to aquatic life or environment, with possible long-lasting effects[291]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, C, N; risk phrases: R5; R14; R20; R21 (frostbite); R23/24/25; R35; R36/37/38; R39; R48/20; R50; safety phrases: S1; S9; S16; S26; S23; S33; S37/S39; S38; S41; S45; S60; S61; S63 (see Appendix 4)

Description: Sulfuryl fluoride is a colorless, poisonous gas. Odorless. Molecular weight = 102.06; specific gravity (H_2O:1) = 1.7 @ − 55°C; boiling point = −55°C; freezing/melting point = −137°C; relative vapor density (air = 1) = 3.72; vapor pressure = 12,000 mmHg @ 21°C. Slightly soluble in water; solubility = 0.2 @ 0°C. ₩ Water and air reactive.

Potential Exposure: Sulfuryl fluoride is used an insecticidal fumigant. It is also used in organic synthesis of drugs and dyes.

Incompatibilities: Reacts with water and steam; at temperatures >300°C, forms strong, highly corrosive acids. Incompatible with strong oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from metal hydroxides, alcohols, alkaline materials, amines, strong acids, strong bases. Fluorides form explosive gases on contact with strong acids or acid fumes.

Permissible Exposure Limits in Air

NIOSH IDLH = 200 ppm

Conversion factor: 1 ppm = 4.18 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 5 ppm/20 milligram per cubic meter TWA

NIOSH REL: 5 ppm/20 milligram per cubic meter TWA; 10 ppm/42 milligram per cubic meter STEL

ACGIH TLV[1]: 5 ppm/21 milligram per cubic meter TWA; 10 ppm/40 milligram per cubic meter STEL

PAC* Ver. 29[138]

PAC-1: 10 ppm

PAC-2: $\mathbf{21_A}$ ppm

PAC-3: **64_A** ppm
*AEGLs are marked with a subscript "**A**" and correspond to 60-minute values.
Australia: TWA 5 ppm (20 milligram per cubic meter), STEL 10 ppm, 1993; Austria: MAK 2.5 mg[F]/m^3, 1999; Belgium: TWA 5 ppm (21 milligram per cubic meter), STEL 10 ppm (42 milligram per cubic meter), 1993; Denmark: TWA 5 ppm (20 milligram per cubic meter), 1999; Finland: TWA 5 ppm (20 milligram per cubic meter), STEL 10 ppm (40 milligram per cubic meter), 1999; France: VME 5 ppm (20 milligram per cubic meter), 1999; Norway: TWA 5 ppm (20 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 20 milligram per cubic meter, 2003; Poland: MAC (TWA) 1 mg[HF]/m^3; MAC (STEL) 3 mg[HF]/m^3, 1999; Sweden: NGV 2 mg[F]/m^3, 1999; Switzerland: MAK-W 5 ppm (20 milligram per cubic meter), 1999; United Kingdom: TWA 5 ppm (21 milligram per cubic meter), STEL 10 ppm (42 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 10 ppm. Several states have set guidelines or standards for sulfuryl fluoride in ambient air[60] ranging from 200−400 μ/m^3 (North Dakota); to 350 μ/m^3 (Virginia); to 400 μ/m^3 (Connecticut); to 476 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #6012, Sulfuryl fluoride.

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guidelines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg [F]/L. Safe Drinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg[F]/L; SMCL = 2 mg/F/L, as Fluoride.

Routes of Entry: Inhalation, eye, and/or skin contact (liquid).

Harmful Effects and Symptoms

Short-Term Exposure: May cause conjunctivitis, rhinitis, pharyngitis, paresthesia. Contact with the liquid may cause frostbite. High exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Overexposure can cause nausea, vomiting, itching, muscle twitching; tremors and seizures.

Long-Term Exposure: May cause kidney damage. Repeated high exposures can cause deposits of fluorides in the bones (fluorosis) that may cause pain, disability, and mottling of the teeth.

Points of Attack: Eyes, skin, respiratory system; CNS; kidneys.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. The fluoride level in urine, (for fluoride in urine use NIOSH #8308). Levels higher than 4 mg/L may indicate overexposure. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure, kidney function tests, examination of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 50* ppm*:* Sa* (APF = 10) (any supplied-air respirator). *Up to 125* ppm*:* Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *Up to 200* ppm*:* SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode. *Escape:* GmFS100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern and having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA). *Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Check oxygen content prior to entering storage area. Poison gas. Color code—Blue: Health Hazard/Poison: Store in a secure poison location. This gas is highly toxic. Even slight exposure to these gasses can cause death. Store outdoors in a secure, restricted area that containing warning signs. This area must be roofed and shaded with the cylinders stored off the ground and separated from all other products assigned to other hazard categories and radiant heat sources on nonwooden floors. If indoors, store in a well-ventilated areas in temperatures not to exceed 50°C. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from water, steam and strong acids. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: UN2191 Sulfuryl fluoride, Hazard Class: 2.3; Labels: 2.3-Poisonous gas, Inhalation Hazard Zone D.

***Spill Handling*: Sulfuryl fluoride**

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.3/0.5

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 1000/300
Then: Protect persons downwind (mi/km)
Day 1.2/1.9
Night 3.2/5.1

If in a building, evacuate building and confine vapors by closing doors and shutting down HVAC systems. Restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak to disperse the gas. Wear chemical protective suit with SCBA to combat spills. Stay upwind and use water spray to “knock down” vapor; contain runoff. Stop the flow of gas, if it can be done safely from a distance. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place; and repair leak or allow cylinder to empty. Keep this chemical out of confined spaces, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include sulfur dioxide and hydrogen fluoride. This chemical is a nonflammable gas. For small fires use dry chemical or carbon dioxide extinguishers. Gas is heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Addition of soda ash-slaked lime solution to form the corresponding sodium and calcium salt solution. This solution can be safely discharged after dilution. The precipitated calcium fluoride may be buried or added to a landfill. Small amounts could also be released directly to the atmosphere without serious harm.

References

(31); (173); (101); (138); (80); (122).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Sulfuryl Fluoride,* Trenton, NJ (May 2000).

Sulfamic Acid S:0830

Formula: H_3NO_3S; H_2NSO_3H

Synonyms: Amidosulfonic acid; Amidosulfuric acid; Aminosulfonic acid; Sulfamic acid; Sulfamidic acid

CAS Registry Number: 5329-14-6

HSDB Number: 795

RTECS Number: WO5950000

UN/NA & ERG Number: UN2967/154

EC Number: 226-218-8 [*Annex I Index No.:* 016-026-00-0]

Regulatory Authority and Advisory Information

Hazard Alert: Primary irritant (w/o allergic reaction), Environmental hazard.

United States Environmental Protection Agency, FIFRA, 1998 Status of Pesticides: Unsupported

Canada, WHMIS, Ingredients Disclosure List Concentration 1%.

Hazardous to aquatic life or environment, with possible long-lasting effects[194]. Harmful to aquatic life with long-lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: Xi, N; risk phrases: R36/38; R52/53; safety phrases: S2; S26; S28; S41; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Sulfamic acid is a white crystalline solid. Molecular weight = 97.1; specific gravity (H_2O:1) = 2.15 @ 20°C; freezing/melting point = about 205°C (decomposition). Soluble in water; slowly reactive.

Potential Exposure: Sulfamic acid is used in metal and ceramic cleaning, bleaching paper pulp; and textiles metal; in acid cleaning; as a stabilizing agent for chlorine and hypochlorite in swimming pools; cooling towers; and paper mills.

Incompatibilities: The aqueous solution is a strong acid. Reacts violently with strong acids (especially fuming nitric acid), bases, chlorine. Reacts slowly with water, forming ammonium bisulfate. Incompatible with ammonia, amines, isocyanates, alkylene oxides; epichlorohydrin, oxidizers.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 9.5 milligram per cubic meter

PAC-2: 100 milligram per cubic meter

PAC-3: 630 milligram per cubic meter

Routes of Entry: Inhalation, ingestion; skin, and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Sulfamic acid can affect you when breathed in. Contact can burn the skin and eyes. Breathing the dust (crystals) or vapor can irritate the nose, mouth and lower airways; and may cause cough with phlegm. High exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: May cause dermatitis and skin allergy. Some closely related sulfonates cause skin allergy. May affect the lungs.

Points of Attack: Lungs, skin.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid, unless full facepiece respiratory protection is worn. Wear dust-proof goggles and face shield when working with powders or dust, unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures to sulfamic acid, use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece respirator with a high efficiency particulate filter. Greater protection is provided by a powered-air purifying respirator. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Sulfamic acid must be stored to avoid contact with strong acids (such as hydrochloric, sulfuric, and nitric); since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from chlorine and nitric acid.

Shipping: UN2967 Sulfamic acid, Hazard class: 8; Labels: 8-Corrosive material.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-

up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Sulfamic acid may burn, but does not readily ignite. Use dry chemical, CO_2, dry sand. *Do not use water* directly on material. If large quantities of combustibles are involved, use water in flooding quantities as spray and fog Thermal decomposition products may include oxides of sulfur and nitrogen. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Sulfamic Acid, Trenton, NJ (May 2000).

Sulprofos S:0840

Formula: $C_{12}H_{19}O_2PS_3$; $CH_3S\text{-}C_6H_4\text{-}OP(S)(SC_3H_7)(OCH_2CH_3)$

Synonyms: AI3-29149; Bayer NTN 9306; Bay-NTN-9306; Bolstar (Bayer); *o*-Ethyl *o*-[4-(methylmercapto)phenyl]-*S*-*n*-propylphosphorothionothiolate; *o*-Ethyl *o*-[4-(methylthio) phenyl]phosphorodithioic acid *S*-propyl ester; *o*-Ethyl *o*-[4-(methylthio)phenyl]phosphorodithioic acid *S*-propyl ester; *o*-Ethyl *o*-(4-methylthiophenyl) *S*-propyl dithiophosphate; *o*-Ethyl *o*-[4-(methylthio)phenyl] *S*-propyl phosphorodithioate; Helothion; Mercaprofos; Mercaprophos; Phosphorodithioic acid, *o*-ethyl *o*-[4-(methylthio)phenyl] *S*-propyl ester; Phosphorothioic acid, *o*-Ethyl *o*-[4-(methylthio)-phenyl] *S*-propyl ester

CAS Registry Number: 35400-43-2

HSDB Number: 6735

RTECS Number: TE4165000

UN/NA & ERG Number: (PIH) UN3018 (organophosphorus pesticide, liquid, toxic)/152

EC Number: 252-545-0

Regulatory Authority and Advisory Information

Hazard Alert: Poison inhalation hazard, Neurotoxin (cumulative), Suspected of causing genetic defects; Environmental hazard.

Banned or Severely Restricted (Germany, Malaysia) (UN)[13]

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B), severe pollutant

United States DOT 49CFR172.101, Inhalation Hazard Chemical as organophosphates.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292].

Hazard symbols, risk, & safety statements: Hazard symbol: T, N; risk phrases: R21; R23/25; R24/25; R26; R33; R50/53; R62; safety phrases: S36/37/39; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Sulprofos is a tan colored liquid. Molecular weight = 322.46; specific gravity (H_2O:1) = 1.20 @ 25°C; boiling point = 155−158°C @ 0.1 mmHg; vapor pressure = 63 mmHg @ 20°C. Poor solubility in water.

Potential Exposure: A potential danger to those involved in the manufacture, formulation, and application of this insecticide that is used for control of certain lepidopterous, dipterous, and hemipterous insects on cotton, etc.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Strong oxidizers may cause release of toxic phosphorus oxides. Organophosphates, in the presence of strong reducing agents such as hydrides, may form highly toxic and flammable phosphine gas. Keep away from alkaline materials.

Permissible Exposure Limits in Air

OSHA PEL: None

NIOSH REL: 1 milligram per cubic meter TWA

ACGIH TLV[1]: 0.008 ppm/0.1 milligram per cubic meter measured as inhalable fraction and vapor TWA; not classifiable as a human carcinogen; BEIA issued for Acetylcholinesterase inhibiting pesticides.

PAC not available.

Australia: TWA 1 milligram per cubic meter, 1993; Belgium: TWA 1 milligram per cubic meter, 1993; France: VME 1 milligram per cubic meter, 1999; Switzerland: MAK-W 1 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 1 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Several states have set guidelines of standards for sulprofos in ambient air[60] ranging from 16.0 μ/m^3 (Virginia); to 20.0 μ/m^3

(Connecticut); to 24.0 μ/m^3 (Nevada); to 100.0 μ/m^3 (North Dakota).

Determination in Air: Use NIOSH Analytical Method (IV) #5600, Organophosphorus pesticides; OSHA Analytical Method PV-2037, Sulprofos.

Determination in Water: Fish Tox = 63.99264000 ppb (INTERMEDIATE).

Routes of Entry: Inhalation, ingestion; skin, and/or eye contact. Absorbed by the skin.

Harmful Effects and Symptoms

Short-Term Exposure: May affect the nervous system; causing convulsions and respiratory failure. Shows typical anticholinesterase effects. Sulprofos can affect you when breathed in and quickly enters the body by passing through the skin. Severe poisoning can occur from skin contact. It is an organophosphate pesticide. Exposure can cause rapid severe poisoning with headaches, sweating, nausea and vomiting; diarrhea, loss of coordination; convulsions, respiratory failure; and death. This is considered a moderately toxic compound (LD_{50} for rats is 65 mg/kg).

Long-Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. Human Tox = 21.00000 ppb (INTERMEDIATE).

Points of Attack: Respiratory system; CNS; cardiovascular system, blood cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in 1−2 weeks while red blood cell levels may be reduced for 1−3 months. When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures *over 1 milligram per cubic meter*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Where possible, automatically transfer material from drums or other storage containers to process containers.

Shipping: UN3018 Organophosphorus pesticides, liquid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling:

Initial isolation and protective action distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.3/0.4
Night 0.8/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 600/200
Then: Protect persons downwind (mi/km)
Day 1.4/2.3
Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Do not touch spilled material. Do not breathe vapors. Stay upwind; keep out of low areas. Remove all ignition sources. Ventilate area of spill or leak. This material is a combustible liquid. For a spill or leak of a combustible liquid, shut off ignition sources; no flares, smoking or flames in hazard area. Stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Soil Adsorption Index $(K_{\mathrm{oc}}) = 12{,}000$ (Estimate).

Fire Extinguishing: Sulprofos may burn, but does not readily ignite. Thermal decomposition products may include oxides of phosphorus, sulfur, nitrogen, and carbon. Use dry chemical, CO_2, water spray; or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Sulprofos, Trenton, NJ (October 1998).

T

2,4,5-T T:0100

Formula: $C_8H_5Cl_3O_3$; $Cl_3C_6H_2OCH_2COOH$
Synonyms: Acetic acid, (2,4,5-T)-; Acetic acid, (2,4,5-trichlorophenoxy)-; Acide 2,4,5-trichlorophenoxyacetique (French); Acido 2,4,5-triclorofenoxiacetico (Spanish); Amine; BCF-Bushkiller; Brush-Off 445 low volatile brush killer; Brush rhap; Brushtox; Dacamine; Debroussaillant concentre; Debroussaillant super concentre; Decamine 4T; Dedweed brush killer; Ded-weed LV-6 brush kill; Dinoxol; Envert-T; Estercide T-2 and T-245; Esteron; Esteron 245; Esteron brush killer; Fence rider; Forron; Forst U 46; Fortex; Fruitone A; Inverton 245; Line rider; Phortox; Reddon; Reddox; Spontox; Super D weedone; 2,4,5-T; T-5 brush kil; Tippon; T-Nox; Tormona; Transamine; Tributon; 2,4,5-Trichlorophenoxyacetic acid; (2,4,5-Trichlor-phenoxy)-essigsaeure (German); Trinoxol; Trioxal; Trioxon; Trioxone; Veon; Veon 245; Verton 2T; Visko rhap low volatile ester; Weedar; Weedone
CAS Registry Number: 93-76-5
HSDB Number: 1145
RTECS Number: AJ8400000
UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154; UN3345/153
EC Number: 202-273-3 [*Annex I Index No*.: 607-041-00-9]
Regulatory Authority and Advisory Information
Carcinogenicity: IARC: Human Limited Evidence, animal Inadequate Evidence, possibly carcinogenic to humans, *possibly carcinogenic to humans*, Group 2B, 1987. United States Environmental Protection Agency Gene-Tox Program, Positive: D *melanogaster* sex-linked lethal; S cerevisiae-reversion; Positive/dose response: *In vivo* cytogenetics-nonhuman bone marrow; Negative: D *melanogaster*-whole sex chrom. loss; Negative: D *melanogaster*-nondisjunction; Inconclusive: Host-mediated assay; Mammalian micronucleus.
Hazard Alert: Poison, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Environmental hazard.
Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)
United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U232
RCRA, 40CFR261, Appendix 8 Hazardous Constituents
RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.72; Nonwastewater (mg/kg), 7.9
RCRA 40CFR264, appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8150 (2)
Safe Drinking Water Act (47FR9352): Priority List (55FR1470)
Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 1000 lb (454 kg)
Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)] (as 2,4,5-T and its salts and esters)
Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.
Hazard Symbols, Risk & Safety statements: Hazard Symbol: Xn, N; Risk phrases: R2; R36/37/38; R50/53; R62; R63; Safety phrases: S24; S29/35; S41; S60; S61 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.
Description: 2,4,5-T Acid is an odorless, colorless to tan crystalline solid. Molecular weight = 255.48; Specific gravity (H_2O:1) = 1.80 @ 25°C; Boiling point = (decomposes); Freezing/Melting point = 152.8°C; Vapor pressure = 1×10^{-7} mmHg. Slightly soluble in water; solubility = 0.03% @ 25°C.
Potential Exposure: Those engaged in the manufacture, formulation, and application of this herbicide used to control woody and herbaceous weeds. The EPA has issued a rebuttable presumption against registration of 2,4,5-T for pesticide uses, however. The Viet Nam war era defoliant, Agent Orange, was a mixture of 2,4,5-T and 2,4-D.
Incompatibilities: The aqueous solution is a weak acid. Incompatible with sulfuric acid, bases, ammonia, aliphatic amines; alkanolamines, isocyanates, alkylene oxides; epichlorohydrin; strong oxidizers, such as chlorine, bromine, fluorine, and strong bases.
Permissible Exposure Limits in Air
NIOSH IDLH = 250 milligram per cubic meter
OSHA PEL: 10 milligram per cubic meter TWA
NIOSH REL: 10 milligram per cubic meter TWA
ACGIH TLV[1]: 10 milligram per cubic meter; Not classifiable as a human carcinogen
Protective Action Criteria (PAC) Ver. 29[138]
PAC-1: 30 milligram per cubic meter
PAC-2: 42 milligram per cubic meter
PAC-3: 250 milligram per cubic meter
DFG MAK: 10 milligram per cubic meter, inhalable fraction [skin]; Peak Limitation Category II(2); Pregnancy Risk Group C
Australia: TWA 10 milligram per cubic meter, 1993; Austria: MAK 10 milligram per cubic meter, [skin], 1999; Belgium: TWA 10 milligram per cubic meter, 1993; Denmark: TWA 5 milligram per cubic meter, [skin], 1999; France: VME 10 milligram per cubic meter, 1993; Hungary: TWA 1 milligram per cubic meter, STEL 2 milligram per cubic meter, [skin], 1993; the Netherlands: MAC-TGG 10 milligram per cubic meter, 2003; the Phillipines: TWA 10 milligram per cubic meter, 1993; Switzerland: MAK-W 10 milligram per cubic meter, STEL 50 milligram per cubic meter, [skin], 1999; Thailand: TWA 10 milligram

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Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens.

per cubic meter, 1993; United Kingdom: TWA 10 milligram per cubic meter, STEL 20 milligram per cubic meter, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Not classifiable as a human carcinogen. Several states have set guidelines or standards for 2,4,5-T in ambient air[60] ranging from 1.0 μ/m^3 (Pennsylvania); to 100.0 μ/m^3 (North Dakota); to 160 μ/m^3 (Virginia); to 238.0 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #5001, 2,4,5-T.

Permissible Concentration in Water: The EPA (see "References" below) has set a lifetime health advisory of 21.0 μg/L. (31); (173); Mexico[35] has set limits of 100 μg/L in estuaries and 10 μg/L in coastal waters. The state of Kansas[61] has set(100). a guideline for (2). drinking water of 700.0 μg/L.

Determination in Water: Liquid-liquid extraction and gas chromatography (See EPA reference below). Fish Tox = 79154.36150000 ppb (VERY LOW). Octanol-water coefficient: Log $K_{ow} = -4$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin, and respiratory tract. *Inhalation*: Increasingly severe symptoms may include nose and throat irritation; weakness, tiredness, metallic taste in mouth; loss of appetite; diarrhea, heart problems; heart failure and death. *Skin*: Reddening and itching may develop. Absorption is slow, but may contribute significantly to total exposure. *Eyes*: Irritation may develop. *Ingestion*: 350 mg (0.01 ounce) produces only a metallic taste in the mouth, lasting about 2 hours. Approximate 4 teaspoonfuls (150 lb man) may cause weakness, tiredness, loss of appetite; diarrhea, heart problems, heart failure; and death. *Note*: Reported effects of 2,4,5-T are due to accidental exposures, often at unknown levels or duration. In addition, 2,4,5-T may be contaminated with very small amounts of another more toxic compound 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD, Dioxin). Therefore, some of the symptoms of exposure to 2,4,5,-T may be due to contaminants.

Long-Term Exposure: Levels above the standard may produce skin irritation, acne-like skin sores; loss of skin coloration in small patches; Gl tract ulcer; and nerve disorders resulting in difficulty controlling muscles. Animal studies also indicate the possibility of an increased susceptibility to infection. Changes in generic material and birth defects have been reported in laboratory studies and may be due to 2,4,5-T or its contaminant. Whether these effects are produced in humans is unknown. In animals: ataxia, skin irritation; acne-like rash; liver damage. Human Tox = 70.00000 ppb (LOW)

Points of Attack: Skin, liver, gastrointestinal tract.

Medical Surveillance: NIOSH lists the following tests: blood plasma; urine (chemical/metabolite); urine (chemical/metabolite), 24-hour collection. If symptoms develop or overexposure is suspected, liver or kidney function tests may be useful.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Note to Physician: If ingested, remove by lavage or emesis. Use general supportive measures for central nervous system (CNS) depression. Use quinidine for myotonia.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *50 milligram per cubic meter*: Qm (APF = 25) (any quarter-mask respirator). *100 milligram per cubic meter*: 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *250 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or PAPRDM, if not present as a fume (any powered, air-purifying respirator with a dust and mist filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA

(APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers, such as chlorine, bromine, fluorine, and strong bases. Where possible, automatically transfer material from drums or other storage containers to process containers. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN3345 Phenoxyacetic acid derivative pesticide, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling:

UN2811: *Isolation Distance, Spill*: 25 meters/75 feet.(NJ). Isolation Distance, Fire: 800 meters/0.5 miles[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Soil Adsorption Index (K_{oc}) = 80.

Fire Extinguishing: 2,4,5-T Acid may burn, but does not readily ignite. Use dry chemical, CO_2, water spray; or foam extinguishers. Thermal decomposition products may include phosgene, hydrogen chloride, and chlorine. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Two disposal procedures have been discussed for 2,4,5-T: (1) Mix with excess sodium carbonate, add water and let stand for 24 hours before flushing down the drain with excess water; and (2) pour onto vermiculite and incinerate with wood, paper, and waste alcohol[22]. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (173); (101); (138).

United States Environmental Protection Agency, *Alert*: *2,4,5-Trichlorphenoxy-Acetic Acid*, Washington, DC, Office of Drinking Water (August 1987)

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 3, No. 5, 20–21 (1983)

New York State Department of Health, *Chemical Fact Sheet: 2,4,5-T, Bureau of Toxic Substance*, Assessment, Albany, NY (March 1980)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* 2,4,5-(Trichlorophenoxy) Acetic Acid, Trenton, NJ (August 2001).

Tabun (Agent GA) T:0110

Formula: $C_5H_{11}N_2O_2P$; $(CH_3)_2NPO(OC_2H_5)CN$

Synonyms: Dimethylamidoethoxyphosphotyl cyanide; Dimethylaminocyanphosphorsaeureaethylester (German); Dimethylphosphoramido cyanidic acid, ethyl ester; Ethyl dimethylamidocyanophosphate; Ethyl *N*,*N*-dimethyl-aminocyanophosphate; Ethyl *N*,*N*-dimethy-lphosphoramidocyanidate; Ethyl dimethyl-phosphoramidocyanidate; GA (military designation); Gelan 1; LE-100; MCE; Phosphoramidocyanidic acid, dimethyl-, ethyl ester; T-2104; Taboon A; TL 1578

CAS Registry Number: 77-81-6

HSDB Number: 6378

RTECS Number: TB4550000

UN/NA & ERG Number: (PIH) UN2810 (toxic liquid, organic, n.o.s.)/153

EC Number: None assigned.

Regulatory Authority and Advisory Information

Department of Home land Security Screening Threshold Quantity: *Theft hazard* CUM 100 g.

Carcinogenicty: GA is not listed by the International Agency for Research on Cancer (IARC), american Conference of Governmental Industrial Hygienists (ACGIH), Occupational Safety and Health Administration (OSHA), or National Toxicology Program (NTP) as a carcinogen.

Hazard Alert: Poison inhalation hazard: exposure can be lethal, Dangerous nerve agent, Neurotoxin (cumulative), Flammable, Dangerously water reactive, Environmental hazard.

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 10 lb (4.54 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 10 lb (4.54 kg)

United States DOT 49CFR172.101, Inhalation Hazard Chemical *Note*: Army Regulation, AR 50-6, deals specifically with the shipment of chemical agents; must be escorted in accordance with Army Regulation, AR 740-32.

United States DOT Regulated Marine Pollutant (49CFR172.101, appendix B) as cyanide mixtures, cyanide solutions

Canada, National Pollutant Release Inventory (NPRI); CEPA Priority Substance List, Ocean dumping prohibited

Description: Tabun (GA), an organophosphorous compound, is a nerve agents, and among the most toxic of the known chemical warfare agents. Exposure to tabun can cause death in minutes. A fraction of an ounce (1−10 mL) of tabun on the skin can be fatal. GA is a clear, colorless to brownish, oily liquid, with a slight fruity odor, like almonds. No odor when pure. *Warning*: Odor is not a reliable indicator of the presence of toxic amounts of Tabun. It is tasteless. Tabun is chemically similar to malathion or parathion, and other organophosphates. Molecular weight = 162.12; Specific gravity (H_2O:1) = 1.07 @ 25°C; Boiling point = 230°C (decomposition); Freezing/Melting point = −50°C; Vapor density (air = 1) = 5.6; Vapor pressure = 0.057 mmHg @ 25°C/0.07@24°C; Volatility = 490 milligram per cubic meter @25°C; Flash point = 78°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 2, Reactivity 0 ₩. Soluble in water; readily hydrolyzed forming hydrogen cyanide; solubility = 9.8×10^4 @ 25°C/7.2 @ 20°C. Henry's Law constant = 1.5×10^{-7} atm-m^3/mol @ 25°C (est)[72].

Potential Exposure: GA is a highly persistent (may remain liquid for more than 24 hours) chemical warfare agent; military nerve gas. Nerve agents are more toxic and potent than insecticides. *Note*: If used as a weapon, notify United States Department of Defense: Army. Damage and/or death may occur before chemical detection can take place. Use M8 paper if available (Detection: yellow) or M256-A1 Detector Kit (Detection limit: 0.005 milligram per cubic meter).

Persistence of Chemical Agent: Tabun (GA): Summer: 10 min to 24 hours; Winter: 2 hours to 3 days. Less toxic than sarin.

Incompatibilities: Tabun (GA) decomposes slowly in water; hydrolysis forms hydrogen cyanide. Under acid conditions, GA hydrolyzes to form hydrofluoric acid (HF). Raising the pH increases the rate of decomposition significantly. Rapidly hydrolyzed in basic solutions (Na_2CO_3, NaOH, or KOH) with a half-life of 1.5 minutes at pH 11 @25°C. GA and its hydrolysis products exhibit no significant phototransformations in sunlight. Tabun and its hydrolysis products are thermally stable at temperatures less than 49°C. Reacts with oxidizing materials. Tabun is destroyed by bleaching powder, but the reaction produces cyanogen chloride (CNCl). Decomposes within six months @ 60°C. Complete decomposition in 3.5 hours @ 150°C; may produce hydrogen cyanide, oxides of nitrogen; oxides of phosphorus; carbon monoxide; and hydogen cyanide. Contact with metals may evolve flammable hydrogen gas

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)* GA

PAC-1: **0.00042**$_{\mathbf{A}}$ **(4.20E-04)** ppm

PAC-2: **0.0053**$_{\mathbf{A}}$ ppm

PAC-3: **0.039**$_{\mathbf{A}}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

STEL: **0.0001** milligram per cubic meter

The suggested permissible airborne exposure concentration for GA for an 8-hour workday or a 40 hour work week is an 8 hour time weight average (TWA) of 0.0001 milligram per cubic meter (2×10^{-5} ppm). This value is based on the TWA of GA as proposed in the USAEHA Technical Guide 169, *Occupational Health Guildelines for the Evaluation and Control of Occupational Exposure to Nerve Agents, GA, GB, GD, and VX*.

WPL (Worker population limit): 0.00003 milligram per cubic meter

GPL (General population limit): 0.000001 milligram per cubic meter

Determination in Air: Military chemical agent detection papers and kits (M18A2 for liquid; M256A1, M8A1, M18A2, ICAD, CAM for vapor). M8, M9 paper will quickly detect the presence of a nerve agents but will not identify the type of agent being used. Also, the following may be helpful: "Accuro" or "Accuro 2000" (Draeger) Air Sampling/Gas (Vapor) System; or use NIOSH Analytical Method (IV) #5600, Organophosphorus pesticides; NIOSH Analytical Method #7904, Cyanides.

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 200 μg[CN]/L; State Drinking Water Standards: California 150 μg[CN]/L; State Drinking Water Guidelines: Arizona 220 μg[CN]/L; Maine. 140 μg [CN]/L; Minnesota 100 μg[CN]/L. United States Army field drinking-water standards for cyanide: 2 mg[CN]/L assuming a water consumption of 15 L/day and 6 mg[CN]/L assuming a water consumption of 5 L/day. United States Army field drinking-water standards for cyanide, long-term consumption 0.5 mg[CN]/L; Short-term consumption; Raw water constituents (maximum) 20 mg[CN]/L.

Determination in Water: Octanol-water coefficient: Log K_{ow} = (estimated) 0.29−0.38. Tabun dissolves in water and remains very dangerous. To prevent anyone from drinking water mixed with tabun, notify local health and pollution control officials. Also, notify operators of nearby water intakes and advise shutting water intakes. Use M272 Chemical Agent Water Testing Kit. Detection limit for nerve agents is 0.02 mg/L. Also, for cyanides, distillation followed by silver nitrate titration or colorimetric analysis using pyridine pyrazolone (or barbituric acid). If used as a weapon, utilize an M272 Water Detection Kit (Detection limit: 0.02 mg/L). Dangerous to aquatic life in high concentrations. May be dangerous if it enters water intakes. This material will be broken down in water quickly, but small amounts may evaporate. This material will be broken down in moist soil quickly. Small amounts may evaporate into the air or travel below the soil surface and contaminate groundwater. Persists 1½ to 2 days in soil. Bleaching powder (chlorinated line) destroys tabun but gives rise to cyanogen chloride (CAS: 506-77-4). See table of contents or name index for location of entry for cyanogen chloride.

Routes of Entry: Skin absorption, absorption through eyes; and inhalation.

Harmful Effects and Symptoms

Short-Term Exposure: Tabun is a nerve agent; it acts as a cholinesterase inhibitor. The median lethal dosage (vapor/respiratory) $LCt_{50} = 400$ mg-minute/m^3 for humans; the median incapacitating dosage is 300 mg-minute/m^3. Respiratory lethal dosages kill in 1 to 10 minutes; liquid in the eye kills nearly as rapidly. The LD_{50} (skin) = 1.0 g/70 kg/156.8 lb [man] (*Medical Aspects of Chemical and Biological Warfare, Part I*, Walter Reed Medical Center, 1997). Skin absorption great enough to cause death may occur in 1−2 minutes, but may be delayed for 1−2 hours. Nerve agent symptoms include difficulty in breathing; drooling, nausea, vomiting, cramps, involuntary defecation and urination; twitching, jerking, staggering, headache, confusion, drowsiness, coma, and convulsions. Inhalation causes dimness of vision and pinpointing of the pupils. GA is an anticholinesterase agent similar in action to GB (sarin). Although only about half as toxic as GB (sarin) by inhalation, GA in low concentrations is more irritating to the eyes than GB (sarin). The number and severity of symptoms which appear are dependent on the quantity, and rate of entry of the nerve agent which is introduced into the body (very small skin dosages sometimes cause local sweating and tremors with few other effects.) Individuals poisoned by GA display approximately the same sequence of symptoms regardless of the route by which the poison enters the body (whether by inhalation, absorption, or ingestion). These symptoms, in normal order of appearance, runny nose; tightness of chest; dimness of vision and pin pointing of the eye pupils; difficulty in breathing; drooling and excessive sweating; nausea, vomiting, cramps; and involuntary defecation and urination; twitching, jerking, staggering, headaches, confusion, drowsiness, coma, and convulsions. These symptoms are followed by cessation of breathing and death. Onset Time of Symptoms: Symptoms appear much more slowly from skin dosage than from respiratory dosage. Although skin absorption great enough to cause death may occur in 1 to 2 minutes, death may be delayed for 1 to 2 hours. Respiratory lethal dosages kill in 1 to 10 minutes, and liquid in the eye kills almost as rapidly. Median Lethal Dosage, animals: LD_{50} (monkey, percutaneous) = 9.3 mg/kg (shaved skin); LCt_{50} (monkey, inhalation) = 187 mg-min/m^3 (t = 10); Median Lethal Dosage, Man: LCt_{50} (man, inhalation) = 135 mg-min/m^3 ($t = 0.5−2$ min) at RMV (Respiratory Minute Volume) of 151/min; 200 mg-min/m^3 at RMV of 101/min GA is not listed by the International Agency for Research on Cancer (IARC); american Conference of Governmental Industrial Hygienists (ACGIH); Occupational Safety and Health Administration (OSHA); or National Toxicology Program (NTP) as a carcinogen.

Long-Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure.

Points of Attack: Respiratory system, lungs, CNS; cardiovascular system, skin, eyes, plasma and red blood cell cholinesterase. Liver, kidneys.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Urine thiocyanate levels. Complete blood count (CBC). Evaluation of thyroid function. Liver function tests. Kidney function tests. CNS tests. EKG.

First Aid: *Inhalation*: Hold breath until respiratory protective mask is donned. If severe signs of agent exposure appear (chest tightens, pupil construction, a lack of coordination; etc.), immediately administer, in rapid succession, all three Nerve Agent Antidote Kit(s), Mark I injectors (or atropine if directed by the local physician). Injections using the Mark I kit injectors may be repeated @ 5 to 20 minute intervals if signs and symptoms are progressing until three series of injections have been administered. No more injections will be given unless directed by medical personnel. In addition, a record will be maintained of all injections given. If breathing has stopped, give artificial respiration. Mouth-to-mouth resuscitation should be used when approved mask-bag or oxygen delivery systems are not available. Do not use mouth-to-mouth resuscitation when facial contamination exists. If breathing is difficult, administer oxygen. Seek medical attention *immediately*. *Eye contact: immediately* flush eyes with water for 10−15 minutes then don respiratory protective mask. Although miosis (pinpointing of the pupils) may be an early sign of agent exposure, an injection will not be administered when miosis is the only sign present. Instead, the individual will be taken immediately to the medical treatment facility for observation. *Skin contact*: Don respiratory protection mask and remove contaminated clothing. Immediately wash contaminated skin with copious amounts of soap and water, 10% sodium carbonate solution, or 5% liquid household bleach. Rinse well with water to remove decontaminate. Use M258A1 and/or M291 kit for skin decontamination. Speed in removing material from skin is of extreme importance. Administer an intramuscular injection with the MARK I kit injectors only if local sweating and muscular twitching symptoms are observed. Seek medical attention *immediately*. *Ingestion*: Do not induce vomiting. First symptoms are likely to be gastrointestinal. *Immediately* administer 2 mg. intramuscular injection of the MARK I kit auto-injectors. Seek medical attention *immediately*.

Medical treatment: Electrocardiogram (EKG), and adequacy of respiration and ventilation, should be monitored. Supplemental oxygenation, frequent suctioning of secretions, insertion of a tube into the trachea (endotracheal intubation), and assisted ventilation may be required. Diazepam (5 to 10 mg in adults and 0.2−0.5 mg/kg in children) may be used to control convulsions. Lorazepam or other benzodiazepines may be used, but barbiturates, phenytoin, and other anticonvulsants are not effective. Administration of atropine (if not already given) should precede the administration of benzodiazepines in order to best control seizures. Patients/victims who have inhalation exposure and who complain of chest pain, chest tightness, or cough should be observed and examined periodically for 6−12 hours to detect delayed-onset inflammation of the large airways (bronchitis), inflammatory lung disease (pneumonia), accumulation of fluid in the lungs (pulmonary edema), or respiratory failure.

Decontamination: This is very important. The rapid physical removal of a chemical agent is essential. If you don't have the equipment and training, don't enter the hot or the warm zone to rescue and/or decontaminate victims. Medical personnel should wear the proper PPE. If the victim can't move, decontaminate without touching and without entering the hot or the warm zone. Nerve gasses stay in clothing; *do not* touch with bare skin—if possible, seal contaminated clothes and personal belongings in a sealed double bag. Use clean water from any source; if possible, use a hose (spray or fog to prevent injury to the victim) or other system to avoid touching the victim. Don't wait for soap or for the victim to remove clothing, begin washing immediately. Do not delay decontamination to obtain warm water; time is of the essence; use cold water instead. Immediately flush the eyes with water for at least 15 minutes. Use caution to avoid hypothermia in children and the elderly. Wash—strip—wash—evacuate up wind and uphill: Patients exposed to nerve agent by vapor. only. should be decontaminated by removing all clothing in a clean-air environment and shampooing or rinsing the hair to prevent vapor-off gassing; Patients exposed to liquid nerve agent should be decontaminated by washing in available clean water at least three times. Use liquid soap (dispose of container after use and replace), large amounts of water, and mild to moderate friction with a single-use sponge or washcloth in the first and second washes. Scrubbing of exposed skin with a brush is discouraged; skin damage may occur and may increase absorption. The third wash should be to rinse with large amounts of warm or hot water. Shampoo can be used to wash the hair. Decontaminate with diluted household bleach* (0.5%, or one part bleach to 200 parts water), but don't let any get in the victim's eyes, open wounds, or mouth. Wash off the diluted bleach solution after 15 minutes. Remember that the water you use to decontaminate the victims is dangerous. Be sure you've decontaminated the victims as much as you can before they are released from the area, so they don't spread the nerve gas. Rinse the eyes, mucous membranes; or open wounds with sterile saline or water and then move away from the hot zone in an upwind and up hill direction.
**Note*: The following can be used in addition to household bleach: (1) solids, powders and solutions containing various types of bleach (NaOCl or $Ca(OCl)_2$); (2) DS2 (2% NaOH, 70% diethylenetriamine, 28% ethylene glycol monomethyl ether); (3) towelettes moistened with sodium hydroxide (NaOH) dissolved in water, phenol, ethanol, and ammonia. *Note*: Use 5% solution of common bleach (sodium hypochlorite) or calcium hypochlorite solution (48 ounces per 5 gallons of water) to decontaminate scissors used in clothing removal, clothes and other items.

Personal Protective Methods:
General information: first responders should use a NIOSH-certified chemical, biological, radiological, nuclear (CBRN) SCBA with a level a protective suit when entering an area with an unknown contaminant or when entering an area where the concentration of the contaminant is unknown. Level a protection should be used until monitoring results confirm the contaminant and the concentration of the contaminant. *Note*: safe use of protective clothing and equipment requires specific skills developed through training and experience.

LEVEL A: (*RED ZONE*)**:** select when the greatest level of skin, respiratory, and eye protection is required. This is the maximum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than the AEGL-2.

A NIOSH-certified CBRN full-facepiece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle. A totally encapsulating chemical protective (TECP) suit that provides protection against CBRN agents.

Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, and a hard hat worn under the TECP suit are optional items.

LEVEL B: (RED ZONE): Select when the highest level of respiratory protection is necessary but a lesser level of skin protection is required. This is the minimum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than AEGL-2. It differs from Level A in that it incorporates a nonencapsulating, splash-protective, chemical-resistant splash suit that provides Level A protection against liquids but is not airtight.

A NIOSH-certified CBRN full-facepiece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL C: (YELLOW ZONE): Select when the contaminant and concentration of the contaminant are known and the respiratory protection criteria factors for using Air Purifying Respirators (APR) or Powered Air Purifying Respirators (PAPR) are met. This level is appropriate when de contaminating patient/victims. A NIOSH-certified CBRN tight-fitting APR with a canister-type gas mask or CBRN PAPR for air levels greater than AEGL-2. A NIOSH-certified CBRN PAPR with a loose-fitting facepiece, hood, or helmet and a filter or a combination organic vapor, acid gas, and particulate cartridge/filter combination or a continuous flow respirator for air levels greater than AEGL-1. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Escape mask, face shield, coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL D: (GREEN ZONE): Select when the contaminant and concentration of the contaminant are known and the concentration is below the appropriate occupational exposure limit or less than AEGL-1 for the stated duration times. Limited to coveralls or other work clothes, boots, and gloves.

Other information: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. butyl rubber gloves and Tyvek "F" decontamination suits provide barrier protection against chemical warfare agents. Although resistant to liquid chemical agents, impermeable protective clothing may be penetrated after a few hours of exposure to heavy concentration of agent. Consequently, liquid contamination on the clothing must be neutralized or removed as soon as possible. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *When used as a weapon, use SCBA Respirator Certified By NIOSH For CBRN Environments.* Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive pressure mode. The M40 Series (which replaced the M17A1 protective mask) mask provides respiratory protection against all known military toxic chemical agents, but it cannot be used in an oxygen deficient environment and is *not approved for civilian use*. It does not afford protection against industrial toxics, such as ammonia and carbon monoxide.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN2810 Toxic liquids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poison Inhalation Hazard, Technical Name Required. Military driver shall be given full and complete information regarding shipment and conditions in case of emergency. AR 50-6 deals specifically with the shipment of chemical agents. Shipments of agent will be escorted in accordance with AR 740-32.

Spill Handling:

UN2810 Toxic liquids, organic, n.o.s.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.2/0.3
Night 0.7/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 1000/300
Then: Protect persons downwind (miles/kilometers)
Day 1.1/1.8
Night 2.8/4.5

GA, when used as a weapon

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)
First: Isolate in all directions (feet/meters) 300/100
Then: Protect persons downwind (miles/kilometers)
Day 0.4/0.6
Night 0.4/0.6

Fire: If tank, rail car, or tank truck is involved in fire, isolate for at least 800 meters (½ mile) in all directions; also, consider initial evacuation for 800 meters (½ mile) in all directions.

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Spills must be contained by covering with vermiculite, diatomaceous earth; clay, fine sand; sponges, and paper or cloth towels. This containment is followed by treatment with copious amounts of aqueous sodium hydroxide solution (a minimum 10% wt.). Scoop up all material and place in a fully removable head drum with a high density polyethylene liner. The decontamination solution must be treated with excess bleach to destroy the CN formed during hydrolysis. Cover the contents with additional bleach before affixing the drum head. After sealing the head, the exterior of the drum shall be decontaminated and then labeled in accordance with IAW, EPA, and DOT regulations. All leaking containers shall be overpacked with vermiculite placed between the interior and exterior containers. Decontaminate and label per IAW EPA and DOT regulations. Dispose of the material per IAW waste disposal methods provided below. Conduct general area monitoring with an approved monitor to confirm that the atmospheric concentrations do not exceed the airborne exposure limit. If 10% wt. sodium hydroxide is not available then the following decontaminants may be used instead and are listed in order of preference: Decontaminating Solution No. 2 [DS2: (2% NaOH, 70% diethylenetriamine, 28% ethylene glycol monomethyl ether)], sodium carbonate and Supertropical Bleach Slurry (STB). Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Tabun is a combustible liquid. Thermal decomposition products may include hydrogen cyanide and oxides of nitrogen, phosphorus and carbon. When heated, vapors may form explosive mixture with air, presenting an explosion hazard indoors, outdoors, and in sewers. Containers may explode when heated. Water, fog, foam, CO_2-Avoid using extinguishing methods that will cause splashing or spreading of the GA. Respiratory protection is required. Positive pressure, full facepiece, NIOSH-approved SCBA will be worn where there is danger of oxygen deficiency and when directed by the fire chief or chemical accident/incident (CAI) operations officer. The M9 or M17 series mask may be worn in lieu of SCBA when there is no danger of oxygen deficiency. In cases where firefighters are responding to a chemical accident/incident for rescue/reconnaissance purposes they will wear appropriate levels of protective clothing. Complete protection required; have decontaminants available (bleach, alkali) and atropine. Bleaching powder (chlorinated line) destroys tabun but gives rise to cyanogen chloride. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156.

Disposal Method Suggested: Principles and methods for destruction of chemical weapons: "Destruction of chemical weapons" means a process by which chemicals are converted in an essentially irreversible way to a form unsuitable for production of chemical weapons, and which in an irreversible manner renders munitions and other devices unusable as such. Each/nation/shall determine how it shall destroy chemical weapons, except that the following processes may not be used: dumping in any body of water, land burial or open-pit burning. It shall destroy chemical weapons only at specifically designated and appropriately designed and equipped facilities. Each. /nation/ shall ensure that its chemical weapons destruction facilities are constructed and operated in a manner to ensure the destruction of the chemical weapons; and that the destruction process can be verified under the provisions of this Convention. [Organization for the Prohibition of Chemical Weapons; Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and Their Destruction]. A minimum of 56 grams of decon solution is required for each gram of GA. The decontamination solution is agitated while GA is added and the agitation is maintained for at least one hour. The resulting solution is allowed to react for 24 hours. At the end of 24 hours, the solution must be tritrated to a pH between 10 and 12. After completion of the 24 hour period, the decontamination solution must be treated with excess bleach (2.5 mole OC1-/mole GA) to destroy the CN formed during hydrolysis.

Scoop up all material and place in a fully removable head drum with a high density polyethylene liner. Cover the contents with additional bleach before affixing the drum head. All contaminated clothing will be placed in a fully removable head drum with a high density polyethylene liner. Cover the contents of the drum with decontaminating solution as above before affixing the drum head. After sealing the head, the exterior of the drum shall be decontaminated and then labeled per IAW state, EPA and DOT regulations. All leaking containers shall be overpacked with vermiculite placed between the interior and exterior containers. Decontaminate and label in accordance with IAW, state, EPA, and DOT regulations. Conduct general area monitoring with an approved monitor to confirm that the atmospheric concentrations do not exceed the airborne exposure limit.

References

(31); (173); (101); (138); (85); (86); (87); (169); (93); (94); (103); (105); (163); (176).; (2).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 2, 63 (1980)

United States Environmental Protection Agency, Chemical Hazard Information Profile: Tabun, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Tabun, Trenton, NJ (April 2004)

Talc (no asbestos & <1% quartz) T:0120

Formula: $H_2Mg_3O_{12}Si$; MF: $H_{203}Si \cdot 3/4Mg$; $Mg_3SiO\ _{10}(OH)_2$
Synonyms: Agalite; Alpine talc; Asbestine; C.I. 77718; Desertalc 57; Emtal 596; Fibrene C 400; French chalk; Hydrous magnesium silicate; Lo micron talc 1; Metro talc; Mistron; Mistron star; Mistron super frost; Mistron vapor; MP-12-50; MP 25-38; NCI-C06008; Nonasbestiform talc; Nonfibrous talc; Nytal; OOS; OXO; Puretalc USP; Seawhite; Sierra C-400; Snowgoose; Steatite talc; Supreme dense; Talc (nonasbestos form); Talcum
CAS Registry Number: 14807-96-6; *(alt.)* 11119-41-8; *(alt.)* 12420-12-1; *(alt.)* 37232-12-5;*(alt.)* 99638-63-8; *(alt.)* 110540-41-5
HSDB Number: 830
RTECS Number: VV8790000
EC Number: 238-877-9
Regulatory Authority and Advisory Information
Carcinogenicty: IARC: Sufficient (*for talc containing asbestiform fibrers*) Group 1; Human Inadequate Evidence (*talc not containing asbestiform fibers*) group 3; NTP (*for talc containing asbestiform fibrers*): Known to be a human carcinogen; NCI: Carcinogenesis Studies (inhalation); clear evidence: rat; no evidence: mouse.
California Proposition 65 Chemical[102]: Cancer (*talc containing asbestiform fibers*) 4/1/90.
Hazard Alert: Possible risk of forming tumors, Primary irritant (w/o allergic reaction).; FDA-over the counter drug
Hazard Symbols, Risk & Safety statements:: Hazard Symbol: Risk phrases: R; Safety phrases: (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): Non hazard to water.

Description: Talc is an odorless solid which exists in both a nonasbestos form and a fibrous form. This entry will be concerned with the nonfibrous form. Molecular weight = 96.33; Freezing/Melting point = 900°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 0. Insoluble in water.
Potential Exposure: Talc is used in the ceramics, paint, roofing, insecticide, paper, cosmetics, lubricant, pharmaceutical, and rubber industries; electrical insulation.
Incompatibilities: None reported.
Permissible Exposure Limits in Air
for talc containing asbestos fibers: See asbestos
the following is for talc containing NO asbestos fibers
NIOSH IDLH = 1000 milligram per cubic meter
OSHA PEL (*containing less than 1% quartz*): 20 mppcf TWA
NIOSH REL: 2 milligram per cubic meter TWA, respirable dust
ACGIH TLV[1]: 2 milligram per cubic meter TWA, (respirable fraction, for particulate matter containing no asbestos and < 1% crystalline silica); not classifiable as a human carcinogen
Protective Action Criteria (PAC) Ver. 28, no values found in Ver. 29[138]
talc
PAC-1: 6 milligram per cubic meter
PAC-2: 66 milligram per cubic meter
PAC-3: 400 milligram per cubic meter
Australia: TWA 2.5 milligram per cubic meter, 1993; Austria: MAK 5 milligram per cubic meter, 1999; Belgium: TWA 2 milligram per cubic meter, 1993; Finland: TWA 5 milligram per cubic meter, 1999; Switzerland: MAK-W 2 milligram per cubic meter (respirable dust), 1999; United Kingdom: TWA 1 milligram per cubic meter, respirable dust, 2000; the Netherlands: MAC-TGG 1 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen
Determination in Air: Use NIOSH (III) P&CAM, Method #355.
Routes of Entry: Inhalation of dust, skin and/or eye contact.
Harmful Effects and Symptoms
Short-Term Exposure: Talc can affect you when breathed in. Can cause eye and lung irritation.
Long-Term Exposure: May affect the lungs, causing talc fibrotic pneumoconiosis. Repeated high exposure can cause scarring of the lungs. Symptoms of shortness of breath and cough can develop. This disease can be disabling and fatal. Talc can cause the chest X-ray to become abnormal. Contact can cause eye irritation, and may lead to a reaction causing serious eye damage.

Points of Attack: Eyes, respiratory system; cardiovascular system.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that. Lung function tests. Chest X-ray every one to three years, after five or more years of heavy exposure should be considered.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 20 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *Up to 10 milligram per cubic meter*: Qm (APF = 25) (any quarter-mask respirator). *Up to 20 milligram per cubic meter*: 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *Up to 50 milligram per cubic meter*: PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter); or Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *Up to 100 milligram per cubic meter*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); SaF (any supplied-air respirator with a full facepiece). *Up to 1000 milligram per cubic meter*: Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode. *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code-Blue (*only for talc containing asbestiform fibrers*): Health Hazard/Poison: Store in a secure poison location. Color code-Green (*talc powder or tablets*): General storage may be used. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Talc itself does not burn. Thermal decomposition products may include acrid fumes and irritating gases. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Land fill.

References

(102); (31); National institute for Occupational Safety and Health (NIOSH), Information Profiles on Potential Occupational(100). Hazards: Talc, pp. 51−53, Report PB-276, 678, Rockville, MD (October 1977)

(173); (101); (138).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Talc, Trenton, NJ (December 2000)

Tantalum & Tantalum Oxide Dusts T:0130

Formula: Ta; O_5Ta_2 (oxide)
Synonyms: *metal*: Elemental tantalum; Tantalum 181; Tantalum metal powder
oxide: Tantalic acid anhydride; Tantalum (V) oxide; Tantalum pentaoxide; Tantalum pentoxide
CAS Registry Number: 7440-25-7 (elemental); 1314-61-0 (oxide)
HSDB Number: 2533 (elemental); 7122 (tantalum compounds)
RTECS Number: WW5505000 (elemental)
UN/NA & ERG Number: Metal powder, in bulk, may be pyrophoric. UN3089 (metal powder, flammable, n.o.s.)/170
EC Number: 231-135-5; 215-238-2 (pentoxide)
Regulatory Authority and Advisory Information
Hazard Alert: Possible risk of forming tumors, Strong reducing agent, Pyrophoric; Flammable solid.
Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.
Toxic Inhalation Hazard, OSHA
Hazard Symbols, Risk & Safety statements: Hazard Symbol: T, F, Xi, Xn; Risk phrases: R11; R21/22; R23/24/25; R36/37/38; R29; R39; R60; R61; Safety phrases: S3/7; S15; S16; S26; S36/37; S45 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): Non hazard to water. (*metal and oxide*) provided they are solid with a particle size $> = 1$ mm; no reaction with water or atmospheric oxygen.
Description: Tantalum is a refractory metal in Group V-B of the periodic table. The pure metal is ductile, steel-blue to gray solid or black, odorless powder. Molecular weight = 180.95; 441.9 (oxide); Specific gravity (H_2O:1) = 16.7 (*metal*); 14.40 (powder) @ 25°C; 8.2 (oxide); Boiling point = 5425°C; Freezing/Melting point = 2996°C; 1872 (oxide); Maximum Explosive concentration (MEC) = < 200 g/m^3. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 0. Insoluble in water.
Potential Exposure: Tantalum metal is used in electronic components: electric capacitors; rectifiers, in chemical equipment; in nuclear reactor components; in chemical equipment; body implants. Tantalum carbide is used in metal cutting tools and wear-resistant parts. Some tantalum salts are used in catalysts.
Incompatibilities: A flammable solid; the dry powder can ignite spontaneously in air. Incompatible with lead chromate. A strong reducing agent; incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, bromine trifluoride, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Tantalum metal is attacked by hydrogen fluoride, fused alkalis, fuming sulfuric acid.
Permissible Exposure Limits in Air
metal, oxides, and dusts
NIOSH IDLH = 2500 milligram per cubic meter
OSHA PEL: 5 milligram per cubic meter TWA
NIOSH REL: 5 milligram per cubic meter TWA; 10 mg [Ta]/m^3 STEL
ACGIH TLV[1]: Withdrawn due to insufficient data.
Protective Action Criteria (PAC) Ver. 29[138]
7440-25-7, elemental
PAC-1: 10 milligram per cubic meter
PAC-2: 11 milligram per cubic meter
PAC-3: 64 milligram per cubic meter
1314-61-0, oxide
PAC-1: 12 milligram per cubic meter
PAC-2: 260 milligram per cubic meter
PAC-3: 1600 milligram per cubic meter
DFG MAK (*metal*): 1.5 milligram per cubic meter, respirable fraction (previously “fine dust”); 4 mg[Ta]/m^3, inhalable fraction (previously “total dust”); Pregnancy Risk Group C.
Arab Republic of Egypt: TWA 0.1 milligram per cubic meter, 1993; Australia: TWA 5 milligram per cubic meter, 1993; Austria: MAK 5 milligram per cubic meter, 1999; Belgium: TWA 5 milligram per cubic meter, 1993; Denmark: TWA 5 milligram per cubic meter, 1999; Finland: TWA 5 milligram per cubic meter, 1999; France: VME 5 milligram per cubic meter, 1993; the Netherlands: MAC-TGG 5 milligram per cubic meter, 2003; the Phillipines: TWA 5 milligram per cubic meter, 1993; Poland: MAC (TWA) 5 milligram per cubic meter, 1999; Russia: STEL 10 milligram per cubic meter, 1993; Switzerland: MAK-W 5 milligram per cubic meter, 1999; United Kingdom: TWA 5 milligram per cubic meter, STEL 10 milligram per cubic meter, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 5 mg. Several states have set guidelines or standards for tantalum in ambient air[60] ranging from 50−100 μ/m^3 (North Dakota); to 80 μ/m^3 (Virginia); to 100 μ/m^3 (Connecticut); to 119 μ/m^3 (Nevada).
Determination in Air: Use NIOSH Analytical Method (IV) #0500, Particulates NOR, total dust.
Permissible Concentration in Water: No criteria set. Insoluble.
Routes of Entry: Inhalation, skin, and/or eye contact.
Harmful Effects and Symptoms
Short-Term Exposure: Irritates the eyes and skin. In animals: pulmonary irritation.
Long-Term Exposure: May be a systemic poison.
Points of Attack: Eyes, skin, respiratory system.
Medical Surveillance. Lung function tests. Consider chest X-ray following acute overexposure.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure,

begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 25 milligram per cubic meter*: Qm (APF = 25) (any quarter-mask respirator). *Up to 50 milligram per cubic meter*: 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100; or Sa (APF = 10) (any supplied-air respirator). *Up to 125 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *Up to 250 milligram per cubic meter*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 2,500 milligram per cubic meter*: Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv100 (APF = 50) (100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA). *Note*: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code-Red Stripe: Flammability Hazard: Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 meters or a 1-hour fire wall from flammable or reactive materials. Store flammable solids up to maximum allowable quantity per control area in an approved flammable storage area. Do not store in a basement. Prior to working with this chemical, personnel should be trained on its proper handling and storage.

Sipping: UN3089 Metal powders, flammable, n.o.s., Hazard Class: 4.1; Labels: 4.1-Flammable solid.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Powder is a flammable solid. Thermal decomposition products may include metal oxides. Use special mixtures of dry chemicals appropriate for extinguishing metal fires. *Do not use water*. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Sanitary landfill if necessary; recover if possible because of economic value. Technology exists for tantalum recovery from spent catalysts, for example.

References

(31); (173); (101); (138); (170); (2); (100).

TDE T:0140

Formula: $C_{14}H_{10}Cl_4$; $ClC_6H_4CH(CHCl_2)C_6H_4Cl$

Synonyms: Benzene, 1,1′-(2,2-dichloroethylidene)bis (4-chloro-); 1,1-Bis(*p*-chlorophenyl)-2,2-dichloroethane; 1,1-Bis(4-chlorophenyl)-2,2-dichloroethane; 2,2-Bis (*p*-chlorophenyl)-1,1-dichloroethane; 2,2-Bis(4-chlorophenyl)-1,1-dichloroethane; DDD; *p,p*′-DDD (EPA); 1,1-Dichlor-2,2-bis(4-chlor-phenyl)-aethan (German); 1,1-Dichloro-2,2-bis(*p*-chlorophenyl)ethane; 1,1-Dichloro-2,2-bis(4-chlorophenyl)ethane; 1,1-Dichloro-2,2-bis (*p*-chlorophenyl)ethane; 1,1-Dichloro-2,2-di(4-chlorophenyl) ethane; *p*-,*p*-′-Dichlorodiphenyldichloroethane; Dichlorodiphenyldichloroethane; Diclorodifeniltricloroetano (Spanish); Dilene; ENT 4,225; ME-1700; NCI-C00475; Rhothane; Rhothane D-3; Rothane; *p*-,*p*-′-TDE; Tetrachlorodiphenylethane

CAS Registry Number: 72-54-8

HSDB number: 285 as DDD

RTECS Number: KI070000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154; UN2761/151

EC Number: 200-783-0

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Sufficient Evidence, *possibly carcinogenic to humans*, Group 2B, 1987; NCI: Carcinogenesis Studies (feed); clear evidence: rat; no evidence: mouse

California Proposition 65 Chemical[102]: Cancer 1/1/1989

Hazard Alert: Poison, Environmental hazard, Agricultural chemical.

Clean Water Act: Section 311 Hazardous Substances/ RQ40CFR117.3 (same as CERCLA, see below); 40CFR423, Appendix A, Priority Pollutants

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U060

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.023; Nonwastewater (mg/kg), 0.087

RCRA 40CFR264, appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8080 (0.1); 8270 (10)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 1 lb (0.454 kg)

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T, F, N; Risk phrases: R11; R21; R25; R38; R39/ 23/24/25; R29; R40; R50/53; Safety phrases: S7; S16; S29; S36/37; S45; S53; S60; S61; S62; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: TDE is a colorless, combustible, crystalline compound. Molecular weight = 320.04; Vapor pressure = 1×10^{-6} mmHg @ 20°C; Freezing/Melting point = 109°C−110°C. Insoluble in water.

Potential Exposure: A potential danger to those involved in the manufacture, formulation and application of this insecticide. In an action of March 18, 1971, EPA cancelled all pesticide uses of this product which is a metabolite of DDT. Hence it is no longer manufactured commercially.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 2.4 milligram per cubic meter

PAC-2: 26 milligram per cubic meter

PAC-3: 160 milligram per cubic meter

Permissible Concentration in Water: Very toxic to aquatic life with long-lasting effects. For the protection of freshwater aquatic life, the value is 0.6 μg/L, based on acute toxicity. For saltwater aquatic life, the value is 3.6 μg/L, based on acute toxicity. For the protection of human health, with respect to TDE, see criteria proposed for DDT, since TDE is a metabolite of DDT. Mexico[35] has set a limit of 30 μg/L in estuaries and 3 μg/L in coastal waters. Russia set a MAC of zero in surface water used for fishery purposes.

Determination in Water: Methylene chloride extraction followed by gas chromatography with electron capture or halogen specific detection (EPA Method 608) or gas chromatography plus mass spectrometry (EPA Method #625). Fish Tox = 0.59514000 ppb (EXTRA HIGH).

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms: In varying degrees, organochlorines are absorbed from the gut and also by the lung and across the skin[72].

Short-Term Exposure: Since DDD is a metabolite of DDT, as well as a contaminant of commercial preparations of DDT, many of the effects of DDT could be mediated through DDD. Irritates the eyes, skin, and respiratory tract. May affect the CNS; causing convulsions and respiratory failure. Exposure may result in death. Symptoms of exposure include lethargy, anorexia, nausea, vomiting, diarrhea, paresthesia of tongue, lips, face; tremor, apprehension, dizziness, confusion, malaise (vague feeling of discomfort), headache, fatigue; convulsions; paresis of hands.

Long-Term Exposure: Based on DDT, them chemical may affect the CNS. May damage the liver. A Suspected Human Carcinogen; there is some evidence that DDD is carcinogenic in mice; however, in other species, it appears to be noncarcinogenic. DDD has been shown to be mutagenic in drosophila, but not in yeast or bacteria. In cell culture, DDD causes chromosomal breaks.

Points of Attack: Eyes, skin, CNS; kidneys, liver, peripheral nervous system.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Kidney and liver function tests. Examination of the nervous system.

First Aid: *Skin Contact*:[52] Flood all areas of the body that have contacted the substance with water. Don't wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others. *Eye Contact*: Remove any contact lenses at once. Flush eyes well with copious quantities of water or normal saline for at least 20–30 minutes. Seek medical attention. *Inhalation*: Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion*: If convulsions are not present, give a glass or two of water or milk to dilute the substance. Assure that the person's airway is unobstructed and contact a hospital or poison center immediately for advice on whether or not to induce vomiting. Medical observation is recommended following acute overexposure.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *at any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration*: SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv100 (APF = 50) [Any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Always store pesticides in their original containers, complete with labels that list ingredients, directions for use, and first aid steps in case of accidental poisoning. Never store pesticides in cabinets with or near food, animal feed, or medical supplies. Do not store pesticides in places where flooding is possible or in places where they might spill or leak into wells, drains, ground water, or surface water[72]. Store in a cool, dry place. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN2761 Organochlorine pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: UN2811: Isolation Distance, Spill: 25 meters/75 feet.(NJ). Isolation Distance, Fire: 800 meters/0.5 miles[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Dampen spilled material with acetone to avoid dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Soil Adsorption Index (K_{oc}) = 10000

Fire Extinguishing: Thermal decomposition products may include hydrogen chloride and chlorine. This chemical is a combustible solid. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration in a unit operating above 850°C equipped with HCl scrubber. Incineration above 1200°C for 1−2 seconds is recommended. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(102); (31); (173); (101); (138); (203); (100).

United States Environmental Protection Agency, *DDD, Health and Environmental Effects Profile No. 58*, Washington, DC, Office of Solid Waste (April 30, 1980)

United States Environmental Protection Agency, *DDT-Ambient Water Quality Criteria*, Washington, DC (1980)

Tellurium T:0150

Formula: Te

Synonyms: Aurum paradoxum; Elemental tellurium; Metallum problematum; Telloy; Telurio (Spanish); Tellurium elemental

CAS Registry Number: 13494-80-9; *(alt.)* 137322-20-4

HSDB Number: 2532

UN/NA & ERG Number: UN3288 (Toxic solid, inorganic, n.o.s.)/151

RTECS Number: WY2625000 (elemental)

UN/NA & ERG Number: Available for Te compounds only: 3284 (tellurium compound, n.o.s.)/151

EC Number: 236-813-4

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Pyrophoric (powder), Suspected of causing genetic defects.

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 1 lb (0.454 kg)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: F+, T: Risk phrases: R12 (powder); R17; R25; R62; Safety phrases: S45 (see Appendix 4)

Description: Tellurium is a grayish or silvery white, lustrous, crystalline, semimetallic element. It may exist in a hexagonal crystalline form or an amorphous powder. It is found in sulfide ores and is produced as a by-product of copper or bismuth refining. Molecular weight = 127.6; Specific gravity (H_2O:1) = 6.2 @ 25°C; Boiling point = 998°C; Freezing/Melting point = 450°C; Vapor pressure = 0.75 mmHg @ 500°C; Autoignition temperature = 340°C. Insoluble in water.

Potential Exposure: The primary use of tellurium is in the vulcanization of rubber and as an additive in ferritic steel production. It is also used as a carbide stabilizer in cast iron, a chemical catalyst; a coloring agent in glazes and glass; a thermocoupling material in refrigerating equipment; as an additive to selenium rectifiers; in alloys of lead, copper, steel, and tin for increased resistance to corrosion and stress, workability, machinability, and creep strength; and in certain culture media in bacteriology. Since tellurium is present in silver, copper, lead, and bismuth ores, exposure may occur during purification of these ores.

Incompatibilities: Finely divided powder or dust may be flammable and explosive. Violent reaction with halogens, interhalogens, zinc and lithium silicide; with incandescence. Incompatible with oxidizers, cadmium; strong bases; chemically active metals; silver bromate; nitric acid.

Permissible Exposure Limits in Air

NIOSH IDLH = 25 mg[Te]/m^3

OSHA PEL: 0.1 mg[Te]/m^3 TWA

NIOSH REL: 0.1 mg[Te]/m^3 TWA, *except tellurium hexafluoride and bismuth telluride*.

ACGIH TLV[1]: 0.1 mg[Te]/m^3 TWA, *except hydrogen telluride*.

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 1.8 milligram per cubic meter

PAC-2: 20 milligram per cubic meter

PAC-3: 110 milligram per cubic meter

Australia: TWA 0.1 milligram per cubic meter, 1993; Austria: MAK

0.1 milligram per cubic meter, 1999; Belgium: TWA 0.1 milligram per cubic meter, 1993; Denmark: TWA 0.1 milligram per cubic meter, 1999; Finland: TWA 0.1 milligram per cubic meter, STEL 0.3 milligram per cubic meter, 1999; France: VME 0.1 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 0.1 mg[Te]/m^3, 2003; the Phillipines: TWA 0.1 milligram per cubic meter, 1993; Poland: MAC (TWA) 0.01 milligram per cubic meter; MAC (STEL) 0.03 milligram per cubic meter, 1999; Sweden: NGV 0.1 milligram per cubic meter, 1999; Switzerland: MAK-W 0.1 milligram per cubic meter, KZG-W 0.5 milligram per cubic meter, 1999; Turkey: TWA 0.1 milligram per cubic meter, 1993; United Kingdom: TWA 0.1 milligram per cubic meter, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 0.1 mg[Te]/m^3. Several states have set guidelines or standards for tellurium in ambient air[60] ranging from 1.0 μ/m^3 (North Dakota); to 1.6 μ/m^3 (Virginia); to 2.0 μ/m^3 (Connecticut and Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #7900. See also #7300, Elements; #7301; #7303; #9102; OSHA Analytical Method ID-121.

Permissible Concentration in Water: EPA[32] has suggested a permissible ambient goal of 1.4 μg/L based on health effects. Russia [43] set a MAC for tellurium in water bodies used for domestic purposes of 0.01 mg/L.

Routes of Entry: Inhalation of dust or fume; percutaneous absorption from dust,ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Tellurium compounds are both an oral and dermal toxic hazard. The material is toxic by ingestion. Oral ingestion of tellurium compounds is generally regarded as extremely toxic. The probable oral lethal dose is 5−50 mg/kg or between 7 drops and 1 teaspoonful for a 70 kg (150 pound) person. Tellurium compounds are regarded as super toxic for skin exposures.

Short-Term Exposure: Irritates the eyes, skin, and respiratory tract. High exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Causes CNS depression. Mode rate skin and eye irritant. Tellurium is capable of doing harm within the body by replacing the essential element sulfur. Signs and symptoms of acute exposure to tellurium may include garlicky breath, metallic taste; sweating; dry mouth; drowsiness, no sweating headache; drowsiness, malaise, fatigue, lassitude, weakness, and dizziness. Gastrointestinal symptoms may include nausea, vomiting, anorexia, and constipation. High levels of the dust or fume may cause bronchitis or pneumonia to develop. In animals: CNS; red blood cell changes.

Long-Term Exposure: Repeated exposure can cause garlic odor on the breath, nausea, vomiting, anorexia, metallic taste; and irritability. Kidney damage, liver injury; and pulmonary effects may also occur. Dermal exposure may result in dermatitis; red, inflamed skin; drying and cracking. At doses which are severely toxic to the mother, tellurium produces teratogenic effects. May damage the unborn fetus. High exposures may cause damage to the nervous system.

Points of Attack: Skin, lungs, cardiovascular system, CNS, kidneys, liver.

Medical Surveillance: Oral hygiene and the respiratory tract should receive special attention in preplacement or periodic examinations. Liver and kidney function tests. Blood tests for liver and kidney function. Examination of the cardiovascular and nervous systems. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Obtain authorization and/or further instructions from the local hospital for administration of an antidote or performance of other invasive procedures. Give a slurry of activated charcoal in water to drink. Seek medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Note to physician: For severe poisoning *do not* use BAL (British Anti-Lewisite), dimercaprol, dithiopropanol ($C_3H_8OS_2$) as it is contraindicated or ineffective in poisoning from tellurium.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 0.5 milligram per cubic meter*: Qm (APF = 25) (any quarter-mask respirator). *Up to 1 milligram per cubic meter*: 95Q X [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *Up to 2.5 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *Up to 5 milligram per cubic meter*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 25 milligram per cubic meter*: Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA). *Note*: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers, chlorine, cadmium. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN3288 Toxic solids, inorganic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical in powder form is a flammable solid. Thermal decomposition products may include metallic oxides of tellurium. Use water spry. Tellurium will burn only slowly in air. Straight water streams will scatter molten tellurium oxide. Wear goggles, rubber gloves, and proper respirator with filter. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (170); (2).

United States Environmental Protection Agency, Chemica*l Hazard Information Profile*: *Tellurium*, Washington, DC (1979)

United States Environmental Protection Agency, Chemical Hazard Information Profile: *Tellurium*, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

Tellurium Hexafluoride T:0160

Formula: F_6Te; TeF_6

Synonyms: Tellurium fluoride

CAS Registry Number: 7783-80-4

HSDB Number: 2535

RTECS Number: WY2800000

UN/NA & ERG Number: UN2195/125

EC Number: 232-027-0

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Theft hazard* 15 (≥0.83.00% concentration)

Sabotage/Contamination Hazard: A placarded amount (commercial grade).

Hazard Alert: Poison inhalation hazard (can be fatal), Corrosive, Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated.

United States National Primary Drinking Water Regulations: MCLG = 4 mg[F]/L; MCL = 4 mg[F]/L; SMCL = 2.0 mg[F]/L, as Fluoride.

OSHA 29CFR1910.119, appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 250 lb (114 kg)

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 100 lb (454 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 100 lb (45.4 kg)

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T, C; Risk phrases: R5; R11; R14; R20; R21; R23/24/25; R35; R36/37/38; R39; R48/20; Safety phrases: S1; S9; S16; S26; S23; S33; S37/S39; S38; S41; S45; S60; S61; S63; S41 (see Appendix 4)

Description: Tellurium hexafluoride is a colorless gas with a repulsive odor. Molecular weight = 241.59; Specific gravity (H_2O:1) = 9.9; Boiling point = (sublimes before reaching its BP) −39°C; Freezing/Melting point = (sublimes) −38°C; Vapor pressure = 760 mmHg @ 20°C; Relative vapor density (air = 1) = 8.34. ₩ Decomposes in water.

Potential Exposure: Tellurium hexafluoride is stated to be a by-product of ore refining.

Incompatibilities: Hydrolyzes slowly in water forming telluric acid. Emits highly toxic fumes when heated or on contact with acid or acid fumes.

Permissible Exposure Limits in Air

NIOSH IDLH = 1 ppm

Conversion factor: 1 ppm = 9.88 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 0.02 ppm/0.2 milligram per cubic meter TWA

NIOSH REL: 0.02 ppm/0.2 milligram per cubic meter TWA
ACGIH TLV[1]: 0.02 ppm/0.2 milligram per cubic meter TWA
Protective Action Criteria (PAC)* Ver. 29[138]
PAC-1: 4.80E-04 ppm
PAC-2: **0.0053_A** ppm
PAC-3: **0.016_A** ppm
*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.
DFG MAK: 0.1 mg[Te]/m^3, inhalable fraction, as Te and its compounds
The following is for reference and consideration in that this compound is also a fluoride compound and some foreign countries use the fluoride standard.
NIOSH IDLH = 250 mg[F]/m^3
OSHA PEL: 3 ppm/2.5 mg[F]/m^3 TWA
NIOSH REL: 3 ppm/2.5 mg[F]/m^3 TWA; 6 ppm/5 mg[F]/m^3, 15 min. Ceiling Concentration
ACGIH TLV[1]: 2.5 mg[F]/m^3 TWA; not classifiable as a human carcinogen; BEI: 3 mg[F]/g creatinine in urine *prior* to end-of-shift; 10 mg[F]/g creatinine in urine end-of-shift
DFG MAK: 1 mg[F]/m^3, inhalable fraction [skin]; Peak Limitation Category II(4); Pregnancy Risk Group C; BAT: 7.0 mg[F]/g creatinine in urine at end-of-shift; 4.0 mg[F]/g creatinine in urine at the beginning of the next shift
Australia: TWA 0.02 ppm (0.2 milligram per cubic meter), 1993; Austria: MAK 2.5 mg[F]/m^3, 1999; Austria: MAK 0.1 mg[Te]/m^3, 1999; Belgium: TWA 0.02 ppm (0.1 milligram per cubic meter), 1993; Denmark: TWA 0.02 ppm (0.2 milligram per cubic meter), 1999; Finland: TWA 0.02 ppm (0.2 milligram per cubic meter), STEL 0.06 ppm (0.6 milligram per cubic meter), 1999; France: VME 0.02 ppm (0.2 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 0.2 milligram per cubic meter, 2003; the Phillipines: TWA 0.02 ppm (0.2 milligram per cubic meter), 1993; Poland: MAC (TWA) 1 mg[HF]/m^3; MAC (STEL) 3 mg[HF]/m^3, 1999; Poland: MAC (TWA) 0.01 mg[Te]/m^3; MAC (STEL) 0.03 mg[Te]/m^3, 1999; Sweden: NGV 2 mg[F]/m^3, 1999; Sweden: NGV 0.1 mg[Te]/m^3, 1999; Switzerland: MAK-W 0.02 ppm (0.2 milligram per cubic meter), 1999; United Kingdom: TWA 2.5 mg[F]/m^3; TWA 0.1 mg[Te]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 0.02 ppm. Several states have set guidelines or standards for TeF_6 in ambient air[60] ranging from 2.0 μ/m^3 (North Dakota); to 3.5 μ/m^3 (Virginia); to 4.0 μ/m^3 (Connecticut); to 5.0 μ/m^3 (Nevada).

Determination in Air: Use NIOSH II (3), Method #S-187.

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guidelines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg [F]/L. SafeDrinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg[F]/L; SMCL = 2 mg/F/L, as Fluoride.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms

Short-Term Exposure: Tellurium hexafluoride can cause death or permanent injury. *Acute*: the material is highly toxic by inhalation exposure and a strong irritant to skin, eyes, lungs, throat, and stomach. Death can occur from filling of the lungs with fluid (pulmonary edema) or from asphyxiation due to spasm of the throat (larynx), or bronchi. Signs and symptoms of acute exposure to tellurium hexafluoride may include drowsiness, malaise, lassitude, weakness, and dizziness.

Long-Term Exposure: Dermal exposure may result in dermatitis; red, inflamed skin; drying and cracking. May cause kidney and liver injury. A metallic taste; garlicky breath; and profuse sweating may develop. Gastrointestinal effects may include nausea, vomiting, anorexia, and constipation.

Points of Attack: Respiratory system, liver and kidneys.

Medical Surveillance: NIOSH lists the following tests: chest X-ray; pulmonary function tests: forced vital capacity, forced expiratory volume (1 seconds). Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Note to physician: For severe poisoning *do not* use BAL (British Anti-Lewisite), dimercaprol, dithiopropanol ($C_3H_8OS_2$) as it is contraindicated or ineffective in poisoning from tellurium.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 0.2 ppm*: Sa (APF = 10) (any supplied-air respirator). *Up to 0.5 ppm*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *Up to 1 ppm*: SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). Emergency or planned entry into unknown concentrations or IDLH conditions: SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted canister providing protection against the compound of concern]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Check oxygen content prior to entering storage area. Poison gas. (1) Color code-Blue: Health Hazard/Poison: Store in a secure poison location. This gas is highly toxic. Even slight exposure to these gasses can cause death. Store outdoors in a secure, restricted area that containing warning signs. This area must be roofed and shaded with the cylinders stored off the ground and separated from all other products assigned to other hazard categories and radiant heat sources on nonwooden floors. If indoors, store in a well-ventilated areas in temperatures not to exceed 50°C. (2) Color code-White stripe: Contact Hazard; Store separately; not compatible with materials in solid white category. Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from water. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169 with the recommendations of the Compressed Gas Association.

Shipping: UN2195 Tellurium hexafluoride, Hazard Class: 2.3; Labels: 2.3-Poisonous gas, 8-Corrosive material, inhalation hazard zone A. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: *Tellurium hexafluoride*

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 600/200
Then: Protect persons downwind (miles/kilometers)
Day 0.7/1.1
Night 2.8/4.5

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 3000/1000
Then: Protect persons downwind (miles/kilometers)
Day 4.2/6.8
Night 7.0+/11.0+*

*+ means distance can be larger in certain atmospheric conditions.

Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of leak to disperse vapors. Stop the flow of the leak. Remove the leaking container to a safe place in the open air and allow the leak to disperse. Use water spray to reduce vapor but do not put water on leak or spill area. *Small spills*: flush area with flooding amounts of water. *Large spills*: dike far ahead of spill for later disposal. Do not get water inside container. Isolate area until gas has dispersed. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition may include highly poisonous tellurium and hydrogen fluorides and metallic tellurium. This chemical is a nonflammable gas but containers may rupture and explode in fire. *Small fires*: dry chemical or carbon dioxide. *Large fires*: water spray, fog or foam. Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Wear positive pressure breathing apparatus and full protective clothing. Do not get water inside container. Move container from fire area if you can do so without risk. Stay away from ends of tanks. Spray cooling water on containers that are exposed to flames until well after fire is out. Isolate area until gas has dispersed. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Nonrefillable cylinders should be disposed of in accordance with local, state and federal regulations. Allow remaining gas to vent slowly into atmosphere in an unconfined area or exhaust hood. Refillable-type cylinders should be returned to original supplier with any valve caps and outlet plugs secured and valve protection caps in place.

References

(31); (173); (101); (138); (122).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Tellurium Hexafluoride, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

TEPP T:0180

Formula: $C_8H_{20}O_7P_2$

Synonyms: Bis-*O*,*O*-diethylphosphoric anhydride; Bladan; Bladon; Diphosphoric acid, Tetraethyl ester; ENT 18,771; Ethyl pyrophosphate, *tetra*-; Fosvex; Grisol; HEPT; Hexamite; Killax; Kilmite 40; Lethalaire G-52; Lirohex; Mortopal; Motopal; Nifos; Nifos T; Nifrost; Phosphoric acid, tetraethyl ester; Pyrophosphate detetraethyle (French); TEP; *O*,*O*,*O*,*O*-Tetraaethyl-diphosphat, bis(*O*,*O*-diaethyl-phosphorsaeure-anhydrid (German); Tetraethyl pyrophosphate; Tetraethyl pyrophosphate, liquid; Tetrastigmine; Tetron; Tetron-100; Vapotone.

Note: for TEPP + compresssed gas mixture see see T:0305

CAS Registry Number: 107-49-3

HSDB Number: 842

RTECS Number: UX6825000

UN/NA & ERG Number: (PIH) UN2810 (toxic liquid, organic, n.o.s.)/153; UN3018 (organophosphorus pesticide, liquid, toxic)/152. *TEPP + compresssed gas mixture see see T:0305*

EC Number: 203-495-3 [*Annex I Index No.*: 015-025-00-2]

Regulatory Authority and Advisory Information

Hazard Alert: Poison inhalation hazard, Neurotoxin (cumulative), Water reactive, Environmental hazard, Drug, Human Data.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P111

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 10 lb (4.54 kg)

United States DOT Regulated Marine Pollutant (49CFR172.101, appendix B)

United States DOT 49CFR172.101, Inhalation Hazard Chemical as organophosphates.

Hazardous to aquatic life or environment, with possible long-lasting effects.[291] Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T+, N; Risk phrases: R26; R27/28; R33; R50/53; Safety phrases: S1/2; S29/35; S36/37/39; S38; S41; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: TEPP is a colorless to amber liquid. Some liquid formulation may contain flammable organic solvents.* A solid (glass-like state) below 0°C. May be transported in molten form. Faint, fruity, aromatic odor. Molecular weight = 290.22; Specific gravity (H_2O:1) = 1.19 @ 25°C; Boiling point = decomposes $<$ BP @ 170°C; 138°C under 2.3 mmHg; Freezing/Melting point = 0°C; Vapor pressure = 2×10^{-4} mmHg @ 25°C; Flash point = $>$ 100°C. ₩ Soluble in water; slow decomposition, forming pyrophosphoric acid. *Physical and toxicological properties may be affected by the carrier solvents used in commercial formulations.

Potential Exposure: A potential danger to those engaged in the manufacture, formulation and application of this aphicide and acaricide; used as an insecticide to control aphids, thrips, and mites; as an anticholinesterase.

Incompatibilities: Organophosphates are susceptible to formation of highly toxic and flammable phosphine gas in the presence of strong reducing agents such as hydrideds and active metals. Partial oxidation by oxidizing agents may result in the release of toxic phosphorus oxides[101]. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, alkalis, water. Hydrolyzes quicklyin water to form pyrophosphoric acid.

Permissible Exposure Limits in Air

NIOSH IDLH = 5 milligram per cubic meter

Conversion factor: 1 ppm = 11.87 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 0.05 milligram per cubic meter TWA [skin]

NIOSH REL: 0.05 milligram per cubic meter TWA [skin]

ACGIH TLV[1]: 0.01 milligram per cubic meter, measured as inhalable fraction and vapor TWA [skin]; BEI_A issued for Acetylcholinesterase inhibiting pesticides.

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 0.091 milligram per cubic meter

PAC-2: 1 milligram per cubic meter

PAC-3: 10 milligram per cubic meter

DFG MAK: 0.005 ppm/0.06 milligram per cubic meter; Peak Limitation Category II(2) [skin]

Arab Republic of Egypt: TWA 0.004 ppm (0.05 milligram per cubic meter), [skin], 1993; Australia: TWA 0.004 ppm (0.05 milligram per cubic meter), [skin], 1993; Austria: MAK 0.005 ppm (0.05 milligram per cubic meter), [skin], 1999; Belgium: TWA 0.004 ppm (0.047 milligram per cubic meter), [skin], 1993; Denmark: TWA 0.004 ppm (0.05 milligram per cubic meter), [skin], 1999; France: VME 0.004 ppm (0.05 milligram per cubic meter), [skin], 1999; the Netherlands: MAC-TGG 0.05 milligram per cubic meter, [skin], 2003; the Phillipines: TWA 0.05 milligram per cubic meter, [skin], 1993; Switzerland: MAK-W 0.005 ppm (0.05 milligram per cubic meter), [skin], 1999; Turkey: TWA 0.05 milligram per cubic meter, [skin], 1993 Occupational Exposure Limit United Kingdom: TWA 0.004 ppm (0.05 milligram per cubic meter), STEL 0.1 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 0.05 milligram per cubic meter (skin)

Determination in Air: Use NIOSH Analytical Method (IV) #2504, Tetraethyl Pyrophosphate; see also NIOSH Analytical Method (IV) Method #5600, Organophosphorus Pesticides.

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Symptoms of exposure include eye pain; blurred vision; lacrimation (discharge of tears); rhinorrhea (discharge of thin nasal mucous); headache, chest tightness; cyanosis, anorexia, nausea, vomiting, diarrhea, weakness, twitching, paralysis, Cheyne-Stokes respiration, convulsions, low blood pressure; cardiac irregular/irregularities; sweating. TEPP is classified as super toxic. Probable oral lethal dose in humans is less than 5 mg/kg (a taste) for a 150 lb person. A small drop in the eye may cause death. Small doses at frequent intervals are additive. Poisonings always develop at a rapid rate. Cholinesterase toxin; Eye irritant; Eye, acute other than irritation; Respiratory irritant-acute, severe, or moderate but not mild irritant effects; Skin irritant-severe; Heart cardiovascular system, acute; Brain, acute; CNS, acute; Nervous system toxin, acute; Respiratory toxin, acute other than severe or moderate irritation[138].

Long-Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Eyes, respiratory system; CNS; cardiovascular system, gastrointestinal tract; blood cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in one to two weeks while red blood cell levels may be reduced for one to three months. When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider CBC. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: *Specific treatment is necessary in case of poisoning with this substance; the appropriate means with instructions must be available.* If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give a slurry of activated charcoal in water to drink. *Do NOT* induce vomiting.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: 0.5 milligram per cubic meter: Sa (APF = 10) (any supplied-air respirator). 1.25 milligram per cubic meter: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). 2.5 milligram per cubic meter: SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). 5 milligram per cubic meter: Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv100 (APF = 50) [Any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, self-contained).

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers (such as chlorine, bromine, and fluorine). Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN2810 Toxic liquids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN3018 Organophosphorus pesticides, liquid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. *Note*: See T:0305 for TEPP + compressd gas.

Spill Handling:

Initial isolation and protective action distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.3/0.4
Night 0.8/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 600/200
Then: Protect persons downwind (miles/kilometers)
Day 1.4/2.3
Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Do not touch spilled material. Do not breathe vapors. Stay upwind; keep out of low areas. Remove all ignition sources. Ventilate area of spill or leak. This material is a combustible liquid. For a spill or leak of a combustible liquid, shut off ignition sources; no flares, smoking or flames in hazard area. Stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible liquid that may be formulated with a flammable substance. Thermal decomposition products may include phosphoric acid and oxides of phosphorus, nitrogen and carbon. Use dry chemical, carbon dioxide; or foam extinguishers if formulated with a flammable substance. Vapors are heavier than air and will collect in low areas. Vapors from a flammable carrier may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. TEPP is 50% hydrolyzed in water in 6.8 hour @ 25°C, and 3.3 hours @ 38°C; 99% hydrolysis requires 45.2 hours @ 25°C, or 21.9 hours @ 38°C. Hydrolysis of TEPP yields nontoxic products. Incineration is, however, an option for TEPP disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (2); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: *TEPP*, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: *TEPP*, Trenton, NJ (January 2001).

Terbufos T:0190

Formula: $C_9H_{21}O_2PS_3$
Synonyms: AC 921000; Counter; Counter 15G soil insecticide; Counter 15G soil insecticide-nematicide; *S*-([(1,1-Dimethylethyl)thio]methyl) *O*,*O*-diethyl phosphorodithioate; Phosphorodithioic acid, *S*-([(1,1-dimethylethyl)thio] methyl), *O,O*-diethyl ester; Phosphorodithioic acid, *S*-[(*tert*-butylthio)methyl], *O*,*O*-diethyl ester; *S*-[(*tert*-Butylthio) methyl] *O*,*O*-diethyl phosphorodithioate
CAS Registry Number: 13071-79-9
HSDB Number: 6444
RTECS Number: TD7200000
UN/NA & ERG Number: (PIH) UN3018 (organophosphorus pesticide, liquid, toxic)/152; UN2783 (organophosphorus pesticides, solid, toxic)/152; UN2810 (toxic liquid, organic, n.o.s.)/153
EC Number: 235-963-8 [*Annex I Index No.*: 015-139-00-2]
Regulatory Authority and Advisory Information
Hazard Alert: Poison inhalation hazard: exposure can be lethal, Neurotoxin (cumulative), Flammable, Environmental hazard.
Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg)
Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 100 lb (45.4 kg)
United States DOT Regulated Marine Pollutant (49CFR172.101, appendix B), severe pollutant
United States DOT 49CFR172.101, Inhalation Hazard Chemical as organophosphates.
Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.
Hazard Symbols, Risk & Safety statements: Hazard Symbol: T + , F, N; Risk phrases: R10; R27/28; R33; R50/53; Safety phrases: S1/2; S29/35; S36/37; S41; S45; S60. S61 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.
Dsescription: Terbufos is a colorless to pale yellow liquid. Molecular weight = 288.45; Boiling point = 70°C @ 0.01 mm; Freezing/Melting point = −29°C; Vapor pressure = 3×10^{-4} mmHg @ 20°C; Flash point = 88°C (oc). Hazard Identification (based on NFPA-704 M Rating System) (liquid in flammable carrier): Health 4, Flammability 2−3, Reactivity 0. Slightly soluble in water.
Potential Exposure: A potential danger to those involved in the manufacture, formulation or application of this organophosphate soil insecticide.
Incompatibilities: Organophosphates are susceptible to formation of highly toxic and flammable phosphine gas in the presence of strong reducing agents such as hydrideds and active metals. Partial oxidation by oxidizing agents may result in the release of toxic phosphorus oxides[101]. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Strong oxidizers may cause release of toxic phosphorus oxides. Organophosphates, in the presence of strong reducing agents, such as hydrides, may form highly toxic and flammable phosphine gas. Keep away from alkaline materials.
Permissible Exposure Limits in Air
ACGIH TLV[1]: 0.01 milligram per cubic meter TWA, inhalable fraction and vapor [skin]; not classifiable as a human carcinogen; BEI issued (1999)
Protective Action Criteria (PAC) Ver. 29[138]
PAC-1: 0.091 milligram per cubic meter
PAC-2: 1 milligram per cubic meter
PAC-3: 2.2 milligram per cubic meter
Determination in Air: Use NIOSH Analytical Method (IV) Method #5600, Organophosphorus Pesticides.
Permissible Concentration in Water: The EPA (see "References" below) has developed a lifetime health advisory of 0.18 μg/L; (100).
Determination in Water: Analysis of terbufos is by a gas chromatographic (GC) method applicable to the determination of certain nitrogen-phosphorus containing pesticides in water samples. In this method, approximately 1 L of sample is extracted with methylene chloride. The extract is concentrated and the compounds are separated using capillary column GC. Measurement is made using a nitrogen-phosphorus detector. Fish Tox = 0.04733000 ppb (EXTRA HIGH).
Routes of Entry: Inhalation, ingestion, skin contact.
Harmful Effects and Symptoms
Short-Term Exposure: This material may be fatal if swallowed, inhaled, or absorbed through the skin. Repeated inhalation or skin contact may progressively increase susceptibility to poisoning. Acute exposure to terbufos may produce the following signs and symptoms: pinpoint pupils; blurred vision; headache, dizziness, muscle spasms; and profound weakness. Vomiting, diarrhea, abdominal pain; seizures, and coma may also occur. The heart rate may decrease following oral exposure or increase following dermal exposure. Chest pain may be noted. Hypotension (low blood pressure) may be noted, although hypertension (high blood pressure) is not uncommon. Respiratory symptoms include dyspnea (shortness of breath), respiratory depression; and respiratory paralysis. Psychosis may occur.
Long-Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, CNS; cardiovascular system, skin, eyes, plasma and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in one to two weeks while red blood cell levels may be reduced for one to three months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider CBC. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. Obtain authorization and/or further instructions from the local hospital for administration of an antidote or performance of other invasive procedures. Transport to a health care facility.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN3018 Organophosphorus pesticides, liquid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN2783 Organophosphorus pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN2810 Toxic liquids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling:

Initial isolation and protective action distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.3/0.4
Night 0.8/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 600/200
Then: Protect persons downwind (miles/kilometers)
Day 1.4/2.3
Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Do not touch spilled material. Do not breathe vapors. Stay upwind; keep out of low areas. Remove all ignition sources. Ventilate area of spill or leak. This material is a combustible liquid. For a spill or leak of a combustible liquid, shut off ignition sources; no flares, smoking or flames in hazard area. Stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Soil Adsorption Index (K_{oc}) = 500.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of phosphorus, sulfur, nitrogen and carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR165 recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (2).

United States Environmental Protection Agency, *Alert*: *Terbufos*, Washington, DC, Office of Drinking Water (August 1987)

United States Environmental Protection Agency, Chemical Hazard Information Profile: Terbufos, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

Terephthalic Acid T:0200

Formula: $C_8H_6O_4$; $HOOCC_6H_4COOH$

Synonyms: Acide terephthalique (French); *p*-Benzene dicarboxylic acid; 1,4-B enzenedicarboxylic acid; *p*-Phthalic acid; Phthalic acid, *p*-isomer; TA 12; TA

CAS Registry Number: 100-21-0

HSDB Number: 834

RTECS Number: WZ0875000

EC Number: 202-830-0

Regulatory Authority and Advisory Information

Hazard Alert: Combustible, Primary irritant (w/o allergic reaction).

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: Xi; Risk phrases: R36/37/38; Safety phrases: S26; S36; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: TPA is a white crystalline solid. Molecular weight = 166.14; Specific gravity (H_2O:1) = 1.51 @ 20°C; Sublimation point ≥ 400°C; Flash point = 260°C; Autoignition temperature = 495°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Slightly soluble in water.

Potential Exposure: TPA is used primarily in the production of polyethylene terephthalate polymer for the fabrication of polyester fibers and films. A high-volume production chemical in the United States.

Incompatibilities: Combustible; dust may form an explosive mixture with air. Compounds of the carboxyl group react with all bases, both inorganic and organic (i.e., amines) releasing substantial heat, water and a salt that may be harmful. Incompatible with arsenic compounds (releases hydrogen cyanide gas), diazo compounds, dithiocarbamates, isocyanates, mercaptans, nitrides, and sulfides (releasing heat, toxic and possibly flammable gases), thiosulfates and dithionites (releasing hydrogen sulfate and oxides of sulfur). Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

ACGIH TLV[1]: 10 milligram per cubic meter TWA

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 30 milligram per cubic meter

PAC-2: 140 milligram per cubic meter

PAC-3: 840 milligram per cubic meter

DFG MAK: 0.1 milligram per cubic meter, inhalable fraction TWA; Peak Limitation Category I(2); Pregnancy Risk Group C

The Netherlands: MAC-TGG 10 milligram per cubic meter, 2003. Russia[43] set a MAC in workplace air of 0.1 milligram per cubic meter. Kansas[60] has set a guideline for ambient air of 556 μ/m^3.

Permissible Concentration in Water: Russia[43] set a MAC in water bodies used for domestic purposes of 0.1 mg/L.

Determination in Water: Octanol-water coefficient: Log K_{ow} = 1.96. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion, eye, and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: *Inhalation*: May cause irritation to mouth, nose, or throat. *Skin*: May cause irritation, especially in open cuts or sores. *Eyes*: Can cause irritation. *Ingestion*: Mildly toxic.

Long-Term Exposure: In a 2001 study, postnatal developmental effects were observed in rats.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. *Note to Physician*: May require supportive measures for allergic reaction. Urinary excretion is rapid.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Wear a dust mask. Where there is potential for overexposure to this chemical, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in detached units of noncombustible construction. As far as possible use dust-tight equipment and vacuum cleaning.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Fine dust may form explosive mixture with air and produce a severe hazard. Thermal decomposition products may include oxides of carbon. Use carbon dioxide, dry chemical or water. Wear SCBA and full protective clothing. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (100).

National institute for Occupational Safety and Health (NIOSH), *Information Profile on Potential Occupational Hazards-Single Chemicals*: *Terephthalic Acid*, pp 115—119, Report TR 79-607, Rockville, MD (December 1979)

New York State Department of Health, *Chemical Fact Sheet*: Terephthalic Acid, Bureau of Toxic Substance Assessment, Albany, NY (April 1986).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Terephthalic Acid, Trenton, NJ (April 2000)

Terphenyls T:0210

Formula: $C_{18}H_{14}$; C_6H_5-C_6H_4-C_6H_5

Synonyms: *ortho-isomer*: *o*-Diphenylbenzene; 1,2-Diphenylbenzene; 2-Phenylbiphenyl; *o*-Terphenyl; 1,2-Terphenyl; *o*-Triphenyl *para*-isomer: *p*-Diphenylbenzene; 1,4-Diphenylbenzene; 4-Phenylbiphenyl; *p*-Terphenyl; 1,4-Terphenyl; *p*-Triphenyl *meta*-isomer: *m*-Diphenylbenzene; 1,3-Diphenylbenzene; Isodiphenylbenzene; 3-Phenylbiphenyl; *m*-Terphenyl; 1,3-Terphenyl; *m*-Triphenyl *hydrogenated*: Hydrogenated terphenyls *mixed isomers*: Delowas S; Delowax OM; Diphenylbenzene; Gilotherm OM 2; Terbenzene; Triphenyl

CAS Registry Number: 92-06-8 (*m*-isomer); 84-15-1 (*o*-isomer); 92-94-4 (*p*-isomer); 26140-60-3 (mixed isomers); 61788-32-7 (hydrogenated); 61788-38-8 (chlorinated)

HSDB Number: 2537 (*m*-isomer); 2538 (*o*-isomer); 5280 (*p*-isomer)

RTECS Number: WZ6470000 (*m*-isomer); WZ6472000 (*o*-isomer); WX6475000 (*p*-isomer); WZ6535000 (hydrogenated)

UN/NA & ERG Number: UN3151 (polyhalogenated terphenyls)/171; 3077

EC Number: 202-122-1 (*m*-); 201-517-6 (*o*-); 202-205-2 (*p*); 247-477-3 (*mixed isomers*); 262-967-7 (hydrogenated)

Regulatory Authority and Advisory Information

Hazard Alert: Combustible (all isomers),

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. (*m-, o-, p*-isomers).

Hazardous to aquatic life or environment, with possible long-lasting effects[291]. (*p*-isomer)

Hazard Symbols, Risk & Safety statements: Hazard Symbol: Xi, N; Risk phrases: R20, R36/37/38; R50/53; Safety phrases: S26; S36/37; S45; S53; S61; S62; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water (*o*- and *p*-isomers; mixed isomers).

Description: There are multiple isomeric terphenyls, all having the formula C_6H_5-C_6H_4-C_6H_5. Pure terphenyl is a white, crystalline solid. The commercial grades are light yellow. All three isomers are unusually stable toward heat. Molecular weight = 230.32 (*m-, o-, p-isomers*). Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 0. All are insoluble in water.

The properties of the terphenyls are:

m-isomer: Specific gravity (H_2O:1) = 1.23 @ 25°C; Boiling point = 365°C; Freezing/Melting point = 89°C; Vapor pressure = 0.01 mmHg @ 93°C; Flash point = 191°C.

o-isomer: Specific gravity (H_2O:1) = 1.10 @ 25°C; Boiling point = 332°C; Freezing/Melting point = 58°C; Vapor pressure = 0.09 mmHg @ 93°C; Flash point = 163°C.

p-isomer: Specific gravity (H_2O:1) = 1.23 @ 25°C; Boiling point = 405°C; Freezing/Melting point = 212.8°C; Vapor pressure = 1.23 mmHg @ 93°C; Flash point = 207°C.

hydrogenated: Molecular weight = 298; Specific gravity (H_2O:1) = 1.01 @ 20°C; Boiling point = 340°C.

Potential Exposure: (*p*-isomer): Agricultural Chemical. Terphenyl is used primarily as a plasticizer and heat transfer agent. It is also used as a high-temperature lubricant; a constituent of waxes and polishes; as a plasticizer for resin-bodied paints; as a coolant and heat storage agent.

Incompatibilities: Materials are combustible. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

NIOSH IDLH = 500 milligram per cubic meter

Conversion factor: 1 ppm = 9.57 milligram per cubic meter (*m*-and *p*-isomers); 1 ppm = 9.42 milligram per cubic meter @ 25°C & 1 atm (*o*-isomer)

all isomers

OSHA PEL: 1 ppm/9 milligram per cubic meter Ceiling Concentration

NIOSH REL: 0.5 ppm/5 milligram per cubic meter Ceiling Concentration

ACGIH TLV[1]: 0.53 ppm/5 milligram per cubic meter Ceiling Concentration

Protective Action Criteria (PAC) Ver. 29[138]

92-94-4, p-isomer

PAC-1: 0.45 milligram per cubic meter

PAC-2: 5 milligram per cubic meter

PAC-3: 150 milligram per cubic meter

26140-60-3, mixed isomers

PAC-1: 0.45 milligram per cubic meter

PAC-2: 5 milligram per cubic meter

PAC-3: 1400 milligram per cubic meter

61788-32-7, hydrogenated

PAC-1: 1.5 milligram per cubic meter

PAC-2: 47 milligram per cubic meter

PAC-3: 280 milligram per cubic meter

Denmark: Ceiling Concentration 0.5 ppm (5 milligram per cubic meter), 1999; Switzerland: MAK-W 0.5 ppm (5 milligram per cubic meter), 1999; United Kingdom: STEL 0.5 ppm (4.8 milligram per cubic meter), 2000

Terphenyls, hydrogenated

Australia: Ceiling Concentration 0.5 ppm (5 milligram per cubic meter), 1993; Belgium: Ceiling Concentration 0.5 ppm (4.9 milligram per cubic meter), 1993; Denmark: Ceiling Concentration 0.4 ppm (4.4 milligram per cubic meter), 1999; France: VME 0.5 ppm (5 milligram per cubic meter), 1999; Russia: STEL 5 milligram per cubic meter, 1993; Switzerland: MAK-W 0.5 ppm (5 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 5 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Ceiling Concentration 0.5 ppm

Russia: MAC 5 milligram per cubic meter. Several states have set guidelines or standards for terphenyls in ambient air[60] ranging from 40 μ/m^3 (Virginia); to 50 μ/m^3 (North Dakota); to 119 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method 5021, *o*-terphenyl

Routes of Entry: Inhalation of dusts and mists, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritation of eyes, skin and respiratory tract. Skin or eye contact may cause thermal burns. Inhalation can cause lung irritation with coughing, wheezing and/or shortness of breath. Symptoms of exposure include headache, sore throat.

Long-Term Exposure: May affect the liver and kidneys. Repeated skin contact can cause dermatitis; drying and cracking. In animals: liver, kidney damage

Points of Attack: Eyes, skin, respiratory system; liver, kidneys.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Lung function tests. Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the

skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *Up to 25 milligram per cubic meter*: Qm (APF = 25) (any quarter-mask respirator). *Up to 50 milligram per cubic meter*: 95XQ (APF = 10)$^{£}$ [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *Up to 125 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *Up to 250 milligram per cubic meter*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 500 milligram per cubic meter*: SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA). *Note*: Substance causes eye irritation or damage; eye protection needed.

Storage: Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN3151 Polyhalogenated biphenyls, liquid or Polyhalogenated terphenyls liquid, Hazard class: 9; Labels: 9-Miscellaneous hazardous material. UN3152 Polyhalogenated biphenyls, solid or Polyhalogenated terphenylssolid, Hazard class: 9; Labels: 9-Miscellaneous hazardous material.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Terphenyls are combustible solid, but do not easily ignite. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; water spray; alcohol foam or polymer foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Terphenyls, Trenton NJ (November 1999)

Testosterone T:0220

Formula: $C_{19}H_{28}O_2$

Synonyms: Androlin; Andronaq; Androst-4-en-17(*β*)-ol-3-one; Androst-4-en-3-one, 17-β-hydroxy-; Androst-4-en-3-one, 17-hydroxy-, (17-*β*)-; Andrusol; Cristerone T; Geno-cristaux gremy; Homosteron; Homosterone; 17-*β*-Hydroxy-4-androsten-3-one; 17-*β*-Hydroxyandrost-4-en-3-one; 7-*β*-Hydroxyandrost-4-en-3-one; Malestrone (AMPS); Mertestate; Neo-testis; Oreton; Oreton-F; Orquisteron; Perandren; Percutacrine androgenique; Primotest; Primoteston; Sustanone; Synandrol F; Teslen; Testandrone; Testiculosterone; Testobase; Testopropon; Testosteroid; Testosteron; Testosterone hydrate; Testostosterone; Testoviron schering; Testoviron T; Testrone; Testryl; Virormone; Virosterone

CAS Registry Number: 58-22-0; 57-85-2 (testosterone propionate)

HSDB Number: 3398

RTECS Number: XA3030000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171; UN3249 (Medicine, solid, toxic, n.o.s.)/151

EC Number: 200-370-5; 200-351-1 (testosterone propionate)

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Sufficient Evidence; Human Limited Evidence, 1979

California Proposition 65 Chemical[102]: Cancer, (testosterone and its esters) 1/1/1988

Hazard Alert: Poison, Environmental hazard,

Hazardous to aquatic life or environment, with possible long-lasting effects.[291] Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T, Xn; Risk phrases: R45; R20; R36/37/38; R34; R40; R50/53; R60; R61; R63; Safety phrases: S22; S24/25; S26; S36/37/39; S45; S53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Testosterone is an odorless, white or slight cream-colored crystals or crystalline powder. Molecular weight = 288.47; Freezing/Melting point = 155°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. Practically insoluble in water.

Potential Exposure: Used as an androgenic, anabolic and estrogenic hormone for both males and females.

Incompatibilities: Combustible; dust may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

No standards or Protective Action Criteria (PAC) available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Russia[43] set a MAC in workplace air of 0.005 milligram per cubic meter ($5\ \mu/m^3$).

Determination in Water: Log $K_{ow} = > 3$. Values above 3.0 are likely to bioaccumulate in aquatic organisms.

Harmful Effects and Symptoms

Short-Term Exposure: Testosterone can affect you when breathed in and by passing through your skin. Testosterone is a teratogen. Handle with extreme caution. Exposure can cause nausea, upset stomach; acne, and fluid and salt retention in body tissues.

Long-Term Exposure: Women can also develop male features, baldness, increased body hair; deep voice and menstrual changes. Men can have lower sperm production, painful enlarged breasts; enlarged prostate; and excess of red blood cells. Repeated exposure can cause women to develop male characteristics including face and body hair, badness, deepened voice and enlarged female genitalia (clitoris). Higher levels can cause irregular menstrual cycles, lighter periods and smaller breasts. If carried home (clothing, etc.) children in the home may have stunted growth, premature puberty in boys, and masculine appearance and abnormal genitals in girls.

Points of Attack: Blood cells, sex organs.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Frequent exams (at least monthly) are recommended to evaluate for any signs or symptoms of exposure. If exposure is suspected, the following are recommended: red blood cell count (in men). Urine test for androsterone and/or etiocholanolone. (The more common 17-ketosteroid test is not sufficiently sensitive for such exposures).

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration*: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA-or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full-facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code-Blue: Health Hazard /Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required. UN3249 Medicine, solid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Testosterone may burn, but does not readily ignite. Use dry chemical, CO_2, water spray; or foam extinguishers. Thermal decomposition products may include oxides of carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: It is inappropriate and possibly dangerous to the environment to dispose of expired or waste pharmaceuticals by flushing them down the toilet or discarding them to the trash. Household quantities of expired or waste pharmaceuticals may be mixed with wet cat litter or coffee grounds, double-bagged in plastic, discard in trash. Larger quantities shall carefully take into consideration applicable DEA, EPA, and FDA regulations. If possible return the pharmaceutical to the manufacturer for proper disposal being careful to properly label and securely package the material. Alternatively, the waste pharmaceutical shall be labeled, securely packaged, and transported by a state licensed medical waste contractor to dispose by burial in a licensed hazardous or toxic waste landfill or incinerator.

References

(102); (31); (173); (101); (138); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 3, 81−82 (1981)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Testosterone, Trenton, NJ (February 17, 1987)

Tetrachlorodibenzo-*p*-dioxin T:0230

Formula: $C_{12}H_4Cl_4O_2$

Synonyms: Dibenzo(b,e)-1,4-dioxin, 2,3,7,8-tetrachloro-; Dibenzo-*p*-dioxin, 2,3,7,8-tetrachloro-; Dioxine; Dioxin (herbicide contaminant); NCI-CO3714; TCDBD; 2,3,7,8-TCDD; TCDD; 2,3,7,8-Tetrachlorodibenzo(b,e)(1,4) dioxan; 2,3,6,7-Tetrachlorodibenzo-*p*-dioxin; 2,3,7,8-Tetrachlorodibenzo-*p*-dioxin; 2,3,7,8-Tetrachlorodibenzo-1,4-dioxin; Tetrachlorodibenzodioxin; Tetradioxin

CAS Registry Number: 1746-01-6

HSD B Num ber: 4151

RTECS Number: HP3500000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 217-122-7

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen; IARC: Human Limited Evidence; Animal Sufficient Evidence, *carcinogenic to humans*, Group 1, 1997; NIOSH: Potential occupational carciogen. Carcinogenesis studies; on test (two year studies), October, 2000; Carcinogenesis studies; on test (prechronic studies),

October, 2000; Carcinogenesis studies; test completed (peer review), October, 2000; NCI: Carcinogenesis Studies (gavage); clear evidence: mouse, rat; (dermal); clear evidence: mouse. United States Environmental Protection Agency Gene-Tox Program, Positive: Carcinogenicity-mouse/rat; Negative: Rodent dominant lethal

California Proposition 65 Chemical[102]: Cancer 1/1/1988; Developmental/Reproductive toxin 4/1/1991.

Hazard Alert: Possible risk of forming tumors, Endocrine disruptor (high) (2,3,7,8-Tetrachlorodibenzo-*p*-dioxin), Reproductive toxin: possible risk of gene damage/impaired fertilty; Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction).

Banned or Severely Restricted (UN)[13]

Persistent Organic Pollutants (UN) *as polychlorinated dibenzo-p-dioxins*

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112).

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants; 40CFR401.15 Section 307 Toxic Pollutants

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed.

United States National Primary Drinking Water Regulations: MCL = zero mg/L; MCL = 0.00000003 mg/L [Dioxin (2,3,7,8-TCDD) 828-00-2]

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.000063; Nonwastewater (mg/kg), 0.001

RCRA 40CFR264, appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8250 (0.005)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 1 lb (0.454 kg)

EPCRA Section 313 Form R *de minimis* Concentration Reporting Level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%.

List of Stockholm Convention POPs: Annex C (Unintentional production and release) as *polychlorinated dibenzo-p-dioxins (PCDD).*

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T, F, Xn; Risk phrases: R45; R19; R20; R22; R23/24/25; R36/37/38; R34; R39; R48/20; R50; R62; R63; R65; R67; Safety phrases: S7; S16; S22; S24/25; S26; S36/37/39; S45; S53; S62; S41 (see Appendix 4)

Description: Tetrachlorodibenzo-*p*-dioxin is a white, needle-shaped, crystalline solid. Molecular weight = 321.97; Boiling point = (decomposition); Freezing/Melting point = 295°C; Vapor pressure = 2×10^{-6} mmHg @ 25°C. Thermal decomposition begins @ 500°C and is virtually complete within 21 seconds @ 800°C. Very slightly soluble in water; solubility = 0.00000002%. Polychlorinated dibenzo-p-dioxins are formed in the manufacturing process of all chlorophenols. However, the amount formed is dependent on the degree to which the temperature and pressure are controlled during production. An especially toxic dioxin, 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD), is formed during the production of 2,4,5,-TCP (trichlorophenol); by the alkaline hydrolysis of 1,2,4,5-tetrachloorobenzene.

Potential Exposure: TCDD is primarilly a research chemical. As noted above, TCDD is an inadvertent contaminant in herbicide precursors and thus in the herbicides themselves. It is also formed during various combustion processes including the incineration of chemical wastes (chlorophenols, chlorinated benzenes, and biphenyl ethers). It may be found in flue gases, fly ash, and soot particles. It is highly persistent in soil, and contamination may be retained for years. TCDD is the most toxic of all the dioxins, and has the potential for bio-accumulation in animals. Thus, it is applied in herbicide formulations, but is not used per se. It has been estimated that approximately 2 million acres in the United States have been treated for weed control on one or more occasions with approximately 15 million pounds of TCDD contaminated 2,4,5,-T, 2,4,-D, or combinations of the two.

Incompatibilities: Decomposes in ultraviolet (UV) light.

Permissible Exposure Limits in Air

OSHA PEL: None

NIOSH REL: Carcinogen; Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 1.30E-04E milligram per cubic meter

PAC-2: 0.0014 milligram per cubic meter

PAC-3: 0.0085 milligram per cubic meter

DFG MAK: 1.0×10^{-8}, inhalable fraction Peak Limitation Category II(8) [skin]; Carcinogen Category 4; Pregnancy Risk Group C.

Austria: carcinogen, 1999; Finland: carcinogen, 1999; France: carcinogen, 1993; Switzerland: carcinogen, 1999. Several states have set guidelines or standards for TCDD in ambient air[60] ranging from zero (North Dakota and South Carolina); to 1.1 picograms/m^3 (Massachusetts); to 0.003 nanogram/m^3 (North Carolina); to 0.0001 μ/m^3 (Pennsylvania); to 3.0 μ/m^3 (Virginia); to 450.0 μ/m^3 (Indiana).

Determination in Air: No method available.

Permissible Concentration in Water: Safe Drinking Water Act (47FR 9352): MCL, 0.000000003 mg/L; MCLG, zero. For the protection of human health, the concentration is preferably zero. An additional lifetime cancer risk of 1 in 100,000 is posed at a concentration of 4.55×10^{-7} μg/L as of 1979. A concentration of 0.0039 μg/L was estimated to limit cancer risk to one in a million by EPA in 1980. States which have set guidelines for TCDD in drinking water include Maine @ 2×10^{-4} μg/L and Minnesota @ 2×10^{-6} μg/L[61].

Determination in Water: Methylene chloride extraction followed by transfer to benzene and capillary column gas chromatography/mass spectrometry with electron impact ionization (EPA Method 613); or gas chromatography plus mass spectrometry (EPA Method 625).

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

In varying degrees, organochlorines are absorbed from the gut and also by the lung and across the skin[72].

Short-Term Exposure: *Note*: 2,3,7,8-TCDD is one of the most toxic synthetic chemicals, and the most toxic of the 75 dioxins. LD_{50} = (oral-rat) 0.05 mg/kg. Exposure can headache, weakness, and digestive disturbances. Most symptoms develop slowly, over many days. Inhalation can cause burning sensation in nose and throat, headache, dizziness, nausea, vomiting, pain in the joints; tiredness, emotional disorders; blurred vision; muscle pain; nervousness, irritability and intolerance to cold. Itching, swelling and redness, followed by acne-like eruptions of the skin known as chloracne commonly occur. Symptoms of chloracne may appear weeks or months after initial exposure and may last a few months or Up to 15 years. Can cause abnormalities of liver, pancreas, circulatory system, respiratory system, and death. Skin contact with very small amounts can cause chloracne. Eye contact can cause burning and irritation. Animal studies suggest that daily exposure to amounts smaller than one grain of salt may cause severe symptoms and death within a few weeks.

Long-Term Exposure: Reproductive difficulties; increased risk of cancer (2,3,7,8-TCDD). Can cause effects under inhalation, especially chloracne (an acne-like skin rash), as well as numbness and tingling in arms and legs. Can cause allergic dermatitis porphyria; gastrointestinal disturbance; possible reproductive problems. A blood abnormality may occur which may include light sensitive skin, blisters, dark skin coloration; excessive hair growth and dark red urine. Reproductive problems and an increased susceptibility to infection may occur. TCDD is considered a potential occupational carcinogen because extremely low levels cause cancer and birth defects in animals. May cause liver, kidney damage. May be a teratogen. May decrease fertility in males and females.

Points of Attack: Eyes, skin, liver, kidneys, reproductive system, liver and kidneys. Cancer site in animals: tumors at many sites; liver, lung, mouth, tongue, skin cancer. Causes lymphomas in humans.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. In short, contact with TCDD should be avoided but obviously careful preplacement and regular physical exams should be carried out in those cases where worker exposure cannot be avoided, with emphasis on liver and kidney function studies. Examination of the nervous system.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Note to Physician: Liver and nerve function screening tests should be performed. Also monitor serum triglycerides and cholesterol.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration*: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Use in isolated area with adequate ventilation, preferably a hood; segregated glass-ware and tools; and plastic backed absorbent. Thoroughly wash hands and forearms after each manipulation and before leaving work area. Use the same precautions required for radioactive work.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Warn other workers of spill. Wearing protective clothing, collect powdered material in the most convenient and safe manner and deposit in sealed containers. Rinse area with 1,1,1-trichloroethane, then wash with detergent and water. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide; water spray; or foam extinguishers. Thermal decomposition products may include hydrogen chloride and oxides of carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(109); (102); (31); (173); (101); (138); (203).

United States Environmental Protection Agency, *2,3,7,8-Tetrachlorodibenzo-p-Dioxin*: *Ambient Water Quality Criteria*, Washington, DC (1979)

United States Public Health Service, *Toxicological Profile for 2,3,7,8-Tetrachloro-Dibenzo-p-Dioxin*, Atlanta, Georgia, agency for Toxic Substance & Disease Registry (November 1987)

United States Environmental Protection Agency, *TCDD, Health and Environmental Effects Profile No. 155*, Washington, DC, Office of Solid Waste (April 30, 1980)

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 2, 63−64 (1980)

National Institute for Occupational Safety and Health, *2,3,7,8-Tetrachlorodiabenzop-dioxin*, Current Intelligence Bulletin 40, DHHS (NIOSH), Publication No. 84-104, Cincinnati, Ohio (January 23, 1984)

New York State Department of Health, *Chemical Fact Sheet*: *2,3,7,8-TCDD (Dioxin)*, Bureau of Toxic Substance Assessment, Albany, NY (March 1986)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: *2,3,7,8-Tetrachlorodibenzo-p-dioxin*, Trenton NJ (September, 2002)

Tetrachlorodifluoroethanes T:0240

Formula: $C_2Cl_4F_2$; Cl_2FCCl_2F; CCl_3CF_2Cl

Synonyms: *1,1,1,2-*: 1,2-Difluoro-1,1,2,2-tetrachloroethane; Ethane, 1,1,2,2-tetrachloro-1,2-difluoro-; F-112; Freon 112; Genetron 112; Halocarbon 112; *sym*-Tetrachloro-1,2-difluoroethane; 1,1,2,2-Tetrachloro-1,2-difluoroethane; Tetrachloro-1,2-difluoroethane 1,1,2,2-:1,1-Difluoroperchloroethane; 2,2-Difluoro-1,1,1,2-tetrachlorethane; Ethane, 1,1,1,2-Tetrachloro-2,2-difluoro-; Halocarbon 112A; Refrigerant 112A; 1,1,1,2-Tetrachloro-2,2-difluoroethane

CAS Registry Number: 76-11-9 (1,1,1,2-T-2,2,-D); 76-12-0 (1,1,2,2-T-1,2,-D)

HSDB Number: 1092 (76-11-9); 144 (76-12-0)

RTECS Number: KI1420000 (1,1,2,2-T-1,2,-D); KI1425000 (1,1,1,2-T-2,2,-D)

UN/NA & ERG Number: UN1078/126

EC Number: 200-934-0 (1,1,1,2-T-2,2,-D); 200-935-6 (1,1,2,2-T-1,2,-D)

Regulatory Authority and Advisory Information

Hazard Alert: Combustible, Asphyxiation hazard, Possible risk of forming tumors, Primary irritant (w/o allergic reaction), Contains gas under pressure; may explode if heated.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: N, Xi, Xn; Risk phrases: R22; R36/37/38; R59; Safety phrases: S3/7; S16; S22; S24/25; S26; S36; S37/39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. (both CAS numbers).

Description: 1,1,2,2-Tetrachloro-1,2-difluoroethane, CCl_2FCCl_2F, and 1,1,1,2-Tetrachloro-2,2-difluoroethane, CCl_3CF_2Cl, are both colorless liquids or solids with slight ethereal odor. Molecular weight = 203.82 (either compound); Specific gravity (H_2O:1) = 1.65 @ 25°C (both); Boiling point 93°C (1,1,2,2-) and 91.7°C (1,1,1,2-); Freezing/Melting point = 25°C (1,1,2,2-) and 41°C (1,1,1,2-); Vapor pressure = 40 mmHg @ 25°C (both); 40 mmHg @ 20°C[77]. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Both are practically insoluble in water; solubility = 0.01%.

Potential Exposure: (1,1,2,2-): Possible risk of forming tumors, Primary irritant (w/o allergic reaction). 1,1,1,2-is used as a refrigerant, corrosion inhibitor; and blowing agent; making plastics. 1,1,2,2-is used as a refrigerant, a solvent extractant; and in the dry cleaning industry.

Incompatibilities: Acids and chemically active metals, such as potassium, beryllium, powdered aluminum; zinc, calcium, magnesium, and sodium.

Permissible Exposure Limits in Air

NIOSH IDLH = 2000 ppm

Conversion factor: 1 ppm = 8.34 milligram per cubic meter (both)@ 25°C & 1 atm

76-11-9, (1,1,2,2-)

OSHA PEL: 500 ppm/4170 milligram per cubic meter TWA

NIOSH REL: 500 ppm/4170 milligram per cubic meter TWA

ACGIH TLV[1]: 100 ppm /834 milligram per cubic meter TWA

DFG MAK: 200 ppm/1700 milligram per cubic meter TWA; Peak Limitation Category II(2) [Pregnancy Risk Group D.

Australia: TWA 500 ppm (4170 milligram per cubic meter), 1993; Austria: MAK 500 ppm (4179 milligram per cubic meter), 1999; Belgium: TWA 500 ppm (4170 milligram per cubic meter), 1993; Denmark: TWA 500 ppm (4170 milligram per cubic meter), 1999; Finland: TWA 500 ppm (4170 milligram per cubic meter), STEL 625 ppm (5215 milligram per cubic meter), 1999; France: VME 500 ppm (4170 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 4170 milligram per cubic meter, 2003; Switzerland: MAK-W 500 ppm (4200 milligram per cubic meter), 1999; United Kingdom: TWA 100 ppm (847 milligram per cubic meter), STEL 100 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 500 ppm

76-11-9, (1,1,2,2-)

NIOSH IDLH = 2000 ppm

OSHA PEL: 500 ppm/4170 milligram per cubic meter TWA

NIOSH REL: 500 ppm/4170 milligram per cubic meter TWA

ACGIH TLV[1]: 500 TWA

Protective Action Criteria (PAC) Ver. 29[138]

76-12-0, (1,1,2,2-T-1,2,-D)

PAC-1: 150 ppm

PAC-2: 1600 ppm

PAC-3: 15,000 ppm

DFG MAK: 200 ppm/1700 milligram per cubic meter; Pregnancy Risk Group D

Australia: TWA 500 ppm (4170 milligram per cubic meter), 1993; Austria: MAK 200 ppm (1690 milligram per cubic meter), 1999; Belgium: TWA 500 ppm (4170 milligram per cubic meter), 1993; Denmark: TWA 200 ppm (1665 milligram per cubic meter), 1999; Finland: TWA 500 ppm (4170 milligram per cubic meter), STEL 625 ppm (5215 milligram per cubic meter), 1999; France: VME 500 ppm (4170 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 850 milligram per cubic meter, 2003; the Phillipines: TWA 500 ppm (4170 milligram per cubic meter), 1993; Switzerland : MAK-W 500 ppm (4200 milligram per cubic meter), STEL 1000 ppm, 1999; United Kingdom: TWA 100 PPM (847 MG/ minute3), STEL 100 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 500 ppm. Several states have set guidelines or standards for these compounds in ambient air[60] ranging from 0.57 milligram per cubic meter (Massachusetts); to 41.7 milligram per cubic meter (North Dakota); to 51.7 milligram per cubic meter (North Carolina); to 70.0 milligram per cubic meter (Virginia); to 83.4 milligram per cubic meter (Connecticut); to 99.296 milligram per cubic meter (Nevada).

Determination in Air: NIOSH Analytical Method (IV) #1016; OSHA Analytical Method 7.

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guide lines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg [F]/L. SafeDrinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg[F]/L; SMCL = 2 mg/F/L, as Fluoride.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Contact with either chemical can irritate the eyes and the skin, causing a rash or a burning feeling. 1,1,1,2-Tetrachloro-2,2-difluoroethane can affect you when breathed in. May cause CNS depression. High levels may irritate the lungs, causing coughing, shortness of breath; drowsiness, dyspnea (breathing difficulty). Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. 1,1,2,2,-Tetrachloro-1,2-difluoroethane can affect you when breathed in. Exposure can cause you to become dizzy, lightheaded and to pass out. Very high exposures could cause death. May affect the heart, causing an irregular rhythm. Exposure can cause you to become dizzy and lightheaded. Extremely high levels could cause you to pass out and even die. It can irritate the lungs, causing coughing and/or shortness of breath. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: Either compound may cause liver damage. Repeated exposure to either compound may reduce the number of white blood cells.

Points of Attack: Eyes, skin, respiratory system; CNS; heart.

Medical Surveillance: *For the 1,1,1,2-compound*: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: Holter monitor (a special 24 hour EKG to look for irregular heart rhythms). Consider chest X-ray after acute overexposure. Liver function tests. CBC.

For the *1,1,2,2-compound*: If symptoms develop or overexposure has occurred, blood tests for liver function, a CBC and lung function tests may be useful. If heart rhythm symptoms are occurring, special 24-hour EKG test might be indicated.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy. (This is particularly true of the 1,1,1,2-compound).

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Barrier and Viton gloves; Tychem BR, Tychem TK, Responder, and Trellchem suits. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid or dust-proof goggles and face shield when working with powders or dusts, unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 2000 ppm*: Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd, Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,P p: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code-Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. Check oxygen content before entering area. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Tetrachloro-difluoroethanes must be stored to avoid contact with chemically active metals (such as sodium, potassium, beryllium, zinc, powdered aluminum; or magnesium), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat.

Shipping: UN1078 Refrigerant gases, n.o.s., Hazard Class: 2.2; Labels: 2.2-Nonflammable compressed gas, Technical Name Required

Spill Handling: Absorb liquid in vermiculite, dry sand; earth, or similar material and deposit in sealed containers. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include hydrogen chloride, hydrogen fluoride, phosgene and oxides of carbon. Extinguish fire using an agent suitable for type of surrounding fire. Tetrachloro-difluoroethanes do not burn. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138) (122); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: 1,1,1,2-Tetrachloro-2,2-Difluoroethane, Trenton, NJ (September 2002)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: 1,1,2,2-Tetrachloro-1,2-Difluoroethane, Trenton, NJ (August 2002)

1,1,1,2-Tetrachloroethane T:0250

Formula: $C_2H_2Cl_4$; Cl_3CCH_2Cl

Synonyms: *asym*-Tetrachloroethane; (Chloromethyl)trichloromethane; Ethane, 1,1,1,2-tetrachloro-; F 130A; HCC

130A; NC I-C52459; TCA; 1,1,1,2-Tetrachloroethane 1,1,1,2-Tetracloroetano (Spanish)
CAS Registry Number: 630-20-6
HSDB Number: 4148
RTECS Number: KI8450000
UN/NA & ERG Number: UN1702/151
EC Number: 211-135-1

Regulatory Authority and Advisory Information

Carcinogenicity: EPA: Possible Human Carcinogen; NCI: Carcinogenesis Studies (gavage); clear evidence: mouse; equivocal evidence: rat. IARC: Animal Limited Evidence; Human No Adequate Data, *not classifiable as carcinogenic to humans*, Group 3, 1999; NTP: Toxicity studies, RPT#TOX-45, October 2000.

California Proposition 65 Chemical[102]: Cancer9/13/2013

Hazard Alert: Poison, Possible risk of forming tumors, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction), Environmental hazard. Listed for Tier 1 screening as an endocrine disruptor[88].

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U208

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.057; Nonwastewater (mg/kg), 6.0

RCRA 40CFR264, appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8010 (5); 8240 (5)

Safe Drinking Water Act (47FR 9352): Priority List (55 FR 1470)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 100 lb (45.4 kg)

EPCRA Section 313 Form R *de minimis* Concentration Reporting Level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, appendix B)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T, Xn; Risk phrases: R45, R22; R20/22; R23/24/25; R36/37/38; R39; R40; R41; R60; R61; R62; Safety phrases: S7; S16; S24; S26; S36/37/39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: 1,1,1,2-Tetrachloroethane is a colorless to yellowish-red liquid. Molecular weight = 167.85; Specific gravity (H_2O:1) = 1.54 @ 20°C; Boiling point = 136°C; Freezing/Melting point = −70°C; Vapor pressure = 14 mmHg @ 25°C; 7.5 mmHg @ 17°C[138]. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Slightly soluble in water; solubility = 0.1%.

Potential Exposure: 1,1,1,2-Tetrachloroethane is used as a solvent and in manufacture of insecticides, herbicides, soil fumigants; blanches, paints, and a number of widely used products; as are the other chloroethanes.

Incompatibilities: 1,1,1,2-Tetrachloroethane is incompatible with strong oxidizing agents and strong bases. It is also incompatible with dinitrogen tetraoxide, 2,4-dinitrophenyl disulfide, potassium, potassium hydroxide, nitrogen tetraoxide, sodium and sodium potassium alloy. It may react with chemically active metals, strong caustics, hot iron, aluminum and zinc in presence of steam. It may also react with mixtures of dinitrogen tetraoxide with halocarbons[NTP,1992].

Permissible Exposure Limits in Air

OSHA PEL: None

NIOSH REL: No numerical value but users are cautioned to handle with caution in the workplace. See *NIOSH Pocket Guide*, Appendix C.

Protective Action Criteria (PAC) Ver. 29[138]
PAC-1: 0.2 ppm
PAC-2: 2.2 ppm
PAC-3: 13 ppm

Brazil[35] 4 ppm (27 milligram per cubic meter) for workplace air over a 48 hour week. Russia[43] set a MAC for tetrachloroethanes (no isomer indicated) of 5 milligram per cubic meter in workplace air.

Determination in Air: No method available.

Permissible Concentration in Water: For 1,1,1,2-tetrachoroethane the criterion to protect freshwater aquatic life is 9,320 μg/L based on acute toxicity data. For saltwater aquatic life, no criterion for 1,1,1,2-tetrachloroethane can be derived using the guidelines, and there is insufficient data to estimate a criterion using other procedures. For the protection of human health, there is insufficient data to derive criteria for 1,1,1,2-tetrachloroethane.

Determination in Water: Octanol-water coefficient: Log K_{ow} = 2.4. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Contact irritates the eyes and skin. Inhalation can irritate the respiratory tract causing coughing, wheezing, and/or shortness of breath. Can cause headache, nausea and vomiting. May cause CNS depression. Symptoms of exposure include weakness, restlessness, tremor, dizziness, drowsiness, irregular/irregularities of respiration; decreased muscle coordination; coma.

Long-Term Exposure: There is limited evidence that this chemical causes liver cancer in animals. Can cause dermatitis; drying and cracking. May affect the liver and nervous system.

Points of Attack: Eyes, skin, CNS; liver.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Liver function tests. Examination of the nervous system. Evaluation by a dermatologist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Viton and polyvinyl alcohol are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration*: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA-or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full-facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Store in tightly closed containers in a cool, well-ventilated area away from potassium, sodium, dinitrogen tetraoxide; potassium hydroxide; nitrogen tetroxide; sodium potassium alloy; 2,4-dinitrophenyl disulfide. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded.

Shipping: UN1702 Tetrachloroethane, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible liquid. Thermal decomposition products may include chlorine and hydrogen chloride. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rock et great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(102); (31); (173); (101); (138); (100).

United States Environmental Protection Agency, *1,1,1,2-Tetrachloroethane, Health and Environmental Effects Profile No. 156*, Washington, DC, Office of Solid Waste (April 30, 1980)

United States Environmental Protection Agency, *Chlorinated Ethanes*: *Ambient Water Quality Criteria*, Washington, DC (1980)

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 4, No. 3, 93−95 (1984)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: *1,1,1,2-Tetrachloroethane*, Trenton NJ (October 1999)

1,1,2,2-Tetrachloroethane T:0260

Formula: $C_2H_2Cl_4$; $CHCl_2CHCl_2$
Synonyms: Acetosol; Acetylene tetrachloride; Bonoform; Boroform; Cellon; 1,1-Dichloro-2,2-dichloroethane; Ethane,1,1,2,2-tetrachloro-; F-130; F-130 (halocarbon); NCI-C03554; *s*-Tetrachloroethane; *sym*-Tetrachloroethane; Symmetrical tetrachloroethane; TCA; TCE; 1,1,2,2-TCE; 1,1,2,2-Tetrachloraethan (German); Tetrachlorethane; 1,1,2,2-Tetrachlorethane (French); Tetrachlorethane; 1,1,2,2-Tetrachloro-; 1,1,2,2-Tetrachloroethane; Tetrachlorure d'acetylene (French); Westron
CAS Registry Number: 79-34-5
HSDB Number: 123
RTECS Number: KI8575000
UN/NA & ERG Number: UN1702/151
EC Number: 201-197-8 [*Annex I Index No*.: 602-015-00-3]
Regulatory Authority and Advisory Information
Carcinogenicity: IARC: Animal Limited Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1999; EPA: Possible Human Carcinogen; NCI: Carcinogenesis Bioassay (gavage); clear evidence: mouse; equivocal evidence: rat; NIOSH: Potential occupational carcinogen. United States Environmental Protection Agency Gene-Tox Program, Positive: *E coli polA* without S9; S *cerevisiae* gene conversion; Positive: S *cerevisiae-homozygosis*; S cerevisiae-reversion; Positive/limited: Carcinogenicity-mouse/rat. NTP: Toxicity studies, RPT-TOX-45, October 2000.
California Proposition 65 Chemical[102]: Cancer 1/1/1990.
Hazard Alert: Poison, Possible risk of forming tumors, Suspected of causing genetic defects, Environmental hazard.
Banned or Severely Restricted (UK, Belgium) (UN)[13]
Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)
United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U209
RCRA 40CFR264, appendix 9; TSD Facilities Ground Water Monitoring List
Suggested methods (PQL μg/L): 8010 (0.5); 8240 (5)
RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.057; Nonwastewater (mg/kg), 6.0
Safe Drinking Water Act (47FR9352): Priority List (55 FR 1470)
Clean Water Act: Section 307(a)(1)Toxic Pollutants subject to effluent limitations as Chlorinated ethanes.
Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 100 lb (45.4 kg)
EPCRA Section 313 Form R *de minimis* Concentration Reporting Level: 1.0%.
United States DOT Regulated Marine Pollutant (49CFR172.101, appendix B)
Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.
Hazardous to aquatic life or environment, with possible long-lasting effects[293]. Toxic to aquatic life with long-lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.
Hazard Symbols, Risk & Safety statements: Hazard Symbol: T+, N; Risk phrases: R26/27; R50/53; R62; Safety phrases: S1/2; S29/35; S38; S41; S45; S61 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.
Description: Tetrachloroethane is a heavy, volatile colorless to light yellow liquid. It has a sweetish, chloroform-like odor. The Odor Threshold is 0.5 ppm in water and 1.5 ppm in air. Molecular weight = 167.9; Specific gravity (H_2O:1) = 1.6 @ 20°C; Boiling point = 145°C; Freezing/Melting point = −42.4°C; Vapor pressure = 5.8 mmHg @ 25°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Slightly soluble in water; solubility = 0.29% @ 20°C.
Potential Exposure: Tetrachloroethane is used as an intermediate in the trichloroethylene production from acetylene and as a solvent; as a dry cleaning agent; as a fumigant; in cement; and in lacquers. It is used in the manufacture of artificial silk, artificial leather, and artificial pearls. Recently, its use as a solvent has declined due to replacement by less toxic compounds. It is also used in the estimation of water content in tobacco and many drugs, and as a solvent for chromium chloride impregnation of furs.
Incompatibilities: Violent reaction with chemically active metals; strong caustics; strong acids; especially fuming sulfuric acid. Degrades slowly when exposed to air. Attacks plastic and rubber.
Permissible Exposure Limits in Air
NIOSH IDLH = 100 ppm, potential occupational carcinogen.
The Odor Threshold is 1.5 ppm in air.
OSHA PEL: 5 ppm/35 milligram per cubic meter TWA [skin]
NIOSH REL: 1 ppm/7 milligram per cubic meter TWA [skin]; potential occupational carcinogen; See *NIOSH Pocket Guide*, Appendix A and C (chloroethanes).
ACGIH TLV[1]: 1 ppm/6.9 milligram per cubic meter TWA [skin]; confirmed animal carcinogen with unknown relevance to humans.
Protective Action Criteria (PAC) Ver. 29[138]
PAC-1: 3 ppm
PAC-2: 120 ppm
PAC-3: 150 ppm

DFG MAK: 1 ppm /7.0 milligram per cubic meter TWA; Peak Limitation Category II(2) [skin]; Carcinogen Category 3B; Pregnancy Risk Group D

Australia: TWA 1 ppm (7 milligram per cubic meter), [skin], 1993; Austria: MAK 1 ppm (7 milligram per cubic meter), [skin], Suspected: carcinogen, 1993; Belgium: TWA 1 ppm (6.9 milligram per cubic meter), [skin], 1993; Denmark: TWA 1 ppm (7 milligram per cubic meter), [skin], 1999; Finland: TWA 1 ppm (7 milligram per cubic meter), STEL 3 ppm (21 milligram per cubic meter), [skin], 1999; France: VME 1 ppm (7 milligram per cubic meter), VLE 5 ppm (35 milligram per cubic meter), 1999; Japan: 1 ppm (6.9 milligram per cubic meter), [skin], 1999; the Netherlands: MAC-TGG 7 milligram per cubic meter, [skin], 2003; Norway: TWA 1 ppm (7 milligram per cubic meter), 1999; the Phillipines: TWA 5 ppm (35 milligram per cubic meter), [skin], 1993; Poland: MAC (TWA) 5 milligram per cubic meter; MAC (STEL) 35 milligram per cubic meter, 1999; Russia: TWA 1 ppm, 1993; Switzerland: MAK-W 1 ppm (7 milligram per cubic meter), [skin], 1999; Turkey: TWA 5 ppm (35 milligram per cubic meter), 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: confirmed animal carcinogen with unknown relevance to humans. Russia set a MAC for ambient air in residential areas[35] of 60 μ/m^3 on a once-daily basis. Several states have set guidelines or standards for 1,1,2,2-tetrachloro ethane in ambient air[60] ranging from zero (North Carolina); to 1.2 μ/m^3 (Massachusetts); to 16.667 μ/m^3 (Kansas); to 23.3 μ/m^3 (New York); to 34.4 μ/m^3 (Connecticut); to 167.0 μ/m^3 (Pennsylvania).

Determination in Air: Adsorption on charcoal, workup with CS_2, analysis by gas chromatography/flame ionization. Use NIOSH Analytical Method 1019[18].

Permissible Concentration in Water: Clean Water Act: Section 307(a)(1)Toxic Pollutants subject to effluent limitations as chlorinated ethanes. State Drinking Water Standards: California 1 μg/L; New Jersey 1 μg/L. State Drinking Water Guidelines: Arizona 0.17 μg/L; Connecticut 28 μg/L; Florida 1 μg/L; Maine 1.8 μg/L; Minnesota 2 μg/L; Wisconsin 2 μg/L.

Determination in Water: Inert gas purge followed by gas chromatography with halide specific detection (EPA Method 601) or gas chromatography plus mass spectrometry (EPA Method 624).

Routes of Entry: Inhalation of vapor and absorption of liquid through the skin (there is some evidence that tetrachloroethane absorbed through the skin affects the CNS only), ingestion, and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: A CNS depressant. Symptoms may include nervousness, loss of appetite; constipation, tremors, fatigue, dizziness, nausea, vomiting and headache. May cause liver and kidney damage. These symptoms have been reported after prolonged exposure to 75 ppm. *Inhalation*: Exposure of 116 ppm for 20 minutes has caused dizziness and vomiting. At 260 ppm for 10 minutes, irritation of nose and throat were felt also. At 335 ppm for 10 minutes, rapid fatigue was also experienced. These symptoms generally disappear when exposure stops. Large accidental exposures have resulted in death. *Skin*: Causes skin irritation. Absorption through skin is possible. Significant skin absorption may occur to produce toxic effects. Earliest and most common symptom is tremors of hands, followed by skin irritation, numbness and effects listed above. Death has occurred from a combination of inhalation and skin absorption. *Eyes*: Causes irritation and tearing. *Ingestion*: Abdominal pain; nausea, and vomiting followed by similar symptoms as *inhalation*. As little as 3 mL (1/10 liquid oz) may cause unconsciousness. LD_{50} = (oral-rat) 25 mg/kg.

Long-Term Exposure: Repeated exposure may cause dermatitis, drying and cracking. May damage the blood forming organs, causing monocytosis (increased blood monocytes). May affect the CNS causing tremors, weakness, dizziness, decreased coordination; and even unconsciousness and death. May cause kidney and liver damage; jaundice, hepatitis, liver tenderness. Tetrachloroethane is a mutagen and a potential occupational carcinogen. There is limited evidence that this chemical is a teratogen in animals.

Points of Attack: Skin, liver, kidneys, CNS; gastrointestinal tract. Cancer site in animals: liver tumors.

Medical Surveillance: NIOSH lists the following tests: Blood Urea Nitrogen; liver function tests; urinalysis (routine). Preplacement and periodic examination should be comprehensive because of the possible involvement of many systems. Special attention should be given to liver, kidney, and bone marrow function, as well as to the central and peripheral nervous system. Alcoholism may be a predisposing factor.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/ manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Teflon, Viton, and polyvinyl alcohol are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration*: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). Escape: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. 1,1,2,2-Tetrachloroethane must be stored to avoid contact with chemically active metals (such as potassium, powdered aluminum; sodium, magnesium, and zinc) or strong acids (such as hydrochloric, sulfuric, and nitric), since violent reactions occur. Where possible, automatically transfer material from other storage containers to process containers.

Shipping: UN1702 Tetrachloroethane or 1,1,2,2-Tetrachloroe thane, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include phosgene, chlorine, and hydrogen chloride. Extinguish fire using an agent suitable for type of surrounding fire. 1,1,2,2-Tetrachloroethane itself does not burn. Vapors are heavier than air and will collect in low areas. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced[22].

References

(102); (31); (173); (101); (138); (2); (100).

National institute for Occupational Safety and Health (NIOSH), "Criteria for a Recommended Standard: Occupational Exposure to 1,1,2,2-Tetrachoroethane," NIOSH Document Number 77-121, Cincinnati OH (1977)

United States Environmental Protection Agency, Chemical Hazard Information Profile: 1,1,2,2-Tetrachloroethane, Washington, DC (1979)

United States Environmental Protection Agency, Chlorinated Ethanes: Ambient Water Quality Criteria, Washington, DC (1980)

United States Environmental Protection Agency, 1,1,2,2-Tetrachloroethane, Health and Environmental Effects Profile No. 157, Washington, DC, Office of Solid Waste (April 30, 1980)

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 5, 84−85 (1981), 2, No. 6, 79−83 (1982); 3, No. 2, 60−64 (1983)

United States Public Health Service, "Toxico logical Profile for 1,1,2,2-Tetrachloroethane," Atlanta, Georgia, agency for Toxic Substances and Disease Registry (December 1988)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: 1,1,2,2-Tetrachloroethane, Trenton, NJ (October 1999)

New York State Department of Health, *Chemical Fact Sheet*: 1,1,2,2-Tetrachloroethane, Bureau of Toxic Substance Assessment, Albany, NY (March 1986 and Version 3)

Tetrachloroethylene T:0270

Formula: C_2Cl_4; $Cl_2C=CCl_2$

Synonyms: Ankilostin; Antisal 1; Carbon bichloride; Carbon dichloride; Didakene; Dilatin PT; Dowper; ENT 1,860; Ethene, tetrachloro-; Ethylene tetrachloride; Ethylene tetrachloro-; Fedal-UN; Freon 1110; NC I-C04580; Nema; PER; Perawin; PERC; Perchlor; Perchloraethylen, per (German); Perchlorethylene; Perchlorethylene, per (French); Perclene; Percloroetileno (Spanish); Percosolve; PERK; Perklone; Persec; Tetlen; Tetracap; Tetrachloraethen (German); 1,1,2,2-Tetrachloroethene; Tetrachloroethene; 1,1,2,2,-Tetrachloroethylene; Tetrachloroethylene; Tetraclo roetileno (Spanish); Tetraleno; Tetralex; Tetravec; Tetroguer; Tetropil

CAS Registry Number: 127-18-4

HSDB Number: 124

RTECS Number: KX3850000

UN/NA & ERG Number: UN1897/160

EC Number: 204-825-9

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Animal, Sufficient Evidence; Human, Limited Evidence, Group 2A, 1995; NCI: Carcinogenesis Studies (inhalation); clear evidence: mouse, rat; Carcinogenesis Bioassay (gavage); inadequate studies: rat; NTP: Carcinogenesis Studies (inhalation); clear evidence: mouse, rat; NIOSH: Potential occupational carcinogen. United States Environmental Protection Agency Gene-Tox Program, Positive: Cell transformation-RLV F344 rat embryo; Positive: S *cerevisiae* gene conversion; S *cerevisiae-homozygosis*; Positive: S cerevisiae-reversion; Positive/limited: Carcinogenicity-mouse/rat; Negative: Cell transformation-SA7/SHE.

California Proposition 65 Chemical[102]: Cancer 4/1/1988.

Hazard Alert: Poison, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction), Environmental hazard.

Banned or Severely Restricted (Japan) (UN)[13]

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); 40CFR401.15 Section 307 Toxic Pollutants

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U210

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.056; Nonwastewater (mg/kg), 6.0

RCRA 40CFR264, appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8010 (0.5); 8240 (5)

United States National Primary Drinking Water Regulations: MCL = zero mg/L; MCL = 0.005 mg/L

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 100 lb (45.4 kg)

EPCRA Section 313 Form R *de minimis* Concentration Reporting Level: 0.1%.

United States DOT Regulated Marine Pollutant (49CFR172.101, appendix B)

Hazardous to aquatic life or environment, with possible long-lasting effects[293]. Toxic to aquatic life with long-lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects[293]. Toxic to aquatic life with long-lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T, F, N, Xn; Risk phrases: R11; R23/25; R38; R39/23/24/29; R40; R50/53; R60/61; R62; R63; R65; R67; Safety phrases: S7; S16; S24; S29/35; S36/37; S45; S53; S60; S61; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Tetrachloroethylene is a clear, colorless, nonflammable liquid with a characteristic odor. The odor is noticeable @ 47 ppm, though after a short period it may become inconspicuous, thereby becoming an unreliable warning signal. The Odor Threshold is variously given as 5 ppm[41] to 6.17 (3M). Molecular weight = 165.83; Specific gravity (H_2O:1) = 1.62 @ 20°C; Boiling point = 121.1°C; Freezing/Melting point = −18.9°C; −22°C[138]; Vapor pressure = 14 mmHg @ 25°C; 7.5 mmHg @ 10°C. Explosive limits: LEL = 12,000 ppm, UEL: Unknown. Slightly soluble in water; solubility = 0.02%.

Potential Exposure: Tetrachloroethylene is used in the textile industry and as a chemical intermediate or a heat-exchange fluid; a widely used solvent with particular use as a dry cleaning agent; a degreaser; a fumigant, and medically as an anthelmintic.

Incompatibilities: Violent reaction with strong oxidizers; powdered, chemically active metals, such as aluminum, lithium, beryllium, and barium; caustic soda; sodium hydroxide; potash. Tetrachloroethylene is quite stable. However, it reacts violently with concentrated nitric acid to give carbon dioxide as a primary product. Slowly decomposes on contact with moisture producing trichloroacetic acid and hydrochloric acid. Decomposes in UV light and in temperatures above 150°C, forming hydrochloric acid and phosgene.

Permissible Exposure Limits in Air

NIOSH IDLH = 150 ppm, potential occupational carcinogen.

Conversion factor: 1 ppm = 6.78 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 100 ppm TWA; 200 ppm Ceiling Concentration; 300 ppm [5-min. maximum peak in any 3 hrs]

NIOSH REL: Potential occupational carcinogen; limit exposure to lowest feasible concentration; See *NIOSH Pocket Guide*, Appendix A

ACGIH TLV[1]: 25 ppm/170 milligram per cubic meter TWA; 100 ppm/685 milligram per cubic meter STEL, animal carcinogen with unknown relevance to humans; BEI issued

Protective Action Criteria (PAC)* Ver. 29[138]

PAC-1: $\mathbf{35_A}$ ppm

PAC-2: $\mathbf{230_A}$ ppm

PAC-3: $\mathbf{1200_A}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

DFG MAK: [skin]; Carcinogen Category 3B; BAT: 1 mg [tetrachloroethylene]/L in blood at the beginning of the next shift.

Arab Republic of Egypt: TWA 5 ppm (35 milligram per cubic meter), [skin], 1993; Australia: TWA 50 ppm (335 milligram per cubic meter), STEL 150 ppm, carcinogen, 1993; Austria: MAK 50 ppm (345 milligram per cubic meter), Suspected: carcinogen, 1999; Belgium: TWA 50 ppm (339 milligram per cubic meter), STEL 200 ppm (1368 milligram per cubic meter), 1993; Denmark: TWA 10 ppm (70 milligram per cubic meter), [skin], 1999; Finland: TWA 50 ppm (335 milligram per cubic meter), STEL 75 ppm (520 milligram per cubic meter), [skin], 1999; France: VME 50 ppm (335 milligram per cubic meter), carcinogen, 1999; the Netherlands: MAC-TGG 240 milligram per cubic meter, [skin], 2003; Japan: 50 ppm (340 milligram per cubic meter), 2B carcinogen, 1999; Norway: TWA 20 ppm (130 milligram per cubic meter), 1999; the Phillipines: TWA 100 ppm (670 milligram per cubic meter), 1993; Poland: MAC (TWA) 60 milligram per cubic meter; MAC (STEL) 480 milligram per cubic meter, 1999; Russia: TWA 50 ppm, STEL 10 milligram per cubic meter, 1993; Sweden: NGV 10 ppm (70 milligram per cubic meter), KTV 25 ppm (170 milligram per cubic meter), carcinogen, 1999; Switzerland: MAK-W 50 ppm (345 milligram per cubic meter), STEL 100 ppm, [skin], 1999; Thailand: TWA 100 ppm, STEL 200 ppm, 1993; United Kingdom: TWA 50 ppm (345 milligram per cubic meter), STEL 199 ppm, 2000; New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 100 ppm. Limits in ambient air in residential areas have been set by The Czech Republic[35] @ 1.0 milligram per cubic meter on a daily average basis and 4.0 milligram per cubic meter on a half-hour basis as well as by Russia at 0.06 milligram per cubic meter on a daily average basis and 0.5 milligram per cubic meter on a once-daily basis. Several states have set guidelines or standards for tetrachloroethylene in ambient air[60] ranging from 0.05 μ/m^3 (Rhode Island); to 0.18 μ/m^3 (Massachusetts); to 1.7 μ/m^3 (Michigan); to 5.882 μ/m^3 (Kansas); to 21.0 μ/m^3 (North Carolina); to 1,116.0 μ/m^3 (New York); to 1,700.0 μ/m^3 (Connecticut); to 3,350.0 μ/m^3 (Indiana, South Carolina, South Dakota); to 3,350−13,400 μ/m^3 (North Dakota); to 5,600 μ/m^3 (Virginia); to 7,976.0 μ/m^3 (Nevada); to 8,040 μ/m^3 (Pennsylvania).

Determination in Air: Use NIOSH Analytical Method #1003, Hydrocarbons, halogenated[18]; #2549, Volatile organic compounds; OSHA Analytical Method 1001.

Permissible Concentration in Water: Safe Drinking Water Act (47FR 9352): MCL, 0.005 mg/L; MCLG, zero. State Drinking Water Standards: Delaware 1 μg/L; Florida 3 μg/L; New Jersey 1 μg/L; State Drinking Water Guidelines: Arizona 0.67 μg/L; Connecticut 5 μg/L; Maine 7 μg/L; Minnesota 5 μg/L.

Determination in Water: Inert gas purge followed by gas chromatography with halide specific detection (EPA Method 601); or gas chromatography plus mass spectrometry (EPA Method 624). Octanol-water coefficient: Log $K_{ow} = -3$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation of vapor, percutaneous absorption of liquid, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: *Inhalation*: Irritates the eyes and respiratory tract causing coughing and/or shortness of breath. High exposure can cause headache, dizziness, lightheadedness, nausea, vomiting, and unconsciousness. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Exposures of 200 ppm for 1 hour can cause irritation of the nose, mouth and throat; dizziness, headaches and lightheadedness; exposures of 1000 ppm for 30 minutes can cause difficult breathing; weakness, loss of muscle control; irritability, tremors, convulsions, paralysis, coma, heart irregularities and death. *Skin*: Contact can cause irritation and burns. Can cause dry, scaly skin; a mild to moderate burning sensation; redness and inflammation. *Eyes*: Can cause burning and irritation. *Ingestion*: Can cause nausea, vomiting, diarrhea, bloody stool; a reddening of face and neck; weakness and loss of muscle control.

Long-Term Exposure: Liver problems; increased risk of cancer. May affect the liver, kidneys and nervous system. Exposures *over 200 ppm* during weeks or months can cause irritation of the respiratory tract, nausea, head ache, sleeplessness, abdominal pain; constipation, dizziness, increased perspiration; fatigue, skin infection; kidney and liver damage; fluid in the lungs and coma. Long-term exposure can cause dermatitis; drying and cracking of the skin. Tetrachloroethylene has caused liver cancer and birth defects in mice. Whether it causes cancer in humans is unknown. May damage the developing fetus.

Points of Attack: Liver, kidneys, lungs.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. NIOSH lists the following tests: whole blood (chemical/metabolite). For those with frequent or potentially high exposure (half the TLV or greater, or significant skin contact) the following are recommended before beginning work and at regular times after that: urinalysis. Liver function tests. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Special 24 hour EKG (Holter monitor) to look for irregular hearthbeat.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Exposure to tetrachloroethylene should not be controlled with the use of respirators except: during the time period necessary to install or implement engineering or work practice controls; in work situations in which engineering and work practice controls are technically not feasible; to supplement engineering and work practice controls when such controls fail to adequately control exposure to tetrachloroethylene; for operations which require entry into tanks or closed vessels; or in emergencies.

Respirator Selection: NIOSH: *At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration*: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). Escape: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Tetrachloroethylene must be stored to avoid contact with strong oxidizers, such as chlorine, bromine, and chlorine dioxide; chemically active metals; such as barium, lithium, and beryllium; and nitric acid, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat.

Shipping: UN1897 Tetrachloroethylene, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120 (q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Tetrachloroethylene itself does not burn. Thermal decomposition products may include hydrogen chloride, phosgene, chlorine and oxides of carbon are produced in fire or heat above 150°C. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire.

Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced. Alternatively, PCE may be recovered from waste gases and reused.

References

(109); (102); (31); (173); (101); (138); (2); (80); (100).

National institute for Occupational Safety and Health (NIOSH), "Criteria for a Recommended Standard: Occupational Exposure to Tetrachloroethylene," NIOSH Document Number 76-185, Cincinnati OH (1986)

National institute for Occupational Safety and Health (NIOSH), Current Intelligence Bulletin No. 20: Tetrachloroethylene, Washington, DC (January 20, 1978)

United States Public Health Service, "Toxicological Profile for Tetrachloroethylene," Atlanta, Georgia, agency for Toxic Substances and Disease Registry (December 1987)

United States Environmental Protection Agency, Tetrachloroethylene: Ambient Water Quality Criteria, Washington, DC (1980)

United States Environmental Protection Agency, Health Assessment Document for Tetrachloroethylene, Research Triangle Park, NC, Environmental Criteria and Assessment Office (January 1980)

United States Environmental Protection Agency, Tetrachloroethylene, Health and Environmental Effects Profile No. 158, Washington, DC, Office of Solid Waste (April 30, 1980)

New York State Department of Health, *Chemical Fact Sheet*: Tetrachloroethylene, Bureau of Toxic Substance Assessment, Albany, NY (March 1986 and Version 2)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Tetrachloroethylene, Trenton, NJ (March 2002)

Tetracycline T:0280

Formula: $C_{22}H_{24}N_2O_8$

Synonyms: Abramycin; Abricycline; Achromycin; Agromicina; Ambramicina; Ambramycin; Bio-tetra; Bristaciclin; Bristacycline; Cefracycline suspension; Criseocicline; Cyclomycin; Democracin; Deschlorobiomycin; Hostacyclin; Liquamycin; 6-Methyl-1,11-dioxy-2-naphthacenecarboxamide; Neocycline; Oletetrin; Panmycin; Polycycline; Purocyclina; Robitet; Sanclomycine; Sigmamycin; SK-Tetracycline; Steclin; T-125; Tetrabon; Tetracycline I; Tetracyn; Tetradecin; Tetraverine; Tsiklomitsin; ω-Mycin

hydrochloride: Achro; Achromycin; Achromycin hydrochloride; Achromycin V; AI3-50120; Amycin, hydrochloride; Artomycin; Bristacycline; Cefracycline tablets; Chlorhydrate de tetracycline (French); Diacycine; 4-(Dimethylamino)-1,4,4 a,5,5 a,6,11,12 a-octa hydro-3,6,10,12,12a-penta hydroxy-6-methyl-1,11-dioxo-2-naphthacenecarboxamide monohydrochloride; Dumocycin; Medamycin; Mephacyclin; 2-Naphthacenecarboxamide, 4-(dimethylamino)-1,4,4a,5,5a,6,11,12a-octahydro-3,6,10,12,12a-pentahydroxy-6-methyl-1,11-dioxo-, monohydrochloride; 2-Naphthacenecarboxamide,4-(dimethylamino)-1,4,4a,5,5a,6,11,12a-octahydro-3,6, 10,12,12 a-pentahydroxy-6-methyl-1,11-dioxo-, monohydrochloride, [4s-(4a,4a.a,5aa,6b,12aa)]-; NCI-C55561; Neocyclin; Paltet; Panmycin hydrochloride; Polycycline hydrochloride; Qidtet; Quadracycline; Remicyclin; Ricycline; RO-Cycline; SK-Tetracycline; Steclin hydrochloride; Stilciclina; Subamycin; Supramycin; Sustamycin; T-250 Capsules; TC Hydrochloride; Tefilin; Teline; Telotrex; TET-CY; Tetrabakat; Tetrablet; Tetracaps; Tetrachel; Tetracompren; Tetracycline chloride; Tetracyn hydrochloride; Tetra-D; Tetralution; Tetramavan; Tetramycin; Tetrasure; Tetra-Wedel; Tetrosol; Topicycline; Totomycin; Triphacyclin; U-5965; Unicin; Unimycin; Vetquamycin-324

CAS Registry Number: 60-54-8; 64-75-5 (hydrochloride)

HSDB Number: 3188 (60-54-8);

RTECS Number: QI8750000

UN/NA & ERG Number: UN3249 (Medicines, toxic, solid, n.o.s.)/151

EC Number: 200-481-9; 200-593-8 (hydrochloride)

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Combustible, Suspected of causing genetic defects, Suspected reprotoxic hazard, Environmental hazard.

Banned or Severely Restricted (several countries) (UN)[13]

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: Xn, N, Xi; Risk phrases: R20/21/22; R36/37/38;

R50/53; R62; R63; Safety phrases: S22; S26; S29/35; S36; S45 (see Appendix 4)

hydrochloride:

EPCRA Section 313 Form R *de minimis* Concentration Reporting Level: 1.0%.

California Proposition 65 Developmental/Reproductive toxin [Tetracycline (internal use)] 10/1/1992; [Tetracycline hydrochloride (internal use)] 1/1/1991

Hazard Alert: Combustible, Reproductive toxin, Environmental hazard.

Hazardous to aquatic life or environment, with possible long-lasting effects[192]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: Xn, Xi; Risk phrases: R20/21/22; R36/37/38; R50/53; R51 (hydrochloride); R62; R63; Safety phrases: S22; S26; S36; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water; *hydrochloride*: 2-Hazard to water.

Description: Tetracycline trihydrate is a white crystalline substance. Molecular weight = 280.94 (hydrochloride, 64-75-5); 444.48; Freezing/Melting point = 170°C−175°C (decomposition). It is commonly employed as the *hydrochloride*; Molecular weight = 480.94; Freezing/Melting point = 214°C (decomposes). Explosive limits: LEL = 49,000 ppm, UEL: unknown; Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 1. Tetracycline is slightly soluble in water; the hydrochloride is highly soluble in water.

Potential Exposure: Tetracycline is an antibiotic medicine used as capsules, tablets, or intravenous injections against certain infections in humans and animals.

Incompatibilities: Although no dangerous incompatibilities are reported, the potency of this medicine is reduced by heat, sunlight, and solutions with pH <2; and destroyed by caustic hydroxide solutions.

Permissible Exposure Limits in Air

64-75-5, hydrochloride

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 19 milligram per cubic meter

PAC-2: 210 milligram per cubic meter

PAC-3: 1300 milligram per cubic meter

Russia[43] set a MAC in workplace air of 0.1 milligram per cubic meter and also MAC values for ambient air in residential areas of 0.01 milligram per cubic meter on a momentary basis and 0.006 milligram per cubic meter on a daily average basis.

Determination in Air: No method available.

Routes of Entry: Ingestion, inhalation.

Harmful Effects and Symptoms

Short Term Exposure: Tetracycline can affect you when breathed in. Exposure can cause sneezing, itching of the nose; stomach upset; vomiting and diarrhea.

Long-Term Exposure: Tetracycline can cause an allergic skin rash to develop. If skin allergy develops, sunlight may exacerbate the reaction. May cause stomach upset with nausea, vomiting, and diarrhea. Tetracycline is used as a medical drug. Used that way, it may cause liver and kidney damage. It is not known if this can occur with occupational exposure. May cause mutations. Whether it poses a cancer risk requires more study. Handle with extreme caution. It may also damage the developing fetus.

Points of Attack: Liver, kidneys, skin.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from sunlight, heat and caustic materials.

Shipping: UN3249 Medicine, solid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include nitrogen oxides [and in the case of the *hydrochloride*: hydrogen chloride] and, for both, oxides of carbon. This chemical is a non combustible solid. Use any agent suitable for surrounding fires. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: It is inappropriate and possibly dangerous to the environment to dispose of expired or waste pharmaceuticals by flushing them down the toilet or discarding them to the trash. Household quantities of expired or waste pharmaceuticals may be mixed with wet cat litter or coffee grounds, double-bagged in plastic, discard in trash. Larger quantities shall carefully take into consideration applicable DEA, EPA, and FDA regulations. If possible return the pharmaceutical to the manufacturer for proper disposal being careful to properly label and securely package the material. Alternatively, the waste pharmaceutical shall be labeled, securely packaged and transported by a state licensed medical waste contractor to dispose by burial in a licensed hazardous or toxic waste landfill or incinerator.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Tetracycline, Trenton, NJ (February 1986

Tetraethylenepentamine T:0290

Formula: $C_8H_{23}N_5$; $H_2N(C_2H_4NH)_3C_2H_4NH_2$

Synonyms: *N*-(2-Aminoethyl)-*N*-(2-[(2-aminoethyl) amino] ethyl-1,2-ethanediamine); Amino ethyl-1,2-ethanediamine; D.E.H. 26; 1,2-Ethanediamine, *N*-(2-aminoethyl)-*N*′-(2-aminoethyl) aminoethyl-; 1,2-Ethanediamine, *N*-(2-aminoethyl)-*N*′-[2-(2-aminoethyl)ethyl]-; 1,4,7,10,13-Pentaazatridecane

CAS Registry Number: 112-57-2

HSDB Number: 5171

RTECS Number: KH8585000

UN/NA & ERG Number: UN2320/153

EC Number: 203-986-2 [*Annex I Index No.*: 612-060-00-0]

Regulatory Authority and Advisory Information

Hazard Alert: Combustible, Corrosive, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction) Sensitization hazard (skin), Environmental hazard.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects[293]. Toxic to aquatic life with long-lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: C, N, Xi; Risk phrases: R21/22; R34; R36/37/38; R43; R51/53; R62; Safety phrases: S1/2; S29/35; S26; S36/37/39; S41; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Tetraethylenepentamine is a yellow, viscous liquid. Molecular weight = 189.36; Specific gravity (H_2O:1) = 1 @ 20°C; Boiling point = 333°C–340°C; Freezing/Melting point = −40°C to −30°C; Flash point = 163°C–185°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Soluble in water; solution can be strongly acidic.

Potential Exposure: Tetraethylenepentamine is used as a solvent for resins and dyes, in manufacture of synthetic rubber; and intermediate for oil additives; in papermaking.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. This chemical is strongly alkaline; reacts with acids.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 15 milligram per cubic meter

PAC-2: 130 milligram per cubic meter

PAC-3: 790 milligram per cubic meter

Routes of Entry: Inhalation, ingestion, eye, and/or skin contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Tetraethylenepentamine can affect you when breathed in and by passing through your skin. Tetraethylenepentamine is a corrosive chemical, and skin or eye contact can cause burns. The vapor is strongly irritating to the nose, throat and bronchial tubes. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: Repeated exposure may damage the liver, kidneys, heart muscle and/or brain; impairing thinking; reasoning, and concentration. Some related chemicals can cause a skin or lung allergy to develop. It is not known whether this chemical can cause the same allergies.

Points of Attack: Lungs, liver, kidneys, heart, brain.

Medical Surveillance: Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended. Lung function tests. Exam of CNS. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer 50/50 solution of vinegar/water, water, or milk. Do not induce vomiting. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures to Tetraethylenepentamine, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Tetraethylenepentamine must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where tetraethylenepentamine is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN2320 Tetraethylenepentamine, Hazard class: 8; Labels: 8-Corrosive material.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References
(31); (173); (101); (138); (100).
New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Tetraethylenepentamine, Trenton, NJ (February 2000

Tetraethyl Lead T:0300

Formula: $C_8H_{20}Pb$; $Pb(C_2H_5)_4$
Synonyms: Lead, tetraethyl-; Motor fuel antiknock compound; NCI-C54988; NSC-22314; Piombo tetra-etile; Plumbane, tetraethyl-; TEL; Tetraethylolovo; Tetraethylplumbane; Tetraethylplumbium
CAS Registry Number: 78-00-2
HSDB Number: 841
RTECS Number: TP4550000
UN/NA & ERG Number: UN1649/131
EC Number: 201-075-4; Listed in part 3 of Annex I to Regulation (EC) 689/2008; HS 2931.00.
Regulatory Authority and Advisory Information
Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Animal Inadequate Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1987.
United States Environmental Protection Agency Gene-Tox Program, Positive: Cell transformation-SA7/SHE.
California Proposition 65 Chemical[102]: (*lead and compounds*) Cancer; 10/1/1992; (*lead and compounds*) Developmental/Reproductive toxin (male, female) 2/27/1987.
Hazard Alert: Poison, Highly poisonous (skin, inhalation, ingestion), Neurotoxin (cumulative), Flammable, Possible risk of forming tumors, Organometallic, Strong reducing agent, Reproductive toxin: possible risk of gene damage/impaired fertilty; Suspected reprotoxic hazard, Environmental hazard.
EPA Acceptable Daily Intake (ADI) = (preschool children) less than the 3 mg[Pb]/wk recommended provisionally for adults.
United States National Primary Drinking Water Regulations: MCLG = zero mg[Pb]/L; MCL = Action Level = 0.015 mg [Pb]/L. Lead is regulated by a Treatment Technique (TT) that requires systems to control the corrosiveness of their water. If more than 10% of tap water samples exceed the action level, water systems must take additional steps, as Lead (Pb).
Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)
United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P110
RCRA, 40CFR261, Appendix 8 Hazardous Constituents
Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg)
Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 10 lb (4.54 kg)
United States DOT Regulated Marine Pollutant (49CFR172.101, appendix B) (liquid)
Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.
Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)]
Hazardous to aquatic life or environment, with possible long-lasting effects[291,292].
Hazard Symbols, Risk & Safety statements: Hazard Symbol: T+, F, N; Risk phrases: R45; R10; R26/27/28; R33; 38; R50/53; R62; R63; Safety phrases: S26; S29/35; S36/37/39; S45; S53; S60; S61 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.
Description: Tetraethyl lead is a colorless oily liquid. Sweet, slight musty odor. In commerce it is usually dyed red, orange or blue. Tetraethyl lead will decompose in bright sunlight yielding needlelike crystals of tri-, di-, and mono-ethyl lead compounds, which have a garlic odor. Molecular weight = 323.47; Specific gravity (H_2O:1) = 1.66 @ 20°C; Boiling point (decomposes) 118.9°C; Freezing/Melting point = −130°C; Vapor pressure = 0.2 mmHg @ 25°C; 1 mmHg @ 38.4C[138]; Flash point = 93°C; Autoignition temperature ≥110°C. Explosive limits: LEL = 1.8%; UEL-unknown. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 2₩. Practically insoluble in water; solubility 0.00002%.
Potential Exposure: Tetraethyl lead is used as a component of antiknock mixes for gas and as an intermediate in making fungicides; Tetraethyl lead (used as an antiknock compound in gasoline) can also contains impurities, such as *ethylene dibromide* and *ethylene dichloride*.
Incompatibilities: Vapors may form explosive mixture with air. A strong reducing agent. Violent reaction with strong oxidizers, sulfuryl chloride; halogens, oils and fats; rust, potassium permanganate. Decomposes slowly in light and at room temperature, and more rapidly at temperatures above 110°C. Attacks rubber and some plastics and coatings.
Permissible Exposure Limits in Air
NIOSH IDLH = 40 mg[Pb]/m^3
OSHA PEL: 0.075 mg[Pb]/m^3 TWA [skin]
NIOSH REL: 0.075 mg[Pb]/m^3 TWA [skin]
ACGIH TLV[1]: 0.1 mg[Pb]/m^3 [skin]; not classifiable as a human carcinogen
Protective Action Criteria (PAC) Ver. 29[138]
PAC-1: 0.3 milligram per cubic meter
PAC-2: 4 milligram per cubic meter
PAC-3: 40 milligram per cubic meter
DFG MAK: 0.05 mg[Pb]/m^3; Peak Limitation Category II(2) [skin]; Pregnancy Risk Group B
National primary and secondary ambient air quality standards for lead and its compounds, 1.5 μ[Pb]/m^3, maximum arithmetic mean averaged over a calendar quarter [40 CFR50.12, Appendix G].
Arab Republic of Egypt: TWA 0.1 milligram per cubic meter, 1993; Australia: TWA 0.1 milligram per cubic

meter, [skin], 1993; Austria: MAK 0.1 ppm (0.075 milligram per cubic meter), [skin], 1999; Belgium: TWA 0.1 milligram per cubic meter, [skin], 1993; Denmark: TWA 0.007 ppm (0.05 milligram per cubic meter), [skin], 1999; France: VME 0.10 milligram per cubic meter, [skin], 1999; Hungary: TWA 0.005 milligram per cubic meter, STEL 0.01 milligram per cubic meter, [skin], 1993; the Netherlands: MAC-TGG 0.05 milligram per cubic meter, [skin], 2003; Norway: TWA 0.001 ppm (0.075 milligram per cubic meter), 1999; the Phillipines: TWA 0.075 milligram per cubic meter, [skin], 1993; Poland: MAC (TWA) 0.05 milligram per cubic meter; MAC (STEL) 0.1 milligram per cubic meter, 1999; Russia: STEL 0.005 milligram per cubic meter, [skin], 1993; Sweden: NGV 0.05 milligram per cubic meter, ktv 0.2 milligram per cubic meter, [skin], 1999; Switzerland: MAK-W 0.01 ppm (0.075 milligram per cubic meter), KZG-W 0.02 ppm, [skin], 1999; Thailand: TWA 0.075 milligram per cubic meter, 1993; United Kingdom: LTEL 0.10 milligram per cubic meter, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV : not classifiable as a human carcinogen. Several states have set guidelines or standards for TEL in ambient air[60] ranging from 1.0 μ/m^3 (North Dakota); to 1.5 μ/m^3 (Connecticut); to 1.6 μ/m^3 (Virginia); to 2.0 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #2533, Tetraethyl lead (as Pb).

Permissible Concentration in Water: No criteria set, but EPA[32] has suggested a permissible ambient goal of 1.4 μg/L based on health effects. Russia[35,43] set a MAC of zero in water bodies used for domestic purposes.

Determination in Water: Octanol-water coefficient: Log $K_{ow} = >4$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood. See also "Lead" entry.

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Tetraethyl lead is extremely poisonous; may be fatal if inhaled, swallowed, or absorbed through the skin. Irrita tes the moist eyes, skin, and respiratory tract. Contact may cause burns to skin and eyes; causing permanent loss of vision. Most symptoms of poisoning are due to the effects of tetraethyl lead on the nervous system. Signs and symptoms of acute exposure to tetraethyl lead may be severe and include intoxication, anxiety, irritability, insomnia, violent/frightening, strange dreams; headache, disorientation, hyperexcitability, delusions, reduced memory; hallucinations, personality changes; tremors, convulsions, and death. Muscular weakness, ataxia, tremors, convulsions, cerebral edema; and coma may occur. A metallic taste may be noted. Sneezing, bronchitis, and pneumonia may be ob served. Bradycardia (slow heart rate), Hypotension (low blood pressure), hypothermia, and pallor may also occur. Gastrointestinal symptoms include vomiting and diarrhea.

Long-Term Exposure: May be a reproductive toxin; may damage the developing fetus. There is limited evidence that this chemical causes cancer in animals. High levels can cause muscle and joint pains, weakness, muscle cramps; and easy fatigue. Repeated exposure may cause lead to accumulate in the body. May cause kidney and brain damage, and damage to the blood cells; causing anemia.

Points of Attack: CNS; cardiovascular system, kidneys, eyes.

Medical Surveillance: NIOSH lists the following tests: whole blood (chemical/metabolite); whole blood (chemical/metabolite): blood urea nitrogen, Calcium, carbon dioxide; Sugar/Glucose; Biologic Monitoring of Urine every 3 Months; urine (chemical/metabolite); urine (chemical/metabolite), end-of-shift; urinalysis (routine). If symptoms develop or overexposure is suspected, the following may be useful: Urine test for lead (levels of 0.1 mg/L of urine indicate increased exposure. Such levels increase risk from further exposure). Blood lead tests are not usually accurate with exposure to tetraethyl lead. Kidney function tests. Examination of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *0.75 ppm*: Sa (APF = 10) (any supplied-air respirator). *1.875 ppm*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *3.75 ppm*: SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *40 ppm*: Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

Lead (1910.1025 & 1926.62): < or = 0.5 milligram per cubic meter (milligrams per cubic meter) (10 × PEL) Half-mask* air-purifying respirator equipped with high-efficiency filters**. < or = 2.5 milligram per cubic meter (50 × PEL) Full-face piece air-purifying respirator with high-efficiency filters**. < or = 50 milligram per cubic meter (1000 × PEL) (1) Any powered air-purifying respirator with high-efficiency filters**; or (2) Half-mask* supplied-air respirator operated in positive-pressure mode. < or = 100 milligram per cubic meter (2000 × PEL) Supplied-air respirators with full facepiece, hood, helmet, or suit, operated in positive-pressure mode. >100 milligram per cubic meter, unknown concentration, or firefighting full-facepiece, SCBA operated in positive-pressure mode.

* Full facepiece is required if the lead aerosols cause eye or skin irritation at the use concentrations.

** A high-efficiency filter means a filter that is at least 99.97% efficient against mono-dispersed particles of 0.3 μm in diameter or higher.

Storage: Color code-Blue: Health Hazard /Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Tetraethyl lead must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates) and chemically active metals (such as potassium, sodium, magnesium, and zinc), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Protect storage containers from physical damage. Sources of ignition, such as smoking and open flames, are prohibited where tetraethyl lead is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Use only nonsparking tools and equipment, especially when opening and closing containers of tetraethyl lead. Wherever tetraethyl lead is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1649 Motor fuel antiknock mixtures, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include lead and carbon monoxide. Use dry chemical, carbon dioxide; mist, and foam. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Use water from unmanned monitors and hose-holders to keep fire-exposed containers cool. When stopping leak, use water spray to protect firefighters from a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Controlled incineration with scrubbing for collection of lead oxides which may be recycled or land filled. It is also possible to recover alkyl lead compound from wastewaters as an alternative to disposal.

References

(109); (102); (31); (173); (101); (138); (2); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: *Tetraethyl lead*, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

New York State Department of Health, *Chemical Fact Sheet*: *Tetraethyl Lead*, Bureau of Toxic Substance Assessment, Albany, NY (March 1986)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: *Tetraethyl lead*, Trenton, NJ (March 2002)

United States Department of Health and Hum an Services Public Health Service National Toxicology Program, *Final Report on Carcinogens Background Document for Lead and Lead Compounds*, Contract Number N01-ES-85421, Research Triangle Park, NC 27709, May 8, 2003

Tetraethyl Pyrophosphate + Compressed Gas Mixture T:0305

Formula: $C_8H_{20}O_7P_2$

Synonyms: Bis-*O,O*-diethylphosphoric anhydride and compressed gas mixture; Bladan and compressed gas mixture; Ethyl pyrophosphate and compressed gas mixture; Pyrophosphoric acid, tetraethyl ester and compressed gas mixture; TEP and compressed gasmixture; TEP (phosphate) and compressed gas mixture; TEPP and compressed gas mixture; Tepp tetraethyl diphosphate and compressed gas mixture; Tetraethyl pyrophosphate and compressed gas mixture

Note: for TEPP liquid see T:0180

CAS Registry Number: 107-49-3

HSDB Number: 842

RTECS Number: UX6825000 (TEPP)

UN/NA & ERG Number: UN/NA1955/123

EC Number: 203-495-3 [*Annex I Index No.*: 015-025-00-2] (TEPP)

Regulatory Authority and Advisory Information

Hazard Alert: Poison inhalation hazard (may be fatal), Water reactive, Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated, Environmental hazard.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P111

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 10 lb (4.54 kg)

United States DOT 49CFR172.101, Inhalation Hazardous Chemical, Substance ID: TFC260.

United States DOT Regulated Marine Pollutant (49CFR172.101, appendix B)

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T+, N; Risk phrases: R5; R21; R26; R27/28; R33; R44; R50/53; Safety phrases: S1/2; S9; S33; S36/37/39; S38; S41; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Tetraethyl pyrophosphate and compressed gas mixture is a liquid charged with a gas. It is a colorless liquid. Its vapor is heavier than air. Faint, fruity, aromatic odor. Molecular weight = 290.22; Specific gravity (H_2O:1) = 1.19 @ 25°C; Boiling point = Decomposes below BP @ 170°C; 138°C under 2.3 mmHg; Freezing/Melting point = 0°C; Vapor pressure = 2×10^{-4} mmHg @ 25°C. It is soluble in water; reacts slowly in cold water forming phosphoric acid. Physical and toxicological properties may be affected by the carrier solvents and gas mixtures used in commercial formulations.

Incompatibilities: Tetraethyl pyrophosphate may be susceptible to formation of highly toxic and flammable phosphine gas in the presence of hydrides and other strong reducing agents. Partial oxidation by oxidizing agents may result in the release of toxic phosphorus oxides. Hygroscopic. Hydrolyzed in water with formation of mono-. di-, and triethyl-orthophosphates. Reacts slowly with cold water forming phosphoric acid. Attacks metals in the presence of water.

Permissible Exposure Limits in Air:

NIOSH IDLH = 5 milligram per cubic meter as TEPP

Conversion factor: 1 ppm = 11.87 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 0.05 milligram per cubic meter TWA [skin]

NIOSH REL: 0.05 milligram per cubic meter TWA [skin]

ACGIH TLV[1]: 0.01 milligram per cubic meter, measured as inhalable fraction and vapor TWA [skin]; BEI issued for Acetylcholinesterase inhibiting pesticides.

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 0.091 milligram per cubic meter

PAC-2: 1 milligram per cubic meter

PAC-3: 10 milligram per cubic meter

DFG MAK: 0.005 ppm/0.06 milligram per cubic meter; Peak Limitation Category II(2) [skin]

Arab Republic of Egypt: TWA 0.004 ppm (0.05 milligram per cubic meter), [skin], 1993; Australia: TWA 0.004 ppm (0.05 milligram per cubic meter), [skin], 1993; Austria: MAK 0.005 ppm (0.05 milligram per cubic meter), [skin], 1999; Belgium: TWA 0.004 ppm (0.047 milligram per cubic meter), [skin], 1993; Denmark: TWA 0.004 ppm (0.05 milligram per cubic meter), [skin], 1999; France: VME 0.004 ppm (0.05 milligram per cubic meter), [skin], 1999; the Netherlands: MAC-TGG 0.05 milligram per cubic meter, [skin], 2003; the Phillipines: TWA 0.05 milligram per cubic meter, [skin], 1993; Switzerland: MAK-W 0.005 ppm (0.05 milligram per cubic meter), [skin], 1999; Turkey: TWA

0.05 milligram per cubic meter, [skin], 1993 Occupational Exposure Limit United Kingdom: TWA 0.004 ppm (0.05 milligram per cubic meter), STEL 0.1 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 0.05 milligram per cubic meter (skin)

Determination in Air: Use NIOSH Analytical Method (IV) #2504, Tetraethyl Pyrophosphate; see also NIOSH Analytical Method (IV) Method #5600, Organophosphorus Pesticides.

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Symptoms of exposure include eye pain; blurred vision; lacrimation (discharge of tears); rhinorrhea (discharge of thin nasal mucous); headache, chest tightness; cyanosis, anorexia, nausea, vomiting, diarrhea, weakness, twitching, paralysis, Cheyne-Stokes respiration, convulsions, low blood pressure; cardiac irregular/irregularities; sweating. TEPP is classified as super toxic. Probable oral lethal dose in humans is less than 5 mg/kg (a taste) for a 150 lb person. A small drop in the eye may cause death. Small doses at frequent intervals are additive. Poisonings always develop at a rapid rate. Cholinesterase toxin; Eye irritant; Eye, acute other than irritation; Respiratory irritant-acute, severe, or moderate but not mild irritant effects; Skin irritant-severe; Heart cardiovascular system, acute; Brain, acute; CNS, acute; Nervous system toxin, acute; Respiratory toxin, acute other than severe or moderate irritation[138].

Long-Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Eyes, respiratory system; CNS; cardiovascular system, gastrointestinal tract; blood cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in one to two weeks while red blood cell levels may be reduced for one to three months. When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider CBC. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: *Specific treatment is necessary in case of poisoning with this substance; the appropriate means with instructions must be available.* If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give a slurry of activated charcoal in water to drink. *Do NOT* induce vomiting.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: 0.5 milligram per cubic meter: Sa (APF = 10) (any supplied-air respirator). 1.25 milligram per cubic meter: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). 2.5 milligram per cubic meter: SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). 5 milligram per cubic meter: Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv100 (APF = 50) [Any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, self-contained).

Storage: Poison inhalation hazard chemical (PIH) chemical; check oxygen content prior to entering storage area. Poison gas. (1) Color code-Blue: Health Hazard/Poison: Store in a secure poison location. This gas is highly toxic. Even slight exposure to these gasses can cause death. Store outdoors in a secure, restricted area that containing warning signs. This area must be roofed and shaded with the cylinders stored off the ground and separated from all other products assigned to other hazard categories and radiant heat sources on nonwooden floors. If indoors, store in a well-ventilated areas in temperatures not to exceed 50°C. Store in a cool, well ventilated area away from incompatible materials listed above. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage.

Shipping: NA1955 Organic phosphate, mixed with compressed gas or Organic phosphate compound, mixed with compressed gas or Organic phosphorus compound, mixed with compressed gas, Hazard Class: 2.3; Labels: 2.3-Poison Gas, Domestic (USA), Inhalation Hazard Zone C. UN/NA1955* *(NA prefix) Compressed gas, toxic, n.o.s., Hazard Class: 2.3; Labels: 2.3-Poison Gas, Technical Name Required, Inhalation Hazard Zone C; NA2783 *(NA prefix) Organic phosphate, mixed with compressed gas; or, Organic phosphate compound, mixed with compressed gas; or, Organic phosphorus compound, mixed with compressed gas: Hazard Class 2.3; Labels: 2.3-Poisonous gas, Domestic United States, Inhalation Hazard Zone C. (UN-prefix) Compressed gas, toxic, n.o.s., Inhalation Hazard Zone A: Hazard Class: 2.3; Labels: 2.3-Poisonous gas, Technical Name Required, Inhalation Hazard Zone A. (UN-prefix) Compressed gas, toxic, n.o.s. Inhalation Hazard Zone B; Hazard Class: 2.3; Labels: 2.3-Poisonous gas, Technical Name Required, Inhalation Hazard Zone B. (UN-prefix) Compressed gas, toxic, n.o.s. Inhalation Hazard Zone C; Hazard Class: 2.3; Labels: 2.3-Poisonous gas, Technical Name Required, Inhalation Hazard Zone C; (UN-prefix) Compressed gas, toxic, n.o.s. Inhalation Hazard Zone D, Hazard Class: 2.3; Labels: 2.3-Poisonous gas, Technical Name Required, Inhalation Hazard Zone D.

**Notes*: (1) whether the displayed information is for domestic (USA) or international shipping (UN), if neither is specifically indicated, it applies to both, (2) whether the proper shipping name must include one or more technical names of the hazardous material in parentheses, and (3) whether the hazardous material is an inhalation hazard.

Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the com pressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling:

Initial isolation and protective action distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.3/0.4
Night 0.8/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 600/200
Then: Protect persons downwind (miles/kilometers)
Day 1.4/2.3
Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Do not touch spilled material. Do not breathe vapors. Stay upwind; keep out of low areas. Remove all ignition sources. Ventilate area of spill or leak. This material is a combustible liquid. For a spill or leak of a combustible liquid, shut off ignition sources; no flares, smoking or flames in hazard area. Stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Compound burn but may not ignite readily. Vapors from liquefied gas are initially heavier than air and spread along ground. Cylinders exposed to fire may vent and release toxic and/or corrosive gas through pressure relief devices. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers. *Small fires*: dry chemical or carbon dioxide. *Large fires*: water spray, fog or foam. Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Wear positive pressure breathing apparatus and full protective clothing. Do not get water inside container. Move container from fire area if you can do so without risk. Stay away from ends of tanks. Spray cooling water on containers that are exposed to flames until well after fire is out. Isolate area until gas has dispersed. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. TEPP is 50% hydrolyzed in water in 6.8 hours @ 25°C, and 3.3 hours @ 38°C; 99% hydrolysis requires 45.2 hours @ 25°C, or 21.9 hours @ 38°C. Hydrolysis of TEPP yields nontoxic products. Incineration is, however, an option for TEPP disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (2); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: *TEPP*, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: *TEPP*, Trenton, NJ (January 2001).

Tetraethyltin T:0310

Formula: $C_8H_{20}Sn$

Synonyms: Stannane, tetraethyl-; TET; Tetraethylstannane; Tetraethyltin; Tin, tetraethyl-

CAS Registry Number: 597-64-8

HSDB Number: 6398

RTECS Number: WH8625000

UN/NA & ERG Number: UN3384/131; UN2788/153

EC Number: 209-906-2

Regulatory Authority and Advisory Information

Hazard Alert: Poison, High acute toxicity, Pyrophoric hazard, Highly flammable, Organometallic, Strong reducing agent, Poisonous Inhalation hazard, Environmental hazard, Agricultural chemical.

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 100 lb (45.4 kg)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T+, N; Risk phrases: R11; R17; R26/27/28; R34; R36/37/38; R42; R50/53; Safety phrases: S16; S21; S23; S26; S28; S29; S36 /37; S39; S45; S57; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Tetraethyltin is a colorless organotin liquid. Molecular weight = 234.97; Specific gravity (H_2O:1) = 1.2 @ 23°C; Boiling point = 181°C; Freezing/Melting point = −112°C; Vapor pressure = 1.99 mmHg @ 25°C Flash point = 53°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 3, Reactivity 0. Insoluble in water.

Potential Exposure: Used as biocide, bactericide, fungicide and insecticide; preservative for wood, textile, paper, and leather. Not registered as a pesticide in the United States.

Incompatibilities: A strong reducing agent. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

NIOSH IDLH = 25 mg[Sn]/m^3 [skin]

OSHA PEL: 0.1 mg[Sn]/m^3 TWA

NIOSH REL: 0.1 mg[Sn]/m^3 TWA [skin]

ACGIH TLV[1]: 0.1 mg[Sn]/m^3 TWA; 0.2 mg[Sn]/m^3 STEL [skin]

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 0.4 milligram per cubic meter

PAC-2: 7 milligram per cubic meter

PAC-3: 42 milligram per cubic meter

DFG MAK: 0.1 mg[Sn]/m^3 inhalable fraction [skin]; Pregnancy Risk Group D

Determination in Air: Use NIOSH Analytical Method (IV) #5504, Organotin.

Permissible Concentration in Water: State Drinking Water Guidelines: Minnesota 4000 μg[Sn]/L.

Routes of Entry: Inhalation, skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin, and respiratory tract. Contact may cause skin burns. Inhalation can cause coughing, wheezing and/or shortness of breath. Toxic hazard rating is high for oral, intravenous, intraperitoneal administration. This material causes swelling of the brain and spinal cord. Exposure may result in muscular weakness and paralysis, leading to respiratory failure; convulsive movements; closure of eyelids and sensitivity to light; headaches, EEG changes; dizziness, psychological and neurological disturbances; vertigo (an illusion of movement), sore throat; cough, abdominal pain; nausea, vomiting, diarrhea, urine retention; paresis, focal anesthesia; pruritus. Higher levels can cause unconsciousness, collapse and death.

Long-Term Exposure: Repeated or prolonged contact can cause dermatitis; dry and cracked skin. May cause brain damage, hepatic necrosis; kidney damage.

Points of Attack: Skin, brain, kidneys.

Medical Surveillance: NIOSH lists the following tests: Glaucoma; Kidney Function tests; liver function tests; urine (chemical/metabolite); urinalysis (routine). Also consider, psychological testing; examination of the nervous system; EEG.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with sub stance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/ manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 1 milligram per cubic meter*: CcrOvDM [any chemical cartridge respirator with organic vapor cartridge(s) in combination with a dust and mist filter]; or Sa (APF = 10) (any supplied-air respirator). *Up to 2.5 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOvHie (APF = 25) (any air-purifying full facepiece respirator equipped with an organic vapor cartridge in combination with a high-efficiency particulate filter). *Up to 5 milligram per cubic meter*: CcrFOv100 (APF = 50) (any air-purifying full facepiece respirator equipped with organic vapor cartridge(s) in combination with an N100, R100, or P100 filter); or GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or PaprTOvHie (APF = 50) [any powered, air-purifying respirator with a tight-fitting facepiece and organic vapor cartridge(s) in combination with a high-efficiency particulate filter]; or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 25 milligram per cubic meter*: SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). Emergency or planned entry into unknown concentrations or IDLH conditions: SCBAF: Pd, Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF : Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive pressure mode). Escape: GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Poison inhalation chemical (PIH); check oxygen content prior to entering storage area. Color cod e-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN3384 Toxic by inhalation liquid, flammable, n.o.s. with an LC_{50} $\leq 1000\ mL/m^3$ and saturated vapor concentration $\geq$ to 10 LC_{50}, Hazard class: 6.1; Labels: 6.1-Poisonous materials, 3-Flammable liquid, Technical Name Required, Inhalation Hazard Zone B. UN2788

Organotin compounds, liquid, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling:

Poisonous by inhalation liquid, flammable, n.o.s. (Inhalation Hazard Zone B)

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)
Day 0.3/0.5
Night 0.5/0.8

Wear fully encapsulating, vapor protective clothing. Stop the release if it can be done safely from a distance. Prevent material and runoff from entering sewers and waterways if it can be done safely well ahead of the release. *Small spill*: absorb with earth, sand, or other noncombustible material and transfer to containers with clean, nonsparking tools for later disposal. *Large spill*: Dike far ahead of liquid spill for later disposal. Water spray may reduce vapor; but may not prevent ignition in closed spaces. Ventilate confined area if it can be done without placing personnel at risk Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources and dampen spilled material with toluene to avoid airborne dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material is a flammable liquid. Thermal decomposition products may include oxides of tin and carbon. Fire: If tank, rail car or tank truck is involved in a fire, *isolate* for 0.5 miles/800 meters in all directions; also, consider initial evacuation for 0.5 miles/800 meters in all directions. Extinguish small fires with dry chemical, carbon dioxide; water spray or foam. For large fires, use water spray, fog, or foam. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR 165 recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (170); (2); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Tetraethyltin, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Tetraethyltin, Trenton NJ (November 1999)

Tetrafluoroethylene T:0320

Formula: C_2F_4

Synonyms: Ethene, tetrafluoro-; Ethylene, tetrafluoro-; Fluroplast 4; Perfluoroethene; Perfluoroethylene; Teflon 1,1,2,2-Tetrafluoroethylene; Tetrafluoroethylene, Inhibited; Tetrafluoroethene; TFE

CAS Registry Number: 116-14-3

HSDB Number: 844

RTECS Number: KX4000000

UN/NA & ERG Number: UN1081 (stabilized)/116 (P)

EC Number: 204-126-9

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Animal Sufficient Evidence, *possibly carcinogenic to humans*, Group 2B.

California Proposition 65 Chemical[102]: Cancer 5/1/1997

Hazard Alert: Extremely flammable gas, Polymerization hazard (nonstabilized), Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T, F+; Risk phrases: R45; R5; R12; R19; R20/22; R21; R23/24/25; R36/37/38; R3923/24/25; R44; Safety phrases: S1; S7; S9; S16; S26; s33; S36/37/39; S38; S45; S53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: TFE is a colorless, flammable gas. Molecular weight = 100.02; Specific gravity (H_2O:1) = 1.5 @ −76°C; Boiling point = −76°C; Freezing/Melting point = −143°C; Vapor pressure = 750 mmHg @ −76°C; Flash point ≤ 0°C; Autoignition temperature = 188°C. Its flammable limits in air are LEL = 10%; UEL: 50%. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 4, Reactivity 3. Insoluble in water.

Potential Exposure: A potential danger to those involved in the production of TFE and the manufacture of fluorocarbon polymers.

Incompatibilities: Reacts with air. Hazardous polymerization may occur unless inhibited. Will explode at pressures above 2.7 bar if terpene inhibitor is not added. Inhibited monomer can decompose explosively in fire, under pressure, or upon contact with materials with which it can react exothermically. Violent reaction with oxygen, oxidizers, sulfur trioxide; halogen compounds.

Permissible Exposure Limits in Air

ACGIH TLV[1]: 2 ppm/8.2 milligram per cubic meter TWA; confirmed animal carcinogen with unknown relevance to humans.

Protective Action Criteria (PAC)* Ver. 29[138]

PAC-1: $\mathbf{22_A}$ ppm

PAC-2: $\mathbf{55_A}$ ppm

PAC-3: $\mathbf{330_A}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

DFG MAK: Carcinogen Category 2

Permissible Concentration in Water: Russia[43] set a MAC in water bodies used for domestic purposes of 0.5 mg/L.

Routes of Entry: Inhalation, eye and/or skin contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Tetrafluoroethylene can affect you when breathed in. Irritates the eyes, skin, and respiratory tract. Very high exposures can displace the oxygen in the air, causing lightheadedness, dizziness, poor coordination and unconsciousness. High levels may also damage the liver and/or kidneys and irritate the lungs. Contact with liquefied gas may cause frostbite.

Long-Term Exposure: May cause lung irritation; bronchitis may develop. May cause kidney and liver damage.

Points of Attack: Lungs, kidneys, liver

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. NIOSH lists the following tests: chest X-ray, EKG, pulmonary function tests: forced vital capacity, forced expiratory volume (1 seconds); pelvic X-ray; sputum cytology; urine (chemical/metabolite); urine (chemical/metabolite) preand postshift; urinalysis (routine); CBC/differential.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Neoprene, Viton, butyl rubber; and polyvinyl alcohol are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration*: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or

European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full-facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Check oxygen content prior to entering storage area. Flammable gas. Color code-Red Stripe: Flammability Hazard: Store separately from all other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 meters or a 1-hour fire wall from flammable or reactive materials. High concentrations cause a deficiency of oxygen with the risk of unconsciousness or death. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Check that oxygen content is at least 19% before entering storage or spill area. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Tetrafluoroethylene must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilate area. Protect storage against physical damage. Will explode at pressures above 2.7 bar if terpene inhibitor is not added. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: UN1081 Tetrafluoroethylene, stabilized, Hazard Class: 2.1; Labels: 2.1-Flammable gas. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. High concentrations cause a deficiency of oxygen with the risk of unconsciousness or death. Check that oxygen content is at least 19% before entering storage or spill area. Remove all ignition sources. Ventilate area of leak to disperse the gas. Stop the flow of gas if it can be done safely. If source of leak is a cylinder and the leak cannot be stopped in place, remove leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. Keep this chemical out of confined space, such as a sewer because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable gas. Thermal decomposition products may include hydrogen fluoride and carbonyl fluoride. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Nonrefillable cylinders should be disposed of in accordance with local, state and federal regulations. Allow remaining gas to vent slowly into atmosphere in an unconfined area or exhaust hood. Refillable-type cylinders should be returned to original supplier with any valve caps and outlet plugs secured and valve protection caps in place.

References

(109); (102); (31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Tetrafluoroethylene, Trenton, NJ (May 2004)

Tetrafluoromethane T:0330

Formula: CF_4

Synonyms: Arcton O; Carbon fluoride; Carbon tetrafluoride; F 14; FC 14; Freon 14; Halocarbon 14; Halon 14; Methane, tetrafluoro-; Perfluoromethane; R 14

CAS Registry Number: 75-73-0

HSDB Number: 1327

RTECS Number: FG4920000

UN/NA & ERG Number: UN1982/126

Ec Number: 200-896-5

Regulatory Authority and Advisory Information

Hazard Alert: Contains gas under pressure; may explode if heated, Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated,

Global Warming potential (100 year time horizon): 7390 (40 CFR 98, Subpart A)

Hazard Symbols, Risk & Safety statements: Hazard Symbol: N; Risk phrases: R5; R21; R44; Safety phrases: S9; S15; S16; S33; S38; S45 (see Appendix 4)

Description: Tetrafluoromethane is a colorless, odorless gas. Molecular weight = 88.01; Specific gravity (H_2O:1) = 3.03 @ 20°C; Boiling point = −128°C; Freezing/Melting point = −184°C. Explosive limits: LEL = 120,000 ppm, UEL: unknown; Autoignition temperature ≥ 1100°C. Insoluble in water.

Potential Exposure: Tetrafluoromethane is used in fire extinguishers and as a low temperature refrigerant.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Forms hydrogen fluoride and fluorides on decomposition with hot surfaces above 125°F/52°C or open flame. Incompatible with powdered metals; including aluminum, zinc, and beryllium.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 92 ppm

PAC-2: 1000 ppm

PAC-3: 6000 ppm

Routes of Entry: Inhalation, skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Tetrafluoromethane can affect you when breathed in. High levels can cause you to feel dizzy, lightheaded and to pass out. Very high levels could cause death. Similar chemicals can affect the cardiovascular system, causing irregular heartbeat, which could lead to death. Contact with the liquefied gas could cause frostbite. Exposure at high levels can cause depletion of oxygen, causing unconsciousness and death by suffocation.

Long-Term Exposure: Unknown at this time.

Points of Attack: Cardiovascular system.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: Special 24 hour EKG (Holter monitor) to look for irregular heart beat.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof goggles unless full facepiece respiratory protections is worn. Wear splash-proof chemical goggles and face shield when working with liquid, unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposure to tetrafluoromethane exists, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full face piece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Check oxygen content prior to entering storage area. High concentrations cause a deficiency of oxygen with the risk of unconsciousness or death. Check that oxygen content is at least 19% before entering storage or spill area. Prior to working with this chemical, personnel should be trained on its proper hand ling and storage. Store in tightly closed containers in a cool, well-ventilated area away from powdered metals; including aluminum, zinc and beryllium; and from open flames or temperatures above 125°F/51.6°C. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: UN1982 Tetrafluoromethane, compressed or or Refrigerant gas R14, Hazard Class: 2.2; Labels: 2.2-Nonflammable gas. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: High concentrations cause a deficiency of oxygen with the risk of unconsciousness or death. Check that oxygen content is at least 19% before entering storage or spill area. If in a building, evacuate building and confine vapors by closing doors and shutting down HVAC systems. Restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak to disperse the gas. Wear chemical protective suit with SCBA to combat spills. Stay upwind and use water spray to "knock down" vapor; contain runoff. Stop the flow of gas, if it can be done safely from a distance. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place; and repair leak or allow cylinder to empty. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. Keep this chemical out of confined spaces, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Tetrafluoromethane may burn, but does not readily ignite. Use dry chemical or CO_2 extinguishers. Thermal decomposition products may include fluorides, such as hydrogen fluoride. Containers may explode in fire. If liquid or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Nonrefillable cylinders should be disposed of in accordance with local, state and federal regulations. Allow remaining gas to vent slowly into atmosphere in an unconfined area or exhaust hood. Refillable-type cylinders should be returned to original supplier with any valve caps and outlet plugs secured and valve protection caps in place.

References

(31); (173); (101); (138).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Tetrafluoromethane, Trenton, NJ (November 2004

Tetrahydrofuran T:0340

Formula: C_4H_8O

Synonyms: Butane, 1,4-epoxy-; Butylene oxide; Cyclotetramethylene oxide; Diethylene oxide; 1,4-Epoxybutane; Furanidine; Furan, tetrahydro-; Hydrofuran; NCI-C60560; Oxacyclopentane; Oxolane; Tetrahydrofuranne (French); Tetramethylene oxide; THF

CAS Registry Number: 109-99-9

HSDB Number: 125

RTECS Number: LU5950000

UN/NA & ERG Number: UN2056/127

EC Number: 203-726-8 [*Annex I Index No*.: 603-025-00-0]

Regulatory Authority and Advisory Information

Carcinogenicity: NCI: Carcinogenesis Studies (inhalation); clear evidence: mouse; equivocal evidence: rat; NTP: Carcinogenesis Studies (inhalation): some evidence: rat. ACGIH: A3; Confirmed animal carcinogen with unknown relevance. to humans.

Hazard Alert: Highly flammable, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard.

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U213

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 1000 lb (454 kg)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: F, Xi; Risk phrases: R11; R19; R36/37; R40; R60; R61; R62; R63; Safety phrases: S2; S16; S21; S29; S33; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Tetrahydrofuran is a colorless liquid. Ethereal odor. The Odor Threshold is listed @ 3.8 (3M), 20−50 ppm,[41] and 31 ppm. Molecular weight = 72.1; Specific gravity (H_2O:1) = 0.89 @ 20°C; Boiling point = 65°C; Freezing/Melting point: −108.4°C; Vapor pressure = 75 mmHg @ 9°C; Flash point = −15°C (cc); Autoignition temperature = 321°C. Explosive limits: LEL = 2%; UEL:

11.8%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 1. Soluble in water.

Potential Exposure: The primary use of tetrahydrofuran is as a solvent to dissolve synthetic resins, particularly polyvinyl chloride and vinylidene chloride copolymers. It is also used to cast polyvinyl chloride films, to coat substrates with vinyl and vinylidene chloride; and to solubilize adhesives based on or containing polyvinyl chloride resins. A second large market for THF is as an electrolytic solvent in the Grignard reaction-based production of tetramethyl lead. THF is used as an intermediate in the production of polytetramethylene glycol.

Incompatibilities: Forms thermally explosive peroxides in air on standing (in absence of inhibitors). Peroxides can be detonated by heating, friction, or impact. Reacts violently with strong oxidizers, strong bases and some metal halides. Attacks some forms of plastics, rubber and coatings.

Permissible Exposure Limits in Air

NIOSH IDLH = 2000 ppm [LEL]

Conversion factor: 1 ppm = 2.95 milligram per cubic meter @ 25°C & 1 atm.

OSHA PEL: 200 ppm/590 milligram per cubic meter TWA

NIOSH REL: 200 ppm/590 milligram per cubic meter TWA; 250 ppm/735 milligram per cubic meter STEL

ACGIH TLV[1]: 50 ppm/147 milligram per cubic meter TWA; 100 ppm /295 milligram per cubic meter STEL [skin] confirmed animal carcinogen with unknown relevance to humans

Protective Action Criteria (PAC)* Ver. 29[138]

PAC-1: $\mathbf{100_A}$ ppm

PAC-2: $\mathbf{500_A}$ ppm

PAC-3: $\mathbf{5000_A}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

DFG MAK: 50 ppm/150 milligram per cubic meter TWA; Peak Limitation Category I(2) [skin]; Carcinogen Category 4; Pregnancy Risk Group C; BAT: 8 mg/L in urine/end o f shift.

Australia: TWA 200 ppm (590 milligram per cubic meter), STEL 250 ppm, 1993; Austria: MAK 200 ppm (590 milligram per cubic meter), 1999; Belgium: TWA 200 ppm (590 milligram per cubic meter), STEL 250 ppm (738 milligram per cubic meter), 1993; Denmark: TWA 100 ppm (295 milligram per cubic meter), 1999; Finland: TWA 100 ppm (290 milligram per cubic meter), STEL 150 ppm (440 milligram per cubic meter), 1999; France: VME 200 ppm (590 milligram per cubic meter), 1999; Hungary: TWA 200 milligram per cubic meter, STEL 400 milligram per cubic meter, 1999; Japan: 200 ppm (590 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 300 milligram per cubic meter, [skin], 2003; Norway: TWA 50 ppm (150 milligram per cubic meter), 1999; the Phillipines: TWA 200 ppm (590 milligram per cubic meter), 1993; Poland: MAC (TWA) 600 milligram per cubic meter, MAC (STEL) 750 milligram per cubic meter, 1999; Russia: TWA 200 ppm, STEL 100 milligram per cubic meter, 1993; Sweden: NGV 50 ppm (150 milligram per cubic meter), KTV 80 ppm (250 milligram per cubic meter), 1999; Switzerland: MAK-W 200 ppm (590 milligram per cubic meter), STEL 1000 ppm, 1999; Turkey: TWA 200 ppm (590 milligram per cubic meter), 1993; United Kingdom: TWA 100 ppm (300 milligram per cubic meter), STEL 200 ppm, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 250 ppm; Russia[43] set a MAC values for ambient air in residential areas of 0.2 milligram per cubic meter both on a momentary and a daily average basis. Several states have set guidelines or standards for tetrahydrofuran in ambient air[61] ranging from zero (North Carolina); to 0.8 milligram per cubic meter (Massachusetts); to 5.9−7.35 milligram per cubic meter (North Dakota); to 9.8 milligram per cubic meter (Virginia); to 11.8 milligram per cubic meter (Connecticut, Florida, New York); to 14.048 milligram per cubic meter (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #1609;[18] 3800; OSHA Analytical Method 7.

Permissible Concentration in Water: No criteria set but EPA[32] has suggested a permissible ambient goal of 8,100 μg/L (based on health effects. Russia[43] set a MAC in water bodies used for domestic purposes of 0.5 mg/L (500 μg/L). States which have set guidelines for tetrahydrofuran in drinking water include Wisconsin @ 50.0 μg/L and New Hampshire @ 154 μg/L.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Tetrahydrofuran can affect you when breathed in and may enter the body through the skin. Eye contact causes severe irritation and possible damage. Skin contact causes severe irritation. If covered by clothing or prolonged, blistering can occur. The vapors irritate the eyes, nose, throat and lungs. Very high exposures can affect the CNS; causing narcosis, unconsciousness, and rapid death. High exposure can damage the liver and kidneys. The probable oral lethal dose in humans is 50−500 mg/kg[88].

Long-Term Exposure: May cause dermatitis; drying and cracking. Repeated exposure may cause liver and kidney damage. May cause lung irritation; bronchitis may develop.

Points of Attack: Eyes, skin, respiratory system; CNS; liver and kidneys.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended.

Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Liver and kidney function tests. Evaluation by a dermatologist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Teflon is among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: As a suspected carcinogen: *At any detectable concentration*: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA-or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full-facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

2000 ppm: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); CcrFOv (APF = 50) [any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s)]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted acid gas canister]; or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive pressure mode). *Escape*: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA). *Note*: Substance causes eye irritation or damage; eye protection needed.

Storage: Color code-Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. May form peroxides in storage. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Tetrahydrofuran must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area. Protect storage containers from physical damage. Sources of ignition, such as smoking and open flames, are prohibited where tetrahydrofuran is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of tetrahydrofuran should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of tetrahydrofuran.

Shipping: UN2056 Tetrahydrofuran, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Concentrated waste containing peroxides-perforation of a container of the waste from a safe distance followed by open burning.

References

(31); (173); (101); (138); (2); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Tetrahydrofuran, Washington, DC (October 21, 1977). (Revised edition issued 1979)

National institute for Occupational Safety and Health (NIOSH), Profiles on Occupational Hazards for Criteria Document Priorities, Report PB-274,073, Cincinnati, OH, pp 314−316 (1977)

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 2, 64−65 (1980) and 5, No. 5, 83−87 (1985)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Tetrahydro furan, Trenton, NJ (May 2004)

Tetramethyl Lead T:0360

Formula: $C_4H_{12}Pb$; $Pb(CH_3)_4$

Synonyms: Lead, tetramethyl-; Plumbane, tetramethyl-; Tetramethylplumbane; TML

CAS Registry Number: 75-74-1

HSDB Number: 1677

RTECS Number: TP4725000

UN/NA & ERG Number: UN1649 (motor fuel antiknock mixture)/131

EC Number: 200-897-0; Listed in Title I, Part 3 with no Index Number. HS2931.00.

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen (as lead and lead compounds); IARC: (organolead) Animal Inadequate Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1987

California Proposition 65 Chemical[102]: (*lead and compounds*) Cancer; 10/1/1992; (*lead and compounds*) Developmental/Reproductive toxin (male, female) 2/27/1987.

Hazard Alert: Poison, Highly flammable, Organometallic; Reproductive toxin: Suspected of causing genetic defects, Environmental hazard.

EPA Acceptable Daily Intake (ADI) = (preschool children) less than the 3 mg[Pb]/wk recommended provisionally for adults.

OSHA 29CFR1910.119, appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 1000 lb (450 kg)

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg)

EPA Acceptable Daily Intake (ADI) = (preschool children) less than the 3 mg[Pb]/wk recommended provisionally for adults

United States National Primary Drinking Water Regulations: MCLG = zero mg[Pb]/L; MCL = Action Level = 0.015 mg[Pb]/L. Lead is regulated by a Treatment Technique (TT) that requires systems to control the corrosiveness of their water. If more than 10% of tap water samples exceed the action level, water systems must take additional steps, as Lead (Pb).

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number D008

EPCRA Section 313 (as organic lead compound) Form R *de minimis* concentration reporting level: 1.0%.

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 100 lb (45.4 kg)

United States DOT Regulated Marine Pollutant (49CFR172.101, appendix B)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)]

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T+, N; Risk phrases: R11; R23/24/25; R26/27/28;

R33; R36/37/38; R50/53; R52/53; R61; R62; Safety phrases: S1; S1; S21; S22; S26; S28; S29/35; S36/37/39; S45; S53; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Tetramethyl lead is a colorless liquid with a slight musty odor. In commerce it is usually dyed red, orange or blue. Molecular weight = 267.35; Specific gravity (H_2O:1) = 1.99 @ 20°C; Boiling point ≥ (decomposes) 100°C−110°C; Freezing/Melting point = −28°C; Vapor pressure = 0.2 mmHg @ 20°C; Flash point = 37°C. Explosive limits: LEL = 1.8%; UEL = 12.4%. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 3, Reactivity 3₩. Insoluble in water.

Potential Exposure: Those engaged in the manufacture, distribution, and blending into gasoline of this antiknock agent for aviation gasoline.

Incompatibilities: Highly flammable liquid; Vapors may form explosive mixture with air. Violent reaction with oxidizers, such as sulfuryl chloride or potassium permanganate; strong acids; especially nitric acid; chemically active metals. Decomposes and may explode in heat above 90°C. Attacks rubber.

Permissible Exposure Limits in Air

NIOSH IDLH = 40 mg[Pb]/m^3

OSHA PEL: 0.075 mg[Pb]/m^3 TWA [skin]

NIOSH REL: 0.075 mg[Pb]/m^3 TWA [skin]

ACGIH TLV[1]: 0.15 mg[Pb]/m^3 [skin]

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 0.45 milligram per cubic meter

PAC-2: 4 milligram per cubic meter

PAC-3: 40 milligram per cubic meter

National primary and secondary ambient air quality standards for lead and its compounds, 1.5 μ[Pb]/m^3, maximum arithmetic mean averaged over a calendar quarter [40 CFR50.12, Appendix G].

DFG MAK: 0.05 mg[Pb]/m^3; Peak Limitation Category II (2); Peak Limitation Category II(2) [skin]; Pregnancy Risk Group B

Arab Republic of Egypt: TWA 0.05 mg[Pb]/m^3, 1993; Australia: TWA 0.15 mg[Pb]/m^3, 1993; Australia: TWA 0.15 milligram per cubic meter, [skin], 1993; Austria: MAK 0.01 ppm (0.075 milligram per cubic meter), [skin], 1993; Austria: MAK 0.01 ppm (0.075 milligram per cubic meter), 1999; Belgium: TWA 0.15 mg[Pb]/m^3, 1993; Belgium: TWA 0.15 milligram per cubic meter, [skin], 1993; Denmark: TWA 0.007 ppm (0.05 milligram per cubic meter), [skin], 1999; the Netherlands: MAC-TGG 0.05 milligram per cubic meter, [skin], 2003; Finland: TWA 0.1 mg [Pb]/m^3, 1993; France: VME 0.15 mg[Pb]/m^3, [skin], 1999; VME 0.15 milligram per cubic meter, [skin], 1993; Hungary: STEL 0.04 mg[Pb]/m^3, carcinogen, 1993; Hungary: TWA 0.005 milligram per cubic meter, STEL 0.01 milligram per cubic meter, [skin], 1993; Norway: TWA 0.01 ppm (0.075 milligram per cubic meter), 1999; the Phillipines: TWA 0.07 milligram per cubic meter, [skin], 1993; the Phillipines: TWA 0.15 mg[Pb]/m^3, 1993; Russia: STEL 0.005 ppm (0.01 mg[Pb]/m^3), 1993; Sweden: NGV 0.05 mg[Pb]/m^3, KTV 0.2 mg[Pb]/m^3, [skin], 1999; NGV 0.05 milligram per cubic meter, STEL 0.2 milligram per cubic meter, [skin], 1993; Switzerland: MAK-W 0.01 ppm (0.075 milligram per cubic meter), KZG-W 0.02 ppm, [skin], 1999; TWA 0.01 ppm (0.075 milligram per cubic meter), STEL 0.02 ppm, [skin], 1993; TWA 0.1 mg[Pb]/m^3, 1993; Thailand: TWA 0.07 milligram per cubic meter, 1993; TWA 0.2 mg[Pb]/m^3, 1993; Turkey: TWA 0.2 mg[Pb]/m^3, 1993; United Kingdom: LTEL 0.15 mg[Pb]/m^3, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 0.15 mg[Pb]/m^3 [skin]. Several states have set guidelines or standards for TML in ambient air[60] ranging from 1.5 μ/m^3 (Connecticut and North Dakota); to 2.5 μ/m^3 (Virginia); to 4.0 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #2534.

Permissible concentration in Water: Federal Drinking Water Standards: MCGL = zero mg/L; State Drinking Water Standards: Arizona: 50 μg[Pb]/L; State Drinking Water Guidelines: Arizona: 20 μg[Pb]/L; Maine: 10 μg[Pb]/L.

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Vapors are very toxic. Tetramethyl lead irritates the moist skin, eyes, and mucous membrane. May affect the CNS. Fatal lead poisoning may occur by ingestion, vapor inhalation or skin absorption. Several cases of acute toxicity, usually in the form of degenerative brain disease, have been described following occupational exposure. Signs and symptoms of acute exposure to tetramethyl lead may be severe and include nausea, delirium, mania, anxiety, irritability, headache, insomnia, disorientation, violent/frightening dreams; hyperexcitability, delusions, and hallucinations. Muscular weakness, tremor, a lack of coordination; convulsions, cerebral edema; and coma may occur. A metallic taste may be noted. Sneezing, bronchitis, and pneumonia may be noted. Bradycardia (slow heart rate), hypotension (low blood pressure), hypothermia, and pallor may also occur. Gastrointestinal symptoms include vomiting and diarrhea.

Long-Term Exposure: High levels can cause muscle and joint pains, weakness, muscle cramps; and fatigue. Lead can accumulate in the body with repeated exposure. May affect the kidneys.

Points of Attack: CNS; cardiovascular system, kidneys.

Medical Surveillance: NIOSH lists the following tests: Biologic monitoring of urine every three months; urine (chemical/metabolite); urine (chemical/metabolite), end-of-Shift; urinalysis (routine). If symptoms develop or overexposure is suspected, the following may be useful: Urine test for lead levels of 0.1 mg/L of urine indicate increased exposure. Such levels increase risk from further exposure. Blood lead tests are not usually accurate with exposure to tetramethyl lead. CBC. Kidney function tests. Examination of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Effects may be delayed; medical observation is recommended.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *0.75 milligram per cubic meter*: Sa (APF = 10) (any supplied-air respirator). *1.875 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *3.75 milligram per cubic meter*: SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *40 milligram per cubic meter*: Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry in to unknown concentrations or IDLH conditions*: SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

Lead (1910.1025 & 1926.62): $<$ or = 0.5 milligram per cubic meter (milligrams per cubic meter) (10 × PEL) Half-mask* air-purifying respirator equipped with high-efficiency filters**. $<$ or = 2.5 milligram per cubic meter (50 × PEL) Full-face piece air-purifying respirator with high-efficiency filters**. $<$ or = 50 milligram per cubic meter (1000 × PEL) (1) Any powered air-purifying respirator with high-efficiency filters**; or (2) Half-mask* supplied-air respirator operated in positive-pressure mode. $<$ or = 100 milligram per cubic meter (2000 × PEL) Supplied-air respirators with full facepiece, hood, helmet, or suit, operated in positive-pressure mode. $>$ 100 milligram per cubic meter, unknown concentration, or firefighting full-facepiece, SCBA operated in positive-pressure mode.

* Full facepiece is required if the lead aerosols cause eye or skin irritation at the use concentrations.

** A high-efficiency filter means a filter that is at least 99.97% efficient against mono-dispersed particles of 0.3 μm in diameter or higher.

Storage: (1) Color code-Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. (2) Color code-Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Tetramethyl lead must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates) and chemically active metals (such as potassium, sodium, magnesium, and zinc), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Protect storage containers from physical damage. Sources of ignition, such as smoking and open flames, are prohibited where Tetramethyl lead is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of tetramethyl lead should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of tetramethyl lead. Wherever tetramethyl lead is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1649 Motor fuel antiknock mixtures, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Tetramethyl lead is a flammable and reactive liquid. Use dry chemical, CO_2, water spray; or foam extinguishers. Thermal decomposition products may include lead, lead oxides and carbon monoxide. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Controlled incineration with scrubbing for collection of lead oxides which may be recycled or landfilled. It is also possible to recover alkyl lead compounds from wastewaters (A-58) as an alternative to disposal.

References

(109); (102); (31); (173); (101); (138); (2); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Tetramethyl lead, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Tetramethyl Lead, Trenton, NJ (March 2002)

United States Department of Health and Human Services Public Health Service National Toxicology Program, *Final Report on Carcinogens Background Document for Lead and Lead Compounds*, Contract Number N01-ES-85421, Research Triangle Park, NC 27709, May 8, 2003

Tetranitromethane T:0380

Formula: CN_4O_8; $C(NO_2)_4$

Synonyms: Methane, tetranitro-; NCI-C55947; Tetan; Tetranitrometano (Spanish); TNM

CAS Registry Number: 509-14-8

HSDB Number: 852

RTECS Number: PB4025000

UN/NA & ERG Number: (PIH) UN1510/143

EC Number: 208-094-7

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Human Inadequate Evidence; Animal Sufficient Evidence, *possibly carcinogenic to humans*, Group 2B, 1996; NCI: Carcinogenesis Studies (inhalation); clear evidence: mouse, rat

California Proposition 65 Chemical[102]: Cancer 7/1/1990.

Hazard Alert: Poison inhalation hazard, Combustible, Explosive, Possible risk of forming tumors, Suspected reprotoxic hazard.

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P112

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500 lb (227 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 10 lb (4.54 kg)

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: O, T; Risk phrases: R45; R8, R9, R20/22; R23/24/25; R26; R36/37/38; R50/53; R60; R61; Safety phrases: S1; S8; S28; 36/37/39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Tetranitromethane, a nitroparaffin, is a colorless to pale yellow liquid or solid with a pungent odor. It causes tears. Molecular weight = 196.03; Specific gravity (H_2O:1) = 1.64 @ 25°C; Boiling point = 126°C; Freezing/Melting point 14°C; Vapor pressure = 7.5 mmHg @ 20°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 3 (Oxidizer). Insoluble in water.

Potential Exposure: Tetranitromethane is used as a solvent for polymers and as a stabilizer; as an oxidizer in rocket propellant combinations. It is also used as an explosive in admixture with toluene.

Incompatibilities: Tetranitromethane is a powerful oxidizer. It is more easily detonated than TNT. Contact with hydrocarbons, alkalis, or metals form explosive mixtures. Contact with toluene or cotton may cause fire and explosion. Combustible material wet with tetranitromethane may be highly explosive. The potential for explosion is severe, especially when exposed to heat, powerful oxidizers, or reducing agents; or, when subject to mild shock. Impurities can also cause explosives. Attacks some plastics, rubber and coatings.

Permissible Exposure Limits in Air

NIOSH IDLH = 4 ppm

Conversion factor: 1 ppm = 8.02 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 1 ppm/8 milligram per cubic meter TWA

NIOSH REL: 1 ppm/8 milligram per cubic meter TWA

ACGIH TLV[1]: 0.005 ppm/0.04 milligram per cubic meter TWA; confirmed animal carcinogen with unknown relevance to humans.

Protective Action Criteria (PAC)* Ver. 29[138]

PAC-1: 0.047 ppm

PAC-2: $\mathbf{0.52_A}$ ppm

PAC-3: $\mathbf{1.7_A}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

DFG MAK : [skin] Carcinogen Category 2

Australia: TWA 1 ppm (8 milligram per cubic meter), 1993; Austria: carcinogen, 1999; Belgium: TWA 1 ppm (8 milligram per cubic meter), 1993; Denmark: TWA 1 ppm (8 milligram per cubic meter), 1999; Finland: TWA 1 ppm (8 milligram per cubic meter), STEL 3 ppm (24 milligram per cubic meter), 1999; France: VME 1 ppm (8 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 0.04 milligram per cubic meter, 2003; the Phillipines: TWA 1 ppm (8 milligram per cubic meter), 1993; Poland: MAC (TWA) 0.04 milligram per cubic meter, 1999; Russia: STEL 0.3 milligram per cubic meter, 1993; Sweden: NGV 0.05 ppm (0.4 milligram per cubic meter), KTV 0.2 ppm (0.8 milligram per cubic meter), 1999; Switzerland: MAK-W 1 ppm (8 milligram per cubic meter), carcinogen, 1999; Turkey: TWA 1 ppm (8 milligram per cubic meter), 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV : confirmed animal carcinogen with unknown relevance to humans. Several states have set guidelines or standards for TNM in ambient air[60] ranging from 80 μ/m^3 (North Dakota); to 130 μ/m^3 (Virginia); to 160 μ/m^3 (Connecticut); to 190 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #3513.

Permissible Concentration in Water: Russia[43] set a MAC in water bodies used for domestic purposes of 0.5 mg/L.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin, and respiratory tract. Skin contact causes burns. After more prolonged inhalation, headache, dizziness, chest pain; dyspnea, and respiratory distress may occur. After prolonged exposure, CNS; heart, liver, and kidney damage can occur as well as pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Can cause methemoglobinemia and cyanosis.

Long-Term Exposure: Chronic signs and symptoms include weariness, and pneumonia. May cause CNS, kidney and liver damage.

Points of Attack: Respiratory system, eyes, skin, blood, CNS.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Consider the points of attack in preplacement and periodic physical examinations. Kidney and liver function tests. CBC. Examination of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Note to Physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 4 ppm*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); ccrFS (APF = 50) [any chemical cartridge respirator with a full facepiece and cartridge(s) providing protection against the compound of concern]; or GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted canister providing protection against the compound of concern]; or PaprS (APF = 25) [any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full face piece.) *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd, Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted canister providing protection against the compound of concern]; or SCBAE (any appropriate escape-type, SCBA). *Note*: Substance causes eye irritation or damage; requires eye protection. Only nonoxidizable sorbents allowed (not charcoal).

Storage: Poison inhalation chemical (PIH); check oxygen content prior to entering storage area. (1) Color code-Yellow: Reactive Hazard; Store in a location separate from other materials, especially flammables and combustibles. Oxidizers, including oxidizing gases, should have a boundary separation of 8−10 meters or a 1-hour fire wall from flammable or reactive materials. (2) Color code-Blue: Health Hazard/Toxics/Poisons: Store in a secure poison location. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Store in an explosion proof freezer. Keep away from metals and other organic and easily oxidized compounds. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Store in a cool, well ventilated area away from incompatible materials listed above. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage.

Shipping: UN1510 Tetranitromethane, Hazard Class: 6.1; Labels: 6.1-Poison Inhalation Hazard, 5.1-Oxidizer, Inhalation Hazard Zone B.

Spill Handling:

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.2/0.3
Night 0.2/0.3

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)
Day 0.4/0.6
Night 0.6/1.0

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Avoid shock and friction if liquid spills on combustible material, such as wood, or paper. Use water spray to reduce vapors. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Flush area with flooding amounts of water and dike spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Combustible liquid, but difficult to ignite. Thermal decomposition products may include oxides of nitrogen and carbon. Material is a strong oxidizer. The potential for explosion is severe, especially when exposed to heat or to powerful oxidizing or reducing agents; or when shocked or heated. It is more easily detonated than TNT. Impurities can also cause explosives. Extinguish small fires with water only, no dry chemicals or carbon dioxide. For large fires, flood the fire area with water.

Do not move cargo or vehicle if cargo has been exposed to heat. Cool containers that are exposed to flames with water from the side until well after fire is out. For massive fire, use unmanned hose holder or monitor nozzles; if this is impossible, withdraw from area and let fire burn. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Open burning at remote burning sites is not entirely satisfactory since it makes no provision for the control of the toxic effluents, nitrogen oxides and HCN. Suggested procedures are to employ modified closed pit burning, using blowers for air supply and passing the effluent combustion gases through wet scrubbers.

References

(109); (102); (31); (173); (101); (138); (2); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 5, No. 5, 87−91 (1985)

United States Environmental Protection Agency, Chemical Hazard Information Profile: Tetranitromethane, Washington, DC, Chemical Emergency
Preparedness Program (November 30, 1987)

Tetrasodium EDTA T:0390

Formula: $C_{10}H_{12}N_2N$; O_8; $[(NaOOCCH_2)_2NCH_2]_2$

Synonyms: *N*,*N*′-1,2-Ethanediylbis[*N*-(carboxymethyl)] glycine tetrasodium salt; Ethylene dinitrilotetra-acetic acid tetrasodium salt; Sodium EDTA; Sodium ethylene-diamine-tetraacetate; Sodium ethylenediaminetetraacetic acid; Sodium salt of ethylene-diaminetetraacetic acid; Tetrasodium ethylenediaminetetraacetate; Tetrasodium ethylene-diaminetetracetate; Tetrasodium (ethylenedinitrilo)-tetraacetate; Tetrasodium salt of EDTA; Tetrasodium salt of ethylenediaminetetracetic acid

CAS Registry Number: 64-02-8

HSDB Number: 5003

RTECS Number: AH5075000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 200-573-9 [*Annex I Index No.*: 607-428-00-2]

Regulatory Authority and Advisory Information

This chemical is not specifically listed by the EPA, but ETDA is regulated:

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 5000 lb (2270 kg).

Hazard Symbols, Risk & Safety statements: Hazard Symbol: Xn; Risk phrases: R22; R41; S51; Safety phrases: S2; S26; S39; S41; S46 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Tetrasodium EDTA is a white crystalline solid. Molecular weight = 380.2; Freezing/Melting point = (decomposes) 220°C; Explosive limits: LEL = 25,000 ppm, UEL: unknown. Highly soluble in water.

Potential Exposure: Used therapeutically in treating arteriosclerosis. Used as a metal cleaner; in detergents, liquid soaps; shampoos; metal chelating agent; in textiles industry to improve dyeing, scouring, and detergent operations; antioxidant.

Incompatibilities: Compounds of the carboxyl group react with all bases, both inorganic and organic (i.e., amines) releasing substantial heat, water and a salt that may be harmful. Incompatible with arsenic compounds (releases hydrogen cyanide gas), diazo compounds, dithiocarbamates, isocyanates, mercaptans, nitrides, and sulfides (releasing heat, toxic and possibly flammable gases), thiosulfates and dithionites (releasing hydrogen sulfate and oxides of sulfur). Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Can solubilize metals

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)* Ver. 29[138]

PAC-1: 75 milligram per cubic meter

PAC-2: 830 milligram per cubic meter

PAC-3: 5000 milligram per cubic meter

Permissible Concentration in Water: Russia[43] set a MAC for the disodium salt in water bodies used for fishery purposes of 0.05 mg/L. Maryland[61] has set a guideline for drinking water of 180 μg/L (0.18 mg/L)[61].

Harmful Effects and Symptoms

Short-Term Exposure: *Inhalation*: Dust may cause irritation of the nose and throat. *Skin*: May cause irritation. Prolonged skin contact to high concentrations may cause irritation, even a mild burn. *Eyes*: May cause irritation. Alkaline solution can burn the eyes. *Ingestion*: Doses of 200 mg/kg have caused muscle spasms. Kidney damage has been reported at doses of 600 mg/kg for 4 days.

Long-Term Exposure: ETDA may cause kidney injury; which may be due to chelating action, not inherent nephrotoxicity. Symptoms of exposure include vomiting, depression, and bloody diarrhea. It is not known if this chemical has the same effects.

Points of Attack: Kidneys.

Medical Surveillance: Kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to Physician: May cause a negative calcium imbalance.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Green: General storage may be used. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in a well-ventilated area away from sources of heat. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Nonflammable. Use extinguisher appropriate to other burning material. Thermal decomposition products may include oxides of sodium, nitrogen and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: It is inappropriate and possibly dangerous to the environment to dispose of expired or waste drugs and pharmaceuticals by flushing them down the toilet or discarding them to the trash. Household quantities of expired or waste pharmaceuticals may be mixed with wet cat litter or coffee grounds, double-bagged in plastic, discard in trash. Larger quantities shall carefully take into consideration applicable DEA, EPA, and FDA regulations. If possible return the pharmaceutical to the manufacturer for proper disposal being careful to properly lab el and securely package the material. Alternatively, the waste pharmaceutical shall be labeled, securely packaged and transported by a state licensed medical waste contractor to dispose by burial in a licensed hazardous or toxic waste landfill or incinerator

References

(31); (173); (101); (138); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 7, No. 4, 76–80 (1987) (for EDTA)

New York State Department of Health, *Chemical Fact Sheet*: Tetrasodium-EDTA, Bureau of Toxic Substance Assessment, Albany, NY (July 1986)

Tetryl T:0410

Formula: $C_7H_5N_5O8$; $(NO_2)_3C_6H_2N(NO_2)CH_3$
Synonyms: *N*-Methyl-*N*-2,4,6-tetranitroaniline; Nitramine; Picrylnitromethylamine; Pyrenite; Tetralite; *N*-2,4,5-Tetranitro-*N*-methylaniline; 2,4,6-Tetryl; 2,4,6-Trinitrophenyl-*N*-methylnitramine; 2,4,6-Trinitro-phenylmethylnitramine; Trinitrophenylmethylnitramine
CAS Registry Number: 479-45-8
HSDB Number: 2857
RTECS Number: BY6300000
UN/NA & ERG Number: UN0208 (Tetryl, Trinitrophenylmethylnitramine)/112
EC Number: 207-531-9 [*Annex I Index No.*: 612-017-00-6]
Regulatory Authority and Advisory Information
Carcinogenicity: The carcinogenicity of tetryl in humans and animals has not been studied.
Hazard Alert: Explosive, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction).
Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.
Hazard Symbols, Risk & Safety statements: Hazard Symbol: E, T; Risk phrases: R3; R23/24/25; R33; R51/53; R62; Safety phrases: S1/2; S3/7; S35; S36/37; S41; S45; S63 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 2-Hazard to water. (est.)
Description: Tetryl is a colorless to yellow, odorless crystalline solid. High explosive material. Molecular weight = 287.2; Specific gravity (H_2O:1) = 1.57 @ 19°C; Boiling point = 180°C−190°C (explodes); Freezing/Melting point = 129°C−131°C; Flash point = 187°C (explodes); Vapor pressure = < 1 mmHg @ 25°C. Practically insoluble in water; solubility = 0.02%.
Potential Exposure: Tetryl is used in explosives; as an intermediary detonating agent; and as a booster charge for military devices; it is also used as a chemical indicator. No longer manufactured or used in the United States.
Incompatibilities: Violent reaction with hydrazine; reducing agents, oxidizable materials. May explosively decompose from heat, shock, friction, or concussion. Explosive decomposition/detonation from heat takes approximately 1000 seconds @ 160°C; 0.1 seconds @ 500°C.
Permissible Exposure Limits in Air
NIOSH IDLH = 750 milligram per cubic meter
OSHA PEL: 1.5 milligram per cubic meter TWA [skin]
NIOSH REL: 1.5 milligram per cubic meter TWA [skin]
ACGIH TLV[1]: 1.5 milligram per cubic meter TWA [skin]
Protective Action Criteria (PAC) Ver. 29[138]
PAC-1: 4.5 milligram per cubic meter
PAC-2: 14 milligram per cubic meter
PAC-3: 1300 milligram per cubic meter
DFG MAK: [skin] danger of skin sensitization; Carcinogen Category 3B
Australia: TWA 1.5 milligram per cubic meter, 1993; Austria: MAK 1.5 milligram per cubic meter, [skin], 1999; Belgium: TWA 1.5 milligram per cubic meter, 1993; Denmark: TWA 1.5 milligram per cubic meter, [skin], 1999; Finland: TWA 1.5 milligram per cubic meter, STEL 3 milligram per cubic meter, [skin], 1993; France: VME 1.5 milligram per cubic meter, [skin], 1999; the Netherlands: MAC-TGG 1.5 milligram per cubic meter, [skin], 2003; the Phillipines: TWA 1.5 milligram per cubic meter, [skin], 1993; Switzerland: MAK-W 1.5 milligram per cubic meter, [skin], 1999; Turkey: TWA 1.5 milligram per cubic meter, 1993; United Kingdom: TWA 1.5 milligram per cubic meter, STEL 3 milligram per cubic meter, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 1.5 milligram per cubic meter
Several states have set guidelines or standards for tetryl in ambient air[60] ranging from $15\ \mu/m^3$ (North Dakota); to $25\ \mu/m^3$ (Virginia); to $30\ \mu/m^3$ (Connecticut); to $36\ \mu/m^3$ (Nevada).
Determination in Air: Use NIOSH II(3), Method #S225.
Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.
Harmful Effects and Symptoms
Short-Term Exposure: Irritates the eyes, skin, and respiratory tract. May affect the nervous system. Contact may stain skin and hair yellow or orange. Tetryl is acutely irritating to the mucous membranes of the respiratory tract and the eyes, causing coughing, sneezing, epistaxis, conjunctivitis, and palpebral and periorbital edema.
Long-Term Exposure: Tetryl is a potent sensitizer, and allergic dermatitis is common. Dermatitis first appears on exposed skin areas, but can spread to other parts of the body in fair-skinned individuals or those with poor personal hygiene. Repeated or prolonged inhalation exposure may cause asthma. The severest forms show massive generalized edema with partial obstruction of the trachea due to swelling of the tongue, and these cases require hospitalization. Tetryl exposure may cause irritability, easy fatigability; malaise, headaches, lassitude, insomnia, nausea, and vomiting. Anemia of the marrow depression or deficiency type has been observed among tetryl workers. Tetryl exposure has produced liver and kidney damage in animals. The substance may have effects on the liver, kidneys and blood.
Points of Attack: Eyes, skin, respiratory system; CNS; liver, kidneys.
Medical Surveillance: NIOSH lists the following tests: CBC; anemia; liver function tests. Preplacement physical examination should give special attention to those individuals with a history of allergy, blood dyscrasias, or skin, liver, or kidney disease. Periodic examinations should be directed primarily to the control of dermatitis and allergic

reactions, plus any effects on the respiratory tract, eyes, CNS; blood, liver and kidneys.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 7.5 milligram per cubic meter*: Qm (APF = 25) (any quarter-mask respirator). *Up to 15 milligram per cubic meter*: 95XQ* (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa* (APF = 10) (any supplied-air respirator). *Up to 37.5 milligram per cubic meter*: Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie* (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *Up to 75 milligram per cubic meter*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 750 milligram per cubic meter*: SaF: Pd, Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). Emergency or planned entry into unknown concentrations or IDLH conditions: SCBAF: Pd, Pp (APF = 10,000) (any SCBA that has a full-faceplate and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA). *Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Explosive. Color code-Red Stripe: Flammability Hazard: Store separately from all other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 meters or a 1-hour fire wall from flammable or reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers, hydrazine and sources of heat. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN0208 Tetryl, Hazard Class: 1.1D; Labels:1.1D-Explosives (with a mass explosion hazard); D-Substances or articles which may mass detonate (with blast and/or fragment hazard) when exposed to fire.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is an explosive solid. Thermal decomposition products may include oxides of nitrogen and carbon. If material is on fire and conditions permit, do not extinguish. Cool exposures using unattended monitors. If fire must be extinguished, use any agent appropriate for the burning material. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Cool exposed containers from unattended equipment or remove intact containers if it can be done safely. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full

facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Solution in acetone and incineration in furnace equipped with afterburner and caustic soda solution scrubber.

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Tetryl, Trenton, NJ (September 2000)

Thallium & Compounds T:0420

Formula: Tl

Synonyms: *elemental*: Ramor; Talio (TL) (Spanish); Thallium elemental

CAS Registry Number: 7440-28-0 (elemental)

HSDB Number: 4496 (elemental)

RTECS Number: XG3425000 (elemental)

UN/NA & ERG Number: UN3288 (Toxic solid, inorganic, n.o.s.)/151; UN1707 (thallium compounds, n.o.s.)/151

EC Number: 081-001-00-3 (elemental)

Regulatory Authority and Advisory Information

Hazard Alert: Poison, (elemental); Systemic agent, Suspected reprotoxic hazard, [thallium(I)carbonate], Suspected of causing genetic defects, Suspected reprotoxic hazard, [sulfate(I) Suspected of causing genetic defects, Environmental hazard, Agricultural chemical.

7440-28-0, thallium, elemental

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants; 40CFR423, Appendix A, Priority Pollutants

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 1.4; Nonwastewater (mg/L), 0.78 TCLP

RCRA 40CFR264, appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): total dust 6010 (400); 7840 (1000); 7841 (10)

United States National Primary Drinking Water Regulations: MCLG = 0.0005 mg/L; MCL = 0.002 mg/L.

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 1000 lb (454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0% (Thallium compounds)

thallium compounds:

Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants as thallium and compounds

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed

PCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, appendix B) as thallium compounds, n.o.s.; thallium compounds (pesticides)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects[291].

European/International Regulations (*thallium; 7440-28-0*): Hazard Symbol: T+, N; Risk phrases: R26/28; R33; R53; Safety phrases: S1/2; S13; S28; S45; S61; (*thallium compounds*): Hazard Symbol: T+, N; Risk phrases: R28; R33; R38; R48/25; R51/53; Safety phrases: S1/2; S13; R33; S36/37; S45; S61.

WGK[100] (German Aquatic Hazard Class): No value found. [2-Hazard to waters (est.)]

Description: Thallium is a soft, bluish-white, heavy, very soft metal insoluble in water and organic solvents. It turns gray on exposure to air. Molecular weight = 204.38; Specific gravity (H_2O:1) = 11.9 @ 20°C; Boiling point = 1457°C; 1473°C[138]; Freezing/Melting point = 304°C; Vapor pressure = 1.41×10^{-23} mmHg @ 25°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0.

Potential Exposure: Thallium is usually obtained as a by-product from the flue dust generated during the roasting of pyrite ores in the smelting and refining of lead and zinc. Thallium has not been produced in the United States since 1984, but is imported for use in the manufacture of electronics, optical lenses, and imitation precious jewels. It also has use in some chemical reactions and medical procedures. Thallium and its compounds are used as a rodenticide* and fungicide; in the manufacture of plates and prisms, high-density liquids; as insecticides, catalysts; in certain organic reactions, in phosphor activators; in bromoiodide crystals for lenses, plates, and prisms in infrared optical instruments; in photoelectric cells; in mineralogical analysis; alloyed with mercury in low-temperature thermometers, switches and closures; in high-density liquids; in dyes and pigments; in fire-works; and imitation precious jewelry. It forms a stainless alloy with silver and a corrosion-resistant alloy with lead. Its medicinal use for epilation has been almost discontinued. Highly persistent in the environment.

**Note*: Thallium was used in the past as a rodenticide, it has been banned in the United States due to its toxicity from accidental exposure. In some countries, thallium(I)sulfate(2:1) is still used as a rat poison and ant bait.

Incompatibilities: Varies. Cold thallium ignites on contact with fluorine. Thallium metal reacts violently with strong acids (such as hydrochloric, sulfuric, and nitric) and strong oxidizers (such as chlorine, bromine, and fluorine). Cold thallium ignites on contact with fluorine. Reacts with other halogens at room temperature.

Permissible Exposure Limits in Air

NIOSH IDLH = 15 mg[Tl]/m^3

OSHA PEL: 0.1 mg[Tl]/m^3 TWA [skin]

NIOSH REL: 0.1 mg[Tl]/m^3 TWA [skin]

ACGIH TLV[1]: 0.1 mg[Tl]/m^3 TWA [skin]

7440-28-0, elemental

Protective Action Criteria (PAC) Ver. 29[138]
PAC-1: 0.06 milligram per cubic meter
PAC-2: 33 milligram per cubic meter
PAC-3: 20 milligram per cubic meter
DFG MAK: *soluble compounds*: No numerical value established. Data may be available.
Australia: TWA 0.1 milligram per cubic meter, [skin], 1993; Austria: MAK 0.1 milligram per cubic meter, 1999; Belgium: TWA 0.1 milligram per cubic meter, [skin], 1993; Finland: TWA 0.1 milligram per cubic meter, [skin], 1999; France: VME 0.1 milligram per cubic meter, 1999; Norway: TWA 0.1 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 0.1 milligram per cubic meter, [skin], 2003; Poland: MAC (TWA) 0.1 mg[Tl]/m^3; MAC (STEL) 0.3 mg[Tl]/m^3, 1999; Switzerland: MAK-W 0.1 milligram per cubic meter, [skin], 1999; Thailand: TWA 0.1 milligram per cubic meter, 1993; Turkey: TWA 0.1 milligram per cubic meter, [skin], 1993; United Kingdom: LTEL 0.1 milligram per cubic meter, [skin], 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 0.1 mg[Tl]/m^3 [skin]. Several states have set guidelines or standards for thallium soluble compounds in ambient air[60] ranging from 0.238 μ/m^3 (Kansas); to 0.33 μ/m^3 (New York); to 1.0 μ/m^3 (Florida, North Dakota); to 1.6 μ/m^3 (Virginia); to 2.0 μ/m^3 (Connecticut and Nevada); to 2.47 μ/m^3 (Pennsylvania).

Determination in Air: Use NIOSH Analytical Method (IV) #7300; #7301; #7303; #9102; # 8005, (Elements in blood or tissue); OSHA Analytical Method ID-121.

Permissible Concentration in Water: Safe Drinking Water Act (47 FR 9352): MCL, 0.002 mg/L; MCLG, 0.0005 mg/L. Federal Drinking Water Guidelines: EPA 10 μg[Tl]/L; State Drinking Water Guidelines: Arizona 13 μg[Tl]/L; Minnesota 0.6 μg[Tl]/L. United States National Primary Drinking Water Regulations: MCLG = 0.0005 mg/L; MCL = 0.002 mg/L. Runoff from spills or fire control may cause water pollution.

Determination in Water: Digestion followed by atomic absorption measurement gives total thallium. Dissolved thallium may be determined by the same procedure preceded by 0.45 micron filtration. Octanol-water coefficient: Log K_{ow} = (estimated) 0.23.

Routes of Entry: Ingestion and percutaneous absorption of dust, eye/skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Hair loss, changes in blood; kidney, intestine or liver problems. Thallium salts may be eye and skin irritants and skin sensitizes. Exposure can cause fatigue, weakness, poor appetite; insomnia, and mood changes. Acute poisoning rarely occurs in industry, and is usually due to ingestion of thallium. When it occurs, gastrointestinal symptoms, abdominal colic; loss of kidney function; peripheral neuritis; strabismus, disorientation, convulsions, joint pain; and alopecia develop rapidly. The symptoms of acute thallium poisoning (except for gastrointestinal symptoms) do not become manifest until 12 hours to 4 days after exposure. Death is due to damage to the CNS. Thallium may affect the peripheral and the CNS; liver and kidneys; the gastrointestinal tract; skin (hair) and the cardiovascular system; resulting in polyneuritis; optic nerve atrophy; encephalopathy, cardiac disturbances; liver and kidney damage; alopecia. Exposure may result in death. The nitrate can irritate and burn the skin and eyes. The nitrate can damage the nervous system causing headache, weakness, irritability, pain, "pins and needles" in arms and leg; convulsions, coma, and death. The sulfate(I) irritates the eyes and the skin. May affect the nervous system; cardiovascular system; kidneys and gastrointestinal tract. Exposure may result in death. Exposure may result in hair loss.

Long-Term Exposure: Thallium is an extremely toxic and cumulative poison. In nonfatal occupational cases of moderate or long-term exposure, early symptoms usually include fatigue, limb pain; metallic taste in the mouth and loss of hair; although loss of hair is not always present as an early symptom. Later, peripheral neuritis, proteinuria, and joint pains occur. Occasionally, neurological signs are the presenting factor, especially in more severe poisonings. Long-term exposure may produce optic atrophy, paresthesia, and changes in papillary and superficial tendon reflexes (slowed responses). Some thallium compounds are teratogens in animals.

Points of Attack: Eyes, CNS; lungs, liver, kidneys, gastrointestinal tract; body hair.

Medical Surveillance: NIOSH lists the following tests: whole blood (chemical/metabolite); biologic tissue/biopsy; nerve conduction studies; urine (chemical/metabolite); urinalysis (routine). Preplacement and periodic examinations should give special consideration to the eyes, CNS; gastrointestinal symptoms; and liver and kidney function. Hair loss may be a significant sign.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or in haled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. *Skin* : If this chemical contacts the skin, remove contaminated clothing and immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure to substance may be delayed. The symptoms of acute thallium poisoning (except for gastrointestinal symptoms) may not become manifest until 12 hours to 4 days after exposure. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is also recommended for at least 24 to 48 hours after breathing overexposure as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. *Eyes*: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. *Inhalation*: If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. *Ingestion*: Get medical attention. If patient is conscious, give a slurry of activated charcoal in water to drink and induce vomiting. Do not make an unconscious person vomit. *Note for qualified medical personnel*: For severe poisoning consider BAL (British Anti-Lewisite), dimercaprol, dithiopropanol ($C_3H_8OS_2$) which has been used to treat toxic symptoms of certain heavy metals poisoning. In the case of thallium it may have *some* value. Although BAL is reported to have a large margin of safety, caution must be exercised, because toxic effects may be caused by excessive dosage. Most can be prevented by premedication with 1-ephedrine sulfate (CAS: 134-72-5).

Person al Protective Methods:

General information: first responders should use a NIOSH-certified chemical, biological, radiological, nuclear (CBRN) SCBA with a level a protective suit when entering an area with an unknown contaminant or when entering an area where the concentration of the contaminant is unknown. Level a protection should be used until monitoring results confirm the contaminant and the concentration of the contaminant. *Note*: safe use of protective clothing and equipment requires specific skills developed through training and experience.

LEVEL A: (RED ZONE): select when the greatest level of skin, respiratory, and eye protection is required. This is the maximum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than the AEGL-2.

A NIOSH-certified CBRN full-facepiece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle. A TECP suit that provides protection against CBRN agents.

Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, and a hard hat worn under the TECP suit are optional items.

LEVEL B: (RED ZONE): Select when the highest level of respiratory protection is necessary but a lesser level of skin protection is required. This is the minimum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than AEGL-2. It differs from Level A in that it incorporates a nonencapsulating, splash-protective, chemical-resistant splash suit that provides Level A protection against liquids but is not airtight.

A NIOSH-certified CBRN full-facepiece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL C: (YELLOW ZONE): Select when the contaminant and concentration of the contaminant are known and the respiratory protection criteria factors for using Air Purifying Respirators (APR) or Powered Air Purifying Respirators (PAPR) are met. This level is appropriate when decontaminating patient/victims. A NIOSH-certified CBRN tight-fitting APR with a canister-type gas mask or CBRN PAPR for air levels greater than AEGL-2. A NIOSH-certified CBRN PAPR with a loose-fitting facepiece, hood, or helmet and a filter or a combination organic vapor, acid gas, and particulate cartridge/filter combination or a continuous flow respirator for air levels greater than AEGL-1. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Escape mask, face shield, coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL D: (GREEN ZONE): Select when the contaminant and concentration of the contaminant are known and the concentration is below the appropriate occupational exposure limit or less than AEGL-1 for the stated duration times. Limited to coveralls or other work clothes, boots, and gloves.

Other information: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield un less full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA [as thallium (soluble compounds)]: *0.5 milligram per cubic meter*: Qm (APF = 25), if not present as a fume ((any quarter-mask respirator). *1 milligram per cubic meter*: 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator).

2.5 milligram per cubic meter: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PAPRDM, if not present as a fume (any powered, air-purifying respirator with a dust and mist filter). *5 milligram per cubic meter*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *15 milligram per cubic meter*: SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand o r other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code-Blue: Health Hazard /Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Thallium must be stored to avoid contact with strong acids (such as hydrochloric, sulfuric, and nitric) and strong oxidizers (such as chlorine, bromine, and fluorine), since violent reactions occur.

Shipping: Thallium: UN3288 Toxic solids, inorganic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN1707 Thallium compounds, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thallium *metal* may burn, but does not readily ignite. Thermal decomposition of thallium metal releases oxides of thallium. Also, poisonous gases produced in fire will vary, including for *thallium sulfide*: oxides of thallium and sulfur; *thaallium nitrates*: oxides of nitrogen and thallium), etc. Extinguish fire using an agent suitable for type of surrounding fire. For the *nitrate* use water only; *do not* use chemicals, foam, or carbon dioxide. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Dilute thallium solutions may be disposed of in chemical waste landfills. When possible, thallium should be recovered and returned to the suppliers.

References

(31); (173); (101); (138); (2); (100).

United States Environmental Protection Agency, Thallium: Ambient Water Quality Criteria, Washington, DC (1980)

United States Environmental Protection Agency, Thallium, Health and Environmental Effects Profile No. 159, Washington, DC, Office of Solid Waste (April 30, 1980)

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 4, No. 1, 94−97 (1984) (Sulfate) 7, No. 2, 92−94 (1987) (Acetate) and 8, no. 4, 13−22 (1988) (Nitrate)

United States Environmental Protection Agency, Chemical Hazard Information Profile: Thallous Carbonate, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

United States Environmental Protection Agency, Chemical Hazard Information Profile: Thallous Chloride, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

United States Environmental Protection Agency, Chemical Hazard Information Profile: Thallous Malonate, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

United States Environmental Protection Agency, Chemical Hazard Information Profile: Thallic Oxide, Washington, DC, Chemical Emergency Preparedness Program (October 31, 1985)

United States Environmental Protection Agency, Chemical Hazard Information Profile: Thallium Sulfate, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

United States Environmental Protection Agency, Chemical Hazard Information Profile: Thallous Sulfate, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Thallium Acetate, Trenton, NJ (December 2000)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Thallium Sulfate, Trenton, NJ (November 2000)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Thallium Nitrate, Trenton, NJ (November 2004)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Thallium, Trenton, NJ (November 2004)

Thioacetamide T:0430

Formula: C_2H_5NS; CH_3CSNH_2

Synonyms: Acetamide, thio-; Acetimidic acid, thio-; Acetothio amide; Ethanethioamide; TAA; Thiacetamide; Tioacetamida (Spanish)

CAS Registry Number: 62-55-5

HSDB Number: 1318

RTECS Number: AC8925000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 200-541-4 [*Annex I Index No.*: 616-026-00-6]

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Human No Adequate Data; Animal Sufficient Evidence, *possibly carcinogenic to humans*, Group 2B, 1987. United States Environmental Protection Agency Gene-Tox Program, Positive: Carcinogenicity-mouse/rat; SHE-clonal assay; Positive: Cell transformation-mouse embryo; Positive: Cell transformation-RLV F344 rat embryo; Host-mediated assay; Positive: D *melanogaster* sex-linked lethal; Weakly Positive: S *cerevisiae-homozygosis*; Negative: *E coli polA* with S9; Histidine reversion-Ames test; Negative: Sperm morphology-mouse; Inconclusive: *E coli polA* without S9.

California Proposition 65 Chemical[102]: Cancer 1/1/1988.

Hazard Alert: Poison, Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard.

Banned or Severely Restricted (Sweden) (UN)[13]

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U218

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazardous to aquatic life or environment, with possible long-lasting effects[194]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T, N; Risk phrases: R45; R22; R36/38; R50/53; R62; R63; Safety phrases: S41; S45; S53; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Thioacetamide is combustible, crystalline compound. Slight mercaptan odor. Molecular weight = 75.14; Freezing/Melting point = 116°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Highly soluble in water.

Potential Exposure: Thioacetamide is used as a replacement for hydrogen sulfide in qualitative analyses. Thioacetamide has been used as an organic solvent in the leather, textile, and paper industries; as an accelerator in the vulcanization of buna rubber; and as a stabilizer of motor fuel.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 0.92 milligram per cubic meter

PAC-2: 10 milligram per cubic meter

PAC-3: 60 milligram per cubic meter

United Kingdom: carcinogen, 2000. North Dakota[60] has set a guideline for thioacetamide in ambient air at zero concentration.

Determination in Water: Harmful to aquatic life with long-lasting effects. Octanol-water coefficient: Log K_{ow} = low, about—0.40. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact. Absorbed by the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Skin andeye irritation; conjunctivitis. Irritates the respiratory tract causing coughing. Symptoms of exposure include fatigue, nausea, vomiting, anorexia, liver damage; respiratory depression; CNS depression; acidosis, hypotension, tremors, convulsions, and unconsciousness.

Long-Term Exposure: May cause liver damage severe enough to cause death. May cause lung damage. May cause dermatitis; eczema. A potential occupational carcinogen.

Points of Attack: Liver, lungs.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Liver function tests. Lung function tests.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/ manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration*: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA-or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full-facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in a refrigerator or a cool, dry place. Where possible, automatically transfer material from other storage containers to process containers. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: *Isolation Distance, Spill*: 25meters/75 feet.(NJ). Isolation Distance, Fire: 800 meters/ 0.5 miles[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. Use absorbent dampened with 60%−70% acetone to pick up remaining material. Wash surfaces well with soap and water. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thioacetamide is a combustible solid. Thermal decomposition products may include hydrogen sulfide, sulfur dioxide and oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Treatment in an incinerator, boiler or cement kiln.

References

(109); (102); (31); (173); (101); (138); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 2, 66−67 (1980) and 5, No. 5, 91−94 (1985)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Thioacetamide, Trenton NJ (March 2002)

4,4′-Thiobis(6-tert-butyl-*m*-cresol) T:0440

Formula: $C_{12}H_{18}OS$; $[(CH_3)_3CC_6H_2(OH)(CH_3)_2]S$
Synonyms: Bis-3-*tert*-butyl-4-hydroxy-6-methylphenyl) sulfide; Bis(4-hydroxy-5-*tert*-butyl-2-methylphenyl) sulfide; *m*-Cresol, 4,4′-thiobis(6-tert-butyl-); Disperse MB-61; Santonox; Santowhite crystals; Santox; Thioalkofen BM4; 4,4′-Thiobis(3-methyl-6-*tert*-butylphenol); 1,1′-Thiobis(2-methyl-4-hydroxy-5-*tert*-butylbenzene)
CAS Registry Number: 96-69-5
HSDB Number: 5304
RTECS Number: GP3150000
EC Number: 202-525-2
Regulatory Authority and Advisory Information
Carcinogenicity: NCI: Carcinogenesis Studies (feed); no evidence: mouse, rat
Hazard Alert: Combustible, Possible risk of forming tumors,
Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.
Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.
Hazard Symbols, Risk & Safety statements: Hazard Symbol: T, Xi; Risk phrases: R36/37/38; R48; R51/53; Safety phrases: S16; S26; S36/37/39; S41 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.
Description: 4,4′-Thiobis(6-tert-butyl-*m*-cresol) is a light gray to tan powder. Aromatic odor. Molecular weight = 359; Specific gravity (H_2O:1) = 1.1 @ 25°C; Freezing/Melting point = 150°C; Vapor pressure = 6×10^{-7} mmHg @ 25°C; Flash point = 207°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Practically insoluble in water; solubility 0.08%. This material is sensitive to base hydrolysis and may spontaneously oxidize in solution[101].
Potential Exposure: This material is used as an antioxidant in the plastics and rubber industries; in Neoprene and other synthetic rubbers; in polyethylene and polypropylene.
Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. May evolve explosive hydrogen sulfide upon contact with moisture or acids.
Permissible Exposure Limits in Air
OSHA PEL: 15 milligram per cubic meter, total dust TWA; 5 milligram per cubic meter, respirable fraction TWA
NIOSH REL: 10 milligram per cubic meter, total dust TWA; 5 milligram per cubic meter, respirable fraction TWA
ACGIH TLV[1]: 10 milligram per cubic meter, total dust TWA, not classifiable as a human carcinogen; *Notice of intended change*: 1 milligram per cubic meter inhalable fraction TWA.
Protective Action Criteria (PAC) Ver. 29[138]
PAC-1: 3 milligram per cubic meter
PAC-2: 82 milligram per cubic meter
PAC-3: 460 milligram per cubic meter
Denmark: TWA 10 milligram per cubic meter, 1999; France: VME 10 milligram per cubic meter, 1999; Switzerland: MAK-W 10 milligram per cubic meter, 1999; United Kingdom: TWA 10 milligram per cubic meter, STEL 20 milligram per cubic meter, 2000; the Netherlands: MAC-TGG 10 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Several states have set guidelines or standards for this material in ambient air[60] ranging from 100 μ/m^3 (North Dakota); to 160 μ/m^3 (Virginia); to 200 μ/m^3 (Connecticut); to 238 μ/m^3 (Nevada).
Determination in Air: Use NIOSH(IV), Particulates NOR: Method #0500, total dust; Method #0600 (respirable).
Routes of Entry: Inhalation, ingestion; skin and/or eye contact.
Harmful Effects and Symptoms
Short-Term Exposure: Irritates the eyes, skin, and respiratory tract. Although reported to be poisonous, this compound is insignificantly toxic on the basis of acute oral toxicity to rats. However, gastroenteritis, retarded weight gain, and enlarged livers resulted in rat feeding studies.
Long-Term Exposure: Repeated or high exposures may cause liver damage.
Points of Attack: Eyes, skin, respiratory system; liver.
Medical Surveillance: Liver function tests.
First Aid: *Skin Contact*: [52] Flood all areas of body that have contacted the substance with water. Don't wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others. *Eye Contact*: Remove any contact lenses at once. Flush eyes well with copious quantities of water or normal saline for at least 20−30 minutes. Seek medical attention. *Inhalation*: Leave contaminated area immediately; breathe

fresh air. Proper respiratory protection must be supplied to any rescuers. IF coughing, difficult breathing or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion*: If convulsions are not present, give a glass or two of water or milk to dilute the substance. Assure that the person's airway is unobstructed and contact hospital or poison center immediately for advice on whether or not to induce vomiting.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for Exposures over *10 milligram per cubic meter*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. This material should be protected from exposure to light, and store it at ambient temperatures[101]. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create A potential fire or explosion hazard. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. The spilled material may be dampened with alcohol to avoid dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Thermal decomposition products may include oxides of sulfur and carbon. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: 4,4′-Thiobis(6-t-Butyl-m-Cresol), Trenton, NJ (January 2001).

4,4′-Thiodianiline T:0444

Formula: $C_{12}H_{12}N_2S$

Synonyms: Aniline, 4,4′-thiodi-; Benzenamine, 4,4′-thiobis-; Bis(p-aminophenyl)sulfide; Bis(4-aminophenyl) sulfide; Bis (*p*-aminophenyl)sulphide; Bis(4-aminophenyl)sulphide; *p,p*′-Diaminodiphenylsulfide; 4,4′-Diaminodiphenylsulfide; *p,p*′-Diaminodiphenylsulphide; 4,4-Diaminodiphenyl sulphide; 4,4′-Diaminodiphenylsulphide; Di(*p*-aminophenyl) sulfide; Di(*p*-aminophenyl)sulphide; NCI-C01707; Sulfide, bis (*p*-aminophenyl); Thioaniline; 4,4′-Thiobis(aniline); 4,4′-Thiobisbenzenamine; *p,p*-Thiodianiline; Thiodi-*p*-phenylenediamine

CAS Registry Number: 139-65-1

HSDB Number: 5074 as 4,4′-Thiobisbenzenamine

RTECS Number: BY9625000

UN/NA & ERG Number: UN3143 (solid)/151; UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 205-370-9

Regulatory Authority and Advisory Information

Carcinogenicity: NTP, Reasonably anticipated to be a human carcinogen, 2005; IARC, Group 2B: The agent is possibly carcinogenic to humans, 1987.

California Proposition 65 Chemical[102]: Cancer 4/1/1988.

Hazard Alert: Poison, Possible risk of forming tumors, Suspected of causing genetic defects, Environmental hazard.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects[293]. Toxic to aquatic life with long-lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T, N; Risk phrases: R45; R22; R51/53; R62; R63; Safety phrases: S29; S45; S53; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: 4,4′-Thiodianiline is a brown-purple powder or needles. Molecular weight = 216.32; Specific gravity (H_2O:1) = @ 20°C; Boiling point = °C; Vapor pressure = 1.1×10^{-5} mmHg @ 25°C (est.)[72]; Henry's Law constant = 3.9×10^{-12} atm-m^3/mol @ 25°C (est)[72]. Slightly soluble in water; solubility = 310 mg/L @ 25°C. Moisture sensitive.

Potential Exposure: 4,4′-Thiodianiline is used as a dye intermediate; in organic sythesis; as a lab reagent. Antiplatyhelmintic agents; Carcinogens[NLM]

Incompatibilities: This material may be combustible. 4,4′-Thiodianiline is incompatible with acids, diazo and azo compounds, halocarbons, isocyanates, aldehydes, alkali metals, nitrides, hydrides, and other strong reducing agents. May generate heat with these materials and hydrogen gas or hydrogen sulfide gas. May liberate hydrogen sulfide if heated to decomposition or mixed with an acid. Also incompatible with peroxides, phenols (acidic), epoxides, anhydrides, and acid halides[101]. Light and moisture sensitive

Permissible Exposure Limits in Air:

No standards or Protective Action Criteria (PAC) available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Permissible Concentration in Water: Toxic to aquatic life with long-lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Determination in Water: Thin layer chromatography. Octanol-water coefficient: Log $K_{ow} = 2.2$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation ingestion, skin and eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the skin, eyes, and respiratory tract. Highly toxic, may be fatal if inhaled, swallowed or absorbed through skin. Effects of contact or inhalation may be delayed. LD_{50} = (oral-rat) <1 g/kg.

Long-Term Exposure: May be carcinogenic, mutagenic and tumorigenic. Suspected of causing genetic defects

Points of Attack: Thyroid

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method* if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed.

Personal Protective Methods:

Respirator Selection: *At any detectable concentration*: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA-or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code-Blue: Health Hazard/Poison. Refrigerate under nitrogen in a secure poison location. 3,3′-Dimethoxybenzidine may react with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates). Store in tightly closed containers in a cool, well-ventilated area. Avoid exposure to light. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required. UN3143 dye intermediates, solid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 meters/150 feet for liquids and at least 25 meters/75 feet for solids. Keep unauthorized personnel away. Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Stay upwind. Keep out of low areas. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Stop leak if you can do it without risk. Prevent entry into waterways, sewers, basements or confined areas. Cover with plastic sheet to prevent spreading. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This material may be combustible. Thermal decomposition products may include toxic hydrogen sulfide and oxides of nitrogen, sulfur, and carbon. Runoff from fire control or dilution water may be corrosive and/or toxic and may cause pollution. Runoff may pollute waterways. If tank, rail car or tank truck is involved in a fire, isolate for 800 meters/0.5 in all directions; also, consider initial evacuation for 800 meters/0.5 in all directions. Small Fire: Use dry chemical, CO_2 or water spray. *Large Fire*: Water spray, fog or regular foam. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal; do not scatter the material. Use water spray or fog; do not use straight streams. *Fire involving Tanks or Car/Trailer Loads*: Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Do not get water inside containers. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. *Always* stay away from tanks engulfed in fire. For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn. *Do not* get water inside containers.

Disposal Method Suggested: It is inappropriate and possibly dangerous to the environment to dispose of expired or waste drugs and pharmaceuticals by flushing them down the toilet or discarding them to the trash. Household quantities of expired or waste pharmaceuticals may be mixed with wet cat litter or coffee grounds, double-bagged in plastic, discard in trash. Larger quantities shall carefully take into consideration applicable DEA, EPA, and FDA regulations. If possible return the pharmaceutical to the manufacturer for proper disposal being careful to properly label and securely package the material. Alternatively, the waste pharmaceutical shall be labeled, securely packaged and transported by a state licensed medical waste contractor to dispose by burial in a licensed hazardous or toxic waste landfill or incinerator.

References

(102); (31); (173); (101); (138). (100).

Thiofanox T:0450

Formula: $C_9H_{18}N_2O_2S$; $(CH_3)_3CC(CH_2SCH_3) = NOCONHCH_3$

Synonyms: Dacamox; Diamond Shamrock DS-15647; 3,3-Dimethyl-1-(methylthio)-2-butanone-*O*-[(methylamino) carbonyl] oxime; DS-15647; ENT 27,851; Thiofanocarb (South Africa)

CAS Registry Number: 39196-18-4

HSDB Number: 6045

RTECS Number: EL8200000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154; UN2757 (carbamate pesticides, solid, toxic)/151

EC Number: 254-346-4 [*Annex I Index No*.: 006-064-00-6]

Regulatory Authority and Advisory Information

Hazard Alert: Poison (skin contact may be fatal), Possible neurotoxic effects (dimethyl carbamate), Environmental hazard, Agricultural chemical.

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P045

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 100 lb (45.4 kg).

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T+, N; Risk phrases: R27/28; R33; R50/53; Safety phrases: S1/2; S27; S29/35; S36/37; S41; S45; S60, 61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to waters (est.)]

Description: Thiofanox is a colorless solid with a pungent odor. Molecular weight = 218; Freezing/Melting point = 57°C.

Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0.

Potential Exposure: A potential danger to those involved in the manufacture, formulation and application of this thiocarbamate systemic insecticide and acaricide.

Incompatibility: Thiocarbamate esters are combustible. They react violently with powerful oxidizers such as calcium hypochlorite. Poisonous gases are generated by the thermal decomposition of thiocarbamate compounds, including carbon disulfide, oxides of sulfur, oxides of nitrogen, hydrogen sulfide, ammonia, and methylamine. Many materials in this group slowly decompose in aqueous solution to form carbon disulfide and methylamine or other amines. Such decompositions are accelerated by acids. Flammable gases are generated by the combination of thiocarbamates with aldehydes, nitrides, and hydrides. Thiocarbamates are incompatible with acids, peroxides, and acid halides. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 0.77 milligram per cubic meter

PAC-2: 8.5 milligram per cubic meter

PAC-3: 51 milligram per cubic meter

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: This material is moderately to highly toxic. It is a cholinesterase inhibitor. Symptoms of exposure include nausea, vomiting, abdominal cramps; diarrhea, excessive salivation; sweating, weakness, runny nose; tightness of chest (inhalation exposure); blurred vision; tearing, muscle spasm; loss of eye coordination; ocular pain, extreme dilation of the pupil; loss of muscle coordination; slurring of speech; difficulty in breathing; excessive respiratory tract mucous; skin discoloration; and hypertension. High exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure.

Points of Attack: Blood, eyes, lungs.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in one to two weeks while red blood cell levels may be reduced for one to thre months. When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving carbamate or organophosphate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider CBC. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Eye examination. Lung function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN2757 Carbamate pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: *Isolation Distance, Spill*: 25meters/75 feet.(NJ). Isolation Distance, Fire: 800 meters/0.5 miles[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of sulfur, nitrogen and carbon. Stay upwind; keep out of low areas. Ventilate closed spaces before entering. Use water spray, fog, or foam. Move container from fire area (only without risk). Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter material. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBA apparatuses that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR 165 recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Thiofanox, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987

Thioglycolic Acid T:0460

Formula: $C_2H_4O_2S$; $HSCH_2COOH$

Synonyms: Acetic acid, mercapto-; Acetyl mercaptan; Acide thioglycolique (French); Glycolic acid, 2-thio-; Glycolic acid, thio-; Mercaptoacetate; 2-Mercaptoacetic acid; α-Mercaptoacetic acid; Mercaptoacetic acid; 2-Thioglycolic acid; Thioglycolic acid; Thioglycollic acid; Thiovanic acid

CAS Registry Number: 68-11-1

HSDB Number: 2702 as mercaptoacetic acid

RTECS Number: AI5950000

UN/NA & ERG Number: UN1940/153

EC Number: 200-677-4 [*Annex I Index No*.: 607-090-00-6]

Regulatory Authority and Advisory Information

Hazard Alert: Primary irritant (w/o allergic reaction).

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T+, C; Risk phrases: R23/24/25; R26; R34; Safety phrases: S1/2; S23; S25; S27; S28; S36/37/39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Thioglycolic acid is a colorless liquid with a strong unpleasant odor like rotten eggs. Molecular weight = 92.12; Specific gravity (H_2O:1) = 1.32 @ 25°C; Boiling point = 120°C @ 20 mmHg; 104°C−106°C @ 11 mmHg; 220C @ Freezing/Melting point = −16.5°C; Vapor pressure = 10 mmHg @ 18°C; Flash point = > 110°C; Autoignition temperature = 350°C. Explosive limits: LEL = 5.9%; UEL-unknown. Soluble in water.

Potential Exposure: Thioglycolic acid is used to make thioglycolates; in sensitivity tests for iron; in formulations of permanent wave solutions and depilatories; in pharmaceutical manufacture; as a stabilizer in vinyl plastics.

Incompatibilities: Compounds of the carboxyl group react with all bases, both inorganic and organic (i.e., amines) releasing substantial heat, water and a salt that may be harmful. Incompatible with arsenic compounds (releases hydrogen cyanide gas), diazo compounds, dithiocarbamates, isocyanates, mercaptans, nitrides, and sulfides (releasing heat, toxic and possibly flammable gases), thiosulfates and dithionites (releasing hydrogen sulfate and oxides of sulfur). Air, strong oxidizers; bases, active metals, for example, sodium potassium, magnesium, and calcium. Readily oxidized by air. Thermal decomposition causes release of hydrogen sulfide. May attack various metals.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 3.77 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: None

NIOSH REL: 1 ppm/4 milligram per cubic meter TWA [skin]
ACGIH TLV[1]: 1 ppm/3.8 milligram per cubic meter TWA [skin]
Protective Action Criteria (PAC) Ver. 29[138]
PAC-1: 3 ppm
PAC-2: 33 ppm
PAC-3: 200 ppm
Australia: TWA 1 ppm (4 milligram per cubic meter), 1993; Belgium: TWA 1 ppm (3.8 milligram per cubic meter), 1993; Denmark: TWA 1 ppm (5 milligram per cubic meter), 1999; Finland: TWA 1 ppm (5 milligram per cubic meter), STEL 3 ppm (15 milligram per cubic meter), 1993; France: VME 1 ppm (5 milligram per cubic meter), [skin], 1999; Hungary: TWA 0.5 milligram per cubic meter, STEL 1 milligram per cubic meter, 1993; Norway: TWA 1 ppm (5 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 4 milligram per cubic meter, [skin], 2003; Russia: STEL 0.1 milligram per cubic meter, [skin], 1993; United Kingdom: TWA 1 ppm, 3.8 milligram per cubic meter, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 1 ppm [skin]. Several states have set guidelines or standards for thioglycolic acid in ambient air[60] ranging from 40 μ/m^3 (North Dakota); to 80 μ/m^3 (Virginia); to 100 μ/m^3 (Connecticut); to 119 μ/m^3 (Nevada).

Determination in Water: Octanol-water coefficient: Log K_{ow} = low, <0.1. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Corrosive to the eyes, skin, and respiratory tract. Contact can cause eye and skin burns and blisters. It can also cause conjuctival edema and corneal damage. Inhalation can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Ingesting the liquid may cause chemical pneumonitis. Exposure can cause death. Irritation, blistering, and severe burns of the skin, eyes, and mucous membranes; corrosion of tissues[52]. If ingested, severe burning pain in the mouth, pharynx and abdomen; vomiting, bloody diarrhea; sharp drop in blood pressure: and asphyxia. If inhaled;coughing, choking, headache, dizziness, weakness, tightness in the chest; air hunger; and cyanosis. In animals: weakness, asping respirations; convulsions.

Long-Term Exposure: Repeated contact may cause a skin rash.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 20 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, contact a physician, hospital or poison center at once. If the victim is unconscious or convulsing, do not induce vomiting or give anything by mouth. If conscious, do not induce vomiting. For dilute acid; ive water, milk, milk of magnesia; $A(OH)_3$, or $Ca(OH)_2$. Avoid carbonates or bicarbonates. For concentrated acid, it may be dangerous to administer water or antacids. Some authorities suggest ice water or a snow slurry. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema or pneumonitis, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures *over 1* ppm; Use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area away from oxidizers.

Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored.

Shipping: UN1940 Thyoglycolic acid, Hazard class: 8; Labels: 8-Corrosive material.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120 (q) may be applicable.

Fire Extinguishing: Thioglycolic acid may burn, but does not readily ignite. Thermal decomposition products may include hydrogen sulfide and oxides of sulfur and carbon. Use dry chemical, CO_2, water spray; or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve in flammable solvent and burn in furnace equipped with afterburner and alkaline scrubber.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Thioglycolic Acid, Trenton, NJ (August 2005)

Thionyl Chloride T:0480

Formula: Cl_2OS; $SOCl_2$

Synonyms: Sulfinyl chloride; Sulfur chloride oxide; Sulfur oxychloride; Sulfurous dichloride; Sulfurous oxychloride; Thionyl dichloride

CAS Registry Number: 7719-09-7

HSDB Number: 859

RTECS Number: XM5150000

UN/NA & ERG Number: (PIH) UN1836/137

EC Number: 231-748-8 [*Annex I Index No.*: 016-015-00-0]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): Sabotage/Contamination Hazard: A placarded amount (commercial grade).

Hazard Alert: Poison inhalation hazard: exposure can be lethal, Corrosive, Violently water reactive; Air reactive, Lacrimator.

OSHA 29CFR1910.119, appendix A. Process Safety List of Highly Hazardous Chemicals, TQ = 250 lb (114 kg)

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

United States National Primary Drinking Water Regulations: SMCL = 250 mg$[Cl^-]$/L as Chloride

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T+, C; Risk phrases: R14; R15/29; R20/22; R29; R34; R35; R37; Safety phrases: S1/2; S26; S36/37/39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Thionyl chloride is a pale yellow to reddish liquid. Suffocating odor like sulfur dioxide. Fumes form when exposed to moist air. Molecular weight = 119; Specific gravity (H_2O:1) = 1.64 @ 16°C; Boiling point = 79°C (decomposes to SO_2 and S_2Sl_2 @ 140°C); Freezing/Melting point = −105°C; Vapor pressure = 100 mmHg @ 21°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 0, Reactivity 2 ₩. Reacts violently with water releasing hydrogen chloride and sulfur dioxide gas.

Potential Exposure: Thionyl chloride is used as specialty chlorinating agent, particularly in preparation of organic acid chlorides; in organic synthesis; as a catalyst.

Incompatibilities: Reacts violently with water releasing sulfur dioxide and hydrogen chloride. Keep away from water, acids, alcohols, alkalis, ammonia, chloryl perchlorate.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 4.87 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: None

NIOSH REL: 1 ppm/5 milligram per cubic meter Ceiling Concentration

ACGIH TLV[1]: 0.2 ppm TWA Ceiling Concentration
Protective Action Criteria (PAC)* Ver. 29[138]
PAC-1: **0.2_A** ppm
PAC-2: **2.4_A** ppm
PAC-3: **14_A** ppm
*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.
Australia: TWA 1 ppm (5 milligram per cubic meter), 1993; Belgium: STEL 1 ppm (4.9 milligram per cubic meter), 1993; Denmark: TWA 1 ppm (5 milligram per cubic meter, 1999; Switzerland: MAK-W 1 ppm (5 milligram per cubic meter), 1999; United Kingdom: STEL 1 ppm (4.9 milligram per cubic meter), 2000; the Netherlands: MAC 5 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Ceiling Concentration 1 ppm
North Dakota[60] has set a guideline for thionyl chloride in ambient air of 50 μ/m^3 (5 milligram per cubic meter).

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: A corrosive irritant to the eyes, skin, and mucous membrane. Contact causes eye and skin burns. Can cause dermatitis, rhinitis (inflammation of the nose), and pneumonia. High exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. This chemical is more toxic than sulfur dioxide.

Long-Term Exposure: Highly irritating substances can cause lung irritation; bronchitis may develop.

Points of Attack: Lungs. Consider chest X-ray following acute overexposure.

Medical Surveillance. Medical observation is recommended for 24–48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. Lung function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water, or milk. Do not induce vomiting. Medical observation is recommended for 24–48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Note to medical personnel: Administer oxygen, using intermittent positive-pressure breathing apparatus: 5% solution of sodium bicarbonate may be used, as well as bronchodilators and decongestants.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/ manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Color code-White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with thionyl chloride all handlers should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area away from water, acids, alkalis, ammonia, chloryl perchloride. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: UN1836 Thionyl chloride, Hazard class: 8; Labels: 8-Corrosive material.

Spill Handling:

Initial isolation and protective action distances; UN1836 Thionyl chloride

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

when spilled on land

Small spills (*From a small package or a small leak from a large package*)
First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)

Day 0.2/0.3
Night 0.5/0.8
Large spills (From a large package or from many small packages)
First: Isolate in all directions (feet/meters) 300/100
Then: Protect persons downwind (miles/kilometers)
Day 0.6/0.9
Night 1.2/1.9
Small spills (*From a small package or a small leak from a large package*)
when spilled in water
First: Isolate in all directions (feet/meters) 300/90
Then: Protect persons downwind (miles/kilometers)
Day 0.7/1.1
Night 1.9/3.1
Large spills (From a large package or from many small packages)
First: Isolate in all directions (feet/meters) 2500/800
Then: Protect persons downwind (miles/kilometers)
Day 6.2/10
Night 7.0 +/11.0 +*
*+ means distance can be larger in certain atmospheric conditions.

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Cover with sodium bicarbonate or an equal mixture of soda ash and slaked lime. After mixing, spray water from an atomizer with great caution. Transfer slowly into a large container of water. Neutralize and drain into the sewer with sufficient water. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible liquid. Thermal decomposition products may include chlorine, sulfur chloride, sulfur dioxide, hydrogen chloride and oxides of sulfur and carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. Keep water out of open containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Spray on a thick layer of a (1:1) mixture of dry soda ash and slaked lime behind a shield. After mixing, spray water from an atomizer with great precaution. Transfer slowly into a large amount of water. Neutralize and drain into the sewer with sufficient water.

References
(31); (173); (101); (138); (100).

Thiophanate-methyl T:0483

Formula: $C_{12}H_{14}N_4O_4S_2$

Synonyms: Allophanic acid, 4,4′-o-phenylenebis(3-thio-, dimethyl ester; BAS 32500F; o-Bis(3-methoxycarbonyl-2-thioureido)benzene; 1,2-Bis(methoxycarbonylthioureido) benzene; 1,2-Bis(3-(methoxycarbonyl)-2-thioureido)benzene; Caligran; Carbamic acid, (1,2-phenylenebis(iminocarbonothioyl))bis-, dimethyl ester; Cercobin M; Cercobin methyl; Cycosin; Dimethyl ((1,2-phenylene)bis-(iminocarbonothioyl))bis(carbamate); Dimethyl-4,4′-o-phenylene-bis-(3-thioallophanate); Ditek; Easout; Enovit M; Enovit methyl; Enovit Super; Frumidor; Fungitox; Fungo; Fungo 50; Methylthiofanate; Methyl thiophanate; Methyl Topsin; Metoben; Mildothane; Neotopsin; PELT 14; PELT-44; Sipcaplant; Sipcasan; Sipcavit; TD 1771; Thiophanate M; Topsin M; Topsin NF-44; Topsin WP methyl; Trevin; Zyban

CAS Registry Number: 23564-05-8

HSDB Number: 6937

RTECS Number: BA3675000

UN/NA & ERG Number: UN2771 (Thiocarbamate, solid, toxic)/151; UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 245-740-7 [*Annex I Index No*.: 006-069-00-3]

Regulatory Authority and Advisory Information

Carcinogenicty: Carcinogenicity[83]: EPA, Likely to be carcinogenic to humans.

California Proposition 65 Chemical[102]: Cancer (5/18/99).

Hazard Alert: Poison, Suspected of causing genetic defects, Suspected reprotoxic hazard, Sensitization hazard, Environmental hazard, Agricultural chemical.

SARA Title III, Section 311/312 Hazard Category: Immediate Health Hazard

RCRA Universal Treatment Standards: Wastewater (mg/L), 0.056; Nonwastewater (mg/kg), 1.4

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimus* concentration reporting level: 1.0%.

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U409

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

United States DOT Regulated marine pollutant (49CFR172.101, Appendix B), severe

EPA Oral reference dose (RfD) = 0.08 mg/kg/day

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T, Xn, N; Risk phrases: R45; R20/21/22; R36; R41; R50/53; R62; R63; R68; Safety phrases: S16; S26; S29; S36/37/39; S45; R46; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Methyl thiophanate is a colorless crystals, prisms or light brown powder. Molecular weight = 342.4; Freezing/Melting point = (decomposes) 172°C; Decomposes ~ 163°C[72]; Vapor pressure = $< 1 \times 10^{-7}$ mmHg @ 20°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Henry's Law constant = 1.21×10^{-9} atm-m^3/mol @ 25°C (est)[72] Slightly soluble in water; solubility = < 30 mg/mL @ 20°C.

Potential Exposure: Methyl thiophanate is thiocarbamate ester, used in the synthesis of polymers and in agriculture as pesticides, soil fumigants, and seed disinfectants.

Incompatibilities: Thiocarbamate esters are combustible; dust may form explosive mixture with air. Decomposes-163°C[72]. Thiocarbamate esters are combustible. They react violently with powerful oxidizers such as calcium hypochlorite. Poisonous gases are generated by the thermal decomposition of thiocarbamate compounds, including carbon disulfide, oxides of sulfur, oxides of nitrogen, hydrogen sulfide, ammonia, and methylamine. Thio and dithio carbamates slowly decompose in aqueous solution to form carbon disulfide and methylamine or other amines. Such decompositions are accelerated by acids. Flammable gases are generated by the combination of thiocarbamates with aldehydes, nitrides, and hydrides. Thiocarbamates are incompatible with acids, peroxides, and acid halides[101].

Determination in Water: Octanol-water coefficient: Log $K_{ow} = < 1.5$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Poisoning can occur by inhalation, ingestion and absorption through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: The slow release of poisonous gases from hydrolysis of many thiocarbamates require the use of respirators during handling. LD_{50} = (oral-rat) 6640 mg/kg.

Long-Term Exposure: Suspected reprotoxic hazard, Suspected of causing genetic defects. May cause skin allergy.

Points of Attack:

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. If skin or lung sensitization is suspected, consider evaluation by a qualified allergist, including exposure history and testing, may help diagnose allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Shampoo hair. Speed in removing material from skin is of extreme importance. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration*: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA-or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create A potential fire or explosion hazard. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical.

Shipping: UN2771 Thiocarbamate pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include toxic oxides of nitrogen, sulfur, and carbon. Stay upwind; keep out of low areas. Ventilate closed spaces before entering. Use water spray, fog or foam. Move container from fire area (only without risk). Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter material. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: In accordance with 40CFR 165 recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(102); (31); (173); (101); (138). (100).

United States Code of Regulations, 40 CFR 240-280, 300-306, 702-799, Washington, DC (July 1, 2000)

Thiophosgene T:0485

Formula: CCl_2S

Synonyms: Carbon chlorosulfide; Carbonothioic dichloride; Carbonyl chloride, thio-; Dichlorothiocarbonyl; Phosgene, thio-; Thiocarbonic dichloride; Thiocarbonyl chloride; Thiocarbonyl dichloride; Thiofosgen; Thiokarbonylchlorid

CAS Registry Number: 463-71-8

HSDB Number: 861

RTECS Number: XN2450000

UN/NA & ERG Number: (PIH) UN2474/157

EC Number: 207-341-6; [*Annex I Index No.*: 607-201-00-8]

Regulatory Authority and Advisory Information

Hazard Alert: Poison inhalation hazard: exposure can be lethal, Combustible, Primary irritant (w/o allergic reaction). United States DOT 49CFR172.101, Inhalation Hazardous Chemical,

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T+; Risk phrases: R15/29; R22; R23; R36/37/38; Safety phrases: S7; S9; S30; S36/37; S41; S45 (see Appendix 4).

Description: A clear dark red to reddish-yellow liquid. Sharp, choking odor. Molecular weight = 115; Specific gravity = 1.53 @ 20°C. Boiling point 73.5°C; Flash point = < 100°C.Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 1, Reactivity 0. ₩ Decomposes in water; reaction with cold water is slow and highly dangerous, liberating hydrogen sulfide and flammable hydrogen gas. Hot water speeds reaction.

Potential Exposure: Primary irritant (w/o allergic reaction). There is not large-scale production of the chemical in the United States It is used to make other chemicals and in laboratory synthesis.

Incompatibilities: Vapors may form explosive mixture with air. Incompatible with water and alcohols. Reacts with water releasing toxic hydrogen chloride, carbon disulfide, and carbon dioxide. Reaction is slow unless the water is hot. Decomposes above 200°C to highly flammable carbon bisulfide and carbon tetrachloride[136]. Corrodes metals, rubber and some plastics in the presence of moisture. Thiophosgene is incompatible with acids, diazo and azo compounds, halocarbons, isocyanates, aldehydes, alkali metals, nitrides, hydrides, and other strong reducing agents. Reactions with these materials generate heat and in many cases hydrogen gas. Liberates hydrogen sulfide upon reaction with acids[101].

Permissible Exposure Limits in Air: No standards or Protective Action Criteria (PAC) available.

Determination in Water: Effect of low concentrations on aquatic life is unknown.

Routes of Entry: Inhalation, eyes and skin.

Harmful Effects and Symptoms

Short-Term Exposure: A corrosive lacrimator and irritant to the eyes, skin, and mucous membrane. May severely burn skin and eyes on contact. Highly toxic by inhalation and by skin absorption. Ingestion causes severe irritation of the mouth and stomach. May also cause headache and nausea. Inhalation causes coughing, shortness of breath, rhinitis (inflammation of the nose), and possible pneumonia. Exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Grade 2, LD_{50} = (oral, rat) 929 mg/kg[136]

Long-Term Exposure: skin

Points of Attack: Lungs, skin, organs.

Medical Surveillance: Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered.

First Aid: Get medical attention at once after any exposure to this compound. *Inhalation*: remove victim from exposure. Administer oxygen as soon as possible; support respiration; watch for pulmonary edema. *Eyes*: irrigate with large quantities of water for 15 minutes. *Skin*: flush with water. *Ingestion*: *Do NOT induce vomiting*; give large amount of water[136]

Person al Protective Methods: SCBA or organic canister mask; goggles or face shield; rubber gloves (USCG, 1999)

Respirator Selection: Get medical attention at once after any exposure to this compound. *Inhalation*: remove victim from exposure; support respiration; watch for pulmonary edema. *Eyes*: irrigate with large quantities of water for 15 minutes. *Skin*: flush with water. *Ingestion*: *Do NOT induce vomiting*; give large amount of water[136]

Storage: Poison inhalation chemical (PIH); check oxygen content prior to entering storage area. (1) Color code-Blue: Health Hazard/Toxics/Poisons: Store under nitrogen in a secure poison location. (2) White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical, personnel should be trained on its proper handling and storage.

Shipping: UN2474 Thiophosgene, Hazard class: 6.1; Labels: 6.1-Poison Inhalation Hazard; Inhalation Hazard Zone B. PG 2. STN: 49 232 98.

Spill Handling:

Thiophosgene

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)
Day 0.4/0.6
Night 1.2/1.9

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 1000/300
Then: Protect persons downwind (miles/kilometers)
Day 1.7/2.8
Night 3.4/5.5

Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources and dampen spilled material with toluene to avoid airborne dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Flammable liquid. Decomposes above 200°C to highly flammable carbon bisulfide and carbon tetrachloride[136]. Thermal decomposition products may include phosgene, carbon disulfide, hydrogen chloride (HCl), hydrogen sulfide, carbon tetrachloride and oxides of sulfur and carbon. Extinguish with dry chemicals or carbon dioxide. *Do not use water or foam on fire*. Cool exposed containers with water. Effect of low concentrations on aquatic life is unknown. May be dangerous if it enters water intakes. Notify local health and wildlife officials. Notify operators of nearby water intakes.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138).

Thiosemicarbazide T:0490

Formula: CH_5N_3S; $H_2NNHCSNH_2$

Synonyms: AI3-16319; *N*-Aminothiourea; 1-Amino-2-thiourea; 1-Aminothiourea; Aminothiourea; Hydrazine carbothioamide; Isothiosemicarbazide; Semicarbazide, 3-thio-; Semicarbazide, thio-; Thiocarbamoylhydrazine; Thiocarbamylhydrazine; 2-Thiosemicarbazide; 3-Thio semicarbazide; Tiosemicarbazida (Spanish); TSC; TSZ

CAS Registry Number: 79-19-6

HSDB Number: 6050 as 1-amino-2-thiourea

RTECS Number: VT4200000

UN/NA & ERG Number: UN2771/151; UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 201-184-7

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Combustible, Suspected of causing genetic defects, Poisonous.

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P116

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 100 lb (45.4 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T+; Risk phrases: R10; R26/27/28; R33; R50/53; R62; Safety phrases: S13; S22; S26; S28; S36/37/39; S41; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Thiosemicarbazide is an odorless, white crystalline powder. Molecular weight = 91.15; Freezing/Melting point = 180°C−184°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Soluble in water.

Potential Exposure: Thiosemicarbazide is a dithiocarbamide compound is used as an intermedialte for pharmaceuticals and herbicides; as a reagent for ketones and certain metals; in certain photography and dye operations; as a rodenticide. It is also effective for control of bacterial leaf blight of rice.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.) and strong reducing agents; contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. May react with nitrates.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 1.1 milligram per cubic meter

PAC-2: 12 milligram per cubic meter

PAC-3: 13 milligram per cubic meter

Permissible Concentration in Water: No criteria set.

Determination in Water: Octanol-water coefficient: Log $K_{ow} = -0.67$. See Feigel; *Spot Tests in Organic Analysis*, Elsevier Publishing Company, New York.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: This material is highly poisonous by ingestion. May cause delayed toxic effects in blood and skin. May be mutagenic in human cells. Thiosemicarbazide may induce goiter and has also been reported to cause bone marrow depression with accompanying decreases in white blood cells and platelets. It may also cause skin irritation.

Long-Term Exposure: May cause delayed toxic effects in blood and skin. May be mutagenic in human cells. May be a cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure.

Points of Attack: Respiratory system, lungs, CNS; cardiovascular system, skin, eyes, plasma and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in one to two weeks while red blood cell levels may be reduced for one to three months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of “normal.” Reassignment to work not involving carbamate pesticides (or organophosphates) is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider CBC. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Where possible, automatically transfer material from drums or other storage containers to process containers.

Shipping: UN2771 Thiosemicarbazide, pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: *Isolation Distance, Spill*: 25meters/75 feet.(NJ). Isolation Distance, Fire: 800 meters/ 0.5 miles[70]. Avoid skin contact, ingestion or inhalation. Do not touch spilled material; stop leak if you can do it without risk. *Small spills*: take up with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills*: with clean shovel place material into clean, dry container and cover; move containers from spill area. *Large spills*: dike far ahead of spill for later disposal. Remove all ignition sources. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Flammable solid. Thermal decomposition products may include oxides of sulfur, nitrogen and carbon. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: *Thiosemicarbazide*, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

Thiotepa T:0500

Formula: $C_6H_{12}N_3PS$

Synonyms: 1,1′,1″-Phosphinothioylidynetrisaziridine; Phosphorothioic acid triethylenetriamide; SK 6882; Tespamine; Thiofozil; Thiophosphamide; Thio-TEP; Tiofosfamid; Tiofozil; Triaziridinylphosphine sulfide; *N,N*′,*N*″-Tri-1,2-ethanediylphosphorothioic triamide; *N,N*′, *N*″-Tri-1,2-ethanediylthiophosphoramide; Tri(ethyleneimino) thiophosphoramide; *N,N*′,*N*″-Triethylene phosphorothioic-triamide; *N,N*′,*N*″-Triethylenethiophosphamide; *N,N*′,*N*″-Triethylen-ethiophosphoramide; Triethylenethiophosphorotriamide; Tris(1-aziridinyl)phosphine sulfide; Tris(ethylenimino) thiophosphate

CAS Registry Number: 52-24-4

HSDB Number: 3258

RTECS Number: SZ2975000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154; UN3249 (Medicines, toxic, solid, n.o.s.)/151

EC Number: 200-135-7

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen; IARC: Human Sufficient Evidence, 1978; Animal Sufficient Evidence, *carcinogenic to humans*, Group 1, 1997; NCI: Carcinogenesis Studies (ipr); clear evidence: mo use, rat.

California Proposition 65 Chemical[102]: Cancer 1/1/1988

Hazard Alert: Poison, Polymerization hazard, Environmental hazard.

Banned or Severely Restricted (in household products) (Japan)[13].

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T+; Risk phrases: R45; R19; R26/27/28; R46; R50/53; Safety phrases: S13; S22; S26; S28; S29/35; S36/ 37/39; S45; S53; S61 (see Appendix 4)

Description: Thiotepa is a crystalline substance. Molecular weight = 189.24; Freezing/Melting point = 51.5°C. Practically insoluble in water.

Potential Exposure: Used in the treatment of cancers resistant to chemotherapy. Antineoplastic: thiotepa has been prescribed for a wide variety of neoplastic diseases: adenocarcinomas of the breast and the ovary; superficial carcinoma of the urinary bladder; controlling intracavitary or localized neoplastic disease; lymphomas, such as lymphosarcomas and Hodgkin's disease; as well as bronchogenic carcinoma.

Incompatibilities: Tris(aziridinyl)phosphine sulfide polymerizes readily upon exposure to heat or moisture, especially at acidic pH[101]. Incompatible with strong oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

No standards or Protective Action Criteria (PAC) available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Symptoms of exposure to this compound include nausea, anorexia, headache and vomiting. It may also cause leukopenia and thrombocytopenia. Other symptoms include bone-marrow depression, anemia, dizziness, amenorrhea, interference with spermatogenesis, alopecia and apnea. Febrile reaction and weeping from a subcutaneous lesion may occur as the result of breakdown of tumor tissue. Allergic reactions are rare, but hives and skin rash have been noted occasionally. Death from septicemia and hemorrhage has occurred as a direct result of hematopoietic depression. Other symptoms include granulocytopenia, hypoplasia of all elements of bone marrow, lymphopenia and precipitation of uric acid in kidney tubules[101].

Long-Term Exposure: Exposure to this compound may result in the development of acute nonlymphocytic leukemia[101]. Tris(1-aziridinyl)phosphine sulfide (Thiotepa) is carcinogenic in mice and rats after administration by various routes, producing a variety of malignant tumors. There are several reports and epidemiological studies suggesting the development of acute nonlymphocytic leukemia in patients treated with thiotepa for ovarian and other malignant tumors.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/ manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration*: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full-facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Protect from light and store in a refrigerator. Prior to working with this chemical, personnel should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers. Where possible, automatically transfer material from drums or other storage containers to pro cess containers.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN3249 Medicine, solid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: UN2811: *Isolation Distance, Spill*: 25meters/75 feet.(NJ). Isolation Distance, Fire: 800 meters/ 0.5 miles[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of nitrogen, sulfur, phosphorus and carbon. This chemical is a combustible solid. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: It is inappropriate and possibly dangerous to the environment to dispose of expired or waste pharmaceuticals by flushing them down the toilet or discarding them to the trash. Household quantities of expired or waste pharmaceuticals may be mixed with wet cat litter or coffee grounds, double-bagged in plastic, discard in trash. Larger quantities shall carefully take into consideration applicable DEA, EPA, and FDA regulations. If possible return the pharmaceutical to the manufacturer for proper disposal being careful to properly label and securely package the material. Alternatively, the waste pharmaceutical shall be labeled, securely packaged and transported by a state licensed medical waste contractor to dispose by burial in a licensed hazardous or toxic waste landfill or incinerator.

References

(109); (102); (31); (173); (101); (138).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 2, 69−70 (1980)

Thiourea T:0510

Formula: CH_4N_2S; $H\ _2NCSNH_2$

Synonyms: Carbamide, thio-; Isothiourea; Pseudothiourea; Pseudourea, 2-thio-; Sulfourea; Sulourea; Thiocarbamate; Thiocarbamide; β-Thiopseudourea; 2-Thiourea; THU; Tiourea (Spanish); TSIZP 34; Urea, 2-thio-

CAS Registry Number: 62-56-6

HSDB Number: 1401

RTECS Number: YU2800000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154; UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 200-543-5 [*Annex I Index No*.: 612-082-00-0]

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Animal Limited Evidence; Human No Adequate Data, *not classifiable as carcinogenic to humans*, Group 3, 2000. United States Environmental Protection Agency Gene-Tox Program, Positive: Carcinogenicity-mouse/rat; Cell transformation-SA7/F344 rat EPA; Positive: SHE-clonal assay; Cell transformation-RLV F344 rat embryo EPA; Positive: Host-mediated assay EPA; Negative: Cell transformation-SA7/SHE; *E coli polA* with S9 EPA; Negative: Histidine reversion-Ames test; Sperm morphology-mouse EPA; Negative: S *cerevisiae-homozygosis* EPA; Inconclusive: *E coli polA* without S9.

California Proposition 65 Chemical[102]: Cancer 1/1/1988.

Hazard Alert: Poison, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Sensitization hazard (skin); Primary irritant (w/o allergic reaction), Environmental hazard.

Banned or Severely Restricted (Sweden) (UN)[13]

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U219

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Hazardous to aquatic life or environment, with possible long-lasting effects[293]. Toxic to aquatic life with long-lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%.

Hazardous to aquatic life or environment, with possible long-lasting effects[293]. Toxic to aquatic life with long-lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T, Xn, N, Xi; Risk phrases: R45; R22; R36/37/38; R40; R43; R50/53; R62; R62; R63; Safety phrases: S2; S29/35; S36/37; S41; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Thiourea consists of colorless, lustrous crystals or powder with a bitter taste. Molecular weight = 76.1; Specific gravity (H_2O:1) = 1.4 @ 20°C; Boiling point = decomposes below BP; Freezing/Melting point =

178°C−181°C; Flash point = 55°C. Partially soluble in water.

Potential Exposure: Thiourea is used as rubber antiozonant, toning agent; corrosion inhibitor; and in pharmaceutical manufacture; in the manufacture of photosensitive papers; flame-retardant textile sizes; boiler water treatment. It is also used in photography; pesticide manufacture; in textile chemicals.

Incompatibilities: Dust may form explosive mixture with air. Reacts violently with acrolein, strong acids (nitric acid). Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 0.38 milligram per cubic meter

PAC-2: 4.1 milligram per cubic meter

PAC-3: 25 milligram per cubic meter

DFG MAK: [skin] Danger of skin sensitization; danger of photo-contact sensitization; Carcinogen Category 3B.

Austria Suspected: carcinogen, 1999; Finland: carcinogen, 1999; France: carcinogen, 1993; Russia: STEL 0.3 milligram per cubic meter, 1993; Sweden: carcinogen, 1999; the Netherlands: MAC-TGG 0.5 milligram per cubic meter, [skin], 2003. Several states have set guidelines or standards for thiourea in ambient air[60] ranging from zero (North Dakota); to 0.03 μ/m^3 (New York).

Determination in Water: Octanol-water coefficient: Log $K_{ow} = < -1$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes. Thiourea may affect you when breathed in. A related chemical (naphthylthiourea) in higher exposures can cause fluid in the lungs, a medical emergency. It is not known if thiourea has this effect. May cause allergic skin eruptions[136].

Long-Term Exposure: Repeated exposure can cause goiter (enlarged thyroid gland). Exposure may damage the bone marrow, causing reduced red blood cells; white blood cells and platelets (reduced blood clotting ability). Thiourea has been identified as a sensitizer in people suffering from photosensitivity. A possible human carcinogen.

Points of Attack: Thyroid gland, blood, skin. Cancer site in animals: thyroid, liver.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended. Lung function tests. CBC. Consider thyroid test for thyroxin. If symptoms develop or overexposure is suspected, the following may be useful. Consider chest X-ray after acute overexposure. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Eye protection is included in the recommended respiratory protection. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Based on potential carcinogenicity the following is recommended by NIOSH: *At any detectable concentration*: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA-or European Standard EN149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full-facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Thiourea must be stored to avoid contact with acrolein, hydrogen peroxide; and nitric acid, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: UN2811: *Isolation Distance, Spill*: 25meters/75 feet.(NJ). Isolation Distance, Fire: 800 meters/ 0.5 miles[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Thermal decomposition products may include nitrogen, sulfur and carbon oxides. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(109); (102); (31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: *Thiourea*, Washington, DC (1979)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: *Thiourea*, Trenton, NJ (July 2002)

Thiram T:0520

Formula: $C_6H_{12}N_2S_4$

Synonyms: Aapirol; Aatack; Aatiram; Accelerator T; Accelerator thiuram; Accel TMT; Aceto TETD; AI3-00987; Anles; Arasan; Arasan 42S; Arasan 42-S; Arasan 70; Arasan 70-S Red; Arasan 75; Arasan-M; Arasan-SF; Arasan-SF-X; Atiram; Attack; Aules; Bis(diethylthiocarbamoyl) sulfide; Bis[(dimethylamino) carbonothioyl] disulfide; Bis[(dimethylamino)carbonothioyl] disulphide; Bis(dimethylthiocarbamoyl) disulfide; Bis(dimethylthiocarbamoyl) disulphide; Chipco Thiram 75; Cunitex; Cyuram DS; Delsan; Disulfide, bis(dimethylthiocarbamoyl); α,α′-Dithiobis(dimethy-lthio)formamide; *N*,*N*-(Dithio-dicarbo nothioyl)bis(*N*-methylmethanamine); Ekagom TB; ENT 987; Falitiram; Fermide; Fermide 850; Fernacol; Fernasan; Fernasan A; Fernide; Flo Pro T seed protectant; FMC 2070; Formalsol; Formamide, 1,1′-dithiobis(*N*,*N*-dimethylthio-); Hermal; Hermat TMT; Heryl; Hexathir; HY-VIC; Kregasan; Mercuram; Methyl thiram; Methylthiuram disulfide; Methyl tuads; Metiurac; NA2771; Nobecutan; Nomersan; Normersan; NSC 1771; Panoram 75; Polyram ultra; Pomarsol; Pomarsol forte; Pomasol; Puralin; Rezifilm; Royal TMTD; Sadoplon; Spotrete; Spotrete-F; SQ 1489; Sranan-SF-X; STCC 4941187; Teramethylthiuram disulfide; Tersan; Tersan 75; Tersantetramethyl diurane sulfide; Tetramethyldiurane sulphite; Tetramethylenethiuram disulfide; Tetramethylenethiuram disulphide; Tetramethylthiocarbamoyldisulphide; Tetramethyl-thioperoxydicarbonicdiamide; Tetramethylthiuram; Tetramethylthiuram bisulfide; Tetramethylthiuram bisulphide; *N*,*N*,*N*′,*N*′-Tetramethylthiuram disulfide; *N*,*N*-Tetramethylthiuram disulfide; Tetramethylthiuram disulfide; Tetramethylthiuram disulphide; Tetramethylthiuran disulphide; Tetramethylthiurane disulfide; Tetramethyl thiurane disulphide; Tetramethylthiurum disulfide; Tetramethylthiurum disulphide; Tetrapom; Tetrasipton; Tetrathiuram disulfide; Tetrathiuram disulphide; Thianosan; Thillate; Thimar; Thimer; Thioknock; Thioperoxydicarbo NIC diamide, tetramethyl-; Thioperoxydicarbonic diamide, tetramethyl-; Thiosan; Thioscabin; Thiotex; Thiotox; Thiram 75; Thiram 80; Thiramad; Thiram B; Thirame (French); Thirampa; Thirasan; Thiulin; Thiulix; Thiurad; Thiuram; Thiuram D; Thiuramin; Thiuramyl; Thylate; Tiram (Spanish); Tirampa; Tiuramyl; TMTD; TMTDS; Trametan; Tridipam; Tripomol; TTD; Tuads; Tuex; Tulisan; Vancida TM-95; Vancide TM; Vuagt-1-4; Vulcafor TMTD; Vulkacit MTIC; Vulkacit Thiuram; Vulkacit Thiuram/C

CAS Registry Number: 137-26-8; *(alt.)* 12680-07-8; *(alt.)* 12680-62-5; *(alt.)* 39456-80-9; *(alt.)* 66173-72-6; *(alt.)*

HSDB Number: 863
RTECS Number: JO14000000
UN/NA & ERG Number: UN2771/151
EC Number: 205-286-2 [*Annex I Index No.*: 006-005-00-4]
Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Inadequate Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1991. United States Environmental Protection Agency Gene-Tox Program, Positive: Mammalian micronucleus; B *subtilis* rec assay

Hazard Alert: Poison, Combustible, Endocrine disruptor (high), Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Sensitization hazard, Primary irritant (w/o allergic reaction), Environmental hazard.

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U244

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)](as dustable powder formulations containing a combination of: Benomyl @ or >7%; carbofuran @ or >10 %; thiram @ or >15%).

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: Xn, N, Xi; Risk phrases: R20/22; R36/38; R43; R48/22; R50/53; R62; R63; Safety phrases: S2; S26; S29/35; S36/37; S41; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Thiram is a colorless to yellow, crystalline solid. Characteristic odor. Commercial pesticide products may be dyed blue. Molecular weight = 240.44; Boiling point = 129°C; Freezing/Melting point = 156°C; Flash point = 148°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Insoluble in water.

Potential Exposure: Thiram is a dithiocarbamate. Some thiurams have been used as rubber components: thiram is used as a rubber accelerator and vulcanizer; a seed, nut, fruit, and mushroom disinfectant; a bacteriostat for edible oils and fats; and as an ingredient in suntan and antiseptic sprays and soaps. It is also used as a fungicide, rodent repellent; wood preservative; and may be used in the blending of lubricant oils.

Incompatibilities: Dust may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from strong alkaline materials, strong acids, strong bases and nitrating agents.

Permissible Exposure Limits in Air

NIOSH IDLH = 100 milligram per cubic meter
OSHA PEL: 5 milligram per cubic meter TWA
NIOSH REL: 5 milligram per cubic meter TWA
ACGIH TLV[1]: 0.05 milligram per cubic meter, measured as inhalable fraction and vapor TWA; not classifiable as a human carcinogen

Protective Action Criteria (PAC) Ver. 29[138]
PAC-1: 0.15 milligram per cubic meter
PAC-2: 250 milligram per cubic meter
PAC-3: 1500 milligram per cubic meter

DFG MAK: MAK: 1 milligram per cubic meter, inhalable fraction TWA; Peak Limitation Category II(2); danger of skin sensitization; Pregnancy Risk Group C.

Australia: TWA 5 milligram per cubic meter, 1993; Austria: MAK 5 milligram per cubic meter, 1999; Belgium: TWA 5 milligram per cubic meter, 1993; Denmark: TWA 1 milligram per cubic meter, 1999; Finland: TWA 5 milligram per cubic meter, STEL 10 milligram per cubic meter, [skin], 1999; France: VME 5 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 5 milligram per cubic meter, 2003; the Phillipines: TWA 5 milligram per cubic meter, 1993; Poland: MAC (TWA) 0.5 milligram per cubic meter; MAC (STEL) 2 milligram per cubic meter, 1999; Russia: STEL 0.5 milligram per cubic meter, [skin], 1993; Sweden: TWA 1 milligram per cubic meter, STEL 2 milligram per cubic meter, 1999; Switzerland: MAK-W 5 milligram per cubic meter, STEL 25 milligram per cubic meter, 1999; Thailand: TWA 5 milligram per cubic meter, 1993; Turkey: TWA 5 milligram per cubic meter, 1993; United Kingdom: TWA 5 milligram per cubic meter, STEL 10 milligram per cubic meter 2000 Occupational Exposure Limit; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Russia[35][43] has set MAC values for ambient air in residential areas of 0.01 milligram per cubic meter on a momentary basis and 0.006 milligram per cubic meter on a daily average basis. Several states have set guidelines or standards for Thiramin ambient air[60] ranging from 50 μ/m^3 (North Dakota); to 80 μ/m^3 (Virginia); to 100 μ/m^3 (Connecticut); to 119 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #5005, Thiram.

Permissible Concentration in Water: Russia [43] set a MAC in water bodies used for domestic purposes of 1.0 μg/L. Further it set a MAC in water bodies used for fishery purposes of zero. The state of Maine[61] has set a guideline for thiram in drinking water of 10 μg/L.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin, and respiratory tract. Skin irritation can lead to rash, and allergy. High exposures can cause kidney and liver damage. Brain and nerve damage can also occur. Inhalation can cause irritation of the respiratory tract with stuffy nose; nosebleeds, hoarseness, cough and/or phlegm. *Inhalation*: Animal studies indicate that irritation of the nose and throat may occur at levels above 5 milligram per cubic meter. *Skin*: Exposure to spray containing 45% Thiram resulted in irritation and skin sensitization. *Eyes*: May cause irritation, tearing and sensitivity to light. *Ingestion*: No information available on human exposure. In animal studies, 38 ppm in food caused nausea, vomiting, diarrhea, hyperexcitability, weakness and loss of muscle control. Death may occur from ingestion of approximately one teaspoonful. *Note*: Can cause extreme illness when exposure is combined with alcohol ingestion.

Long-Term Exposure: Repeated or prolonged contact may cause skin sensitization. Prolonged contact has causedeye irritation; tearing, increased sensitivity to light; reduced night vision and blurred vision. Occupational exposures to 0.03 milligram per cubic meter over a five-year period has caused mild irritation of the nose and throat. Whether it has this effect in humans is not known. May affect the thyroid and liver. Thiram has caused birth defects in laboratory animals and has been shown to be a teratogen in animals.

Points of Attack: Eyes, skin, respiratory system; CNS. Dithiocabamates can affect thyroid function.

Medical Surveillance: Preplacement and periodic medical examinations should give special attention to history of skin allergy, eye irritation; and significant respiratory, liver, or kidney disease. Workers should be aware of the potentiating action of alcoholic beverages when working with tetramethylthiuram disulfide. Thyroid function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *50 milligram per cubic meter*: CcrOv95 (APF = 10) [any air-purifying half-mask respirator equipped with an organic vapor cartridge(s) in combination with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *100 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or CcrFOv100 (APF = 50) [any air-purifying full facepiece respirator equipped with organic vapor cartridge(s) in combination with an N100, R100, or P100 filter]; or GmFOv100 (APF = 50) [Any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or PaprOvHie (APF = 25) (any powered air-purifying respirator with an organic vapor cartridge in combination with a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full face piece). *Emergency or planned entry in to unknown concentrations or IDLH conditions*: SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv100 (APF = 50) [Any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA). *Note*: Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in a cool place away from strong oxidizers; strong acids; oxidizable materials.

Shipping: UN2771 Thiocarbamate pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Cover the spill with weak solution of calcium hypochlorite (Up to 15%). Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include carbon disulfide and oxides of sulfur, nitrogen and carbon. This chemical is a combustible solid. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Thiram can be dissolved in alcohol or other flammable solvent and burned in an incinerator with an afterburner and scrubber.

References

(31); (173); (101); (138); (2); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 5, 41–42 (1981)

New York State Department of Health, *Chemical Fact Sheet*: Thiram, Bureau of Toxic Substance Assessment, Albany, NY (April 1986)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Thiram, Trenton NJ (June 2000)

Thorium & Compounds T:0525

Formula: Th; $Th(NO_3)_4$; ThO_2

Synonyms: *metal*: Thorium-232; Thorium metal; *Thorium chloride*: (Spanish) Tetrochlorothorium; Thorium tetrachloride; *Thorium dioxide*: Dioxido de torio (Spanish); Thoria; Thorium oxide (tho2); thorium(IV) oxide; Thorotrast; Thortrast; Umbrathor; *Thorium nitrate*: Nitric acid, thorium (4+) salt; Thorium(4+) nitrate; Thorium (IV) nitrate; Thorium tetranitrate

CAS Registry Number: 7440-29-1 (elemental); 10026-08-1 (chloride); 13823-29-5 (nitrate); 1314-20-1 (dioxide);

HSDB Number: 13825-36-0 (hydroxide); 2040-52-0 (oxalate); 16045-17-3 (perchlorate)

RTECS Number: XO6400000 (elemental); XO6825000 (nitrate); XO6950000 (dioxide); 237-514-1(nitrate)

UN/NA & ERG Number: Metal powder, in bulk, may be pyrophoric. UN2975 (metal, pyrophoric)/162; UN2976 (nitrate); UN3077 (environmentally hazardous substances, solid, n.o.s.)/171 (dioxide)

EC Number: 231-139-7 (elemental); 233-056-1 (chloride); 215-225-1(dioxide)

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: There is sufficient evidence in experimental animals for the carcinogenicity of mixed α-particle emitters. This includes thorium-227, thorium-228, thorium-230, thorium-232[193].

California Proposition 65 Chemical[102]: Cancer, 1/1/1989 as radionuclides.

Thorium:

Hazard Alert: Highly flammable (powder); Pyrophoric hazard, Dangerous radioactive hazard, Environmental hazard.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112) as radionuclides

CERCLA *Reportable Quantities (RQs) for radionuclides of Thorium, radioactive compounds*: Persons in charge of vessels or facilities are required to notify the National Response Center (NRC) immediately, when there is a release of this designated hazardous substance, in an amount equal to or greater than its reportable quantity (RQ) reported in curies (ci)/TBq (terabecquerel):

- Thorium_{229}: RQ ≥ 0.001 ci/3.7×10^7 TBq
- Thorium_{228}; Thorium_{230}: RQ ≥ 0.01 ci/3.7×10^8 TBq
- Thorium_{227}: RQ ≥ 1.0 ci/0.37×10^{10} TBq
- Thorium_{226}; Thorium_{231}; Thorium_{234}: RQ ≥ 100 ci/3.7×10^{12} TBq

The toll free number of the NRC is (800) 424-8802. The rule for determining when notification is required is stated in 40 CFR302.4 (section IV. D.3.b).

thorium dioxide:

Carcinogenicity: *Thorium dioxide*: NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen: Thorium dioxide; IARC: Human Sufficient Evidence [diagnostic injection of thorium-232 as stabilized thorium-232 dioxide in colloidal form (Thorotrast)]; Humans Inadequate Evidence (inhalation thorium-232), generally in Group, 2001; RTECS: (thorium dioxide)[9]

California Proposition 65 Chemical[102]: Cancer 2/27/1987

Hazard Alert: Radioactive material, Possible risk of forming tumors.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T, F, N; Risk phrases: R45; R10 (powder); R23/24/25; R34; Safety phrases: S26; S27; S28; S29/35; S36/37/39; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. (all CAS numbers shown above)

Description: Thorium is a silvery-white, soft, ductile metal which is a natural radioactive element. Atomic weight = 232; Specific gravity (H_2O:1) = 11.7 @ 20°C; Boiling point = 4500°C Freezing/Melting point = 1750 ± 30°C. Insoluble in water. It occurs in the minerals monazite, thorite, and thorinite; usually mixed with its disintegration products.

Thorium chloride is a crystalline solid. Molecular weight = 373.80; Boiling point = 927.5°C; Freezing/Melting point = 770°C. Soluble in water

Thorium hydroxide $Th(OH)_4$: Molecular weight = 300.1; Specific gravity (H_2O:1) = @ 20°C; Boiling point = °C; Freezing/Melting point = °C.

Thorium nitrate, [$Th(NO_3)_4$; ThN_4O_{12}]: a crystalline solid which decomposes @ 500°C. Molecular weight = 480; Specific gravity (H_2O:1) = @ 20°C; Boiling point = °C; Freezing/Melting point = °C.

Thorium nitrite: Molecular weight = 416.03; Specific gravity (H_2O:1) = @ 20°C; Boiling point = °C; Freezing/Melting point = °C.

Thorium oxide ($ThO_{2)}$ is a white crystalline powder or solid. Molecular weight = 264.00; Specific gravity (H_2O:1) = 9.7 @ 20°C; Boiling point = 4400°C; Freezing/Melting point = 3390°C. Insoluble in water.

Thorium oxalate: Molecular weight = 444; Specific gravity (H_2O:1) = 4.6 @ 16°C; Boiling point = °C; Freezing/Melting point = °C.

Thorium perchlorate ($ThClO_4$): Molecular weight = 331.49; Specific gravity (H_2O:1) = @ 20°C; Boiling point = °C; Freezing/Melting point = °C.

Potential Exposure: *Metallic thorium* is used in nuclear reactors to produce nuclear fuel; in the manufacture of incandescent mantles; as an alloying material, especially with some of the lighter metals, for example, magnesium as a reducing agent in metallurgy; for filament coatings in incandescent lamps and vacuum tubes; as a catalyst in organic synthesis; in ceramics; and in welding electrodes. Exposure may occur during production and use of thorium-containing materials, in the casting and machining of alloy parts; and from the fume produced during welding with thorium electrodes.

Thorium nitrate is an oxidizer. Contact with combustibles, and reducing agents will cause violent combustion or ignition.

Incompatibilities: The powder may ignite spontaneously in air. Heating may cause violent combustion or explosion. May explosively decompose from shock, friction, or concussion. Incompatible with strong oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause violent fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, nitryl fluoride; peroxyformic acid; silver, sulfur.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC) Ver. 29[138]

7440-29-1, elemental; 1314-20-1, oxide; 13825-36-0, hydroxide; *16045-17-3, perchlorate*; *2040-52-0, oxalate*; *z-0090, nitrite*

PAC-1: 30 milligram per cubic meter
PAC-2: 330 milligram per cubic meter
PAC-3: 2000 milligram per cubic meter

13823-29-5, nitrate

PAC-1: 2.9 milligram per cubic meter
PAC-2: 32 milligram per cubic meter
PAC-3: 190 milligram per cubic meter

North Dakota[60] has set a guideline for ambient air of zero for thorium dioxide.

Routes of Entry: Ingestion of liquid, inhalation of dust or gas, and dermal absorption.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin, and respiratory tract. Inhalation may cause damage to the bone marrow and lungs. May affect the blood forming system, reducing the ability to produce white blood cells, resulting in pernicious anaemia.

Long-Term Exposure: Gas and aerosols can penetrate the body by way of the respiratory system, the digestive system, and the skin. Only 0.001% of an ingested dose is retained in the body. Thorium, once deposited in the body, remains in the bones, lymph system; lungs and other body organs; and parenchymatous tissues for long periods of time. Low repeated exposures may scar the lungs, and damage the liver and kidneys. Characteristic effects of the activity of thorium and its disintegration products are changes in blood forming, nervous and reticuloendothelial systems; and functional and morphological damage to lung and bone tissue. Only much later do illness and symptoms characteristic of chronic radiation disease appear. After a considerable time, neoplasms may occur and the immunological activity of the body may be reduced. Repeated or prolonged contact with skin may cause dermatitis. A potential occupational carcinogen. May cause heritable genetic damage. May cause birth defects.

Points of Attack: Bone marrow, lungs. Liver, kidneys, lungs. Cancer site in humans (thorium dioxide): liver.

Medical Surveillance: Thorium oxide is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Monitoring of personnel for early symptoms and changes, such as abnormal leukocytes in the blood smear, may be of value. In cases of chronic or acute exposure, the determination of thorium in the urine or the use of whole body radiation counts and breath radon are useful methods of monitoring the exposure dose and excretion rates. White blood cell count. Lung function test. Consider periodic chest X-ray for persons with potentially high or repeated lower exposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately.

If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration*: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full-facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Radioactive. Color code-Yellow Stripe: Reactivity Hazard; Store separately in a area isolated from flammables, combustibles, or other yellow coded materials. Prior to working with this chemical, personnel should be trained on its proper hand ling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Thorium nitrate must be stored to avoid contact with combustible, organic or other readily oxidizable materials, since violent reactions occur.

Shipping: UN2975 Thorium metal, pyrophoric, Hazard class: 7; Labels: 7-Radioactive material, 4.2-Spontaneously combustible material. Note: UN/NA 2975 doesn't appear in the 49 CFR Hazmat Table.

UN2976* Thorium nitrate, solid, Radioactive Materials (Low to Moderate Level Radiation. *Note: UN/NA 2976 doesn't appear in the 49 CFR Hazmat Table.

UN2909 Radioactive material, excepted package-articles manufactured from natural uranium or depleted uranium or natural thorium, Hazard class: 7; Labels: 7-Radioactive material Notes: There are three notes: (1) whether the displayed information is for domestic (USA) or international shipping (if neither is specifically indicated, it applies to both), (2) whether the proper shipping name must include one or more technical names of the hazardous material in parentheses, and (3) whether the hazardous material is an inhalation hazard.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120 (q) may be applicable.

Fire Extinguishing: Fire: When a large quantity of this material is involved in a major fire, consider an initial evacuation distance of 300 meters (1000 feet) in all directions. Radiation presents minimal risk to transport workers, emergency response personnel and the public during transportation accidents. Packaging durability increases as potential hazard of radioactive content increases. Very low levels of contained radioactive materials and low radiation levels outside packages result in low risks to people. Damaged packages may release measurable amounts of radioactive material, but the resulting risks are expected to be low. Some radioactive materials cannot be detected by commonly available instruments. Packages do not have "RADIOACTIVE I, II, or III" labels. Some may have EMPTY labels or may have the word "Radioactive" in the package marking[31]. Thorium dioxide may burn, but does not readily ignite. Thermal decomposition products may include metallic oxides of metal (thorium); and, in thorium nitrate, nitrogen oxides. Thorium nitrate can cause violent combustion or ignition when in contact with readily combustible substances. On thorium nitrate use dry chemical, carbon dioxide; water spray; or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Recovery and recycling is in the preferred route.

References

(109); (102); (31); (173); (101); (138); (170); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 8, No. 4, 72−74 (1988) (Thorium Chloride)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Thorium Nitrate, Trenton, NJ (February 2001).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Thorium Dioxide, Trenton, NJ (June 2006)

Tin & Inorganic Compounds T:0530

Formula: Sn

Synonyms: Alloy 510; Alloy 511; Alloy 521; Alloy 725; Estano (Spanish); Metallic tin; Prepared bath 2137; Tin, elemental; Tin flake; Tin metal; Tin powder; Zinn (German)

Other tin inorganic compounds for reference: Tin fluoroborate (B_2F_8Sn) (13814-97-6); Tin hydroxide (H_2O_2Sn) (12026-24-3); Tin nitrate (41480-79-9); Tin nitrite (100737-27-7); Tin(II) chloride dihydrate ($C_{12}H_4O_2Sn$) (10025-69-1); Tin(II) oxide (1332-29-2); Tin(IV) oxide (O_2Sn) (18282-10-5); Stannic tetra chloride ($C_{14}Sn$); (7646-78-8); Stannous chloride (Cl_2Sn) (7772-99-8); Tin hydroxide (12026024-3)

CAS Registry Number: 7440-31-5 (metal); 18282-10-5 [Tin(IV) oxide]; 21651-19-4 (oxide)

HSDB Number: 5035

RTECS Number: XP7320000 (elemental)

UN/NA & ERG Number:

EC Number: 231-141-8

Regulatory Authority and Advisory Information

Hazard Alert: Combustible, Reducing agent, Possible risk of forming tumors.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%., tin, elemental and tin compounds, n.o.s.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: F, C, Xi; Risk phrases: R11; R20/21/22; R34; R36/37/38; Safety phrases: S7/9; S16; S24/25; S26; S33; S36/37/39; S45(see Appendix 4).

WGK[100] (German Aquatic Hazard Class): Nonwater polluting agent (particle size >1 mm; metal, oxide)

Description: Tin is a gray to almost silver-white, ductile, malleable, lustrous metal. Specific gravity (H_2O:1) = 7.28 @ 25°C; Molecular weight = 119; Specific gravity (H_2O:1) = 5.8; Boiling point = 2625°C; Freezing/Melting point = 232°C. Ignition temperature of dust cloud = 630°C; Minimum Explosive concentration = 0.19 oz/ft^3[209]. Relative explosion hazard of dust: Mode rate (due to oxide coating). Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 1. Insoluble in water. The primary commercial source of tin is cassiterite (SnO_2, tinstone).

Tin (II) oxide & (IV) oxide, (stannic oxide): Molecular weight = 151; Specific gravity (H_2O:1) = 6.95; Freezing/Melting point = 1630°C.

Tin(II) chloridedihydrate: Molecular weight = 226; Specific gravity (H_2O:1) = 2.7; Boiling point = 652°C; Freezing/Melting point = 38°C. Tin hydroxide [$Sn(OH)_2$]: Molecular weight = 153.

Potential Exposure: The most important use of tin is as a protective coating for other metals, such as in the food and beverage canning industry; in roofing tiles; silverware, coated wire; household utensils; electronic components; and pistons. Common tin alloys are phosphor bronze; light brass; gun metal; high tensile brass; manganese bronze; die-casting alloys; bearing metals; type metal; and pewter. These are used as soft solders, fillers in automobile bodies; and as coatings for hydraulic brake parts; aircraft landing gear and engine parts. Metallic tin is used in the manufacture of collapsible tubes and foil for packaging. Exposures to tin may occur in mining, smelting, and refining; and in the production and use of tin alloys and solders. Inorganic tin compounds are important industrially in the production of ceramics; porcelain, enamel, glass; and inks; in the production of fungicides; anthelmintics, insecticides; as a stabilizer it is used in polyvinyl plastics and chlorinated rubber paints; and it is used in plating baths.

Incompatibilities: TIN is a reducing agent. Stable in bulk form in air, but as powder it corrodes (oxidizes) in air, especially in the presence of moisture. Keep away from strong oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Incompatible with acids, alkalies, bases, chlorine, turpentine; reacts violently with acetic aldehyde, ammonium nitrate, ammonium perchlorate, hexachloroethane. Strong reducing agents may react violently with halogens, bromine fluoride, chlorine trifluoride, copper nitrate, disulfur dichloride, nitrosyl fluoride, potassium dioxide, sodium peroxide, sulfur, and other chemicals. May form explosive compounds with hexachloroethane, pentachloroethane, picric acid, potassium iodate, potassium peroxide, 2,4,6-trinitrobenzene-1,3,5-triol.

Permissible Exposure Limits in Air

7440-31-5, metal

NIOSH IDLH = 100 mg[Sn]/m^3

OSHA PEL: 2 mg[Sn]/m^3 TWA [also applies to other inorganic tin compounds (as Sn), including tin oxides]

NIOSH REL: 2 mg[Sn]/m^3 TWA [also applies to other inorganic tin compounds (as Sn) *except* tin oxides]

ACGIH TLV[1]: 2 mg[Sn]/m^3 TWA [also applies to other inorganic tin compounds (as Sn), including tin oxides]

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 6 milligram per cubic meter

PAC-2: 67 milligram per cubic meter

PAC-3: 400 milligram per cubic meter

EUR OEL: 2 mg[Sn]/m^3 as TWA

DFG MAK: *inorganic compounds*: Not established (Section Iib); *organic compounds*: 0.1 milligram per cubic meter, inhalable fraction TWA; Peak Limitation Category II(2) [skin]; Pregnancy Risk Group D

Australia: TWA 0.1 mg[Sn]/m^3, [skin], 1993; Australia: TWA 2 milligram per cubic meter, 1993; Austria: MAK 2 milligram per cubic meter, 1999; Belgium: TWA 2 milligram per cubic meter, 1993; Denmark: TWA 2 gm/m^3, 1999; Finland: TWA 2 milligram per cubic meter, 1999; Hungary: TWA 1 milligram per cubic meter, STEL 2 milligram per cubic meter, [skin], 1993; the Netherlands: MAC-TGG 2 milligram per cubic meter, 2003; Norway: TWA 1 milligram per cubic meter, 1999; the Phillipines: TWA 2 milligram per cubic meter, 1993; Poland: TWA 2 milligram per cubic meter, 1999; Switzerland : MAK-W 2 milligram per cubic meter, KZG-W 4 milligram per cubic meter, 1999; Thailand: TWA 2 milligram per cubic meter, 1993; United Kingdom: TWA 2 mg[Sn]/m^3, STEL 4 mg[Sn]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 2 milligram per cubic meter

Several states have set guidelines or standards for tin in ambient air[60] ranging from 1.6 μ/m^3 (Virginia); to 20.0 μ/m^3 (North Dakota); to 40.0 μ/m^3 (Connecticut); to 48.0 μ/m^3 (Nevada).

1332-29-2 [tin (II) oxide], 18282-10-5 [Tin(IV) oxide (stannic oxide)],10025-69-1, Tin(II) chloride dihydrate, Tin hydroxide

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 7.6 mg[S n]/m^3

PAC-2: 85 mg[S n]/m^3

PAC-3: 510 mg[Sn]/m^3

Determination in Air: Use NIOSH Analytical Method (IV) #7300, Element; #7301; #7303; OSHA Analytical Method ID-121; ID-206.

Permissible Concentration in Water: State Drinking Water Guidelines: Minnesota 4000 μg[Sn]/L.

Routes of Entry: Inhalation of dust, eye and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Dust irritates the eyes, skin, and respiratory tract. Tin may be contaminated with toxic lead or arsenic, causing exposure to these chemicals from dust or fumes. Inorganic tin salts are irritants to the skin and mucous membranes; they may be strongly acid or basic depending on the cation or anion present. In animals: vomiting, diarrhea, paralysis with muscle twitching.

Long-Term Exposure: Exposure to dust or fumes of inorganic tin is known to cause a benign pneumoconiosis (stannosis). Tin or dust fumes can cause "spots" to appear on chest X-ray and may represent reduced lung function. This form of pneumoconiosis produces distinctive progressive X-ray changes of the lungs as long as exposure persists, but there is no distinctive fibrosis; no evidence of disability; and no special complicating factors. Because tin is so radio-opaque, early diagnosis is possible. Fumes can also cause chronic cough and may cause reduced lung function. Tin may interfere with the body's ability to absorb iron from food or vitamin pills, contributing to iron deficiency anemia.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: NIOSH lists the following tests: whole blood (chemical/metabolite), Chest X-ray; urine (chemical/metabolite). Also, see, NIOSH Analytical Method #8310, Metals in urine.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA *Up to 10 milligram per cubic meter*: Qm (APF = 25) (any quarter-mask respirator). *Up to 20 milligram per cubic meter*: 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa* (APF = 10) (any supplied-air respirator). *Up to 50 milligram per cubic meter*: Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25)* (any powered air-purifying respirator with a high-efficiency particulate filter). *Up to 100 milligram per cubic meter*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter. Click here for information on selection of N, R, or P filters); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry in to unknown concentrations or IDLH conditions*: SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SAF; PD,PP: ASCBA (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus). *Escape*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Powdered tin is combustible and a mode rate explosion risk. Color code-Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in a area isolated from flammables, combustibles, or other yellow coded materials. Color code-Green (*tin metal*): General storage may be used. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Tin must be stored to avoid contact with chlorine, bromine, bromine trifluoride; chlorine monofluoride; copper nitrate; turpentine, and potassium dioxide, since violent reactions occur. Sources of ignition, such as smoking and open flames, are prohibited where tin is used, handled, or stored in a manner that could create A potential fire or explosion hazard.

Shipping: UN3089 Metal powders, flammable, n.o.s., Hazard Class: 4.1; Labels: 4.1-Flammable solid.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Tin dust may be a combustible fire hazard. Thermal decomposition products may include oxides of metal. On small fires, *Do not use* water, halogenated, or CO$_2$ extinguishers. Smother with dry chemical agents; special powders, dry sand, dry clay, crushed limestone, sodium chloride, dry graphite, dry ground dolomite. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (2); (100).

United States Environmental Protection Agency, Toxicology of Metals, Vol. II: Tin, Report EPA-600/1-77-022, Research Triangle Park, NC, pp 405−426 (May 1977)

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 3, 82−83, New York, Van Nostrand Reinhold Co. (1981)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Tin, Trenton, NJ (April 2001).

Tin Tetrachloride T:0550

Formula: Cl$_4$Sn; SnCl$_4$

Synonyms: Libavius fuming spirit; Stannic chloride, anhydrous; Tetrachlorostannane; Tin perchloride; Tin chloride, fuming; Tin perchloride; Tin tetrachloride, anhydrous; Zinntetrachlorid (German)

pentahydrate:

CAS Registry Number: 7646-78-8; 10026-06-9 (pentahydrate)

HSDB Number: 781 (7646-78-8);

HSDB Number: 781 as stannic chloride

RTECS Number: XP8750000

UN/NA & ERG Number: UN1827 (anydrous)/137; UN2440 (pentahydrate)/154

EC Number: 231-588-9 [*Annex I Index No.*: 050-001-00-5]

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Corrosive, Suspected repro toxic hazard, Violently water reactive, Environmental hazard.

United States National Primary Drinking Water Regulations: SMCL = 250 mg[Cl$^-$]/L as Chloride

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects[194]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: C, N; Risk phrases: R14; R29; R34; R37; R52/53; Safety phrases: S1/2; S7/8; S26; S29/35; S38; S45; 61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Tin tetrachloride is a colorless fuming liquid. Molecular weight = 261; Specific gravity (H_2O:1) = 2.2 @ 20°C; Boiling point = 114°C; Freezing/Melting point = −33°C; Vapor pressure = 10 mmHg @ 10°C; Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 1 ₩. Soluble in water;

reacts violently, slowly forming hydrochloric acid. Slow reaction in cold water; fast reaction in hot water and steam.

Potential Exposure: Tin tetrachloride is used in the production of blueprints and electroconductive readings, as a bleaching agent for sugar and resin stabilizer.

Incompatibilities: Slowly forms hydrochloric acid in cold water; fast reaction in hot water and steam. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, water, turpentine, potassium, sodium, ethylene oxide; nitrates, alcohols, amines, chlorine, strong acids; strong bases. Attacks metals, rubbers and some plastics in the resence of moisture.

Permissible Exposure Limits in Air

NIOSH IDLH = 25 mg[Sn]/m^3

OSHA PEL: 2 mg[Sn]/m^3 TWA (also applies to other inorganic tin compounds (as Sn) except tin oxides)

NIOSH REL: 2 mg[Sn]/m^3 TWA (also applies to other inorganic tin compounds (as Sn) except tin oxides)

ACGIH TLV[1]: 2 mg[Sn]/m^3 TWA

EUR OEL: 2 mg[Sn]/m^3 as TWA

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 13 milligram per cubic meter

PAC-2: 150 milligram per cubic meter

PAC-3: 880 milligram per cubic meter

DFG MAK: *tin, inorganic compounds*: No numerical value established. Data may be available.

Australia: TWA 2 mg[Sn]/m^3, 1993; Austria: MAK 2 milligram per cubic meter, 1999; Belgium: TWA 2 mg[Sn]/m^3, 1993; Denmark: TWA 2 mg[Sn]/m^3, 1999; Finland: TWA 2 mg[Sn]/m^3, 1999; Hungary: TWA 1 mg[Sn]/m^3; STEL 2 mg[Sn]/m^3, [skin], 1993; Norway: TWA 2 mg[Sn]/m^3, 1999; the Phillipines: TWA 2 mg[Sn]/m^3, 1993; Poland: TWA 2 mg[Sn]/m^3, 1999; Switzerland: MAK-W 2 mg[Sn]/m^3, KZG-W 4 mg[Sn]/m^3, 1999; Thailand: TWA 2 mg[Sn]/m^3, 1993; United Kingdom: TWA 2 mg[Sn]/m^3; STEL 4 mg[Sn]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 2 mg[Sn]/m^3

Determination in Air: Filter; Acid; Inductively coupled plasma; NIOSH Analytical Method (IV) #7300, Element.

Permissible Concentration in Water: State Drinking Water Guidelines: Minnesota 4000 μg[Sn]/L.

Routes of Entry: Inhalation, eyes and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Tin tetrachloride can affect you when breathed in. Tin tetrachloride is a corrosive chemical and eye or skin contact can cause severe burns. Breathing Tin Tetrachloride can irritate the throat and bronchial tubes, causing cough and/or difficulty breathing. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: May affect the nervous system. May cause lung irritation; bronchitis may develop. Changes may occur on chest X-ray with repeated exposures.

Points of Attack: Eyes, skin, respiratory system; CNS; liver, kidneys, urinary tract; blood.

Medical Surveillance: NIOSH lists the following tests: whole blood (chemical/metabolite), Chest X-ray; urine (chemical/metabolite). Also, see, NIOSH Analytical Method #8310, Metals in urine. Before beginning employment and at regular times after that, the following are recommended. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Hemoglobin or hematocrit.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water, or milk. Do not induce vomiting. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA *Up to 10 milligram per cubic meter*: Qm (APF = 25) (any quarter-mask respirator). *Up to 20 milligram per cubic meter*: 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa* (APF = 10) (any supplied-air respirator). *Up to 50 milligram per cubic meter*: Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25)* (any powered air-purifying respirator with a high-efficiency particulate filter). *Up to 100 milligram per cubic meter*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter. Click here for information on selection of N, R, or P filters); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SAF; PD,PP: ASCBA (any supplied-air respirator that has a full face piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA breathing apparatus). *Escape*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code-White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Tin tetrachloride must be stored to avoid contact with water, alcohols, amines, chlorine, turpentine, ethylene oxide; alkyl nitrates; potassium and sodium, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from flammable and combustible materials. Keep tin tetrachloride dry and out of direct sunlight. If moisture enters containers, pressure may cause the containers to burst. Tin tetrachloride can attack some plastics, rubbers and coatings.

Shipping: UN1827 Stannic chloride, anhydrous, Hazard class: 8; Labels: 8-Corrosive material. UN2440 Stannic chloride pentahydrate, Hazard class: 8; Labels: 8-Corrosive material.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include hydrogen chloride and oxides of tin. Tin tetrachloride does not burn, but it does react violently with water. *Do not use water*. Use dry chemical or CO_2 extinguishers to extinguish surrounding fire. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers, but do not get water inside containers or on spilled tin tetrachloride as poisonous gases will be formed. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: $SnCl_4$: Pour onto sodium bicarbonate; spray with ammonium hydroxide while adding crushed ice; when reaction subsides, flush down drain.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Tin Tetrachloride, Trenton, NJ (October 1998)

Titanium T:0560

Formula: Ti (see also list of other compounds below)

Synonyms: C.P. Titanium; IMI 115; NCI-C04251; Ontimet 30; Oremet; T40; Titanate; Titanium 50A; Titanium alloy; Titanium, elemental; VT 1

Other titanium compounds: titanium aluminide (TiAl) 39410-63-4; titanium boride (TiB2) 12045-63-5); titanium carbide (TiC) 12070-08-5; titanium disulfide (Ti S_2) 12039-13-3;titanium(III) fluoride (TiF_3)13470-08-1; titanium monoxide (TiO) 12137-20-1; titanium sulfate (TiO_5S) 13825-74-6; titanium trichloride ($TiCl_2$) 7705-07-9; titanium tetrachloride see T:0580; titanium dioxide see T:0570

CAS Registry Number: 7440-32-6 (metal); 7704-98-5 [hydride (Ti H_2)]

HSDB Number: 868 (metal)

RTECS Number: XR1700000 (elemental)

UN/NA & ERG Number: UN2546 (titanium powder, dry;)/135; UN1352 (titanium powder, wetted with not <25% water)/170; UN2878(titanium sponge granule or powders)/170; UN1871 (titanium hydride)/170; UN2441/135 titanium trichloride, pyrophoric; titanium trichloride mixture, pyrophoric; UN2869157 titanium trichloride mixture; 3174135 titanium disulfide/disulphide

EC Number: 231-142-3

Regulatory Authority and Advisory Information

Hazard Alert: (powder) Pyrophoric hazard, Self-heating, Highly flammable, Explosion danger, Possible risk of forming tumors, Suspected reprotoxic hazard.

European GHS Class (powder): Catches fire spontaneously if exposed to air H250; Self-heating; may catch fire: H251; Self-heating in large quantities; may catch fire:H252

Hazard Symbols, Risk & Safety statements: Hazard Symbol: F, Xi; Risk phrases: R11; R17; R20/21/22; R36/37/38 R62; Safety phrases: S2; S6; S16; S21; S26; S27; S33; S36/37/39; S43 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): Nonwater polluting agent, particle size >1 mm.

Description: Titanium is a silvery metal or dry, dark-gray amorphous, lustrous powder. Molecular weight = 47.9; Specific gravity (H_2O:1) = 4.51; Boiling point = 3260°C−3287°C; Freezing/Melting point = 1668°C −1675°C; Autoignition temperature = 1200°C (solid); 480°C (powder in air). Hazard Identification (based on NFPA-704 M Rating System) (powder): Health 1, Flammability 3, Reactivity 1; (solid metal) Health 1, Flammability 0, Reactivity 0. It is brittle when cold and malleable when hot. The dry powder is easily ignited, and burns with an intense flame. Ignition temperature of dust cloud = 460°C; Minimum Explosive concentration = 0.45 oz/ft^3[USBM]. Relative explosion hazard of dust: Severe. Insoluble in water. The most important minerals containing titanium are ilmenite, rutile, perovskite, and titanite or sphene. Insoluble in water.

Potential Exposure: Titanium metal, because of its low weight, high strength, and heat resistance, is used in the aerospace and aircraft industry as tubing, fittings, fire walls; cowlings, skin sections; jet compressors; and it is also used in surgical appliances. It is used, too, as control-wire casings in nuclear reactors, as a protective coating for mixers in the pulp-paper industry and in other situations in which protection against chlorides or acids is required; in vacuum lamp bulbs and X-ray tubes; as an addition to carbon and tungsten in electrodes and lamp filaments; and to the powder in the pyrotechnics industry. It forms alloys with iron, aluminum, tin, and vanadium, of which ferrotitanium is especially important in the steel industry. Other titanium compounds are utilized in smoke screens, as mordants in dyeing; in the manufacture of cemented metal carbides; as thermal insulators; and in heat resistant surface coatings in paints and plastics.

Incompatibilities: Powder and dust may ignite spontaneously in air. Violent reactions occur on contact with water, steam, halocarbons, halogens, and aluminum. The dry powder is a strong reducing agent; Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC) Ver. 29[138]

7440-32-6, titanium metal, 12045-63-5, titanium boride; 12070-08-5, titanium carbide; 12137-20-1, titanium(II) oxide; *z-0081, titanium based alloys (titanium compounds)*

PAC-1: 30 milligram per cubic meter

PAC-2: 330 milligram per cubic meter

PAC-3: 2000 milligram per cubic meter

7704-98-5, titanium hydride

PAC-1: 1.2 milligram per cubic meter

PAC-2: 13 milligram per cubic meter

PAC-3: 79 milligram per cubic meter

13470-08-1, titanium(III) fluoride

PAC-1: 14 milligram per cubic meter

PAC-2: 150 milligram per cubic meter

PAC-3: 920 milligram per cubic meter

Determination in Air: Filter; Acid; Hydride generation atomic absorption spectrometry; NIOSH Analytical Method (IV) #7900. See also #7300, Elements.

Permissible Concentration in Water: No criteria set, but EPA[32] has suggested a permissible ambient goal for titanium compounds (as Ti) of 83 μg/L, based on health effects.

Routes of Entry: Inhalation of dust or fume, eyes.

Harmful Effects and Symptoms

Short-Term Exposure: Titanium can affect you when breathed in. Contact may irritate the eyes. Breathing titanium may irritate the throat and air passages with cough and phlegm.

Long-Term Exposure: Repeated exposure may cause chronic bronchitis and possibly emphysema. There is limited evidence that titanium may damage the developing fetus.

Points of Attack: Lungs.

Medical Surveillance: Preemployment and periodic physical examinations should give special attention to lung disease, especially if irritant compounds are involved. Chest X-ray should be included in both examinations and pulmonary function evaluated periodically. Smoking history should be taken. Careful attention should be given to the eyes and the skin.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures to titanium, use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator equipped with particulate (Dust/fume/mist) filters. More protection is provided by a full facepiece respirator than by a half-mask respirator, and even greater protection is provided by a powered-air purifying respirator. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Titanium powder is a severe explosion risk. (1) Color code-Red Stripe: Flammability Hazard (4.2): Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 meters or a 1-hour fire wall from flammable or reactive materials. Store flammable solids (spontaneously combustible) up to maximum allowable quantity per control area in an approved flammable storage area. Do not store in a basement. (2) Color code-Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in a area isolated from flammables, combustibles, or other yellow coded materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Titanium must be stored to avid contact with water, steam, halocarbons, halogens and aluminum, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where titanium is used, handled, or stored in a manner that could create A potential fire or explosion hazard. Use only nonsparking tools and equipment, especially when opening and closing containers of titanium. Wherever titanium is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN2546 Titanium powder, dry, Hazard Class: 4.2; Labels: 4.2-Spontaneously combustible material. UN1352 Titanium powder, wetted with not $<$ 25% water (a visible excess of water must be present) (a) mechanically produced, particle size $<$3 microns; (b) chemically produced, particle size $<$840 microns, Hazard Class: 4.1; Labels: 4.1-Flammable solid. UN2878 Titanium sponge granules or Titanium sponge powders, Hazard Class: 4.2; Labels: 4.2-Spontaneously combustible material. UN1871 titanium hydride, Hazard Class: 4.1; Labels: 4.1-Flammable solid.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Use HEPA vacuum or wet method to reduce dust during cleanup. Do not dry sweep. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Titanium is a flammable solid; dust and powders are an explosion hazard. Thermal decomposition products may include toxic metal oxides of titanium. *Do not use water* on burning titanium; this can cause explosion. Ordinary extinguishers are often ineffective. Use special extinguishers designed for metal fires. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (170); (138); (100).

United States Environmental Protection Agency, Toxicology of Metals, Vol. II: Titanium, pp 427−441, Report EPA-600/1-77-022, Research Triangle Park, NC (May 1977)

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 3, 83 (1981) and 4, No. 3, 27−29 (1984)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Titanium, Trenton, NJ (December 2000)

Titanium Dioxide T:0570

Formula: O_2Ti; TiO_2
Synonyms: A-FIL cream; Anatase; Atlas white titanium; Austiox; Bayeritian; Bayertitan; Brookite; Calcotone white T; C.I. 77891; C.I. Pigment white 6; Cosmetic white C47-5175; C-Weiss 7 (German); Flamenco; Hombitan; Horse head A-410; KH 360; Kronos titanium dioxide; Levanox white RKB; NCI-C04240; Rayox; Runa RH20; Rutile; Tiofine; Tioxide; Titanium oxide; Tronox Unitane 0-110; Zopaque 1700 white
CAS Registry Number: 13463-67-7; *(alt.)* 1309-63-3
HSDB Number: 869
RTECS Number: XR2275000
UN/NA & ERG Number: Not subject to regulation.
EC Number: 236-675-5
Regulatory Authority and Advisory Information
Carcinogenicity: IARC: Human Inadequate Evidence; Animal Sufficient Evidence, *possibly carcinogenic to humans*, Group 2B; NCI: Carcinogenesis Bioassay (feed); no evidence: mouse, rat; NIOSH: Potential occupational carcinogen. United States Environmental Protection Agency Gene-Tox Program, Negative: Carcinogenicity-mouse/rat; Cell transformation-SA7/SHE.
Hazard Alert: Possible risk of forming tumors, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction), FDA-over the counter drug.
Hazard Symbols, Risk & Safety statements: Hazard Symbol: T, Xn; Risk phrases: R10; R20/21/22; R36 /37/38; R62; Safety phrases: S2; S25; S26; S36/37; S41 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): Non hazard to water.
Description: Ttitanium dioxide is an odorless white powder. Molecular weight = 79.9; Specific gravity (H_2O:1) = 4.2 @ 25°C; Boiling point = 2500°C−3000°C; Freezing/Melting point = (decomposes) 1830°C−1850°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 0, Reactivity 0. Insoluble in water.
Potential Exposure: Titanium dioxide is a white pigment used as a pigment in paint; in the rubber, plastics, ceramics, paint, and varnish industries, in dermatological preparations; and is used as a starting material for other titanium compounds; as a gem; in curing concrete; and in coatings for welding rods. It is also used in paper and cardboard manufacture.
Incompatibilities: Titanium dioxide is incompatible with strong oxidizers and strong acids. Violent or incandescent reactions may occur with metals (e.g., aluminum, calcium, magnesium, potassium, sodium, zinc, and lithium)[101].
Permissible Exposure Limits in Air
NIOSH IDLH = 5000 milligram per cubic meter
OSHA PEL: 15 milligram per cubic meter, total dust TWA
NIOSH REL: Potential occupational carcinogen; Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A
ACGIH TLV[1]: 10 milligram per cubic meter TWA, not classifiable as a human carcinogen
Protective Action Criteria (PAC) Ver. 29[138]
PAC-1: 30 milligram per cubic meter
PAC-2: 330 milligram per cubic meter
PAC-3: 2000 milligram per cubic meter
DFG MAK: 1.5 milligram per cubic meter, respirable fraction (previously "fine dust"); Pregnancy Risk Group C
Arab Republic of Egypt: TWA 15 milligram per cubic meter, 1993; Australia: TWA 10 milligram per cubic meter, 1993; Austria: MAK 6 milligram per cubic meter, 1999; Belgium: TWA 10 milligram per cubic meter, 1993; Denmark: TWA 6 mg[Ti]/m^3, 1999; France: VME 10 milligram per cubic meter, 1999; Norway: TWA 5 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 10 milligram per cubic meter, 2003; Poland: MAC (TWA) 10 mg [Ti]/m^3; MAC (STEL) 30 mg[Ti]/m^3, 1999; Sweden: NGV 5 milligram per cubic meter, 1999; Turkey: TWA 15 milligram per cubic meter, 1993; United Kingdom: TWA 10 milligram per cubic meter, (total inhalable dust); TWA 4 milligram per cubic meter, (respirable dust), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Russia have set limits for ambient air in residential areas at 0.5 milligram per cubic meter on a momentary basis. Several states have set guidelines or standards for titanium dioxide in ambient air[60] ranging from 0.13−0.79 μ/m^3 (Montana); to 17.86 μ/m^3 (Kansas); to 80.0 μ/m^3 (Virginia); to 300.0 μ/m^3 (Connecticut).
Determination in Air: Use NIOSH II(3), Method #S385; #7300, Elements by ICP.
Permissible Concentration in Water: No criteria set, but EPA[32] has suggested a permissible ambient goal for titanium compounds (as Ti) of 83 μg/L, based on health effects.
Routes of Entry: Inhalation of dust.
Harmful Effects and Symptoms
Short-Term Exposure: Inhalation can cause irritation of the eyes and respiratory tract, causing cough and phlegm. Irritates the skin.
Long-Term Exposure: High exposures may cause lung irritation; bronchitis may develop. Continued exposure may result in emphysema, lung scarring; lung fibrosis; and tumors. A potential occupational carcinogen.
Points of Attack: Respiratory system. Cancer site in animals: lung tumors.
Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity

properties, the exposure level, length of exposure, and the route of exposure. Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: chest X-ray should be considered.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration*: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). Escape: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code-Green: General storage may be used. Prior to working with this chemical, personnel should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Store in tightly closed containers in a cool, well-ventilated area away from strong acids and other metals. Where possible, automatically transfer material from other storage containers to process containers.

Shipping: Not subject to transport regulation.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Thermal decomposition products may include oxides of metal. Use any extinguishing agent suitable for surrounding fires. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Land fill.

References

(31); (173); (101); (138); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 3, 84 (1981) and 3, No. 1, 85–89 (1983)

New York State Department of Health, *Chemical Fact Sheet*: Titanium Dioxide, Bureau of Toxic Substance Assessment, Albany, NY (March 1986 and Version 2)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Titanium Dioxide, Trenton, NJ (May 2006

Titanium Tetrachloride T:0580

Formula: Cl_4Ti; $TiCl_4$

Synonyms: FM (military designation); Tetrochlorure de titane (French); Tetrachlorotitanium; Titane (tetrachlorure de) (French); Tetracloruro de titanio (Spanish); Titanium chloride (TICL4) (T-4)-; Titantetrachlorid (German); Titanium(IV) chloride

CAS Registry Number: 7550-45-0

HSDB Number: 870

RTECS Number: XR1925000

UN/NA & ERG Number: (PIH) UN1838/137 titanium tetrachloride (water reactive)

EC Number: 231-441-9 [*Annex I Index No.*: 022-001-00-5]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 2500 (1.00% concentration); *Theft hazard* 45 (≥13.33% concentration); Sabotage/ Contamination Hazard : A placarded amount (commercial grade).

Hazard Alert: Poison inhalation hazard, Violent reaction with hot water or steam, Corrosive to eyes and respiratory tract, Known catalytic activity.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 2500 lb (1135 kg)

United States National Primary Drinking Water Regulations: SMCL = 250 mg$[Cl^-]$/L as Chloride

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 1000 lb (454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: C; Risk phrases: R14; R34; Safety phrases: S1/2; S7/8; S26; S36/37/39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Titanium tetrachloride is a noncombustible, colorless to light yellow liquid that fumes in air. Penetrating acrid odor. Molecular weight = 189.7; Specific gravity (H_2O:1) = 1.7 @ 20°C; Boiling point = 136.5°C; Freezing/ Melting point = −24°C. Reacts with water. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 2. ₩ Decomposes in water; if the water is hot or steam, it may explode.

Potential Exposure: Used in the manufacture of titanium salts; mordant dye; titanium pigments; and used as a chemical intermediate for titanium metal; titanium dioxide; as an agent in smoke screens; polymerization catalyst; and iridescent agent in glass and pearl manufacturing.

Incompatibilities: Violent reaction with water or steam, releasing heat and hydrogen chloride fumes. Contact with moist air releases hydrogen chloride. Attacks many metals in presence of moisture.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)* Ver. 29[138]

PAC-1: **0.65**$_{\mathbf{E}}$ ppm

PAC-2: **1.0**$_{\mathbf{A}}$ ppm

PAC-3: **5.7**$_{\mathbf{A}}$ ppm

*ERPG [Emergency Response Planning Guidelines] are marked with a subscript "**E.**"

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: This compound is a highly corrosive to the eyes and respiratory tract. Acute irritant to the skin, eyes, mucous membranes and the respiratory tract. It is capable of causing death or permanent injury due to exposures encountered in normal use. Even short contact may lead to eye inflammation which may result in corneal opacities. Inhalation symptoms include congestion and irritation of upper respiratory tract, coughing, burning of the throat; headache and weakness. High exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Prolonged exposure to low concentrations may cause cough and pneumonia. Ingestion causes mouth, throat and gastrointestinal tract irritation, nausea, vomiting, cramps and diarrhea.

Long-Term Exposure: May cause respiratory problems; lung damage; bronchitis may develop.

Points of Attack: Respiratory system, eyes.

Medical Surveillance. Lung function tests. Eye examination. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water, or milk. Do not induce vomiting. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/ manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid unless full

facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Poison inhalation chemical (PIH); check oxygen content prior to entering storage area. Color code-White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store away from possible contact with all forms of moisture. Store in tightly closed containers in a cool, well ventilated area. Metal containers involving the transfer of this chemical should be grounded and bonded. Where possible, automatically pump liquid from drums or other storage containers to process containers.

Shipping: UN1838 Titanium tetrachloride, Hazard class: 6.1; Labels: 6.1-Poison Inhalation Hazard, 8-Corrosive material, Inhalation Hazard Zone B.

Spill Handling:

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

when spilled on land

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)

when spilled in water

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.3/0.5
Night 0.4/0.6

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)
Day 0.3/0.5
Night 1.1/1.8

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Not flammable. Thermal decomposition products may include hydrogen chloride and oxides of metal. For small fires, use dry chemical or carbon dioxide. For large fires, flood fire area with water from a distance. Do not get solid streams of water on spilled material. Move container from fire area if this can be done without risk. Cool containers exposed to flames with water until well after fire is out. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Titanium Tetrachloride, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

o-Tolidine T:0590

Formula: $C_{14}H_{16}N_2$; $H_2NC_6H_3(CH_3)\text{-}C_6H_3(CH_3)NH_2$

Synonyms: Benzidine, 3,3′-dimethyl-; Bianisidine; (1,1′-Biphenyl)-4,4′-diamine, 3,3′-dimethyl-; 4,4′-Bi-*o*-toluidine; C.I. 37230; C.I. azoic diazo component 113; (4,4′-

Diamine)-3,3′-dimethyl(1,1′-biphenyl); 4,4′-Diamino-3,3′-dimethylbiphenyl; Diaminoditolyl; 3,3′-Dimethylbenzidin (German); 3,3′-Dimethylbenzidine; 3,3′-Dimethyl-(1,1′-biphenyl)-4,4′-diamine; 3,3′-Dimethyl-4,4′-biphenyldiamine; 3,3′-Dimethyl-4,4′-diaminobiphenyl; 3,3’-Dimethyl-4,4′-diphenyldiamine; 3,3′-Dimethyldiphenyl-4,4′-diamine; 4,4′-Di-*o*-toluidine; Fast dark Blue base R; 3,3′-Me thylphenyl-4,4′-diamine; *o*-Tolidin (German); 3-Tolidin (German); *o*-Tolidina (Spanish); 2-Tolidina (Spanish); *o*,*o*′-Tolidine; 2-Tolidine; 3,3′-Tolidine; Tolidine

CAS Registry Number: 119-93-7

HSDB Number: 1640

Dyes based on o-tolidine for reference: 612-82-8 (3,3′-dimethylbenzidine dihydrochloride); 41766-75-0 (3,3′-Dimethylbenzidine dihydrofluoride); 992-59-6 [Disodiumotolidinediazobis(1-naphthylamine-4-sulfonate]

RTECS Number: DD1225000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154; UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 210-322-5 [*Annex I Index No.*: 612-081-00-5] (*4,4′-bi-o-toluidine dihydrochloride*)
[*Annex I Index No.*: 612-041-00-7]

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen; IARC: Human No Adequate Data; Animal Sufficient Evidence, *possibly carcinogenic to humans*, Group 2B, 1987; NIOSH: Potential occupational carcinogen. United States Environmental Protection Agency Gene-Tox Program, Positive: Carcinogenicity-mouse/rat; Positive: Cell transformation-RLV F344 rat embryo; Positive: Mammalian micronucleus; Histidine reversion-Ames test; Inconclusive: *In vitro* UDS-human fibroblast.

California Proposition 65 Chemical[102]: Cancer 1/1/1988; 4/1/1992, as dihydrochloride.

Hazard Alert: Poison, Combustible, Possible risk of forming tumors, Suspected reprotoxic hazard, Environmental hazard.

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U095

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazardous to aquatic life or environment, with possible long-lasting effects[293]. Toxic to aquatic life with long-lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T, N; Risk phrases: R45; R10; R 22; R50/53; Safety phrases: S29/35; S41; S45; S53; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: o-Tolidine is a white to reddish crystal or powder. Darkens on exposure to air. Often used in paste or wet cake form. Used as a basis for many dyes. Molecular weight = 212.3; Boiling point = 264.9°C−131°C; Freezing/Melting point = 131°C; Flash point = 243.8°C; Autoignition temperature = 526°C. Explosive limits: LEL = 16,000 ppm, UEL: unknown; Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 0. Slightly soluble in water; solubility = 0.1% @ 25°C.

Potential Exposure: Over 75% of *o*-tolidine is used as a dye and as an intermediate in the production of rubber products, dyestuffs, pigments and pesticides. Approximately 20% of *o*-tolidine is used in the production of polyurethane-based high-strength elastomers, coatings, and rigid plastics. *o*-Tolidine has also been used in small quantities in chlorine test kits by water companies and swimming pool owners. Used as a laboratory agent to detect blood.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, strong reducing agents.

Permissible Exposure Limits in Air

OSHA PEL: Cancer suspect agent. Exposures of workers to this chemical is to be controlled through the required use of engineering controls, work practices; and personal protective equipment, including respirators. See 29 CFR1910.1003-1910.1016 for specific details of these requirements.

NIOSH REL: Carcinogen: 0.02 milligram per cubic meter [60 min.] Ceiling Concentration; [skin]; Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A & C. *Note*: OSHA and NIOSH concluded that benzidine and benzidine-based dyes were potential occupational carcinogens and recommended that worker exposure be reduced to the lowest feasible level. OSHA and NIOSH further concluded that *o*-tolidine and *o*-dianisidine [119-90-4] (and dyes based on these chemicals) may present a cancer risk to workers and should be handled with caution and exposure minimized.

ACGIH TLV[1]: [skin]; confirmed animal carcinogen with unknown relevance to humans.

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 0.0018 milligram per cubic meter

PAC-2: 0.02 milligram per cubic meter

PAC-3: 36 milligram per cubic meter

No Protective Action Criteria (PAC) available for dihydrochloride.

DFG MAK: Carcinogen Category 2

Australia [skin], carcinogen, 1993; Austria: carcinogen, 1999; Finland: carcinogen, 1999; France: carcinogen, 1993; Switzerland: carcinogen, 1999; United Kingdom: carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV:

confirmed animal carcinogen with unknown relevance to humans.

Guidelines or standards which have been set for *o*-tolidine in ambient air[60] range from zero (North Dakota); to 20.0 μ/m^3 (Virginia).

Determination in Air: OSHA Analytical Method #ID-71; NIOSH Analytical Method (IV) #5013, Dyes.

Determination in Water: Octanol-water coefficient: Log $K_{ow} = 2.34$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: *o*-Tolidine can affect you when breathed in and can rapidly enter the body through the skin. High exposure can irritate the nose and throat.

Long-Term Exposure: *o*-Tolidine may affect the kidneys and bladder; a known carcinogen of the bladder.

Points of Attack: Eyes, respiratory system; liver, kidneys. Cancer site in animals: liver, bladder, and mammary gland tumors.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Before employment and every six months thereafter, the following are recommended to detect bladder cancer at an early stage: Kidney function tests. Urine cytology test (a test for abnormal cells in urine).

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration*: SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus) *Escape*: GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister having an N100, R100, or P100 filter].

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from direct light. Sources of ignition, such as smoking and open flames, are prohibited where 3,3′-dimethylbenzidine is used, handled, or stored in a manner that could create A potential fire or explosion hazard. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: UN2811: *Isolation Distance, Spill*: 25meters/75 feet.(NJ). Isolation Distance, Fire: 800 meters/0.5 miles[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; water spray; or extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve in flammable solvent and spray into firebox of an incinera tor equipped with afterburner and scrubber[22]. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(109); (102); (31); (173); (101); (138); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 5, No. 3, 75−77 (1985)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: 3,3′-Dimethylbenzidine, Trenton, NJ (January 2001).

Toluene T:0600

Formula: C_7H_8; $C_6H_5CH_3$

Synonyms: Antisal 1A; Benzene, methyl-; Black out black; CP 25; Methacide; Methane, phenyl-; Methylbenzene; Methylbenzol; NCI-C07272; Phenylmethane; Tolueno (Spanish); Toluol; Tolu-sol

CAS Registry Number: 108-88-3

HSDB Number: 131

RTECS Number: XS5250000

UN/NA & ERG Number: UN1294/130

EC Number: 203-625-9 [*Annex I Index No.*: 601-021-00-3]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal No Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1999; EPA: Inadequate Information to assess carcinogenic potential; NCI: Carcinogenesis Studies, inhalation; no evidence: mouse, rat. United States Environmental Protection Agency Gene-Tox Program, Negative: Cell transformation-SA7/SHE; *In vitro* SCE-human; Negative: Sperm morphology-mouse; Inconclusive: *E coli polA* without S9.

California Proposition 65 Developmental/Reproductive toxin 1/1/1991; (female) 8/7/2009

Hazard Alert: Highly flammable, Possible risk of forming tumors, Suspected reprotoxic hazard, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction).

List II, DEA chemical code 6594 (Title 21 CFR1310.02).

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

United States National Primary Drinking Water Regulations: MCLG = 1 mg/L; MCL = 1 mg/L.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR 401.15

Section 307 Toxic Pollutants; 40CFR423, Appendix A, Priority Pollutants.

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U220

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.080; Nonwastewater (mg/kg), 10

RCRA 40CFR264, appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8020 (2); 8240 (5)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 1000 lb (454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects[293]. Toxic to aquatic life with long-lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: F, Xn; Risk phrases: R11; R20/21/22; R36/37/38; R48/20; R62; R63; R65; R67; Safety phrases: S2; S21; S36/37; S46; S62 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Toluene is a clear, colorless, noncorrosive liquid with a sweet, pungent, benzene-like odor. The Odor Threshold in air is variously given as 0.17 ppm, [41] 2.9 ppm (NJ) and 8 ppm (EPA). The Odor Threshold in water is 0.04−1.0 mg/L. Molecular weight = 92.1; Specific gravity (H_2O:1) = 0.86; Boiling point = 111°C; Freezing/Melting point = −95°C; Vapor pressure = 21 mm Hg @ 25°C; 7.5 mmHg @ 1.5°C[138]; Flash point = 4°C (cc); Autoignition temperature = 480°C. Explosive limits: LEL = 1.1%; UEL: 7.1%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 3, Reactivity 0. Insoluble in water.

Potential Exposure: Toluene is used as an industrial chemical, chemical intermediate; solvent, and emulsifier; may be encountered in the manufacture of benzene. It is also used as a chemical feed for toluene diisocyanate, phenol, benzyl and benzoyl derivatives; benzoic acid; toluene sulfonates; nitrotoluenes, vinyltoluene, and saccharin; as a solvent for paints and coatings; or as a component of automobile and aviation fuels.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Violent reaction with mixtures of nitric and sulfuric acid.

Permissible Exposure Limits in Air

NIOSH IDLH = 500 ppm

Conversion factor: 1 ppm = 3.77 milligram per cubic meter @ 25°C & 1 atm

Odor threshold = variously given as 0.17 ppm, [41] 2.9 ppm[70] and 8 ppm[72].

OSHA PEL: 200 ppm/754 milligram per cubic meter Ceiling Concentration; 300 ppm/500 ppm [10-min. maximum peak per 8-hour shift]

NIOSH REL: 100 ppm/375 milligram per cubic meter TWA; 150 ppm/560 milligram per cubic meter STEL

ACGIH TLV[1]: 20 ppm/75 milligram per cubic meter TWA [skin]. BEI; 0.5 mg[*o*-cresol]/L in urine/end-of-shift; 1.6[hippuric acid]g/L creatinine in urine/end-of-shift; 0.05 mg[toluene]/L in blood, prior to last shift of workweek., not classifiable as a human carcinogen.

Protective Action Criteria (PAC)* Ver. 29[138]

PAC-1: $\mathbf{67_A}$ ppm

PAC-2: $\mathbf{560_A}$ ppm

PAC-3: $\mathbf{3700_A}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

DFG MAK : 50 ppm/190 milligram per cubic meter TWA; Peak Limitation Category II(4) [skin], Pregnancy Risk Group: C; BAT:0.1 mg[toluene]/L in blood/end-of-shift; 0.3 mg

[*o*-cresol]/L in urine/end-of-shift, for long-term exposure, after several shifts. Australia: TWA 100 ppm (375 milligram per cubic meter), STEL 150 ppm, 1993; Austria: MAK 100 ppm (380 milligram per cubic meter), 1999; Belgium: TWA 100 ppm (377 milligram per cubic meter), STEL 150 ppm (565 milligram per cubic meter), 1993; Denmark: TWA 35 ppm (130 milligram per cubic meter), [skin], 1999; Finland: TWA 100 ppm (375 milligram per cubic meter), STEL 150 ppm, [skin], 1999; France: VME 100 ppm (375 milligram per cubic meter), VLE 150 ppm (550 milligram per cubic meter), 1999; Hungary: TWA 100 milligram per cubic meter, STEL 300 milligram per cubic meter, [skin], 1993; the Netherlands: MAC-TGG 150 milligram per cubic meter, 2003; Norway: TWA 25 ppm (94 milligram per cubic meter), 1999; the Phillipines: TWA 100 ppm (375 milligram per cubic meter), 1993; Poland: MAC (TWA) 100 milligram per cubic meter; MAC (STEL) 350 milligram per cubic meter, 1999; Russia: TWA 100 ppm, STEL 50 milligram per cubic meter, 1993; Sweden: NGV 50 ppm (200 milligram per cubic meter), TKV 100 ppm (400 milligram per cubic meter), [skin], 1999; Switzerland: MAK-W 50 ppm (190 milligram per cubic meter), KZG-W 250 ppm (950 milligram per cubic meter), 1999; Thailand: TWA 200 ppm, STEL 300 ppm, 1993; Turkey: TWA 200 ppm (750 milligram per cubic meter), 1993; United Kingdom: TWA 50 ppm (191 milligram per cubic meter), STEL 150 ppm, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a hum an carcinogen. Russia[35,43] has also set a MAC for ambient air in residential areas of 0.6 milligram per cubic meter, both on a momentary and a daily average basis. Several states have set guidelines or standards for toluene in ambient air[60] ranging from 0.05 milligram per cubic meter (Massachusetts); to 1.0 milligram per cubic meter (Arizona); to 0.4−2.0 milligram per cubic meter (Rhode Island); to 1.875 milligram per cubic meter (Indiana); to 3.75−5.60 milligram per cubic meter (North Dakota); to 6.0 milligram per cubic meter (Virginia); to 7.5 milligram per cubic meter (Connecticut, New York and South Dakota); to 8.929 milligram per cubic meter (Nevada); to 4.7−56.0 milligram per cubic meter (North Carolina).

Determination in Air: Use NIOSH Analytical Method #8002, Toluene in blood; #1500 Hydrocarbons, (BP 36°C−126°C), #1501, Hydrocarbons, aromatic, #4000, Toluene (passive); OSHA Analytical Method #111

Permissible Concentration in Water: Safe Drinking Water Act (47FR 9352): MCL, 1.0 mg/L; MCLG, 1.0 mg/L. Federal Drinking Water Standards: EPA 1000 μg/L; Federal Drinking Water Guidelines: EPA 1000 μg/L; State Drinking Water Standards: California 150 μg/L; State Drinking Water Guidelines: Arizona 2000 μg/L; Maine 1400 μg/L; Minnesota 1000 μg/L.

Determination in Water: Inert gas purge followed by gas chromatography and photoionization detection (EPA Method 602) or gas chromatography plus mass spectrometry (EPA Method 624). Octanol-water coefficient: Log $K_{ow} = 2.7$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation of vapor, percutaneous absorption of liquid, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes and respiratory tract. Causes CNS depression. High levels of exposure may cause fatigue, weakness, confusion, euphoria, dizziness, headache, dilated pupils; lacrimation (discharge of tears); nervousness, muscle fatigue, insomnia, paresthesia; cardiac dysrhythmia; unconsciousness and death may occur. *Inhalation*: 100 ppm exposure can cause dizziness, drowsiness and hallucinations. 100−200 ppm can cause depression; 200−500 ppm can cause headaches; nausea, loss of appetite; loss of energy; loss of coordination and coma. In addition to the above, death has resulted from exposure to 10,000 ppm for an unknown time. *Skin*: Can cause dryness and irritation. Absorption may cause or increase the severity of symptoms listed above. *Eyes*: Can cause irritation @ 300 ppm. *Ingestion*: Can cause a burning sensation in the mouth and stomach, upper abdominal pain; cough, hoarseness, headache, nausea, loss of appetite; loss of energy; loss of coordination; and coma.

Long-Term Exposure: Nervous system, kidney or liver problems. Repeated or prolonged contact with skin may cause dermatitis; drying, cracking, itching, and skin rash. May cause liver, kidney, and brain damage; decreased learning ability; psychological disorders. Levels below 200 ppm may produce headache, tiredness and nausea. From 200–750 ppm symptoms may include insomnia, irritability, dizziness, some loss of memory; cause heart palpitations and loss of coordination. Blood effects and anemia have been reported but are probably due to contamination by benzene.

Points of Attack: Eyes, skin, respiratory system; CNS; liver, kidneys. May affect the reproductive system.

Medical Surveillance: Pregnant women should avoid contact. Employees should be notified by a physician that this chemical may affect the reproductive system. In addition to comprehensive initial medical and work histories emphasizing reproductive experience and menstrual history, patient should have physical examination and testing of genitourinary tract, sperm count, motility and morphology. If required, other tests, such as serum testosterone, serum follicle-stimulating hormone (FSH), and serum lutenizing hormone (LH), may be indicated. Whole blood (chemical/metabolite); whole blood (chemical/metabolite), end-of-shift; whole blood (chemical/metabolite), end-of-workweek; whole blood (chemical/metabolite), prior-to-last-shift-of-workweek, expired air, Expired Air, During Exposure; urine (chemical/metabolite). For those with frequent or potentially high exposure (half the TLV or greater, or significant skin contact), the following is recommended before beginning work and at regular times after that: Urinary hippuric acid excretion (at the end-of-shift) as an index of overexposure. If symptoms develop or overexposure is suspected, the following may be useful: exam of the nervous system. Liver and kidney function tests, and evaluation for renal tubular acidosis. CBC.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. *Note to Physician*: Exposure to toluene at levels greater than 200 ppm may result in hippuric acid levels above 5 gm/L urine. After elevated exposure, toluene may also be detected in blood.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Viton/Neoprene, Teflon, Viton/chlorobutyl, and Silvershield, are recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *500 ppm*: CcrFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted acid gas canister]; or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive pressure mode). *Escape*: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code-Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Toluene must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine), since violent reactions occur. Protect storage containers from physical damage. Sources of ignition, such as smoking and open flames, are prohibited where toluene is used, handled, or stored in a manner that could create A potential fire or explosion hazard. Metal containers involving the transfer of 5 gallons or more of toluene should be grounded and bonded. Drums must be equipped with self-closing, valves, pressure vacuum bungs; and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of toluene.

Shipping: UN1294 Toluene, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (173); (101); (138); (2); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Toluene, Washington, DC (1979)

United States Environmental Protection Agency, Toluene: Ambient Water Quality Criteria, Washington, DC (1980)

National institute for Occupational Safety and Health (NIOSH), "Criteria for a Recommended Standard: Occupational Exposure to Toluene," NIOSH Document Number 73-11023, Cincinnati OH (1973)

United States Environmental Protection Agency, Toluene, Health and Environmental Effects Profile No. 160, Washington, DC, Office of Solid Waste (April 30, 1980)

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 2, No. 6, 83−87 (1982), 5, No. 5, 94−99 (1985) and 7, No. 5, 2−14 (1987)

United States Public Health Service, "Toxicological Profile for Toluene," Atlanta, Georgia, agency for Toxic Substance and Disease Registry (December 1988)

New York State Department of Health, *Chemical Fact Sheet*: Toluene, Bureau of Toxic Substance Assessment, Albany, NY (March 1986 and Version 2)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Toluene, Trenton, NJ (August 1998

Toluene-2,4-diamine & Toluenediamine Isomers T:0610

Formula: $C_7H_{10}N_2$; $H_3CC_6H_3(NH_2)_2$

Synonyms: 3-Amino-*p*-toluidine; 5-Amino-*o*-toluidine; Azogen developer H; 1,3-Benzenediamine, 4-methyl; Benzofur MT; C.I. 76035; C.I. Oxidation base; C.I. Oxidation base 20; C.I. Oxidation base 200; C.I. Oxidation base 35; Developer B; Developer DB; Developer DBJ; Developer H; Developer MC; Developer MT; Developer MT-CF; Developer MTD; Developer T; 1,3-Diamino-4-methylbenzene; Diaminotoluene; 2,4-Diaminotoluene; 2,4-Diamino-1-toluene; 2,4-Diaminotolueno (Spanish); 2,4-Diaminotoluol; Eucanine GB; Fouramine; Fouramine J; Fourrine 94; Fourrine M; 4-Methyl-1,3-benzenediamine; 4-Methyl-*m*-phenylenediamine; MTD; Nako TMT; NCI-C02302; Pelagol grey J; Pelagol J; Pontamine developer TN; Renal MD; TDA; Tetral G; 2,4-Tolamine; *m*-Toluenediamine; Toluene-2,4-diamine; *m*-Toluylenediamine; *m*-Tolylenediamine; 2,4-Tolylenediamine; 4-*m*-Toly lenediamine; Zoba GKE; Zogen developer H

Mixed isomers: Benzenediamine, *ar*-methyl-; Diaminotoluene; Diaminotolueno (Spanish); Methylphenylene diamine; Toluendiamina (Spanish); Toluene-*ar,ar′*-diamine; Toluene-*ar,ar*-diamine; Toluenediamine; Tolylenediamine

CAS Registry Number: 95-80-7 (to luene-2,4-diamine); 25376-45-8 (toluenediamine); *(alt.)* 26764-44-3; *(alt.)* 30143-13-6; 108-71-4 (toluene-3,5-diamine); 95-70-5 (toluene-2,5-diamine); 823-40-5 (toluene-2,6-diamine); 25376-45-8 (mixed isomers); 496-72-0 (toluene-3,4-diamine)

HSDB Number: 2849 (95-80-7)

RTECS Number: XS9625000; XS944500 (toluenediamine)

UN/NA & ERG Number: UN1709 (2,4-toluylenediamine, solid or 2,4-toluenediamine. solid)/151; UN3814 (2,4-toluylenediamine solution or 2,4-toluenediamine solution)/151

EC Number: 202-453-1 [*Annex I Index No.*: 612-099-00-3] (toluene-2,4-diamine); 246-910-3 (toluenediamine); 203-609-1 (toluene-3,5-diamine)

Regulatory Authority and Advisory Information

Carcinogenicity: (2,4-Diaminotoluene), NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Human No Adequate Data; Animal Sufficient Evidence, *possibly carcinogenic to humans*, Group 2B, 1987; NCI: Carcinogenesis Bioassay (feed); clear evidence: mouse, rat; NTP: Carcinogenesis studies; test completed (peer review), October 2000. United States Environmental Protection Agency Gene-Tox Program, Positive: Carcinogenicity-mouse/rat; Histidine reversion-Amestest; Positive: D *melanogaster* sex-linked lethal; Negative: *N crassa-aneuploidy*; Sperm morphology-mouse; Inconclusive: SHE-clonal assay

California Proposition 65 Chemical[102]: Cancer (95-80-7) 1/1/1988; *mixed isomers only, Delisted for Cancer /12/20/ 2015 (25376-45-8)*

Hazard Alert: Poison, Combustible, Possible risk of forming tumors, Sensitization hazard (skin), Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction). *toluene-2,6-diamine*: Suspected of causing genetic defects, Environmental hazard.

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 10 lb (4.54 kg)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U221

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects[293]. Toxic to aquatic life with long-lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

European/International Regulations (*95-80-7*, *toluene-2,4-diamine*): Hazard Symbol: T, N, Xi; Risk phrases: R45; R21; R25; R36; R43; R48/22; R50/53; R62; R63; R68; Safety phrases: S29/35; S53; S45; S61; (*95-70-5; toluene-2,6-diamine*): Hazard Symbol: T, N, Xi; Risk phrases: R45; R20/21; R25; R43; R50/53; R62; R63; Safety phrases: S1/2; S24; S29/35; S37; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class) (*95-80-7):* 3-Severe hazard to water.

mixed isomers:

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U221

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%, Toluene-2,4-diamine, Toluene-3,4-diamine, Toluene-*ar,ar′*-diamine, Toluene-3,5-diamine.

Hazardous to aquatic life or environment, with possible long-lasting effects[293]. Toxic to aquatic life with long-lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T; Risk phrases: R62; R63;?; Safety phrases: (see Appendix 4).

WGK[100] (German Aquatic Hazard Class) (*25376-45-8*): 3-Severe hazard to water.

Description: Toluene-2,4-diamine takes the form of colorless needles. Molecular weight = 122.2 (-2,4-diamine and-2,6-diamine); Specific gravity (H_2O:1) = 1.05 (liquid @ 100°C); Boiling point = 292°C; Freezing/Melting point = 99°C; 105°C (-2,6-diamine); Vapor pressure = 1 mmHg @ 107°C; Flash point = 148°C. Soluble in water.

Potential Exposure: Toluene-2,4-diamine is a chemical intermediate for toluene diisocyanate (used in the production of flexible and rigid polyurethane foams, polyurethane coatings; cast elastomers including fabric coatings and polyurethane and other adhesives), for dyes used on textiles; leather, furs; and in hair-dye formulations.

Incompatibilities: Strong acids; chloro formates, oxidizers.

Permissible Exposure Limits in Air

OSHA PEL: None

NIOSH REL: (*all isomers*) Potential occupational carcinogen; Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A

25376-45-8, mixed isomers

95-80-7, toluene-2,4-diamine

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 0.015 ppm

PAC-2: 3.3 ppm

PAC-3: 20 ppm

DFG MAK (*toluene-2,4-diamine*): [skin] danger of skin sensitization; Carcinogen Category 2; DFG TRK: *Air*: toluene-2,4-diamine 0.100 milligram per cubic meter; *Urine*: Sampling time: end of exposure or end-of-shift, Total toluene-2,4-diamine 100 μg[creatinine]/g in urine

Austria: carcinogen, 1999; Finland: carcinogen, 1999; Poland: MAC (TWA) 0.04 milligram per cubic meter; MAC (STEL) 0.1 milligram per cubic meter, 1999; Russia: STEL 2 milligram per cubic meter, [skin], 1993; Sweden: carcinogen, 1993; Switzerland: MAK-W 0.1 milligram per cubic meter, carcinogen, 1999.

95-70-5, toluene-2,5-diamine

DFG MAK (*toluene-2,4-diamine*): [skin] danger of skin sensitization

823-40-5, toluene-2,6-diamine

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 3 milligram per cubic meter

PAC-2: 33 milligram per cubic meter

PAC-3: 200 milligram per cubic meter

Determination in Air: Use NIOSH Analytical Method (IV) #5516, OSHA Analytical Method #ID-65.

Routes of Entry: Inhalation, eye and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes and skin. Eye contact may cause permanent damage. Skin contact may cause burns and blistering. Methemoglobinemia, CNS depression, and degeneration of the liver typically result from exposure to toluene-2,4-diamine. Exposure can cause cyanosis, headache, fatigue, dizziness, nausea, vomiting.

Long-Term Exposure: May cause liver damage. Jaundice and anemia are reported. Repeated exposure causes CNS depression causing headache, weakness, dizziness, fatigue, nausea, vomiting, and possible death. There is limited evidence that toluenediamines may reduce fertility in males and may affect the developing fetus. 2,4-Diaminotoluene is carcinogenic in rats and after its oral administration, producing hepatocellular carcinomas; and its subcutaneous injection, inducing local sarcomas. Diaminotoluenes are mutagens.

Points of Attack: CNS; liver, blood. Cancer site in animals: liver, mammary glands.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examination. Examination of the nervous system. Methemoglobin level. CBC. Liver function tests.

First Aid: *Skin Contact*:[52] Flood all areas of body that have contacted the substance with water. Don't wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others. *Eye Contact*: Remove any contact lenses at once. Flush eyes well with copious quantities of water or normal saline for at least 20−30 minutes. Seek medical attention. *Inhalation*: Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion*: If convulsions are not present, give a glass or two of water or milk to dilute the substance. Assure that the person's airway is unobstructed and contact a hospital or poison center immediately for advice on whether or not to induce vomiting.

Note to Physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Butyl rubber is recommended. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use SCBA.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in a cool, dry place or a refrigerator. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN1709 2,4-Toluylenediamine, solid or 2,4-Toluenediamine, solid, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN3814 2,4-Toluylenediamine, solution or 2,4-Toluenediamine, solution, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen spilled material with alcohol to avoid dust, then transfer material to a suitable container. Use absorbent dampened with alcohol to pick up remaining material. Wash surfaces well with soap and water. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical may burn but does not easily ignite. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Controlled incineration (oxides of nitrogen are removed from the effluent gas by scrubbers and/or thermal devices).

References

(109); (102); (31); (173); (101); (138); (2); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Toluene-2,4-Diamine, Washington, DC (1979)

United States Environmental Protection Agency, 2,4-Toluenediamine, Health and Environmental Effects Profile No. 161, Washington, DC, Office of Solid Waste (April 30, 1980)

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 5, No. 5, 99−103 (1985)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: 2,4-Diaminotoluene, Trenton NJ (December 2005)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Diaminetoluenes, (mixed isomers), Trenton, NJ (December 2005)

Toluene Diisocyanates T:0620

Formula: $C_9H_6N_2O_2$: 2,4-$CH_3C_6H_3(NCO)_2$

Synonyms: Benzene, 2,4-diisocyanato-1-methyl-; Benzene,2,4-diisocyanato-1-methyl-; Benzene,2,4-diisocyanatomethyl-; Cresorcinol diisocyanate; Desmodur T80; Di-*iso*-cyanatoluene; Di-isocyanate de toluylene (French); 2,4-Diisocyanato-1-methylbenzene; 2,4-Diisocyanatotoluene; Diisocyanat-toluol (German); Hylene T; Hylene TCPA; Hylene TLC; Hylene TM; Hylene TM-65; Hylene TRF; Isocyanic acid, 4-methyl-*m*-phenylene ester; Isocyanic acid, methylphenylene ester; 4-Methyl-phenylene diisocyanate; 4-Methyl-phenylene isocyanate; Mondur TDS; Nacconate 1OO; NCI-C50533; Niax TDI; Niax TDI-P; Scuranate; 2,4-TDI; TDI; TDI-80; Toluen-2,4-diisociato (Spanish); 2,4-Toluene diisocyanate; Toluene diisocyanate; Toluene di-isocyanate; Toluylene 2,4-diisocyanate; Tolyene 2,4-diisocyanate; 2,4-Tolylene diisocyanate; 2,4-Tolylenediisocyanat E; Tolylene 2,4-diisocyanate; Tuluylen diisocyanat (German); Tuluylene 2,4-diisocyanate; Voranate T-80; Voranate T-80, type I; Voranate T-80, type II

CAS Registry Number: 26471-62-5 (mixed isomers); 584-84-9 (2,4-isomer); 91-08-7 (2,6-isomer)

HSDB Number: 6003

RTECS Number: CZ6300000

UN/NA & ERG Number: UN2078/156 (P)

EC Number: 209-544-5 [*Annex I Index No.*: 615-006-00-4]

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen (Toluene diisocyanates); IARC: Human Inadequate Evidence; Animal Sufficient Evidence, *possibly carcinogenic to humans*, Group 2B, 1999; NIOSH: Potential occupational cacinogen.

Hazard Alert: Poison, Polymerization hazard, Combustible, Violently water reactive, Possible risk of forming tumors, Suspected of causing genetic defects, Sensitization hazard, Primary irritant (w/o allergic reaction), Environmental hazard.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); Accidental Release Prevention/Flammable Substances (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U223 (all isomers)

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500 lb (127.5 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 100 lb (45.4 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazardous to aquatic life or environment, with possible long-lasting effects[194]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T, N, Xi; Risk phrases: R45; R14; R19; R26; R29; R36/37/38; R42/43; R52/53; R61; R62; Safety phrases: S1/2; S23; S29/35; S36/37; S41; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Toluene diisocyanate is a colorless, yellow, or dark liquid or solid. It has a sweet, fruity, pungent odor. Toluene diisocyanate (technical, 26471-62-5) is an 80: 20 mixture of 2,4-and 2,6-isomers. A solid above 71/F/22°C. The Odor Threshold is 0.4−2.14 ppm. Molecular weight = 174.16; Specific gravity (H_2O:1) = 1.22 @ 25°C; Boiling point = 251°C @ 760 mmHg; Free zing/Melting point = 19.5°C−22°C; Vapor pressure = 0.025 mmHg @ 25°C; 1 mmHg @ 80°C; Relative vapor density (air = 1) = 6.1; Flash point = 121°C; Autoignition temperature = > 149°C; 620°C. Explosive limits: LEL = 0.9%; 9,000 ppm; UEL: 9.5%. Hazard Identification (based on NFPA-704 M Rating System *for 2,4 isomer, CAS 584-84-9*): Health 3, Flammability 1, Reactivity 2₩. Insoluble in water; reacts exothermically, releasing heat and toxic fumes.

Potential Exposure: Toluene diisocyanate is used in the production of polyurethane flexible foams, coatings, paints, and elastomers. It is more widely used than MDI (diphenylmethane diisocyanate). Polyurethanes are formed by the reaction of isocyanates with polyhydroxy compounds. Since the reaction proceeds rapidly at room temperature, the reactants must be mixed in pots or spray guns just before use. These resins can be produced with various physical properties, for example, hard, flexible, semirigid foams; and have found many uses, for example, upholstery padding; thermal insulation; molds, surface coatings; shoe inner soles; and in rubbers, adhesives, paints, and textile finishes. Because of TDI's high volatility, exposure can occur in all phases of its manufacture and use. MDI has a much lower volatility, and problems generally arise only in spray applications.

Incompatibilities: May form explosive mixture with air. Isocyanates are highly flammable and reactive with many compounds, even with themselves. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Reaction with moist air, water or alcohols may form amines and insoluble polyureas and react exothermically, releasing toxic, corrosive or flammable gases, including carbon dioxide; and, at the same time, may generate a violent release of heat increasing the concentration of fumes in the air. Incompatible with amines, aldehydes, alkali metals, ammonia, carboxylic acids, caprolactum, alkaline materials, glycols, ketones, mercaptans, hydrides, organotin catalysts, phenols, strong acids, strong bases, strong reducing agents such as hydrides, urethanes, and ureas. Elevated temperatures or contact with acids, bases, tertiary amines, and acyl-chlorides may cause explosive polymerization. Attacks some plastics, rubber and coatings. Contact with metals may evolve flammable hydrogen gas. May accumulate static electrical charges, and may cause ignition of its vapors.

Permissible Exposure Limits in Air

NIOSH IDLH = 2.5 ppm, potential occupational carcinogen.

Conversion factor: 1 ppm = 7.13 milligram per cubic meter @ 25°C & 1 atm

Odor threshold = 0.4 to 2 ppm

OSHA PEL: 0.02 ppm/0.14 milligram per cubic meter Ceiling Concentration

NIOSH REL: Potential occupational carcinogen; Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A

ACGIH TLV[1]: [2,4- or 2,6-isomer (or as a mixture)]: 0.001 ppm/0.007 milligram per cubic meter, measured as inhalable fraction and vapor TWA; 0.005 ppm/0.035 milligram per cubic meter, measured as inhalable fraction and vapor STEL, [skin]; dermal sensitizer [DSEN]; respiratory sensitizer [RSEN], not classifiable as a human carcinogen.

26471-62-5 mixed isomers

Protective Action Criteria (PAC)* Ver. 29[138]

PAC-1: 0.02 ppm

PAC-2: 0.083 ppm

PAC-3: 0.51 ppm

Protective Action Criteria (PAC)* Ver. 29[138]

95-80-7, toluene-2,4-diisocyanate; toluene-2,6-diisocyanate

PAC-1: 0.015 ppm

PAC-2: 3.3 ppm

PAC-3: 20 ppm

DFG MAK: Danger of sensitization of the airways; Carcinogen Carcinogen Category 3A

Arab Republic of Egypt: TWA 0.02 ppm (0.14 milligram per cubic meter), 1993; Austria: MAK 0.01 ppm (0.07 milligram per cubic meter), 1999; Belgium: TWA 0.005 ppm (0.036 milligram per cubic meter), STEL 0.02 ppm, 1993; Denmark: TWA 0.005 ppm (0.035 milligram per cubic meter), 1999; France: VME 0.01 ppm (0.08 milligram per cubic meter), STEL 0.02 ppm (0.16 milligram per cubic meter), 1993; Hungary: STEL 0.04 milligram per cubic meter, 1993; Japan; 0.02 ppm (0.14 milligram per cubic meter), 1993; the Netherlands: MAC-TGG 0.04 milligram per cubic meter, 2003; Norway: TWA 0.005 ppm (0.035 milligram per cubic meter), 1999; the Phillipines: TWA 0.02 ppm (0.14 milligram per cubic meter), 1993; Poland: MAC (TWA) 0.035 milligram per cubic meter; MAC (STEL) 0.070 milligram per cubic meter, 1999; Russia: STEL 0.05 milligram per cubic meter, 1993; Sweden: NGV 0.005 ppm (0.04 milligram per cubic meter), KTV 0.01 ppm (0.07 milligram per cubic meter), 1999; Switzerland: MAK-W 0.005 ppm (0.04 milligram per cubic meter), KZG-W 0.01 ppm (0.08 milligram per cubic meter), 1999; Thailand: TWA 0.02 ppm (0.14 milligram per cubic meter), 1993; Turkey: TWA 0.02 ppm (0.14 milligram per cubic meter), 1993; United Kingdom: TWA 0.02 [NCO]milligram per cubic meter, STEL 0.07 mg[NCO]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 0.02 ppm

Russia has also set MAC values for ambient air in residential areas of 0.05 milligram per cubic meter on a momentary basis and 0.02 milligram per cubic meter on a daily average basis. Several states have set guidelines or standards for TDI in ambient air[60] ranging from 0.03−0.20 μ/m^3 (Rhode Island); to 0.13 μ/m^3 (New York); to 0.4 μ/m^3 (South Carolina); to 0.48 μ/m^3 (Massachusetts); to 0.70 μ/m^3 (Virginia); to 0.72 μ/m^3 (Connecticut and South Dakota); to 0.4−1.5 μ/m^3 (North Dakota); to 0.9 μ/m^3 (Nevada); to 4.8−16.0 μ/m^3 (North Carolina).

Determination in Air: Use NIOSH Analytical Method (IV) #5521, Isocyanates, monomeric, #5522 Isocyanates, #2535, Toluene-2,4-diisocyanate, and OSHA Analytical Method #18, superseded by #42 and #33

Determination in Water: Octanol-water coefficient: Log $K_{ow} = 0.2$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation of vapor, ingestion and skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritate the eyes, skin, and respiratory tract. Inhalation of the vapor may cause asthma tic reactions; chemical bronchitis, pneumonitis, and pulmonary edema. Pulmonary edema is a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. *Note*: TDI is a strong sensitizer. Allergic individuals may experience symptoms at very low concentrations.

Inhalation: Causes irritation of nose, throat and lungs; insomnia, euphoria, difficulty in walking; loss of consciousness; poor memory; personality changes; irritability and depression. Allergic response is also possible. Sensitive individuals may react to 0.007 ppm or less. Exposure to high levels leads to chemical pneumonia. Levels of

0.01−0.03 ppm reportedly caused no symptoms. At 0.03−0.07 ppm, respiratory illness with continuous coughing, sore throat; difficulty in breathing; fatigue and nocturnal sweating were reported. In another study, 10 minutes at 0.5 ppm caused nose and throat irritation. Lung damage may be permanent. *Skin*: If not removed promptly, may cause redness, pain, swelling, and blistering. TDI is corrosive and may be absorbed through the skin. Repeated contact has caused skin sensitization in humans and allergic eczema. *Eyes*: May cause redness, pain; blurred vision; severe irritation, tears and damage to the cornea. Prolonged contact may cause permanent dam age. *Ingestion*: May cause sore throat, abdominal pain; diarrhea, and irritation of mouth and stomach.

Long-Term Exposure: May produce asthma-like allergy and chronic lungs disease; chronic obstructive bronchitis; emphysema, chemical bronchitis; asthmatic syndrome. May cause memory loss and concentration problems; psychological effects; CNS effects. May cause chest tightness (sometimes very severe), sneezing, cyanosis (blue coloration), blood changes; and collapse. Sensitization may occur after exposure to spills or other unusually high concentrations. Decreased lung function has been reported from estimated exposure to 0.02 ppm for two years. It has also been reported that excessive loss of pulmonary function occurs at 0.0035 ppm possibly to 0.002 ppm. Sensitization has been reported on the first exposure at concentration below 0.05 ppm and as late as 14 years (0.06 ppm) after first exposure. This substance is a probable carcinogen in humans. There is limited evidence that TDI may cause temporary impotence in males.

Points of Attack: Eyes, skin, respiratory system Cancer site in animals: pancreas, liver, mammary gland; circulatory system; and skin tumors.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. NIOSH lists the following tests: Blood Gas Analysis; blood plasma; chest X-ray, EKG, pulmonary function tests: forced vital capacity, forced expiratory volume (1 seconds); pulmonary function tests; pre- and post-shift; sputum cytology; urine (chemical/metabolite); white blood cell count/differential. Preplacement and periodic medical examinations should include chest rentgenography, pulmonary function tests; and an evaluation of any respiratory disease or history of allergy. Periodic pulmonary function tests may be useful in detecting the onset of pulmonary sensitization. See also "References."[4]

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15(100). minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pneumonitis or pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Toluene diisocyanates can react with cellulose-based absorbents, mineral-based and clay-based absorbents, dirt/earth. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Teflon, Silvershield, Viton, polyethylene, nitrile, chlorinated polyethylene; and polyvinyl alcohol are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid, unless full facepiece respiratory protection is worn. Wear dust-proof goggles and face shield when working with powders or dust, unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *at any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration*: SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive pressure mode). *Escape*: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool well-ventilated area away from amines, strong bases (such as sodium hydroxide) and alcohols. Toluene 2.4-diisocyanate should not be stored in contact with water, because they react and release CO_2 gas. Toluene 2,4-diisocyanate will polymerize and rupture containers at temperatures over 177°C/350°F. At normal temperatures (21°C/70°F) Toluene 2.4-diisocyanate levels quickly exceed the PEL and therefore proper ventilation must be in practice or personal protective equipment must be worn. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2078 Toluene diisocyanate, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Stay upwind and uphill. Isolate the area of release or fire and deny entry. Remove all ignition sources. Stop the release if it can be done safely from a distance. All equipment used to handle this material must be grounded. Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. *Small spill*: Cover with *dry* earth, *dry* sand, or other noncombustible material followed with plastic sheet to minimize spreading or contact with water or rain. Use clean nonsparking tools to collect material and place material into loosely covered plastic containers for later disposal. Prevent material and runoff from entering sewers and waterways if it can be done safely well ahead of the release. Use vapor suppressing foam to disperse vapors—contain runoff. Water spray may reduce vapor, but may not prevent ignition in enclosed spaces. Ventilate confined area if it can be done without placing personnel at risk. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Combustible and a polymerization hazard. Thermal decomposition products may include hydrogen cyanide and oxides of nitrogen and carbon. *Solid*: Water gently applied to surface or foam may cause frothing which will extinguish the fire (NFPA). If material is on fire or involved in fire do not extinguish fire unless flow can be stopped. Use water in flooding quantities as fog. Solid streams of water may be ineffective. Cool all affected containers with flooding quantities of water. Apply water from as far a distance as possible. Use "alcohol" foam, carbon dioxide or dry chemical. Use water spray to absorb vapor. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode. *Liquid*: Combustible. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥ 100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Controlled incineration (oxides of nitrogen are removed from the effluent gas by scrubbers and/or thermal devices). In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(109); (31); (173); (101); (138); (2).

National institute for Occupational Safety and Health (NIOSH), "Criteria for a Recommended Standard: Occupational Exposure to Toluene Diisocyanate," NIOSH Document Number 73-11022, Cincinnati OH (1973)

National institute for Occupational Safety and Health (NIOSH), Information Profiles on Potential Occupational Hazards: Organoisocyanates, Report PB-276,678, Rockville, MD, pp 265—275 (October 1977)

United States Environmental Protection Agency, Toluene Diisocyanate, Health and Environmental Effects Profile No. 162, Washington, DC, Office of Solid Waste (April 30, 1980)

United States Environmental Protection Agency, Chemical Hazard Information Profile: Toluene 2,4-Diisocyanate, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

United States Environmental Protection Agency, Chemical Hazard Information Profile: Toluene Diisocyanate, Washington, DC, Office of Toxic Substances (July 25, 1984)

New York State Department of Health, *Chemical Fact Sheet*: Toluene Diisocyanate, Bureau of Toxic Substance Assessment, Albany, NY (May 1986 and Version 2)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Toluene 2,4-Diisocyanate, Trenton, NJ (April 2002)

o-Toluidine T:0640

Formula: C_7H_9N; $CH_3C_6H_4NH_2$

Synonyms: 1-Amino-2-methylbenzene; 2-Amino-1-methylbenzene; *o*-Aminotoluene; 2-Aminotoluene; Aniline, 2-methyl-; Benzenamine, 2-methyl-; C.I. 37077; 1-Methyl-1,2-amino-benzene; 1-Methyl-2-aminobenzene; 2-Methyl-1-aminobenzene; *o*-Methylaniline; 2-Methylaniline; *o*-Methylbenzenamine; 2-Methylbenzenamine; *o*-Toluidina (Spanish); 2-Toluidine; Toluidine, *o*-; *o*-Tolylamine

CAS Registry Number: 95-53-4; 636-21-5 (hydrochloride)

HSDB Number: 2042 as 2-aminotoluene

RTECS Number: XU2975000

UN/NA & ERG Number: UN1708/153

EC Number: 202-429-0 [*Annex I Index No.*: 612-091-00-X]; 211-252-8 (hydrochloride)

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen; IARC *(95-53-4)*: Human Sufficient Evidence, 1978; Animal Sufficient Evidence, *carcinogenic to humans*, Group 1; NTP *(95-53-4 & 636-21-5)*: NIOSH *(95-53-4)*: Potential occupational carcinogen.

United States Environmental Protection Agency Gene-Tox Program, Positive: Carcinogenicity-mouse/rat; Positive: Cell transformation-RLV F344 rat embryo; Positive: *E coli polA* without S9; Negative: Sperm morphology-mouse; *Scerevisiae-homozygosis*; Inconclusive: Histidine reversion-Ames test.

California Proposition 65 Chemical[102]: Cancer 1/1/1988; *o*-Toluidine hydrochloride 1/1/1988.

Hazard Alert: Poison, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction), Environmental hazard. Listed for Tier 1 screening as an endocrine disruptor[88].

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U328

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR264, appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 100 lb (45.4 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazardous to aquatic life or environment, with possible long-lasting effects.[291] Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol *(95-53-4)*: T, N; Risk phrases: R45; R23/25; R36; R50; S62; S63 Safety phrases: S29/35; S53; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class) (*95-53-4*): 3-Severe hazard to water.

Description: *o*-Toluidine is a colorless to pale yellow liquid with a weak, pleasant, aromatic odor. Molecular weight = 107; Specific gravity (H_2O:1) = 1.01; Boiling point = 200°C; Freezing/Melting point = −14C; Vapor pressure = 0.3 mmHg @ 21°C; Flash point = 85°C (cc); Autoignition temperature = 482°C. Explosive limits: LEL = 1.5%; UEL-unknown. Slightly soluble in water; solubility = 2%.

Potential Exposure: *o*-Toluidine is used as an intermediate in the manufacture of dyes; as an intermediate in pharmaceutical manufacture; in textile printing; in rubber accelerators; in production of *o*-aminoazotoluene

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

NIOSH IDLH = 50 ppm, potential occupational carcinogen.

Conversion factor: 1 ppm = 4.38 milligram per cubic meter @ 25°C & 1 atm

Odor Threshold = 0.25 ppm

OSHA PEL: 5 ppm/22 milligram per cubic meter TWA [skin]

NIOSH REL: [skin] Potential occupational carcinogen; Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A

ACGIH TLV[1]: 2 ppm/8.8 mg/m TWA [skin], confirmed animal carcinogen with unknown relevance to humans; BEI_M issued as methemoglobin inducers

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 6 ppm

PAC-2: 8.2 ppm

PAC-3: 100 ppm

DFG MAK: [skin] Carcinogen Category 1; Germ Cell Mutation Category 3A

Australia: TWA 2 ppm (9 milligram per cubic meter), [skin], carcinogen, 1993; Austria [skin], carcinogen, 1999; Belgium: TWA 2 ppm (8.8 milligram per cubic meter),

[skin], Carcinogen 1993; Denmark: TWA 2 ppm (9 milligram per cubic meter), [skin], 1999; Finland: TWA 5 ppm (22 milligram per cubic meter), STEL 10 ppm (44 milligram per cubic meter), [skin], carcinogen, 1999; France: VME 2 ppm (9 milligram per cubic meter), carcinogen, 1999; Carcinogen (salts), 1993; Japan; 1 ppm (4.4 milligram per cubic meter), [skin], 2B carcinogen, 1999; Norway: TWA 1 ppm (4.5 milligram per cubic meter), 1999; the Phillipines: TWA 5 ppm (22 milligram per cubic meter), [skin], 1993; Poland: MAC (TWA) 3 milligram per cubic meter; MAC (STEL) 9 milligram per cubic meter, 1999; Russia: TWA 0.5 milligram per cubic meter, STEL 1 milligram per cubic meter, [skin], carcinogen, 1993; Sweden: carcinogen, 1999; Switzerland: MAK-W 0.1 ppm (0.5 milligram per cubic meter), [skin], carcinogen, 1999; Turkey: TWA 5 ppm (22 milligram per cubic meter), [skin], 1993; United Kingdom: carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: confirmed animal carcinogen with unknown relevance to humans.

Also, many states have set guidelines for ambient air.

Determination in Air: Use NIOSH Analytical Method #2002, amines, aromatic, #2017, #8317, OSHA Analytical Method ID-73.

Permissible Concentration in Water: No criteria set, but EPA[32] has suggested an ambient water goal of 304 μg/L based on health effects.

Determination in Water: Octanol-water coefficient: Log $K_{ow} = 1.32$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Exposure may affect the blood causing cyanosis and formation of methemoglobin. Exposure to high concentrations may result in damage to kidneys and bladder.

Inhalation: Combines with blood cells to prevent binding of oxygen. Early symptoms are headache, nausea, vomiting, diarrhea, low blood pressure; increased salivation and loss of appetite. Causes cyanosis, lips, fingernails and tongue may turn blue. Symptoms may begin to appear @ 6 ppm after several hours, or @ 100 ppm after 1 hour. Continued exposure may lead to difficult breathing; dizziness, stupor, unconsciousness, and death. *Skin*: Causes irritation. May cause excessive drying of skin, and irritation. Absorption is significant and may increase severity of symptoms listed under inhalation. *Eyes*: Causes irritation, redness and chemical burns. *Ingestion*: Animal studies suggest that symptoms as listed under inhalation would occur, and that death may result from ingestion of about 2 ounces by a 150 lb person.

Long-Term Exposure: Skin and inhalation exposures may cause the formation of methemoglobin and cyanosis, mild Blue coloration of the skin due to lack of oxygen in the blood. Loss of appetite and weight, headache, dizziness may occur. Irritation of the kidneys and bladder may occur, with decreased functions and damage. *o*-Toluidine is A potential occupational carcinogen.

Points of Attack: Eyes, skin, blood, kidneys, liver, cardiovascular system. *Cancer site*: bladder cancer.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. NIOSH lists the following tests: whole blood (chemical/metabolite), Methemoglobin; CBC; red blood cells/count; urine (chemical/metabolite); urine (chemical/metabolite) [Whole Blood (chemical/metabolite)]; urinalysis (routine). Before beginning employment and at regular times after that, the following is recommended: Urine exam for blood and abnormal cells (urine cytology) and blood. If symptoms develop or overexposure is suspected, the following may be useful: methemoglobin level every 3−6 hours for 18−24 hours. Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Effects may be delayed. Medical observation is recommended.

Note to Physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Teflon is among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration*: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive pressure mode). *Escape*: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. *o*-Toluidine must be stored to avoid contact with strong oxidizers, (such as chlorine, bromine, and fluorine) because violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where *o*-toluidine is used, handled, or stored in a manner that could create A potential fire or explosion hazard. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN1708 Toluidines, liquid, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Controlled incineration (oxides of nitrogen are removed from the effluent gas by scrubbers and/or thermal devices).

References

(109); (102); (31); (173); (101); (138); (2); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile Draft Report; *o*-Toluidine; *o*-Toluidine Hydrochloride, Washington, DC (February 23, 1984)

New York State Department of Health, *Chemical Fact Sheet*: *o*-Toluidine, Bureau of Toxic Substance Assessment, Albany, NY (March 1986 and Version 2)

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 2, No. 1, 121−123 (1982)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: *o*-Toluidine, Trenton, NJ (January 2001).

p-Toluidine T:0642

Formula: C_7H_9N; $C_6H_4CH_3NH_2$

Synonyms: 4-Amino-1-methylbenzene; 4-Aminotoluene; *p*-Methylaniline; *para*-Toluidine; 4-Toluidine; Toluidine, *para-*

CAS Registry Number: 106-49-0; 540-23-8 (hydrochloride)

HSDB Number: 1441

RTECS Number: XU3150000

UN/NA & ERG Number: UN3451 (solid)/154

Regulatory Authority and Advisory Information

Carcinogenicity: A3; Confirmed animal carcinogen with unknown relevance to humans.

California Proposition 65 Chemical[102]: Cancer, 1/1/1990, *Delisted 10/29, 1999*

Hazard Alert: Poison, Flammable, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction), Environmental hazard.

EPA hazardous waste number (RCRA No.): U353

RCRA Section 261 Hazardous Constituents.

EPCRA Section 304 Reportable Quantity (RQ): CERCLA, 100 lbs. (45.4 kgs.).

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1% (hydrochloride).

Hazardous to aquatic life or environment, with possible long-lasting effects[293]. Toxic to aquatic life with long-lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: F, N; Risk phrases: R40; R10; R23/24/25; R36; R43; R50/53; R62; Safety phrases: S28; S29/35; S36/37; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: *p*-Toluidine is a colorless solid. Molecular weight = 107.2; Specific gravity (H_2O:1) = 1.0 @ 20°C; Boiling point = 200.56°C; Freezing/Melting point = 44.5°C; Vapor pressure = 1 mmHg @ 42.2°C; Relative vapor density (air = 1) = 3.9; Flash point = 86.7°C (cc); Explosive limits: LEL: 1.1%, UEL: 6.6%; Autoignition temperature = 481.67°C; Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 0. Henry's Law constant = 2.8×10^{-10} atm-m^3/mol @ 25°C (est)[72]. Soluble in water; solubility = 0.7%[77]

Potential Exposure: *para*-Toluidine is used in dyes, and in organic chemical manufacturing

Incompatibilities: *para*-Toluidine is incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. p-Toluidine neutralizes acids to form salts plus water in exothermic reactions. May be incompatible with isocyanates, halogenated organics, peroxides, phenols (acidic), epoxides, anhydrides, and acid halides. Flammable gaseous hydrogen is generated in combination with strong reducing agents, such as hydrides[101]. Hypergolic reaction with red fuming nitric acid[Kit and Evered, 1960, p. 239, 242].

Permissible Exposure Limits in Air:

NIOSH IDLH: Potential human carcinogen

ACGIH TLV: 2 ppm TWA; [skin]; Confirmed animal carcinogen with unknown relevance to humans; BEI issued

MAK: [skin]; sensitization of skin; Carcinogen category: 3B; (2004).

Australia: TWA 2 ppm (9 milligram per cubic meter), [skin], Carcinogen, 1993; Austria [skin], Suspected Carcinogen, 1999; Belgium: TWA 2 ppm (8.8 milligram per cubic meter), [skin], Carcinogen 1993; Denmark: TWA 2 ppm (9 milligram per cubic meter), [skin], 1999; GERMANY [skin], Carcinogen, 1999; Russia: STEL 1 milligram per cubic meter, [skin], 1993; Switzerland: MAK-W 2 ppm (9 milligram per cubic meter), [skin], 1999; The Netherlands: MAC-TGG 9 milligram per cubic meter, [skin], 2003; Argentina, Bulgaria, Columbia, Jordan, Korea, ZEALAND, Singapore, Vietnam: ACGIH TLV: Confirmed Animal Carcinogen with Unknown Relevance to Humans.

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 6 ppm

PAC-2: 8.2 ppm

PAC-3: 30 ppm

Determination in Water: Octanol/water partition coefficient as log Pow: 1.39. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Dermal and eye contact, inhalation, ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: The substance irritates the eyes and the skin. Exposure to high concentrations may result in damage to kidneys and bladder. The effects may be delayed. Medical observation is indicated. Toxicity by Ingestion: Grade 3; LD_{50} (oral, mouse) = 330 mg/kg[136]

Long-Term Exposure: Repeated or prolonged contact may cause skin sensitization. The substance may have effects on the blood, resulting in formation of methaemoglobin. The substance may cause effects on the blood, bladder and kidneys, resulting in tissue lesions and formation of methaemoglobin.

Points of Attack: Blood, bladder, kidneys.

Medical Surveillance: Preemployment and periodic examinations should be concerned particularly with a history of blood dyscrasias, reactions to medications; alcohol intake; eye disease; and skin; cardiovascular status. Liver and renal functions should be evaluated periodically as well as blood and general health. Blood methemoglobin levels should be followed until normal in all cases of suspected cyanosis. This chemical is a suspected carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Skin: Wear appropriate personal protective clothing to prevent skin contact. Eyes: Wear appropriate eye protection to prevent eye contact. Wash skin: The worker should immediately wash the skin when it becomes contaminated. The worker should wash daily at the end of each work shift. Remove: Work clothing that becomes wet or significantly contaminated should be removed and replaced. Change: Workers whose clothing may have become contaminated should change into uncontaminated clothing before leaving the work premise. Provide: Eyewash fountains should be provided in areas where there is any possibility that workers could be exposed to the substance; this is irrespective of the recommendation involving the wearing of eye protection. Facilities for quickly drenching the body should be provided within the immediate work area for emergency use where there is a possibility of exposure. [*Note:* It is intended that these facilities provide a sufficient quantity or flow of water to quickly remove the substance from any body areas likely to be exposed. The actual determination of what constitutes an adequate quick drench facility depends on the specific circumstances. In certain instances, a deluge shower should be readily available, whereas in others, the availability of water from a sink or hose could be considered adequate.][77].

Respirator Selection: *At any detectable concentration*: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA- or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full-facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. *o*-Toluidine must be stored to avoid contact with strong oxidizers, (such as chlorine, bromine, and fluorine) because violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where *o*-toluidine is used, handled, or stored in a manner that could create A potential fire or explosion hazard. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN3451 Toluidines, solid, Hazard Class: 6.1; Labels: 6.1-Poisonous materials

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Controlled incineration (oxides of nitrogen are removed from the effluent gas by scrubbers and/or thermal devices).

References

(102); (31); (173); (101); (138); (100).

Kit and Evered, 1960, p. 239, 242

Trichlorfon T:0670

Formula: $C_4H_8Cl_3O_4P$; $(CH_3O)_2POCHOHCCl_3$
Synonyms: Aerol 1 (pesticide); Agroforotox; Anthon; Bay 15922; Bayer 15922; Bayer L 13/59; Bilarcil; Bovinox; Briton; Britten; Cekufon; Chlorak; Chlorofos; Chloroftalm; Chlorophos; Chlorophthalm; Chloroxyphos; Ciclo-som; Combot; Combot equine; Danex; DEP (pesticide); Depthon; DETF; Dimethoxy-2,2,2-trichloro-1-hydroxy-ethylphosphine oxide; *O*,*O*-Dimethyl (1-hydroxy-2,2,2-trichloraethyl)phosphat (German); *O*,*O*-Dimethyl (1-hydroxy-2,2,2-trichloraethyl)phosphonsaeure ester (German); *O*, *O*-Dimethyl (1-hydroxy-2,2,2-trichloroethyl) phosphonate; Dimethyl 1-hydroxy-2,2,2-trichloroethylphosphonate; *O*,*O*-Dimethyl (2,2,2-trichloro-1-hydroxyethyl) phosphonate; Dimethyl (2,2,2-trichloro-1-hydroxyethyl)phosphonate; Dimetox; Dipterex; Dipterex 50; Diptevur; Ditrifon; Dylox; Dylox-Metasystox-R; Dyrex; Dyvon; ENT 19,763; Equino-acid; Equino-aid; Flibol E; Fliegenteller; Forotox; Foschlor; Foschlor R; Foschlor R-50; 1-Hydroxy-2,2,2-trichloroethylphosphonic acid dimethyl ester; Hypodermacid; Leivasom; Loisol; Masoten; Mazoten; Methyl chlorophos; Metifonate; Metrifonate; Metriphonate; NCI-C54831; Neguvon; Neguvon A; Phoschlor; Phoschlor R50; Phosphonic acid, (2,2,2-trichloro-1-hydroxyethyl)-, dimethyl ester; Polfoschlor; Proxol; Ricifon; Ritsifon; Satox 20W SC; Soldep; Sotipox; 2,2,2-Trichloro-1-hydroxyethyl-phosphonate, dimethyl ester; (2,2,2-Trichloro-1-hydroxyethyl)phosphonic acid dimethyl ester; Trichlorophene; Trichlorphon; Trichlorphon FN; Trinex; Tugon; Tugon fly bait; Tugon stable spray; Vermicide bayer 2349; Volfartol; Votexit; WEC 50; Wotexit
CAS Registry Number: 52-68-6
HSDB Number: 881
RTECS Number: AO700000
UN/NA & ERG Number: (PIH) UN2783 (organophosphorus pesticides, solid, toxic)/152
EC Number: 200-149-3 [*Annex I Index No.*: 015-021-00-0]
Regulatory Authority and Advisory Information
Carcinogenicity: IARC: Animal, Inadequate Evidence; Human No Adequate Data, *not classifiable as carcinogenic to humans*, Group 3, 1987. United States Environmental Protection Agency Gene-Tox Program, Positive: Body fluid assay; Host-mediated assay; Positive: Histidine reversion-Ames test; S *cerevisiae-homozygosis*; Weakly Positive: *In vitro* UDS-human fibroblast; Positive/dose response: TRP reversion; Negative: D *melanogaster* sex-linked lethal; Inconclusive: Mammalian micronucleus; B *subtilis* rec assay; Inconclusive : *E coli polA* without S9
Hazard Alert: Poison inhalation hazard, Neurotoxin (cumulative), Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Sensitization hazard, Primary irritant (w/o allergic reaction), Environmental hazard.
Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).
Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 100 lb (45.4 kg)
Dropped from Extremely Hazardous Substance (EPA-SARA) in 1988
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
United States DOT 49CFR172.101, Inhalation Hazard Chemical as organophosphates
United States DOT Regulated Marine Pollutant (49CFR172.101, appendix B)
Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.
Hazard Symbols, Risk & Safety statements: Hazard Symbol: Xn, Xi, N; Risk phrases: R22; R33; R43; R50/53; R62; R63; Safety phrases: S2; S24; S29/35; S37; S41; S60; S61 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.
Description: Trichlorfon is a white to pale yellow crystalline solid. Molecular weight = 257.44; Specific gravity (H_2O:1) = 1.73 @ 20°C; Boiling point = 100°C @ 1 mmHg; Freezing/Melting point = 83°C−84°C; Vapor pressure = 2×10^{-6} mmHg @ 20°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Soluble in water; solubility = 15.4 g/100 mL @ 25°C.
Potential Exposure: Trichlorfon is used as an agricultural and forest insecticide.
Incompatibilities: This chemical may be characterized as an organo-phosphate or-chlorine compound. Organophosphates are susceptible to formation of highly toxic and flammable phosphine gas in the presence of strong reducin g agents such as hydrideds and active metals. Partial oxidation by oxidizing agents may result in the release of toxic phosphorus oxides[101]. Alkaline materials: lime, lime sulfur, etc. Corrosive to iron, steel and possibly to other metals.
Permissible Exposure Limits in Air
OSHA PEL: None
NIOSH REL: None
ACGIH TLV[1]: 1 milligram per cubic meter (intermittent) TWA, sensitizer, not classifiable as a human carcinogen; BEI_A issued for acetylcholinesterase inhibiting pesticides.
Protective Action Criteria (PAC) Ver. 29[138]
PAC-1: 3 milligram per cubic meter
PAC-2: 13 milligram per cubic meter
PAC-3: 57 milligram per cubic meter
Poland: MAC (TWA) 0.5 milligram per cubic meter, MAC (STEL) 2 milligram per cubic meter, 1999; Russia: STEL 0.5 milligram per cubic meter, [skin] 1993. Russia[43] set a

MAC in residential areas of 0.04 milligram per cubic meter on a momentary basis and 0.02 milligram per cubic meter on a daily average basis.

Determination in Air: OSHA versatile sampler-2; Toluene/Acetone; Gas chromatography/Flame photometric detection for sulfur, nitrogen, or phosphorus; NIOSH Analytical Method (IV) Method #5600, Organophosphorus Pesticides.

Permissible Concentration in Water: Russia[35,43] set a MAC in water bodies used for domestic purposes of 0.05 mg/L and in water bodies used for fishery purposes of zero.

Determination in Water: Fish Tox = 24.99773000 (ppb) (INTERMEDIATE). Octanol-water coefficient: Log $K_{ow} = < 0.5$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion, skin contact.

Harmful Effects and Symptoms

In varying degrees, organochlorines are absorbed from the gut and also by the lung and across the skin[72].

Short-Term Exposure: Very toxic: probable oral lethal dose (human) 50−500 mg/kg, between 1 teaspoon and 1 ounce for 150 lb (70 kg) person. Toxicity is relatively low among organic phosphate insecticides, although it is a potent cholinesterase inhibitor. Skin sensitivity has been reported. Symptoms of exposure: muscle weakness; twitching, respiratory depression; sweating, vomiting, diarrhea, chest and abdominal distress; sometimes pulmonary edema; excessive salivation; headache, giddiness, vertigo and weakness; runny nose and sensation of tightness in chest (inhalation), blurring of vision; tearing, ocular pain; loss of muscle coordination; and slurring of speech.

Long-Term Exposure: Cholinesterase inhibitor; cumulative effect is possible. This chemical may damage the nervous system with repeated exposure, resulting in convulsions, respiratory failure. May cause liver damage.

Points of Attack: Respiratory system, lungs, CNS; cardiovascular system, skin, eyes, plasma and red blood cell cholinesterase.

Medical Surveillance: Before employment and at regular times after that, the following are recommended: plasma and red blood cell cholinesterase levels (tests for the enzyme poisoned by this chemical). If exposure stops, plasma levels return to normal in one to two weeks, while red blood cell levels may be reduced for one to three months.

When cholinesterase enzyme levels are reduced by 25% or more below preemployment levels, risk of poisoning is increased, even if results are in lower ranges of "normal." Reassignment to work not involving organophosphate or carbamate pesticides is recommended until enzyme levels recover. If symptoms develop or overexposure occurs, repeat the above tests as soon as possible and get an exam of the nervous system. Also consider CBC. Consider chest X-ray following acute overexposure. Do not drink any alcoholic beverages before or during use. Alcohol promotes absorption of organic phosphates.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive pressure mode. A/P2 filter respirator for organic vapor and harmful dust.

Escape: GmFOv 100 [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).****

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area away from alkaline materials. Where possible, automatically transfer material from other storage containers to process containers.

Shipping: UN2783 Organophosphorus pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling:

Initial isolation and protective action distances:

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30

Then: Protect persons downwind (miles/kilometers)

Day 0.3/0.4

Night 0.8/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 600/200

Then: Protect persons downwind (miles/kilometers)

Day 1.4/2.3

Night 2.8/4.5

Organophosphorus pesticide: stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Wear positive pressure breathing apparatus and special protective clothing. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills*: with clean shovel place material into clean dry containers and cover; move containers from spill area. *Large spills*: dike far ahead of spill for later disposal. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Soil Adsorption Index (K_{oc}) = 10.

Fire Extinguishing: This material may burn, but does not ignite readily. Thermal decomposition products may include hydrogen chloride and oxides of phosphorus and carbon. For small fires, use dry chemical, carbon dioxide; water spray; or foam. For large fires, use water spray, fog, or foam. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Add a combustible solvent and burn in a furnace equipped with an afterburner and an alkali scrubber[22].In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (80); (203); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 7, No. 2, 95−101 (1987)

United States Environmental Protection Agency, Chemical Hazard Information Profile: Trichlorophon, Washington, DC, Chemical Emergency Preparedness Program (October 31, 1985)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Trichlorofon, Trenton, NJ (November 2004)

Trichloroacetic Acid T:0680

Formula: $C_2HCl_3O_2$: Cl_3CCOOH

Synonyms: Acetic acid, trichloro-; Aceto-caustin; Acide trichloracetique (French); AMCHEM grass killer; Dow sodium TCA solution; Konesta; Sodium TCA solution; TCA; Trichloressigsaeure (German); Trichloroethanoic acid; Varitox

CAS Registry Number: 76-03-9

HSDB Number: 1779

RTECS Number: AJ7875000

UN/NA & ERG Number: UN1839 (solid)/153; UN2564 (solution)/153

EC Number: 200-927-2 [*Annex I Index No.*: 607-004-00-7]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal, Limited Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1999; EPA: Possible Human Carcinogen. ACGIH: A3; Confirmed animal carcinogen with unknown relevance to humans. United States Environmental Protection Agency Gene-Tox Program, Inconclusive: Histidine reversion-Ames test.

California Proposition 65 Chemical[102]: Cancer, 9/13/2013

Hazard Alert: Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction).

United States National Primary Drinking Water Regulations: MCLG = 0.3 mg/L; MCL = 0.060 mg/L, trichloroacetic acid, as a haloacetic acid (HAA_5).

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects[192]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: C, N; Risk phrases: R45; R35; R50/53; R62; R63; Safety phrases: S1/2; S26; S36/37/39; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Trichloroacetic acid is a colorless crystalline solid which is used in liquid solutions. Molecular weight = 163; Specific gravity (H_2O:1) = 1.62 @ 20°C; Boiling point = 198°C; Freezing/Melting point = 58°C; Vapor pressure = 1 mmHg @ 51°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 0. Soluble in water.

Potential Exposure: This haloacetic acid can be a byproduct of drinking water disinfection and may increase the risk of cancer. Trichloroacetic acid is used as medication; in organic syntheses; as a reagent for albumin detection; as an intermediate in pesticide manufacture and in the production of sodium trichloroacetate which is itself a herbicide.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, silver salts, strong acids, strong bases, moisture, iron, zinc, aluminum. Corrosive to iron, steel and other metals.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 6.68 milligram per cubic meter @ 25°C & 1 atm

OSHA PE L: None

NIOSH REL: 1 ppm/7 milligram per cubic meter TWA

ACGIH TLV[1]: 1 ppm/6.7 milligram per cubic meter TWA, confirmed animal carcinogen with unknown relevance to humans.

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 1.5 ppm

PAC-2: 16 ppm

PAC-3: 99 ppm

Austria: MAK 1 ppm (5 milligram per cubic meter), 1999; Belgium: TWA 1 ppm (6.7 milligram per cubic meter), 1993; Denmark: TWA 1 milligram per cubic meter, 1999; France: VME 1 ppm (5 milligram per cubic meter), 1999; Norway: TWA 0.75 ppm (5 milligram per cubic meter), 1999; Russia: STEL 5 milligram per cubic meter, [skin], 1993; Switzerland: MAK-W 1 ppm (7 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 1 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea ACGIH TLV: confirmed animal carcinogen with unknown relevance to humans.

EPA[32] suggests an ambient air limit of 162 μ/m^3 based on health effects.

Permissible Exposure Limits in Water: United States National Primary Drinking Water Regulations: MCLG = 0.3 mg/L; MCL = 0.060 mg/L, trichloroacetic acid, as a haloacetic acid (HAA_5).

Determination in Water: FishTox: 538434.64955000 ppb (VERY LOW).

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: *Inhalation*: Causes irritation to respiratory tract with choking, coughing, dizziness and weakness. Swelling of throat and lungs can occur. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. *Skin*: Corrosive to the skin. Burns and blisters may result if not removed promptly. May cause thickening of skin. *Eyes*: Corrosive to the eyes. Can cause extremely painful burns and sores on eyes, which can result in blindness. *Ingestion*: May cause intense burning of mouth, throat and stomach; vomiting, diarrhea and fatigue. Throat may swell to block airway. The estimated lethal dose is about 1 gm (1/30 oz).

Long-Term Exposure: Increased risk of cancer. Fumes may produce irritation of throat and lungs with persistent cough. Disturbances of the digestive tract may also be noticed. These should only be significant at levels above the recommended occupational exposure limit. Human Tox = 60.00 000 ppb (LOW).

Points of Attack: Eyes, skin, respiratory system; gastrointestinal tract.

Medical Surveillance: This chemical may increase the risk of cancer. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Lung function tests, kidney function tests. Examination of the nervous system. For those with frequent or potentially high exposure (half the TLV or greater) the following are recommended before beginning work and at regular times after that. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water, or milk. Do not induce vomiting. Medical observation is

recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof goggles and face shield when working with powders or dust, unless full facepiece respiratory protection is worn. Wear splash-proof chemical goggles and face shield when working with liquid, unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration*: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA-or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full-facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA)

Storage: Color code-White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in a cool, dry, well-ventilated place away from strong oxidizers, strong bases. Where possible, automatically transfer material from other storage containers to process containers.

Shipping: UN1839 (solid) & UN2564 (solution) Trichloroacetic acid, solid and Trichloroacetic acid, solution, Hazard class: 8; Labels: 8-Corrosive material.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Wearing protective equipment and clothing, spread soda ash on spill and mop up with water. Shovel slurry into appropriate container. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Soil Adsorption Index (K_{oc}) = 3

Fire Extinguishing: Thermal decomposition products may include chlorine, chloroform (trichloromethane), phosgene, hydrogen chloride and oxides of carbon. Extinguish fire using an agent suitable for type of surrounding fire. Trichloroactic acid itself does not burn. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(102); (31); (173); (101); (138); (80); (100).

New York State Department of Health, *Chemical Fact Sheet*: Trichloroacetic Acid, Bureau of Toxic Substance Assessment, Albany, NY (March 1986)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Trichloroacetic Acid, Trenton, NJ (May 2004)

Trichloroacetyl Chloride T:0690

Formula: C_2Cl_4O; Cl_3CCOCl

Synonyms: Acetyl chloride, trichloro-; Cloruro de tricloroacetilo (Spanish); NSC 190466; Superpalite; Trichloroacetic acid chloride; Trichloroacetochloride

CAS Registry Number: 76-02-8

HSDB Number: 6321

RTECS Number: AO7140000

UN/NA & ERG Number: (PIH) UN2442/156

EC Number: 200-926-7

Regulatory Authority and Advisory Information

Hazard Alert: Poison inhalation hazard, Highly poisonous, Corrosive, Violently water reactive.

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500 lb (127.5 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 500 lb (127.5 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT 49CFR172.101, Inhalation Hazardous Chemical (PIH).

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T+; Risk phrases: R14; R22; R26; R27/28; R29; R34; R35; R50/53; Safety phrases: S8; S13; S23; S26; S28; S36/37/39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Trichloroacetyl chloride is a clear liquid. Molecular weight = 182; Specific gravity (H_2O:1) = 1.63 @ 20°C; Boiling point = 118°C; Freezing/Melting point = −146°C; Vapor pressure = 21 mmHg @ 25°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 1₩. Decomposes violently in water, forming hydrochloric acid and trichloroacetic acid.

Potential Exposure: Used in chemical syntheses.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, ethers and metal salts. Violent reaction with water, forming hydrochloric acid and trichloroacetic acid.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 0.055 ppm

PAC-2: 0.61 ppm

PAC-3: 2.8 ppm

Russia[43] set a MAC in workplace air[43] of 0.1 milligram per cubic meter.

Routes of Entry: Inhalation, ingestion, dermal and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Corrosive. Severe irritation to the eyes, skin and respiratory tract. Skin or eye contact may cause burns. Moderately toxic by ingestion and inhalation. High exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: Highly irritating substances may affect the lungs; bronchitis may develop.

Points of Attack: Lungs.

Medical Surveillance. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy. Lung function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water, or milk. Do not induce vomiting.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive pressure mode.

Storage: (1) Color code-White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. (2) Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area. Where possible, automatically transfer material from other storage containers to pro cess containers.

Shipping: UN2442 Trichloroacetyl chloride, Hazard class: 8; Labels: 8-Corrosive material, 6.1-Poisonous materials.

Spill Handling:

Trichloroacetyl chloride

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30

Then: Protect persons downwind (miles/kilometers)

Day 0.1/0.2

Night 0.2/0.3

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)
Day 0.4/0.6
Night 0.8/1.3

Stay upwind and uphill. Isolate the area of release or fire and deny entry. Remove all ignition sources. Stop the release if it can be done safely from a distance. All equipment used to handle this material must be grounded. Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. *Small spill*: Cover with *dry* earth, *dry* sand, or other noncombustible material followed with plastic sheet to minimize spreading or contact with water or rain. Use clean nonsparking tools to collect material and place material into loosely covered plastic containers for later disposal. Prevent material and runoff from entering sewers and waterways if it can be done safely well ahead of the release. Use vapor suppressing foam to disperse vapors—contain runoff. Water spray may reduce vapor, but may not prevent ignition in enclosed spaces. Ventilate confined area if it can be done without placing personnel at risk. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Material may burn but does not ignite readily. Material reacts violently with water. Thermal decomposition products may include phosgene, hydrogen chloride and oxides of carbon. *Small fire*: use *dry* chemical, CO_2, *dry* sand, or alcohol-resistant foam. May react with foams releasing corrosive/toxic gases. *Large fire*: use water spray or alcohol-resistant foam if it is available in sufficient amounts. Under favorable conditions, experienced crews can use coordinated fog streams to sweep the flames off the surface of the burning liquid. Combustible material: may burn but does not ignite readily. Most vapors are heavier than air. They will spread along ground and collect in low or confined areas (sewers, basements, tanks). Vapors may travel to source of ignition and flash back. Containers may explode when heated or if contaminated with water. Keep exposures cool long after fire is out to protect against reignition. Do not direct straight streams into the liquid. Cool exposed containers with large quantities of water from unattended equipment or remove intact containers if it can be done safely. *Do not get water on spilled substance or inside containers*. If cooling streams are ineffective (*venting sound increases in volume and pitch, tank discolors or shows signs of deforming*), withdraw immediately to a secure location. Always stay away from ends of tanks, especially when engulfed in flames. If material or contaminated runoff from fire control enters waterways, notify downstream users of potentially contaminated water. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Do not discharge into drains or sewers. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Controlled incineration (oxides of nitrogen are removed from the effluent gas by scrubbers and/or thermal devices) Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Trichloroacetyl Chloride, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987

1,2,4-Trichlorobenzene T:0700

Formula: $C_6H_3Cl_3$

Synonyms: Benzene, 1,2,4-trichloro-; Hostetex L-PEC; 1,2,5-Trichlorobenzene; 1,3,4-Trichlorobenzene; *asym*-Trichlorobenzene; 1,2,4-Trichlorobenzol; 1,2,4-Triclorobenceno (Spanish)

CAS Registry Number: 120-82-1

HSDB Number: 1105

RTECS Number: DC2100000

UN/NA & ERG Number: UN2321/153

EC Number: 204-428-0 [*Annex I Index No*.: 602-087-00-6]

Regulatory Authority and Advisory Information

Carcinogenicity: EPA: Not Classifiable as to human carcinogenicity.

Hazard Alert: Poison, Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction), Environmental hazard. Listed for Tier 1 screening as an endocrine disruptor[88].

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.055; Nonwastewater (mg/kg), 19

RCRA 40CFR264, appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10)

United States National Primary Drinking Water Regulations: MCLG = 0.07 mg/L; MCL = 0.07 mg/L

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 100 lb (45.4 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, appendix B) as trichlorobenzenes, liquid

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects[192]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: Xn, N; Risk phrases: R22; R38; R50/53; R62; R63; Safety phrases: S2; S37/39; S41; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: 1,2,4-Trichlorobenzene is a low-melting solid or liquid with a pleasant, aromatic odor. The Odor Threshold is 1.4 ppm. Molecular weight = 181.5; Specific gravity (H_2O:1) = 1.46 @ 20°C; Boiling point = 214°C; Freezing/Melting point 17°C; Vapor pressure = 0.5 mmHg @25°C; Flash point = 105°C; Autoignition temperature = 571°C. Explosive limits: LEL = 2.5%; UEL: 6.6%, both @ 150°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Insoluble in water; solubility = 0.003%.

Potential Exposure: 1,2,4-Trichlorobenzene is used as a dye carrier, herbicide intermediate; a heat transfer medium; a dielectric fluid in transformers; a degreaser; a lubricant; as an industrial chemical; solvent, emulsifier, and as a potential insecticide against termites. The other trichlorobenzene isomers are not used in any quantity.

Incompatibilities: Reacts violently with oxidants, acids, acid fumes; steam.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 7.42 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: None

NIOSH REL: 5 ppm/40 milligram per cubic meter Ceiling Concentration

ACGIH TLV[1]: 5 ppm/37 milligram per cubic meter Ceiling Concentration

European OEL: 2 ppm/15.1 milligram per cubic meter TWA; 5 ppm, 37.8 milligram per cubic meter STEL [skin][2003].

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 0.45 ppm

PAC-2: 5 ppm

PAC-3: 20 ppm

DFG MAK: [skin] Carcinogen Category 3B

Australia: TWA 5 ppm (40 milligram per cubic meter), 1993; Austria: MAK 5 ppm (40 milligram per cubic meter), 1999; Belgium: STEL 5 ppm (37 milligram per cubic meter), 1993; Denmark: TWA 5 ppm (40 milligram per cubic meter), 1999; Finland: TWA 5 ppm (40 milligram per cubic meter), STEL 10 ppm (74 milligram per cubic meter), [skin], 1999; France: VME 5 ppm (40 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 15.1 milligram per cubic meter, [skin], 2003; Switzerland: MAK-W 5 ppm (40 milligram per cubic meter), 1999; United Kingdom: TWA 1 ppm (7.6 milligram per cubic meter), [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Ceiling Concentration 5 ppm

Several states have set guidelines or standards for 1,2,4-trichlorobenzene in ambient air[60] ranging from 133 μ/m^3 (New York); to 350 μ/m^3 (Virginia); to 400 μ/m^3 (North Dakota and South Carolina); to 800 μ/m^3 (Connecticut); to 952 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #5517, Polychlorobenzenes.

Permissible Concentration in Water: Safe Drinking Water Act (47FR 9352): MCL, 0.07 mg/L; MCLG, 0.7 mg. To protect human health-no criterion developed due to insufficient data[6]. Several states have set guidelines or standards for 1,2,4-trichlorobenzene in drinking water[61]. These include a guideline of 13 μg/L (Kansas) and a standard of 8 μg/L (New Jersey). Russia [43] set a MAC for water bodies used for domestic purposes of 30 μg/L.

Determination in Water: Methylene chloride extraction followed by concentration, gas chromatography with electron capture detection (EPA Method 612) or gas chromatography plus mass spectrometry (EPA Method 625). Octanol-water coefficient: Log $K_{ow} = \sim 4$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: *Inhalation*: May cause irritation to the nose and throat, nervousness, restlessness, tremors, increased heart rate and blood pressure; weakness, digestive disturbances; weight loss; and headache.

Skin: May cause severe irritation. Prolonged contact may cause skin burns.

Eyes: Causes irritation. Levels greater than 5 ppm may cause severe irritation.

Ingestion: Animal studies suggest that a dose of 2 ounces may cause liver damage and death.

Long-Term Exposure: Changes to the adrenal glands. May cause liver and kidney damage. Removes the skin's natural oils, causing drying and cracking. Possible teratogenic effects.

Points of Attack: Eyes, skin, respiratory system; liver, reproductive system.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function test. Urinary 2,5-dichlorophenol excretion test.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Teflon, Neoprene , and polyvinyl alcohol are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures *over 5* ppm; Use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive pressure mode.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. 1,2,4-Trichlorobenzene must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates), since violent reactions occur. Sources of ignition, such as smoking and open flames, are prohibited where 1,2,4-trichlorobenzene is used, handled, or stored in a manner that could create A potential fire or explosion hazard.

Shipping: UN2321 Trichlorobenzenes, liquid, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include phosgene, chlorine, hydrogen chloride and oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced[22].

References

(31); (173); (101); (138); (2); (100).

United States Environmental Protection Agency, Chlorinated Benzenes: Ambient Water Quality Criteria, Washington, DC (1980)

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 4, No. 3, 96−99 (1984)

New York State Department of Health, *Chemical Fact Sheet*: 1,2,4-Trichlorobenzene, Bureau of Toxic Substance Assessment, Albany, NY (Version 2-March 1986)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: 1,2,4-Trichlorobenzene, Trenton, NJ (August 2005)

Trichloro(chloromethyl)silane T:0710

Formula: CH_2Cl_4Si; $Si(CH_2Cl)Cl_3$
Synonyms: (Chloromethyl)trichlorosilane; Chloromethyl (trichloro)silane; Trichloro(chloromethyl)silane
CAS Registry Number: 1558-25-4
HSDB Number: 6419
RTECS Number: VV2200000
UN/NA & ERG Number: (PIH) UN3389 (Inhalation Hazard Zone A)/154; UN1295(trichlorosilane)/139;
EC Number: 216-316-9

Regulatory Authority and Advisory Information

Hazard Alert: Poison inhalation hazard, Combustible, Extremely Flammable; may ignite spontaneously, Corrosive, Violently reactive with water.

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg)

OSHA 29CFR1910.119, Appendix A, Process Safety List of Highly Hazardous Chemicals, TQ = 100 lb (45 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 100 lb (45 kg)

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T+, F, C; Risk phrases: R10; R14; R15/29; R26; R27/28; R34; R50/53; Safety phrases: S7/8; S13; S17; S26; S28; S30; S36/37/39; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Trichloro(chloromethyl)silane is a colorless liquid. Sharp, biting odor. Molecular weight = 184; Specific gravity (H_2O:1) = 1.5 @ 20°C; Boiling point = 118°C; Freezing/Melting point = 111°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 1 ₩. Reacts violently with water, rapidly releasing corrosive hydrogen chloride gas.

Potential Exposure: Used in the synthesis of polysiloxane (silicone polymers).

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Chlorosilanes react vigorously with bases and both organic and inorganic acids generating toxic and/or flammable gases. Chlorosilanes react with water, moist air, or steam to produce heat and toxic, corrosive fumes of hydrogen chloride. They may also produce flammable gaseous hydrogen. Attacks metals in the presence of moisture.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)* Ver. 29[138]
PAC-1: $\mathbf{0.60_A}$ ppm
PAC-2: $\mathbf{7.3_A}$ ppm
PAC-3: $\mathbf{33_A}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin, and respiratory tract. Contact with the eyes causes irritation, pain, swelling; corneal erosion and blindness may result. Contact with the skin causes dermatitis (red, inflamed skin), severe burns; pain, and shock generally follow dermal exposure. Acute inhalation exposure may result in sneezing, choking, laryngitis, dyspnea (shortness of breath), respiratory tact irritation; and chest pain. Bleeding of nose and gums, ulceration of the nasal and oral mucosa; pulmonary edema; chronic bronchitis; and pneumonia may also occur. If ingested, symptoms include increased salivation; intense thirst; difficulty in swallowing; chills, pain, and shock. Effects may include severe pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Oral, esophageal, and stomach burns are common. Vomitus generally has a coffee-ground appearance. The potential for circulatory collapse is high following ingestion.

Long-Term Exposure: Highly irritating substances may cause lung effects and damage.

Points of Attack: Lungs.

Medical Surveillance: Medical observation is recommended for 24–48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Obtain authorization and/or further instructions from the local hospital for administration of an antidote or performance of other invasive procedures. Rush to a health care facility. Medical observation is recommended for 24–48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area away from oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored.

Storage: Poison inhalation chemical (PIH); check oxygen content prior to entering storage area. (1) Color code-Red Stripe: Dangerous when wet materials release flammable gases on contact with water. Do not store this material in a room protected by water sprinkler systems. Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8–10 meters or a 1-hour fire wall from flammable or reactive materials. Do not store in a basement. (2) Color code-Red: Flammability Hazard: Store in a flammable (liquid or solid materials) storage area or approved cabinet away from sources if ignition. (3) Color code-White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location; keep acids away from bases and red, yellow, and blue-coded chemicals. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from strong oxidizers. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN3389 Toxic by inhalation liquid, corrosive, n.o.s. with an $LC_{50} \leq 200$ mL/m^3 and saturated vapor concentration ≥ 500 Hazard Class: 6.1; Labels: 6.1-Poisonous materials, 8-Corrosive material, Technical Name Required, Inhalation Hazard Zone A. UN1295 Trichlorosilane, Hazard Class: 4.3; Labels: 4.3-Dangerous when wet material, 3-Flammable liquid, 8-Corrosive material.

Spill Handling:
Inhalation Hazard Zone A

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)
First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)
Day 0.2/0.3
Night 0.6/0.9

Large spills (From a large package or from many small packages)
First: Isolate in all directions (feet/meters) 600/180
Then: Protect persons downwind (miles/kilometers)
Day 1.0/1.5
Night 1.9/3.1

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Stay upwind; keep out of low areas. If water pollution occurs, notify appropriate authorities. Shut off ignition sources; no flares, smoking or flames in hazard area. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors do not get water inside container. *Small spills*: flush area with flooding amounts of water. *Large spills*: dike far ahead of sp ill for later disposal. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extremely flammable; may spontaneously ignite. Avoid sources of extreme heat or ignition including sparks or fire. Upon contact with water, trichloro (chloromethyl) silane will release hydrochloric acid. Thermal decomposition products may include hydrogen chloride and oxides of carbon. Use dry chemical, CO_2 or foam extinguishers. *Do not use water*. Vapor explosion hazard indoors, outdoors, or in sewers. Runoff to sewer may create fire or explosion hazard. Move container from fire area if you can do it without risk. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. Do not get water inside container. Cool containers that are exposed to flames with water from the side until well after fire is out. Stay away from ends of tanks. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Trichloro(Chloromethyl)Silane, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

1,1,1-Trichloroethane T:0720

Formula: $C_2H_3Cl_3$; CH_3CCl_3

Synonyms: Aerothene TT; CF2; Chlorotene; Chlorothane NU; Chlorothene; Chlorothene NU; Chlorothene SM; Chlorothene VG; Chlorten; Ethana NU; Ethane, 1,1,1-trichloro-; ICI-CF2; Inhibisol; Methylchloroform; Methyltrichloromethane; NCI-C04626; Solvent 111; Strobane; α-T; Tafclean; 1,1,1-TCE; 1,1,1-Trichloraethan (German); 1,1,1-Trichlorethane; α-Trichloroethane; Trichloro-1,1,1-ethane (French); Trichloroethane; Trichloromethylmethane; 1,1,1-Tricloroetano (Spanish); Tri-ethane

CAS Registry Number: 71-55-6; (*alt.*) 74552-83-3

HSDB Number: 157

RTECS Number: KJ2975000

UN/NA & ERG Number: UN2831/160

EC Number: 200-756-3 [*Annex I Index No.*: 602-013-00-2]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal, Inadequate Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1999; EPA: Inadequate Information to assess carcinogenic potential; NIOSH: Potential occupational carcinogen.

Hazard Alert: Poison, Combustible, Vapors may have a narcotic effect, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction). Listed for Tier 1 screening as an endocrine disruptor[88].

Clean AIR Act: Hazardous Air Pollutants (Title I, Part A, Section 112); Stratospheric ozone protection (Title VI, Subpart A, appendix A), Class I, Ozone Depletion Potential (ODP) = 0.1, all isomers except 1,1,2-trichlorethane

Harms public health and the environment by destroying ozone in the upper atmosphere.

Clean Water Act: Section 307(a)(1)Toxic Pollutants subject to effluent limitations as chlorinated ethanes

Clean Water Act: Toxic Pollutant (Section 401.15) & Section 307(a)(1)Toxic Pollutants subject to effluent limitations as Chlorinated ethanes.

United States National Primary Drinking Water Regulations: MCLG = 0.2 mg/L; MCL = 0.2 mg/L

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U226

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.054; Nonwastewater (mg/kg), 6.0

RCRA 40CFR264, appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8240(5)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 1000 lb (454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%.

Harms public health and the environment by destroying ozone in the upper atmosphere.

Hazard Symbol: Xn, N; Risk phrases: R20; R58/59; R61; R62; R63; Safety phrases: S2; S24/25; S57; S59; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: 1,1,1-Trichloroethane is a colorless liquid. It has an odor similar to chloroform. The Odor Threshold is 120 ppm (NJ) or 400 ppm (NY). Molecular weight = 133.4; Specific gravity (H_2O:1) = 1.34 @ 20°C; Boiling point = 74°C; Freezing/Melting point = −30°C; Vapor pressure = 100 mmHg @ 25°C; 75 mm Hg @ 14.2°C[138]; Flash point = none; Autoignition temperature = 537. Explosive limits: LEL = 7.5%; UEL: 12.5%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Practically insoluble in water; solubility = 0.4%. ₩ Reacts slowly with water forming hydrochloric acid.

Potential Exposure: 1,1,1-Trichloroethane is used as a cleaning solvent, chemical intermediate for vinylidene chloride. In liquid form it is used as a degreaser and for cold cleaning, dip-cleaning; and bucket cleaning of metals. Other industrial applications of 1,1,1-trichlroethane's solvent properties include its use as a dry-cleaning agent; a vapor degreasing agent; and a propellant. In recent years, 1,1,1-trichloroethane has found wide use as a substitute for carbon tetrachloride.

Incompatibilities: Not flammable under normal conditions. However, in close or closed spaces, it may form a dangerously explosive atmosphere. See also fireextinguishing section. Strong caustics; strong oxidizers; chemically active metals, such as aluminum, magnesium powder; sodium, potassium. Reacts slowly with water forming hydrochloric acid. Upon contact with hot metal or exposure to UV radiation, it will decompose to form hydrochloric acid, phosgene and dichloroacetylene. Forms shock-sensitive mixtures with potassium or its alloys. Attacks natural rubber.

Permissible Exposure Limits in Air

NIOSH IDLH = 700 ppm

Conversion factor: 1 ppm = 5.46 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 350 ppm/1900 milligram per cubic meter TWA

NIOSH REL: 350 ppm/1900milligram per cubic meter [15 min.] Ceiling Concentration. NIOSH considers methyl chloroform to be A potential occupational carcinogen. Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix C.

ACGIH TLV[1]: 350 ppm /1910 milligram per cubic meter TWA, 450 ppm/2460 milligram per cubic meter STEL, not classifiable as a human carcinogen; BEI: 40 ppm methyl chloroform in end-exhaled air prior to last shift of workweek; 10 mg/L trichloroacetic acid in urine at end of work week; 30 mg/L total trichloroethanol in urine, end-of-shift at end-of-workweek; 1 mg/L total trichloroethanol in bolld, end-of-shift at end of workweek.

Protective Action Criteria (PAC)* Ver. 29[138]

PAC-1: $\mathbf{230}_{\mathbf{A}}$ ppm

PAC-2: $\mathbf{600}_{\mathbf{A}}$ ppm

PAC-3: $\mathbf{4200}_{\mathbf{A}}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

DFG MAK: 200 ppm/1100 milligram per cubic meter TWA; Peak Limitation Category II(1) [skin], Pregnancy Risk Group: C; BAT: 550 μg]/L in blood after several shifts [for long-tme exposure]; at the beginning of next shift.

Australia: TWA 125 ppm (680 milligram per cubic meter), 1993; Austria: MAK 200 ppm (1080 milligram per cubic meter), 1999; Belgium: TWA 350 ppm (1910 milligram per cubic meter), STEL 450 ppm (2460 milligram per cubic meter), 1993; Denmark: TWA 50 ppm (275 milligram per cubic meter), 1999; Finland: TWA 100 ppm (540 milligram per cubic meter), STEL 250 ppm (1400 milligram per cubic meter), 1999; France: VME 300 ppm (1650 milligram per cubic meter), VLE 450 ppm (2500 milligram per cubic meter), 1999; Hungary: TWA 100 milligram per cubic meter, STEL 300 milligram per cubic meter, [skin], 1993; the Netherlands: MAC-TGG 555 milligram per cubic meter, 2003; Norway: TWA 50 ppm (270 milligram per cubic meter), 1999; the Phillipines: TWA 350 ppm (1900 milligram per cubic meter), 1993; Poland: MAC (TWA) 300 milligram per cubic meter; MAC (STEL) 1400 milligram per cubic meter, 1999; Russia: TWA 200 ppm, STEL 20 milligram per cubic meter, 1993; Sweden: NGV 50 ppm (300 milligram per cubic meter), KTV 90 ppm (500 milligram per cubic meter), 1999; Switzerland: MAK-W 200 ppm (1080 milligram per cubic meter), KZG-W 1000 ppm, 1999; Turkey: TWA 350 ppm (1900 milligram per cubic meter), 1993; United Kingdom: TWA 200 ppm (1110 milligram per cubic meter), STEL 400 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 450 ppm. Several states have set guidelines or standards for 1,1,1-Trichloroethane in ambient air[60] ranging from 1.3 milligram per cubic meter (Massachusetts); to 12.0−245.0 milligram per cubic meter (North Carolina); to 19.0 milligram per cubic meter (Indiana); to 19.0−24.5 milligram per cubic meter (North Dakota); to 32.0 milligram per cubic meter (Virginia); to 38.0 milligram per cubic meter (Connecticut, New York, South Dakota); to 45.238 milligram per cubic meter (Nevada). Russia set a MAC for ambient air[43] in residential areas of 2.0 milligram per cubic meter on a once-daily basis and 0.2 milligram per cubic meter on a daily average basis.

Determination in Air: Use NIOSH Analytical Method #1003, Hydrocarbons, halogenated,[18]; OSHA Analytical Method 14. See also, NIOSH Analytical Method #2549, Volatile organic compounds

Permissible Concentration in Water: Safe Drinking Water Act (47FR 9352): MCL, 0.2 mg/L; MCLG, 0.20 mg/L. Federal Drinking Water Standards: EPA 200 μg/L; Federal Drinking Water Guidelines EPA 200 μg/L; State Drinking Water Standards: New Jersey 30 μg/L; State Drinking Water Guidelines: Arizona 200 μg/L; Connecticut 200 μg/L; Minnesota 9000 μg/L.

Determination in Water: Charcoal tube; CS2; Gas chromatography/Flame ionization detection; NIOSH Analytical Method (IV) #1003, Halogenated hydrocarbons. Octanol-water coefficient: Log $K_{ow} = 2.5$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation of vapor, moderate skin adsorption, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin, and respiratory tract. *Inhalation*: Exposure can cause headache, lassitude (weakness, exhaustion), CNS depressant/depression; poor equilibrium; cardiac arrhythmias; liver damage. May affect the heart and CNS; kidneys and liver; causing cardiac disorders and respiratory failure. Levels above 900 ppm can cause dizziness, mental confusion; drowsiness, loss of coordination and unconsciousness. Death may result. *Skin*: Contact can cause irritation and rash. Absorption is moderate; may contribute significantly to health hazard. *Eyes*: Contact causes irritation The vapor has caused irritation at levels of 450 ppm. *Ingestion*: May cause symptoms similar to inhalation. In addition, may cause mouth, throat and stomach irritation.

Long-Term Exposure: Liver, nervous system, or circulatory system problems. High exposures may damage the liver and kidneys. Prolonged contact can cause thickening and cracking of the skin. Repeated or prolonged contact at levels of 450 ppm or above may result in irritation and dry, scaley, fractured skin. Additionally, NIOSH recommends that this chemical be treated in the workplace with caution because of its structural similarity to other chloroethanes shown to be carcinogenic in animals.

Points of Attack: Eyes, skin, CNS; cardiovascular system, liver.

Medical Surveillance: NIOSH lists the following tests: whole blood (chemical/metabolite); whole blood (chemical/metabolite), During Exposure; whole blood (chemical/metabolite), end-of-shift; whole blood (chemical/metabolite), end-of-workweek; whole blood (chemical/metabolite), end-of-workweek, expired air, expired air, 16 Hours following end of exposure; expired air, end-of-workweek; expired air, prior to next shift; expired air prior to last shift of workweek; urine (chemical/metabolite); urine (chemical/metabolite), end-of-shift; urine (chemical/metabolite), endo f-shift at end-of-workweek; urine (chemical/metabolite), end-of-workweek; urine (chemical/metabolite), prior to next shift. Consider the skin, liver function; cardiac status, especially arrythmias; in preplacement or periodic examinations. Expired air analyses may be useful in monitoring exposure. Persons with heart disease may be at an increased risk of irregular heartbeat from very high exposures.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin contact: **8 hours**: polyvinyl alcohol gloves; Viton gloves, suits; 4H and Silver Shield gloves; Barricade coated suits; CPF3 suits; Responder suits; Trychem 1000 suits; **4 hours**: Teflon gloves, suits, boots. Also, protective clothing of leather or Neoprene may offer some protection. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, head gear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 700 ppm*: Sa (APF = 10) (any supplied-air respirator);* or SCBA (any SCBA with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus). *Escape*: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA). *Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Methyl chloroform must be stored to avoid contact with strong caustics (such as sodium and potassium hydroxide); acetone, strong oxidizers (such as chlorine, chlorine dioxide, and bromine); and chemically active metals (such as potassium aluminum, zinc, and magnesium); since violent reactions occur. Do not allow vapor near sources of UV light, such as arc welding, because poisonous gases may be produced. Store in tightly closed containers in a cool, well-ventilated area away from heat and moisture. Do not use aluminum containers.

Shipping: UN2831 1,1,1-Trichloroethane, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: 1,1,1-Trichloroethane's combustible mixtures with air do not readily ignite, but ignition may occur in conditions of excess oxygen or in the presence of a high-energy ignition sources, such as sparks, a furnace; or welding. Thermal decomposition products may include hydrogen chloride, chlorine, phosgene, dichloroacetylene and oxides of carbon. Use dry chemical, CO_2, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced. As an alternative to disposal, trichloroethane may be recovered from waste gases and liquids from various processes and recycled.

References

(31); (173); (101); (138); (2); (80); (100).

National institute for Occupational Safety and Health (NIOSH), "Criteria for a Recommended Standard: Occupational Exposure to 1,1,1-Trichloroethane (Methyl Chloroform)," NIOSH Document Number 76-184, Cincinnati OH (1976)

United States Environmental Protection Agency, Chlorinated Ethanes: Ambient Water Quality Criteria, Washington, DC (1980)

United States Environmental Protection Agency, 1,1,1-Trichloroethane, Health and Environmental Effects Profile No. 164, Washington, DC, Office of Solid Waste (April 30, 1980)

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 1, 124–126 (1982), and 5, No. 6, 28–30 (1985)

New York State Department of Health, *Chemical Fact Sheet*: 1,1,1-Trichloroethane, Bureau of Toxic Substance Assessment, Albany, NY (April 1986)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Methyl Chloroform, Trenton, NJ (February 2001).

1,1,2-Trichloroethane T:0730

Formula: $C_2H_3Cl_3$; $CH_2ClCHCl_2$

Synonyms: Cement-339; Ethane trichloride; Ethane, 1,1, 2-trichloro-; NCI-C04579; β-T; 1,2,2-Trichloroethane; β-Trichloroethane; 1,1,2-Tricloroetano (Spanish); Vinyltrichloride

CAS Registry Number: 79-00-5

HSDB Number: 1412

RTECS Number: KJ3150000

UN/NA & ERG Number: UN3082 (environmentally hazardous substances, liquid, n.o.s.)/171

EC Number: 201-166-9 [*Annex I Index No*.: 602-014-00-8]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal, Inadequate Evidence; Human No Adequate Data, *not classifiable as carcinogenic to humans*, Group 3, 1999; EPA: Possible Human Carcinogen; NCI: Carcinogenesis Bioassay (gavage); clear evidence: mouse; no evidence: rat; NIOSH: Potential occupational carcinogen.

California Proposition 65 Chemical[102]: Cancer 10/1/1990.

Hazard Alert: Combustible (when heated), Possible risk of forming tumors, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction). Listed for Tier 1 screening as an endocrine disruptor[88].

Clean AIR Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Clean Water Act: Section 307(a)(1)Toxic Pollutants subject to effluent limitations as Chlorinated ethanes.

Water Monitoring List. Suggested test method(s) (PQL μg/L): 8010 (0.2); 8240 (5)

United States National Primary Drinking Water Regulations: MCLG = 0.003 mg/L; MCL = 0.005 mg/L.

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U227

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.054; Nonwastewater (mg/kg), 6.0

RCRA 40CFR264, appendix 9; TSD Facilities Ground

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 100 lb (45.4 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects.[291] Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T, Xn; Risk phrases: R45; R20/21/22; R40; R50/53; R62; R66; Safety phrases: S2; S9; S36; S37; S46 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: 1,1,2-Trichloroethane is a colorless, nonflammable (must be pre-heated before ignition can occur) liquid Sweet, chloroform-like odor. Molecular weight = 133.40; Specific gravity (H_2O:1) = 1.44 @ 25°C; Boiling point = 114°C; Freezing/Melting point = −36°C. Vapor pressure = 19 mmHg @ 25°C; Flash point: None but material is combustible when preheated above 109/F/43°C. Ignition temperature = > 450°C. Explosive limits are: LEL = 6.0%; UEL: 15.5%. Hazard Identification (based on NFPA-704 M Rating System): Health 2−3, Flammability 1, Reactivity 0. Practically insoluble in water; solubility = 0.4%.

Potential Exposure: 1,1,2-Trichloroethane is used as an intermediate in the production of vinylidine chloride, and a component of adhesives; as a solvent; but is not as widely used as is its isomer 1,1,1-Trichloroethane; it is an isomer of 1,1,1-Trichloroethane *but should not be confused with it toxicologically*. 1,1,2-Trichloroethane is comparable to carbon tetrachloride and tetrachloroethane in toxicity. Forms a flammable vapor−air mixture at 43°C and higher.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong acids, strong caustics; chemically active metals;, such as aluminum, magnesium powders, sodium, potassium. Attacks some plastics, rubber, coatings, steel, and zinc.

Permissible Exposure Limits in Air

NIOSH IDLH = 100 ppm

Conversion factor: 1 ppm = 5.46 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 10 ppm/45 milligram per cubic meter TWA [skin]

NIOSH REL: 10 ppm/45 milligram per cubic meter TWA [skin], Potential occupational carcinogen; limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide* Appendix A & C.

ACGIH TLV[1]: 10 ppm TWA [skin], animal carcinogen with Unknown Relevance to Humans.

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 30 ppm

PAC-2: 180 ppm

PAC-3: 500 ppm

DFG MAK: 10 ppm/55 milligram per cubic meter TWA; Peak Limitation Category II(2) [skin]; Carcinogen Category 3B

Arab Republic of Egypt: TWA 10 ppm (40 milligram per cubic meter), [skin], 1993; Australia: TWA 10 ppm (45 milligram per cubic meter), [skin], 1993; Austria: MAK 10 ppm (55 milligram per cubic meter), [skin], Suspected: carcinogen, 1999; Belgium: TWA 10 ppm (55 milligram per cubic meter), [skin], 1993; Denmark: TWA 10 ppm (54 milligram per cubic meter), [skin], 1999; Finland: TWA 10 ppm (54 milligram per cubic meter), STEL 20 ppm (110 milligram per cubic meter), [skin], 1999; Hungary: TWA 10 milligram per cubic meter, STEL 20 milligram per cubic meter, [skin], 1993; the Netherlands: MAC-TGG 45 milligram per cubic meter, [skin], 2003; Norway: TWA 10 ppm (54 milligram per cubic meter), 1999; Russia: TWA 10 ppm, 1993; Switzerland: MAK-W 10 ppm (55 milligram per cubic meter), KZG-W 50 ppm (275 milligram per cubic meter), [skin], 1999; United Kingdom: LTEL 10 ppm (45 milligram per cubic meter), STEL 20 ppm, [skin], 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: confirmed animal carcinogen with unknown relevance to humans. Several states have set guidelines or standards for 1,1,2-trichloro ethane in ambient air[60] ranging from 0.00 μ/m^3 (Massachusetts); to 7.0 μ/m^3 (Rhode Island); to 27.0 μ/m^3 (Pennsylvania); to 107.143 μ/m^3 (Kansas); to 150.0 μ/m^3 (New York); to 225.0 μ/m^3 (Connecticut and Indiana); to 450.0 μ/m^3 (Florida and North Dakota); to 900.0 μ/m^3 (Virginia); to 1,071.0 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #1003, Halogenated hydrocarbons, OSHA Analytical Method 11.

Permissible Exposure Limits in Water: Safe Drinking Water Act (47FR 9352): MCL, 0.005 mg/L; MCLG, 0.003 mg/L. Federal Drinking Water Standards: EPA 5 μg/L; Federal Drinking Water Guidelines EPA 3 μg/L; State Drinking Water Standards: New Jersey 3 μg/L; State Drinking Water Guidelines: Arizona 0.61 μg/L; Maine 6 μg/L; Minnesota 3 μg/L.

Determination in Water: Unlikely to bioaccumulate in marine organisms. Inert gas purge followed by gas chromatography with halide specific detection (EPA Method 601) or gas chromatography plus mass spectrometry (EPA Method 624). Octanol-water coefficient: Log $K_{ow} = < 2$. Unlikely to bioaccumulate in marine organisms. Harmful to aquatic life in low concentrations[136].

Routes of Entry: Inhalation of vapor, absorption through the skin, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Exposure may cause central nervous depression. May affect the kidneys and liver. *Inhalation*: Inhalation may produce headache, lassitude, dizziness, a lack of coordination; low blood pressure; irregular heart beat; coma and death from respiratory arrest.

Exposure to vapor concentrations near 2000 ppm for 5 minutes causes CNS depression and anesthetic effects. Symptoms are nasal irritation, drowsiness an equilibrium disturbances. Death may result from 13,600 ppm for 2 hours. *Skin*: Can cause irritation and chemical burns if allowed to remain on the skin for a prolonged period. May be absorbed through the skin to cause or increase the severity of symptoms listed above. *Eyes*: Can cause irritation. *Ingestion*: May cause effects similar to those listed under inhalation. Laboratory studies with animals suggest that the probable lethal dose for humans is about 12 ounces. Liver and kidney damage have occurred in animals.

Long-Term Exposure: Liver, kidney and/or immune system problems. Can destroy the skin's natural oils, causing drying and cracking. Inhalation may cause liver and kidney damage. NIOSH recommends this chemical be treated as A potential occupational carcinogen. Has caused cancer in laboratory animals.

Points of Attack: Eyes, respiratory system; CNS; liver, kidneys. Cancer site in animals: liver cancer.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. NIOSH lists the following tests: Expired Air. For those with frequent or potentially high exposure (half the TLV or greater, or significant skin contact) the following are recommended before beginning work and at regular times after that: Liver and kidney function tests. If symptoms develop or overexposure is suspected, the following may be useful: special 24 hour EKG (Holter monitor), to look for irregular heart beat.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Viton and Teflon are recommended as protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration*: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive pressure mode). Escape: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

Storage: (1) Color code-Blue: Health Hazard/Poison: Store in a secure poison location. (2) Color code-Red: Flammability Hazard: Store in a flammable (liquid or materials) storage ea or approved cabinet. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. 1,1,2-Trichloroethane must be stored to avoid contact with strong oxidizers (such as chlorates, nitrates, peroxides, chlorine, and bromine); strong caustics; and chemically active metals (such as potassium, magnesium, zinc, and sodium); because violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where 1,1,2-trichloroethane is used, handled, or stored in a manner that could create A potential fire or explosion hazard. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN3082 Environmentally hazardous substances, liquid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Nonflammable (must be pre-heated before ignition can occur) Containers may explode in fire. Not flammable under normal conditions but can be ignited by high-energy ignition sources, such as a furnace, or welding. Forms a flammable vapor−air mixture at >43°C. Thermal decomposition products may include hydrogen chloride, phosgene and oxides of carbon. Use dry chemical, CO_2, or foam extinguishers and water to keep fire-exposed containers cool. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced.

References

(102); (31); (173); (101); (138); (2); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: 1,1,2-Trichloroethane, Washington, DC (August 1, 1978) (Revised issue 1979)

United States Environmental Protection Agency, Chlorinated Ethanes: Ambient Water Quality Criteria, Washington, DC (1980)

United States Environmental Protection Agency, 1,1,2-Trichloroethane, Health and Environmental Effects Profile No. 165, Washington, DC, Office of Solid Waste (April 30, 1980)

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 2, No. 6, 88−90 (1982) and 3, No. 2, 66−69 (1983)

United States Public Health Service, "Toxicological Profile for 1,1,2-Trichloroethane," Atlanta, Georgia, agency for Toxic Substances and Disease Registry (December 1988)

New York State Department of Health, *Chemical Fact Sheet*: 1,1,2-Trichloroethane, Bureau of Toxic Substance Assessment, Albany, NY (May 1986 and Version 2)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: 1,1,2-Trichloroethane, Trenton, NJ (march 2002)

Trichloroethylene T:0740

Formula: C_2HCl_3; $ClCH{=}CCl_2$

Synonyms: Acetylene trichloride; Algylen; Anamenth; Benzinol; Blacosolv; Cecolene; Chlorilen; Chlorylea; Chorylen; Circosolv; Crawhaspol; Densinfluat; Dow-tri; Dukeron; Ethene, trichloro-; Ethinyl trichloride; Ethylene trichloride; Ethylene, trichloro-; Fleck-flip; Fluate; Germalgene; Halocarbon 113; Lanadin; Lethurin; Narcogen; Narkosoid; NCI-C04546; Nialk; Perm-α-chlor; Petzinol; TCE; Threthylen; Threthylene; Trethylene; Tri; Triad; Triasol; Trichloraethen (German); Trichloran; Trichloren; Trichlorethene (French); Trichloroethene; 1, 1,2-Trichloroethylene; Trichloroethylene tri (French); Trichlororan; 1,1,2-Trichloro-1,2,2-trifluoroethane; Triclene; Tricloroetileno (Spanish); Trielene; Trielin; Trieline; Trilentrilene; Trimar; Tri-plus; TTE; Vestrol; Vitran; Westrosol

CAS Registry Number: 79-01-6; *(alt.)* 52037-46-4

HSDB Number: 133

RTECS Number: KX4550000

UN/NA & ERG Number: UN1710/160

EC Number: 201-167-4 [*Annex I Index No.*: 602-027-00-9]

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Animal, Sufficient Evidence; Human, Limited Evidence, Group 2A, 1995; NCI: Carcinogenesis Studies (gavage); clear evidence: mouse; no evidence: rat; NIOSH: Potential occupational carcinogen. United States Environmental Protection Agency Gene-Tox Program, Positive: Cell transformation-RLV F344 rat embryo; Host-mediated assay; Positive: Mouse spot test; Sperm morphology-mouse; Positive: S *cerevisiae* gene conversion; S *cerevisiae-homozygosis*; Positive: S cerevisiae-reversion; Positive/limited: Carcinogenicity-mouse/rat; Negative: D *melanogaster* sex-linked lethal; Inconclusive: Histidine reversion-Ames test.

California Proposition 65 Chemical[102]: Cancer 4/1/1988.

Hazard Alert: Poison, Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction).

Clean AIR Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

United States National Primary Drinking Water Regulations: MCL = zero mg/L; MCL = 0.005 mg/L.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR 401.15 Section 307 Toxic Pollutants; 40CFR423, Appendix A, Priority Pollutants

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U228; D040

RCRA Toxicity Characteristic (Section 261.24), Maximum Concentration of Contaminants, regulatory level, 0.5 mg/L

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.054; Nonwastewater (mg/kg), 6.0

RCRA 40CFR264, appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8010 (1); 8240 (5)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 100 lb (45.4 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects[194]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T, N; Risk phrases: R45; R36/38; R50/53; R61; R62; R63; R67; Safety phrases: S41; S45; S53; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Trichloroethylene, a colorless (often dyed blue), nonflammable, noncorrosive liquid that has the "sweet" odor characteristic of some chlorinated hydrocarbons. The Odor Threshold is 25−50 ppm. Molecular weight = 132; Specific gravity (H_2O:1) = 1.5 @ 20°C; Boiling point = 87°C; Freezing/Melting point = −85°C; Vapor pressure = 58 mmHg @ 25°C; 75 mmHg @ 27°C; Autoignition temperature = 410°C. Explosive limits: LEL = 8.0%; UEL: 10.5% @ 25°C; LEL = 7.8%; UEL: 52% @ 100°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 0. Practically insoluble in water; solubility = 0.1%.

Potential Exposure: Trichloroethylene is used as a vapor degreaser of metal parts, as a solvent; and as a drug; It is also used for extracting caffeine from coffee, as a dry-cleaning agent; and as a chemical intermediate in the production of pesticides; in making waxes, gums, resins, tars, paints, varnishes, and specific chemicals; such as chloroacetic acid.

Incompatibilities: Contact with strong caustics causes decomposition and the production of highly toxic and flammable dichloroacetylene. Violent reaction with chemically active metals; powders, or shavings, such as aluminum, barium, lithium, sodium, magnesium, and titanium. Violent reaction with aluminum in the presence of dilute hydrochloric acid. Thermal decomposition of trichloroethylene, due to contact with hot metal or UV radiation, forms hazardous products including chlorine gas, hydrogen chloride; and phosgene. Keep this chemical away from high temperatures, such as arc welding or cutting, unshielded resistance heating; open flames; and high intensity UV light. Slowly decomposed by light in presence of moisture, with formulation of hydrochloric acid.

Permissible Exposure Limits in Air

NIOSH IDLH = 1000 ppm [LEL]

Conversion factor: 1 ppm = 5.37 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 100 ppm TWA; 200 ppm; 300 ppm [5-min. maximum peak in any 2 hours.] Ceiling Concentration

NIOSH REL: 25 ppm TWA; 2 ppm [60 min. when used as a waste anesthetic gas] STEL; Potential occupational carcinogen. Limit exposure to lowest feasible concentration. See the *NIOSH Pocket Guide*, Appendix A & C.

ACGIH TLV[1]: 10 ppm TWA; 25 ppm STEL, Suspected Human Carcinogen. BEI: 100 mg[trichloroacetic acid]/g creatinine in urine, end-of-workweek; 300 mg[trichloroacetic acid and trichloroethanol]/g creatinine in urine, end-of-shift, end-of-workweek; 4 mg[trichloroethylene]/g in blood, end-of-shift, end-of-workweek

Protective Action Criteria (PAC)* Ver. 29[138]

PAC-1: **130**$_{\mathbf{A}}$ ppm

PAC-2: **450**$_{\mathbf{A}}$ ppm

PAC-3: **3800**$_{\mathbf{A}}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

DFG MAK: Carcinogen Category: 1; Germ Cell Mutagen Group: 3B; TRK: 5 mg[trichloroethanol]/L in blood, end of exposure, end-o f-shift; for long-term exposure, after several shifts; 100 mg[trichloro acetic acid]/L in urine, end of exposure, end-of-shift; for long-term exposure, after several shifts.

Australia: TWA 50 ppm (270 milligram per cubic meter), STEL 200 ppm, 1993; Austria: MAK 50 ppm (270 milligram per cubic meter), Suspected: carcinogen, 1999; Belgium: TWA 50 ppm (269 milligram per cubic meter), STEL 200 ppm (1070 milligram per cubic meter), 1993; Denmark: TWA 10 ppm (55 milligram per cubic meter), 1999; Finland: TWA 30 ppm (160 milligram per cubic meter), STEL 45 ppm (240 milligram per cubic meter), [skin], 1999; France: VME 75 ppm (405 milligram per cubic meter), VLE 200 ppm (1080 milligram per cubic meter), carcinogen, 1999; Hungary: TWA 10 milligram per cubic meter, STEL 40 milligram per cubic meter, 1993; the Netherlands: MAC-TGG 190 milligram per cubic meter, 2003; Norway: TWA 20 ppm (110 milligram per cubic meter), 1999; the Phillipines: TWA 100 ppm (535 milligram per cubic meter), 1993; Poland: MAC (TWA) 50 milligram per cubic meter; MAC (STEL) 400 milligram per cubic meter, 1999; Russia: TWA 50 ppm, STEL

10 milligram per cubic meter, 1993; Sweden: NGV 10 ppm (50 milligram per cubic meter), KTV 25 ppm (140 milligram per cubic meter), carcinogen, 1999; Switzerland: MAK-W 50 ppm (260 milligram per cubic meter), KZG-W 250 ppm (1300 milligram per cubic meter), 1999; Thailand: TWA 100 ppm, STEL 200 ppm, 1993; Turkey: TWA 100 ppm (535 milligram per cubic meter), 1993; United Kingdom: TWA 100 ppm (550 milligram per cubic meter), STEL 150 ppm, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 100 ppm. Russia has set MAC values for ambient air in residential areas of 4.0 milligram per cubic meter on a momentary basis and 1.0 milligram per cubic meter on a daily average basis. Several states have set guidelines or standards for trichloroethylene in ambient air[60] ranging from zero (North Carolina); to 0.25 μ/m^3 (Arizona); to 0.8 μ/m^3 (Michigan); to 2.43 μ/m^3 (Kansas); to 6.1 μ/m^3 (Massachusetts); to 900.0 μ/m^3 (New York); to 1,350.0 μ/m^3 (Connecticut), to 2,675.0 μ/m^3 (Indiana); to 2,700.0 μ/m^3 (Florida and South Dakota); to 4,500.0 μ/m^3 (Virginia); to 2,700.0 to 10,800.0 μ/m^3 (North Dakota); to 6,429 μ/m^3 (Nevada); to 6,750 μ/m^3 (South Carolina); to 6,840 μ/m^3 (Pennsylvania).

Determination in Air: Use NIOSH Analytical Method, #1022, Trichloroethylene, by portable GC. #3800; OSHA Analytical Method 1001.

Permissible Concentration in Water: Safe Drinking Water Act (47FR 9352): MCL, 0.005 mg/L; MCLG, zero. Federal Drinking Water Standards: EPA 5 μg/L; State Drinking Water Standards: New Jersey 1 μg/L; Delaware 1 μg/L; Florida 3 μg/L; State Drinking Water Guidelines: Arizona 3.2 μg/L; Connecticut 5 μg/L; Maine 32 μg/L; Minnesota 5 μg/L.

Determination in Water: Inert gas purge followed by gas chromatography with halide specific detection (EPA Method 601) or gas chromatography plus mass spectrometry (EPA Method 624). Octanol-water coefficient: Log $K_{ow} = 2.4$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation percutaneous absorption, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Exposure to the vapor irritates the eyes, skin, and respiratory tract. High exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Inhalation causes headache, sleepiness, nausea, vomiting, dizziness and coughing have been felt around 100 ppm. Unconsciousness can result @ 3,000 ppm. Exposure to 8,000 ppm can cause death. Can be absorbed through skin. Can cause skin irritation, burning or redness; blistering can occur. Can causeeye irritation; burning sensation; and/or watering, and can cause permanent damage. Ingestion can cause chemical pneumonitis and diminish kidney action. It can cause drunkenness, vomiting, diarrhea or abdominal pain. Unconsciousness, liver or kidney damage, vision distortion and death have been reported at large doses. Exposure to TCE may affect the CNS causing lightheadedness, dizziness, visual disturbances; feeling of excitement; nausea, and vomiting. High levels can cause irregular heartbeat; unconsciousness, and death.

Long-Term Exposure: Liver problems; increased risk of cancer. May affect kidneys. Contact with vapor levels near 100 ppm can cause giddiness, nervous exhaustion, increased sensitivity to alcohol including redness in the face (trichloroethylene blush); the ability to become addicted to the vapo; as well as effects of acute exposure listed above. Higher levels can cause irregular heartbeat. Repeated contact with hands can cause excessive dryness, cracking, burning, loss of sense of touch or temporary paralysis of fingers. Most of these effects seem to go away after exposure has stopped. Trichloroethylene is considered a cancer suspect agent because high levels cause liver cancer in mice.

Points of Attack: Eyes, skin, respiratory system; heart, liver, kidneys, CNS. Cancer site in animals: liver and kidneys.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. NIOSH lists the following tests: whole blood (chemical/metabolite); whole blood (chemical/metabolite), end-of-shift; whole blood (chemical/metabolite), end-o f-shift-, end-of-workweek; whole blood (chemical/metabolite), end-of-workweek, expired air, Expired Air, end-of-workweek; Expired Air, prior to next shift; urine (chemical/metabolite); urine (chemical/metabolite), end-of-shift; urine (chemical/metabolite), end-of-shift at end-of-workweek; urine (chemical/metabolite), end-of-workweek; urine (chemical/metabolite), prior to next shift. For those with frequent or potentially high exposure (half the TLV or greater, or significant skin contact), the following are recommended before beginning work and at regular times after that: Liver function tests. If symptoms develop or overexposure is suspected, the following may be useful: exam of the nervous system. Consider nerve conduction tests. Urinary trichloroacetic acid level (for repeated exposures) or blood trichloroethylene levels (for acute exposure). Consider chest X-ray after acute overexposure. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately.

If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to Physician: *Inhalation*: Bronchodilators, decongestants and oxygen may be used if necessary. Corticosteroids are useful for treating pneumonitis.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Teflon and Silvershield are among the recommended materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration*: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive pressure mode). Escape: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Trichloroethylene must be handled and stored away from operations which generate high temperatures, such as arc welding or cutting; unshielded resistance heating; open flames; and high intensity UV light. It must also be handled to avoid contact with hot metals. Thermal decomposition products may include toxic and corrosive phosgene, and hydrogen chloride. Prevent contact of trichloroethylene with strong alkalis, such as sodium hydroxide or potassium hydroxide, because a highly flammable, toxic liquid is produced. Also prevent contact with aluminum in the presence of dilute hydrochloric acid, because a violent reaction will occur. Prevent contact with chemically active metals; powders, or shavings, such as barium, lithium, sodium, or magnesium; and titanium powders or shavings, since an explosion can occur. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN1710 Trichloroethylene, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include hydrogen chloride, chlorine, phosgene, and oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced.

An alternative to disposal for TCE is recovery and recycling.

References

(109); (102); (31); (173); (101); (138); (2); (100).

National institute for Occupational Safety and Health (NIOSH), “Criteria for a Recommended Standard: Occupational Exposure to Trichloroethylene,” NIOSH Document Number 73-11025, Cincinnati OH (1973)

National institute for Occupational Safety and Health (NIOSH), (Special Occupational Hazard Review with Control Recommendations: Trichloroethylene,” NIOSH Document Number 78-130, Washington, DC (January 1978)

United States Environmental Protection Agency, Trichloroethylene: Ambient Water Quality Criteria, Washington, DC (1980)

United States Environmental Protection Agency, Status Assessment of Toxic Chemicals: Trichloroethylene, Report EPA-600/2-79-210m, Cincinnati, OH (December 1979)

United States Environmental Protection Agency, Trichloroethylene, Health and Environmental Effects Profile No. 166, Washington, DC, Office of Solid Waste (April 30, 1980)

United States Public Health Service, “Toxicological Profile for Trichloroethylene,” Atlanta, Georgia, agency for Toxic Substances and Disease Registry (January 1988)

Sax, N. I., Ed., “*Dangerous Properties of Industrial Materials Report*,” 1, No. 2, 67–69 (1980), 3, No. 1, 89–94 (1953), 4, No. 3, 30–32 (1984) and 7, No. 1, 83–92 (1987)

New York State Department of Health, *Chemical Fact Sheet*: Trichloroethylene, Bureau of Toxic Substance Assessment, Albany, NY (March 1986 and Version 3)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Trichloroethylene, Trenton, NJ (January 2000)

Trichlorophenols T:0770

Formula: $C_6H_3Cl_3O$; $HOC_6H_2Cl_3$

Synonyms: *25167-82-2*: Omal; Phenachlor; Phenol, trichloro-; Trichlorofenol (Spanish); Triclorofenol

15950-66-0: Phenol, 2,3,4-trichloro-; 2,3,4-Trichlorofenol (Spanish); 2,3,4-Trichlorophenol; Trichlorophenol, 2,3,4-

933-78-8: Phenol, 2,3,5-trichloro-; 2,3,5-Trichlorofenol (Spanish); 2,3,5-Trichlorophenol trichlorophenol, 2,3,5-

933-75-5: Phenol, 2,3,6-trichloro-; 2,3,6-Trichlorofenol (Spanish); 2,3,6-Trichlorophenol; Trichlorophenol, 2,3,6-

88-06-2: Dowicide 2S; NCI-CO2904; Omal; Phenachlor; Phenol, 2,4,6-trichloro-; 2,4,6-Trichlorfenol (Spanish); 1,3,5-Trichloro-2-hydroxybenzene; Trichlorophenol, 2,4,6-; 2,4,6-Trichlorophenos

609-19-8: Phenol, 3,4,5-trichloro-; 3,4,5-Trichlorofenol (Spanish); 3,4,5-Trichlorophenol; Trichlorophenol, 3,4,5-

CAS Registry Number: 25167-82-2 (mixed isomers); 15950-66-0 (2,3,4-); 933-78-8 (2,3,5-); 933-75-5 (2,3,6-); 95-95-4 (2,4,5-); 88-06-2 (2,4,6-); 609-19-8 (3,4,5-)

HSDB Number: 4067 (95-95-4)

RTECS Number: SN1400000 (2,4,5-); SN1575000 (2,4,6-); SN1650000 (3,4,5-); SN1300000 (2,3,6-)

UN/NA & ERG Number: UN2020 (solid)/153

EC Number: 246-694-0 (mixed isomers); 240-083-2 (2,3,4-); 213-272-2 (2,3,5-); 213-271-7 (2,3,6-); 202-467-8 [*Annex I Index No*.: 604-017-00-X] (2,4,5-); 201-795-9 [*Annex I Index No*.: 604-018-00-5] (2,4,6-); 210-183-0 (3,4,5-)

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC:[9] Human Inadequate Evidence, animal Sufficient Evidence, 1982, *possibly carcinogenic to humans*, Group B2, 1987.

California Proposition 65 Chemical[102]: Cancer (*2,4,6*-isomer) 1/1/1988

Hazard Alert: (*2,4,5-*) Poison, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard Environmental hazard. Other isomers: Poison, (*2,4,6-*): Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction) (*2,3,6-*) Suspected of causing genetic defects.

mixed isomers-isomer:

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 10 lb (4.54 kg)

2,3,4-; 2,3,5-; 2,3,6-; 3,4,5-isomers:

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 10 lb (4.54 kg)

2,4,5-isomer:

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen (2,4,6-; IARC: Animal Limited Evidence, 1999; Human Limited Evidence, 1986

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Clean Water Act: Section 307(a)(1)Toxic Pollutants subject to effluent limitations as chlorinated ethanes.

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U230

RCRA Toxicity Characteristic (Section 261.24), Maximum Concentration of Contaminants, regulatory level, 400.0 mg/L

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.18; Nonwastewater (mg/kg), 7.4

RCRA 40CFR264, appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects[291].

European/International Regulations (*2,4,5-isomer*): Hazard Symbol: Xn, N; Risk phrases: R22; R36/38; R50/53; Safety phrases: S2; S26; S28; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class) (*2,4,5*): 3-Severe hazard to water.

2,4,6-isomer:

Carcinogenicity: NCI: Carcinogenesis Bioassay (feed); clear evidence: mouse, rat; NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Animal Limited Evidence, 1999; Human Limited Evidence, 1986. United States Environmental Protection Agency Gene-Tox Program, Positive: Carcinogenicity-mouse/rat; S cerevisiae-forward mutation; Negative: Mouse spot test; Histidine reversion-Ames test; Negative: S *cerevisiae* gene conversion; *cerevisiae-homozygosis*

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U231

RCRA Toxicity Characteristic (Section 261.24), Maximum Concentration of Contaminants, regulatory level, 2.0 mg/L

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.035; Nonwastewater (mg/kg), 7.4

RCRA 40CFR264, appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8040 (5); 8270 (10)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

European/International Regulations (*2,4,6-*): Hazard Symbol: Xn; Risk phrases: R22; R36/38; R40; Safety phrases: S2; S36/37 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class) (*2,4,6-*): No value assigned.

Description: Trichlorophenols exists as 6 isomers (2,4,5-; 3,4,5-; 2,4,6-; 2,3,4-; 2,3,5-and 2,3,6-). The most important (heavily regulated) are the 2,4,5-and 2,4,6-isomers. The 2,4,5-isomer is white powder or needles; 2,3,5-and 2,3,6-are colorless crystals; 2,4,5-is a gray crystalline solid or flakes; 2,4,6-is a colorless to light yellow crystalline solid. They have a phenolic odor. Molecular weight = 197−198; Specific gravity (H_2O:1) = 1.7 @ 20°C (*2,4,5-*); 1.5 @ 75°C (2,4,6-); Boiling point = 253°C (*2,3,5-*); 253°C (*2,3,6-*); 253°C (2,4,5-); 247°C (2,4,6-); Freezing/Melting point = 84°C (*2,3,4-*); 62°C (2,3,5-); 58°C (*2,3,6-*); 69°C (*2,4,5-*); 70°C (*2,4,6-*); Vapor pressure = 8×10^{-X} mmHg @ 25°C (2,4,5-); 0.75 mmHg @ 72C (2,4,6-); Flash point = 78°C (*2,3,6-*); 61°C (*2,4,6-*). Hazard Identification (based on NFPA-704 M Rating System): (*2,4,5-*; *2,4,6-*) Health 2, Flammability 1, Reactivity 0. All isomers are slightly soluble or practically insoluble in water.

Potential Exposure: 2,4,5-TCP is used as antifungal agent in adhesives and as preservative in polyvinylacetate emulsions. 2,4,6-T is used in manufacturing slime-control agents and as an effective germicide and preservative; to produce defoliant 2,4,5-T and related products. Also used directly as a fungicide, anti-mildew and preservative agent; algicide, bactericide. 2,4,6-TCP is used to produce 2,3,4,6-TCP and PCP. Used directly as germicide, bactericide, glue and wood preservative; and anti-mildew treatment. 2,3,6-TCP is used as intermediate in production of fungicides and plant growth regulators.

Incompatibilities: Perhaps the most notable incompatibility is the reaction of 2,4,5-trichlorophenol in alkaline medium at high temperatures to produce dioxin. (2,3,4-isomer) reacts with oxidizers, acid anhydrides; and acid chlorides. (2,3,5-isomer) Decomposes on heating, on burning and on contact with strong oxidants producing toxic and corrosive fumes of hydrogen chloride. The substance is a weak acid. (2,3,6-isomer); the substance is a weak acid. pH = 4.8/4.2-; (2,4,6-isomer); reacts violently with strong oxidants and is incompatible with acid chlorides and acid anhydrides.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC) Ver. 29[138]

933-75-5, 2,3,6-isomer

PAC-1: 1.8 milligram per cubic meter

PAC-2: 20 milligram per cubic meter

PAC-3: 120 milligram per cubic meter

95-95-4,2,4,5-isomer

PAC-1: 2.5 milligram per cubic meter

PAC-2: 27 milligram per cubic meter

PAC-3: 160 milligram per cubic meter

88-06-2, 2,4,6-isomer

PAC-1: 2.5 milligram per cubic meter

PAC-2: 27 milligram per cubic meter

PAC-3: 160 milligram per cubic meter

DFG MAK: No numerical value established. Data may be available.

Denmark: TWA 0.5 milligram per cubic meter, [skin] 1999 (2,4,5-and 2,3,6-isomers)

Sweden: MAC 0.5 milligram per cubic meter; STEL 1.5 milligram per cubic meter. Russia set a MAC in ambient air in residential areas of 3.0 μ/m^3 for the 2,4,6-isomer on a once-daily basis. Several states have set guidelines or standards for the trichlorophenols in ambient air[60].

Massachusetts has set zero for the 2,4,6-isomer and 1.6 μ/m^3 for the 2,4,5-isomer. Pennsylvania has set 3,500 μ/m^3 for the 2,4,5-isomer on a one-year exposure basis.

Determination in Air: Use NIOSH: (*o*-chlorophenol) P&CAM Method #337 (chlorophenols).

Permissible Concentration in Water: Clean Water Act: Section 307(a)(1)Toxic Pollutants subject to effluent limitations as chlorinated ethanes. Federal Drinking Water Standards (*2,4,6-trichlorophenol*): EPA The levels which may result in incremental increase in cancer risk over the lifetime are estimated at 10^{-5}, 10^{-6}, and 10^{-7}. The corresponding criteria are 12 μg/L, 1.2 μg/L, and 0.12 μg/L, respectively. State Drinking Water Guidelines: Arizona 1.8 μg/L; Florida 10 μg/L; Maine 32 μg/L; Minnesota 30 μg/L; New Hampshire 3.0 μg/L; New Jersey 1 μg/L.

Determination in Water: Methylene chloride extraction followed by gas chromatography with flame ionization or electron capture detection (EPA Method 604); or gas chromatography plus mass spectrometry (EPA Method 625).

Routes of Entry: Inhalation, ingestion; skin and/or eye contact may be absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Trichlorophenols irritates the eyes, skin, and the respiratory tract. A CNS depressant. High exposures can cause weakness, difficulty in breathing; tremors, convulsions, coma, and possible death. See also *chlorophenols*.

2,3,5-isomer: a mixture of trichlorophenols may cause irritation of the skin, eyes and respiratory tract. These substances may cause acute metabolic effects resulting in damage in several organs notably the CNS. Some technical products may contain highly toxic impurities including polychlorinated dibenzo-p-dioxins and-furans.

For the 2,4,5-isomer: [52] irritation of the skin, eyes, nose, and pharynx; redness and edema of the skin; dermatitis, corneal injury; iritis; sweating, thirst, nausea, vomiting, diarrhea, abdominal pain; cyanosis, hyperactivity, stupor, decreased activity and motor weakness; increase followed by decrease in respiratory rate and urinary output; fever; increased bowel action; lung, liver or kidney damage; convulsions, collapse, and coma.

Long-Term Exposure: Repeated or prolonged contact with skin may cause dermatitis; drying and cracking. May affect the liver and kidneys. A related chemical, *phenol*, can cause liver and kidney damage. May be carcinogenic to humans. If any of the trichlorophenols is contaminated with 2,3,7,8-tetrachlorodibenzo-p-dioxin, the following effects may occur: acne-like skin rash; liver damage; nervous system damage with symptoms of weakness, pain in the legs, and numbness.

Points of Attack: *Inhalation*: Human (2,4,5-): lung, thorax, or respiration; structural or functional change in trachea or bronchi; lung, thorax, or respiration: other changes. Animal tests: change in liver weight, changes in spleen weight; other changes. Cancer site in animals (2,4,6-): liver and leukemia.

Medical Surveillance: Liver and kidney function tests. CBC.

First Aid: *Skin Contact*:[52] Flood all areas of body that have contacted the substance with water. Don't wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others.

Eye Contact: Remove any contact lenses at once. Immediately flush eyes well with copious quantities of water or normal saline for at least 20−30 minutes. Seek medical attention.

Inhalation: Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure.

Ingestion: If unconscious or convulsing, do not induce vomiting or give anything by mouth. Assure that victim's airway is open and lay him on his side with his head lower than his body and transport at once to a medical facility. If conscious and not convulsing, give a slurry of activated charcoal in water. If medical advice is not readily available, do not induce vomiting, and rush the victim to the nearest medical facility.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive pressure mode.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in a cool dry place or a refrigerator away from oxidizing agents and other incompatible materials listed above. Where possible, automatically transfer material from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of this chemical should be grounded and bonded. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2020 Chlorophenols, solid, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Remove all sources of ignition and dampen spilled material with 60%−70% ethanol to avoid airborne dust, then transfer material to a sealed container. Ventilate the spill area and use absorbent dampened with 60%−70% ethanol to pick up remaining material. Wash surfaces well with soap and water. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Trichlorophenols are combustible, but are not easy to ignite. Poisonous and corrosive gases are produced in fire, including hydrogen chloride, chlorine and oxides of carbon. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced[22].

References

(109); (102); (31); (173); (101); (138); (80); (100).

United States Environmental Protection Agency, Chlorinated Phenols: Ambient Water Quality Criteria, Washington, DC (1980)

United States Environmental Protection Agency, 2,4,6-Trichlorophenol, Health and Environmental Effects Profile No. 168, Washington, DC, Office of Solid Waste (April 30, 1980)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: 2,4,6-Trichlorophenol, Trenton NJ (August 2002)

1,2,3-Trichloropropane T:0780

Formula: $C_3H_5Cl_3$; $CH_2ClCHClCH_2Cl$

Synonyms: AI3-26040; Allyltrichloride; Glycerol trichlorohydrin; Glyceryl trichlorohydrin; NCI-C60220; NSC 35403; Propane, 1,2,3-trichloro-; Trichlorohydrin; Trichloropropane; 1,2,3-Tricloropropano (Spanish)

CAS Registry Number: 96-18-4

HSDB Number: 1340

RTECS Number: TZ9275000

UN/NA & ERG Number: UN2810 (toxic liquid, organic, n.o.s.)/153 (P)

EC Number: 202-486-1 [*Annex I Index No.*: 602-062-00-X]

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Animal, Sufficient Evidence; Human, Insufficient Evidence, Group 2A, 1995; NCI: Carcinogenesis Studies (gavage); clear evidence: mouse, rat; EPA: Likely to produce cancer in humans; NIOSH: Potential occupational carcinogen.

California Proposition 65 Chemical[102]: Cancer 10/1/1992

Hazard Alert: Poison, Flammable, Polymerization hazard (nonstabilized), Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction).

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, waste number not listed

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.85; Nonwastewater (mg/kg), 30

RCRA 40CFR264, appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8010 (10); 8240 (5)

Safe Drinking Water Act (47FR 9352): Priority List (55FR 1470)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects[293]. Toxic to aquatic life with long lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T; Risk phrases: R45; R10; R20/21/22; R60; R61; R62; R63; Safety phrases: S53; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: 1,2,3-Trichloropropane is a colorless liquid with a strong acid odor. Molecular weight = 147.4;

Specific gravity (H_2O:1) = 1.4 @ 20°C; Boiling point = 157°C; Freezing/Melting point = −15°C; Vapor pressure = 7.5 mmHg @ 37°C; Flash point = 71°C (cc); Autoignition temperature = 304°C. Explosive limits: LEL = 3.2% @ 120°C; UEL: 12.6% @ 150°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 2, Reactivity 1. Poor solubility in water; solubility = 0.1%.

Potential Exposure: Trichloropropane dissolves oils, fats, waxes, chlorinated rubber; and numerous resins; it is used as a paint and varnish remover; a solvent; and a degreasing agent.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Violent decomposition with chemically active metals; strong bases. Keep away from chlorinated rubber, resins and waxes; and sunlight.

Permissible Exposure Limits in Air

NIOSH IDLH = 1000 ppm [LEL]

Conversion factor: 1 ppm = 6.03 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 50 ppm/300 milligram per cubic meter TWA

NIOSH REL: 10 ppm/60 milligram per cubic meter TWA [skin], Potential occupational carcinogen. Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A

ACGIH TLV[1]: 10 ppm/60 milligram per cubic meter TWA [skin] confirmed animal carcinogen with unknown relevance to humans.

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 0.015 ppm

PAC-2: 170 ppm

PAC-3: 1000 ppm

DFG MAK: [skin] Carcinogen Category 2

Australia: TWA 10 ppm (60 milligram per cubic meter), [skin], 1993; Austria: MAK 50 ppm (300 milligram per cubic meter), 1999; Belgium: TWA 10 ppm (60 milligram per cubic meter), [skin], 1993; Denmark: TWA 10 ppm (60 milligram per cubic meter), [skin], 1999; Finland: TWA 50 ppm (300 milligram per cubic meter), STEL 75 ppm (450 milligram per cubic meter), 1999; Norway: TWA 10 ppm (60 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 0.108 milligram per cubic meter, [skin], 2003; Russia: STEL 2 milligram per cubic meter, 1993; Switzerland: carcinogen, 1999; United Kingdom: TWA 50 ppm (306 milligram per cubic meter), STEL 75 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea; New Zealand, Singapore, Vietnam: ACGIH TLV: confirmed animal carcinogen with unknown relevance to humans.

Russia[43] set a MAC for ambient air in residential areas of 0.05 milligram per cubic meter on a daily average basis. Several states have set guidelines or standards for 1,2,3-trichloropropane in ambient air[60] ranging from 3.0−4.5 milligram per cubic meter (North Dakota); to 5.0 milligram per cubic meter (Virginia); to 6.0 milligram per cubic meter (Connecticut); to 7.143 milligram per cubic meter (Nevada).

Determination in Air: Use NIOSH Analytical Method #1003, Hydrocarbons, halogenated; OSHA Analytical Method 7[18].

Permissible Concentration in Water: Russia[43] has set 0.07 mg/L as a MAC in water bodies used for domestic purposes.

Determination in Water: Octanol-water coefficient: Log $K_{ow} = 2.3$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Skin absorption; ingestion; inhalation, skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Trichloropropane is highly toxic by inhalation and moderately toxic by skin absorption. It is a local irritant and produces a number of unpleasant sensory effects; irritates the eyes, skin, and respiratory tract. Human subjects exposed to trichloropropane @ 100 ppm found this to be an objectionable level of exposure, and all reported eye and throat irritation as well as an unpleasant odor. Also, according to NIOSH, skin irritation, CNS depression and liver injury may result. Exposure to high concentrations may result in unconsciousness.

Long-Term Exposure: Repeated contact can cause dermatitis; drying and cracking of the skin. May affect the heart and damage the liver. Although this chemical has not been adequately evaluated for brain and disturbed sleep; many solvents and petroleum-based products can cause these effects. Symptoms of exposure can include reduced memory; reduced ability to concentrate; personality changes; fatigue, sleep disturbance; reduced coordination; weakness, and/or feeling of "pins and needles" in extremities. A potential occupational carcinogen.

Points of Attack: Eyes, skin, respiratory system; CNS; liver, kidneys. Cancer site in animals: fore-stomach, liver, and mammary gland cancer.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. NIOSH lists the following tests: Expired Air. Liver function tests; EKG, Evaluation for brain effects and psychological changes.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions,

including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Viton and PVC are among the recommended materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration*: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive pressure mode). Escape: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in a refrigerator or a cool, dry place and keep away from chemically active metals; oxidizers, strong caustics. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored.

Shipping: UN2810 Toxic liquids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling:

UN2810 Toxic liquids, organic, n.o.s.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.2/0.3
Night 0.7/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 1000/300
Then: Protect persons downwind (miles/kilometers)
Day 1.1/1.8
Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include hydrogen chloride, phosgene, chlorine and oxides of carbon. Use dry chemical, carbon dioxide; alcohol foam; or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA

1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced.

References

(109); (102); (31); (173); (101); (138); (2); (100).

National institute for Occupational Safety and Health (NIOSH), Profiles on Occupational Hazards for Criteria Document Priorities, Report PB-274,073. Cincinnati, OH, pp 289−91 (1977)

United States Environmental Protection Agency, 1,2,3-Trichloropropane, Health and Environmental Effects Profile No. 169, Washington, DC, Office of Solid Waste (April 30, 1980)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: 1,2,3-Trichloropropane, Trenton NJ (May 1999)

1,1,2-Trichloro-1,2,2-trifluoroethane T:0790

Formula: $C_2Cl_3F_3$; CCl_2FCClF_2

Synonyms: Arcton 63; Arklone P; Asahifron 113; Daiflon S 3; Distillex DS 5; Ethane, 1,1,2-trichloro-1,2,2,-trifluoro-; F 113; FC 113; Fluorocarbon 113; Forane 113; Freon 113T R-T; Freon TF; Frigen 113; Frigen 113A; Frigen 113TR; Frigen 113TR-N; Frigen 113TR-T; Genesolv D solvent; Genetron 113; Isceon 113; Kaiser chemicals 11; Khladon 113; Ledon 113; MS-180 freon TF solvent; R 113; Refrigerant 113; Refrigerant R 113; 1,1,2-Trichloro-1,2,2-trifluoroethane; 1,1,2-Trichlorotrifluoroethane; 1,1,2-Triclorofluoetano (Spanish); 1,1,2-Trifluoro-1,2,2-trichloroethane; 1,1,2-Trifluorotrichloroethane

CAS Registry Number: 76-13-1

HSDB Number: 145

RTECS Number: KJ4000000

UN/NA & ERG Number: UN3082 (environmentally hazardous substances, liquid, n.o.s.)/171

EC Number: 200-936-1

Regulatory Authority and Advisory Information

Hazard Alert: Suspected of causing genetic defects, Sensitization hazard, Primary irritant (w/o allergic reaction), Environmental hazard, Drug.

Clean Air Act: Stratospheric ozone protection (Title VI, Subpart A, appendix A), Class I, Ozone Depletion Potential (ODP) = 0.8

Harms public health and the environment by destroying ozone in the upper atmosphere.

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.057; Nonwastewater (mg/kg), 30

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Harms public health and the environment by destroying ozone in the upper atmosphere, H420

Hazardous to aquatic life or environment, with possible long-lasting effects[192]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T, N, Xi; Risk phrases: R20/21/22; R23/24/25; R33; R36/38; R39; R43; R44; R49; R51/53; R59; R62; Safety phrases: S20/21; S26; S28; S29/35; S36/37/39; S45; S53; S45; S57; S59; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: TTE is a colorless liquid. Carbon tetrachloride-like odor at high concentrations. A gas above 48°C. Molecular weight = 187.4; Specific gravity (H_2O:1) = 1.56 @ 20°C; Boiling point = 48°C; Freezing/Melting point = −36°C; Vapor pressure = 285 mmHg @ 25°C. Noncombustible liquid at ordinary temperatures, but the gas will ignite and burn weakly @ 680°C (autoignition temperature). Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 0, Reactivity 2. Practically insoluble in water; solubility = 0.02%.

Potential Exposure: TTE is used as a solvent and refrigerant; it is used in fire extinguishers; as a blowing agent and as an intermediate in the production of chlorotrifluoroethylene monomer by reaction with zinc.

Incompatibilities: Violent reaction with chemically active metals (such as powdered aluminum; beryllium, magnesium and zinc); calcium. Contact with alloys containing more than 2% magnesium causes decomposition, releasing hydrogen chloride, hydrogen fluoride; and carbon monoxide. May react exothermically with aluminum.

Permissible Exposure Limits in Air

NIOSH IDLH = 2000 ppm

Conversion factor: 1 ppm = 7.67 milligram per cubic meter @ 25°C & 1 atm

Odor Threshold = 45 to 68 ppm.

OSHA PEL: 1000 ppm/7600 milligram per cubic meter TWA

NIOSH REL: 1000 ppm/7600 milligram per cubic meter TWA; 1250 ppm/9500 milligram per cubic meter STEL

ACGIH TLV[1]: 1000 ppm/7670 milligram per cubic meter TWA; 1250 ppm/9590 milligram per cubic meter STEL, not classifiable as a human carcinogen.

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 1250 ppm

PAC-2: 3900 ppm

PAC-3: 4500 ppm

DFG MAK: 500 ppm/3900 milligram per cubic meter TWA; Peak Limitation Category II(2); Pregnancy Risk Group D

Australia: TWA 1000 ppm (7600 milligram per cubic meter), STEL 1250 ppm, 1993; Austria: MAK 500 ppm (3800 milligram per cubic meter), 1999; Belgium: TWA 1000 ppm (7670 milligram per cubic meter), STEL 1250 ppm, 1993; Denmark: TWA 500 ppm (3800 milligram per cubic meter), 1999; Finland: TWA 1000 ppm (7600 milligram per cubic meter), STEL 1250 ppm, 1999; France: VME 1000 ppm (7600 milligram per cubic meter), VLE 1250 ppm, 1999; Hungary: STEL 40 milligram per cubic meter, 1993; the Netherlands: MAC-TGG 1170 milligram per cubic meter, 2003; Norway: TWA 500 ppm (3800 milligram per cubic meter), 1999; the Phillipines: TWA 1000 ppm (7600 milligram per cubic meter), 1993; Russia: TWA 500 ppm, STEL 5000 milligram per cubic meter, 1993; Sweden: NGV 500 ppm (4000 milligram per cubic meter), KTV 750 ppm (6000 milligram per cubic meter), 1999; Switzerland: MAK-W 500 ppm (3800 milligram per cubic meter), 1999; Turkey: TWA 1000 ppm (7600 milligram per cubic meter), 1993; United Kingdom: TWA 1000 ppm (7790 milligram per cubic meter), STEL 1250 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 1250 ppm. Several states have set guidelines or standards for TTE in ambient air[60] ranging from 0.152 milligram per cubic meter (Connecticut); to 0.225 milligram per cubic meter (Indiana); to 76.0−95.0 milligram per cubic meter (North Dakota); to 180.952 milligram per cubic meter (Nevada); to 950.0 milligram per cubic meter (North Carolina).

Determination in Air: Use NIOSH Analytical Method #1020, 1,1,2-Trichloro-1,2,2-trifluoroethane, #2549, Volatile organic compound; OSHA Analytical Method 113.

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guidelines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg [F]/L. SafeDrinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg[F]/L; SMCL = 2 mg/F/L, as Fluoride.

Determination in Water: Octanol-water coefficient: Log $K_{ow} = > 3$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes and respiratory tract. May be a CNS depressant in high concentrations, causing headache, dizziness, loss of coordination and unconsciousness; asphyxiation can result. *Inhalation*: No effects may be felt below 1000 ppm. Irregular heartbeat (arrhythmia) can occur at levels above 2000 ppm; may cause unconsciousness and possible death. Levels above 2500 ppm may cause loss of concentration; tiredness and a feeling of heaviness of the head. Levels above 200,000 ppm may cause irritation of the nose and lungs, tremors and coma. *Ingestion*: No information is available on human ingestion. However, animal studies show that Freon 113 cause unresponsiveness, facial swelling; diarrhea, and bleeding lungs. *Skin*: May cause irritation and frostbite if TTE is cold from refrigeration

Long-Term Exposure: Skin contact can cause dermatitis; drying and cracking. Can accumulate in brain and kidneys from exposure below 2000 ppm. Will generally not produce noticeable effects at this level and may pass from the body within a week after exposure stops.

Points of Attack: Skin, heart, CNS; cardiovascular system.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: Special 24 hour EKG (Holter monitor) to look for irregular heart beat.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 2000 ppm*: Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd, Pp (APF = 10,000) (any NIOSH/MS HA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive pressure mode). Escape: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code-Green: General storage may be used. Prior to working with this chemical, personnel should be trained on its proper handling and storage. 1,1,2-Trichloro-1,2,2-trifluoroethane must be stored to avoid contact with chemically active metals, such as calcium, powdered aluminum; zinc, magnesium, and beryllium because violent reactions occur. Store in tightly closed containers in a cool, well ventilated area away from oxidizers. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames are prohibited where this chemical is handled, used, or stored.

Shipping: UN3082 Environmentally hazardous substances, liquid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: 1,1,2-Trichloro-1,2,2-trifluoroethane itself does not easily burn. Thermal decomposition products may include carbonyl fluoride; hydrogen chloride; hydrogen fluoride, phosgene, and oxides of carbon. Extinguish fire using agent suitable for type of surrounding fire. The gas will ignite and burn weakly when exposed to high heat or flame. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced.

References

(31); (173); (101); (138); (2); (122); (100).

New York State Department of Health, *Chemical Fact Sheet*: Trichlorotrifluoroethane, Bureau of Toxic Substance Assessment, Albany, NY (March 1986)

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 6, No. 3, 91–93 (1986)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: 1,1,2-Trichloro-1,2,2-Trifluoroethane, Trenton, NJ (June 2000)

Tricresyl Phosphates T:0800

Formula: $C_{21}H_{21}O_4P$; $(CH_3C_6H_4O)_3PO$

Synonyms: *o*-Cresyl phosphate; Fosfito de tricresilo (Spanish); Phosflex 179-C; Phosphoric acid, tri-*o*-cresyl ester; Phosphoric acid, tris(methyl phenyl) ester; TCP; TOCP; TOFK; *o*-Tolyl phosphate; TPTP; Tri-*o*-cresyl ester of phosphoric acid; *o*-Tricresyl phosphate; Tri-*o*-cresyl phosphate; Tricresyl phosphate, *o*-; *o*-Trikresylphosphat (German); Tri-2-methylphenyl phosphate; Tris(*o*-cresyl) phosphate; Tris(*o*-methylp henyl) phosphate; Tri-*o*-tolyl phosphate; Tri-2-tolyl phosphate

CAS Registry Number: 78-30-8 (*o*-isomer); 563-04-2 (*m*-isomer); 78-32-0 (*p*-isomer); 1330-78-5 (mixed isomers)

HSDB Number: 4084 (*o*-isomer); 4085 (*m*-isomer); 2559 (*p*-isomer)

RTECS Number: TD0350000

UN/NA & ERG Number: UN2574 (tricresyl phosphate, with >3% ortho (o-) isomer)/151

EC Number: 201-103-5 [*Annex I Index No.*: 015-015-00-8] (*o*-isomer); 209-241-8 (*m*-isomer); 201-105-6 [*Annex I Index No.*: 015-016-00-3] (*p*-isomer); 215-548-8 (mixed isomers or tris(methylphenyl) phosphate)

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Combustible, Suspected of causing genetic defects, Suspected reprotoxic hazard.

Hazardous to aquatic life or environment, with possible long-lasting effects[293]. Toxic to aquatic life with long-lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

European/International Regulations (*o-o-o; o-o-m; o-o-p; o-m-m; o-m-p; o-p-p isomers*): Hazard Symbol: T, N; Risk phrases: R39; R23/24/25; R51/53; R62; R63; Safety phrases: S1/2; S20/21; S28; S41; S45; S6; *(m-m-m; m-m-p; m-p-p; p-p-p isomers)* Hazard Symbol: Xn, N; Risk phrases: R21/2251/53; R62; R63; Safety phrases: S2; S28; S41; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to waters (*all isomers*).

Description: Tricresyl phosphates are available as the *o*-isomer (TOCP), the *m*-isomer (TMCP), and *p*-isomer (TPCP). The *ortho*-isomer is the most toxic of the three; the meta-and para-isomers are relatively inactive. The commercial product may contain the *ortho*-isomer as a contaminant unless special precautions are taken during manufacture. Pure tri-para-cresyl phosphate is a solid, and ortho-and meta-are liquids (see below). The *tri-o-cresyl phosphate* will be discussed here as the specific example of these compounds because it is the most toxic of the tricresyl phosphates and specifically regulated by OSHA. TOCP is a colorless to pale yellow, odorless liquid or solid (below 52/F/11°C). Molecular weight = 368.39; Specific gravity (H_2O:1) = 1.17 @ 20°C; Boiling point = 410°C (with decomposition); Freezing/Melting point = 11°C; Vapor pressure = 0.00002 mmHg @ 25°C; Flash point = 110°C−225°C; Autoignition temperature = 385°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1−2, Flammability 1, Reactivity 0. Practically insoluble in water.

Potential Exposure: Tricresyl phosphate is used as an additive in hydraulic fluids; as a plasticizer; pigment dispersant; flame retardant; as a plasticizer for chlorinated rubber; vinyl plastics; polystyrene, polyacrylic, and polymethacrylic esters; as an adjuvant in milling of pigment pastes; as a solvent and as a binder in nitrocellulose and various natural resins, and as an additive to synthetic lubricants and gasoline. It is also used in the recovery of phenol in coke-oven wastewaters.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Contact with magnesium may cause explosion. Organophosphates, such as tricresyl phosphate, are susceptible to formation of highly toxic and flammable phosphine gas in the presence of strong reducing agents such as hydrideds and active metals. Partial oxidation by oxidizing agents may result in the release of toxic phosphorus oxides.

Permissible Exposure Limits in Air

NIOSH IDLH = 40 milligram per cubic meter

OSHA PEL: 0.1 milligram per cubic meter TWA

NIOSH REL: 0.1 milligram per cubic meter TWA [skin]

ACGIH TLV[1]: 0.1 mg/m TWA [skin], not classifiable as a human carcinogen; BEI$_A$ issued for Acetylcholinesterase inhibiting pesticides.

Protective Action Criteria (PAC) Ver. 29[138]

78-30-8, o-isomer

PAC-1: 0.3 ppm

PAC-2: 13 ppm

PAC-3: 40 ppm

Australia: TWA 0.1 milligram per cubic meter, [skin], 1993; Austria: MAK 0.1 milligram per cubic meter, 1999; Belgium: TWA 0.1 milligram per cubic meter, [skin], 1993; Denmark: TWA 0.1 milligram per cubic meter, 1999; Finland: TWA 0.1 milligram per cubic meter, STEL 0.3 milligram per cubic meter, [skin], 1999; France: VME 0.1 milligram per cubic meter, [skin], 1999; Hungary: TWA 0.1 milligram per cubic meter, STEL 0.2 milligram per cubic meter, [skin], 1993; the Netherlands: MAC-TGG 0.1 milligram per cubic meter, 2003; the Phillipines: TWA 0.1 milligram per cubic meter, 1993; Poland: MAC (TWA) 0.1 milligram per cubic meter; MAC (STEL) 0.3 milligram per cubic meter, 1999; Switzerland: MAK-W 0.1 milligram per cubic meter, 1999; United Kingdom: TWA 0.1 milligram per cubic meter, STEL 0.3 milligram per cubic meter, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Several states have set guidelines or standards for the compound in ambient air[60] ranging from 1.0 μ/m^3 (North Dakota); to 2.0 μ/m^3 (Connecticut and Nevada); to 160.0 μ/m^3 (Virginia).

Determination in Air: Use NIOSH Analytical Method (IV) #5037, Triorthocresyl phosphate.

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact. The widespread epidemics of poisoning that have occurred have been due to ingested ortho-isomer as a contaminant of food-stuffs. Experimental human studies with labeled phosphorus derivatives show only 0.4% of the applied dose was absorbed.

Harmful Effects and Symptoms

Short-Term Exposure: May affect the central and peripheral nervous systems, causing impaired functions (paralysis). Exposure above exposure limits may cause permanent paralysis. The major effects from inhaling, swallowing, or absorbing tricresyl phosphate through the skin are on the spinal cord and peripheral nervous system; the poison attacking the anterior horn cells and pyramidal tract as well as the peripheral nerves. Gastrointestinal symptoms on acute exposure (nausea, vomiting, diarrhea, and abdominal pain) are followed by a latent period of 3−30 days with the progressive development of muscle soreness and numbness of fingers, calf muscles, and toes; with foot and wrist drop. In chronic intoxication, the gastrointestinal symptoms pass unnoticed, and after a long latent period, flaccid paralysis of limb and leg muscles appear. There are minor sensory changes and no loss of sphincter control.

Long-Term Exposure: May affect the nervous system; causing peripheral neuropathy; cramps in calves; paresthesia in feet or hands; weakness in the feet; wrist drop; muscular paralysis.

Points of Attack: Peripheral nervous system; CNS.

Medical Surveillance: Preplacement and periodic examinations should include evaluation of spinal cord and neuromuscular function, especially in the extremities; and a history of exposure to other organophosphate esters; pesticides, or neurotoxic agents. Periodic cholinesterase determination may relate to exposure, but not necessarily to neuromuscular effect.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Effects may be delayed. Medical observation is recommended.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Viton, polyvinyl chloride, Nitrile + PVC, butyl rubber; and polyethylene are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *0.5 milligram per cubic meter*: Qm (APF = 25) (any quarter-mask respirator). *1 milligram per cubic meter*: 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *2.5 milligram per cubic meter*: Sa: Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *5 milligram per cubic meter*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *40 milligram per cubic meter*: Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full-faceplate and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in a refrigerator or a cool, dry place away from oxidizing materials. Where possible, automatically pump liquid from drums or other storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored.

Shipping: UN2574 Tricresyl phosphate with >3% ortho (*o*-) isomer, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: *Solid* (below 52/F/11°C): Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Liquid: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of phosphorus and carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138). (2); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 2, No. 2, 73–75 (1982) and 2, No. 3, 83–84 (1982)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Tricresylphosphate (mixed isomers) Trenton, NJ (February 2007)

Triethylamine T:0810

Formula: $C_6H_{15}N$; $(C_2H_5)_3N$

Synonyms: (Diethylamino)ethane; *N,N*-Diethylethaneamine; Ethanamine, *N,N*-diethyl-; TEA; TEN; Triaethylamin (German); Trietilamina (Spanish)

CAS Registry Number: 121-44-8

HSDB Number: 896

RTECS Number: YE0175000

UN/NA & ERG Number: UN1296/132

EC Number: 204-469-4 [*Annex I Index No.*: 612-004-00-5]

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Corrosive, Highly Flammable, Possible risk of forming tumors, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction).

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U404

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 5000 lb (2270 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T, F,C; Risk phrases: R11; R20/21/22; R35; R61; R62; Safety phrases: S1/2; S3; S16; S21; S26; S29; S36/37/39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Triethylamine is a colorless liquid. Strong ammonia odor. Molecular weight = 101.22; Specific gravity (H_2O:1) = 0.73 @ 20°C; Boiling point = 90°C; Freezing/Melting point = −115°C; Vapor pressure = 54 mmHg @ 25°C; Flash point = −7°C; Autoignition temperature = 249°C; also listed @ 230°C. Explosive limits: LEL = 1.2%; UEL: 8.0%. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 3, Reactivity 0. Slightly soluble in water; solubility = 2%.

Potential Exposure: Triethylamine is and aliphatic amine used as a solvent; corrosion inhibitor; in chemical synthesis; and accelerator activators; paint remover; base in methylene chloride or other chlorinated solvents. TEA is used to solubilize 2,4,5-T in water and serves as a selective extractant in the purification of antibiotics. It is used to manufacture quaternary ammonia compounds and octadecyloxymethyltriethylammonium chloride; an agent used in textile treatment.

Incompatibilities: A strong base. Violent reaction with strong acids; halogenated compounds; and strong oxidizers. Attacks some forms of plastics, rubber and coatings. Corrosive to aluminum, zinc, copper, and their alloys in the presence of moisture. Reaction with nitrosating agents (e.g., nitrites, nitrous gases, and nitrous acid) capable of releasing carcinogenic nitrosamines.

Permissible Exposure Limits in Air

NIOSH IDLH = 200 ppm

Conversion factor: 1 ppm = 4.14 milligram per cubic meter @ 25°C & 1 atm

Odor Threshold = 0.48 ppm.

OSHA PEL: 25 ppm/100 milligram per cubic meter TWA

NIOSH REL: No established REL; See *NIOSH Pocket Guide*, Appendix D.

ACGIH TLV[1]: 0.5 ppm/2.05 milligram per cubic meter TWA; 1 ppm/6.2 milligram per cubic meter STEL, not classifiable as a human carcinogen [skin]

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 1 ppm

PAC-2: 170 ppm

PAC-3: 1000 ppm (≥10% LEL, lower explosive limit but < 50% LEL)

DFG MAK : 1 ppm/4.2 milligram per cubic meter TWA; Peak Limitation Category I(2); Pregnancy Risk Group D

Europe OEL: 2 ppm/8.4 milligram per cubic meter TWA; 3 ppm/12.6 milligram per cubic meter STEL [skin] 2002. Australia: TWA 10 ppm (40 milligram per cubic meter), STEL 15 ppm, 1993; Austria: MAK 2.5 ppm (10 milligram per cubic meter), 1999; Belgium: TWA 10 ppm (41 milligram per cubic meter), STEL 15 ppm, 1993; Denmark: TWA 10 ppm (40 milligram per cubic meter), 1999; Finland: TWA 10 milligram per cubic meter, STEL 20 milligram per cubic meter, [skin], 1999; France: VLE 10 ppm (40 milligram per cubic meter), 1999; Hungary: TWA 20 milligram per cubic meter, STEL 40 milligram per cubic meter, 1993; the Netherlands: MAC-TGG 20 milligram per cubic meter, [skin], 2003; Norway: TWA 10 ppm (40 milligram per cubic meter), 1999; the Phillipines: TWA 25 ppm (100 milligram per cubic meter), 1993; Russia: STEL 10 milligram per cubic meter, [skin], 1993; Sweden: NGV 2 ppm (8 milligram per cubic meter), KTV 10 ppm (40 milligram per cubic meter), 1999; Switzerland: MAK-W 10 ppm (40 milligram per cubic meter), KZG-W 20 ppm (80 milligram per cubic meter), 1999; Turkey: TWA 25 ppm (100 milligram per cubic meter), 1993; United Kingdom: TWA 10 ppm (42 milligram per cubic meter), STEL 15 ppm (63 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 3 ppm [skin]. Russia[43] set a MAC in ambient air of residential areas of 0.14 milligram per cubic meter both on a momentary and a daily average basis. Several states have set guidelines or standards for triethylamine in ambient air[60] ranging from 5.6 μ/m^3 (Massachusetts); to 20.0−200.0 μ/m^3 (Rhode Island); to 400.0−600.0 μ/m^3 (North Dakota); to 660.0 μ/m^3 (Virginia); to 800.0 μ/m^3 (Connecticut); to 952.0 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (II-3) #S-152, OSHA Analytical Method PV2060.

Determination in Water: Octanol-water coefficient: Log $K_{ow} = 1.45$. Unlikely to bioaccumulate in marine organisms.

Permissible Concentration in Water: Russia[43] set a MAC in water bodies used for domestic purposes of 2.0 mg/L.

Routes of Entry: Inhalation, ingestion, skin absorption, skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Triethylamine can affect you when breathed in and by passing through your skin. Corrosive to the eyes, skin, and respiratory tract. Contact can cause severe eye damage. Breathing the vapor can irritate the lungs. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. A CNS depressant.

Long-Term Exposure: Can irritate the lungs; repeated exposures may cause bronchitis to develop. May cause skin allergy. May damage the kidneys and liver. Similar compounds can cause an asthma-like allergy to develop. Once allergy develops, even very small future exposures can cause wheezing, chest tightness and shortness of breath. In animals: myocardial, kidney, liver damage.

Points of Attack: Eyes, skin, respiratory system; cardiovascular system, liver, kidneys.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater, or significant skin contact), the following are recommended before beginning work and at regular times after that: lung function tests; liver function tests. If symptoms develop or overexposure is suspected, the following may be useful: liver and kidney function tests; exam of the eyes and vision; evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water, or milk. Do not induce vomiting. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. nitrile, Viton, and chlorinated polyethylene are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Provide: eyewash (>1%), quick drench (>1%).

Respirator Selection: OSHA: *200 ppm*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive pressure mode). *Escape*: GmFS (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted canister providing protection against the compound of concern]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code-Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Triethylamine must be stored to avoid contact with strong acids (such as hydrochloric, sulfuric, and nitric); or oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates) because violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where triethylamine is used, handled, or stored in a manner that could create A potential fire or explosion hazard. Metal containers involving the transfer of 5 gallons or more of triethylamine should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of triethylamine.

Shipping: UN1296 Triethylamine, Hazard Class: 3; Labels: 3-Flammable liquid, 8-Corrosive material.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Dangerous decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Water may be ineffective. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Controlled incineration (incinerator equipped with a scrubber or thermal unit to reduce nitrogen oxides emissions).

References

(31); (173); (101); (138); (2); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: *Ethylamines*, Washington, DC (April 1, 1978)

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 3, No. 6, 81–83 (1983)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: *Triethylamine*, Trenton, NJ (June 2003)

Trifluorobromomethane T:0820

Formula: $CBrF_3$

Synonyms: Bromofluroform; Bromotrifluormetano (Spanish); Bromotrifluoromethane; Carbon monobromide trifluoride; F 13 B1; FC 13 B1; Flugex 13 B1; Fluorocarbon 1301; Freon 13 B1; Halon 1301; Methane, bromotrifluoro-; R 13 B1; Refrigerant 1301; Trifluoromethyl bromide; Trifluoromonobromomethane

CAS Registry Number: 75-63-8

HSDB Number: 141 as bromotrifluoromethane

RTECSNumber: PA5425000

UN/NA & ERG Number: UN1009/126

EC Number: 200-887-6

Regulatory Authority and Advisory Information

Hazard Alert: Environmental danger (ozone depletion), Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated.

Clean Air Act: Stratospheric ozone protection (Title VI, Subpart A, appendix A), Class I, Ozone Depletion Potential (ODP) = 10.0

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Harms public health and the environment by destroying ozone in the upper atmosphere.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: Xi, N; Risk phrases: R5; R20; R21; R36/37/38; R58/59; Safety phrases: S9; S16; S23; S26; S33; S36/37/39; S38; S57; S59; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Trifluorobromomethane is a colorless gas with a slight ethereal odor. Shipped as a liquefied compressed gas. Molecular weight = 148.91; Specific gravity (H_2O:1) = 1.50 @ 20°C; Boiling point = −58°C; Freezing/Melting point = −172°C; Vapor pressure = 750 mmHg @ −58°C. Slightly soluble in water; solubility = 0.03%.

Potential Exposure: This material is used as a fire extinguishing agent, a chemical intermediate, and as a refrigerant.

Incompatibilities: Keep away from chemically active metals, such as calcium, powdered aluminum; zinc, magnesium. Attacks some plastics, rubber, and coatings.

Permissible Exposure Limits in Air

NIOSH IDLH = 40,000 ppm

Conversion factor: 1 ppm = 6.09 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 1000 ppm/6100 milligram per cubic meter TWA

NIOSH REL: 1000 ppm/6100 milligram per cubic meter TWA

ACGIH TLV[1]: 1000 ppm/6090 milligram per cubic meter TWA

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 3000 ppm

PAC-2: 4200 ppm

PAC-3: 40,000 ppm

DFG MAK: 1000 ppm/6200 milligram per cubic meter^{TWA}; Peak limitaiont Category (II(8); Pregnancy Group C

Australia: TWA 1000 ppm (6100 milligram per cubic meter), 1993; Austria: MAK 1000 ppm (6100 milligram per cubic meter), 1999; Belgium: TWA 1000 ppm (6090 milligram per cubic meter), 1993; Denmark: TWA 1000 ppm (6100 milligram per cubic meter), 1999; Finland: TWA 1000 ppm (6100 milligram per cubic meter), STEL 1250 ppm (7625 milligram per cubic meter), 1999; France: VME 1000 ppm (6100 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 6100 milligram per cubic meter, 2003; the Phillipines: TWA 1000 ppm (6100 milligram per cubic meter), 1993; Russia: STEL 3000 milligram per cubic meter, 1993; Switzerland: MAK-W 1000 ppm (6100 milligram per cubic meter), 1999; Turkey: TWA 1000 ppm (6100 milligram per cubic meter), 1993; United Kingdom: TWA 1000 ppm (6190 milligram per cubic meter), STEL 1200 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 1000 ppm. Several states have set guidelines or standards for this compound in ambient air[60] ranging from 61.0 milligram per cubic meter (North Dakota); to 100 milligram per cubic meter (Virginia); to 122 milligram per cubic meter (Connecticut); to 145.238 milligram per cubic meter (Nevada).

Determination in Air: Absorption on charcoal, workup with methylene chloride; analysis by gas chromatography.

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guide lines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg [F]/L. SafeDrinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg[F]/L; SMCL = 2 mg/F/L, as Fluoride.

Determination in Water: Octanol-water coefficient: Log K_{ow} = 1.86. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, eye and/or skin contact with the liquid.

Harmful Effects and Symptoms

Short-Term Exposure: Trifluorobromomethane can affect you when breathed in. Irritates the eyes. Contact with the liquid may cause frostbite. Exposure can cause CNS depression, causing lightheadedness, and trouble concentrating. Breathing high concentrations of the vapor may cause the heart to beat irregularly or to stop.

Long-Term Exposure: Unknown at this time. However, some related chemicals are known to cause liver damage with high or repeated exposure.

Points of Attack: CNS; heart.

Medical Surveillance: If symptoms develop or overexposure has occurred, the following may be useful: A special 24 hour EKG (Holter monitor) to look for irregular heartbeat; consider liver function tests. Examination of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming

frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 10,000 ppm*: Sa (APF = 10) (any supplied-air respirator). *Up to 25,000 ppm*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *Up to 40,000 ppm*: SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive pressure mode). Escape: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Check oxygen content prior to entering storage area. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Trifluorobromomethane must be stored to avoid contact with chemically active metals (such as calcium, powdered aluminum; zinc and magnesium), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Outdoor, ventilated, fireproof storage preferred. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169 with the recommendations of the Compressed Gas Association.

Shipping: UN1009 Bromotrifluoromethane or Refrigerant gas, R-13B, Hazard Class: 2.2; Labels: 2.2-Nonflammable gas. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: If in a building, evacuate building and confine vapors by closing doors and shutting down HVAC systems. Restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak to disperse the gas. Wear chemical protective suit with SCBA to combat spills. Stay upwind and use water spray to "knock down" vapor; contain runoff. Stop the flow of gas, if it can be done safely from a distance. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place; and repair leak or allow cylinder to empty. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. Keep this chemical out of confined spaces, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120 (q) may be applicable.

Fire Extinguishing: This chemical is a nonflammable gas. Thermal decomposition products may include toxic and corrosive gases including phosgene, hydrogen bromide; hydrogen fluoride and oxides of carbon. Extinguish fire using an agent suitable for type of surrounding fire. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced.

References

(31); (173); (101); (138); (122); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Trifluorobromomethane, Trenton, NJ (June 2006)

Trifluoroethane T:0830

Formula: $C_2H_3F_3$
Synonyms: *1,1,1-isomer*: Ethane, 1,1,1-trifluoro-; FC143A; Fluorocarbon FC143A; Methylfluoroform; R 143a; 1,1,1-Trifluoroethane; 1,1,1-Trifluoroform; *1,1,2-isomer*: Ethane, 1,1,2-trifluoro-; R 143
CAS Registry Number: 420-46-2 (1,1,1-isomer); 430-66-0 (1,1,2-isomer); 27987-06-0 (mixed isomers)
RTECS Number: KJ4100000 (trifluoroethane); KJ4110000 (1,1,1-isomer)
UN/NA & ERG Number: UN2035 (1,1,1-Trifluoroethane, compressed or Refrigerant gas, R 143a)/115
EC Number: 206-996-5 (1,1,1-isomer); 207-066-1 (1,1,2-isomer); 248-764-6 (mixed isomers)
Regulatory Authority and Advisory Information
Hazard Alert: Extremely Flammable gas, Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated, Environmental hazard (ozone depletion).
40 CFR Part 98 Subpart A, Table A-1-Global Warming Potentials) As amended in 79 FR 73779, December 11, 2014; Effective date 1/1/2015: Global Warming Potential = 4470 (1,1,1-isomer); 353 (1,1,2-isomer)
Harms public health and the environment by destroying ozone in the upper atmosphere.
Hazard Symbols, Risk & Safety statements: Hazard Symbol: F+, N; Risk phrases: R5; R12; R21; R58/59; Safety phrases: S9; S16; S24; S33; S38; S45; S57; S59; S61 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water. (*CAS*: *420-46-2*).
Description: 1,1,1-Trifluoroethane is a colorless gas or a liquid under pressure. Molecular weight = 84.04; Specific gravity (H_2O:1) = 0.942 @ 20 Boiling point = −48°C; Freezing/Melting point = −111°C; Autoignition temperature = 750°C; Explosive limits: LEL: 7.4%; UEL: 18.7%. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 4, Reactivity 0. Low solubility in water.
Potential Exposure: The 1,1,1-isomer is used to make other chemicals and used as a refrigerant.
Incompatibilities: 1,1,1-Trifluoroethane forms an explosive mixture with air. Low molecular weight haloalkanes are highly flammable and can react with some metals to form dangerous products. Materials in this group are incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.) and reducing agents such as hydrides, nitrides, alkali metals, and sulfides. Also, they are incompatible with many amines, nitrides, azo/diazo compounds, alkali metals, and epoxides[101].
Permissible Exposure Limits in Air
Russia: The 1,1,1-isomer has a MAC in workplace air of 3,000 milligram per cubic meter[43]
Protective Action Criteria (PAC) not available
Permissible Concentration in Water: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guidelines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg [F]/L. SafeDrinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg[F]/L; SMCL = 2 mg/F/L, as Fluoride.
Routes of Entry: Inhalation.
Harmful Effects and Symptoms
Short-Term Exposure: Trifluoroethane can affect you when breathed in. Inhalation may cause CNS depression. Higher levels may cause dizziness, lightheadedness, unconsciousness, and asphyxiation. Physical contact with the liquid may cause frostbite. Exposure may cause cardiac arrhythmia (irregular heart beat).
Long-Term Exposure: No chronic health effects are known at this time.
Points of Attack: Heart, CNS.
Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: Holter monitor (a special 24 hour EKG to look for irregular heartbeats). Examination of the nervous system.
First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.
Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquids, unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Where exposure to cold equipment, vapors, or liquid may occur, employees should be provided with special clothing designed to prevent the freezing of body tissues.
Respirator Selection: Where there is potential exists for exposure to trifluoroethane, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a

full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive pressure mode.

Storage: Check oxygen content prior to entering storage area. Flammable gas. Color code-Red Stripe: Flammability Hazard: Store separately from all other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 meters or a 1-hour fire wall from flammable or reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Outdoor or detached storage is recommended. Sources of ignition, such as smoking and open flames, are prohibited where trifluoroethane is used, handled, or stored in a manner that could create A potential fire or explosion hazard. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: UN2035 1,1,1-Trifluoroethane, compressed or Refrigerant gas, R 143a, Hazard Class: 2.1; Labels: 2.1-Flammable gas. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of leak to disperse the gas. Stop the flow of gas if it can be done safely. If source of leak is a cylinder and the leak cannot be stopped in place, remove leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. Keep this chemical out of confined space, such as a sewer because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Trifluoroethane is a flammable gas. Thermal decomposition products including hydrogen fluoride and oxides of carbon. Use dry chemical, CO_2, water spray; or foam extinguishers. Use water spray to keep fire-exposed containers cool. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Nonrefillable cylinders should be disposed of in accordance with local, state and federal regulations. Allow remaining gas to vent slowly into atmosphere in an unconfined area or exhaust hood. Refillable-type cylinders should be returned to original supplier with any valve caps and outlet plugs secured and valve protection caps in place.

References

(31); (101); (122); (122); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Trifluoroethane, Trenton, NJ (March 1987)

Trifluralin T:0840

Formula: $C_{10}H_9F_3N_3O_4$; $C_3H_7N\text{-}C_6H_2(NO_2)_2CF_3$

Synonyms: Agreflan; Agriflan 24; Autumn kite; Benzenamine, 2,6-dinitro-*N*,*N*-dipropyl-4-(trifluoromethyl-); Benzeneamine, 2,6-dinitro-*N*,*N*-dipropyl-4-(trifluoromethylaniline); Campbell's trifluron; Chandor; Crisalin; Devrinol T; Digermin; 2,6-Dinitro-*N*,*N*-dipropyl-4-(trifluoromethyl)aniline; 2,6-Dinitro-*N*,*N*-dipropyl-4-(trifluoromethyl)benzenamine; 2,6-Dinitro-*N*,*N*-di-*N*-propyl-α,α,α-trifluro-*p*-toluidine; 2,6-Dinitro-4-trifluormethyl-*N*,*N*-dipropylanilin (German); 4-(Di-*N*-propylamino)-3,5-dinitro-1-trifluoromethylbenzene; *N*,*N*-Di-*N*-propyl-2,6-dinitro-4-trifluoromethylaniline; *N*,*N*-Dipropyl-4-trifluoromethyl-2,6-dinitroaniline; Elancolan; Ethane, trifluoro-; Flint; Ipersan; Janus; L-36352; Lilly 36,352; Linnet; Marksman; Marksman 2, Trigard; M.T.F; NCI-C00442; Nitran; Olitref; Onslaught; Sinflowan; Solo; Suseguro carpidor; Synfloran; *p*-Toluidine, α,α,α-trifluoro-2,6-dinitro-*N*,*N*-dipropyl-; Trefanocide; Treficon; Treflan; Treflanocide elancolan; Trifarmon; α,α,α-Trifluoro-2,6-dinitro-*N*,*N*-dipropyl-*p*-toluidine; Trifluralina (Spanish); Trifluralina 600; Trifluraline; Triflurex; Trifurex; Trigard; Trikepin; Trilin; Trilin 10G; Trim; Trimaran; Tripart Trifluralin 48 EC; Tristar

CAS Registry Number: 1582-09-8; *(alt.)* 39300-53-3; *(alt.)* 52627-52-8; *(alt.)* 61373-95-3; *(alt.)* 75635-23-3

HSDB Number: 1003 (1582-09-8)

RTECS Number: XU9275000

UN/NA & ERG Number: UN2588 (Pesticides, solid, toxic, n.o.s.)/151; UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 216-428-8 [*Annex I Index No*.: 609-046-00-1]

Regulatory Authority and Advisory Information

Carcinogenicity: EPA: Group C, Possible Human Carcinogen[193]. Basis for classification: Classification is based on the induction of urinary tract tumors (renal pelvis carcinomas and urinary bladder papillomas) and thyroid tumors (adenomas/carcinomas combined) in one animal species (F344 rats) in one study[USEPA]. GHS Classification: Suspected of causing cancer. IARC: Animal, Limited Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1991; NCI: Carcinogenesis Bioassay (feed); clear evidence: mouse; no evidence: rat. *aneuploidy*; Weakly Positive: S *cerevisiae-homozygosis*; Positive/limited: Carcinogenicity-mouse/rat; Negative: D *melanogaster* sex-linked lethal; Negative: *In vitro* UDS-human fibroblast; TRP reversion; Inconclusive: B *subtilis* rec assay; *E coli polA* without S9.

Hazard Alert: Poison, Combustible, Sensitization hazard, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Environmental hazard.

Banned or Severely Restricted (in United States) (UN)[13]

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Safe Drinking Water Act (47FR 9352): Priority List (55 FR 1470)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

European/International Regulations *(containing <0.5 ppm NPDA)*: Hazard Symbol: T, N, Xi; Risk phrases: R45; R36; R43; R51; R60; R61; R62; R63; Safety phrases: S2; S24; S29/35; S37; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Trifluralin is an orange crystalline solid. Molecular weight = 335.32; Boiling point = 139°C; Freezing/Melting point = 49°C; Vapor pressure = 0.0001 mmHg. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 0. Practically insoluble in water.

Potential Exposure: A potential danger to those involved in the manufacture, formulation and application of this selective, preemergence herbicide.

Incompatibilities: Trifluralin is a trifluoromethyl dinitroaniline derivative. Dinitroaniline has a record of industrial explosions. Nothing has been reported implicating trifluralin in any such accidents. This may be because of the trifluoromethyl substitution may mitigate the instability of the molecule. However, care should be taken in the extremes of heat, shock, and friction sources that may trigger an explosive release of energy[101]. Fluorocarbons can react violently with barium, potassium, sodium.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 1.2 milligram per cubic meter

PAC-2: 13 milligram per cubic meter

PAC-3: 78 milligram per cubic meter

The state of Pennsylvania has set a guideline for trifluralin in ambient air[60] of 1,150 μ/m^3.

Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 10 μg/L; State Drinking Water Guidelines: Arizona 2 μg/L; Florida 4.5 μg/L; Maine 45 μg/L; Wisconsin 7.5 μg/L. *Fluoride ion*: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guidelines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg[F]/L. SafeDrinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg [F]/L; SMCL = 2 mg/F/L, as Fluoride.

Determination in Water: Octanol-water coefficient: Log $K_{ow} = 5.1$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood. Fish Tox = 1.57645000 ppb MATC (HIGH).

Routes of Entry: Inhalation, skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Inhalation can cause irritation of the respiratory tract with cough, phlegm, and/or tightness in the chest. The vapor can cause eye and skin irritation. Skin contact can cause irritation and rash which can be exacerbated by sunlight. The majority of reported trifluralin exposure cases were occupational in nature. Other reported symptoms include respiratory involvement, abdominal cramps; nausea, diarrhea, headache, lethargy, and parasthesia following dermal or inhalation exposure.

Long-Term Exposure: May cause skin sensitization. High or repeated exposure may affect the liver and kidneys and/or cause anemia. There is some dispute about the actual carcinogenic effect of trifluralin. NCI[9] reports clear evidence of carcinogenicity in mice but not in rats. Some authorities feel that dipropyl nitrosamine formed in trifluralin manufacture and contained in the technical material might be the actual culprit, and the purified trifluralin might not have this problem. Human Tox = 5.00000 ppb (HIGH).

Points of Attack: Skin, eyes, liver, kidneys, blood.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Kidney and liver function tests. CBC.

First Aid: *Skin Contact*:[52] Flood all areas of body that have contacted the substance with water. Don't wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent to prevent contact by others. *Eye Contact*: Remove any contact lenses at once. Flush eyes well with copious quantities of water or normal saline for at least 20−30 minutes. Seek medical attention. *Inhalation*: Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion*: If convulsions are not present, give a glass or two of water or milk to dilute the substance. Assure that the person's airway is unobstructed and contact a hospital or poison center immediately for advice on whether or not to induce vomiting.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration*: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA-or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full-facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code-Blue: Health Hazard/Poison: Store in temperatures above 4.4°C in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in a cool, dry place and protect from prolonged exposure to light.

Shipping: UN2588 Pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen spilled material with alcohol to avoid dust, then transfer material to a suitable container. Use absorbent dampened with alcohol to pick up remaining material. Wash surfaces well with soap and water. Collect waste material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Soil Adsorption Index (K_{oc}) = 8000

Fire Extinguishing: Thermal decomposition products may include hydrogen fluoride and oxides of nitrogen and carbon. This chemical is a combustible solid. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed. Trifluralin does contain fluorine, and therefore incineration presents the increased hazard of HF in the off-gases. Prior to incineration, fluorine-containing compounds should be mixed with slaked lime plus vermiculite, sodium carbonate or sand-soda ash mixture (90-10).

References

(31); (173); (101); (138); (122); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 2, 70–71 (1980)

United States Environmental Protection Agency, "Alert: Trifluralin, Washington, DC, Office of Drinking Water (August 1987)

Trimellitic Anhydride T:0850

Formula: $C_9H_4O_5$

Synonyms: Anhydrotrimellitic acid; 1,2,4-Benzenetricarboxylic acid anhydride; 1,2,4-Benzenetricarboxylic acid, cyclic 1,2-anhydride; 1,2,4-Benzenetricarboxylic anhydride; 4-Carboxyphthalic anhydride; 1,3-Dihydro-1,3-dioxo-5-isobenzofurancarboxylic acid; 1,3-Dioxo-5-phthalancarboxylic acid; Diphenylmethane-4,4′-diisocyanate-trimellic anhydride-ethomid HT polymer; NCI-C56633; TMA; TMAN; Trimellic acid anhydride; Trimellitic acid cyclic-1,2-anhydride

CAS Registry Number: 552-30-7

HSDB Number: 4299

RTECS Number: DC2050000

EC Number: 209-008-0 [*Annex I Index No.*: 607-097-00-4]

Regulatory Authority and Advisory Information

Hazard Alert: Combustible, Sensitization hazard (skin, resp.).

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: Xn, Xi; Risk phrases: R37; R41; R42/43; Safety phrases: S2; S22; S26; S36/37/39 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Trimellitic anhydride is a crystalline solid. It is the anhydride of trimellitic acid (1,2,4-benzenetricarboxylic acid). Molecular weight = 192.13; Boiling point = 245°C; Freezing/Melting point = 166.7°C; Vapor pressure = 0.000004 mmHg; Flash point = 227°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 1, Reactivity 1~~W~~. Highly soluble; reacts with water.

Potential Exposure: TMA is used to produce trimellitate plasticizers, poly (amide-imide) polymers; in paints, enamels, and coatings; polymers, polyesters; as a curing agent for epoxy and other resins; in vinyl plasticizers; agricultural chemicals; dyes and pigments; pharmaceuticals, surface active agents; modifiers, intermediates, and specialty chemicals.

Incompatibilities: Dust can cause an explosion. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Reacts slowly with water, forming trimellitic acid. Compounds of the carboxyl group react with all bases, both inorganic and organic (i.e., amines) releasing substantial heat, water and a salt that may be harmful.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 7.86 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: None

NIOSH REL: 0.005 ppm/0.04 milligram per cubic meter TWA, Should be handled in the workplace as an extremely toxic substance.

ACGIH TLV[1]: 0.0005 milligram per cubic meter measured as inhalable fraction and vapor TWA; 0.002 milligram per cubic meter measured as inhalable fraction and vapor Ceiling Concentration; [skin]; danger of sensitization.

DFG MAK: 0.04 milligram per cubic meter TWA; Peak Limitation Category I(1); danger of sensitization of the airways

Australia: TWA 0.005 ppm (0.04 milligram per cubic meter), 1993; Austria: MAK 0.005 ppm (0.04 milligram per cubic meter), 1999; Belgium: TWA 0.005 ppm (0.059 milligram per cubic meter), 1993; Denmark: TWA 0.1 milligram per cubic meter, 1999; Finland: TWA 0.005 ppm, 1999; Norway: TWA 0.005 ppm (0.04 milligram per cubic meter), 1999; Russia: STEL 0.1 milligram per cubic meter, 1993; Sweden: NGV 0.04 milligram per cubic meter, TGV 0.08 milligram per cubic meter, 1999; Switzerland: MAK-W 0.005 ppm (0.04 milligram per cubic meter), KZG-W 0.01 ppm (0.08 milligram per cubic meter), 1999; United Kingdom: TWA 0.04 milligram per cubic meter, STEL 0.12 milligram per cubic meter, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Ceiling Concentration 0.04 milligram per cubic meter. Several states have set guidelines or standards for trimellitic anhydride in ambient air[60] ranging from 0.4 μ/m^3 (North Dakota); to 0.7 μ/m^3 (Virginia); to 0.8 μ/m^3 (Connecticut); to 1.0 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #5036, Trimellitic anhydride, OSHA Analytical Method 98.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Trimellitic anhydride can affect you when breathed in. Irritates the eyes, skin, and respiratory tract. High exposure may cause runny nose; cough, wheezing and shortness of breath; malaise (vague feeling of discomfort), fever, muscle aches. "TMA-flu" with symptoms of cough, chills, shortness of breath; body aches; weakness, and coughing up blood may be delayed for 4–12 hours following overexposure. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: Repeated skin and/or inhalation exposure may cause sensitization asthma which may be delayed and may be aggravated by physical activity.

Allergic asthma occurs sometimes weeks or months after exposure. Trimellitic anhydride can also cause "Pulmonary Disease-Anemia Syndrome" with low blood count, and different lung changes.

Points of Attack: Eyes, skin, respiratory system; blood.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended: lung function test-these may be normal if the person is not having an attack at the time of the test. If symptoms develop or overexposure is suspected, the following may be useful: special tests for trimellitic anhydride allergy (IgE antibodies against TM-HAS). Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose allergy. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential for exposures *over 0.005 ppm* exists, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN 149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive pressure mode.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool well-ventilated area.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid (no flash point can be found in the literature). Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (2); (100).

National institute for Occupational Safety and Health (NIOSH), Trimellitic Anhydride (TMA), Current Intelligence Bulletin No. 21, Washington, DC (February 3, 1978)

United States Environmental Protection Agency, Chemical Hazard Information Profile: Trimellitic Anhydride, Washington, DC (March 3, 1978)

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 5, No. 6, 30−31 (1985)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Trimellitic Anhydride, Trenton, NJ (May 2000)

Trimethylamine T:0860

Formula: C_3H_9N; $(CH_3)_3N$
Synonyms: *N,N*-Dimethylmethanamine; Methamine, *N,N*-dimethyl-; Methanamine, *N,N*-dimethyl-; TMA; *N*-Trimethylamine; Triméthylamine, anhydre (French); Trimethylamine, anhydrous; Trimethylamine, aqueous solution; Trimetilamina, anhidra (Spanish)
CAS Registry Number: 75-50-3
HSDB Number: 808
RTECS Number: YH2880000
UN/NA & ERG Number: UN1083 (anhydrous)/118; UN1297 (aqueous solutions)/132
EC Number: 200-875-0 [*Annex I Index No.*: 612-001-00-9]
Regulatory Authority and Advisory Information
Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).
Hazard Alert: Extremely flammable, Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated, Suspected of causing genetic defects.
Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg)
Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below).
Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 100 lb (45.4 kg)
Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.
Hazard Symbols, Risk & Safety statements: Hazard Symbol: F+, Xn; Risk phrases: R5; R12; R20; R21; R37/38; R41; R60, R61; Safety phrases: S1; S2; S9; S16; S26; S33; S38; S39 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 2-Hazard to water (anhydrous)
Description: Trimethylamine is compressed gas or liquid. Flammable gas. Shipped as a compressed gas, it may be present in an aqueous solution. It has a strong, fishy, ammoniacal odor. The Odor Threshold is 0.00011−0.87 ppm. *Warning*: The Odor Threshold range is so broad that odor alone should not be used as a warning of potentially hazardous exposures. Molecular weight = 59.13; Boiling point = 3°C; Specific gravity (H_2O:1) = 0.58 @ 25°C; Freezing/Melting point = −117°C; Vapor pressure = 1454 mmHg @ 21°C; Flash point = flammable gas; Autoignition temperature = 190°C. Explosive limits: LEL = 2.0 %; UEL: 11.6%. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 4, Reactivity 0. Soluble in water; solubility = 48% @ 30°C.
Potential Exposure: Trimethylamine is used as a chemical intermediate in organic synthesis of quaternary ammonium compounds; as an insect attractant; as a warning agent in natural gas; flotation agent.
Incompatibilities: A medium strong base. Violent reaction with strong oxidizers (such as chlorine, bromine, fluorine), ethylene oxide; nitrosating agents, for example, nitrites, sodium nitrite, nitrous gases, nitrous acid) capable of releasing carcinogenic nitrosamines.); keep away from mercury, strong acids. Corrosive to many metals, for example, zinc, brass, aluminum, copper, tin, and their alloys.
Permissible Exposure Limits in Air
Conversion factor: 1 ppm = 2.42 milligram per cubic meter @ 25°C & 1 atm
OSHA PEL: None
NIOSH REL: 10 ppm /24 milligram per cubic meter TWA; 15 ppm /36 milligram per cubic meter STEL
ACGIH TLV[1]: 5 ppm/12 milligram per cubic meter TWA; 15 ppm /36 milligram per cubic meter STEL
Protective Action Criteria (PAC)* Ver. 29[138]
PAC-1: $\mathbf{8.0_A}$ milligram per cubic meter
PAC-2: $\mathbf{120_A}$ milligram per cubic meter
PAC-3: $\mathbf{380_A}$ milligram per cubic meter
DFG MAK: 2 ppm/4.9 milligram per cubic meter TWA; Peak Limitation Category I(2); Pregnancy Risk Group C
Australia: TWA 10 ppm (24 milligram per cubic meter), STEL 15 ppm, 1993; Belgium: TWA 10 ppm (24 milligram per cubic meter), STEL 15 ppm, 1993; Denmark: TWA 10 ppm (24 milligram per cubic meter), 1999; France: VLE 10 ppm (25 milligram per cubic meter), 1999; Hungary: TWA 5 milligram per cubic meter, STEL 10 milligram per cubic meter, 1993; Norway: TWA 10 ppm (24 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 1 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 15 ppm. Several states have set guidelines or standards for trimethylamine in ambient air[60] ranging from 57.143 μ/m^3 (Kansas); to 240−360.0 μ/m^3 (North Dakota); to 400.0 μ/m^3 (Virginia); to 480.0 μ/m^3 (Connecticut); to 952.0 μ/m^3 (Nevada).
Determination in Air: Use OSHA Analytical Method PV2060.
Determination in Water: Octanol-water coefficient: Log $K_{ow} = 0.2$. Unlikely to bioaccumulate in marine organisms.
Routes of Entry: Inhalation, ingestion (solution), skin and/or eye contact.
Harmful Effects and Symptoms
Short-Term Exposure: Trimethylamine can affect you when breathed in. Exposure can irritate the eyes, skin and respiratory tract Very high levels may cause a buildup of fluid in the lungs (pulmonary edema). This can cause death. Contact can cause severe irritation and burns to the eyes and skin. May cause blurred vision, corneal necrosis. Contact may cause frostbite.
Long-Term Exposure: Long-term effects are not known at this time.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray following acute overexposure. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid, unless full facepiece respiratory protection is worn. Wear gas-proof goggles, unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures *over 10* ppm; Use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive pressure mode.

Storage: Check oxygen content prior to entering storage area. Flammable gas. (1) Color code-Red Stripe: Flammability Hazard: Store separately from all other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 meters or a 1-hour fire wall from flammable or reactive materials. (2) Color code-Corrosive or Contact Hazard; Store separately in a corrosion-resistant location; keep acids away from bases and red, yellow, and blue-coded chemicals. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Trimethylamine must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine) and mercury, since violent reactions occur. Sources of ignition, such as smoking and open flames, are prohibited where trimethylamine is used, handled, or stored in a manner that could create A potential fire or explosion hazard. Use only nonsparking tools and equipment, especially when opening and closing containers of trimethylamine. Wherever trimethylamine is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: UN1083 Trimethylamine, anhydrous, Hazard Class: 2.1; Labels: 2.1-Flammable gas. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner. UN1297 Trimethylamine, aqueous solutions with not >50% trimethylamine by mass, Hazard Class: 3; Labels: 3-Flammable liquid, 8-Corrosive material.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Stop the flow of gas if it can be done safely. If source of leak is a cylinder and the leak cannot be stopped in place, remove leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. For a spill of a liquid solution of trimethylamine, absorb liquid with sodium bisulfate, sand, vermiculite, earth or a similar material. Keep this chemical out of confined space, such as a sewer because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Trimethylamine is an extremely flammable gas or liquid. Thermal decomposition products may include poisonous and irritating oxides of nitrogen and carbon, hydrocarbons (i.e., ethane and methane), and explosive hydrogen. For a small fire involving trimethylamine gas, use dry chemical or CO_2 extinguishers. For small water solution fires, use dry chemical, CO_2, water spray; or foam extinguishers. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If liquid or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Nonrefillable cylinders should be disposed of in accordance with local, state and federal regulations. Allow remaining gas to vent slowly into atmosphere in an unconfined area or exhaust hood. Refillable-type cylinders should be returned to original supplier with any valve caps and outlet plugs secured and valve protection caps in place.

References

(31); (173); (101); (138); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 2, No. 2, 70−73 (1982) and 5, No. 6, 96−98 (1985)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Trimethylamine, Trenton, NJ (June 2003)

2,4,6-Trimethylaniline T:0870

Formula: $C_9H_{13}N$; $C_6H_2(CH_3)_3NH_2$

Synonyms: Aminomesitylene; 2-Amino-1,3,5-trimethylbenzene; Aniline, 2,4,6-trimethyl-; Mesidine; Mesitylamine; Mezidine; 2,4,6-Trimethylbenzenamine

CAS Registry Number: 88-05-1

HSDB Number: 2694

RTECS Number: BZ0700000

UN/NA & ERG Number: UN2810 (toxic liquid, organic, n.o.s.)/153

EC Number: 201-794-3

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Animal Inadequate Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1982. Suspect occupational carcinogen. (Nonspecific, aromatic amines)

CERCLA/SARA 40CFR302 Extremely Hazardous Substances: TPQ = 500 lb (227 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 500 lb (227 kg)

Canada, WHMIS, Classification D2B. On NDSL list.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T+; Risk phrases: R21/22; R23/24/25; R26; R33; R36/38; R50/53; Safety phrases: S26; S28; S36/37; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Aniline, 2,4,6-Trimethyl-is a clear liquid. Molecular weight = 135.23; Specific gravity (H_2O:1) = 0.96 @ 20°C; Boiling point = 232°C; Freezing/Melting point = −5°C; Flash point = 95.7°C. Insoluble in water.

Potential Exposure: Used on small scale in organic synthesis.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 0.26 milligram per cubic meter

PAC-2: 2.9 milligram per cubic meter

PAC-3: 10 milligram per cubic meter

Routes of Entry: Inhalation, dermal contact, Ingestion.

Harmful Effects and Symptoms

Short-Term Exposure: This material is moderately toxic orally. It is also considered highly toxic by dermal contact and inhalation. Also, it is a skin and eye irritant. The danger of acute poisoning is represented by methemoglobinemia leading to adverse effects on the red cells. Some amines may act as skin sensitizers. Repeated exposure results in narrowing of peripheral vision, increase in size of blind spot and decrease in photosensitivity. The LC_{50} inhalation (mouse) is 0.29 mg/L/2 hours.

Long-Term Exposure: Suspect occupational carcinogen. This material is a suspect carcinogen on the basis of being an aromatic amine but unlike the 2,4,5-trimethyl-isomer, is not animal positive.

Points of Attack: Blood, skin, eyes, respiratory system.

Medical Surveillance: This chemical is a suspected human carcinogen (nonspecific, aromatic amines). Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to Physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration*: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA-or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full-facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area. Where possible, automatically pump liquid from drums or other storage containers to process containers Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Wherever this chemical is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2810 Toxic liquids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling:

UN2810 Toxic liquids, organic, n.o.s.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.2/0.3
Night 0.7/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 1000/300
Then: Protect persons downwind (miles/kilometers)
Day 1.1/1.8
Night 2.8/4.5

Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: dike far ahead of spill for later disposal. Wear positive pressure breathing apparatus and special protective clothing. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of nitrogen and carbon. *Small fires*: dry chemical, carbon dioxide; water spray or foam. *Large fires*: water spray, fog or foam. Move container from fire area if you can do so without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Wear positive pressure breathing apparatus and special protective clothing. If water pollution occurs, notify appropriate authorities. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Aniline, 2,4,6-Trimethyl, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

Trimethylbenzenes T:0880

Formula: C_9H_{12}; $C_6H_3(CH_3)_3$

See also separate ***Mesitylene*** *108-67-8 (1,3,5-Trimethylbenzene) record*

Synonyms: *1,2,3-isomer*: Hemellitol; Hemimellite; 1,2,3-Trimethylbenzene; 1,2,3-Trimetilbenceno (Spanish)

1,2,4-isomer: Pseudocumene; PSI-Cumene; *asym*-Trimethylbenzene; 1,2,4-Trimethylbenzene; 1,2,4-Trimetilbenceno (Spanish)

1,3,5-isomer: Mesitylene, *sym*-trimethylbenzene; *sym*-Trimethylbenzene; 1,3,5-Trimethylbenzene; 1,3,5-Trimetilbenceno (Spanish)

mixed isomers: Trimethylbenzene, mixed isomers; Trimetilbenceno (Spanish) *Note*: Hemimellitene is a mixture of the 1,2,3-isomer with Up to 10% of related aromatics, such as the 1,2,4-isomer

CAS Registry Number: 526-73-8 (1,2,3-isomer); 95-63-6 (1,2,4-isomer); 108-67-8 (1,3,5-isomer); 25551-13-7 (mixed isomers)

HSDB Number: 7551 (526-73-8); 5293 (95-63-6); 92 (108-67-8)

RTECS Number: OX6825000 (1,3,5-isomer); DC3325000 (1,2,4-isomer); DC3300000 (1,2,3-isomer); DC3225000 (mixed isomers)

UN/NA & ERG Number: UN3295/128; UN2325 (1,3,5-isomer)/129; 1,2,4-isomer: UN1993 (flammable liquids, n.o.s.)/128

EC Number: 208-394-8 (1,2,3-isomer); 202-436-9 [*Annex I Index No.*: 601-043-00-3] (1,2,4-isomer); 203-604-4 [*Annex I Index No.*: 601-025-00-5] (1,3,5-isomer); 247-099-9 (mixed isomers)

Regulatory Authority and Advisory Information

95-63-6, 1,2,4-isomer

Hazard Alert: Poison, Flammable, Suspected of causing genetic defects (mixed isomers) Primary irritant (w/o allergic reaction).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%, 1,2,4-and 1,3,5-isomers; 1% 1,2,3- and mixed isomers. *Note*: Only the 1,2,4-isomer is regulated by the United States Environmental Protection Agency. All three isomers are "regulated" by NIOSH. The 1,3,5-isomer was dropped from the EPA's Extremely Hazardous Substance List (EPA-SARA) in 1988.

European/International Regulations (*95-63-6*): Hazard Symbol: F, Xn; Risk phrases: R10; R20; R36/37/38; R51; Safety phrases S2; S26; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to waters *95-63-6 (1,2,4-isomer)*

Description: Trimethylbenzenes exists in three isomeric forms. All isomers are clear, colorless liquids with a distinctive, aromatic odor. Molecular weight = 120.2; Specific gravity (H_2O:1) = 0.88 to 0.89 @ 20°C; Boiling point = 176°C (1,2,3-isomer); 169°C (1,2,4-isomer); 165°C (1,3,5-isomer); Freezing/Melting point = −25°C (1,2,3-isomer); −44°C (1,2,4-isomer); −45°C (1,3,5-isomer); Vapor pressure = 1 mmHg @ 17°C (1,2,3-); 1 mmHg @ 13°C (1,2,4-); Flash points = 44°C (1,2,3-& 1,2,4-isomers); 50°C (1,3,5-isomer); 53°C [1,2,3-isomer (90.5%)]; Autoignition temperature = 470°C (1,2,3-isomer); 479°C [1,2,3-isomer (90.5%)]; 500°C (1,2,4-isomer); 559°C (1,3,5-isomer). Explosive limits: LEL = 0.9%; UEL: 6.4% (1,2,4-isomer); LEL = 0.8%; UEL: 6.6% (1,2,3-isomer). NFPA 704M Hazard Identification (all isomers): Health 1, Flammability 2, Reactivity 0. Practically insoluble in water; solubility = 0.005% (1,2,3-isomer); 0.006% (1,2,4-isomer).

Potential Exposure: (1,2,3-and 1,2,4-isomers): These materials are used as solvents and in dye and perfume manufacture. The 1,2,3-isomer is used as raw material in chemical synthesis and as an UV stabilizer. The 1,2,4-isomer is used as the raw material for trimellitic anhydride manufacture. These compounds are found in diesel engine exhaust fumes.

Incompatibilities: Vapors may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air
Odor Threshold (for the class) = 0.55 ppm.
all isomers
Conversion factor: 1 ppm = 4.92 milligram per cubic meter @ 25°C & 1 atm
OSHA PEL: None
NIOSH REL: 25 ppm/125 milligram per cubic meter TWA
ACGIH TLV[1] (*mixed isomers*): 25 ppm/123 milligram per cubic meter TWA
DFG MAK: (*all isomers*) 20 ppm/100 milligram per cubic meter TWA; Peak Limitation Category II(2); Pregnancy Group C
Protective Action Criteria (PAC)* Ver. 29[138]
526-73-8, 1,2,3-isomer, 95-63-6, 1,2,4-isomer & 108-67-8, 1,3,5-isomer
PAC-1: **140_A** ppm
PAC-2: **360_A** ppm
PAC-3: 480 ppm
Austria: MAK 25 ppm (125 milligram per cubic meter), 1999; Denmark: TWA 25 ppm (120 milligram per cubic meter), 1999; Japan; 25 ppm (120 milligram per cubic meter), 1999; Norway: TWA 20 ppm (100 milligram per cubic meter), 1999; United Kingdom: TWA 25 ppm (125 milligram per cubic meter), 2000; the Netherlands: MAC-TGG 100 milligram per cubic meter, 2003
95-63-6, 1,2,4-isomer
Denmark: TWA 25 ppm (120 milligram per cubic meter), 1999; Japan; 25 ppm (120 milligram per cubic meter), 1999; Norway: TWA 20 ppm (100 milligram per cubic meter), 1999; United Kingdom: TWA 25 ppm (125 milligram per cubic meter), 2000; the Netherlands: MAC-TGG 100 milligram per cubic meter, 2003
mixed isomers
Australia: TWA 25 ppm (125 milligram per cubic meter), 1993; Austria: MAK 25 ppm (125 milligram per cubic meter), 1999; Belgium: TWA 25 ppm (123 milligram per cubic meter), 1993; Denmark: TWA 25 ppm (120 milligram per cubic meter), 1999; Finland: TWA 25 ppm (120 milligram per cubic meter), STEL 40 ppm (200 milligram per cubic meter), [skin], 1999; France: VME 25 ppm (125 milligram per cubic meter), 1999; Norway: TWA 20 ppm (100 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 100 milligram per cubic meter, 2003; Sweden: NGV 25 ppm (120 milligram per cubic meter), KTV 35 ppm (170 milligram per cubic meter), 1999; Switzerland: MAK-W 25 ppm (125 milligram per cubic meter), 1999; United Kingdom: LTEL 25 ppm (125 milligram per cubic meter), STEL 35 ppm, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 25 ppm. Several states have set guidelines or standard for Trimethyl benzenes in ambient air[60] ranging from 1.25−1.70 milligram per cubic meter (North Dakota); to 2.1 milligram per cubic meter (Virginia); to 2.5 milligram per cubic meter (Connecticut); to 2.976 milligram per cubic meter (Nevada).

Determination in Air: Use OSHA Analytical Method PV-2091

Determination in Water: Octanol-water coefficient: Log K_{ow} = (1,2,3-) >3.5. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation percutaneous absorption, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Trimethyl benzene can affect you when breathed in. Irritates the eyes, skin, and respiratory tract. Exposure can cause you to feel dizzy, lightheaded, and to pass out. Symptoms of exposure can also include headache, drowsiness, fatigue, dizziness, nausea, a lack of coordination; vomiting, nervousness, tenseness, confusion. Liquid deposition in lungs causes bronchitis or chemical pneumonitis.

Long-Term Exposure: Repeated exposures can cause headaches, tiredness, and a feeling of nervous tension. Can affect the blood cells and the blood's clotting ability; hypochromic anemia. Delayed or chronic health hazard is possible including asthmatic bronchitis with coughing and/or shortness of breath. The use of alcoholic beverages enhances the effect. May cause liver damage. The liquid destroys the skin's natural oils, causing drying and cracking.

Points of Attack: Eyes, skin, respiratory system; CNS; blood, liver.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended. Lung function tests. CBC and platelet count. If symptoms develop or overexposure is suspected, the following may be useful: liver function tests. CBC and platelet count.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to Physician: *Inhalation*: Bronchodilators, decongestants and oxygen may be used if necessary. Corticosteroids are useful for treating pneumonitis.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures *over 25* ppm; Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator with an organic vapor cartridge/canister. More protection is provided by a full facepiece respirator than by a half-mask respirator, and even greater protection is provided by a powered-air purifying respirator. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive pressure mode.

Storage: Color code-Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Trimethylbenzene must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates); and strong oxidizers (such as chlorine, bromine, and fluorine), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create A potential fire or explosion hazard. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical.

Shipping: UN3295 Hydrocarbons, liquid, n.o.s., Hazard Class: 3; Labels: 3-Flammable liquid. UN1993 Flammable liquids, n.o.s., Hazard Class: 3; Labels: 3-Flammable liquid, Technical Name Required. 1,3,5-Trimethylbenzene; UN2325, Hazard Class: 3; Labels: 3-Flammable liquid. 1,2,4-Trimethylbenzene:

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of carbon. *Small fires*: dry chemical, carbon dioxide; water spray; or alcohol-resistant foam. *Large fires*: water spray, fog, or alcohol foam. Move container from fire area if you can do so without risk. Spray cooling water on containers that are exposed to flames until well after fire is out. For massive fire in cargo area, use unmanned hose holder or monitor nozzles; if this is impossible, withdraw from area and let fire burn. Isolate for one-half mile in all directions if tank car or truck is involved in fire. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138). (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Mesitylene, Washington, DC, Chemical Emergency Preparedness Program (October 31, 1985)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Trimethylbenzene (mixed isomers), Trenton, NJ (May 2003)

Trimethylchlorosilane T:0890

Formula: C_3H_9ClSi

Synonyms: Chlorotrimethylsilane; Monochloro-trimethylsilicon; NSC 15750; Silane, chlorotrimethyl-; Silane, trimethylchloro-; Silicane, chlorotrimethyl-; Silylium, trimethyl-, chloride; STCC 4907680; TL 1163; Trimethylsilyl chloride; Trimetilclorosilano (Spanish)

CAS Registry Number: 75-77-4

HSDB Number: 1009

RTECS Number: VV2710000

UN/NA & ERG Number: UN1298/132

EC Number: 200-900-5

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Hazard Alert: Highly flammable, Corrosive, Violently water reactive Possible risk of forming tumors, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction).

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg)

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 1000 lb (454 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 1000 lb (454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T, F+, C, Xn; Risk phrases: R11; R14; R19; R20/22; R21; R23/24/25; R34; R36/37/38; R39; R40; R41; R62; Safety phrases: S1; S7; S16; S21; S26; S36/37/39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Trimethylchlorosilane is a colorless, fuming liquid. Irritating odor. Molecular weight = 108.66; Specific gravity (H_2O:1) = 0.85 @ 20°C; Boiling point = 57°C; Freezing/Melting point = −40°C; Flash point = −15°C (cc); Vapor pressure = 200 mmHg @ 18C; Autoignition temperature = 395°C. Explosive limits: LEL: 1.5%; UEL: >60%; Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 3, Reactivity 2, ~~W~~ Reacts violently with water, rapidly releasing corrosive hydrogen chloride gas.

Potential Exposure: Trimethylchlorosilane is used as an intermediate to make silicone products, including lubricants.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Chlorosilanes react vigorously with bases and both organic and inorganic acids generating toxic and/or flammable gases. Chlorosilanes react with water, moist air, or steam to produce heat and toxic, corrosive fumes of hydrogen chloride. They may also produce flammable gaseous hydrogen. Attacks metals in the presence of moisture. Vigorous reaction with aluminum powder.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)* Ver. 29[138]

PAC-1: $\mathbf{1.8_A}$ ppm

PAC-2: $\mathbf{22_A}$ ppm

PAC-3: $\mathbf{100_A}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

Determination in Air:

No standards or Protective Action Criteria (PAC) available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the respiratory tract causing coughing and wheezing. Contact can cause severe skin and eye irritation and burns with possible permanent damage. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: Can irritate the lungs; bronchitis may develop with coughing, phlegm, and/or shortness of breath. There is limited evidence that trimethylchlorosilane causes cancer in animals.

Points of Attack: Cancer site in animals: lungs.

Medical Surveillance. Lung function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water, or milk. Do not induce vomiting. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/

manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear-splash-proof chemical goggles and face shield when working with liquid unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved.

Storage: Color code-Red: Flammability Hazard: Store Store in temperatures below 21°C in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool (below 70/F/21°C), well-ventilated area away from moisture of any form and strong oxidizers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create A potential fire or explosion hazard. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical.

Shipping: UN1298 Trimethylchlorosilane, Hazard Class: 3; Labels: 3-Flammable liquid, 8-Corrosive material.

Spill Handling:

Trimethylchlorosilane when spilled in water

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (*From a small package or a small leak from a large package*)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)
Day 0.4/0.6
Night 1.0/1.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Stay upwind; keep out of low areas. If water pollution occurs, notify appropriate authorities. Shut off ignition sources; no flares, smoking or flames in hazard area. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors do not get water inside container. *Small spills*: flush area with flooding amounts of water. *Large spills*: dike far ahead of spill for later disposal. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include hydrogen chloride and oxides of silicon and carbon. Use dry chemical or carbon dioxide. Fire may restart after is has been extinguished. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Do not discharge into drains or sewers. Use a licensed disposal contractor to an approved landfill. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office for guidance on acceptable disposal practices. The most favorable course of action is to use an alternative chemical product with less inherent propensity for occupational exposure or environmental contamination. Recycle any unused portion of the material for its approved use or return it to the manufacturer or supplier. Ultimate disposal of the chemical must consider: the material's impact on air quality; potential migration in soil or water; effects on animal, aquatic, and plant life; and conformance with environmental and public health regulations[72].

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Trimethylchlorosilane, Trenton, NJ (June 2003)

Trimethyl Phosphite T:0900

Formula: $C_3H_9O_3P$; $(CH_3O)_3P$

Synonyms: Methyl phosphite; Phosphorus acid, trimethy ester; TMP; Trimethoxyphosphine; Trimethyl ester of phosphorous acid

CAS Registry Number: 121-45-9

HSDB Number: 1007

RTECS Number: TH1400000

UN/NA & ERG Number: UN2329/130

EC Number: 204-471-5

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Theft hazard* 220 (≥80.00% concentration).

Hazard Alert: Highly Flammable, Violent decomposition in water, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction).

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T, F+, Xi, Xn; Risk phrases: R11; R21/22; R23/24/25; R36/37/38; R29; R36/37/38; R39; R41; R46; R48/23/24/25; R60; R61; R62; R65; Safety phrases: S1; S3/7; S16; S21; S26; S36/37; S39; S45; S53; S62; R66; R67 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Trimethyl phosphite is a colorless liquid. Distinctive pungent, pyridine-like odor. The Odor Threshold is 0.0001 ppm. Molecular weight = 124.09; Specific gravity (H_2O:1) = 1.05 @ 20°C; Boiling point = 111°C; Freezing/Melting point = −78°C; Vapor pressure = 24 mmHg @ 25°C; Flash point = 28°C. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 3, Reactivity 1. ~~W~~ Practically insoluble in water; violent reaction.

Potential Exposure: Trimethyl phosphite is a flame retardant, and used as an intermediate in the manufacture of a number of pesticides, and organophosphorus additives.

Incompatibilities: Vaor May form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Violent reaction with magnesium perchlorate[Allison, 1968/Cameo]. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Reacts (hydrolyzes) with water. Incompatible with air, moisture.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 5.08 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: None

NIOSH REL: 2 ppm/10 milligram per cubic meter TWA

ACGIH TLV[1]: 2 ppm TWA

Protective Action Criteria (PAC)* Ver. 29[138]

PAC-1: **6.1**$_{\mathbf{A}}$ ppm

PAC-2: **61**$_{\mathbf{A}}$ ppm

PAC-3: **310**$_{\mathbf{A}}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

Australia: TWA 2 ppm (10 milligram per cubic meter), 1993; Belgium: TWA 2 ppm (10 milligram per cubic meter), 1993; Denmark: TWA 0.5 ppm (2.6 milligram per cubic meter), 1999; Finland: TWA 0.5 ppm (2.6 milligram per cubic meter), STEL 10 ppm (52 milligram per cubic meter), [skin], 1999; France: VME 2 ppm (10 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 10 milligram per cubic meter, 2003; United Kingdom: TWA 2 ppm (10 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 2 ppm. Several states have set guidelines or standards for Trimethyl phosphite in ambient air[60] ranging from 100 μ/m^3 (North Dakota); to 160 μ/m^3 (Virginia); to 200 μ/m^3 (Connecticut); to 238 μ/m^3 (Nevada).

Determination in Air

DFG MAK: No numerical value established. Data may be available.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Trimethyl phosphite can affect you when breathed in and by passing through your skin. The vapor irritates the eyes, skin, and upper respiratory tract. Contact can severely irritate and may permanently damage the eyes. High exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Trimethyl phosphite can severely irritate the skin and can cause a rash and skin allergy. Exposure may damage the liver and kidneys.

Long-Term Exposure: Can cause lung irritation; bronchitis may develop. Exposure may cause emphysema. May damage the liver and kidneys. In animals: teratogenic effects

Points of Attack: Eyes, skin, respiratory system; reproductive system.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy; and liver and kidney function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24–48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures *over 2* ppm; Use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece respirator with an organic vapor cartridge/canister. Increased protection is obtained from full facepiece powered-air purifying respirators. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive pressure mode.

Storage: Color code-Red: Flammability Hazard: Store under a nitrogen blanket in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool well-ventilated area away from magnesium diperchlorate. Sources of ignition, such as smoking and open flames, are prohibited where trimethyl phosphite in handled, used, or stored. Metal containers involving the transfer of 5 gallons or more of trimethyl phosphite should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters.

Shipping: UN2329 Trimethyl phosphite, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include phosphine, and oxides of phosphorus and carbon. Use dry chemical, carbon dioxide; alcohol foam; or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Trimethyl Phosphite, Trenton, NJ (October 1998)

Trinitrobenzene T:0910

Formula: $C_6H_3N_3O_6$; 1,3,5-$C_6H_3(NO_2)_3$

Synonyms: Benzene, 1,3,5-trinitro-; TNB; 1,3,5-Trinitrobenceno (Spanish); *sym*-Trinitrobenzene; *symmetrical*-Trinitrobenzene; Trinitrobenzene; Trinitrobenzene, dry; Trinitrobenzol (German)

CAS Registry Number: 99-35-4

HSDB Number: 6005

RTECS Number: DC3850000

UN/NA & ERG Number: UN0214 (dry or wetted with <30% water, by mass)/112; UN1354 (wetted with not <30% water, by mass)/113

EC Number: 202-752-7 [*Annex I Index No.*: 609-005-00-8]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 5000 (commercial grade); *Theft hazard* 400 (commercial grade). Security issue: EXP/IEDP = explosives/improvised explosive device precursors.

Carcinogenicity: Insufficient data available.

Hazard Alert: Explosive (when dry), Highly toxic, Strong oxidizer, Suspected reprotoxic hazard, Sensitization hazard, Primary irritant (w/o allergic reaction), Environmental hazaard.

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 10 lb (4.54 kg)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U234

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR264, appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8270 (10).

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292].

Explosive; mass explosion hazard, GHS H201.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: E, F +, T +, N, Xi; Risk phrases: R1; R2; R12; R23/24/25; R26/27/28; R33; R29/35; R36/37/38; R41; R43; R50/53; R63; Safety phrases: S1; S1; S13; S16; S23; S24/25; S27; S28; S35; S36/37; S45; S53; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Trinitrobenzene is a yellow crystalline solid. Molecular weight = 213.1; Vapor pressure = 1.45 mmHg @ 152°C; Boiling point = 315°C; Freezing/Melting point = 123°C. Hazard Identification (based on NFPA-704 M Rating System): (*wetted or with <30% water*) Health 2, Flammability 4, Reactivity 4; (wetted with >30% water) Health 2, Flammability 4, Reactivity 2. Insoluble in water.

Potential Exposure: *Trinitrobenzene is explosive when dry*. Used as an explosive; as a vulcanizing agent for natural rubber. Trinitrobenzene may be more powerful than TNT; and is reported to be less sensitive to impact than TNT. However it is difficult to produce, and is not used as widely as TNT.

Incompatibilities: Sensitive to shock and heat. Incompatible with initiating explosives, combustible materials. Aromatic nitro compounds, such as trinitrobenzene, range from slight to strong oxidizing agents. Keep away from strong reducing agents, including hydrides, alkali metals; aluminium and other metal powder; phosphorus; sulfides and nitrides, alkaline material, strong bases; contact may initiate vigorous reactions that culminates in a detonation. The aromatic nitro compounds may explode in the presence of a base such as sodium hydroxide or potassium hydroxide even in the presence of water or organic solvents[101]. The aromatic nitro compounds may explode in the presence of a base such as sodium hydroxide or potassium hydroxide even in the presence of water or organic solvents[101]. Incompatible with strong oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 1.5 milligram per cubic meter

PAC-2: 16 milligram per cubic meter

PAC-3: 54 milligram per cubic meter

Permissible Concentration in Water: Very Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment. Russia[43] has set a MAC in water bodies used for domestic purposes of 0.4 mg/L.

Determination in Water: Log $K_{ow} = < 2$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion, eye and/or dermal contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin, and respiratory tract. Risk of serious eye damage. LD_{50} = (oral-rat) <300 mg/kg.

Long-Term Exposure: Information on the carcinogenicity, mutagenicity, teratogenicity, or adverse reproductive effects of trinitrobenzene was not found in the available literature. Trinitrobenzene has been reported to produce liver damage, CNS damage; and methemoglobin formation in animals. Breathing difficulties have also been reported. Eye damage reported in the munitions industry. May cause skin sensitization. Methemoglobinemia may develop.

Points of Attack: Eyes, skin, liver, blood, CNS; respiratory system.

Medical Surveillance. Lung function tests. Liver function tests. Examination of the eyes by an ophthalmologist; nervous system. Evaluation by a dermatologist and a qualified allergist.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to Physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBAs with a full facepiece operated in pressure-demand or other positive pressure mode.

Storage: UN0214 Explosive. UN1354 Color code-Red Stripe: Flammability Hazard: Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8-10 meters or a 1-hour fire wall from flammable or reactive materials. Store flammable solids up to maximum allowable quantity per control area in an approved flammable storage area. Do not store in a basement. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from heat, explosives, oxidizable materials. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create A potential fire or explosion hazard. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Store in a cool, well ventilated area away from incompatible materials listed above. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage.

Shipping: UN0214 Trinitrobenzene, dry or wetted with <30% water, by mass, Hazard Class: 1.1D; Labels:1.1D-Explosives (with a mass explosion hazard); *D-Substances or articles which may mass detonate (with blast and/or fragment hazard) when exposed to fire*. UN1354 Trinitrobenzene, wetted with not <30% water, by mass, Hazard Class: 4.1; Labels: 4.1-Flammable solid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is an explosive solid. Rapid heating may cause explosion. Thermal decomposition products may include oxides of nitrogen and carbon. If material is on fire and conditions permit, do not extinguish. Cool exposures using unattended monitors. If fire must be extinguished, use any agent appropriate for the burning material. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Cool exposed containers from unattended equipment or remove intact containers if it can be done safely. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for fire-fighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Dissolve in a combustible solvent and spray into an incinerator equipped with afterburner and scrubber.

References
(31); (173); (101); (138); (100).
United States Environmental Protection Agency, Trinitrobenzene, Health and Environmental Effects Profile No. 171, Washington, DC, Office of Solid Waste (April 30, 1980)

Trinitrotoluene T:0920

Formula: $C_7H_5N_3O_6$
Synonyms: Entsufon; 1-Methyl-2,4,6-trinitrobenzene; NCI-C56155; α-TNT; TNT; TNT-tolite (French); Tolit; Tolite; Toluene, 2,4,6-trinitro,-(wet); *sym*-Trinitrotoluene; 2,4, 6-Trinitrotoluene; Trinitrotoluene; Trinitrotoluene, wet; *s*-Trinitrotoluol; *sym*-Trinitrotoluol; 2,4,6-Trinitrotoluol (German); Trinitrotoluol; Tritol; Trotyl; Trotyl oil
CAS Registry Number: 118-96-7
HSDB Number: 1146
RTECS Number: XU0175000
UN/NA & ERG Number: UN0209 (TNT, dry or wetted with <30% water, by mass)/112; UN1356 (wetted with not <30% water, by mass)/113
EC Number: 204-289-6 [*Annex I Index No.*: 609-008-00-4]
Regulatory Authority and Advisory Information
Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 5000 (commercial grade); *Theft hazard* 400 (commercial grade). Security issue: EXP/IEDP = explosives/improvised explosive device precursors.
Carcinogenicity: IARC: Animal, Inadequate Evidence; Human, Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1996. United States Environmental Protection Agency Gene-Tox Program, Positive: Histidine reversion-Ames test
Hazard Alert: Explosive (dry), Strong oxidizer, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction), Environmental hazard.
Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.
Hazardous to aquatic life or environment, with possible long-lasting effects[293]. Toxic to aquatic life with long-lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government. H201 Explosive; mass explosion hazard,.
Hazard Symbols, Risk & Safety statements: Hazard Symbol: E, T, N, Xi; Risk phrases: R45; R2; R11; R23/24/25; R26/27/28; R33; R36/37/38; R41; R43; R51/53; R62; R63; Safety phrases: S1; S1; S13; S16; S23; S24/25; S27; S28; S29/35; S36/37; S41; S45; S53; S60; S61 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): No value found. [2-Hazard to waters (est.)]

Description: TNT exists in five isomers; 2,4,6-trinitrotoluene is the most commonly used. It is a colorless to pale yellow odorless solid (pellets, cast blocks, and cast slabs) or crushed flakes. Molecular weight = 227.15; Specific gravity (H_2O:1) = 1.65 @ 25°C; Boiling point = (explodes) 240°C; Freezing/Melting point = 80°C; Vapor pressure = 0.0002 mmHg @ 25°C; Ionization Potential = 10.59 eV. It explodes @ 232°C (also reported @ 240°C and 297°C) but burns @ 295°C when not confined. TNT is a relatively stable high explosive. Practically insoluble in water; solubility = 0.01% @ 25°C.
Potential Exposure: TNT is used as an explosive, that is, as a bursting charge in military explosive shells, bombs, grenades, and mines; and an intermediate in dyestuffs and photographic chemicals.
Incompatibilities: Sensitive to shock and heat. Incompatible with initiating explosives, combustible materials. Aromatic nitro compounds, such as trinitrobenzene, range from slight to strong oxidizing agents. Keep away from strong reducing agents, including hydrides, alkali metals; aluminium and other metal powder; phosphorus; sulfides and nitrides, alkaline material, strong bases; contact may initiate vigorous reactions that culminates in a detonation. The aromatic nitro compounds may explode in the presence of a base such as sodium hydroxide or potassium hydroxide even in the presence of water or organic solvents[101]. The aromatic nitro compounds may explode in the presence of a base such as sodium hydroxide or potassium hydroxide even in the presence of water or organic solvents[101]. Incompatible with strong oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions.
Permissible Exposure Limits in Air
NIOSH IDLH = 500 milligram per cubic meter
OSHA PEL: 1.5 milligram per cubic meter TWA [skin]
NIOSH REL: 0.5 milligram per cubic meter TWA [skin]
ACGIH TLV[1]: 0.1 milligram per cubic meter TWA [skin]
DFG MAK: 0.011 ppm/0.1 milligram per cubic meter TWA; Peak Limitation Category II(2) [skin]; Carcinogen Category 3B; Pregnancy Risk Gropup D
Arab Republic of Egypt: TWA 0.5 milligram per cubic meter, 1993; Australia: TWA 0.5 milligram per cubic meter, [skin], 1993; Austria: MAK 0.01 ppm (0.1 milligram per cubic meter), [skin], Suspected: carcinogen, 1999; Belgium: TWA 0.5 milligram per cubic meter, [skin], 1993; Denmark: TWA 0.1 milligram per cubic meter, [skin], 1999; Finland: TWA 0.5 milligram per cubic meter, STEL 3 milligram per cubic meter, [skin], 1999; France: VME 0.5 milligram per cubic meter, [skin], 1999; the Netherlands: MAC-TGG 0.1 milligram per cubic meter, [skin], 2003; Norway: TWA 0.1 milligram per cubic meter, 1999; the Phillipines: TWA 1.5 milligram per cubic meter, [skin], 1993; Poland: MAC (TWA) 1 milligram per cubic meter; MAC (STEL) 3 milligram per cubic meter, 1999; Russia: TWA 0.1 milligram per cubic meter, STEL 0.5 milligram per cubic meter, [skin],

1993; Sweden: NGV 0.1 milligram per cubic meter, KTV 0.2 milligram per cubic meter, [skin], 1999; Switzerland: MAK-W 0.1 milligram per cubic meter, [skin], 1999; Turkey: TWA 1.5 milligram per cubic meter, [skin], 1993; United Kingdom: TWA 0.3 milligram per cubic meter, [skin]; TWA 0.2 ppm (0.89 milligram per cubic meter), [skin], carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 0.1 milligram per cubic meter [skin]. Several states have set guidelines or standards for TNT in ambient air[60] ranging from 5.0 μ/m^3 (North Dakota); to 8.0 μ/m^3 (Virginia); to 10.0 μ/m^3 (Connecticut); to 12.0 μ/m^3 (Nevada).

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 0.3 milligram per cubic meter

PAC-2: 17 milligram per cubic meter

PAC-3: 1000 milligram per cubic meter

Determination in Air: Use OSHA Analytical Method 44.

Determination in Water: Octanol-water coefficient: Log $K_{ow} = 1.60$. Unlikely to bioaccumulate in marine organisms.

Permissible Concentration in Water: Russia[43] set a MAC in water bodies used for domestic purposes of 0.5 mg/L.

Routes of Entry: Inhalation of dust, fume, or vapor; ingestion of dust; percutaneous absorption from dust, skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Exposure to trinitrotoluene may cause irritation of the eyes, nose, and throat with sneezing, cough, and sore throat. It may cause skin irritation; dermatitis, and may stain the skin, hair, and nails a yellowish color. Numerous fatalities have occurred in workers exposed to TNT from toxic hepatitis or aplastic anemia. TNT exposure may also cause methemoglobinemia with cyanosis, weakness, drowsiness, dyspnea, and unconsciousness. Ingestion may cause hallucinations or distorted perceptions, cyanosis (blue color to the skin, lips and fingertips), and gastrointestinal changes.

Long-Term Exposure: May affect the liver, causing hepatitis and jaundice. May affect the blood causing hemolysis, formation of methemoglobin. And cyanosis. May affect vision, causing cataracts. In addition, it may cause muscular pains, heart irregularities; renal irritation; menstrual irregularities; and peripheral neuritis.

Points of Attack: Blood, liver, eyes, cardiovascular system; CNS; kidneys, skin.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. NIOSH lists the following tests: CBC; aplastic anemia; liver function tests; urine (chemical/metabolite); urinalysis (routine). Placement or periodic examinations should give special considerations to history of allergic reactions, blood dyscrasias; reactions to medications; and alcohol intake. The skin, eyes, blood, and liver and kidney function should be followed. Urine may be examined for TNT using the Webster test or for the urinary metabolite 2,6-dinitro-4-aminotuluene; however, both may be negative if there is liver injury.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to Physician: Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Polyvinyl chloride is among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. The Webster skin test (colorimetric tests with alcoholic sodium hydroxide) or indicator soap should be used to make sure workers have washed all TNT off their skins.

Respirator Selection: NIOSH: *Up to 5 milligram per cubic meter*: Sa* (APF = 10) (any supplied-air respirator). *Up to 12.5 milligram per cubic meter*: Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode). *Up to 25 milligram per cubic meter*: SCBAF (APF = 50) (any SCBA with a full facepiece; or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 500 milligram per cubic meter*: SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd, Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA). *Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Check oxygen content prior to entering storage area. TNT is an explosive. Color code-Red Stripe: Flammability Hazard: Store separately from all other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 meters or a 1-hour fire wall from flammable or reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in a explosion-proof refrigerator and keep away from reducing agents[52]. Keep material wet with water or treat as an explosive. Keep away from heat, sources of ignition; metal, nitric acid; and reducing materials. Protect containers from shock. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Store in a cool, well ventilated area away from incompatible materials listed above. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. See OSHA Standard 1910.104 and NFPA 43A *Code for the Storage of Liquid and Solid Oxidizers* for detailed handling and storage.

Shipping: UN1356 Trinitrotoluene, wetted with not <30% water, by mass, Hazard Class: 4.1; Labels: 4.1-Flammable solid. UN0209 Trinitrotoluene or TNT, dry or wetted with < 30% water, by mass, Hazard Class: 1D; Labels:1D-Explosive (with a mass explosion hazard); *D-Substances or articles which may mass detonate (with blast and/or fragment hazard) when exposed to fire.*

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen spilled material with alcohol to avoid dust. Collect waste material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a dangerously explosive solid. Thermal decomposition products may include oxides of nitrogen and carbon. If material is on fire and conditions permit, do not extinguish. Evacuate area and let burn. Cool exposures using unattended monitors. If fire must be extinguished, use any agent appropriate for the burning material. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. Cool exposed containers from unattended equipment or remove intact containers if it can be done safely. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: TNT is dissolved in acetone and incinerated. The incinerator should be equipped with an afterburner and a caustic soda solution scrubber.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: 2,4,6-Trinitrotoluene, Washington, DC (1979)

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 2, No. 5, 93−96 (1982) and 8, No. 4, 75−80 (1988

Triphenylamine T:0930

Formula: $C_{18}H_{15}N$; $(C_6H_5)_3N$

Synonyms: *N*,*N*-Diphenylaniline; *N*,*N*-Diphenyl benzenamine

CAS Registry Number: 603-34-9

HSDB Number: 2098

RTECS Number: YK2680000

EC Number: 210-035-5

Regulatory Authority and Advisory Information

Hazard Alert: Combustible, Environmental hazard.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects[192]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: Xi; Risk phrases: R36/37/38; R51/53; Safety phrases: S16; S26; S28; S29/35; S36/37/39; S41; S45, S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [2-Hazard to water. (est.)]

Description: Triphenylamine is a colorless crystalline solid. Molecular weight = 245.34; Specific gravity (H_2O:1) =

0.77 @ 25°C; Boiling point = 365°C; also reported @ 195°C @ 10 mmHg; Freezing/Melting point = 127°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, Flammability 1, Reactivity 0. Insoluble in water.

Potential Exposure: Triphenylamine is used as a primary photoconductor and in making photographic film coated on photographic film bases.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxo acids, epoxides, aldehydes, ketones.

Permissible Exposure Limits in Air

OSHA PEL: None

NIOSH REL: 5 milligram per cubic meter TWA

ACGIH TLV[1]: withdrawn due to insufficient data.

Australia: TWA 5 milligram per cubic meter, 1993; Belgium: TWA 5 milligram per cubic meter, 1993; Denmark: TWA 5 milligram per cubic meter, 1999; Finland: TWA 5 milligram per cubic meter, STEL 10 milligram per cubic meter, [skin], 1999; France : VME 5 milligram per cubic meter, 1999; Norway: TWA 5 milligram per cubic meter, 1999; IN Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 5 milligram per cubic meter. Several states have set guidelines or standards for triphehylamine in ambient air[60] ranging from 8.0 μ/m^3 (Virginia); to 50.0 μ/m^3 (North Dakota); to 100.0 μ/m^3 (Connecticut).

Determination in Air: No method available.

Determination in Water: Log $K_{ow} = \sim 6$. Values above 3.0 are likely to bioaccumulate in aquatic organisms.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Triphenylamine can affect you when breathed in and by passing through your skin. Contact can irritate the skin.

Long-Term Exposure: No known long-term effects are known, although some related aromatic amines can cause skin and lung allergies and have been shown to be carcinogenic to the human bladder, ureter, prostate, intestines, lung, and liver.

Points of Attack: Skin.

First Aid: *Skin Contact*:[52] Flood all areas of body that have contacted the substance with water. Don't wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others. *Eye Contact*: Remove any contact lenses at once. Immediately flush eyes well with copious quantities of water or normal saline for at least 20−30 minutes. Seek medical attention. *Inhalation*: Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion*: Contact a physician, hospital or poison center at once. If the victim is unconscious or convulsing, do not induce vomiting or give anything by mouth. Assure that the patient's airway is open and lay him on his side with his head lower than his body and transport immediately to a medical facility. If conscious and not convulsing, give a glass of water to dilute the substance. Vomiting should not be induced without a physician's advice.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures *over 5 milligram per cubic meter*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive pressure mode.

Storage: Color code-Green: General storage may be used. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool well-ventilated area away from aldehydes, ketones, nitrates, oxidizers, oxygen and peroxides. Where possible, automatically transfer material from storage containers to process containers.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. The powdered material may be dampened with 60%−70% acetone to avoid airborne dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Use dry chemical, carbon dioxide; water spray; or foam extinguishers. Thermal decomposition products may include oxides of nitrogen and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Triphenylamine, Trenton, NJ (November 2000)

Triphenyl Phosphate T:0940

Formula: $C_{18}H_{15}O_4P$; $(C_6H_5O)_3PO$

Synonyms: Celluflex TPP; Disflamoll-TP; Fosfato de trifenilo (Spanish); Phenyl phosphate; Phiosflex-TPP; Phosphoric acid, triphenyl ester; TP; TPP; Triphenoxyphosphine oxide; Triphenyl ester of phosphoric acid

CAS Registry Number: 115-86-6

HSDB Number: 2536

RTECS Number: TC8400000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 204-112-2

Regulatory Authority and Advisory Information

Hazard Alert: Combustible, Environmental hazard

United States Environmental Protection Agency TSCA Section 8(e) Risk Notification, 8EHQ-0892-9169; 8EHQ-0892-8839; 8EHQ-0892-9290

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: F, Xn, N; Risk phrases: R20/21/22; R36/R37; R38; R40; R41; R48/20/22; R51/53; Safety phrases: S16; S22; S24/25; S26; S36/37/39; S38; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Triphenyl phosphate is a colorless crystalline powder with a faint, phenol-like odor. Molecular weight = 326.30; Specific gravity (H_2O:1) = 1.29 @ 25°C; Boiling point = 413.3°C; Freezing/Melting point = 49°C; Vapor pressure = 1 mmHg @ 193°C; Flash point = 220°C (cc). Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 0. Practically insoluble in water; solubility 0.002% @ 54°C.

Potential Exposure: Triphenyl phosphate is used to impregnate roofing paper and as a fire-resistant plasticizer in plastics; for cellulose esters in lacquers and varnishes. Used in making adhesives, gasoline additives; flotation agents; insecticides, surfactants, antioxidants, and stabilizers. A substitute for camphor.

Incompatibilities: Incompatible with strong oxidizers; strong acids; nitrates may cause fire or explosions. Phosphates are incompatible with antimony pentachloride, magnesium, silver nitrate, zinc acetate.

Permissible Exposure Limits in Air

NIOSH IDLH = 1000 milligram per cubic meter

OSHA PEL: 3 milligram per cubic meter TWA

NIOSH REL: 3 milligram per cubic meter TWA

ACGIH TLV[1]: 3 milligram per cubic meter TWA, not classifiable as a human carcinogen

Australia: TWA 3 milligram per cubic meter, 1993; Belgium: TWA 3 milligram per cubic meter, 1993; Denmark: TWA 3 milligram per cubic meter, 1999; Finland: TWA 3 milligram per cubic meter, STEL 6 milligram per cubic meter, [skin], 1999; France: VME 3 milligram per cubic meter, 1999; Norway: TWA 3 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 3 milligram per cubic meter, 2003; Switzerland : MAK-W 3 milligram per cubic meter, 1999; United Kingdom: LTEL 3 milligram per cubic meter, STEL 6 milligram per cubic meter, 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Several states have set guidelines or standards for triphenyl phosphate in ambient air[60] ranging from 1.6 μ/m^3 (Virginia); to 30.0 μ/m^3 (North Dakota); to 60.0 μ/m^3 (Connecticut); to 71.0 μ/m^3 (Nevada).

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 9 milligram per cubic meter

PAC-2: 360 milligram per cubic meter

PAC-3: 2100 milligram per cubic meter

Determination in Air: Use NIOSH Analytical Method (IV) #5038, Triphenyl phosphate.

Determination in Water: Octanol-water coefficient: Log $K_{ow} = > 4.5$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact. Slowly absorbed by the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Slowly absorbed by the skin. May cause eye and skin irritation.

Long-Term Exposure: Minor changes in blood enzymes. In animals: muscular weakness, paralysis. May be a cholinesterase inhibitor, but not a potent one.

Points of Attack: Blood, peripheral nervous system[77].

Medical Surveillance: Consider the blood in preplacement and periodic physical examinations. Examination of the peripheral nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, rinse mouth and get medical attention.

Personal Protective Methods: Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 15 milligram per cubic meter*: Qm (APF = 25) (any quarter-mask respirator). *Up to 30 milligram per cubic meter*: 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *Up to 75 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *Up to 150 milligram per cubic meter*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 1000 milligram per cubic meter*: SA: PD,PP (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd, Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive pressure mode). Escape: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in a cool, dry place away from antimony pentachloride, magnesium, silver nitrate; zinc acetate.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Dampen spilled material with alcohol to avoid dust. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include phosphine and oxides of nitrogen, phosphorus and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incinerate in furnace equipped with alkaline scrubber.

References

(31); (173); (101); (138); (2); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 6, No. 4, 91−100 (1986)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Triphenyl phosphate, Trenton, NJ (M ay 2001).

Triphenyltin Compounds T:0950

Formula: $C_{20}H_{18}O_2Sn$; $C_{18}H_{15}ClSn$; $C_{18}H_{16}OSn$; $(C_6H_5)_3SnOOCCH_3$; $(C_6H_5)_3SnCl$; $(C_6H_5)_3SnOH$

Synonyms: *acetate*: Acetate de triphenyl-etain (French); Acetotriphenylstannine; Acetoxy-triphenyl-stannan (German); Acetoxytriphenylstannane; Acetoxytriphenyltin; (Acetyloxy)triphenyl-stannane; Batasan; Brestan; ENT 25,208; Fenolovo acetate; Fentin acetat (German); Fentin acetate; Fentine acetate (French); GC 6936; HOE-2824; Liromatin; Lirostanol; Phentin acetate; Phentinoacetate; Stannane, acetoxytriphenyl-; Suzi; Tinestan; Tinestan 60 WP; Tin triphenyl acetate; TPTA; TPZA; Triphenylacetostannane; Triphenyltin acetate; Triphenylzinnacetat (German); Tubotin

chloride: AI3-25207; Aquatin 20 EC; Brestanol; Chlorotriphenylstannane; Chlorotriphenyltin; Fentin chloride; GC 8993; General chemicals 8993; HOE 2872; LS 4442; NSC 43675; Phenostat-C; Stannane, chlorotriphenyl-; Tinmate; TPTC; Triphenylchlorostannane; Triphenylchlorotin; Triphenyltin chloride[72]

hydroxide: AI3-28009; Brestan H 47.5 WP fungicide; Dowco 186; Duter; Du-Ter; Duter extra; Du-Ter fungicide; Du-Ter fungicide wettable powder; Du-Ter PB-47 fungicide; Du-Ter W-50; Du-Tur flowable-30; ENT 28,009; Fentin; Fentin hydroxide; Fintine hydroxyde (French); Fintin hydroxid (German); Flotin 4L; Haitin; Haitin WP 20 (fentin hydroxide 20%); Haitin WP 60 (fentin hydroxide 60%); Hydroxyde de triphenyl-etain (French); Hydroxytriphenylstannane; Hydroxytriphenyltin; IDA, IMC Flo-tin 4L; K19; NCI-C00260; NSC 113243; Phenostat-H; Stannane, hydroxytriphenyl-; Stannol, triphenyl-; Super tin; Super tin 4l gardian flowable fungicide; Suzu H; Tin, hydroxytriphenyl-; TN IV; TPTH; TPTH technical; TPTOH; Triphenylstannanol; Triphenylstannium hydroxide; Triphenyltin(IV) hydroxide; Triphenyltin hydroxide (EPA); Triphenyltin hydroxide organotin fungicide; Triphenyltin oxide; Triphenyl-zinnhydroxid (German); Triple-tin; Triple tin 4l; Tubotin; Vancide KS; Vito spot fungicide; Wesley technical triphenyltin hydroxide

CAS Registry Number: 900-95-8 (acetate); 639-58-7 (chloride); 76-87-9 (hydroxide); 752-74-9 [Tris(triphenylstannyl) isocyanurate]

HSDB Number: 1783 (900-95-8); 6404 (639-58-7); 1784 (76-87-9)

RTECS Number: WH6650000 (acetate); WH6860000 (chloride); WH8575000 (hydroxide)

UN/NA & ERG Number: UN2786 (organotin compounds, toxic)/153; UN3020 (organotin pesticides, liquid, toxic)/153; UN3146 (organotin compounds, solid, n.o.s.)/153

EC Number: 212-984-0 [050-003-00-6] (fentin acetate); 211-358-4 (fentin chloride); 200-990-6 [050-004-00-1] (fentin hydroxide)

Regulatory Authority and Advisory Information

acetate:

Carcinogenicity: (*acetate*) ACGIH A4 Not classifiable as a human carcinogen

Hazard Alert: Poison, Combustible, Organometallic compound(s), Strong reducing agents, Sensitization hazard, Environmental hazard.

United States DOT Regulated Marine Pollutant (49CFR172.101, appendix B) as triphenyltin compounds

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

European/International Regulations (*900-95-8*): Hazard Symbol: T+, N, Xi; Risk phrases: R24/25; R26; R36/38; R43; R50/53; Safety phrases: S1/2; S29/35; S36/37; S41; S45; S60; S61 (see Appendix 4).

chloride:

California Proposition 65 Chemical[102]: (*Triphenyltin hydroxide*) Cancer 1/1/1992; Developmental/Reproductive toxin 3/18/2002

Hazard Alert: Poison, Reproductive toxin, Environmental hazard.

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg) (chloride)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 1 lb (0.454 kg) (chloride)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, appendix B) as triphenyltin compounds

Regulations: Hazard Symbol: T+, N; Risk phrases: R24/25; R26; R37/38; R40; R41; R48/23; R63; R50/53; Safety phrases: S1/2; S26; S28; S29/35; S36/37/39; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water. (*Triphenyltin chloride*).

hydroxide:

Carcinogenicity: NCI: Carcinogenesis Bioassay (feed); no evidence: mouse, rat. United States Environmental Protection Agency Gene-Tox Program, Negative: Carcinogenicity-mouse/rat

Hazard Alert: Possible risk of forming tumors, Suspected of causing genetic defects, Organometallic; Suspected of causing genetic defects, Primary irritant (w/o allergic reaction).

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, appendix B) as triphenyltin compounds

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%. (acetate and hydroxide); 1% (chloride)

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

European/International Regulations (*76-87-9*): Hazard Symbol: T + , N; Risk phrases: R10; R24/25; R26; R37/38; R40; R41; R48/23; R63; R50/53; Safety phrases: S1/2; S26; S28; S36/37/39; S45; S60; 61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water. (*fentin hydroxide*).

Description: *Triphenyltin acetate* is a white solid. Molecular weight = 409.07; Freezing/Melting point = 122°C. Practically insoluble in water. *Triphenyltin chloride* is a colorless to yellow crystalline solid with a characteristic odor. Molecular weight = 385.47; Boiling point = 240°C @ 13.5 mmHg; Freezing/Melting point = 106°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 0. Hydrolyzes to hydroxide in water. *Triphenyltin hydroxide* is a white crystalline solid. Molecular weight = 367.03; Freezing/Melting point = 118°C−120°C (decomposes). Practically insoluble in water.

Potential Exposure: The hydroxide is used in vinyl products to protect against mildew growth and stiffening by bacteria and fungi. At risk are those engaged in the manufacture, formulation and application of insecticides used for fungus, algae and mollusk control; as a chemosterilant.

Incompatibilities: Triphenyltin chloride: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Keep away from moisture.

Permissible Exposure Limits in Air

NIOSH IDLH = 25 mg[Sn]/m^3

OSHA PEL: 0.1 mg[Sn]/m^3 TWA

NIOSH REL: 0.1 mg[Sn]/m^3 TWA [skin]

ACGIH TLV[1]: 0.1 mg[Sn]/m^3 TWA; 0.2 mg[Sn]/m^3 STEL [skin]

Protective Action Criteria (PAC) Ver. 29[138]

900-95-8, acetate

PAC-1: 0.69 milligram per cubic meter

PAC-2: 20 milligram per cubic meter

PAC-3: 28 milligram per cubic meter

639-58-7, chloride

PAC-1: 0.69 milligram per cubic meter

PAC-2: 20 milligram per cubic meter

PAC-3: 38 milligram per cubic meter

DFG MAK: 0.1 mg[Sn]/m^3, inhalable fraction Peak Limitation Category II(2); [skin]; Pregnancy Risk Group D

hydroxide

Australia: TWA 0.1 mg[Sn]/m^3, [skin], 1993; Austria: MAK 0.1 mg[Sn]/m^3, [skin], 1999; Belgium: TWA 0.1 mg[Sn]/m^3, [skin], 1993; Denmark: TWA 0.1 mg[Sn]/m^3, [skin], 1999; Finland: TWA 0.1 mg[Sn]/m^3, STEL 0.3 mg[Sn]/m^3, 1999; France: VME 0.1 mg[Sn]/m^3, VLE 0.2 mg[Sn]/m^3, 1999; Hungary: STEL 0.1 mg[Sn]/m^3, [skin], 1993; Norway: TWA 0.1 mg[Sn]/m^3, 1999; the Phillipines: TWA 0.1 mg[Sn]/m^3, 1993; Switzerland: MAK-W 0.1 mg[Sn]/m^3, KZG-W 0.2 mg [Sn]/m^3, [skin], 1999; Thailand: TWA 0.1 mg[Sn]/m^3, 1993; United Kingdom: TWA 0.1 mg[Sn]/m^3, STEL 0.2 mg [Sn]/m^3, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Not classifiable as a human carcinogen

Determination in Air: Use NIOSH Analytical Method (IV) #5504, Organotin compounds.

Permissible Concentration in Water: State Drinking Water Guidelines: Minnesota 4000 μg[Sn]/L.

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: These chemicals are strong poisons. Toxic and irritating to the eyes, skin, and respiratory system. Dermal exposure may lead to severe skin burns as well as renal failure, and possible death in the case of the chloride. Symptom of exposure include headache, vertigo (an illusion of movement); psycho-neurologic disturbance; sore throat; cough; abdominal pain; vomiting, urine retention; paresis, focal anesthesia.

Long-Term Exposure: Exposure may affect the nervous system causing headache, nausea, vomiting, dizziness, decreased coordination; muscle weakness; and visual changes. Triphenyltin chloride can irritate the lungs; bronchitis may develop. In animals: hemolysis, hepatic necrosis; kidney damage.

Points of Attack: Kidneys, liver.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure. Kidney and liver function tests. Evaluation of the nervous system. Lung function tests.

First Aid: *For triphenyltin hydroxide*: *Skin Contact*:[52] Flood all areas of body that have contacted the substance with water. Don't wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Speed in removing material from skin is of extreme importance. Shampoo hair promptly if contaminated. Isolate contaminated clothing when removed to prevent contact by others. *Eye Contact*: Remove any contact lenses at once. Immediately flush eyes well with copious quantities of water or normal saline for at least 20−30 minutes. Seek medical attention. *Inhalation*: Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion*: Contact a physician, hospital or poison center at once. If the victim is unconscious or convulsing, do not induce vomiting or give anything by mouth. Assure that the patient's airway is open and lay him on his side with his head lower than his body and transport immediately to a medical facility. If conscious and not convulsing, give a glass of water to dilute the substance. Vomiting should not be induced without a physician's advice.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/ manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid, unless full facepiece respiratory protection is worn. Wear dust-proof goggles and face shield when working with powders or dust, unless full facep iece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA *[Tin, organic compounds as (Sn)]* : *Up to 1 milligram per cubic meter*: CcrOv95 (APF = 10) [any air-purifying half-mask respirator with organic vapor cartridge(s) in combination with an N95, R95, or P95 filter. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *Up to 2.5 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOvHie (APF = 25) (any air-purifying full facepiece respirator equipped with an organic vapor cartridge in combination with a high-efficiency particulate filter). *Up to 5 milligram per cubic meter*: CcrFOv100 (APF = 50) [any air-purifying full facepiece respirator equipped with organic vapor cartridge(s) in combination with an N100, R100, or P100 filter]; or GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or PaprTOvHie (APF = 50) [any powered, air-purifying respirator with a tight-fitting facepiece and organic vapor cartridge(s) in combination with a high-efficiency particulate filter]; or SaT: Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full face piece). *Up to 25 milligram per cubic meter*: SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd, Pp (APF = 10,000) (any SCBA that has a full-faceplate and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: GmFOv100 (APF = 50) [Any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well ventilated area away from incompatible materials. Where possible, automatically transfer material from storage containers to process containers. Sources of ignition, such as smoking and open flames are prohibited where this chemical is handled, used, or stored.

Shipping: UN3146 Organotin compounds, solid, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN2786 Organotin compounds, solid, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN2788 Organotin compounds, liquid, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Remove and isolate contaminated clothing at the site. Do not touch spilled material; stop leak if you can do it without risk, Use water spray to reduce vapors. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills*: with clean shovel place material into clean, dry container and cover; move containers from spill area. *Large spills*: dike far ahead of spill for later disposal. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include hydrogen chloride, triphenyltin chloride and oxides of metal. Small fires: dry chemical, carbon dioxide; water spray; or foam. *Large fires*: water spray, fog, or foam. Stay upwind; keep out of low areas. Ventilate closed spaces before entering them. Wear positive pressure breathing apparatus and special protective clothing. Move container from fire area is you can do so without risk. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Organic tin compounds may be disposed of in sealed containers in secured sanitary landfill. [organic tin compounds (as tin)]. *Chemical treatability of tin; Concentration Process*: Chemical precipitation; Chemical Classification: Metals; Scale of Study: Pilot scale; Type of Wastewater Used: Synthetic wastewater; Results of Study: At 600 ppm, 95.3% reduction with alum. At 500 ppm, 98% reduction with ferric chloride, 92% reduction with lime; (Three coagulants used: 200 mg of alum at pH = 6.4, 40 ppm of ferric chloride @ pH = 6.2, 41 ppm of lime @ pH = 11.5 Chemical coagulation was followed by dual media filtration)[134].

References

(102); (31); (173); (101); (138); (2); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Acetoxytriphenyl Stannane, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

United States Environmental Protection Agency, Chemical Hazard Information Profile: Triphenyltin Chloride, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 2, No. 4, 92−94 (1982)

Tris(2-chloroethyl)amine (Agent HN-3) T:0960

Formula: $C_6H_{12}Cl_3N$; $(ClCH_2CH_2)_3N$

Synonyms: AI3-16198; 2-Chloro-*N*,*N*-bis(2-chloroethyl) ethanamine; HN-3 (military designation); Nitrogen Mustard-3; TL 145; Trichlormethine; Tri-(2-chloroethyl) amine; 2,2′,2″-Trichlorotriethylamine; Tris(2-chloroethyl) amine; Tris(β-chloroethyl)amine; TS160

CAS Registry Number: 555-77-1

HSDB Number: 6395

RTECS Number: YE2625000

UN/NA & ERG Number: (PIH) UN2810 (toxic liquid, organic, n.o.s.)/153

EC Number: None assigned.

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity: *Theft hazard* cumulative = 100 g.

Hazard Alert: Poison inhalation hazard: exposure can be lethal, Blister agent/vesicant, Combustible, Highly dangerous vesicant (blistering agent), Polymerization hazard, Suspected of causing genetic defects, Possible risk of forming tumors, Primary irritant (w/o allergic reaction).

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 100 lb (45.4 kg)

United States DOT 49CFR172.101, Inhalation Hazardous Chemical

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T+, Xi; Risk phrases: R40; R19; R36/37/38; R41; R48; R62; Safety phrases: S1; S24/25; S26; S41 (see Appendix 4)

Description: HN-3, a nitrogen mustard blister agent (vesicants, is a colorless to pale yellow liquid. Pure material is odorless; otherwise, it has a faint fish-or soap-like odor. Density: 1.2347 @ 25°C; Molecular weight = 204.53; Boiling point = 256°C (HN-3 decomposes before its boiling point is reached or cond enses under all conditions; the reactions involved could generate enough heat to cause an explosion[77]); Freezing/Melting point = −3.9°C; Vapor Pressure = 0.0106 mmHg @20°C; 0.0109 mmHg @ 25°C. Volatility: 0.120 mg/L @ 25°C. Hazard Identification (based on NFPA-704 M Rating System): Health 4, Flammability 1, Reactivity 0. Sparingly soluble in water; solubility = 160 mg/L @ 25°C. Aqueous so lution is strongly basic.

Potential Exposure: Trichlorotriethylamine is a (slow-acting) vesicant but has never been used in military conflict. Is used as an antineoplastic agent. Has been tested as a fixing agent in textile dyes[193].

Incompatibilities: HN-3 is not stable; it undergoes slow but steady polymerization. Avoid contamination with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, bleaches and pool chemicalsetc); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Unstable in the presence of light and heat and forms dimers at temperatures above 50°C. HN-3 decomposes before its boiling point is reached or condenses under all conditions; the reactions involved could generate enough heat to cause an explosion. Polymerizes slowly, so munitions would be effective for several years. Heated to decomposition emits hydrogen chloride and nitrogen oxide. ***Note:*** Chlorinating agents destroy nitrogen mustards. Dry chlorinated lime and chloramines with a high content of active chlorine vigorously chlorinate nitrogen mustards to the carbon chain giving low toxicity products. In the presence of water this interaction proceeds less actively. They are rapidly oxidized by peracids in aqueous solution at weakly alkaline pH. In acid solution the oxidation is much slower.

Potential Exposure: Sulfur mustards were formerly used as a gas warfare agent. Nitrogen mustards have not previously been used in warfare[77]. Exposure to nitrogen mustard damages the eyes, skin, and respiratory tract and suppresses the immune system. Although the nitrogen mustards cause cellular changes within minutes of contact, the onset of pain and other symptoms is delayed. Exposure to large amounts can be fatal[77].

Permissible Exposure Limits in Air

Protective Action Criteria (PAC)* Ver. 29[138]

PAC-1: 0.002 milligram per cubic meter

PAC-2: $\mathbf{0.022_A}$ milligram per cubic meter

PAC-3: $\mathbf{0.37_A}$ milligram per cubic meter

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

AEL (United States Military): 0.003 milligram per cubic meter

Determination in Water: A water contaminant. Octanol-water coefficient: Log K_{ow} = (estimated) 2.27[77] Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion, skin contact.

Harmful Effects and Symptoms

Nitrogen mustards are extremely toxic and may damage the eyes, skin, and respiratory tract and suppress the immune system. Although these agents cause cellular changes within minutes of contact, the onset of pain and other symptoms is delayed. Thus, patients/victims arriving immediately from the scene of nitrogen mustard exposure are not likely to have signs and symptoms. The sooner after exposure that symptoms occur, the more likely they are to progress and become severe [77]. Most toxic of the nitrogen mustards. The median lethal dose for inhalation is 1,500 mg-min/m3; for skin absorption (masked personnel) is 10,000 mg-min/m3. The medium incapacitating dose for eye injury is 200 mg-min/m3; for skin absorption is 2,500 mg-min/m^3[88].

Short-Term Exposure: Extremely toxic and may damage the eyes, skin, and respiratory tract and suppress the immune system. Although these agents cause cellular changes within minutes of contact, the onset of pain and other symptoms is delayed. Most toxic of the nitrogen mustards. The median lethal dose for inhalation is 1500 mg-min/m^3; for skin absorption (masked personnel) is 10,000 mg-min/m^3. The medium incapacitating dose for eye injury is 200 mg-min/m^3; for skin absorption is 2500 mg-min/m^3. Irritates the eyes in quantities which do not significantly damage the skin or respiratory tract, insofar as single exposures are concerned. After mild vapor exposure, there may be no skin lesions. After severe vapor exposures, or after exposure to the liquid, erythema may appear. Irritation and itching may occur. Later, blisters may appear in the erythematous areas. Effects on the respiratory tract include irritation of the nose and throat, hoarseness progressing to loss of voice, and a persistent cough. Fever, labored respiration, and moist rales develop. Bronchial pneumonia may appear after the first 24 hours. Following ingestion or systemic absorption, material causes inhibition of cell mitosis, resulting in depression of the blood-forming mechanism and injury to other tissues. Severe diarrhea, which may be hemorrhagic, occurs. Lesions are most marked in the small intestine and consist of degenerative changes and nercosis in the mucous membranes. Ingestion of 2−6 mg causes nausea and vomiting. The median incapacitating dose for the eyes is 200 mg/min/m^3 [76]. LC_{t50} (the product of concentration times time that is lethal to 50% of the exposed population by inhalation) approximately 1,500 mg.min/m^3 [76].

Long-Term Exposure: Chronic or repeated exposure to HN-3 may cause Bone marrow suppression resulting in damage to the blood forming (hematopoietic) system;, lymph node damage, weakening of the immune system, kidney damage, and reproductive system damage[77]. Early signs of bone marrow suppression include a low white blood cell count; an increased risk for developing infections; a tendency for easy bruising and bleeding. May cause lymph node damage and a weakened immune system. It also causes liver and kidney damage, damage to the reproductive systems of both men and women leading to decreased fertility. It is mutagenic, toxic to the developing embryo, and possibly carcinogenic.

Medical Surveillance: Nitrogen mustards are vesicants causing skin, eye, and respiratory tract injury.

First Aid: There is no antidote for nitrogen mustard toxicity. Because health effects due to nitrogen mustard may not occur until several hours after exposure, patients/victims should be observed in a hospital setting for at least 24 hours. Gastric lavage is contraindicated following ingestion of this agent due to the risk of perforation of the esophagus or upper airway. If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Speed in removing material from skin is of extreme importance. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

Personal Protective Methods:

General information: first responders should use a NIOSH-certified chemical, biological, radiological, nuclear (CBRN) SCBA with a level a protective suit when entering an area with an unknown contaminant or when entering an area where the concentration of the contaminant is unknown. Level a protection should be used until monitoring results confirm the contaminant and the concentration of the contaminant. *Note*: safe use of protective clothing and equipment requires specific skills developed through training and experience.

LEVEL A: (*RED ZONE*): select when the greatest level of skin, respiratory, and eye protection is required. This is the maximum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than the AEGL-2.

A NIOSH-certified CBRN full-facepiece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle. A TECP suit that provides protection against CBRN agents.

Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, and a hard hat worn under the TECP suit are optional items.

LEVEL B: (RED ZONE): Select when the highest level of respiratory protection is necessary but a lesser level of skin protection is required. This is the minimum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than AEGL-2. It differs from Level A in that it incorporates a nonencapsulating, splash-protective, chemical-resistant splash suit that provides Level A protection against liquids but is not airtight.

A NIOSH-certified CBRN full-facepiece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL C: (YELLOW ZONE): Select when the contaminant and concentration of the contaminant are known and the respiratory protection criteria factors for using Air Purifying Respirators (APR) or Powered Air Purifying Respirators (PAPR) are met. This level is appropriate when decontaminating patient/victims. A NIOSH-certified CBRN tight-fitting APR with a canister-type gas mask or CBRN PAPR for air levels greater than AEGL-2. A NIOSH-certified CBRN PAPR with a loose-fitting facepiece, hood, or helmet and a filter or a combination organic vapor, acid gas, and particulate cartridge/filter combination or a continuous flow respirator for air levels greater than AEGL-1. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Escape mask, face shield, coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL D: (GREEN ZONE): Select when the contaminant and concentration of the contaminant are known and the concentration is below the appropriate occupational exposure limit or less than AEGL-1 for the stated duration times. Limited to coveralls or other work clothes, boots, and gloves.

Other protective equipment: Wear TECP suit that provides protection against CBRN agents; Chemical-resistant inner and outer gloves; Chemical-resistant boots with a steel toe and shank; Coveralls, long underwear, and a hard hat worn under the TECP suit are optional items. Take all necessary precutions to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Decontamination: Decontamination of all potentially exposed areas within minutes after exposure is the only effective means of decreasing tissue damage[77]. Remove clothes and place contaminated clothes and personal belongings in a sealed double bag. Decontamination of mustard-exposed victims by either vapor or liquid should be performed within the first two minutes following the exposure to prevent tissue damage. If not accomplished within the first several minutes, decontamination should still be performed to ensure any residual liquid mustard is removed from the skin or clothes, or to ensure any trapped mustard vapor is removed with the clothing. Removing trapped mustard vapor will prevent vapor off-gassing or subsequent cross-contamination of other emergency responders/healthcare providers or the healthcare facility. Physical removal of the mustard agent, rather than detoxification or neutralization, is the most important principle in patient decontamination. Mustard is not detoxified by water alone and will remain in decontamination effluent (in dilute concentrations) if hydrolysis has not taken place.

(1) Patients exposed to vapor should be decontaminated by removing all clothing in a clean air environment and shampooing or rinsing the hair to prevent vapor off-gassing. (2) Patients exposed to liquid should be decontaminated by (a) Washing in warm or hot water at least three times. Use liquid soap (dispose of container after use and replace), large volumes of water, and mild to moderate friction with a single-use sponge or washcloth in the first and second washes. Scrubbing of exposed skin with a brush is discouraged, because skin damage may occur which may enhance absorption. The third wash should be to rinse with large amounts of warm or hot water. Shampoo can be used to wash the hair. The rapid physical removal of a chemical

agent is essential. If warm or hot water is not available, but cold water is, use cold water. Do not delay decontamination to obtain warm water. (b) Rinse the eyes, mucous membranes; or open wounds with sterile saline or water. (3) The healthcare provider should (a) Check the victim after the three washes to verify adequate decontamination before allowing entry to the medical treatment facility. If the washes were inadequate, repeat the entire process. (b) Be prepared to stabilize conventional injuries during the decontamination process. Careful decontamination can be a time consuming process. The healthcare provider may have to enter the contaminated area to treat the casualty during this process. Medical personnel should wear the proper PPE and evaluate the exposed workers.

Respirator Selection: *When used as a weapon, use SCBA Respirator Certified By NIOSH For CBRN Environments.* Where a potential exposure to the chemical exists, use a A NIOSH-certified CBRN full facepiece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved SCBA with a full facepiece operated in pressure-demand or other positive pressure mode.

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create A potential fire or explosion hazard. Metal containers involving the transfer of 5 gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical.

Shipping: UN2810 Toxic liquids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. Military driver of HN-3 shall be given full and complete information regarding shipment and conditions in case of emergency. AR 50-6 deals specifically with the shipment of chemical agents. Shipments of agent will be escorted in accordance with AR 740-32.

Spill Handling:

UN2810 Toxic liquids, organic, n.o.s.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.2/0.3
Night 0.7/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 1000/300
Then: Protect persons downwind (miles/kilometers)
Day 1.1/1.8
Night 2.8/4.5

Small spills (From a small package or a small leak from a large package)

HN-3, when used as a weapon

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 200/60
Then: Protect persons downwind (miles/kilometers)
Day 0.2/0.3
Night 0.2/0.3

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Avoid inhalation and skin contact. Do not touch spilled material; stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills*: absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Large spills*: dike far ahead of spill for later disposal. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include hydrogen chloride and oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; or foam extinguishers. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the

containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Tris(2-Chloroethyl)Amine, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987)

United States Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry (ATSDR), *Medical Management Guidelines for Blister Agents*: *Nitrogen Mustard (HN-1) (C6H13Cl2N) Nitrogen Mustard (HN-2) ($C_5H_{11}Cl_2N$) Nitrogen Mustard (HN-3) ($C_6H_{12}Cl_3N$)*, http://www.atsdr.cdc.gov/MHMI/mmg165.pdf

Tris(2,3-dibromopropyl) Phosphate T:0970

Formula: $C_9H_{15}Br_6O_4P$; $[BrCH_2CH(Br)CH_2O]_3P = O$

Synonyms: 3PBR; Anfram 3PB; Apex 462-5; Bromkal P 67-6HP; 2,3-Dibromo-1-propanol phosphate; ES 685; Firemaster LV-T 23P; Firemaster T 23; Firemaster T 23P; Firemaster T 23P-LV; Flacavon R; Flammex AP; Flammex LV-T 23P; Flammex T 23P; Fosfato detris(2,3-dibromopropilo) (Spanish); Fyrol HB 32; NCI-C03270; Phoscon PE 60; Phoscon UF-S; Phosphoric acid tris(2,3-dibromopropyl) ester; 1-Propanol, 2,3-dibromo-, phosphate (3:1); T23P; TDBP; TDBPP; Tris; Tris BP; Tris(dibromopropyl) phosphate; Tris(2,3-dibromopropyl) phosphoric acid ester; Tris (flame retardant); Zetofex ZN

CAS Registry Number: 126-72-7

HSD B Number: 2581

RTECS Number: UB0350000

UN/NA & ERG Number: UN3082 (environmentally hazardous substances, liquid, n.o.s.)/171

EC Number: 204-799-9

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Animal, Sufficient Evidence; Human, Inadequate Evidence, Group 2A, 1999; NCI: Carcinogenesis Bioassay (feed); clear evidence: mouse, rat. United States Environmental Protection Agency Gene-Tox Program, Positive: Carcinogenicity-mouse/rat; Positive: D *melanogaster*-reciprocal translocation; Positive: Host-mediated assay; Histidine reversion-Ames test; Positive: Sperm morphology-mouse; D *melanogaster* sex-linked lethal; Positive/dose response: *In vitro* SCE-nonhuman; *In vivo* SCE-nonhuman.

California Proposition 65 Chemical[102]: Cancer 1/1/1988

Hazard Alert: Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction), Environmental hazard.

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U235

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.11; Nonwastewater (mg/kg), 0.10

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%.

Rotterdam Convention Annex III [Chemicals Subject to the Prior Informed Consent Procedure (PIC)]

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T, N; Risk phrases: R45; R20/22; R23/25; R33; R38; R50/53; R61; R62; R63; Safety phrases: S20/21; S26; S28; S29/35; S37; S45; S53; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: TDBP is a thick, clear to yellowish liquid. Odorless. Molecular weight = 697.67; Flash point ≥ 112°C. Stable in temperaturs from 200°C to 250°C[101]. Major decomposition begins at 307.8°C. Practically insoluble in water.

Potential Exposure: Tris-BP is used as a flame retardant additive for synthetic textiles and plastics. It was applied to fabrics used for children's clothes (sleepwear in particular) with some used as a flame retardant in other materials, such as urethane foams. Commercial preparations of tris-BP can be obtained in two grades, viz, HV (high in volatiles) and LV (low in volatiles). A typical LV sample has been reported to contain the following impurities:[1] 0.05% 1,2-dibromo-3-chloropropane ($BrCH_2CHBrCH_2Cl$); 0.05% 1,2,3-tribromopropane ($BrCH_2CHBrCH_2Br$); and

0.20% 2,3-dibromopropanol ($BrCH_2CHBrCH_2OH$). Use and expo sure has greatly decreased after a ruling by the Consumer Product Safety Commission in April 1977.

Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides.

Permissible Exposure Limits in Air

No numerical OELs have been set.

Finland: carcinogen, 1999; France: carcinogen, 1993; Sweden: carcinogen, 1999

Routes of Entry: TDBP was added to fabrics used for children's garments to the extent of 5%−10% by weight. A child wearing such garment and chewing on a sleeve or collar could easily ingest some TDBP, particularly if the garment had not been laundered before use.

Harmful Effects and Symptoms

Short-Term Exposure: May cause nausea, vomiting, gastrointestinal irritation. May cause CNS depression; headaches, dizziness.

Long-Term Exposure: May cause skin sanitization and allergy; chronic lung disease; kidney damage, such as renal tubular necrosis; liver damage; testicular atrophy and sterility. Suspected mutagenesis and carcinogenesis.

Points of Attack: Lungs, kidneys, liver, CNS; reproductive system.

Medical Surveillance. This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Lung function tests. Liver and kidney function tests. Examination of the nervous system.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device*. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid, unless full facepiece respiratory protection is worn. Wear dust-proof goggles and face shield when working with powders or dust, unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration*: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA-or European Standard EN149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full-facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in a cool, dry place and keep away from acids and bases. Where possible, automatically transfer material from storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN3082 Environmentally hazardous substances, liquid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Follow by washing surfaces well, first with 60%−70% acetone, then with soap and water. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include hydrogen bromide and oxides of phosphorus, bromine and carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(109); (102); (31); (173); (101); (138); (100).

United States Environmental Protection Agency, Summary Characterization of Selected Chemicals of Near-Term Interest, Report EPA 560/4-76-004, Washington, DC, Office of toxic Substances (April 1976)

United States Environmental Protection Agency, Status Assessment of Toxic Chemicals: Tris(2,3-Dibromopropyl) Phosphate, Report EPA-600/2-79-210n, Cincinnati, OH (December 1979)

United States Environmental Protection Agency, Investigation of Selected Potential Environmental Contaminants: Haloalkyl Phosphates, Report EPA-560/2-76-007, Washington, DC (August 1976)

Trypan Blue T:0980

Formula: $C_{32}H_{24}N_6Na_4O_{14}S4$; $C_{32}H_{24}N_6O_{14}S_4A4Na$

Synonyms: AI3-26698; Amanil sky blue; Amanil sky Blue R; Amidine Blue 4B; Azidinblau 3B; Azidine Blue 3B; Azirdinblau 3B; Azurro diretto 3B; Bencidal Blue 3B; Benzaminblau 3B; Benzamine blue; Benzamine Blue 3B; Benzanil Blue 3BN; Benzanil Blue R; Benzoblau 3B; Benzo blue; Benzo Blue 3B; Benzo Blue 3BS; Bleu diamine; Bleu diazole N 3B; Bleu directe 3B; Bleue diretto 3B; Bleu trypane N; Blue 3B; Blue EMB; Brasilamina Blue 3B; Brasilazina Blue 3B; Centraline Blue 3B; Chloramiblau 3B; Chloramine blue; Chloramine Blue 3B; Chlorazol Blue 3B; Chrome leather Blue 3B; C.I. 23850; C.I. Direct Blue 14; C.I. Direct Blue 14, tetrasodium salt; Congoblau 3B; Congo blue; Congo Blue 3B; Cresotine Blue 3B; Diaminblau 3B; Diamine blue; Diamine Blue 3B; Diamineblue; Dianilblau; Dianilblau H3 G; Dianil blue; Dianil Blue H3 G; Diaphtamine Blue TH; Diazine Blue 3B; Diazol Blue 3B; 3,3′-[(3,3′-Dimethyl(1,1′-bip henyl)-4,4′-diyl]bis(azo)bis(5-amino-4-hydroxynaphthalene-2,7-disulphonate); Diphenyl Blue 3B; Directakol Blue 3BL; Directblau 3B; Direct Blue 14; Direct Blue 3B; Direct Blue D3B; Direct Blue FFN; Direct Blue H3 G; Direct Blue M 3B; Hispamin Blue 3B; Naphtamine Blue 2B; Naphtamine Blue 3B; 2,7-Naphthalenedisulfonic acid, 2-57-13,3′-([3,3′-dimethyl(1,1′-biphenyl)-4,4′-diyl]bis(azo))bis(5-amino-4-hydroxy-, tetrasodium salt; 2,7-Naphthalenedisulfonic acid, 3,3′-([3,3′-dimethyl(1,1′-biphenyl)-4,4′-diyl]bis(azo))bis(5-amino-4-hydroxy-), tetrasodium salt; 2,7-Naphthalenedisulfonic acid, 3,3′-[(3,3′-dimethyl-4,4′-biphenylylene)bis(azo)]bis(5-amino-4-hydroxy-), tetrasodium salt; Naphthaminblau 3B; Naphthamine Blue 3B; Naphthylamine blue; NCI: C61289; Niagara blue; Niagara Blue 3B; NSC 11247; Orion Blue 3B; Paramine Blue 3B; Parkibleu; Parkipan; Pontamine Blue 3B; Pyrazol Blue 3B; Pyrotropblau; Renolblau 3B; Sodium ditolyl-diazobis-8-amino-1-naphthol-3,6-disulfonate; Sodium ditolyldisazobis-8-amino-1-naphthol-3,6-disulfonate; Sodium ditolyldisazobis-8-amino-1-naphthol-3,6-disulphonate; TB; Tetrasodium; Trianol direct Blue 3B; Triazolblau 3B; Tripan blue; Trypan Blue BPC; Trypan Blue sodium salt; Trypane blue

CAS Registry Number: 72-57-1

HSDB Number: 2945

RTECS Number: QJ6475000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154; UN3143 (dyes, solid, toxic, n.o.s.)/151

EC Number: 200-786-7

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human Inadequate Evidence; Animal Sufficient Evidence, *possibly carcinogenic to humans*, Group 2B, 1987

California Proposition 65 Chemical[102]: Cancer 1/1/1989

Hazard Alert: Explosive (under certain conditions), Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Environmental hazard.

United States National Primary Drinking Water Regulations: MRDL = 4.0 mg/L; MRDLG = 4.0 mg/L as chloramines (as Cl_2)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U236

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 10 lb (4.54 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

United States DOT Regulated marine pollutant (49CFR172.101, Appendix B) as naphthalenes

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T, Xi, N; Risk phrases: R45; R10; R20, R22; R36/37/38; R41; R50; R61; R62; R63; Safety phrases: S23; S26; S36/37/39; S45; S53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Trypan Blue is a dark Blue crystalline solid or powder. Molecular weight = 964.88; 961[138]; Freezing/Melting point = 300°C; Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 1, Reactivity 0. Soluble in water.

Potential Exposure: Used in dyeing textiles; leather and paper; as a biological stain.

Incompatibilities: Dust may form explosive mixture with air. Trypan Blue is incompatible with strong oxidizing agents[101]. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Azo compounds can detonate. This applies in particular to organic azides that have been sensitized by the addition of metal salts or strong acids. Toxic gases are formed by mixing materials of this class with acids, aldehydes, amides, carbamates, cyanides, inorganic fluorides, halogenated organics, isocyanates, ketones, metals, nitrides, peroxides, phenols, epoxides, acylhalides, and strong oxidizing or reducing agents. Flammable gases are formed by mixing materials in this group with alkali metals. Explosive combinations can occur with strong oxidizing agents, metal salts, peroxides, and sulfides. Trypan Blue is sensitive to prolonged exposure to heat.

Permissible Exposure Limits in Air

Protective Action Criteria (PAC) Ver. 27; No value in Ver. 29[138]

PAC-1: 0.37 milligram per cubic meter

PAC-2: 41 milligram per cubic meter

PAC-3: 1200 milligram per cubic meter

Permissible Concentration in Water: Octanol-water coefficient: Log $K_{ow} = > 5$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood. Naphthalenes and naphthenic acids are listed as United States DOT marine pollutants and may persist in the environment.

Harmful Effects and Symptoms

Short-Term Exposure: *Inhalation*: No symptoms reported. *Skin*: may stain skin. *Eyes*: application of 0.2 mL (0.007 ounces) of a 1% solution caused no eye irritation. *Ingestion*: moderately toxic. Probable lethal dose between 1 ounce and 1 pound for a 150 pound person.

Long-Term Exposure: Chloramines can cause eye/nose irritation; stomach discomfort; anemia. A potential occupational carcinogen, mutagen, and teratogen. Has been shown to cause birth defects, cancer and liver injury in laboratory animals.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration*: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA-or European Standard EN149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full-facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and

storage. Avoid creating dust. Where possible, automatically pump material from storage containers to process containers. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is handled, used, or stored. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN3143 dyes, solid, toxic, n.o.s. or dye intermediates, solid, toxic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: Isolation Distance, Spill: 25meters/75 feet.(NJ). Isolation Distance, Fire: 800 meters/ 0.5 miles[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid. Use extinguisher appropriate for burning material. Thermal decomposition products may include oxides of sodium, nitrogen, sulfur and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(102); (31); (173); (101); (138); (100).

New York State Department of Health, *Chemical Fact Sheet*: Trypan Blue, Bureau of Toxic Substance Assessment, Albany, NY (July 1986

Tungsten & Insoluble Compounds T:0985

Formula: W; WC; WCCo; WCNi; WCTi

Synonyms: *metal*: Tungsten, elemental; Tungsten metal; Wolfram

tungsten carbide (cemented): Cemented tungsten carbide; Cemented WC; Hard metal

tungsten other insoluble com pounds: Tungsten(IV) oxide 12036-22-5; Tungsten trioxide 1314-35-8; Tungstic acid (7783-03-1); 12070-12-1 (tungsten carbide)

CAS Registry Number: 7440-33-7 (elemental); 12718-69-3 (92% W, 8% Co); 11107-01-0 (85% W, 15% Co); 37329-

HSDB Number: 49-0 (78% W: 14% Co: 8% Ti)

HSDB Number: 5036 (elemental); 6998 (tungsten compounds)

RTECS Number: YO7175000 (elemental); YO7525000 (92% W: 8% Co); Y07350000 (85% W, 15% Co); YO7700000 (78% W: 14% Co: 8% Ti)

UN/NA & ERG Number: UN3189 (metal powder, self-heating, n.o.s.)/135

EC Number: 231-143-9 (tungsten)

Regulatory Authority and Advisory Information

Carcinogenicity: NIOSH (tungsten carbide containing >0.3% Ni) Potential occupational carcinogen.

Hazard Alert: Combustible, (tungsten powder): Suspected of causing genetic defects, Primary irritant (w/o allergic reaction).

Air in Pollutant Standard Set. See below, "Permissible Exposure Limits Air" section.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%., for tungsten and its compounds

Hazard Symbols, Risk & Safety statements: Hazard Symbol: F, Xi; Risk phrases: R10; R17; R20/21/22; R36/37/38; R48/ 20; R51/53; R62; R65; R67; Safety phrases: S2; S6; S16; S26; S27; S33; S36/37/39; S43; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): Nonwater polluting agent, particle size >1 mm

Description: Tungsten is a hard, brittle, steel-gray to tin-white metal or fine powder. Molecular weight = 183.84; Specific gravity (H_2O:1) = 19.3 @ 20°C; Boiling point = 5555°C[138]; 5927°C; Freezing/Melting point = 3422°C. Insoluble in water.

Tungsten carbide is a gray powder. Cemented tungsten carbide is a mixture, generally consisting of 85%−95% tungsten carbide (WC) and 5%−15% cobalt (Co). Physical properties vary depending upon the specific mixture. Molecular weight = Specific gravity (H_2O:1) = 15.6 @ 20°C; 196; Boiling Point: 6000°C @ 760 mmHg; Freezing/ Melting point = 2730°C−2830°C; solubility in water = < 1 mg/mL @ 18°C[193]. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 2, Reactivity 0. Insoluble in water.

Potential Exposure: Tungsten is used in ferrous and nonferrous alloys, and for filaments in incandescent lamps. It has been stated that the principal health hazards from tungsten and its compounds arise from inhalation of aerosols during mining and milling operations. The principal compounds of tungsten to which workers are exposed are ammonium paratungstate, oxides of tungsten (WO_3, W_2O_5, WO_2); metallic tungsten; and tungsten carbide. In the production and use of tungsten carbide tools for machining, exposure to the cobalt used as a binder or cementing substance may be the most important hazard to the health of the employees. Since the cemented tungsten carbide industry uses such other metals as tantalum, titanium, niobium, nickel, chromium, and vanadium in the manufacturing process, the occupational exposures are generally to mixed dust.

Incompatibilities: *Tungsten*: The finely divided powder is combustible and may ignite spontaneously in air. Incompatible with bromine trifluoride; chlorine trifluoride; fluorine, iodine pentafluoride. *Tungsten carbide*: Incompatible with strong oxidizers: fluorine (may cause ignition), chlorine trifluoride; iodine pentafluoride; mercuric iodine; oxides of nitrogen; lead dioxide; strong acid mixtures (i.e., HNO_3/HCl mixture).

Permissible Exposure Limits in Air

tungsten and insoluble compounds

OSHA PEL: None

(metals and insoluble compounds) 5 mg[W]/m^3 TWA; 10 mg[W]/m^3 STEL; (soluble compounds) 1 mg[W]/m^3 TWA; 3 mg[W]/m^3 STEL. Hard metals containing tungsten carbide & cobalt as [Co]: 0.005 milligram per cubic meter.

7440-33-7, metal

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 10 milligram per cubic meter

PAC-2: 330 milligram per cubic meter

PAC-3: 2000 milligram per cubic meter

Denmark: TWA 5 mg[W]/m^3, 1999; Norway: TWA 5 mg [W]/m^3, 1999; Poland: MAC (TWA) fume and dust 5 mg [W]/m^3, 1999; Russia: STEL 2 mg[W]/m^3, 1993; Sweden: NGV 5 mg[W]/m^3, 1999; United Kingdom: TWA 5 mg [W]/m^3, STEL 10 mg[W]/m^3, 2000

tungsten soluble compounds

OSHA PEL: None

NIOSH REL: 1 mg[W]/m^3 TWA; 3 mg[W]/m^3 STEL

ACGIH TLV[1]: 1 mg[W]/m^3 TWA; 3 mg[W]/m^3 STEL

tungsten carbide containing $>2\%$ Co

NIOSH REL: 0.05 mg[W]/m^3 TWA; See *NIOSH Pocket Guide*, Appendix C.

tungsten carbide containing $> 0.3\%$ Ni

NIOSH REL: 0.015 mg[W]/m^3 TWA; Potential occupational carcinogen; Reduce exposure to lowest feasible level; See *NIOSH Pocket Guide*, Appendix A & C.

tungsten carbide

NIOSH IDLH = 20 mg[Co]/m^3

Protective Action Criteria (PAC) Ver. 29[138]

12070-12-1, (92% W, 8% Co) (tungsten carbide)

PAC-1: 11 milligram per cubic meter

PAC-2: 120 milligram per cubic meter

PAC-3: 730 milligram per cubic meter

Cemented tungsten carbide (e.g., 85%: 15%) or *tungsten carbide, mixed with cobalt and titanium* (e.g., 78% W: 14% Co: 8% Ti) also known as "hard metal" refers to a mixture of tungsten carbide, cobalt, and sometimes metal oxides or carbides and other metals (including nickel). When the *cobalt* (Co) content exceeds 2%, its contribution to the potential hazard is judged to exceed that of tungsten carbide. Therefore, the NIOSH REL (10-hour TWA) for cemented tungsten carbide containing $>2\%$ Co is 0.05 mg [Co]/m^3; the applicable OSHA PEL is 0.1 mg[Co]/m^3 (8-hour TWA). *Nickel* (Ni) may sometimes be used as a binder rather than cobalt. NIOSH considers cemented tungsten carbide containing nickel to be A potential occupational carcinogen and recommends a REL of 0.015 mg [Ni]/m^3 (10-hour TWA). The OSHA PEL for *insoluble nickel*, 1 mg (Ni)/m^3 8-hour TWA applies to mixtures of tungsten carbide and nickel.

tungsten carbide

Australia: TWA 5 mg[W]/m^3, STEL 10 mg[W]/m^3, 1993; Austria: MAK 5 mg[W]/m^3, 1999; Belgium: TWA 5 mg [W]/m^3, STEL 10 mg[W]/m^3, 1993; Denmark: TWA 5 mg [W]/m^3, 1999; Finland: TWA 5 mg[W]/m^3, 1999; Norway: TWA 5 mg[W]/m^3, 1999; the Phillipines: TWA 1 mg [W]/m^3, 1993; Poland: MAC (TWA) 5 mg[W]/m^3, 1999; Sweden: NGV 5 mg[W]/m^3, 1999; Switzerland: MAK 5 mg[W]/m^3, 1999; United Kingdom: TWA 5 mg[W]/m^3, STEL 10 mg[W]/m^3, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 5 mg[W]/m^3; STEL 10 mg[W]/m^3

For both tungsten and tungsten carbide, Russia[43] set a MAC in workplace air of 6.0 mg[W]/m^3. Several states have set guidelines and standards for tungsten in ambient air[60] ranging from 16.0 μ/m^3 (Virginia); to 20.0 μ/m^3 (Connecticut); to 24.0 μ/m^3 (Nevada).

Determination in Air: *For tungsten metal and tungsten soluble compounds*: Use NIOSH Analytical Method (IV) #7074, #7301, OSHA Analytical Method ID-213. See also Method # 7300, Elements. There is no specific method for *cemented tungsten carbide*.

Permissible Concentration in Water: No criteria set, but EPA[32] has suggested a permissible ambient goal of 14 μg/L based on health effects. Russia[43] set a MAC in water bodies used for domestic purposes of 0.1 mg[W]/L.

Determination in Water: By neutron activation analysis.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: *Tungsten* can affect you when breathed in. Irritates the eyes, skin, and respiratory system. Some tungsten compounds can cause lung and skin problems. *Tungsten carbide* can affect you when breathed in. There is no health effects from exposure to pure tungsten carbide alone. However, tungsten carbide is often combined with nickel or cobalt to make cemented tungsten carbide (hard metal). Exposure to *tungsten carbide combined with cobalt or nickel* can cause skin irritation.

Long-Term Exposure: Long-term exposure to *tungsten metal* and *cemented tungsten carbide* may cause diffuse pulmonary fibrosis (lung scarring); loss of appetite; nausea, cough. May cause blood changes. Exposure to *tungsten carbide combined with cobalt or nickel* can cause skin sensitization, lung allergy, with wheezing, coughing, and shortness of breath. Repeated exposure can cause pulmonary fibrosis. Long-term exposure to *tungsten soluble compounds*: in animals: CNS disturbances; diarrhea; respiratory failure; behavioral, body weight, blood changes.

Points of Attack: *Metal* and *cemented tungsten carbides*: Eyes, skin, respiratory system; blood. *Soluble compounds*: Eyes, skin, respiratory system; CNS; gastrointestinal tract.

Medical Surveillance: If you are exposed to tungsten metal alone, no medical tests are necessary. If you are exposed to cemented tungsten carbide (hard metal), the following are recommended before beginning employment and at regular times after that: lung function tests; chest X-ray every two to three years after five or more years of exposure. If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield when working with powders or dust unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH *(tungsten metal and insoluble compounds)*: *Up to 50 mg [W]/m^3*: 100XQ (APF = 10) [Any air-purifying respirator with an N100, R100, or P100 filter (including N100, R100, and P100 filtering facepieces) except quarter-mask respirators.]; or Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd, Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive pressure mode). Escape: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Respirator for Tungsten carbide (cemented) containing Cobalt.

NIOSH/OSHA, for cobalt metal dust and fume: *0.25 milligram per cubic meter*: *if not present as a fume* Qm* (APF = 25) (any quarter-mask respirator). *0.5 milligram per cubic meter*: 95XQ* (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa* (APF = 10) (any supplied-air respirator). *1.25 milligram per cubic meter*: Sa:Cf (APF = 25)* (any supplied-air respirator operated in a continuous-flow mode); or PaprHie* (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *2.5 milligram per cubic meter*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respira tor with a full facepiece). *20 milligram per cubic meter*: SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd, Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

*Note**: Substance reported to cause eye irritation or damage; may require eye protection.

Respirator for Tungsten carbide (cemented) containing Nickel.

At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive pressure mode). Escape: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code-Red Stripe: Flammability Hazard (4.2): Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 meters or a 1-hour fire wall from flammable or reactive materials. Store flammable solids (spontaneously combustible) up to maximum allowable quantity per control area in an approved flammable storage area. Do not store in a basement. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Tungsten must be stored to avoid contact with fluorine and chlorine compounds, since violent reactions occur. Store in a tightly closed container in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames, are prohibited where tungsten is used, handled, or stored in a manner that could create A potential fire or explosion hazard. Tungsten carbide must be stored to avoid contact with fluorine, chlorine trifluoride; iodine pentafluoride; lead dioxide; nitrous oxide; nitrogen dioxide; and mercurium iodine; since violent reactions occur. Store in tightly closed containers in a cool well ventilated area.

Shipping: UN3089 Metal powders, flammable, n.o.s., Hazard Class: 4.1; Labels: 4.1-Flammable solid. UN3189 Metal powder, self heating, n.o.s., Hazard Class: 4.2; Labels: 4.2-Spontaneously combustible material.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers; do not sweep in the case of tungsten carbide. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Tungsten is a flammable powder. Use dry chemicals appropriate for extinguishing metal fires. In the case of tungsten carbide, extinguish fire using an agent suitable for type of surrounding fire. Tungsten carbide itself does not burn. Thermal decomposition products may include oxides of metal. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Recovery of tungsten from sintered metal carbides, scrap and spent catalysts has been described as an alternative to disposal.

References

(31); (173); (101); (138); (2); (100).

United States Environmental Protection Agency, Toxicology of Metals, Vol. II: Tungsten, Report EPA-600/1-77-022, Research Triangle Park, NC, pp 442−453 (May 1977)

National institute for Occupational Safety and Health (NIOSH), "Criteria for a Recommended Standard: Occupational Exposure to Tungsten and Cemented Tungsten Carbide," NIOSH Document Number 77-127, Cincinnati OH (September 1977)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Tungsten, Trenton, NJ (November 2000)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Tungsten Carbide, Trenton, NJ (August 2005)

Tungsten Hexafluoride T:0990

Formula: F_6W; WF_6

Synonyms: Tungsten fluoride

CAS Registry Number: 7783-82-6

HSD B Number: 8038

RTECS Number: YO7720000

UN/NA & ERG Number: UN2196/125

EC Number: 232-029-1

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Theft hazard* 45 (≥7.10% concentration).

Hazard Alert: Highly toxic gas with inadequate warning properties, Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated, Corrosive, Lachrymator.

United States National Primary Drinking Water Regulations: MCLG = 4 mg[F]/L; MCL = 4 mg[F]/L; SMCL = 2.0 mg [F]/L, as Fluoride.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T, C; Risk phrases: R5; R21; R23/24/25; R34; R41; Safety phrases: S1; S9; S26; S28; S33; S36/37/39; S38; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [1-Low hazard to water. (est.)]

Description: Tungsten hexafluoride is a toxic, colorless gas or a light yellow liquid. Molecular weight = 297.85; Specific gravity (H_2O:1) = 13.1 @ 20°C; Freezing/Melting point = 2.3°C. Boiling point = 17.5°C−19.5°C. Reacts with water (decomposes).

Potential Exposure: A strong halogenating agent. Used to apply tungsten coatings to other surfaces by vapor deposition process; making electronics and components; in the manufacture of other chemicals.

Incompatibilities: Decomposes on contact with water and moist air, forming highly corrosive hydrofluoric acid. Violent reaction on contact with methyl silicate (CAS 681-84-5).

Permissible Exposure Limits in Air

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 4.9 milligram per cubic meter

PAC-2: 54 milligram per cubic meter

PAC-3: 320 milligram per cubic meter

Determination in Air: NIOSH Analytical Method (IV) #7074. See also Method #7300; NIOSH Analytical Method (IV) #7902, Fluorides.

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guide lines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg [F]/L. SafeDrinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg[F]/L; SMCL = 2 mg/F/L, as Fluoride.

Harmful Effects and Symptoms

Short-Term Exposure: Tungsten hexafluoride is a corrosive chemical. Irritates the eyes, skin, and respiratory tract. Contact with liquid may cause frostbite. Tungsten hexafluoride can affect you when breathed in. Exposure to tungsten hexafluoride may expose you to both tungsten and fluorides. Exposure to very high levels of fluorides may cause symptoms of nausea, vomiting, abnormal pain; convulsions and kidney damage. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: Repeated high exposures may affect kidneys. Repeated high exposures can cause deposits of fluorides in the bones (fluorosis) that may cause pain, disability and mottling of the teeth. Repeated exposure can cause nausea, vomiting, loss of appetite; diarrhea or constipation. Nosebleeds and sinus problems can also occur.

Points of Attack: Eyes, respiratory system; CNS; skeleton, kidneys, skin.

Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that. Lung function tests. Fluoride level in urine. (for fluoride in urine use NIOSH #8308). Levels higher than 4 mg/L may indicate overexposure. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Kidney function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24−48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid, unless full facepiece respiratory protection is worn. Wear gas-proof goggles and face shield, unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Specific engineering controls are recommended in NIOSH Criteria Document #76-103: *Inorganic fluorides*.

Respirator Selection: *Fluorides*: NIOSH/OSHA *12.5 milligram per cubic meter*: Qm (APF = 25) (any quarter-mask respirator). *25 milligram per cubic meter*: 95XQ (APF = 10)* [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa* (any supplied-air respirator). *62.5 milligram per cubic meter*: Sa:Cf (APF = 25)*$^{+}$ (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25)* *if not present as a fume* (any powered, air-purifying respirator with a high-efficiency particulate filter). *125 milligram per cubic meter*: 100F (APF = 50)$^{+}$ [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *250 milligram per cubic meter*: Sa: Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full faceplate and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive-pressure mode). *Escape*: 100F (APF = 50)$^{+}$ [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or SCBAE (any appropriate escape-type, SCBA). *Substance reported to cause eye irritation or damage; may require eye protection. *May need acid gas sorbent. As Tungsten (insoluble compounds): NIOSH *(tungsten metal)*: *Up to 50 milligram per cubic meter*: 100XQ (APF = 10) [Any air-purifying respirator with an N100, R100, or P100 filter (including N100, R100, and P100 filtering facepieces) except quarter-mask respirators.]; or Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any SCBA with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, SCBA operated in a pressure-demand or other positive pressure mode). Escape: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, SCBA).

Storage: Check oxygen content prior to entering storage area. Poison gas. (1) Color code-Blue: Health Hazard/Poison: Store in a secure poison location. This gas is highly toxic. Even slight exposure to these gasses can cause death. Store outdoors in a secure, restricted area that containing warning signs. This area must be roofed and shaded with the cylinders stored off the ground and separated from all other products assigned to other hazard categories and radiant heat sources on nonwooden floors. If indoors, store in a well-ventilated areas in temperatures not to exceed 50°C. (2) Color code-White stripe: Contact Hazard; Store separately, not compatible with materials in solid white category. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed container in a cool well-ventilated area away from water. Procedures for the handling, use, and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169 with the recommendations of the Compressed Gas Association.

Shipping: UN2196 Tungsten hexafluoride, Hazard Class: 2.3; Labels: 2.3-Poisonous gas, 8-Corrosive material, Inhalation Hazard Zone B. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling:

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (feet/meters) 100/30
Then: Protect persons downwind (miles/kilometers)
Day 0.1/0.2
Night 0.5/0.8

Large spills (From a large package or from many small packages)

First: Isolate in all directions (feet/meters) 500/150
Then: Protect persons downwind (miles/kilometers)
Day 0.6/0.9
Night 2.0/3.2

If in a building, evacuate building and confine vapors by closing doors and shutting down HVAC systems. Restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak to disperse the gas. Wear chemical protective suit with SCBA to combat spills. Stay upwind and use water spray to "knock down" vapor; contain runoff. Stop the flow of gas, if it can be done safely from a distance. If source is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place; and repair leak or allow cylinder to empty. Absorb liquids in vermiculite, dry sand; earth, or a similar material and deposit in sealed containers. Keep this chemical out of confined spaces, such as a sewer, because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include hydrogen fluoride, fluorine, and oxides of tungsten. Tungsten hexafluoride may burn, but does not readily ignite. This gas is under pressure; containers may rupture and explode when heated. For small fires use dry chemical or CO_2 extinguishers. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Nonrefillable cylinders should be disposed of in accordance with local, state and federal regulations. Allow remaining gas to vent slowly into atmosphere in an unconfined area or exhaust hood. Refillable-type cylinders should be returned to original supplier with any valve caps and outlet plugs secured and valve protection caps in place.

References

(31); (173); (101); (138); (122); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Tungsten Hexafluoride, Trenton, NJ (November 2000)

Turpentine T:1000

Formula: $C_{10}H_{16}$ (approx.)

Synonyms: Gum spirits; Gum turpentine; Oil of turpentine; Spirits of turpentine; Steam distilled turpentine; Sulfate wood turpentine; Terebenthine (French); Terpentin oel (German); Turpentine steam distilled; Turps; Wood turpentine

CAS Registry Number: 8006-64-2; selected monoterpenes: 80-56-8 (α & β-Pinene); 127-91-3; 13466-78-9 (Carene); 498-15-7 (Carene)[136]

HSDB Number: 204 (8006-64-2, turpentine)); 720 (80-56-8, α & β-pinene)

RTECS Number: YO8400000

UN/NA & ERG Number: UN1299/128

EC Number: 232-350-7 [*Annex I Index No*.: 650-002-00-6]

Regulatory Authority and Advisory Information

Hazard Alert: Highly flammable, Possible risk of forming tumors, Sensitization hazard (skin), Primary irritant (w/o allergic reaction), Environmental hazard, FDA-over the counter drug.

United States Environmental Protection Agency, FIFRA 1998 Status of Pesticides: Canceled/New AI

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects[293]. Toxic to aquatic life with long-lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

European/International Regulations (*8006-64-2*): Hazard Symbol: Xn, N, Xi; Risk phrases: R11; R20/21/22; R36/38; R43; R51/53; R65; Safety phrases: S2; S21; S29/35; S36/37; S46; S61; S62 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to waters (*CAS: 8006-64-2*)

Description: Turpentine is the oleoresin from species of Pinus Pinacea trees. The crude oleoresin (gum turpentine) is a yellowish, sticky, opaque mass and the distillate (oil of turpentine) is a colorless, volatile liquid with a characteristic odor. Chemically, it contains: *alpha*-pinene; *beta*-pinene; camphene, monocyclic terpene; and terpene alcohols. Molecular weight = 136−140 (approx); Specific gravity (H_2O:1) = 0.84−0.87 @ 20°C; Boiling point = 153.8°C−170°C; Freezing/Melting point = −50°C to −60°C; Vapor pressure = 4 mmHg; Flash point = 35°C (cc), also listed @ 30°C−46°C (cc); Autoignition temperature = 253°C, also listed @ 220°C−255°C. Explosive limit: LEL = 0.8%; UEL: 6%. Hazard Identification (based on NFPA-704 M Rating System): Health 1, Flammability 3, Reactivity 0. Insoluble in water.

Potential Exposure: Turpentines have found wide use as chemical feedstock for the manufacture of floor, furniture, shoe, and automobile polishes; camphor, cleaning materials; inks, putty, mastics, cutting and grinding fluids; paint thinners; resins, and degreasing solutions. Recently, *alpha*-and *beta*-pinenes, which can be extracted, have found use as volatile bases for various compounds. The components *d*-α-pinene and 3-carene, or their hydroperoxides, may be the cause of eczema and toxic effects of turpentine.

Incompatibilities: Forms an explosive mixture with air. Violent reaction with strong oxidizers, especially chlorine; chromic anhydride; stannic chloride; chromyl chloride.

Permissible Exposure Limits in Air

NIOSH IDLH = 200 ppm

Conversion factor: 1 ppm = 5.56 milligram per cubic meter (approx)@ 25°C & 1 atm

OSHA PEL (8006-64-2): 100 ppm/560 milligram per cubic meter TWA

NIOSH REL (8006-64-2): 100 ppm/560 milligram per cubic meter TWA (Intended change)

ACGIH TLV[1] (*terpentine and selected monoterpenes*): 20 ppm/112 milligram per cubic meter TWA, sensitizer; not classifiable as a human carcinogen

Protective Action Criteria (PAC) Ver. 29[138]

8006-64-2, turpentine; 80-56-8, α & β-pinene

PAC-1: 60 ppm

PAC-2: 120 ppm

PAC-3: 1500 ppm

DFG MAK (8006-64-2): 100 ppm/560 milligram per cubic meter; danger of skin sensitization

Australia: TWA 100 ppm (560 milligram per cubic meter), 1993; Austria: MAK 100 ppm (560 milligram per cubic meter), 1999; Belgium: TWA 100 ppm (556 milligram per cubic meter), 1993; Denmark: TWA 25 ppm (140 milligram per cubic meter), 1999; Finland: TWA 100 ppm (560 milligram per cubic meter), STEL 150 ppm, [skin], 1999; France: VME 100 ppm (560 milligram per cubic meter), 1999; Hungary: TWA 300 milligram per cubic meter, STEL 600 milligram per cubic meter, 1993; the Netherlands: MAC-TGG 560 milligram per cubic meter, 2003; the Phillipines: TWA 100 ppm (560 milligram per cubic meter), 1993; Poland: MAC (TWA) 300 milligram per cubic meter; MAC (STEL) 840 milligram per cubic meter, 1999; Russia: STEL 300 milligram per cubic meter, 1993; Sweden: NGV 25 ppm (150 milligram per cubic meter), KTV 50 ppm (300 milligram per cubic meter), [skin], 1999; Turkey: TWA 100 ppm (560 milligram per cubic meter), 1993; United Kingdom: TWA 100 ppm (566 milligram per cubic meter), STEL 150 ppm, 2000; New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen

Russia[35][43] set a MAC for ambient air in residential areas of 2.0 milligram per cubic meter on a momentary basis and 1.0 milligram per cubic meter on a daily average basis. Several states have set guidelines or standards for turpentine in ambient air[60] ranging from 5.6−8.4 milligram per cubic meter (North Dakota); to 9.3 milligram per cubic meter (Virginia); to 11.2 milligram per cubic meter (Connecticut and New York); to 13.333 milligram per cubic meter (Nevada).

Determination in Air: Use NIOSH Analytical Method #1551, Terpentine, #2549, Volatile organic compound[18].

Permissible Concentration in Water: Russia[43] set a MAC in water bodies used for domestic purposes of 0.2 mg/L.

Routes of Entry: Inhalation of vapor and percutaneous absorption of liquid are the usual paths of occupational exposure. However, symptoms have been reported to develop from percutaneous absorption alone. Ingestion and/or skin and/or eye contact are also routes of entry.

Harmful Effects and Symptoms

Short-Term Exposure: Turpentine can affect you when breathed in and by passing through your skin. Exposure can irritate the eyes, nose and throat. Higher levels can affect the CNS, causing headache, vertigo, dizziness, abdominal pain; nausea, vomiting, diarrhea confusion and rapid pulse. Swallowing the liquid may cause chemical pneumonia to develop. High exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Still higher levels can cause hematuria (blood in the urine), albuminuria, kidney damage; convulsions, and death.

Long-Term Exposure: Repeated or prolonged contact may cause skin sensitization and allergy. The liquid destroys the skin's natural oils, causing dryness and cracking. May damage the kidneys, bladder, and the nervous system. Can irritate the lungs; bronchitis may develop. Various kinds of products are in use as turpentine oil. Their respective toxicities and tendency to cause eczema, which probably arise from their content of δ-α-pinene and 3-carene, vary considerably. However, systematic comparative investigations for these products are lacking.

Points of Attack: Eyes, skin, respiratory system; CNS; kidneys.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: kidney function tests. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Examination of the nervous system. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, give plenty of water to drink and get medical attention. Do not induce vomiting. Medical observation is recommended for

24–48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/ manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Teflon and polyvinyl alcohol are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *800 ppm*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]; or CcrFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted acid gas canister]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted acid gas canister]; or SCBAF (APF = 50) (any SCBA with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions*: SCBAF: Pd,Pp (APF = 10,000) (any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive pressure mode). *Escape*: GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, SCBA).

Storage: Color code-Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool well-ventilated area away from oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates). Sources of ignition, such as smoking and open flames, are prohibited where turpentine is used, handled, or stored in a manner that could create A potential fire or explosion hazard. Metal containers involving the transfer of 5 gallons or more of turpentine should be grounded and bonded. Drums must be equipped with self-closing values, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of turpentine.

Shipping: UN1299 Turpentine, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to cleanup spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are SCBAs that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (2); (100).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 2, No. 2, 75–76 (1982)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Turpentine, Trenton, NJ (October 1996)

U

Uranium & Compounds U:0100

Formula: U

Synonyms: *metal:* Uranium 1; Uranium metal

Acetate: Acetato de uranilo (Spanish); Uranium acetate; Uranium bis(aceto-*o*)dioxo-; Uranium oxyacetate; Uranyl acetate

Uranium (IV)oxide: Black uranium oxide; Uranium dioxide; Uranous oxide (UO_2)

Uranyl nitrate, solid (10102-06-4): Bis(nitrato-*O*,*O′*)dioxo uranium; Nitrato de uranilo (Spanish); Uranium bis(nitrato-*o*) dioxo-, (T-4); Uranyl nitrate (EPA)

Uranyl nitrate (36478-76-9): Uranium, bis(nitrato-*O*,*O′*) dioxo, (OC-6-11)-

Nitrate hexahydrate: Bis(nitrato)dioxouranium hexahydrate; Dinitratodioxouranium, hexahydrate

Uranium sulfate (1314-64-3): Uranium (soluble compounds, as U); Uranium sulfate trihydrate; Uranyl sulfate trihydrate ($UO_2SO_4 \cdot 3H_2O$)

CAS ***Registry Number:*** 7440-61-1 (elemental); (*alt.*) 24678-82-8; 541-09-3 (acetate); 1344-57-6 (dioxide); 10102-06-4 (nitrate); 36478-76-9 (uranyl nitrate); 13520-83-7 (uranyl nitrate hexahydrate); 6159-44-0 (uranyl acetate dihydrate); 13536-84-0 (uranium fluoride); 13598-56-6 (uranium hydride); 541-09-3 (uranium oxyacetate); 12138-37-3 (uranium telluride); 12040-21-0 [uranium telluride (U3Te4)]; 541-09-3 uranium oxyacetate

HSDB Number: 2553 (elemental)

RTECS Number: YR3490000 (elemental); YR3850000 (nitrate); YR4705000 [uranium(IV)oxide]

UN/NA & ERG Number: UN2979 (uranium metal, pyrophoric)/162; UN2979 [Radioactive Materials (Low to Moderate Level Radiation)]/162; UN2909 (Radioactive material, excepted package, articles manufactured from depleted Uranium)/161; UN2910 (Radioactive material, excepted package, articles manufactured from depleted Uranium)/161; UN2980 (uranyl nitrate hexahydrate solution)/162; UN2981 (uranyl nitrate, solid)/162

EC Number: 231-170-6 (elemental)

Regulatory Authority and Advisory Information

Carcinoenicity: NIOSH (*uranium, insoluble and soluble compounds*): Potential occupational carcinogen.

United States National Primary Drinking Water Regulations: MCLG = 0 mg[U]/L; MCL = 30 μg[U]/L; MCLG = 0 pCi/L; MCL = 15 pCi/L (U-$_{238}$) as *alpha*-proton emitter.

Hazard Alert: Radioactive, Strong reducing agent, Pyrophoric hazard, Neurotoxic.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)

Superfund/EPC RA 40 CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 100 lb (45.4 kg)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

European/International Regulations *(uranium and compounds*): Hazard symbol: T+; risk phrases: R45; R17; R26/28; R33; R53; safety phrases: S1/2; S20/21; S41; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water. (*uranyl acetate dihydrate*)

Description: Uranium is a silver-white, malleable, ductile, lustrous solid. Weakly radioactive but must be handled with caution. A combustible solid in the form of powder or turnings. Insoluble in water. Molecular weight = 238.00; specific gravity (H_2O:1) = 19.05 @ 25°C (metal); boiling point = 3813°C; freezing/melting point = 1147°C; autoignition temperature = 20°C (dust cloud); ignition temperature of dust cloud = 20°C; minimum explosive concentration = 0.060 oz/ft^3. Relative explosion hazard of dust: Severe. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 0, reactivity 0; minimum explosive concentration (MEC) = 60 g/m^3.

In the natural state, uranium consists of three isotopes: ^{238}U (99.28%), ^{234}U (0.006%), and ^{235}U (0.714%).

There are over 100 uranium minerals; those of commercial importance are the oxides and oxygenous salts. The processing of uranium ore generally involves extraction then leaching either by an acid or a carbonate method. The metal may be obtained from its halides by fused salt electrolysis. *Uranium(IV)oxide* is a black to brown crystalline solid or powder. Molecular weight = 270.03; freezing/melting point = 2865°C. Insoluble in water. *Uranium trioxide* (1344-58-7) molecular weight = 286.03; specific gravity (H_2O:1) = 7.3. *Uranyl chloride* (7791-26-6) is a bright yellow crystalline solid. Molecular weight = 349.90; freezing/melting point = 578°C. Highly soluble in water (unstable). *Uranyl nitrate, solid* (10102-06-4) is a yellow crystalline solid. Molecular weight = 394.02; boiling point = 118°C; freezing/melting point = 60°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 2 (Oxidizer). *Uranyl sulfate:* Molecular weight = 420.2. Soluble in water.

Potential Exposure: The primary use of natural uranium is in nuclear energy as a fuel for nuclear reactors, in plutonium production, and as feeds for gaseous diffusion plants. It is also a source of radium salts. Uranium compounds are used in staining glass, glazing ceramics; and enameling; in photographic processes; for alloying steels; and as a catalyst for chemical reactions; radiation shielding; and aircraft counterweights. Uranium presents both chemical and radiation hazards, and exposures may occur during mining, processing of the ore, and production of uranium metal.

Incompatibilities: *Uranium:* Metal powder is radioactive, pyrophoric (ignites spontaneously in air), and a strong reducing agent. Keep away from chlorine, fluorine, nitric acid; nitric oxide; selenium, sulfur, carbon dioxide; carbon

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Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens.

tetrachloride. Complete coverage of uranium metal scrap or turnings with oil is essential for prevention of fire. *Uranium(IV)oxide:* May spontaneously ignite on contact with air when heated above 700°C. *Uranium hydride:* Keep away from strong oxidizers, water, halogenated hydrocarbons. *Uranyl chloride*: Aqueous solutions are chemically unstable. *Uranyl nitrate(s):* Keep away from combustible materials; reducing agents; Uranium hexafluoride: water.

Permissible Exposure Limits in Air

NIOSH IDLH = 10 mg[U]/m^3

OSHA PEL: (*natural & insoluble compounds*) 0.25 mg[U]/m^3 TWA; (*soluble*) 0.05 mg[U]/m^3 TWA

NIOSH REL: (*natural & insoluble compounds*) 0.2 mg[U]/m^3 TWA; 0.6 mg[U]/m^3 STEL; (*soluble*) 0.05 mg[U]/m^3 TWA; Potential occupational carcinogen. Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A

ACGIH TLV[1]: 0.2 mg[U]/m^3 TWA; 0.6 mg[U]/m^3 STEL, Confirmed Human Carcinogen; BEI issued.

Protective Action Criteria (PAC)* Ver. 29[138]

7440-61-1, elemental
PAC-1: 0.6 milligram per cubic meter
PAC-2: 5 milligram per cubic meter
PAC-3: 30 milligram per cubic meter
12138-37-3, uranium telluride (Te_2U)
PAC-1: 1.2 milligram per cubic meter
PAC-2: 10 milligram per cubic meter
PAC-3: 62 milligram per cubic meter
12040-21-0, uranium telluride (U_3Te_4)
PAC-1: 1 milligram per cubic meter
PAC-2: 8.5 milligram per cubic meter
PAC-3: 51 milligram per cubic meter
541-09-3 uranium oxyacetate
PAC-1: 0.98 milligram per cubic meter
PAC-2: 5.5 milligram per cubic meter
PAC-3: 33 milligram per cubic meter
1344-57-6, uranium dioxide, 10102-06-4, uranium oxide
PAC-1: 0.68 milligram per cubic meter
PAC-2: 10 milligram per cubic meter
PAC-3: 30 milligram per cubic meter
13536-84-0, uranium fluoride
PAC-1: 0.78 milligram per cubic meter
PAC-2: 4.3 milligram per cubic meter
PAC-3: 26 milligram per cubic meter
13598-56-6, uranium hydride
PAC-1: 0.61 milligram per cubic meter
PAC-2: 5 milligram per cubic meter
PAC-3: 30 milligram per cubic meter
541-09-3, uranium oxyacetate
PAC-1: 0.98 milligram per cubic meter
PAC-2: 5.5 milligram per cubic meter
PAC-3: 33 milligram per cubic meter
1344-59-8, triuranium octaoxide
PAC-1: 0.71 milligram per cubic meter
PAC-2: 10 milligram per cubic meter
PAC-3: 50 milligram per cubic meter
1344-58-7, uranium trioxide
PAC-1: 0.045 milligram per cubic meter
PAC-2: $\mathbf{0.5}_{\mathrm{E}}$ milligram per cubic meter
PAC-3: $\mathbf{3}_{\mathrm{E}}$ milligram per cubic meter
36478-76-9, uranyl nitrate
PAC-1: 0.99 milligram per cubic meter
PAC-2: 5.5 milligram per cubic meter
PAC-3: 33 milligram per cubic meter
13520-83-7, uranyl nitrate hexahydrate
PAC-1: 1.3 milligram per cubic meter
PAC-2: 7 milligram per cubic meter
PAC-3: 42 milligram per cubic meter

DFG MAK (uranium compounds): 0.25 mg[U]/m^3, measured as the, inhalable fraction

Australia: TWA 0.2 mg[U]/m^3, STEL 0.6 mg[U]/m^3, 1993; Belgium: TWA 0.2 mg[U]/m^3, STEL 0.5 mg[U]/m^3, 1993; Belgium: TWA 0.2 mg[U]/m^3, STEL 0.6 mg[U]/m^3, 1993; Denmark: TWA 0.2 mg[U]/m^3, 1999; Finland: TWA 0.2 mg[U]/m^3, 1999; Norway: TWA 0.2 mg[U]/m^3, 1999; the Netherlands: MAC-TGG 0.2 mg[U]/m^3, 2003; the Philippines: TWA 0.25 mg[U]/m^3, 1993; Poland: MAC (TWA) 0.015 mg[U]/m^3; MAC (STEL) 0.12 mg[U]/m^3, 1999; Poland: MAC (TWA) 0.075 mg[U]/m^3, 1993; Russia: STEL 0.015 mg[U]/m^3, 1993; Russia: STEL 0.075 mg[U]/m^3, 1993; Switzerland: MAK-W 0.2 mg[U]/m^3, 1999; Turkey: TWA 0.05 mg[U]/m^3, 1993; United Kingdom: LTEL 0.2 mg[U]/m^3, STEL 0.6 mg[U]/m^3, 1993

Uranium, soluble compounds

NIOSH IDLH = 10 mg[U]/m^3

OSHA PEL: 0.05 mg[U]/m^3 TWA

NIOSH REL: TWA 0.05 mg[U]/m^3, Potential occupational carcinogen. Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A

ACGIH TLV[1]: 0.2 mg[U]/m^3 TWA; 0.6 mg[U]/m^3 STEL, Confirmed Human Carcinogen

DFG MAK (uranium compounds): 0.25 mg[U]/m^3, measured as the, inhalable fraction

Several states have set guidelines or standards for uranium in ambient air[60] ranging from 2.0 to 6.0 μ/m^3 (North Dakota); to 3.5 μ/m^3 (Virginia); to 4.0 μ/m^3 (Connecticut); to 5.0 μ/m^3 (Nevada).

EPA Limits and advisory levels:

United States, annual radiation exposure limits are found in Title 10, part 20 of the Code of Federal Regulations, and in equivalent state regulations.

Public dose limits due to licensed activities (NRC) 100 mRem (0.01 Sv)/year

Indoor Air (advisory "action level"): 4 pCi/L radon (Rn)

*Both the air and water standards limit the increased lifetime cancer risk to about 2 in 10,000.

Guidance Matrix for Radiological Dispersal Device (RDD) Incidents

Rem (Sv)/calendar quarter

OSHA Occupational Exposure Limits for Ionizing Radiation 29 CFR 1910.1096	
Whole Body; Head and Trunk; Active Blood-Forming Organs; Lens of Eye or gonads	1.25 (0.0125 Sv)
Hands and Forearms; Feet and Ankles	18.75 (0.1875 Sv)
Skin of Whole Body	7.5 (0.075 Sv)
Minors (under age 18 workers)	10% of above limits
Over age 18 workers	Rem (0.3 Sv) may be permitted under conditions specified in 29 CFR 1910.1096(b)(2)

Determination in Air: No method is available.

Permissible Concentration in Water: Safe Drinking Water Act: MCLG = 0 mg[U]/L; MCL = 30 μg[U]/L; MCLG = 0 pCi/L; MCL = 15 pCi/L (U-$_{238}$), as *alpha*-proton emitter. Federal Drinking Water Guidelines: EPA 30 μg [U]/L; State Drinking Water Guidelines: Arizona 30 μg[U]/L; Mass. 20 μg[U]/L; Maine 20 μg[U]/L. Runoff from spills or fire control may cause water pollution. No criteria set, but EPA[32] has suggested a permissible ambient goal of 3 μg/L based on health effects. Several states have set guidelines and standards for uranium in drinking water ranging from 10 μCi/L (Massachusetts); to 30 μCi/L (California); to 35 μCi/L (Arizona); to 15 μg/L (Colorado).

Routes of Entry: Inhalation of fume, dust, or gas, ingestion; skin and/or eye contact. The following uranium salts are reported to be capable of penetrating intact skin: uranyl nitrate, $UO_2(NO_3)_2 \cdot 6H_2H$; uranyl fluoride, UO_2F_2; uranium pentachloride, UCl_5; uranium trioxide (uranyl oxide), UO_3; sodium diuranate [sodium uranate (VI), $Na_2U_2O_7$]; uranium hexafluoride, UF_6.

Harmful Effects and Symptoms

Short-Term Exposure: Prolonged contact with skin should be avoided to prevent radiation injury. Uranium and its compounds are highly toxic substances. The compounds which are soluble in body fluids possess the highest toxicity. Poisoning has generally occurred as a result of accidents. Acute chemical toxicity produces damage primarily to the kidneys. Kidney changes precede in time and degree the effects on the liver. Chronic poisoning with prolonged exposure gives chest findings of pneumoconiosis, pronounced blood changes; and generalized injury.

It is difficult to separate the toxic chemical effects of uranium and its compounds from their radiation effects. The chronic radiation effects are similar to those produced by ionizing radiation. Reports now confirm that carcinogenicity is related to dose and exposure time. Cancer of the lung, osteosarcoma, and lymphoma has all been reported.

For *soluble compounds*: lacrimation, conjunctivitis, shortness of breath; coughing, chestrales; nausea, vomiting, skin burns; casts in urine; albuminuria, high blood urea nitrogen (BUN); lymphatic cancer. For *insoluble compounds:* dermatitis; cancer of lymphatic and blood-forming tissues.

For tellurium compounds: Tellurium compounds are both an oral and dermal toxic hazard. The material is toxic by ingestion. Oral ingestion of tellurium compounds is generally regarded as extremely toxic. The probable oral lethal dose is 5−50 mg/kg or between 7 drops and 1 teaspoonful for a 70 kg (150 pound) person. Tellurium com pounds are regarded as super toxic for skin exposures.

Long-Term Exposure: Kidney toxicity; increased risk of cancer. Uranium can cause dermatitis, kidney damage; blood changes. A potential occupational carcinogen. Potential for cancer is a result of *alpha*-emitting properties and radioactive decay products (e.g., radon).

Points of Attack: For *soluble compounds*: respiratory system, blood, liver, kidneys, lymphatic system; skin, bone marrow. *Cancer site:* lung cancer. For *metal* and *insoluble compounds*: skin, kidneys, bone marrow; lymphatic system. *Cancer site:* lung cancer.

Medical Surveillance: NIOSH lists the following tests: whole blood (chemical/metabolite); complete blood count; chest X-ray; urine (chemical/metabolite); urinalysis (routine). Special attention should be given to the blood, lung, kidney, and liver in preemployment physical examinations. In periodic examinations, tests for blood changes; changes in chest X-rays, or for renal injury and liver damage are advisable. Uranium excretion in the urine has been used as an index of exposure. Whole body counting may also be useful. BUN for soluble compounds.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: *Soluble compounds*, especially UF_6: Wear appropriate clothing to prevent any possibility of skin contact with UF_6. Wear eye protection to prevent any possibility of eye contact. Employees should wash immediately when skin is wet or contaminated with UF_6 and daily at the end of each work-shift. Work clothing should be changed daily if it is possible that clothing is contaminated with UF_6. Remove nonimpervious clothing immediately if wet or contaminated UF_6. Provide emergency showers and eyewash if UF_6 is involved.

Insoluble compounds: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Soluble Uranium compounds*: *At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape (halides):* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, self-contained breathing apparatus). *Escape (non-halides):* 100F (APF = 50) (any air-purifying, full facepiece respirator with an N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Insoluble Uranium compounds: At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration: SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, self-contained breathing apparatus); or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Radioactive. (1) Color code—Red Stripe: Flammability Hazard: Store in a secure, locked facility separate from all other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8—10 m or a 1-hour fire wall from flammable or reactive materials. (2) Color code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2979 Uranium metal, pyrophoric, requires a shipping label of "RADIOACTIVE, SPONTANEOUSLY COMBUSTIBLE." It falls in Hazard Class 7. UN2909 Radioactive material, excepted package-articles manufactured from natural uranium or depleted uranium or natural thorium, Hazard class: 7-Radioactive material; Labels: None. Uranyl nitrate, solid, requires a shipping label of "RADIOACTIVE, OXIDIZER." It falls in Hazard Class 7. Uranyl nitrate hexahydrate solution, requires a shipping label of "CORROSIVE." It falls in Hazard Class 7.

Spill Handling: *Dry material:* Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. Uranium chips or turnings should be covered with oil to prevent fires, and collected in sealed containers for later disposal. *Liquid:* Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team, Edison, NJ. Telephone 24-hour hotline: 908-548-8730.

Fire Extinguishing: Uranium is an explosion hazard as dust or solid when exposed to flame. Thermal decomposition products may include oxides of metal. In case of fire, contact the local, state, or department of energy radiological response team. *Do not use water.* Use graphite, soda ash; powdered sodium chloride, or suitable dry powder. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Disposal of wastes containing uranium (uranium and compounds) should follow guidelines set forth by the nuclear regulatory commission. Contact the nuclear regulatory commission regarding disposal notification. Recovery for reprocessing is the preferred method. Processes are available for uranium recovery from process wastewaters and process scrap. Burial at an authorized radioactive burial site.

References

(31); (173); (101); (170); (138); (100).

United States Environmental Protection Agency, Toxicology of Metals, Vol. II: Uranium, Report EPA-600/1-77-022, pp. 454−472, Research Triangle Park, NC (May 1977).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 2, No. 2, 78−79 (1982), Uranyl Acetate and 4, No. 1, 99−102, Uranyl nitrate (1984).

United States Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry (ATSDR), Division of Toxicology, "Toxicological Profile for Radium". Atlanta, GA (1990).

Bentor, Yinon. *Chemical Element.com-Radium*. Nov. 2, 2010 ⟨http://www.chemicalelements.com/elements/ra.html⟩.

29 CFR 1910.1096, Ionizing Radiation. OSHA Standard.

Manual of Protective Action Guides and Protective Actions for Nuclear Incidents. Environmental Protection Agency (EPA), Office of Radiation Programs, (1992, May), 16 MB PDF, 274 pages.

Radiological Emergency Response Health and Safety Manual. United States Department of Energy (DOE) Report DOE/NV/11718-440, (2001, May), 1 MB PDF, 103 pages.

United States Army Medical Research Institute of Chemical Defense (USAMRICD), Chemical Casualty Care Division (USAMRICD) MCMR-UV-ZM, *Field Management of Chemical Casualties, 2nd Edition*, Aberdeen Proving Grounds, MD, July 2000

Urea U:0110

Formula: CH_4N_2O; H_2NCONH_2

Synonyms: Carbamide; Carbamide resin; Carbamimidic acid; Carbonyl diamide; Carbonyldiamine; Isourea; NCI-C02119; Prespersion, 75 Urea; Pseudourea; Supercel 3000; Ureaphil; Ureophil; Urevert; Varioform II.

CAS Registry Number: 57-13-6

HSDB Number: 163

RTECS Number: YR6250000

EC Number: 200-315-5

Regulatory Authority and Advisory Information. United States Environmental Protection Agency Gene-Tox Program, Positive: In vitro cytogenetics-human lymphocyte; Negative: Sperm morphology-mouse; Inconclusive: *E. coli polA* without S9

Hazard Alert: Possible risk of forming tumors, Suspected of causing genetic defects, Suspected repro toxic hazard, Primary irritant (w/o allergic reaction).

FDA-over the counter and proprietary drug

Hazard symbols, risk, & safety statements: Hazard symbol: T, Xn, Xi; risk phrases: R36/37/38; R40; R61; R62; R63; safety phrases: S16; S24/25; S26; S36/37/39; S41 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Urea is a white crystalline so lid. Molecular weight = 60.1; specific gravity (H_2O:1) = 1.3 @ 20°C; boiling point = (decomposes); freezing/melting point = (decomposes) 133°C. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 0, reactivity 0. Soluble in water.

Potential Exposure: Urea is used in ceramics, cosmetics, paper processing; resins, adhesives, in animal feeds; in the manufacture of isocyanurates; resins, and plastics; as a stabilizer in explosives; in medicines; anticholelithogenic, and others.

Incompatibilities: Violent reaction with strong oxidizers, chlorine, permanganates, dichromates, nitrites, inorganic chlorides; chlorites, and perchlorates. Contact with hypochlorites can result in the formation of explosive compounds.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 30 milligram per cubic meter

PAC-2: 280 milligram per cubic meter

PAC-3: 1700 milligram per cubic meter

The state of New York[61] has set a guidelines for urea in ambient air of 0.03 μ/m^3.

Russia set an MAC in ambient air in residential areas of 0.2 milligram per cubic meter on a daily average basis.

Permissible Concentration in Water: Russia[43] set a MAC in water bodies used for domestic purposes of 80.0 mg/L.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: *Inhalation:* Causes irritation of the respiratory tract. Dust may cause difficult breathing especially if the person has asthma. *Skin:* May cause irritation, burning or stinging. *Eyes:* Causes irritation. *Ingestion:* There have been no reported cases of human toxicity. However, some toxic effects have been seen in sheep with impaired liver function.

Long-Term Exposure: Prolonged skin contact may cause dermatitis.

Points of Attack: Skin.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately

with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator such as a supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Green: General storage may be used. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Where possible, automatically transfer material from storage containers to process containers.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Thermal decomposition products ($>130°C$) may include isocyanic acid, ammonia and oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; water spray; or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Controlled incineration in equipment containing a scrubber or thermal unit to reduce nitrogen oxide emissions.

References

(31); (173); (101); (138); (80); (100).

New York State Department of Health, *Chemical Fact Sheet:* Urea, Bureau of Toxic Substance Assessment, Albany, NY (April 1986).

Urethane U:0120

Formula: $C_3H_7NO_2$: $H_2NCOOC_2H_5$

Synonyms: A 11032; Aethylcarbamat (German); Aethylurethan (German); Carbamic acid, ethyl ester; Carbamidsaeure-aethylester (German); Estane 5703; Ethyl carbamate; Ethylurethan; *o*-Ethylurethane; Ethyl urethane; Leucethane; Leucothane; NSC 746; Pracarbamin; Pracarbamine; U-Compound; Uretano (Spanish); Urethan; Urethane

CAS Registry Number: 51-79-6

HS DB Number: 2555 as ethyl carbamate

RTECS Number: FA8400000

UN/NA & ERG Number: UN2811 (toxic solid, organic, n.o.s.)/154

EC Number: 200-123-1[*Annex I Index No.:* 607-149-00-6]

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Animal, Sufficient Evidence; Human, Inadequate Evidence, Group 2A; NTP: Carcinogenesis studies; on test (2 year studies), October 2000; NTP: Toxicity studies, RPT#TOX-52, October 2000. United States Environmental Protection Agency Gene-Tox Program, Positive: Carcinogenicity-mouse/rat; SHE-clonal assay; Positive: Cell transformation-mouse embryo; Positive: Cell transformation-RLV F344 rat embryo; Positive: *D. melanogaster*-whole sex chrom. loss; Positive: *D. melanogaster*-reciprocal translocation; Positive: *Mammalian micronucleus*; *N. crassa-reversion*; Positive: *D. melanogaster* sex-linked lethal; Positive: *S. cerevisiae* gene conversion; Positive/dose response: In vitro SCE-non-human; Negative: *D. melanogaster*-nondisjunction; Host-mediated assay; Negative: *E. coli polA* with S9; Histidine reversion-Ames test; Negative: Sperm morphology-mouse; TRP reversion; Negative: *S. cerevisiae-homozygosis*;

Inconclusive: *E. coli polA* without S9; In vitro UDS-human fibroblast.

California Proposition 65 Chemical[102]: Cancer 1/1/1988; Developmental/Reproductive toxin 10/1/1994

Hazard Alert: Combustible, Possible risk of forming tumors, Reproductive toxin: possible risk of gene damage/impaired fertilty; Suspected reprotoxic hazard. Listed for Tier 1 screening as an endocrine disruptor[88].

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U238

RCRA, 40C FR261, Appendix 8 Hazardous Constituents

Superfund/EPC RA 40 CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)

EPCRA Section 313 Form R de minimis concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazard symbols, risk, & safety statements: Hazard symbol: T; risk phrases: R45; R10; R61; R62; R63; safety phrases: S1; S29/56; S41; S45; S53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Urethane is a colorless, almost odorless crystalline solid or powder. Molecular weight = 89.11; specific gravity (H_2O:1) = 1.11 @ 20°C; boiling point = 183°C; freezing/melting point = 49°C; vapor pressure = 0.36 mmHg @ 25°C; flash point = 92°C (cc). Hazard Identification (based on NFPA-704 M Rating System): Health 3, flammability 2, reactivity 0. Slightly soluble in water.

Potential Exposure: Urethane is used as a chemical intermediate in manufacture of pharmaceuticals; pesticides, and fungicides; in the preparation of amino resins. It may be reacted with formaldehyde to give cross-linking agents which impart wash-and-wear properties to fabrics. It has also been used as a solubilizer and cosolvent in the manufacture of pesticides, fumigants, and cosmetics. It was formerly used in the treatment of leukemia. It occurs when diethylpyrocarbonate, a preservative used in wines, fruit juices, and soft drinks, is added to aqueous solutions.

Incompatibilities: Dust may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, gallium, perchlorate.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 5.4 milligram per cubic meter

PAC-2: 60 milligram per cubic meter

PAC-3: 360 milligram per cubic meter

DFG MAK: [skin] Carcinogen Category 2; Germ Cell Mutation Category 3A, *as carbamic acid ethyl ester*

Austria: carcinogen, 1999; Finland: carcinogen, 1993; Sweden: carcinogen, 1999; Switzerland: carcinogen, 1999.

Several states have set guidelines or standards for urethane in ambient air[60] ranging from zero (North Dakota); to 0.03 μ/m^3 (New York); to 5000.0 μ/m^3 (South Carolina).

Determination in Water: Octanol−water coefficient: Log $K_{ow} = -0.15$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Urethane can affect you when breathed in and by passing through your skin. High exposures may affect the CNS, causing dizziness, lightheadedness, and unconsciousness. Very high exposures can cause damage to the liver, brain, and blood forming organs.

Long-Term Exposure: Urethane is a carcinogen and may be a teratogen. Handle with extreme caution. Repeated exposures can damage the liver, brain, and blood forming organs.

Points of Attack: Liver, brain, blood.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure. Before beginning employment, and at regular times after that, for those with frequent or potentially high exposures, the following are recommended: liver function tests. Complete blood count. If symptoms develop or overexposure suspected, the following may be useful: exam of the nervous system.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA-or European Standard EN 149-approved self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-facepiece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Urethane must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine), strong acids (such as hydrochloric, sulfuric, and nitric); strong bases; camphor, menthol, salol, or thymol; since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: *Isolation Distance, Spill*: 25 m/ 75 ft.(NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible solid. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. Thermal decomposition products may include oxides of nitrogen and carbon. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform to EPA regulations governing storage, transportation, treatment, and waste disposal. Controlled incineration (incinerator equipped with a scrubber or thermal unit to reduce nitrogen oxides emissions).

References

(109); (102); (31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Urethane, Washington, DC (1979).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Urethane, Trenton, NJ (May 2001).

V

Valeraldehyde V:0100

Formula: $C_5H_{10}O$; $CH_3(CH_2)_3CHO$
Synonyms: Amyl aldehyde; Butyl formal; *n*-Pentanal; Pentanal; Valeral; *n*-Valeraldehyde; Valerianic aldehyde; Valeric acid aldehyde; *n*-Valeric aldehyde; Valeric aldehyde
CAS Registry Number: 110-62-3
HSDB Number: 851 as *n*-pentanal
RTECS Number: YV3600000
UN/NA & ERG Number: UN2058/129
EC Number: 203-784-4

Regulatory Authority and Advisory Information

Hazard Alert: Highly flammable liquid, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction).

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: F, Xi; Risk phrases: R11; R20/21/22; R36/37/38; R41; R61; R62; Safety phrases: S6; S16; S21; S26; S27; S33; S36/37/39; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.

Description: Valeraldehyde is a colorless liquid with a strong acrid, pungent odor. The odor threshold is 0.028 ppm. Molecular weight = 86.15; specific gravity (H_2O:1) = 0.81 @ 25°C; boiling point = 103°C; freezing/melting point = −92°C; vapor pressure = 26 mmHg; flash point = 12°C (oc); autoignition temperature = 222°C. Explosive limits in air = LEL = 1.4%; UEL: 7.2%. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 3, reactivity 0. Moderately soluble in water; solubility = 1.4% @ 20°C.

Potential Exposure: Valeraldehyde is used in food flavorings; in resin chemistry. It is also used in the acceleration of rubber vulcanization.

Incompatibilities: Vapor may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, caustics, amines.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 3.53 milligram per cubic meter @ 25°C & 1 atm.

OSHA PEL: None

NIOSH REL: 50 ppm/175 milligram per cubic meter TWA, See Appendix C (Aldehydes) of the *NIOSH Pocket Guide*. Limited studies to date indicate that these substances have chemical reactivity and mutagenicity similar to acetaldehyde and malonaldehyde

ACGIH TLV[1]: 50 ppm/176 milligram per cubic meter TWA

Protective Action Criteria (PAC) not available

Australia: TWA 50 ppm (175 milligram per cubic meter), 1993; Belgium: TWA 50 ppm (176 milligram per cubic meter), 1993; Denmark: TWA 50 ppm (175 milligram per cubic meter), 1999; Finland: TWA 50 ppm (175 milligram per cubic meter), STEL 75 ppm (265 milligram per cubic meter), 1999; France: VME 50 ppm (175 milligram per cubic meter), 1999; Norway: TWA 0.3 milligram per cubic meter, 1999; Switzerland: MAK-W 50 ppm (175 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 175 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam; ACGIH TLV: TWA 50 ppm. Several states have set guidelines or standards for valeraldehyde in ambient air[60] ranging from 1.75 milligram per cubic meter (North Dakota); to 2.9 milligram per cubic meter (Virginia); to 3.5 milligram per cubic meter (Connecticut); to 4.167 milligram per cubic meter (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV), #2018, #2536, valeraldehyde, OSHA Analytical Method 85.

Determination in Water: See NIOSH (IV) #2539, aldehydes, screening. Octanol−water coefficient: Log K_{ow} = 1.31. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Valeraldehyde can affect you when breathed in. Contact can severely irritate the eyes, skin, nose, and throat. Exposure to very high levels can cause you to feel dizzy and lightheaded. Poisonous if swallowed.

Long-Term Exposure: Testing has not been completed to determine the carcinogenicity of *n*-valeraldehyde. However, the limited studies to date indicate that these substances have chemical reactivity and mutagenicity similar to acetaldehyde and malonaldehyde. Therefore, NIOSH recommends that careful consideration should be given to reducing exposures to this aldehyde. Further information can be found in the *NIOSH Current Intelligence Bulletin 55: Carcinogenicity of Acetaldehyde and Malonaldehyde, and Mutagenicity of Related Low-Molecular-Weight Aldehydes* [DHHS (NIOSH), Publication No. 91-112].

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: See Long-term Exposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get

DOI: http://dx.doi.org/10.1016/B978-0-323-38968-6.00021-1

Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens.

medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures *over 50 ppm*; Use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece respirator with an organic vapor cartridge/canister. Increased protection is obtained from full facepiece-powered air-purifying respirators. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area (under argon) or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area. Sources of ignition, such as smoking and open flames are prohibited where valeraldehyde is handled, used, or stored. Metal containers involving the transfer of 5 gal or more of valeraldehyde should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of Valeraldehyde.

Shipping: UN2058 Valeraldehyde, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide, or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Valeraldehyde, Trenton, NJ (November 2000).

Vanadium V:0110

Formula: V

Synonyms: Elemental vanadium; Vanadio (Spanish); Vanadium-51; Vanadium, elemental

CAS Registry Number: 7440-62-2; 12070-10-9 (Vanadium carbide); *(alt.)* 11130-21-5

HSDB Number: 1022

RTECS Number: YW1355000

UN/NA & ERG Number: UN 3285/151 (vanadium compound, n.o.s.)

EC Number: 231-171-1; 235-122-5 (vanadium carbide)

Regulatory Authority and Advisory Information

Carcinogenicity: DFG MAK: Carcinogen Category 2, Vanadium and inorganic compounds, inhalable fraction. Germ cell mutagen group: 2.

California Proposition 65 Chemical[102]: [vanadium pentoxide (orthorhombic crystalline form)], cancer 1314-62-12/11/2005

Hazard Alert: Poison, Pyrophoric dust and powder

Except when contained in an alloy:

Clean Water Act: Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

RCRA 40 CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 4.3; Nonwastewater (mg/L), 0.23

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): total dust 6010 (80); 7910 (2000); 7911 (40)

Safe Drinking Water Act (47FR 9352): Priority List (55 FR 1470) as vanadium

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%, elemental; 0.1%, Vanadium trioxide 1314-34-7

Hazard symbols, risk, & safety statements: Hazard symbol (dust and powders): Xi; risk phrases: R45, R17; R36/37/38; safety phrases: S7; S16; S26; S36/37/39; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): (Vanadium and compounds) 3-Severe hazard to water, unless water solubility is <4 μg[V]/L.

Description: Vanadium is a light-gray or silver-white, ductile solid, lustrous powder, or fused hard lump. Molecular weight = 50.94; specific gravity (H_2O:1) = 5.99 @ 20°C; boiling point = 3380°C; freezing/melting point = 1917°C. Explosive limits (dust, powder, fume): LEL = 73,300 ppm, UEL: unknown[138]. Hazard identification (based on NFPA-704 M Rating System) (*Fume and dust*): Health 3, flammability 0, reactivity 0. Practically insoluble in water. It is produced by roasting the ores, thermal decomposition of the iodide; or from petroleum residues; slags from ferro vanadium production; or soot from oil burning.

Vanadium carbide (CV) is a dark gray powder. Insoluble in water. Freezing/Melting point = 2750−2810°C.

Potential Exposure: Vanadium is used as a catalyst in the production of synthetic rubber and sulfuric acid. Most of the vanadium produced is used in ferrovanadium and of this the majority is used in high speed and other alloy steels with only small amounts in tool or structural steels. It is usually combined with chromium, nickel, manganese, boron, and tungsten in steel alloys. Vanadium carbide is used in cutting tool bits. Finely divided form (of vanadium) favors rapid or explosive reactions with oxidizing agents such as air or oxygen. Reacts exothermically with compounds having active hydrogen atoms (such as acids and water) to form flammable hydrogen gas and caustic products. The reactions are much less vigorous than the similar reactions of alkali metals. Can catalyze polymerization reactions in several classes of organic compounds; these polymerizations sometimes proceed rapidly or even explosively[101].

Incompatibilities: Dust may form explosive mixture with air. Dust, fume, and powders are a strong reducing agent; incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, bromine trifluoride, lithium, nitryl fluoride, chlorine trifluoride.

Permissible Exposure Limits in Air

NIOSH IDLH = 35 mg[V]/m^3

Metal

PAC Ver. 29[138]

PAC-1: 3 milligram per cubic meter

PAC-2: 5.8 milligram per cubic meter

PAC-3: 35 milligram per cubic meter

DFG MAK: inhalable fraction, Carcinogen Category: 2; Germ cell mutagen group: 2

Dust and fume: see vanadium pentoxide V:0120

Determination in Air: Use NIOSH Method (vanadium): #7300, #7301; #7303 Elements, #7504, #7504 (vanadium oxides); OSHA Method #185 (Vanadium tetrachloride)

Permissible Concentration in Water: State Drinking Water Guidelines: California: 50 μg[V]/L Arizona 7 μg[V]/L; Florida: 49 μg[V]/L; Minnesota: 50 μg[V]/L; Wisconsin: 30 μg[V]/L. Runoff from spills or fire control may cause water.

Routes of Entry: *For dust and fume:* Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Vanadium can affect you when breathed in. Exposure may irritate the eyes, nose, throat, and air passages; with cough and phlegm. Eye contact may cause irritation. See also "Vanadium Pentoxide." *Ingestion:* acute poisoning in animals of vanadium compounds has been shown to cause nervous disturbances; leg paralysis; respiratory failure; convulsions, bloody diarrhea; coma, and death.

Long-Term Exposure: Can cause greenish-black coloration of the tongue and metallic taste. May cause eczema. Dust and/or fume may cause respiratory irritation; bronchitis may develop; cough, fine rales; wheezing, dyspnea (breathing difficulty).

See also "Vanadium Pentoxide"

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. For those with frequent or potentially high exposure (half the TLV or greater), the following are recommended before beginning work and at regular times after that. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: Urine test for vanadium. An EEC guideline recommends the following based on vanadium urine levels: an every-4-month control at the work-place if a 50 μg/L is reached and an annual control if the 5 μg/L urine level is reached. In case levels exceed 50 μg/L urine, workers should be temporary removed from risk. See also "Vanadium Pentoxide."

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA (as V): *0.5 milligram per cubic meter:* 100XQ* (APF = 10) (any air-purifying respirator with an N100, R100, or P100 filter (including N100, R100, and P100 filtering facepieces) except quarter-mask respirators); or SA* (any supplied-air respirator). *1.25 milligram per cubic meter:* Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie* (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *2.5 milligram per cubic meter:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or PaprHie* (APF = 25)* (any powered, air-purifying respirator with a high-efficiency particulate filter); or SCBAF (APF = 50) (any self-contained breathing apparatus with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

* *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Vanadium must be stored to avoid contact with oxidizers (such as chlorates, nitrates, chlorine and bromine trifluoride), since violent reactions occur. Store the powder in tightly closed containers in a cool, well-ventilated area away from heat and sparks. Use only nonsparking tools and equipment, especially when opening and closing containers of the powder.

Shipping: UN3285* Vanadium compound, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. *This number includes vanadium fume or dust.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Large pieces of vanadium are not combustible. The fine powder is flammable. Use dry chemicals appropriate for extinguishing metal fires. *Do not use water*. Thermal decomposition products may include metal oxides of vanadium. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(102); (31); (173); (101); (170); (138); (100).

National institute for Occupational Safety and Health (NIOSH), "Criteria for a Recommended Standard: Occupational Exposure to Vanadium, NIOSH Document Number 77-222, Cincinnati, OH (1977).

National Academy of Sciences, Medical and Biologic Effects of Environmental Pollutants: Vanadium, Washington, DC (1974).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Vanadium, Trenton, NJ (January 2007).

Vanadium Pentoxide V:0120

Formula: O_5V_2; V_2O_5

Synonyms: Anhydride vanadique (French); C.I. 77938; Divanadium pentoxide; Pentoxido de vanadilo (Spanish); UN2862; Vanadic acid anhydride; Vanadic anhydride; Vanadium oxide; Vanadium(5+) oxide; Vanadium(V) oxide; Vanadiumpentoxid (German); Vanadium pentoxide; Vanadium, pentoxyde de (French)

CAS Registry Number: 1314-62-1

HSDB Number: 1024

RTECS Number: YW 2450000 (*dust*); YW2460000 (fume)

UN/NA & ERG Number: UN2862/151

EC Number: 215-239-8 [*Annex I Index No.:* 023-001-00-8]

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human Inadequate Evidence; Animal Sufficient Evidence, *possibly carcinogenic to humans*, Group 2B; NCI: Carcinogenesis Studies (*dust*): (inhalation); clear evidence: mouse; rat; NTP: Carcinogenesis studies (fume); on test (2 year studies), October 2000. United States Environmental Protection Agency Gene-Tox Program, Positive: *B. subtilis* rec assay. DFG MAK: Carcinogen Category 2, Vanadium and inorganic compounds, inhalable fraction. Germ cell mutagen group: 2.

California Proposition 65 Chemical, cancer, 2/11/2005

Hazard Alert: Poison, Strong reducing agent, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction), Environmental hazard.

OSHA specifically regulated substance.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): P120

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L), total dust 6010 (80); 7910 (2000); 7911 (40)

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg)

Superfund/EPCRA 40 CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 1000 lb (454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 0.1%, vanadium pentoxide

Hazardous to aquatic life or environment, with possible long-lasting effects[293]. Toxic to aquatic life with long-lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, N, Xn; risk phrases: R45; R20/22; R37; R40; R48/23; R50/53; R62; R63; R68; safety phrases: S1/2; S22; S26; S29/35; S36/37/39; S38; S45; S53; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): (Vanadium and compounds) 3-Severe hazard to water, unless water solubility is <4 μg[V]/L.

Description: Vanadium pentoxide dust is an odorless, yellow to red crystal, or powder; or fume (when vanadium is heated). Vanadium pentoxide fume is a finely divided particulate dispersed in air. Molecular weight = 181.88; specific gravity (H_2O:1) = 3.4 @ 25°C; boiling point = 1750°C (decomposes); freezing/melting point = 681°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 0. Practically insoluble in water; solubility = 0.8%.

Potential Exposure: (*dust*); Suspected reprotoxic hazard, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction), (fume) Possible risk of forming tumors, Vanadium pentoxide [V_2O_5] is an industrial catalyst in oxidation reactions; is used in glass and ceramic glazes; is a steel additive; and is used in welding electrode coatings.

Incompatibilities: Strong acids; lithium, chlorine trifluoride; peroxyformic acid; combustible substances.

Permissible Exposure Limits in Air

NIOSH IDLH = 35 mg[V]/m^3

OSHA PEL: 0.5 mg[V_sO_5]/m (*dust*), respirable fraction; 0.1 mg[V_sO_5]/m^3 (fume) Ceiling Concentration

NIOSH REL: 0.05 mg[V]/m^3 Ceiling Concentration [15 min, except vanadium metal and vanadium carbide]

ACGIH TLV[1]: withdrawn

PAC Ver. 29[138]

PAC-1: 0.64 milligram per cubic meter

PAC-2: 7 milligram per cubic meter

PAC-3: 70 milligram per cubic meter

DFG MAK: Carcinogen Category: 2; Germ cell mutagen group: 2 (DFG 2005).

Listed under "dust"

Austria: MAK 0.05 milligram per cubic meter, 1999; Denmark: TWA 0.03 mg[V]/m^3, 1999; Japan; 0.5 mg [V_2O_5]/m^3, 1999; Poland: MAC (TWA) 0.05 milligram per cubic meter; MAC (STEL) 0.5 milligram per cubic meter, 1999; Switzerland: MAK-W 50 ppm (175 milligram per cubic meter), 1999; United Kingdom: TWA 0.5 mg[V]/m^3, total inhalable (*dust*); TWA 0.04 mg[V]/m^3 (fume and respirable dust), 2000.

Listed under "fume"

Austria: MAK 0.05 milligram per cubic meter, 1999; Japan; 0.1 mg [V_2O_5]/m^3, 1999; Poland: MAC (TWA) 0.05 milligram per cubic meter; MAC (STEL) 0.1 milligram per cubic meter, 1999; Sweden: NGV 0.2 mg[V]/m^3, 1999; Switzerland: MAK-W 50 ppm (175 milligram per cubic meter), 1999; United Kingdom: TWA 0.04 mg[V]/m^3, (fume and respirable dust); TWA 5 milligram per cubic meter, 2000. Russia[43] set a MAC in ambient air in residential areas of 0.002 milligram per cubic meter on a daily average basis. Several states have set guidelines or standards for vanadium pentoxide in ambient air[60] ranging from 0.14 μ/m^3 (Massachusetts); to 0.8 μ/m^3 (Virginia); to 1.0 μ/m^3 (Connecticut and Nevada); to 5.0 μ/m^3 (North Dakota).

Determination in Air: Use NIOSH Method #7504 (vanadium oxides); (vanadium): #7300, #7301; #7303 Elements, #7504.

Permissible Concentration in Water: State Drinking Water Guidelines: California: 50 μg[V]/L Arizona 7 μg[V]/L; Florida: 49 μg[V]/L; Minnesota: 50 μg[V]/L; Wisconsin: 30 μg[V]/L. Runoff from spills or fire control may cause water.

Determination in Water: Toxic to aquatic life with long-lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Vanadium pentoxide is irritating to the skin, eyes, and mucous membranes. Blindness and epistaxis (bloody nose) are further complications. Headache, dry mouth; dizziness, nervousness, insomnia, and tremor may be found. Probable oral lethal dose for humans is between 5 and 50 mg/kg or between 7 drops and 1 tsp for a 70 kg (150 lb) person. Toxicity is about the same magnitude as pentavalent arsenic. Acute exposure to vanadium pentoxide may result in pulmonary irritation, bronchospasm, hemoptysis (coughing up of blood), emphysema, anorexia, black stools; and pulmonary edema. Pulmonary edema is a medical emergency that can be delayed for several hours, and can cause death.

Long-Term Exposure: May cause dermatitis; eczema, skin allergy. Lungs may be affected by repeated inhalation of dust or fumes; bronchitis may develop with cough; fine rales; wheezing, dyspnea (breathing difficulty). May cause a green staining of the tongue and skin.

Points of Attack: Eyes, skin, respiratory system.

Medical Surveillance: Before beginning employment and at regular times after that, the following are recommended. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. Consider chest X-ray after acute overexposure. Test for urine level of vanadium. An EEC guideline recommends the following based on vanadium urine levels: an every-4-month control at the workplace if a 50 μg/L is reached and an annual control if the 5 μg/L urine level is reached. In case levels exceed 50 μg/L urine, workers should be temporary removed from risk.

An OSHA specifically regulated substance. See NIOSH Publication No. 2005-110, December 2004.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA (as V): *0.5 milligram per cubic meter:* 100XQ* (APF = 10) (any air-purifying respirator with an N100, R100, or P100 filter (including N100, R100, and P100 filtering facepieces) except quarter-mask respirators); or SA* (any supplied-air respirator). *1.25 milligram per cubic meter:* Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie* (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *2.5 milligram per cubic meter:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or PaprHie* (APF = 25)* (any powered, air-purifying respirator with a high-efficiency particulate filter); or SCBAF (APF = 50) (any self-contained breathing apparatus with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full face piece). *Emergency or planned entry in to unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

* *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Vanadium pentoxide must be stored to avoid contact with chlorine trifluoride; lithium and peroxyformic acid, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat.

Shipping: UN2862 Vanadium pentoxide, nonfused form, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Do not touch spilled materials; stop leak if you can do so without risk. Use water spray to reduce vapors. *Small spills:* absorb with sand or other noncombustible absorbent material and place into containers for later disposal. *Small dry spills:* with clean shovel place material into clean, dry container and cover; move containers from spill area. *Large spills:* dike far ahead of spill for later disposal. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Not combustible but will increase the intensity of an existing fire. Extinguish fire using an agent suitable for type of surrounding fire. Vanadium pentoxide itself does not burn but decomposing dust containing oxygen may increase intensity of fire when in contact with combustible materials. Thermal decomposition products may include metal oxides of vanadium and oxygen. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($100 kg/mo) must conform to EPA regulations governing storage, transportation, treatment, and waste disposal. Vanadium pentoxide may be salvaged or disposed of in a sanitary landfill.

References

(31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Vanadium Pentoxide, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 2, No. 2, 83−84 (1982) and 8, No. 4, 81−92 (1988).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Vanadium Pentoxide, Trenton, NJ (October 1998).

Vanadium Tetrachloride V:0130

Formula: Cl_4V; VCl_4

Synonyms: Vanadium chloride; Vanadium(IV) chloride

CAS Registry Number: 7632-51-1

HSDB Number: 1025

RTECS Number: YW 2625000

UN/NA & ERG Number: UN2444/137

EC Number: 231-561-1

Regulatory Authority and Advisory Information

Carcinogenicity: DFG MAK: Carcinogen Category 2, Vanadium and inorganic compounds, inhalable fraction. Germ cell mutagen group: 2.

Hazard Alert: Chemically unstable and highly reactive (explosion hazard), Water reactive, Corrosive to skin

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States National Primary Drinking Water Regulations: SMCL = 250 mg$[Cl^-]$/L as Chloride

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard symbol: T,C; risk phrases: R8; R45; R14; R20/21/22; R23/24/25; R27/28; R34; R46; R50/53; safety phrases: S13; S22; S26; S27; S36/37/39; S41; S45; S53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): (Vanadium and compounds) 3-Severe hazard to water, unless water solubility is <4 μg[V]/L.

Description: Vanadium tetrachloride is a thick, reddish-brown liquid that gives off fumes on exposure to moist air. Molecular weight = 192.74; specific gravity (H_2O:1) = 1.8 @ 20°C; boiling point = 148°C @ 75 mmHg; freezing/melting point = −28 ± 2°C; vapor pressure = 7.6 mmHg @ 25°C. Hazard identification (based on NFPA-704 M Rating System) (*Fume and dust*): Health 3, flammability 0, reactivity 2₩. Decomposes in water; reaction is violent.

Potential Exposure: Vanadium tetrachloride is used as a fixative in textile dyeing and in the manufacture of other vanadium compounds.

Incompatibilities: Vanadium tetrachloride is chemically unstable, highly reactive with all forms of moisture, including humidity, releasing corrosive hydrogen chloride and/or chloride fumes. Keep away from light, UV, water, steam, lithium, chlorine, trifluoride, alcohols, organic, and combustible materials. Vanadium tetrachloride is a reactive chemical and is an explosion hazard. See storage and handling section. Corrosive to metals and may release flammable hydrogen gas. Vanadium tetrachloride decomposes by the action of light with the formation of Cl_2 gas. Reacts as an acid to neutralize bases. These neutralizations generate heat. Usually does not react as either oxidizing agents or reducing agents but such behavior is not impossible. May catalyze organic reactions[101].

Permissible Exposure Limits in Air

NIOSH IDLH = 35 mg[V]/m^3

PAC Ver. 29[138]

PAC-1: 0.017 milligram per cubic meter

PAC-2: 0.19 milligram per cubic meter

PAC-3: 130 milligram per cubic meter

DFG MAK: inhalable fraction, Carcinogen Category: 2; Germ cell mutagen group: 2; (DFG 2005).

Determination in Air: Use NIOSH Method OSHA Method #185 (Vanadium tetrachloride); (vanadium): #7300, #7301; #7303 Elements, #7504.

Permissible Concentration in Water: State Drinking Water Guidelines: California: 50 μg[V]/L; Arizona 7 μg[V]/L; Florida: 49 μg[V]/L; Minnesota: 50 μg[V]/L; Wisconsin: 30 μg[V]/L. Runoff from spills or fire control may cause water.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Vanadium tetrachloride can affect you when breathed in and by passing through your skin. Vanadium tetrachloride is a corrosive chemical and eye contact can cause irritation and possible damage. Exposure can irritate the eyes, nose, throat, and lungs, with cough and shortness of breath. Higher exposures can cause pneumonia or pulmonary edema (fluid in the lungs). Pulmonary edema is a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: Repeated exposure can cause lung irritation; bronchitis may develop.

Points of Attack: Lungs.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Before beginning employment and at regular times after that, for those with frequent or potentially high exposures, the following are recommended. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: Urine test for vanadium. Test for urine level of vanadium. An EEC guideline recommends the following based on vanadium urine levels: an every-4-month control at the work-place if a 50 μg/L is reached and an annual control if the 5 μg/L urine level is reached. In case levels exceed 50 μg/L urine, workers should be temporary removed from risk.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. If victim is *conscious*, administer water, or milk. Do not induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH/OSHA (as V): *0.5 milligram per cubic meter:* 100XQ* (APF = 10) (any air-purifying respirator with an N100, R100, or P100 filter (including N100, R100, and P100 filtering facepieces) except quarter-mask respirators); or SA* (any supplied-air respirator). *1.25 milligram per cubic meter:* Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie* (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *2.5 milligram per cubic meter:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or PaprHie* (APF = 25)* (any powered, air-purifying respirator with a high-efficiency particulate filter); or SCBAF (APF = 50) (any self-contained breathing apparatus with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:

ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, self-contained breathing apparatus).
* *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Vanadium tetrachloride must be stored to avoid contact with water, since violent reactions occur, including heat and poisonous gases. Store in tightly closed containers in a cool, well-ventilated area away from radiant heat and flammable and combustible materials; lithium, chlorine, and trifluoride. Vanadium tetrachloride decomposes slowly to vanadium trichloride and chloride. Open containers in dry oxygen-free atmosphere or in inert gas, wearing appropriate personal protective equipment. Chill to below 20°C before opening.

Shipping: UN2444 Vanadium tetrachloride, Hazard class: 8; Labels: 8-Corrosive material.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. *Do not use water* or wet method. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep out of sewers because of the possibility of fire and explosion. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Vanadium tetrachloride itself does not burn, but it may increase the intensity of a fire since it is an oxidizer. Use dry chemical or CO_2 extinguishers on surrounding fire. *Do not use water* on this material. Thermal decomposition products may include hydrogen chloride; chlorine, and metal oxides of vanadium. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. Use water spray to keep fire-exposed containers cool and to reduce vapors but do not get water inside containers of vanadium tetrachloride or on spilled material. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Vanadium Tetrachloride, Trenton, NJ (August 2005).

Vanadyl Sulfate V:0140

Formula: O_5SV; $VOSO_4$

Synonyms: C.I. 77940; Oxysulfatovanadium; Vanadium, oxysulfato (2-)-*o*-; Vanadium oxysulfide

CAS Registry Number: 27774-13-6; 12439-96-2 (sulfate oxide hydrate); 123334-20-3 (hydrate)

HSDB Number: 1026 (27774-13-6)

RTECS Number: YW1925000

UN/NA & ERG Number: UN2931/151

EC Number: 248-652-7

Regulatory Authority and Advisory Information

Carcinogenicity: DFG MAK: Carcinogen Category 2, Vanadium and inorganic compounds, inhalable fraction. Germ cell mutagen group: 2.

Hazard Alert: Poison, Corrosive, Suspected of damaging fertility or the unborn child, Primary irritant (w/o allergic reaction)

United States National Primary Drinking Water Regulations: SMCL = 250 mg[SO_4^{-2}]/L as Sulfate

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below)

Superfund/EPCRA 40 CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1000 lb (454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects[293]. Toxic to aquatic life with long-lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, C, N, Xn, Xi; risk phrases: R45; R20/21/22; R34; R35; R36/37/38; R37; R41; R50/53; safety phrases: S16; S36/37/39; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): (Vanadium and compounds) 3-Severe hazard to water, unless water solubility is <4 μg[V]/L.

Description: Vanadyl sulfate is a pale blue crystalline powder. Odorless. Molecular weight = 163; freezing/melting point = (decomposes) 105°C. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 0, reactivity 0. Highly soluble in water.

Potential Exposure: Vanadyl sulfate is used as a fixative for textile dyes, a colorant for glass and ceramics; a reducing agent and a catalyst.

Incompatibilities: Vanadyl sulfate has weak oxidizing or reducing powers. Redox reactions can however still occur[101]. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Vanadyl sulfate may attack metals; sulfates react with aluminum, magnesium.

Permissible Exposure Limits in Air

NIOSH IDLH = 35 mg[V]/m^3

PAC Ver. 29[138]

27774-13-6

PAC-1: 0.015 milligram per cubic meter

PAC-2: 0.16 milligram per cubic meter

PAC-3: 110 milligram per cubic meter

12439-96-2, sulfate oxide hydrate

PAC-1: 0.023 milligram per cubic meter

PAC-2: 0.25 milligram per cubic meter

PAC-3: 170 milligram per cubic meter

DFG MAK: inhalable fraction, Carcinogen Category: 2; Germ cell mutagen group: 2 (DFG 2005).

Determination in Air: Use NIOSH Method (vanadium): #7300, #7301; #7303 Elements, #7504.

Permissible Concentration in Water: State Drinking Water Guidelines: California: 50 μg[V]/L Arizona 7 μg[V]/L; Florida: 49 μg[V]/L; Minnesota: 50 μg[V]/L; Wisconsin: 30 μg[V]/L. Runoff from spills or fire control may cause water.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Toxic when ingested. Vanadyl sulfate can affect you when breathed in. Contact can irritate the skin. Exposure can irritate the eyes, nose, throat, and lungs with cough and phlegm. Higher exposures can cause pneumonia and/or pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: Lungs may be affected by repeated inhalation; bronchitis may develop. May cause a greenish-black discoloration of the tongue and skin.

Points of Attack: Lungs.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. For those with frequent or potentially high exposure (half the TLV or grater), the following are recommended before beginning work and at regular times after that. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: Urine test for vanadium. An EEC guideline recommends the following based on vanadium urine levels: an every-4-month control at the work-place if a 50 μg/L is reached and an annual control if the 5 μg/L urine level is reached. In case levels exceed 50 μg/L urine, workers should be temporary removed from risk. Consider chest X-ray after acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/ manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA-or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-face-piece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, self-contained breathing apparatus). NIOSH/OSHA (as V): *0.5 milligram per cubic meter:* 100XQ* (APF = 10) (any air-purifying respirator with an N100, R100, or P100 filter (including N100, R100, and P100 filtering facepieces) except quarter-mask respirators); or SA* (any supplied-air respirator). *1.25 milligram per cubic meter:* Sa:Cf* (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie* (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *2.5 milligram per cubic meter:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or PaprHie* (APF = 25)* (any powered, air-purifying respirator with a high-efficiency particulate filter); or SCBAF (APF = 50) (any self-contained breathing apparatus with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry in to unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

* *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: (1) Color code—Blue: Health Hazard/Toxics/ Poisons: Store in a secure poison location. (2) Color code—Yellow Stripe (*strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area.

Shipping: UN2931 Vanadyl sulfate, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Extinguish fire using an agent suitable for type of surrounding fire. Use water spray to reduce vapors. Thermal decomposition products may include oxides of sulfur and vanadium. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Vanadyl Sulfate, Trenton, NJ (August 2005).

Vinyl Acetate V:0150

Formula: $C_4H_6O_2$: $CH_3COOCH{=}CH_2$

Synonyms: Acetate de vinyle (French); Acetic acid, ethenyl ester; Acetic acid, vinyl ester; Aceto de vinilo (Spanish); 1-Acetoxyethylene; Ethenyl acetate; Ethenyl ethanoate; Ethonic acid, ethenyl ester; Everflex 81 l; Plyamul 40305-00; Unocal 76 RES 6206; Unocal 76 RES S-55; VAC; VAM; Vinnapas A 50; Vinylacetat (German); Vinyl acetate H.Q.; Vinyl acetate monomer; Vinyl A monomer; Vinyle (acetate de) (French); Vinyl ethanoate; VYAC; Zeset T

CAS Registry Number: 108-05-4; *(alt.)* 61891-42-7; *(alt.)* 82041-23-4

HSDB Number: 190

RTECS Number: AK0875000

UN/NA & ERG Number: UN1301 (stabilized)/129 (P)

EC Number: 203-545-4 [*Annex I Index No.:* 607-023-00-0]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Carcinogenicity: IARC: Human Inadequate Evidence; Animal Limited Evidence, *possibly carcinogenic to humans*, Group 2B, 1995. United States Environmental Protection Agency Gene-Tox Program, Positive: Cell transformation-SA7/SHE; Positive/limited: Carcinogenicity-mouse/rat; Negative: Histidine reversion-Ames test. DFG MAK: Carcinogen Category 3A, Substances which are proved or possibly carcinogenic and give reason for concern.

Hazard Alert: Cancer suspect, Highly flammable, Chemically unstable, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected repro toxic hazard, Primary irritant (w/o allergic reaction), Polymerization hazard, Environmental hazard.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 15,000 lb (6825 kg).

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Priority Pollutants (40CFR PART 423); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8240(5)

CERCLA Section 302, Extremely Hazardous Substances, TPQ = 1000 lb (455 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV.D.3.b, RQ: 5000 lb (2270 kg)

CERCLA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects[194]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, F+; risk phrases: R45; R11; R17; R19; R36/37/38; R51/53; R61; R62; R63; safety phrases: S1; S2; S16; S21; S23; S29; S33; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Vinyl acetate is a colorless, flammable liquid. The odor threshold is 0.12 ppm[41] 0.3 ppm (NY, NJ). Molecular weight = 86.1; specific gravity (H_2O:1) = 0.93 @ 25°C; boiling point = 73°C; freezing/melting point = −93°C; vapor pressure = 83 mmHg @ 25°C; flash point = −8°C (cc); autoignition temperature = 402°C. Explosive limits: LEL = 2.6%; UEL: 13.4%. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 3, reactivity 2. Slightly soluble (2%) in water.

Potential Exposure: Vinyl acetate is used primarily in polymerization processes to produce polyvinyl acetate; polyvinyl alcohol, and vinyl acetate copolymer. The polymers, usually made as emulsions, suspensions, solutions, or resins, are used to prepare adhesives, paints, paper coatings, and textile finishes. Low molecular weight vinyl acetate is used as a chewing gum base.

Incompatibilities: Vinyl acetate may undergo spontaneous exothermic polymerization on exposure to light[101]. Vapors may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, strong light and UV. The vapor may react vigorously with silica gel or aluminum, acids, bases, silica gel; alumina, oxidizers, azo compounds. Ozone readily polymerizes in elevated temperatures, under the influence of light, or peroxides. Usually contains a stabilizer [e.g., hydroquinone (limit to 2 months) or diphenylamine for longer term] to prevent polymerization.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 3.52 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: None

NIOSH REL: 4 ppm/15 milligram per cubic meter [15-min] Ceiling Concentration

ACGIH TLV[1]: 10 ppm/35 milligram per cubic meter TWA; 15 ppm/53 milligram per cubic meter STEL, confirmed animal carcinogen with unknown relevance to humans.

PAC* Ver. 29[138]

PAC-1: **6.7**$_{\mathbf{A}}$ ppm

PAC-2: **36**$_{\mathbf{A}}$ ppm

PAC-3: **180**$_{\mathbf{A}}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

DFG MAK: Carcinogen Category 3A, Substances which are proved or possibly carcinogenic and give reason for concern

Australia: TWA 10 ppm (30 milligram per cubic meter), STEL 20 ppm, 1993; Austria: MAK 1 ppm (35 milligram per cubic meter), Suspected: carcinogen, 1999; Belgium: TWA 10 ppm (35 milligram per cubic meter), STEL 20 ppm, 1993; Denmark: TWA 10 ppm (30 milligram per cubic meter), 1999; Finland: TWA 10 ppm (35 milligram per cubic meter), STEL 20 ppm (70 milligram per cubic meter), 1993; France: VME 10 ppm (30 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 18 milligram per cubic meter, 2003; Poland: MAC (TWA) 10 milligram per cubic meter; MAC (STEL) 30 milligram per cubic meter, 1999; Sweden: NGV 5 ppm (18 milligram per cubic meter), KTV 10 ppm (35 milligram per cubic meter), 1999; Switzerland: MAK-W 10 ppm (35 milligram per cubic meter), KZG-W 20 ppm (70 milligram per cubic meter), 1999; Turkey: TWA 10 ppm (30 milligram per cubic meter), 1993; United Kingdom: TWA 10 ppm (36 milligram per cubic meter), STEL 20 ppm (72 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 15 ppm

Russia[43] set a MAC in ambient air in residential areas of 0.15 milligram per cubic meter both on a momentary and a daily average basis. Several states have set guidelines or standards for vinyl acetate in ambient air[60] ranging from 5.0 μ/m^3 (Virginia); to 9.6 μ/m^3 (Massachusetts); to 300.0–600.0 μm^3 (North Dakota); to 600.0 μ/m^3 (Connecticut); to 714.0 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #1453, vinyl acetate; OSHA Analytical Method 51.

Determination in Water: Octanol−water coefficient: Log $K_{ow} = < 0.8$. Unlikely to bioaccumulate in marine organisms.

Permissible Concentration in Water: Russia[43] set a MAC in water bodies used for domestic purposes of 0.2 mg/L.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the eyes, skin, and respiratory tract causing hoarseness, cough; loss of smell. A CNS depressant; high levels of exposure can cause fatigue, dizziness, lightheadedness and disturbed sleep. *Inhalation:* Irritates the nose and throat, causing coughing and/or shortness of breath. Levels of 19 ppm for 4 hours have caused slight throat irritation. The characteristic odor may not be recognized after about 2 hours. Levels of 71 ppm for 1/2 hour may cause definite throat irritations. May cause lesions of the lung tissue. *Skin:* Contact can cause irritation, dryness. Prolonged contact can cause rash, burns, and blisters. *Eyes:* Levels of 22 ppm and above may produce eye reddening and irritation. Contact can cause burns.

Long-Term Exposure: May affect the heart, central nervous system and liver. Levels above 22 ppm for 1 year may cause reversible irritation to eyes, throat and lungs, sometimes accompanied by skin irritation or rash. Vinyl acetate has been related to reproductive abnormalities. Exposure caused gradual deterioration of heart muscles.

Points of Attack: Liver, eyes, heart, skin.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure. For those with frequent or potentially high exposure (half the TLV or greater), the following is recommended before beginning work and at regular times after that. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: liver function tests. Exam of the nervous system. EKG. Specific engineering controls are recommended for this chemical. Refer to NIOSH Criteria Document #78-205, Occupational Exposure to Vinyl Acetate.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Teflon, polyethylene and ethylene vinyl alcohol are recommended as protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *40 ppm:* CcrFOv (APF = 50) [any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s)]; or Sa (APF = 10) (any supplied-air respirator). *100 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]. *200 ppm:* CcrFOv (APF = 50) [any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s)]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted acid gas canister]; or PaprTOv (APF = 50) [any powered, air-purifying respirator with a tight-fitting facepiece and organic vapor cartridge(s)]; or SCBAF (APF = 50) (any self-contained breathing apparatus with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *400 ppm:* Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, self-contained breathing apparatus). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. May form peroxides in storage. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Vinyl acetate must be stored to avoid contact with oxidizers, such as perchlorates, peroxides, permanganates, chlorates, and nitrates), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat and direct sunlight. Sources of ignition, such as smoking and open flames are prohibited where vinyl acetate is handled, used, or stored. Metal containers involving the transfer of 5 gal or more of vinyl acetate should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of vinyl acetate. Wherever vinyl acetate is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN1301 Vinyl acetate, stabilized, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include harmful oxides of carbon. Water may be ineffective. Use dry chemical, carbon dioxide, or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (2); (100).

National institute for Occupational Safety and Health (NIOSH), “Criteria for a Recommended Standard: Occupational Exposure to Vinyl Acetate”, NIOSH Publication No. 78-205, Cincinnati, OH (1978).

United States Environmental Protection Agency, Chemical Hazard Information Profile Draft Report: Vinyl Acetate, Washington, DC (April 23, 1984).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Vinyl Acetate Monomer, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

New York State Department of Health, *Chemical Fact Sheet:* Vinyl Acetate, Bureau of Toxic Substance Assessment, Albany, NY (Version 2-March 1986).

Sax, N. I., Ed., “*Dangerous Properties of Industrial Materials Report*,” 9, No. 2, 89−106 (1989).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Vinyl Acetate, Trenton, NJ (April 2002).

Vinyl Bromide V:0160

Formula: C_2H_3Br; $CH_2{=}CHBr$

Synonyms: Bromoethene; Bromoethylene; Bromure de vinyle (French); Bromuro de vinilo (Spanish); Ethene, bromo-; Ethylene, bromo-; Monobromoethylene; Vinylbromid (German); Vinyle (bromure de) (French)

CAS Registry Number: 593-60-2

HSDB Number: 1030

RTECS Number: KU8400000

UN/NA & ERG Number: UN1085 (stabilized)/116 (P)

EC Number: 209-800-6 [*Annex I Index No.:* 602-024-00-2]

Regulatory Authority and Advisory Information

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Animal, Sufficient Evidence; Human, No Adequate Data, Group 2A, 1999; NIOSH: Potential Occupational carcinogen.

California Proposition 65 Chemical 10/1/1988

Hazard Alert: Extremely flammable gas, Chemically unstable, Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated, Polymerization hazard, Strong reducing agent, Possible risk of forming tumors, Suspected reprotoxic hazard.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Superfund/EPCRA40 CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.

Hazard symbols, risk, & safety statements: Hazard symbol: F+, T; risk phrases: R5; R45; R12; R19; R21; R60; R61; safety phrases: S33; S38; S45; S53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [2-Hazard to water; possibly 3-Severe hazard to water. (est.)]

Description: Vinyl bromide is a colorless gas or liquid at low ambient temperature. Pleasant odor. Shipped as a liquefied compressed gas with 0.1% phenol added to prevent polymerization. Molecular weight = 106.95; specific gravity (H_2O:1) = 1.49 (liquid @ 20°C; boiling point = 16°C; freezing/melting point = −140°C; vapor pressure = 750 mmHg @ 15°C; relative vapor density (air = 1) = 3.97; flash point = flammable gas; autoignition temperature = 530°C. Explosive limits: LEL = 9.0%; UEL: 15.0%. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 4, reactivity 1. Insoluble in water.

Potential Exposure: Vinyl bromide is used as an intermediate in organic synthesis and for the preparation of plastics by polymerization and copolymerization; as a comonomer with acrylonitrile and other vinyl monomers in modacrylic fibers; in the production of flame-retardant synthetic fibers.

Incompatibilities: Vinyl bromide is a dangerous chemically unstable compound that may polymerize spontaneously in heat, sunlight and possibly exposure to UV. Dangerously reactive with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, acetylene, strong acids, strong bases, copper compounds. Add 0.1% phenol to gas to prevent polymerization.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 4.38 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: None

NIOSH REL: Potential occupational carcinogen. Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A

ACGIH TLV[1]: 0.5 ppm/2.2 milligram per cubic meter TWA, Suspected Human Carcinogen

PAC Ver. 29[138]

PAC-1: 39 ppm

PAC-2: 430 ppm

PAC-3: 2600 ppm

Australia: TWA 5 ppm (20 milligram per cubic meter), carcinogen, 1993; Belgium: TWA 5 ppm (22 milligram per cubic meter), Carcinogen 1993; Denmark: TWA 5 ppm (20 milligram per cubic meter), 1999; Finland: TWA 5 ppm (20 milligram per cubic meter), STEL 10 ppm (40 milligram per cubic meter), carcinogen, 1999; Norway: TWA 1 ppm (4 milligram per cubic meter), 1999; Switzerland: MAK-W 5 ppm (22 milligram per cubic meter), 1999; United Kingdom: LTEL 5 ppm (20 milligram per cubic meter), 1993; the Netherlands: MAC-TGG 0.012 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Suspected Human Carcinogen. Several states have set guidelines or standards for vinyl bromide in ambient air[60] ranging from 0 (North Dakota); to 2.0 μ/m^3 (Virginia); to 44.0 μ/m^3 (Connecticut); to 48.07 μ/m^3 (Pennsylvania); to 66.7 μ/m^3 (New York); to 100.0 μ/m^3 (South Carolina); to 200.0 μ/m^3 (Florida); to 476.0 μ/m^3 (Nevada).

Determination in Air: Charcoal tube; Ethanol; Gas chromatography/Flame ionization detection; NIOSH Analytical Method (IV) #1009, Vinyl bromide, OSHA Analytical Method 08.

Determination in Water: Octanol−water coefficient: Log K_{ow} = 1.6. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion (liquid), skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Vinyl bromide can affect you when breathed in. Contact can irritate the eyes. A nervous system depressant; exposures may cause dizziness, lightheadedness, confusion, a lack of coordination; narcosis, nausea, vomiting. Contact with the liquid can cause frostbite.

Long-Term Exposure: Potential occupational carcinogen.

Points of Attack: Eyes, skin, central nervous system; liver. Cancer site in animals: liver and lymph node tumors.

Medical Surveillance: There are no special tests. However medical attention is recommended if overexposure is suspected.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At concentrations above the NIOSH REL, or where there is NO REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Check oxygen content prior to entering storage area. Flammable gas. Color code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Vinyl bromide must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates) and heat or flame, since violent reactions occur. Sources of ignition, such as smoking and open flames, are prohibited where vinyl bromide is used, handled, or stored in a manner that could create A potential fire or explosion hazard. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: UN1085 Vinyl bromide, stabilized, Hazard Class: 2.1; Labels: 2.1-Flammable gas. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit and to disperse the gas. Stop the flow of gas if it can be done safely. If source of leak is a cylinder and the leak cannot be stopped in place, remove leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. Keep this chemical out of confined space, such as a sewer because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Vinyl bromide is an extremely flammable gas. For small fires, use dry chemical, CO_2, water spray; or foam extinguishers. Thermal decomposition products may include toxic fumes of hydrogen bromine and oxides of carbon. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Nonrefillable cylinders should be disposed of in accordance with local, state and federal regulations. Allow remaining gas to vent slowly into atmosphere in an unconfined area or exhaust hood. Refillable-type cylinders should be returned to original supplier with any valve caps and outlet plugs secured and valve protection caps in place.

References

(109); (31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Vinyl Bromide, Washington, DC (January 30, 1978).

National Institute for Occupational Safety and Health (NIOSH), Vinyl Halides: Carcinogenicity, Current Intelligence Bulletin No. 28, Washington, DC (September 21, 1978).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 2, No. 2, 87−88 (1982) and 4, No. 5, 58−63 (1984) and 9, No. 1, 80−88 (1989).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Vinyl Bromide, Trenton NJ (June 2000).

Vinyl Chloride V:0170

Formula: C_2H_3Cl; $CH_2{=}CHCl$
Synonyms: Chloroethene; Chloroethylene; Chlorure de vinyle (French); Cloruro de vinilo (Spanish); Ethene, chloro-; Ethylene, chloro-; Ethylene monochloride; Monochloroethene; Monochloroethylene; Troviduer; Trovidur; UN1086; VC; VCL; VCM; Vinylchlorid (German); Vinyl chloride monomer; Vinyl C monomer; Vinyle (chlorure de) (French)
CAS Registry Number: 75-01-4
HSDB Number: 169
RTECS Number: KU9625000
UN/NA & ERG Number: UN 1086 (stabilized)/116 (P)
EC Number: 200-831-0 [*Annex I Index No.:* 602-023-00-7]
Regulatory Authority and Advisory Information
Department of Home land Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).
Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen; IARC: Human Sufficient Evidence; Animal Sufficient Evidence, *carcinogenic to humans*, Group 1, 1998; OSHA/NIOSH: Potential occupational carcinogen. United States Environmental Protection Agency Gene-Tox Program, Positive: Carcinogenicity-mouse/rat; Positive: *In vivo* cytogenetics-human lymphocyte; *E. coli polA* with S9; Positive: Histidine reversion-Ames test; Positive: *D. melanogaster* sex-linked lethal; Positive: *S. cerevisiae* gene conversion; *S. pombe*-forward mutation; Negative: *D. melanogaster*-reciprocal translocation; Negative: Rodent dominant lethal; Mouse spot test; Negative: *S. cerevisiae-homozygosis.*
California Proposition 65 Chemical 2/27/1987
Hazard Alert: Extremely flammable gas or liquid, Chemically unstable (with heat increase), Polymerization hazard (nonstabilized), Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated, Possible risk of forming tumors, Reproductive toxin: possible risk of gene damage/impaired fertility; Suspected reprotoxic hazard.
OSHA, 29CFR1910 Specifically Regulated Chemicals (See CFR 1910.1017)
Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); Accidental Release Prevention/Flammable Sub stances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg)
Clean Water Act: Section 313 Water Priority Chemicals (57FR41331, 9/9/1992); 40CFR401.15 Section 307 Toxic Pollutants
United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U043; D043
RCRA Toxicity Characteristic (Section 261.24), Maximum Concentration of Contaminants, regulatory level, 0.2 mg/L
RCRA, 40CFR261, Appendix 8 Hazardous Constituents
RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.27; Nonwastewater (mg/kg), 6.0
RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8010 (2); 8240 (10)
United States National Primary Drinking Water Regulations: MCLG = 0 mg/L; MCL = 0.002 mg/L
Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1 lb (0.454 kg)
EPCRA Section 313 Form R *de minimis* concentration reporting level: 0.1%.
Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.
European/International Regulations (as chloroethylene): Hazard Symbol: T, F+; risk phrases: R45; R5; R12; R19; R21; R39/23/24/25; R61; R62; R63; safety phrases: S1; S7; S9; S33; S36/37; S38; S41; S45; S53 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Vinyl chloride is a flammable gas at room temperature, and is usually encountered as a cooled liquid. The colorless liquid forms a vapor which has a pleasant, ethereal odor. The odor threshold is variously given as 260 ppm[41], 3,000 ppm (NJ fact sheet), 4000 ppm (NY fact sheet) in air and 3.4 ppm in water (EPA Toxicological profile). Shipped as a liquefied compressed gas. Molecular weight = 62.5; specific gravity (H_2O:1) = 0.91 (Liquid) @ 20°C; boiling point = −14°C; freezing/melting point = −154°C; relative vapor density (air = 1) = 2.21; vapor pressure = 750 mmHg @ −14°C; flash point = flammable gas @ −75°C (cc); autoignition temperature = 472°C. Explosive limits: LEL = 3.6%; UEL: 33.0%. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 4, reactivity 2. Insoluble in water; 0.1% @ 25°C.

Potential Exposure: Vinyl chloride is used as a vinyl monomer in the manufacture of polyvinyl chloride (vinyl chloride homopolymer) and other copolymer resins. It is also used as a chemical intermediate and as a solvent.

Incompatibilities: Copper, oxidizers, aluminum, peroxides, iron, steel. Polymerizes in air, sunlight, heat, and on contact with a catalyst, strong oxidizers; and metals, such as aluminum and copper unless stabilized by inhibitors, such as phenol. Attacks iron and steel in presence of moisture.

Permissible Exposure Limits in Air

Conversion factor: 1 ppm = 2.56 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: 1 ppm/2.56 milligram per cubic meter TWA; 5 ppm [Avg not exceeding any 15 min period STEL

NIOSH REL: Potential occupational carcinogen. Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A

ACGIH TLV[1]: 1 ppm/2.6 milligram per cubic meter TWA, Confirmed Human Carcinogen

PAC* Ver. 29[138]

PAC-1: $\mathbf{250_A}$ ppm

PAC-2: $\mathbf{1200_A}$ ppm

PAC-3: $\mathbf{4800_A}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

DFG MAK: Carcinogen Category 1; TRK: 2 mL/m^3/5.2 milligram per cubic meter; 2.4 mg [thioglycolic acid]/24 hours, in urine; after several shifts.

Arab Republic of Egypt: TWA 2.5 milligram per cubic meter, 1993; Australia: TWA 5 ppm (10 milligram per cubic meter), carcinogen, 1993; Austria: carcinogen, 1999; Belgium: TWA 5 ppm (13 milligram per cubic meter), Carcinogen 1993; Denmark: TWA 1 ppm (3 milligram per cubic meter), [skin], 1999; Finland: TWA 5 ppm (15 milligram per cubic meter), STEL 10 ppm (30 milligram per cubic meter), carcinogen, 1993; Hungary: STEL 10 milligram per cubic meter, carcinogen, 1993; Japan 2.5 ppm (6.5 milligram per cubic meter), carcinogen, 1999; the Netherlands: MAC-TGG 7.77 milligram per cubic meter, 2003; Norway: TWA 1 ppm (3 milligram per cubic meter), 1999; the Philippines: TWA 50 ppm (100 milligram per cubic meter), 1993; Poland: MAC (TWA) 5 milligram per cubic meter; MAC (STEL) 30 milligram per cubic meter, 1999; Russia: TWA 1 milligram per cubic meter, STEL 2.5 ppm (5 milligram per cubic meter), 1993; Sweden: NGV 1 ppm (2.5 milligram per cubic meter), KTV 5 ppm (13 milligram per cubic meter), [skin], carcinogen, 1999; Switzerland: MAK-W 2 ppm (5.2 milligram per cubic meter), carcinogen, 1999; Thailand: TWA 1 ppm (2.8 milligram per cubic meter), 1993; Turkey: TWA 500 ppm (1300 milligram per cubic meter), 1993; United Kingdom: TWA 7 ppm, Carcubigen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Confirmed Human Carcinogen. MAC values have been set for ambient air in residential areas[35] by Russia at 0.005 milligram per cubic meter on a momentary basis and by The Czech Republic at 0.3 milligram per cubic meter on a momentary basis and 0.1 milligram per cubic meter on a daily average basis. Several states have set guidelines or standards for vinyl chloride in ambient air[60] ranging from 0 (North Dakota); to 0.038 μ/m^3 (North Carolina); to 0.4 μ/m^3 (Michigan and New York); to 1.0 μ/m^3 (Virginia); to 3.846 μ/m^3 (Kansas); to 3.9 μ/m^3 (Massachusetts); to 5.0 μ/m^3 (Pennsylvania); to 50.0 μ/m^3 (Connecticut, South Carolina, South Dakota); to 238.0 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #1007, vinyl chloride, OSHA Analytical Method 04.

Permissible Concentration in Water: Safe Drinking Water Act (47FR 9352): MCL, 0.002 mg/L; MCLG, zero. For the protection of human health: preferably zero. An additional lifetime cancer risk of 1 in 100,000 is posed by a concentration of 20 μg/L[6]. A long-term health advisory for vinyl chloride of 46 μg/L has been set by EPA[48]. Several states have set guidelines or standards for vinyl chloride in drinking water[61] ranging from 0 (Rhode Island); to 0.15 μg/L (Minnesota); to 1.0 μg/L (Arizona, Florida, Kansas, Massachusetts, New Mexico, Vermont); to 2.0 μg/L (California, Maine, New Jersey, Colorado); to 5.0 μg/L (New York).

Determination in Water: Inert gas purge followed by gas chromatography with halide specific detection (EPA Method 601) or gas chromatography plus mass spectrometry (EPA Method 624). Octanol−water coefficient: Log $K_{ow} = 0.6$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, skin, and/or eye contact (liquid).

Harmful Effects and Symptoms

Short-Term Exposure: *Inhalation:* May affect the central nervous system. High exposures can cause dizziness, lightheadedness, sleepiness. Even higher levels can cause headaches, nausea, weakness, unconsciousness, and possible death. Exposure @ 8000 ppm for 5 minutes can cause a feeling of intoxication, tiredness, drowsiness, abdominal pain; numbness and tingling in fingers and toes; pains in joints; coughing, sneezing, irritability; loss of appetite and weight. *Skin:* Contact with liquid may cause frostbite; contact with vapor may cause irritation and rash. Absorption is possible through the skin. *Eyes:* Can cause severe and immediate irritation. Contact with the liquid may cause frostbite. *Ingestion:* Moderately toxic.

Long-Term Exposure: Increase of cancer risk. May cause "scleroderma" a disease that causes the skin to become smooth, tight and shiny and causes the bones in the fingers to erode (resulting in club-like swelling and shortening of finger tips) and damage the blood vessels in the hands (Raynauds syndrome). This causes the hands or feet to turn numb, pale, or blue with even mild cold exposure. Connective tissue, bones, and joints of arms and legs may suffer damage. Repeated exposure can permanently damage the liver; spleen, kidneys, nervous system; and blood cells. Vinyl chloride can cause symptoms, such as stomach ulcers and skin allergy. Not all symptoms disappear after exposure stops. Vinyl chloride has caused liver cancer in occupationally exposed individuals. It may damage the developing fetus, and there is limited evidence that it is a teratogen in animals. An excess of spontaneous abortions has been reported among spouses of workers who have been exposed to vinyl chloride. Increased rates of birth defects have been reported in areas where vinyl chloride processing plants are located. Vinyl chloride's role in this increased risk is unknown at this time.

Points of Attack: Liver, central nervous system; blood, respiratory system; lymphatic system. Cancer site in humans: liver. Cancer site in animals: liver, brain, lung.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. OSHA mandates the following tests: blood serum; alkaline phosphatase; bilirubin, *gamma*-glutamyl transpeptidase; serum glutamic oxalacetic transaminase; serum glutamic pyruvic transaminase. NIOSH lists the following tests: alkaline phosphatase; blood serum: lactic dehydrogenase; chest X-ray; expired air; liver function tests: alkaline phosphatase, bilirubin, *gamma*-glutamyl transpeptidase, serum glutamic oxalacetic transaminase, serum glutamic pyruvic transaminase; pulmonary function tests; pulmonary function tests: forced vital capacity, forced expiratory volume (1 second); red blood cell count; urine (chemical/metabolite); urinalysis (routine): albumin, whole blood (chemical/metabolite), ultrasonography of the liver. Complete exam of the skin and nervous system. If symptoms develop or overexposure is suspected, the following may be useful: X-rays of the fingers. Test for “urinary thiodiglycolic acid” (normal level is usually less than 2 mg/L). Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Viton, Silvershield, and chlorinated polyethylene are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Eye protection is included in the recommended respiratory protection. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Vinyl chloride (1910.1017): < or = 10 ppm (parts per million): (1) Combination Type C supplied-air respirator, demand type, with half facepiece, and auxiliary self-contained air supply; (2) Type C supplied-air respirator, demand type, with half facepiece; or (3) Any chemical cartridge respirator with an organic vapor cartridge which provides a service life of at least 1 hour for concentrations of vinyl chloride up to 10 ppm. < or = 25 ppm: (1) Powered air-purifying respirator with hood, helmet, full or half facepiece, and a canister which provides a service life of at least 4 hours for concentrations of vinyl chloride up to 25 ppm; or (2) Gas mask with front-or back-mounted canister which provides a service life of at least 4 hours for concentrations of vinyl chloride up to 25 ppm. < or = 100 ppm: (1) Combination Type C supplied-air respirator, demand type, with full facepiece, and auxiliary self-contained air supply; or (2) Open-circuit self-contained breathing apparatus with full facepiece, in demand mode; or (3) Type C supplied-air respirator, demand type, with full facepiece. < or = 1000 ppm: Type C supplied-air respirator, continuous-flow type, with full or half facepiece, helmet, or hood. < or = 3600 ppm: (1) Combination Type C supplied-air respirator, pressure demand type, with full or half facepiece, and auxiliary self-contained air supply; or (2) Combination type continuous-flow supplied-air respirator with full or half facepiece and auxiliary self-contained air supply. >3600 ppm or unknown concentration Open-circuit self-contained breathing apparatus, pressure-demand type, with full facepiece.

Storage: Check oxygen content prior to entering storage area. Flammable gas. Color code—Red Stripe: Flammability Hazard: Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Vinyl chloride must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates), since violent reactions occur. Sources of ignition, such as smoking and open flames, are prohibited where vinyl chloride is handled, used, or stored. Metal containers involving the transfer of 5 gal of vinyl chloride should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of vinyl chloride. Wherever vinyl chloride is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN1086 Vinyl chloride, stabilized, Hazard Class: 2.1; Labels: 2.1-Flammable gas. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Ventilate area of leak to disperse the gas. Establish forced ventilation to keep levels below explosive limit. Stop the flow of gas if it can be done safely. If source of leak is a cylinder and the leak cannot be stopped in place, remove leaking cylinder to a safe place in the op en air, and repair leak or allow cylinder to empty. Keep this chemical out of confined space, such as a sewer because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Vinyl chloride is a flammable gas. Thermal decomposition products may include phosgene, hydrogen chloride; and oxides of carbon. Use dry chemical or CO_2 extinguishers. Fire may restart after it has been extinguished. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform to EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assured to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced[22]. A variety of techniques have been described for vinyl chloride recovery from PVC latexes.

References

(109); (31); (173); (101); (138); (2); (100).

United States Environmental Protection Agency, Scientific and Technical Assessment Report on Vinyl Chloride and polyvinyl chloride, Office of Research and Development, Washington, DC (June 1975).

National Institute for Occupational Safety and Health (NIOSH), Vinyl Halides-Carcinogenicity, Current Intelligence Bulletin No. 28, Washington, DC (September 21, 1978).

United States Environmental Protection Agency, Vinyl Chloride: Ambient Water Quality Criteria, Washington, DC (1980).

United States Environmental Protection Agency, Chloroethene, Health and Environmental Effects Profile No. 45, Office of Solid Waste, Washington, DC (April 30, 1980).

Sittig, M. Vinyl Chloride and PVC Manufacture: Process and Environmental Aspects, Noyes Data Corp., Park Ridge, NJ (1978).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 3, 85−87 (1981) and 6, No. 4, 13−43 (1986).

United States Public Health Service, "Toxicological Profile for Vinyl Chloride," Atlanta, Georgia, agency for Toxic Substances and Disease Registry (January 1988).

New York State Department of Health, *Chemical Fact Sheet:* Vinyl Chloride, Bureau of Toxic Substance Assessment, Albany, NY (March 1986 and Version 2).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Vinyl Chloride, Trenton, NJ (June 2001).

4-Vinyl-1-Cyclohexene V:0180

Formula: C_8H_{12}; $C_6H_9CH{=}CH_2$

Synonyms: Butadiene dimer; Cyclohexenylethylene; 1-Ethenylcyclohexene; 4-Ethenyl-1-cyclohexene; NCI-C54999; 1,2,3,4-Tetrahydrostyrene; 1-Vinylcyclohex-3-

ENE; 1-Vinylcyclohexene-3; 4-Vinyl-1-cyclo hexene; 4-Vinylcyclohexene; 4-Vinylcyclohexene-1

CAS Registry Number: 100-40-3

HSDB Number: 2872

RTECS Number: GW 6650000

UN/NA & ERG Number: UN1993 (flammable liquids, n.o.s.)/128 (P)

EC Number: 202-848-9

Regulatory Authority and Advisory Information

Carcinogenicity: IARC: Human Inadequate Evidence; Animal Sufficient Evidence, *possibly carcinogenic to humans*, Group 2B, 1994; NCI: Carcinogenesis Studies (gavage); clear evidence: mouse; inadequate study: rat.

California Proposition 65 Chemical[102]: Cancer 2/27/1987; Developmental/Reproductive toxin, female 8/7/2009

Hazard Alert: Highly flammable, Polymerization hazard, Aspiration hazard, Tumorogen; Suspected of causing genetic defects.

Hazard symbols, risk, & safety statements: Hazard symbol: T, F, Xn; risk phrases: R45; R11; R19; R20; R36/37/38; R38; R40; R51/53; R62; R65; R67; safety phrases: S16; S21; S22; S24/25; S26; S33; S36/37/39; S45; S53 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: 4-Vinyl-1-cyclohexene, a cyclic alkene, is a highly flammable liquid. Molecular weight = 108.2; specific gravity (H_2O:1) = 0.82 @ 25°C; boiling point = 130.3°C; freezing/melting point = −101°C; vapor pressure = 25 mmHg @ 38°C; flash point = 16−21°C; autoignition temperature = 269°C. Explosive limits: LEL = 26,000 ppm, UEL: unknown; Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 3, reactivity 2. Hydrolyzes in water.

Potential Exposure: 4-Vinyl-1-cyclohexene is used as an intermediate for the production of vinylcyclohexene dioxide, which is used as a reactive diluent in epoxy resins. Previous uses of 4-vinyl-1-cyclohexene include comonomer in the polymerization of other monomers and for halogenation to polyhalogenated derivatives which are used as flame retardants.

Incompatibilities: Vapor may form explosive mixture with air. Hydrolyzes in water. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, amines, alcohols.

Permissible Exposure Limits in Air

OSHA PEL: None

NIOSH REL: None

ACGIH TLV[1]: 0.1 ppm/0.44 milligram per cubic meter TWA; confirmed animal carcinogen with unknown relevance to humans.

PAC Ver. 29[138]

PAC-1: 0.3 ppm

PAC-2: 210 ppm

PAC-3: 340 ppm

DFG MAK: [skin] Carcinogen Category: 2

Poland: MAC (TWA) 10 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 0.4 milligram per cubic meter, 2003

Determination in Water: Octanol−water coefficient: Log K_{ow} = > 3.9. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, skin, and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Vapors cause irritation and smarting of the eyes and respiratory system if present in high concentrations. Aspiration hazard; may be fatal if swallowed and enters airways. Causes skin irritation.

Long-Term Exposure: Workers exposed to 4-vinyl-1-cyclohexene experienced keratitis (inflammation of the cornea), rhinitis, headache, hypotonia, leucopenia (decrease in the number of white blood cells), neutrophilia, lymphocytosis; and impairment of pigment and carbohydrate metabolism. A confirmed carcinogen; and may damage fertility. Prolonged exposure to oxygen-containing gases leads to discoloration and gum formation[193].

Points of Attack: Blood, eyes.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Complete eye examination. Complete blood count and hematocrit.

First Aid: *Skin Contact*[52]*:* Flood all areas of body that have contacted the substance with water. Don't wait to remove contaminated clothing; do it under the water stream. Use soap to help assure removal. Isolate contaminated clothing when removed to prevent contact by others. *Eye Contact:* Remove any contact lenses at once. Flush eyes well with copious quantities of water or normal saline for at least 20−30 minutes. Seek medical attention. *Inhalation:* Leave contaminated area immediately; breathe fresh air. Proper respiratory protection must be supplied to any rescuers. If coughing, difficult breathing or any other symptoms develop, seek medical attention at once, even if symptoms develop many hours after exposure. *Ingestion:* If convulsions are not present, give a glass or two of water or milk to dilute the substance. Assure that the person's airway is unobstructed and contact a hospital or poison center immediately for advice on whether or not to induce vomiting.

Personal Protective Methods: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Viton is among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSH A- or European Standard EN 149-approved self-contained breathing apparatus that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full face-piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full-face-piece respirator with and N100, R100, or P100 filter k-mounted organic vapor canister having a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in an explosion-proof refrigerator. Protect from exposure to oxidizers, alcohols, amines, air, and light. Sources of ignition, such as smoking and open flames are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gal or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN1993 Flammable liquids, n.o.s., Hazard Class: 3; Labels: 3-Flammable liquid, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Water may be ineffective due to the low flash point. Water spray may be used however. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(102); (31); (173); (101); (138); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: 4-Vinyl-1-Cyclohexene, Washington, DC (September 19, 1985).

Vinyl Cyclohexene Dioxide V:0190

Formula: $C_8H_{12}O_2$

Synonyms: 1,2-Epoxy-4-(epoxyethyl)cyclohexane; 3-(Epoxyethyl)-7-oxabicyclo(4.1.0) heptane, vinyl cyclohexene diepoxide; NCI-C60139; 3-Oxiranyl-7-oxabicyclo(4.1.0) heptene; Ucet textile finish 11-74 (obs.); Unox epoxide 206; 4-Vinyl-1,2-cyclohexene diepoxide; 4-Vinyl-1-cyclo hexene diepoxide;4-Vinylcyclohexene diepoxide; Vinyl cyclohexene

diepoxide; 1-Vinyl-3-cyclo hexene dioxide; 4-Vinyl-1-cyclo hexene dioxide; 4-Vinylcyclohexene dioxide
CAS Registry Number: 106-87-6; *(alt.)* 25550-49-6
HSDB Number: 4332
RTECS Number: RN8640000
UN/NA & ERG Number: UN2810 (toxic liquid, organic, n.o.s.)/153 (P)
EC Number: 203-437-7 [*Annex I Index No.:* 603-066-00-4]
Regulatory Authority and Advisory Information
Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen (4-Vinyl-1-cyclohexene diepoxide); IARC: Human Inadequate Evidence; Animal Sufficient Evidence, *possibly carcinogenic to humans*, Group 2B, 1994; NCI: Carcinogenesis Studies (gavage); clear evidence: mouse, rat
California Proposition 65 Chemical[102]: Cancer 7/1/1990; Developmental/Reproductive toxin, female 8/1/2008
Hazard Alert: Poison, Combustible, Polymerization hazard, Reproductive toxin: possible risk of forming tumors, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction).
Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%.
Hazard symbols, risk, & safety statements: Hazard symbol: T, Xi; risk phrases: R45; R19; R23/24/25; R36/37/38; R68/20/21; R61; R62; R63; safety phrases: S1/2; S23; S24; S36/37; S45; S63 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 1-Low hazard to water.
Description: Vinyl cyclohexene dioxide is a colorless liquid. Molecular weight = 140.2; specific gravity (H_2O:1) = 1.10 @ 20°C; boiling point = 227°C; freezing/melting point = −109°C; vapor pressure = 0.1 mmHg @ 25°C; flash point = 110°C; autoignition temperature = 392°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 1, reactivity 0. Highly soluble in water; reacts slowly, hydrolyzed.
Potential Exposure: This material is used as a monomer in the production of epoxy resins for coatings and adhesives; as a chemical intermediate and as a reactive diluent.
Incompatibilities: When heated or in contact with catalysts, epoxides may cause violent polymerization. Epoxides are incompatible with reducing agents and oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. May react, possibly violently, with water in the presence of acid and other catalysts. Reacts with alcohols, amines and other active hydrogen compounds. Slowly hydrolyzes in water.
Permissible Exposure Limits in Air
OSHA PEL: None
NIOSH REL: 10 ppm/60 milligram per cubic meter TWA [skin]; Potential occupational carcinogen. Limit exposure to lowest feasible concentration; See *NIOSH Pocket Guide*, Appendix A
ACGIH TLV[1]: 10 ppm/57 milligram per cubic meter TWA [skin]; confirmed animal carcinogen with unknown relevance to humans.
PAC Ver. 29[138]
PAC-1: 0.3 ppm
PAC-2: 5.9 ppm
PAC-3: 35 ppm
DFG MAK: [skin], Carcinogen Category: 2
Australia: TWA 10 ppm (60 milligram per cubic meter), [skin], carcinogen, 1993; Austria: carcinogen, 1999; Belgium: TWA 10 ppm (57 milligram per cubic meter), [skin], carcinogen, 1993; Denmark: TWA 10 ppm (60 milligram per cubic meter), 1999; Finland: TWA 10 ppm (60 milligram per cubic meter), STEL 20 ppm (120 milligram per cubic meter), carcinogen, 1999; Norway: TWA 10 ppm (60 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 60 milligram per cubic meter, 2003; United Kingdom: LTEL 10 ppm (60 milligram per cubic meter), 1993; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: confirmed animal carcinogen with unknown relevance to humans. Several states have set guidelines or standards for vinyl cyclohexene dioxide in ambient air[60] ranging from 0 (North Dakota); to 6.0 μ/m^3 (Virginia); to 150.0 μ/m^3 (Pennsylvania); to 600.0 μ/m^3 (Connecticut); to 1,429 μ/m^3 (Nevada).
Determination in Air:
No standards or PAC available. This substance may still be harmful or dangerous; follow safe work and usage practices.
Determination in Water: Octanol−water coefficient: Log K_{ow} = 1.32. Unlikely to bioaccumulate in marine organisms.
Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.
Harmful Effects and Symptoms
Short-Term Exposure: Vinyl cyclohexene dioxide can affect you when breathed in and by passing through your skin. Irritates the eyes, skin and severely irritates the nose, throat, and lungs, causing coughing and wheezing. Prolonged contact can cause severe burns and blisters.
Long-Term Exposure: Vinyl cyclohexene dioxide may cause a skin allergy to develop. If this happens, very small future exposure can cause itching and a rash. It can cause lung irritation; bronchitis may develop. A potential occupational carcinogen and a mutagen; handle with extreme caution. It may also damage the testes (male reproductive system). In animals: irritation of the eyes, skin, respiratory system; testicular atrophy; leukopenia (reduced blood leukocytes), necrosis thymus; skin sensitization.
Points of Attack: Eyes, skin, respiratory system; blood, thymus, lungs, reproductive system. Cancer site in animals: skin.
Medical Surveillance: For those with frequent or potentially high exposure (half the TLV or grater), the following are recommended before beginning work and at regular times after that. Lung function tests. If symptoms develop

or overexposure is suspected, the following may be useful: White blood cell count. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: *Eye Contact:* Immediately remove any contact lenses and flush with large amounts of water for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately.

Skin Contact: Quickly remove contaminated clothing. Immediately wash contaminated skin with large amounts of water. Seek medical attention.

Breathing: Remove the person from exposure. Begin (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility.

Ingestion: If convulsions are not present, give a glass or two of water or milk to dilute the substance. Assure that the person's airway is unobstructed and contact a hospital or poison center immediately for advice on whether or not to induce vomiting.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At concentrations above the NIOSHR EL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from heat or flames, water, alcohols, amines. Sources of ignition, such as smoking and open flames are prohibited where this chemical is used, handled, or stored in a manner that could create A potential fire or explosion hazard. Metal containers involving the transfer of 5 gal or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN2810 Toxic liquids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling:

Toxic liquids, organic, n.o.s.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 0.7/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 1000/300
Then: Protect persons downwind (mi/km)
Day 1.1/1.8
Night 2.8/4.5

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a combustible liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Concentrated waste containing no peroxides: discharge liquid at a controlled rate near a pilot flame. Concentrated waste containing peroxides: perforation of a container of the waste from a safe distance followed by open burning.

References

(109); (102); (31); (173); (101); (138); (100).

National Institute for Occupational Safety and Health (NIOSH), Information Profiles on Potential Occupational Hazards: Vinyl Cyclohexene Dioxide, pp 54−57, Report PB-276,678, Rockville, MD (October 1977)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Vinyl Cyclohexene Dioxide, Trenton, NJ (August 2005).

Vinyl Fluoride V:0210

Formula: C_2H_3F; $CHF{=}CH_2$

Synonyms: Ethene, fluoro-; Ethylene fluoro-; Fluorethylene; Fluoroethene; Fluoruro de vinilo (Spanish); Monofluroethylene; Vinyl fluoride monomer

CAS Registry Number: 75-02-5

HSDB Number: 807

RTECS Number: YZ7351000

UN/NA & ERG Number: UN1860 (stabilized)/116 (P)

EC Number: 200-832-6

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Carcinogenicity: NTP 13th Report on Carcinogens, 2014: Reasonably anticipated to be a human carcinogen; IARC: Animal, Sufficient Evidence; Human, Inadequate Evidence, Group 2A, 1995.

California Proposition 65 Chemical[102]: Cancer 5/1/1997

Hazard Alert: Extremely flammable gas, Asphyxiation hazard, Contact with liquid may cause frostbite, Polymerization hazard, Possible risk of forming tumors, Suspected of causing genetic defects.

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg)

United States National Primary Drinking Water Regulations: MCLG = 4 mg[F]/L; MCL = 4 mg[F]/L; SMCL = 2.0 mg [F]/L, as Fluoride.

Hazard symbols, risk, & safety statements: Hazard symbol: F+, Xn; risk phrases: R2; R12; R19; R20/21/22; R40; R62; safety phrases: S1; S9; S16; S23; S36/37/39; S41; S45 (see Appendix 4)

Description: Vinyl fluoride is a colorless gas. Molecular weight = 46.1; specific gravity (H_2O:1) = 0.63.5 @ 20°C; boiling point = −72°C; freezing/melting point = −161°C; relative vapor density (air = 1) = 1.60; vapor pressure = 25.2 atm; flash point = flammable gas; autoignition temperature = 385°C. Explosive limits: LEL = 2.6%; 26,000 ppm; UEL: 21.7%. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 4, reactivity 2. Insoluble in water.

Potential Exposure: Vinyl fluoride's primary use is as a chemical and polymer intermediate; used to make polyvinyl fluoride (Tedlar) film. Polyvinyl fluoride film is characterized by superior resistance to weather, high strength; and a high dielectric constant. It is used as a film laminate for building materials and in packaging electrical equipment. Polyvinyl fluoride film poses a hazard, so it is not recommended for food packaging. Polyvinyl fluoride evolves toxic fumes upon heating.

Incompatibilities: May polymerize. Inhibited with 0.2% terpenes to prevent polymerization. Violent reaction with oxidizers. May accumulate static electrical charges.

Permissible Exposure Limits in Air

NIOSH IDLH = Not determined; suspected occupational carcinogen

Conversion factor: 1 ppm = 1.82 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: None

NIOSH REL: 1 ppm TWA; 5 ppm Ceiling Concentration/15 min, CFR 1910.1017

ACGIH TLV[1]: 1 ppm, Suspected Human Carcinogen

PAC Ver. 29[138]

PAC-1: 570 ppm

PAC-2: 6200 ppm (≥10% LEL, lower explosive limit but <50% LEL)

PAC-3: 37,000 ppm (LEL, lower explosive limit)

The state of South Carolina has set a guideline for vinyl fluoride in ambient air[60] of 19.0 μm^3.

Determination in Air: There is no method listed by NIOSH. However, the following method is listed for gaseous fluorides: NIOSH Analytical Method 7902[18].

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guidelines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware

2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg [F]/L. Safe Drinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg[F]/L; SMCL = 2 mg/F/L, as Fluoride.

Routes of Entry: Inhalation, skin and/or eye contact (liquid).

Harmful Effects and Symptoms

Short-Term Exposure: A CNS depressant, causing headache, dizziness, confusion, a lack of coordination; nausea, vomiting, narcosis, unconsciousness. In industrial use, inhalation of dusts of decomposed fluorocarbon polymers may cause polymer fume fever characterized by headache, aching joints; general feeling of discomfort; cough, shivering, chills, fever, rapid heartbeat and chest discomfort. Animal data indicate that concentrations at and above 30% (300,000 ppm) vinyl fluoride may cause symptoms of intoxication. Contact with the liquid may cause frostbite of the skin or eyes.

Long-Term Exposure: May be a human carcinogen. Repeated high exposures may affect kidneys. Repeated high exposures can cause deposits of fluorides in the bones (fluorosis) that may cause pain, disability and mottling of the teeth. Repeated exposure can cause nausea, vomiting, loss of appetite; diarrhea or constipation. Nosebleeds and sinus problems can also occur.

Points of Attack: Central nervous system; skeleton, kidneys.

Medical Surveillance. Lung function tests. Fluoride level in urine (use NIOSH #8308). Levels higher than 4 mg/L may indicate overexposure. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Kidney function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof or splash-proof chemical goggles and face shield when working with liquid unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *10 ppm:* CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)]; or Sa (APF = 10) (any supplied-air respirator). *25 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]. *50 ppm:* CcrFOv (APF = 50) [any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s)]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted acid gas canister]; or PaprTOv (APF = 50) [any powered, air-purifying respirator with a tight-fitting facepiece and organic vapor cartridge(s)]; or SCBAF (APF = 50) (any self-contained breathing apparatus with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *200 ppm:* SaF: Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentration or IDLH conditions:* SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Flammable gas. Color code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in a well-ventilated area away from sources of ignition. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical.

Shipping: UN1860 Vinyl fluoride, inhibited, Hazard Class: 2.1; Labels: 2.1-Flammable gas.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak

until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Stop the flow of gas if it can be done safely. If source of leak is a cylinder and the leak cannot be stopped in place, remove leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. Keep this chemical out of confined space, such as a sewer because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable gas. Thermal decomposition products may include hydrogen fluoride gas and oxides of carbon. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(109); (102); (31); (173); (101); (138); (122).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Vinyl Fluoride, Washington, DC (January 30, 1978).

New York State Department of Health, *Chemical Fact Sheet:* Vinyl Fluoride, Bureau of Toxic Substance Assessment, Albany, NY (April 1986).

Vinylidene Chloride V:0220

Formula: $C_2H_2Cl_2$

Synonyms: Clorure de vinylidene (French); Cloruro de vinildeno (Spanish); 1,1-DCE; 1,1-Dichloroethene; 1,1-Dichloroethylene; Ethene, 1,1-dichloro-; Ethylene, 1,1-dichloro-; NCI-C54262; Sconatex; *asym*-Dichloroethylene; VDC; Vinylidene chloride(II); Vinylidene dichloride; Vinylidine chloride(II)

CAS Registry Number: 75-35-4

HSDB Number: 1995 as 1,1-dichloroethylene

RTECS Number: KV9275000

UN/NA & ERG Number: UN1303 (stabilized)/130 (P)

EC Number: 200-864-0 [*Annex I Index No.*: 602-025-00-8]

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 (≥1.00% concentration).

Carcinogenicity: EPA, Cancer Classification: Group C, Possible Human Carcinogen; EPA (*inhalation*) Suggestive evidence of carcinogenic potential/(*oral*): Available data are inadequate for an assessment of human carcinogenic potential; ACGIH A4 Not classifiable as a human carcinogen; IARC: Animal, Limited Evidence; Human Inadequate Evidence*, not classifiable as carcinogenic to humans*, Group 3, 1999; Possible Human Carcinogen; NCI: Carcinogenesis Studies (gavage); no evidence: mouse, rat; NIOSH: Potential occupational carcinogen. United States Environmental Protection Agency Gene-Tox Program, Positive: Histidine reversion-Ames test; Positive/limited: Carcinogenicity-mouse/rat; Negative: Rodent dominant lethal

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112); Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg)

Hazard Alert: Exposure can be lethal, Extremely flammable, Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated, Polymerization hazard (nonstabilized), Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Environmental hazard. Listed for Tier 1 screening as an endocrine disruptor[88].

United States National Primary Drinking Water Regulations: MCLG = 0.007 mg/L; MCL = 0.007 mg/L as 1,1-Dichloroethylene

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR423, Appendix A, Priority Pollutants; Section 313 Water Priority Chemicals (57FR 41331, 9/9/1992); Toxic Pollutant (Section 401.15)

United States Environmental Protection Agency Hazardous Waste Number (RCRA No.): U078; D029

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

RCRA Toxicity Characteristic (Section 261.24), Maximum Concentration of Contaminants, regulatory level, 0.7 mg/L

RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 0.025; Nonwastewater (mg/kg), 6.0

RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L): 8010 (1); 8240 (5)

United States National Primary Drinking Water Regulations: MCL, 0.007 mg/L; MCLG, 0.007 mg/L

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T+, F+, N, Xn; risk phrases: R45; R5; R12; R19; R20; R21; R40; R50/53; R61; R62; R63; safety phrases: S1; S2; S7; S9; S16; S29; S33; S36/36; S38; S41; S45; S46; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Vinylidene chloride is a volatile liquid. Mild, sweet odor resembling chloroform. The odor threshold in air is 500 ppm. Molecular weight = 96.94; specific gravity (H_2O:1) = 1.21 @ 25°C; boiling point = 27.2 to 31.7°C @ 760 mm; freezing/melting point = −122.8°C; vapor pressure = 500 mmHg @ 25°C; flash point = −18.9°C (cc); autoignition temperature = 570°C. Explosive limits: LEL = 6.5%; UEL: 15.5%. Hazard identification (based on NFPA-704 M Rating System): Health 4, flammability 4, reactivity 2. Practically insoluble in water; solubility = 0.04%.

Potential Exposure: Vinylidene chloride is used in the manufacture of 1,1,1-trichloroethane (methyl chloroform). However, the manufacture of polyvinylidene copolymers is the major use of VDC. The extruded films of the copolymers are used in packaging and have excellent resistance to water vapor and most gases. The chief copolymer is Saran (polyvinylidene chloride/vinyl chloride), a transparent film used for food packaging. The films shrink when exposed to higher than normal temperatures. This characteristic is advantageous in the heat-shrinking of overwraps on packaged goods and in the sealing of the wraps. Applications of VDC latexes include mixing in cement to produce high-strength mortars and concretes, and as binders for paints and nonwoven fabrics providing both water resistance and nonflammability. VDC polymer lacquers are also used in coating films and paper. VDC is also used to produce fibers. Monofilaments, made by extruding the copolymer, are used in the textile industry as furniture and automobile upholstery; drapery fabric; outdoor furniture; venetian-blind tape; and filter cloths.

Incompatibilities: Readily forms explosive peroxides; violent polymerization from heat or on contact with oxidizers, chlorosulfonic acid; nitric acid; or oleum; or under the influence of oxygen, sunlight, alkali metals; aluminum, copper. Explosive on heating or on contact with flames. Inhibitors, such as the monomethyl ether of hydroquinone are added to prevent polymerization.

Permissible Exposure Limits in Air OSHA PEL: None

NIOSH PEL: None

NIOSH REL: Potential occupational carcinogen. Limit exposure to lowest feasible concentration. See *NIOSH Pocket Guide*, Appendix A

ACGIH TLV[1]: 5 ppm/20 milligram per cubic meter TWA; A4-Not classifiable as a human carcinogen

PAC Ver. 29[138]

PAC-1: 45 ppm

PAC-2: $\mathbf{500_E}$ ppm

PAC-3: $\mathbf{1000_E}$ ppm

*ERPG [Emergency Response Planning Guidelines] are marked with a subscript "**E**."

DFG MAK: 2 ppm/8.0 milligram per cubic meter; Peak Limitation Category II(2); Carcinogen Category 3B; Pregnancy Risk Group C.

Australia: TWA 5 ppm (20 milligram per cubic meter), STEL 20 ppm, 1993; Austria: MAK 2 ppm (8 milligram per cubic meter), Suspected: carcinogen, 1999; Belgium: TWA 5 ppm (20 milligram per cubic meter), STEL 20 ppm (79 milligram per cubic meter), 1993; Denmark: TWA 2 ppm (8 milligram per cubic meter), 1999; Finland: TWA 10 ppm (40 milligram per cubic meter), STEL 20 ppm (80 milligram per cubic meter), carcinogen, 1999; France: VME 5 ppm (20 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 20 milligram per cubic meter, 2003; Poland: MAC (TWA) 50 milligram per cubic meter; MAC (ST EL) 80 milligram per cubic meter, 1999; Russia: STEL 50 milligram per cubic meter, 1993; Sweden: NGV 5 ppm (20 milligram per cubic meter), KTV 10 ppm (40 milligram per cubic meter), 1999; Switzerland: MAK-W 2 ppm (8 milligram per cubic meter), KZG-W 4 ppm (16 milligram per cubic meter), 1999; United Kingdom: TWA 10 ppm (40 milligram per cubic meter), 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: not classifiable as a human carcinogen. Several states have set guidelines or standards for Vinylidene chloride in ambient air[60] ranging from 0.2 μ/m^3 (Massachusetts); to 0.238 μ/m^3 (Kansas); to 3.5 μ/m^3 (Virginia); to 24.0 μ/m^3 (Pennsylvania); to 66.7 μ/m^3 (New York); to 120.0 μ/m^3 (North Carolina); to 200.0 μ/m^3 (Indiana); to 400.0 μ/m^3 (Connecticut); to 476.0 μ/m^3 (Nevada); to 200.0−10,000 μ/m^3 (North Dakota).

Determination in Air: NIOSH Analytical Method (IV) #1015, Vinylidene chloride, OSHA Analytical Method 19.

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 7 μg/L; Federal Drinking Water Guidelines: EPA 7 μg/L; State Drinking Water Standards: California 6 μg/L; New Jersey 2 μg/L; State Drinking Water Guidelines: Arizona 7 μg/L; Maine 0.6 μg/L; Minnesota 200 μg/L.

Determination in Water: Inert gas purge followed by gas chromatography with halide specific detection (EPA Method 601) or gas chromatography plus mass spectrometry (EPA

Method 624). Octanol—water coefficient: Log $K_{ow} = 1.32$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, skin absorption; ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Highly poisonous; this chemical has lethal potential. Vinylidene chloride can affect you when breathed and by passing through skin. Exposure can irritate the eyes, nose and throat. Contact can irritate and burn the eyes and skin. High levels may affect the CNS, causing dizziness, headache, nausea, dyspnea (breathing difficulty), a "drunken" feeling; unconsciousness. Swallowing the liquid may cause chemical pneumonitis.

Long-Term Exposure: Handle with extreme caution. A potential occupational carcinogen. Repeated or prolonged contact with skin may cause dermatitis with drying and cracking. Repeated exposure may damage the liver, kidneys and/or lungs. It may damage the developing fetus and cause reproductive damage in males.

Points of Attack: Eyes, skin, respiratory system; central nervous system; liver, kidneys. Cancer site in animals: liver and kidney tumors; skin.

Medical Surveillance: This chemical is a suspected human carcinogen, with conflicting data. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. For those with frequent or potentially high exposure (half the TLV or greater, or significant skin contact), the following are recommended before beginning work and at regular times after that. Lung function tests. Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. If victim is *conscious*, administer water, or milk. Do not induce vomiting.

Note to Physician: Inhalation: bronchodilators, decongestants and oxygen may be used if necessary. Corticosteroids are useful for treating pneumonitis.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv100 (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter]; or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Check oxygen content prior to entering storage area. Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. May form peroxides in storage. High concentrations cause a deficiency of oxygen with the risk of unconsciousness or death. Check that oxygen content is at least 19% before entering storage or spill area. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration is not present. Vinylidene chloride must be stored to avoid contact with oxidizers, such as perchlorates, peroxides, permanganates, chlorates, and nitrates; and strong acids; such as hydrochloric, sulfuric, and nitric, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from sources of heat. Protect storage containers from physical damage. Sources of ignition, such as smoking and open flames are prohibited where vinylidene chloride is handled, used, or stored. Metal containers involving the transfer of 5 gal or more of vinylidene chloride should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of vinylidene chloride. Wherever vinylidene chloride is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101

and 1910.169, as with the recommendations of the Compressed Gas Association.

Shipping: UN1303 Vinylidene chloride, stabilized, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include phosgene, hydrogen chloride, chlorine, and oxides of carbon. Do not extinguish fire unless flow can be stopped. Use dry chemical, carbon dioxide; or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier. Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform to EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced[22].

References

(31); (173); (101); (138); (100).

The National institute for Occupational Safety and Health (NIOSH), Vinyl Halides-Carcinogenicity, Current Intelligence Bulletin No. 28, Washington, DC (September 21, 1978).

United States Environmental Protection Agency, Dichloroethylenes: Ambient Water Quality Criteria, Washington, DC (1980).

United States Environmental Protection Agency, Status Assessment of Toxic Chemicals: Vinylidene Chloride, Report EPA-600/2-79-210a, Cincinnati, OH (December 1979).

United States Environmental Protection Agency, 1,1-Dichloroethylene, Health and Environmental Effects Profile No. 71, Office of Solid Waste, Washington, DC (April 30, 1980).

United States Environmental Protection Agency, Dichloroethylenes, Health and Environmental Effects Profile No. 73, Office of Solid Waste, Washington, DC (April 30, 1980).

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," Volume 2, No. 6, 92−94 (1982).

United States Public Health Service, "Toxicological Profile for 1,1-Dichloroethene," Atlanta, Georgia, agency for Toxic Substances and Disease Registry (December 1988).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Vinylidene Chloride, Trenton, NJ (August 2002).

Vinylidene Fluoride V:0230

Formula: $C_2H_2F_2$; $CH_2{=}CF_2$

Synonyms: 1,1-Difluoroethylene; Ethene, 1,1-difluoro-; Fluoruro de vinilideno (Spanish); Genetron; Halocarbon 1132A; NCI-C60208; R1132A; Refrigerant gas, R 1132a; VDF; Vinylidene difluoride

CAS Registry Number: 75-38-7

HSDB Number: 5206

RTECS Number: KW0560000

UN/NA & ERG Number: UN1959/116 (P)

EC Number: 200-867-7

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity (pounds): *Release hazard* 10,000 ($\geq$1.00% concentration).

Carcinogenicity: IARC: Animal, Inadequate Data; Human No Adequate Data, *not classifiable as carcinogenic to humans*, Group 3, 1999

Hazard Alert: Extremely flammable gas, Polymerization hazard (high), Possible risk of forming tumors, Suspected of causing genetic defects, Frostbite/Cryogenic burn hazard, Asphyxiation hazard, Contains gas under pressure; may explode if heated.

Clean Air Act: Accidental Release Prevention/Flammable Substances, (Section 112[r], Table 3), TQ = 10,000 lb (4540 kg)

United States National Primary Drinking Water Regulations: MCLG = 4 mg[F]/L; MCL = 4 mg[F]/L; SMCL = 2.0 mg [F]/L, as Fluoride.

Hazard symbols, risk, & safety statements: Hazard symbol: F+; risk phrases: R5; R12; R19; R21; R61; R62; safety phrases: S1; S7/9; S14; S16; S33; S38; S41; S45 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. [3-Severe hazard to water. (est.)]

Description: Vinylidene fluoride is a colorless gas. Faint ethereal odor. Shipped as a liquefied compressed gas. Molecular weight = 64; boiling point = −85.6°C; freezing/melting point = −144°C; vapor pressure = 35.2 atm; flash point (flammable gas) ≤ −65°C; autoignition temperature = 640°C. Explosive limits: LEL = 5.5%; 30,000[138]; UEL: 21.3%. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 4, reactivity 0. Slightly soluble in water.

Potential Exposure: Vinylidene fluoride is used in the formulation of many polymers and copolymers, such as chlorotrifluoroethylene-vinylidene fluoride (Kel F), perfluoropropylene-vinylidene fluoride (Viton, Fluorel); polyvinylidene fluoride; and hexafluoropropylene-*tetra*-fluoroethylene-vinylidene fluoride; elastomeric copolymers. It is also used as a chemical intermediate in organic synthesis. NIOSH has estimated 32,000 workers are exposed annually.

Incompatibilities: Severe polymerization hazard. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, aluminum chloride. Capable of forming unstable peroxides, which can cause explosive polymerization. It can re act violently with hydrogen chloride. Alkyl boron and alkyl hyponitrite compounds initiate polymerization. It will form peroxides on exposure to pure oxygen[193]. May accumulate static electricity, and cause ignition of its vapors.

Permissible Exposure Limits in Air

NIOSH IDLH = Not determined; suspected occupational carcinogen

Conversion factor: 1 ppm = 2.62 milligram per cubic meter @ 25°C & 1 atm

OSHA PEL: None

NIOSH REL: 1 ppm TWA; 5 ppm Ceiling Concentration [15 min], use 29CFR1910.1017

ACGIH TLV[1]: 500 ppm/1310 milligram per cubic meter TWA, Not classifiable as a human carcinogen

PAC Ver. 29[138]

PAC-1: 1500 ppm

PAC-2: 5600 ppm

PAC-3: 11,000 ppm (=>10% LEL, lower explosive limit but <50% LEL)

DFG MAK: Carcinogen Category 3B

Austria: Suspected: carcinogen, 1999; Finland: carcinogen, 1993

Determination in Air: NIOSH Analytical Method #3800[18].

Permissible Concentration in Water: Federal Drinking Water Standards: EPA 4000 μg[F]/L; Federal Drinking Water Guidelines: EPA 2000 μg[F]/L; State Drinking Water Standards: California 2000 μg[F]/L; Delaware 2000 μg[Fl]/L; Pennsylvania 2000 μg[Fl]/L; State Drinking Water Guidelines: Arizona 4000 μg[F]/L; Maine 1680 μg[F]/L. Safe Drinking Water Act: MCL = 4 mg[F]/L; MCLG = 4 mg[F]/L; SMCL = 2 mg/F/L, as Fluoride.

Harmful Effects and Symptoms

Short-Term Exposure: Irritating to skin and pulmonary tract. May affect the CNS, causing dizziness, disorientation, headache, a lack of coordination; narcosis, dizziness, nausea, vomiting. Contact with the liquid or gas can cause burns or frostbite. Vinylidene fluoride is considered toxic by inhalation.

Long-Term Exposure: Repeated high exposures may affect kidneys. Repeated high exposures may cause deposits of fluorides in the bones (fluorosis) that may cause pain, disability, and mottling of the teeth.

Points of Attack: Eyes, respiratory system; central nervous system; skeleton, kidneys, skin.

Medical Surveillance. Lung function tests. Fluoride level in urine (use NIOSH #8308). Levels higher than 4 mg/L may indicate overexposure. If symptoms develop or overexposure is suspected, the following may be useful: consider chest X-ray after acute overexposure. Kidney function tests. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 20 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. If frostbite has occurred, seek medical attention immediately; do *NOT* rub the affected areas or flush them with water. In order to prevent further tissue damage, do *NOT* attempt to remove frozen clothing from frostbitten areas. If frostbite has *NOT* occurred, immediately and thoroughly wash contaminated skin with soap and water.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Viton, and butyl rubber are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear gas-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *Up to 10 ppm:* CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)]; or Sa (APF = 10) (any supplied-air respirator). *Up to 25 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]. *Up to 50 ppm:* CcrFOv (APF = 50) [any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s)]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or PaprTOv (APF = 50) [any powered, air-purifying respirator with a tight-fitting facepiece and organic vapor cartridge(s)]; or SCBAF (APF = 50) (any self-contained breathing apparatus with a full facepiece); or SaF(APF = 50) (any supplied-air respirator with a full facepiece); *Up to 200 ppm:* SaF:Pd,Pp (APF = 2000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode) *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Check oxygen content prior to entering storage area. Flammable gas. Color code—Red Stripe: Flammability Hazard: Store separately from all other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. May form peroxides in storage. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store gas cylinders in a cool, dry place and use the safety precautions necessary with all compressed gases. High concentrations cause a deficiency of oxygen with the risk of unconsciousness or death. Check that oxygen content is at least 19% before entering storage or spill area. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. Compressed gas cylinders should be affixed to a wall. Procedures for the handling, use and storage of cylinders should be in compliance with OSHA 1910.101 and 1910.169, as with the recommendations of the Compressed Gas Association. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN1959 Vinylidene fluoride shipped as 1,1-Difluoroethylene or Refrigerant gas R-1132a, Hazard Class: 2.1; Labels: 2.1-Flammable gas. Cylinders must be transported in a secure upright position, in a well-ventilated truck. Protect cylinder and labels from physical damage. The owner of the compressed gas cylinder is the only entity allowed by federal law (49CFR) to transport and refill them. It is a violation of transportation regulations to refill compressed gas cylinders without the express written permission of the owner.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit and to disperse the gas. Stop the flow of gas if it can be done safely. If source of leak is a cylinder and the leak cannot be stopped in place, remove leaking cylinder to a safe place in the open air, and repair leak or allow cylinder to empty. Keep this chemical out of confined space, such as a sewer because of the possibility of explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable gas. Thermal decomposition products may include hydrogen fluoride, fluorine, and fluorides. Extinguish with CO_2, or dry chemical to allow access to valves to shut off supply if necessary. Do not extinguish the fire unless the flow of gas can be stopped and any remaining gas is out of the line. Specially trained personnel may use fog lines to cool exposures and let the fire burn itself out. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If cylinders are exposed to excessive heat from fire or flame contact, withdraw immediately to a secure location. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Return refillable compressed gas cylinders to supplier.

References

(31); (173); (101); (138); (122); (100); (193).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Vinylidene Fluoride, Washington, DC (January 30, 1978).

Vinyl Toluene V:0240

Formula: C_9H_{10}; $CH_3C_6H_4CH{=}CH_2$

Synonyms: Ethenylmethylbenzene; *m*-Methyl styrene; *p*-Methyl styrene; 3-and 4-Methyl styrene; Methyl styrene; NCI-C56406; Tolyethylene; *m*-Vinyl toluene; *p*-Vinyl toluene; *p*-Vinyltoluene; Vinyl toluene, inhibited; Vinyl toluene, mixed isomers;

CAS Registry Number: 25013-15-4 (mixed isomers); *(alt.)* 1321-45-5; 100-80-1 (*m*-isomer)

HSDB Number: 1035

RTECS Number: WL5075000

UN/NA & ERG Number: UN2618 (stabilized)/130 (P)

EC Number: 246-562-2

Regulatory Authority and Advisory Information

Carcinogenicity: NCI: Carcinogenesis Studies (inhalation); no evidence: mouse, rat; IARC: Animal Lack Carcinogenicity; Human Inadequate Evidence*, not classifiable as carcinogenic to humans*, Group 3, 1994; NTP: Carcinogenesis studies (α-isomer); on test (prechronic studies), October 2000

Hazard Alert: Combustible, Polymerization hazard >30°C, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected repro toxic hazard, Primary irritant (w/o allergic reaction); (*m*-isomer) Possible risk of forming tumors, Suspected repro toxic hazard.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects[293]. Toxic to aquatic life with long-lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: Xi, Xn; risk phrases: R10; R19; R20; R22; R36/37/38; R41; R51/53; R62, R63, R65; safety phrases: S7; S23; S26; S36; S39; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water. (Lit.)

Description: Vinyl toluene is a colorless liquid. Strong disagreeable odor. It consists of mixed *meta*-and *para*-isomers. The odor threshold is 50 ppm. Molecular weight = 118.19; specific gravity (H_2O:1) = 0.89 @ 25°C; boiling point = 170.6°C; freezing/melting point = −76.7°C; flash point = 54.4°C; autoignition temperature = 538°C; also listed @ 489−515°C. Explosive limits: LEL = 0.8%; UEL: 11.0%. Hazard identification (based on NFPA-704 M Rating System): Health 2, flammability 2, reactivity 2. Practically insoluble in water; solubility = 0.009%.

Potential Exposure: (mixed isomers): Vinyl toluene is used in copolymers and as specialty monomer for paint, varnish, and polyester preparations; as a solvent and an organic intermediate.

Incompatibilities: Vapors may form explosive mixture with air. Violent reaction with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, catalysts for vinyl polymerization, such as peroxides, strong acids; iron or aluminum salts. Usually inhibited with *tert*-butylcatechol to prevent polymerization.

Permissible Exposure Limits in Air

NIOSH IDLH = 400 ppm

Conversion factor: 1 ppm = 4.83 milligram per cubic meter @ 25°C & 1 atm

methyl styrene, all isomers

OSHA PEL: 100 ppm/480 milligram per cubic meter TWA

NIOSH REL: 100 ppm/480 milligram per cubic meter TWA

ACGIH TLV[1]: 50 ppm/242 milligram per cubic meter TWA; 100 ppm/483 milligram per cubic meter STEL, Not classifiable as a human carcinogen

PAC not available

DFG MAK: 100 ppm/490 milligram per cubic meter TWA; Peak Limitation Category I(2)

Australia: TWA 50 ppm (240 milligram per cubic meter), STEL 100 ppm, 1993; Austria: MAK 100 ppm (480 milligram per cubic meter), 1999; Belgium: TWA 50 ppm (242 milligram per cubic meter), STEL 100 ppm (483 milligram per cubic meter), 1993; Denmark: TWA 25 ppm (120 milligram per cubic meter), [skin], 1999; Finland: TWA 50 ppm (240 milligram per cubic meter), STEL 100 ppm (480 milligram per cubic meter), 1999; France: VME 50 ppm (240 milligram per cubic meter), 1999; the Netherlands: MAC-TGG 50 milligram per cubic meter, [skin], 2003; the Philippines: TWA 100 ppm (480 milligram per cubic meter), 1993; Poland: MAC (TWA) 100 milligram per cubic meter; MAC (STEL) 300 milligram per cubic meter, 1999; Russia: STEL 50 milligram per cubic meter, 1993; Sweden: NGV 10 ppm (50 milligram per cubic meter), KTV 75 ppm (150 milligram per cubic meter), [skin], 1999; Switzerland: MAK-W50 ppm (240 milligram per cubic meter) KZG-W 100 ppm (480 milligram per cubic meter), 1999; Turkey: TWA

100 ppm (480 milligram per cubic meter), 1993; United Kingdom: TWA 100 ppm (491 milligram per cubic meter), STEL 150 ppm, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 100 ppm. Several states have set guidelines or standards for vinyl toluene in ambient air[60] ranging from 40 μ/m^3 (Virginia); to 2400.0 to 4850.0 μ/m^3 (North Dakota); to 5714 μ/m^3 (Nevada); to 9600.0 μ/m^3 (Connecticut).

m-isomer

Denmark: TWA 25 ppm (120 milligram per cubic meter), [skin], 1999; France: VME 50 ppm (240 milligram per cubic meter), 1999; Switzerland: MAK-W50 ppm (240 milligram per cubic meter), KZG-W 100 ppm (480 milligram per cubic meter), 1999; United Kingdom: TWA 100 ppm (491 milligram per cubic meter), STEL 150 ppm, 2000

Determination in Air: Use NIOSH Analytical Method (IV) #1501, aromatic hydrocarbons, OSHA Analytical Method 7.

Determination in water: Octanol−water coefficient: Log $K_{ow} => 3.5$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Vinyl toluene can affect you when breathed in. Exposure can irritate the eyes, nose, and upper respiratory system. A CNS depressant; very high levels can cause you to become dizzy, lightheaded, and drowsy. In animals: narcosis.

Long-Term Exposure: Repeated exposure may affect the liver, kidneys, and nervous system. There is limited evidence that vinyl toluene may damage the developing fetus.

Points of Attack: Eyes, skin, respiratory system; central nervous system.

Medical Surveillance: Liver and kidney function tests. Evaluation of the nervous system.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Do not induce vomiting.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *400 ppm:* CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)]; or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]; or GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or Sa (APF = 10) (any supplied-air respirator); or SCBAF (APF = 50) (any self-contained breathing apparatus with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color code—Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Vinyl toluene must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates); strong acids and aluminum chloride, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames are prohibited where this chemical is used, handled, or stored in a manner that could create A potential fire or explosion hazard. Metal containers involving the transfer of 5 gal or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical.

Shipping: UN2618 Vinyltoluenes, stabilized, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Oil-skimming equipment and sorbent foams can be app lied to slick if done immediately. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid and a polymerization hazard >30°C. Containers may explode in fire. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; alcohol foam; or polymer foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Vinyl Toluene, Trenton, NJ (November 2000).

VX (Agent VX) V:0250

Formula: $C_{11}H_{26}NO_2PS$

Synonyms: *S*-(2-Diisopropylaminoethyl) *O*-ethyl methylphosphonothiolate; *EA-1701; O*-Ethyl *S*-(2-[bis(1-methylethyl)amino] ethyl) methylphosphonothioate; Ethyl *S*-diiosoropylaminoethylmethylthiophosphonate; *O*-Ethyl *S*-diisopropylamino ethyl methylphosphono thioate; Ethyl *S*-dimethylaminoethyl methyl phosphono thiolate; Methylphosphonothioic acid, *S*-(2-[bis(methylethyl)amino] ethyl) *O*-ethyl ester; Methylphosphono thioic acid, *S*-[2-bis (1-methylethyl)amino]ethyl) *O*-ethyl ester; Phosphonothioic acid, methyl-, *S*-[2-[bis(1-methylethyl)aminoethyl] *O*-ethyl] ester; Phosphono thioic acid, methyl-, S-[2-[bis(1-methylethyl)amino]ethyl] O-ethyl; ester; TX-60; VX (military designation)

CAS Registry Number: 50782-69-9

HSDB Number: 6459

RTECS Number: TB1090000

UN/NA & ERG Number: (PIH) UN2810 (Toxic liquids, organic, n.o.s.)/123

EC Number: None assigned

Regulatory Authority and Advisory Information

Department of Homeland Security Screening Threshold Quantity: *Theft hazard* CUM 100 g.

Carcinogenicty: VX is not listed by the International Agency for Research on Cancer (IARC, American Conference of Governmental Industrial Hygienists (ACGIH); Occupational Safety and Health Administration (OSHA); or National Toxicology Program (NTP) as a carcinogen.

Hazard Alert: Poison inhalation hazard: exposure can be lethal, Dangerous nerve agent, Combustible liquid, Suspected reprotoxic hazard, Environmental hazard.

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 100 lb (45.4 kg)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)

United States DOT 49CFR172.101, Inhalation Hazardous Chemical *Note:* Army Regulation, AR 50-6, deals specifically with the shipment of chemical agents; must be escorted in accordance with Army Regulation, AR 740-32.

Description: VX, a sulfinated organophosphorus compound, is a nerve agent, and the most toxic of all known chemical warfare agents. VX can cause death in minutes. As little as one drop of VX on the skin can be fatal. VX is a colorless, to straw to amber-colored, odorless liquid. Looks like motor oil. Molecular weight = 267.4; boiling point = 298°C (decomposition); freezing/melting point = −51°C; volatility = 8.9−10.5 milligram per cubic meter @ 25°C; vapor density (air = 1): 9.2; vapor pressure = 0.0007 mmHg @ 25°C; vapor density (air = 1) = 9.2; flash point = 159°C. Hazard identification (based on NFPA-704 M Rating System): Health 4, flammability 1, reactivity 0. Slightly to moderately soluble in water below 9.4°C; 30 g/L @ 25°C. See “Medical Surveillance” below for odor detection.

Potential Exposure: VX is a quick-acting, military chemical nerve agent. VX is the most potent of all chemical warfare agents. It attacks the nervous system, causing the muscles to convulse uncontrollably. The nerve agent works similarly to pesticide and was originally developed in the early 1950s. Highly persistent, it can be dangerous for weeks and remains a liquid for more than 24 hours. It poses little vapor hazard. The least volatile of the nerve agents, VX, is very slow to evaporate; about as slowly as motor oil. VX is highly efficient at skin penetration, more than any other of the "G" agents. It is used in the M-23 land mine. VX was never used in combat by the United States and all stockpiles of approximately 4400 t of the Agent were destroyed in 2008 by the United States Army Chemical Materials Agency (CMA).

Persistence of Chemical Agent: Agent VX: Summer: 2 days to a week; Winter: 2 days to weeks.

Incompatibilities: Relatively stable at room temperature. Unstabilized VX of 95% purity decomposed at a rate of 5% a month @ 71°C. Relatively stable at room temperature. Unstabilized VX of 95% purity decomposes at a rate of 5% a month @ 71°C. At pH 12, the toxic by-product has a half-life of about 14 days and in 90 days there is about a 64-fold reduction. Organophosphates are susceptible to formation of highly toxic and flammable phosphine gas in the presence of strong reducing agents such as hydrideds and active metals. Partial oxidation by oxidizing agents may result in the release of toxic phosphorus oxides[101] Contact with metals may evolve flammable hydrogen gas.

Permissible Exposure Limits in Air

Conversion factor: 0.09145 ppm = 1 milligram per cubic meter

PAC VX*

PAC-1: **0.000016_A ($1.60E-05_A$)** ppm

PAC-2: **0.00027_A ($2.70E-04_A$)** ppm

PAC-3: **$9.10E-04_A$** ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.

WPL (worker population limit): 0.000001 milligram per cubic meter

The suggested permissible airborne exposure concentration of VX for an 8 hour work-day or a 40 hour work week is an 8 hour time weighted average (TWA) of 0.00001 milligram per cubic meter (9×10^{-7} ppm). This value is based on the TWA of VX as proposed in the USAEHA Technical Guide No. 169, *Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Nerve Agents GA, GB, GD, and VX.*

GPL (general population limit): 0.0000006 milligram per cubic meter

Determination in Air: Available monitoring equipment for agent VX is the M8/M9 detector paper, (ACADA), detector ticket; M256/M256A1 kits; bubbler. Depot Area Air Monitoring System (DAMMS); automated Continuous Air Monitoring System (ACMS); Real-Time Monitor (RTM); Demilitarization Chemical Agent Concentrator (DCAC); M8/M43, M8A1/M43A1, CAM-M1, Hydrogen Flame Photometric Emission Detector (HYFED); and the Minature Chemical Agent Monitor (MINICAM)

Determination in Water: Octanol−water coefficient: Log K_{ow} (estimated) = 2.06. Unlikely to bioaccumulate in marine organisms. VX is hydrolyzed only slowly, and the hydrolysis products include EA2192, which is nearly as toxic as VX and is hydrolyzed over 1000 times more slowly. Oxidation using common bleach (Na(OCl) and superchlorinated bleach ($Ca(OCl)_2$)-calcium hypochlorite (HTH), will decontaminate.

Permissible Concentration in Water: No criteria set.

Routes of Entry: Inhalation, skin and/or eye contact.

Harmful Effects and Symptoms

Cholinesterase inhibitor. Lowest toxic oral dose (TD_{LO}) (humans) = 4 mg/kg; lowest lethal skin dose to humans (LD_{LO}) = 86 mg/kg. Death within 15 minutes after fatal dose is absorbed[101].

Summary: Exposure can result in loss of consciousness, convulsions, paralysis, and respiratory failure resulting in death.

Short-Term Exposure: VX. Acts as a cholinesterase inhibitor. Lowest toxic oral dose (TD_{LO}) to humans is 4 mg/kg; lowest lethal skin dose to humans (LD_{LO}) is 86 mg/kg. Death occurs within 15 minutes after fatal dose is absorbed. *Also reported:* VX is a lethal anticholinergic agent with the median dose in humans being: LC_{50} (skin) = 0.135 mg/kg; ID LC_{50} (Skin)-0.07−0.71 mg/kg; LCt_{50} (inhalation) = 30 mg min/m^3; LCt_{50} (inhalation)-30 mg min/m^3; LCt_{50} (inhalation)-24 mg min/m^3.

One to several minutes after overexposure to airborne VX the following acute symptoms appear: *Local effects* (lasting 1−15 days, increases with dose). *Eyes*: Miosis (constriction of pupils); redness, pressure sensation on eyes. *Inhalation*: Rhinorrhea (runny nose), nasal congestion; tightness in chest; wheezing, salivation, nausea, vomiting. *Systemic effects* (increases with dose): *Inhalation*-excessive secretion causing coughing/breathing difficulty; salivation and sweating; vomiting, diarrhea, stomach cramps; involuntary urination/defecation; generalized muscle twitching/muscle cramps; CNS depression including anxiety, restlessness, giddiness, insomnia, excessive dreaming and nightmares. With more severe exposure, also headache, tremor, drowsiness, concentration difficulty; memory impairment; confusion, unsteadiness on standing or walking; and progressing to death.

After exposure to liquid VX, the following acute symptoms appear: Local Effects: Eyes: Miosis, redness, pressure sensation on eyes. *Ingestion*: salivation, anorexia, nausea, vomiting, abdominal cramps; diarrhea, involuntary defecation; heartburn. *Skin:* Sweating, muscle twitching. Systemic Effects: Similar to generalized effects from exposure to airborne material.

Long-Term Exposure: Chronic overexposure to VX causes forgetfulness, thinking difficulty; vision disturbances; muscular aches/pains. Although *cer*-organophosphate pesticides have been shown to be teratogenic in animals, these effects have not been documented in carefully controlled toxicological evaluations for VX[United States Army].

Medical Surveillance: A CAM can detect VX at 0.1 milligram per cubic meter. The United States military also has the following detectors for VX and other chemical agents: *M256A1 Chemical Agent Detector Kit*; *M8A1 Automatic Chemical Agent Alarm.* Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered.

First Aid: Immediate decontamination of the smallest drop is essential. For decontamination, the *M291 Skin Decontamination Kit* should be used.

Inhalation: Hold breath until respiratory protective mask is donned. If severe signs of agent exposure appear (chest tightens, pupil constriction; lack of coordination, etc.), immediately administer, in rapid succession; all three Nerve Agent Antidote Kit(s), *Mark 1* injectors (or atropine if directed by the local physician). Injections using the Mark I kit injectors may be repeated @ 5 to 20 minute intervals if signs and symptoms are progressing until three series of injections have been administered. No more injections will be given unless directed by medical personnel. In addition, a record will be maintained of all injections given. If breathing has stopped, give artificial respiration. Mouth-to-mouth resuscitation should be used when approved mask-bag or oxygen delivery systems are not available. Do not use mouth-to-mouth resuscitation when facial contamination exists. If breathing is difficult, administer oxygen. Seek medical attention *immediately*.

Eye contact: Immediately flush eyes with water for 10−15 minutes, then don respiratory protective mask. Although miosis (pinpointing of the pupils) may be an early sign of agent exposure, an injection will not be administered when miosis is the only sign present. Instead, the individual will be taken immediately to the medical treatment facility for observation.

Skin contact: Don respirator with protective mask and remove contaminated clothing. Immediately wash contaminated skin with a solution of 5% household bleach. Rinse well with water to remove excess bleach followed by copious soap and water wash. Administer nerve agent antidote kit, Mark I, only if local sweating and muscular twitching symptoms are present. Seek medical attention *immediately*.

Ingestion: do not induce vomiting. First symptoms are likely to be gastronintestinal. Immediately administer nerve agent antidote kit, Mark I. Seek medical attention *immediately*. Medical observation recommended.

***Medical treatment*:** Electrocardiogram, and adequacy of respiration and ventilation, should be monitored. Supplemental oxygenation, frequent suctioning of secretions, insertion of a tube into the trachea (endotracheal intubation), and assisted ventilation may be required. Diazepam (5 to 10 mg in adults and 0.2 to 0.5 mg/kg in children) may be used to control convulsions. Lorazepam or other benzodiazepines may be used, but barbiturates, phenytoin, and other anticonvulsants are not effective. Administration of atropine (if not already given) should precede the administration of benzodiaze pines in order to best control seizures. Patients/victims who have inhalation exposure and who complain of chest pain, chest tightness, or cough should be observed and examined periodically for 6 to 12 hours to detect delayed-onset inflammation of the large airways (bronchitis), inflammatory lung disease (pneumonia), accumulation of fluid in the lungs (pulmonary edema), or respiratory failure.

Decontamination: This is very important. The rapid physical removal of a chemical agent is essential. If you don't have the equipment and training, don't enter the hot or the warm zone to rescue and/or decontaminate victims. Medical personnel should wear the proper PPE. If the victim can't move, decontaminate without touching and without entering the hot or the warm zone. Nerve gasses stay in clothing; *do not* touch with bare skin—if possible, seal contaminated clothes and personal belongings in a sealed double bag. Use clean water from any source; if possible, use a hose (spray or fog to prevent injury to the victim) or other system to avoid touching the victim. Don't wait for soap or for the victim to remove clothing, begin washing immediately. Do not delay decontamination to obtain warm water; time is of the essence; use cold water instead. Immediately flush the eyes with water for at least 15 minutes. Use caution to avoid hypothermia in children and the elderly. Wash−strip−wash−evacuate up wind and uphill: Patients exposed to nerve agent by vapor only should be decontaminated by removing all clothing in a clean-air environment and shampooing or rinsing the hair to prevent vapor-off gassing; Patients exposed to liquid nerve agent should be decontaminated by washing in available clean water at least three times. Use liquid soap (dispose of container after use and replace), large amounts of water, and mild to moderate friction with a single-use sponge or washcloth in the first and second washes. Scrubbing of exposed skin with a brush is discouraged; skin damage may occur and may increase absorption. The third wash should be to rinse with large amounts of warm or hot water. Shampoo can be used to wash the hair. Decontaminate with diluted household bleach* (0.5%, or one part bleach to 200 parts water), but don't let any get in the victim's eyes, open wounds, or mouth. Wash off the diluted bleach solution after 15 minutes. Remember that the water you use to decontaminate the victims is dangerous. Be sure you've decontaminated the victims as much as you can before they are released from the area, so they don't spread the nerve gas. Rinse the eyes, mucous membranes; or open wounds with sterile saline or water and then move away from the hot zone in an upwind and uphill direction.

**Note*: The following can be used in addition to household bleach: (1) solids, powders and solutions containing various types of bleach (NaOCl or $Ca(OCl)_2$); (2) DS2 (2% NaOH, 70% diethylenetriamine, 28% ethylene glycol monomethyl ether); (3) towelettes moistened with sodium hydroxide (NaOH) dissolved in water, phenol, ethanol, and ammonia.

Note: Use 5% solution of common bleach (sodium HTH) or calcium HTH solution (48 oz per 5 gal of water) to decontaminate scissors used in clothing removal, clothes and other items.

Personal Protective Methods: *General information*: first responders should use a NIOSH-certified chemical, biological, radio logical, nuclear (CBRN) self-contained breathing apparatus (SCBA) with a level a protective suit when entering an area with an unknown contaminant or when entering an area where the concentration of the contaminant is unknown. Level a protection should be used until monitoring results confirm the contaminant and the concentration of the contaminant. *Note:* safe use of protective clothing and equipment requires specific skills developed through training and experience.

LEVEL A: (RED ZONE): select when the greatest level of skin, respiratory, and eye protection is required. This is the maximum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than the AEGL-2.

A NIOSH-certified CBRN full-face-piece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle. A totally encapsulating chemical protective (TECP) suit that provides protection against CBRN agents.

Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, and a hard hat worn under the TECP suit are optional items.

LEVEL B: (RED ZONE): Select when the highest level of respiratory protection is necessary but a lesser level of skin protection is required. This is the minimum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than AEGL-2. It differs from Level A in that it incorporates a nonencapsulating, splash-protective, chemical-resistant splash suit that provides Level A protection against liquids but is not airtight.

A NIOSH-certified CBRN full-face-piece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL C: (YELLOW ZONE): Select when the contaminant and concentration of the contaminant are known and the respiratory protection criteria factors for using Air Purifying Respirators (APR) or Powered Air Purifying Respirators (PAPR) are met. This level is appropriate when decontaminating patient/victims. A NIOSH-certified CBRN tight-fitting APR with a canister-type gas mask or CBRN PAPR for air levels greater than AEGL-2. A NIOSH-certified CBRN PAPR with a loose-fitting face-piece, hood, or helmet and a filter or a combination organic vapor, acid gas, and particulate cartridge/filter combination or a continuous flow respirator for air levels greater than AEGL-1. A hooded chemical-resistant suit that provides protection against CBRN agents. Chemical-resistant gloves (outer). Chemical-resistant gloves (inner). Chemical-resistant boots with a steel toe and shank. Escape mask, face shield, coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.

LEVEL D: (GREEN ZONE): Select when the contaminant and concentration of the contaminant are known and the concentration is below the appropriate occupational exposure limit or less than AEGL-1 for the stated duration times. Limited to coveralls or other work clothes, boots, and gloves.

For emergency situations, wear a "moon suit" consisting of a positive-pressure, pressure-demand, full facepiece self-contained breathing apparatus (SCBA) or pressure-demand supplied air respirator SCBA with escape cylinder in combination with a fully encapsulating, chemical resistant suit capable of maintaining a positive air pressure within the suit. *Protective gloves*: butyl glove M3 and M4; Norton chemical protective glove set. *Eye protection*: Chemical Goggles. For splash hazards use goggles and face shield.

Other protective equipment: Full protective clothing will consist of M9 mask and hood; M3 butyl rubber suit; M2A1 butyl boots; M3 and M4 gloves; unimpregnated underwear; or demilitarization protective ensemble (DPE). For laboratory operations; wear lab coats and have a protective mask readily available. In addition, daily clean smock, foot covers, and head covers will be required when handling contaminated lab animals.

Respirator Selection: *When used as a weapon, use SCBA Respirator Certified By NIOSH For CBRN Environments. Less than 0.00001 milligram per cubic meter:* M9, M17, or M40 series mask shall be available for escape as necessary. 0.00001 *milligram per cubic meter* to 0.02 *milligram per cubic meter:* M9, or M40 series mask with Level A or Level B ensemble. *Greater than 0.02 milligram per cubic meter:* or DPE or TAPES used with prior approval from AMC Field Safety Activity. *Note:* When DPE or TAPES is not available the M9 or M40 series mask with Level A protective ensemble can be used. However, use time shall be restricted to the extent operationally feasible, and may not exceed one hour. As an additional precaution, the cuffs of the sleeves and the legs of the M3 suit shall be taped to the gloves and boots respectively to reduce aspiration.

Local Exhaust: Mandatory. Must be filtered or scrubbed to limit exit conc. to <0.00001 *milligram per cubic meter* (averaged over 8 hour/day, indefinitely).

Special: Chemical laboratory hoods shall have an average inward face velocity of 100 linear feet per minute (lf/m) + 10% with the velocity at any point not deviating from the average face velocity by more than 20 percent. Laboratory hoods shall be located such that crossdrafts do not exceed 20% of the inward face velocity. A visual performance test utilizing smoke-producing devices shall be performed in assessing the ability of the hood to contain agent VX. Emergency back-up power necessary: Hoods should be tested semiannually or after modification or maintenance operations. Operations should be performed 20 cm inside hood face. *Other:* Recirculation of exhaust air from agent areas is prohibited. No connection between agent areas and other areas through ventilation system is permitted.

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. *Precautions to be taken in handling and storing:* in handling, the buddy system will be incorporated. No smoking, eating or drinking in areas containing agent is permitted. Containers should be periodically inspected for leaks (either visually or by a detector kit). Stringent control over all personnel practices must be exercised. Decontamination equipment shall be conveniently located. Exits must be designed to permit rapid evacuation. Chemical showers, eyewash stations, and personal cleanliness facilities shall be provided. Wash hands before meals and each worker will shower thoroughly with special attention given to hair, face, neck, and hands, using plenty of soap before leaving at the end of the work-day. *Other precautions:* agent must be double-contained in liquid and vapor-tight containers when in storage or when outside of the ventilation hood.

Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames are prohibited where this chemical is used, handled, or stored in a manner that could create A potential fire or explosion hazard.

Shipping: UN2810 Toxic liquids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poison Inhalation Hazard, Technical Name Required. Military driver shall be given full and complete information regarding shipment and conditions in case of emergency. AR 50-6 deals specifically with the shipment of chemical agents. Shipments of agent will be escorted in accordance with AR 740-32. Packing Group: 1.

Spill Handling:

UN2810 Toxic liquids, organic, n.o.s.

Initial isolation and protective action distances

Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States Environmental Protection Agency Environmental Response Team at (908) 548-8730 (24-hour response line).

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 0.7/1.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 1000/300
Then: Protect persons downwind (mi/km)
Day 1.1/1.8
Night 2.8/4.5

VX, when used as a weapon

Small spills (From a small package or a small leak from a large package)

First: Isolate in all directions (ft/m) 100/30
Then: Protect persons downwind (mi/km)
Day 0.1/0.2
Night 0.1/0.2

Large spills (From a large package or from many small packages)

First: Isolate in all directions (ft/m) 200/60
Then: Protect persons downwind (mi/km)
Day 0.2/0.3
Night 0.2/0.3

Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. See Medical Surveillance section for decontamination kit. If kit is not available when needed, decontaminants include bleach slurry and hot soapy water.

Fire Extinguishing: Thermal decomposition products may include toxic oxides of nitrogen and sulfur. When heated, vapors may form explosive mixture with air, presenting an explosion hazard indoors, outdoors, and in sewers. Containers may explode when heated. Use moon suit/respirator protection. *Extinguishing media*: Water mist, fog, foam, CO_2-Avoid using extinguishing methods that will cause splashing or spreading of the VX. *Special firefighting procedures*: All persons not engaged in extinguishing the fire should be immediately evacuated from the area. Fires involving VX should be contained to prevent contamination to uncontrolled areas. When responding to a fire alarm in buildings or areas containing nerve agents, firefighting personnel should wear full firefighter protective clothing (without TAP clothing) during chemical agent firefighting and fire rescue operations. Respiratory protection is required. Positive pressure, full facepiece, NIOSH-approved self-contained breathing apparatus (SCBA) will be worn where there is danger of oxygen deficiency and when directed by the fire chief of chemical accident/ incident (CAI) operations officer. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full facepieces and are operated in a pressure-demand or other positive-pressure mode. The M9 or M17 series mask may be worn in lieu of SCBA when there is no danger of oxygen deficiency. In cases where firefighters are responding to a CAI for rescue/reconnaissance purposes they will wear appropriate levels of protective clothing. Do not breathe fumes. Skin contact with V-agents must be avoided at all times. Although the fire may destroy most of the agent, care must still be taken to assure the agent or contaminated liquids do not further contaminate other areas or sewers. Contact with VX or VX vapors can be fatal. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156.

Disposal Method Suggested: Principles and methods for destruction of chemical weapons: "Destruction of chemical weapons" means a process by which chemicals are converted in an essentially irreversible way to a form unsuitable for production of chemical weapons, and which in an irreversible manner renders munitions and other devices unusable as such. Each/nation/shall determine how it shall destroy chemical weapons, except that the following processes may not be used: dumping in any body of water, land burial or open-pit burning. It shall destroy chemical weapons only at specifically designated and appropriately designed and equipped facilities. Each nation shall ensure that its chemical weapons destruction facilities are constructed and operated in a manner to ensure the destruction of the chemical weapons; and that the destruction process can be verified under the provisions of this Convention[Organization for the Prohibition of Chemical Weapons; Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and Their Destruction]. Recommended field procedures (for quantities greater than 50 g): *NOTE:* These procedures can only be used with the approval of a qualified expert or safety officer. An alcoholic calcium HTH mixture is prepared by adding 100 mL of denatured ethanol to a 900 mL slurry of 10% calcium HTH in water. This mixture should be made just prior to use since the HTH can react with the ethanol. Fourteen grams of alcoholic calcium HTH solution is used for each gram of VX. Agitate the contamination mixture as the VX is added. Continue the agitation for a minimum of 1 hour. This reaction is reasonable exothermic and evolves substantial off gassing. The evolved reaction gases should be routed through a decontaminate filled scrubber prior to release through filtration systems. After completion of the one hour minimum agitation, 10% sodium hydroxide is added in a quantity equal to that necessary to assure that a pH of 12.5 is maintained for a period not less than 24 hours. Hold the material at a pH between 10 and 12 for a period not less than 90 days to ensure that a hazardous intermediate material is not formed. After sealing the head, the exterior of the drum shall be decontaminated and then labeled in accordance with IAW, EPA, and DOT regulations. All leaking containers shall be overpacked with vermiculite placed between the interior and exterior containers. Decontaminate and label per IAW EPA and DOT regulations. Conduct general area monitoring to confirm that the atmospheric concentrations do not exceed the airborne exposure limit. If the alcoholic calcium HTH mixture is not available then the following decontaminates may be used instead and are listed in the order of preference: Decontaminating Solution No. 2 [DS2: (2% NaOH, 70% diethylenetriamine, 28% ethylene glycol monomethyl ether)], Supertropical Bleach Slurry (STB), and sodium HTH. Open pit burning or burying of VX or items containing or contaminated with VX in any quantity is prohibited. The detoxified VX (using procedures above) can be thermally destroyed by incineration in an EPA approved incinerator in accordance with appropriate provisions of federal, state and local RCRA regulations. Note: Several states define decontaminated surety material as a RCRA Hazardous Waste.

Recommended laboratory procedures (for quantities less than 50 g): If the active chlorine of the calcium HTH is at least 55%, then 80 g of a 10% slurry is required for each gram of VX. Proportionally more HTH is required if the chlorine activity of the HTH is lower than 55%. The mixture is agitated as the VX is added and the agitation is maintained for a minimum of one hour. If phasing of the VX/deconsolution continues after 5 minutes, an amount of denatured ethanol equal to a 10 wt.% of the total agent/decon shall be added to assist miscibility. *Note:* Ethanol should be minimized to prevent the formation of a hazardous waste. Upon completion of the one hour agitation the decon mixture shall be adjusted to a pH between 10 and 11. Conduct general area monitoring to confirm that the atmospheric concentrations do not exceed the airborne exposure limit.

References

(31); (173); (101); (138); (85); (86); (87); (169); (93); (94); (103); (105); (163); (176).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Phosphonothioic Acid, S-(2-[(bis(1-Methylethyl)Amino]ethyl)-Ethyl Ester, Washington, Chemical Emergency Preparedness Program (November 30, 1987).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* VX, Trenton, NJ (April 2006).

W

Warfarin W:0100

Formula: $C_{19}H_{16}O_4$;$C_{19}H_{15}O_4 \cdot Na$
Synonyms: 3-(α-Acetonylbenzyl)-4-hydroxycoumarin; Arab RatDeth; Atrombine-K; 2*H*-1-Benzopyran-2-one,4-hydroxy-3-(3-*oxo*-1-phenylbutyl)-; Brumin; Compound 42; CO-RAX; Coumadin; Coumafene; Coumarin, 3-(α-acetonylbenzyl)-4-hydroxy-; D-CON; Dethmore; Eastern states duocide; Grovex sewer bait; 4-Hydroxy-3-(3-*oxo*-1-phenylbutyl)coumarin; Killgerm sewarin P; Kilmol; Kumander; Kypfarin; Liqua-tox; Mouse PAK; (Phenyl-1acetyl-2-ethyl)-3-hydroxy-4 coumarine (French); 3-(1′-Phenyl-2′-acetylethyl)-4-hydroxycoumarin; 3-(α-Phenyl-β-acetylethyl)-4-hydroxycoumarin; Plusbait; Prothromadin; Rat-*A*-Way; Rat-B-Gon; Rat-Gard; Rat & mice bait; Rat-o-cide; Ratron; Rats-no-more; Rax; RCR Squirrel killer; Rentokil; Rentokil biotrol; Rodentex; RO-Deth; Rodex blox; Rough & ready mouse mix; Sakarat; Sewarin; Solfarin; Sorexa plus; Sorex Cr1; Spray-trol branch roden-trol; Toxic chemical category code, N874; Twin light rat away; Vampirinip; Warfarine (French); Warf compound; Zoocoumarin
Sodium: 3-(α-Acetonylbenzyl)-4-hydroxy-coumarin sodium salt; Athrombin; Coumadin sodium; 4-Hydroxy-3-(3-*oxo*-1-phenylbutyl)-2*H*-1-benzopyran-2-one sodium salt; Marevan (sodium salt); Panwarfin; Prothrombin; Ratsul soluble; Sodium coumadin; Sodium warfarin; Tintorane; Varfine; Waran; Warcoumin; Warfilone
CAS Registry Number: 81-81-2; 129-06-6 (sodium salt); 5543-57-7 (S)warfarin; 5543-58-8 (R)warfarin
HSDB Number: 1786
RTECS Number: GN4550000; GN4725000 (sodium salt)
UN/NA & ERG Number: UN3027 (coumarin derivative pesticide, solid, poisonous); UN2811 (toxic solid, organic, n.o.s.)/154
EC Number: 201-377-6 [*Annex I Index No.:* 607-056-00-0]; 204-929-4 (sodium salt)
Regulatory Authority and Advisory Information
California Proposition 65 Chemical[102]: Developmental/Reproductive toxin 7/1/1987
Hazard Alert: Exposure can be lethal, Reproductive toxin: Suspected of causing genetic defects, Environmental hazard, Agricultural chemical.
United States EPA Hazardous Waste Number (RCRA No.): P001; U248
RCRA, 40CFR261, Appendix 8 Hazardous Constituents
Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500/10,000 lb (227/4540 kg)
Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 100 lb (45.4 kg)
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0% (Warfarin and salts)
United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)
Hazardous to aquatic life or environment, with possible long-lasting effects[194]. Do not allow release to the environment unless proper permits are obtained from the federal government.
European/International Regulations (*81-81-2*): Hazard symbol: T+; risk phrases: R48/25; R61; R62; R63; safety phrases: S1/2; S3; S45; S61 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.
Warfarin sodium:
Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 100/10,000 lb (45.4/4540 kg)
Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
Hazardous to aquatic life or environment, with possible long-lasting effects[194]. Do not allow release to the environment unless proper permits are obtained from the federal government.
European/International Regulations (*81-81-2*): Hazard symbol: T+, N; risk phrases: R61; R48/25; R52/53; safety phrases: S29/35; S45; S53; S61 (see Appendix 4).
Description: Warfarin is a colorless, odorless crystalline solid. Molecular weight = 308.35; 330.33 (sodium salt). Combustible. Although warfarin is usually available commercially as the sodium salt. Except where noted, the following physical properties refer to the pure substance: freezing/melting point = (decomposes) 161°C; 159−161 (sodium salt); vapor pressure = 0.09 mmHg @ 25°C. Hazard Identification (based on NFPA-704 M Rating System) (*Fume and dust*): Health 4, flammability 0, reactivity 0. Practically insoluble in water; solubility = 0.002%.
Potential Exposure: Warfarin is used as an oral anticoagulant and as a rodenticide or rat poison.
Incompatibilities: Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Dust mixtures with air may cause explosion.
Permissible Exposure Limits in Air
Warfarin 81-81-2
NIOSH IDLH = 100 milligram per cubic meter
OSHA PEL: 0.1 milligram per cubic meter TWA
NIOSH REL: 0.1 milligram per cubic meter TWA
ACGIH TLV[1]: 0.1 milligram per cubic meter TWA
Protective Action Criteria (PAC) Ver. 29[138]
PAC-1: 1.8 milligram per cubic meter
PAC-2: 20 milligram per cubic meter
PAC-3: 350 milligram per cubic meter
129-06-6, sodium salt
PAC-1: 0.82 milligram per cubic meter

Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens.
DOI: http://dx.doi.org/10.1016/B978-0-323-38968-6.00022-3

PAC-2: 9 milligram per cubic meter

PAC-3: 83 milligram per cubic meter

DFG MAK 0.5 milligram per cubic meter, inhalable fraction TWA; Peak Limitation Category II(2).

Australia: TWA 0.1 milligram per cubic meter, 1993; Austria: MAK 0.1 milligram per cubic meter, 1999; Belgium: TWA 0.1 milligram per cubic meter, 1993; Denmark: TWA 0.1 milligram per cubic meter, 1999; Finland: TWA 0.1 milligram per cubic meter, STEL 0.3 milligram per cubic meter, 1999; France: VME 0.1 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 0.1 milligram per cubic meter, 2003; Norway: TWA 0.1 milligram per cubic meter, 1999; the Philippines: TWA 0.1 milligram per cubic meter, 1993; Russia: STEL 0.001 milligram per cubic meter, 1993; Switzerland: MAK-W 0.1 milligram per cubic meter, KZG-W 0.5 milligram per cubic meter, 1999; Thailand: TWA 0.1 milligram per cubic meter, 1993; Turkey: TWA 0.1 milligram per cubic meter, 1993; United Kingdom: TWA 0.1 milligram per cubic meter, STEL 0.3 milligram per cubic meter, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 0.1 milligram per cubic meter.

Determination in Air: Use NIOSH Analytical Method (IV) #5002.

Determination in water: Octanol−water coefficient: Log $K_{ow} = 2.6$. Values above 3.0 are likely to bioaccumulate in aquatic organisms.

Routes of Entry: Skin absorption, ingestion, inhalation, skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Warfarin is classified as very toxic, and may cause hemorrhage at even low levels. Probable oral lethal dose in humans is 50−500 mg/kg, between 1 teaspoon and 1 ounce for a 150 lb person. Material is an anticoagulant. Toxic effects other than hemorrhage are rarely seen in humans. Other symptoms of warfarin exposure begin a few days or weeks after ingestion. They include epistaxis (nose bleed), bleeding gums; pallor, and sometimes hematomas around joints and on buttocks; blood in urine and feces; hematoma arms, legs; bleeding lips; mucous membrane hemorrhage; petechial rash; abnormal/abnormalities hematologic indices. Later, paralysis due to cerebral hemorrhage, and finally, hemorrhagic shock and death may occur. Warfarin sodium is an anticoagulant. Hemorrhage is the most common sign and may be manifested by hemorrhagic skin rashes and lip, nose, and upper airway bleeding. Upper airway pain, difficulty in speaking and swallowing, and dyspnea (shortness of breath) may occur. Back pain may be noted.

Long-Term Exposure: Anemia can result from severe or repeated bleeding. Repeated exposure may affect the liver and kidneys. Material is believed to be teratogenic in humans. There is limited evidence that warfarin may decrease fertility in females. Animal tests indicate that warfarin may cause malformations in human babies.

Points of Attack: Blood, cardiovascular system.

Medical Surveillance: NIOSH lists the following tests: blood plasma: prothrombin time; complete blood count; urine (chemical/metabolite): whole blood (chemical/metabolite); urinalysis (routine): red blood cells/count. Persons taking "blood thinning" medications are at increased risk.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated.

Respirator Selection: *Up to 0.5 milligram per cubic meter*: Qm (APF = 25) (any quarter-mask respirator). *Up to 1 milligram per cubic meter:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *Up to 2.5 milligram per cubic meter:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode) or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *Up to 5 milligram per cubic meter:* 100F (APF = 50) (any air-purifying, full facepiece respirator with and N100, R100, or P100 filter); or SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any self-contained breathing apparatus with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 100 milligram per cubic meter:* Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown* *concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Where possible, automatically transfer material from other storage containers to process containers.

Shipping: UN3027 Coumarin derivative pesticides, solid, toxic, Hazard Class: 6.1; Labels: 6.1-Poisonous materials. UN2811 Toxic solids, organic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required.

Spill Handling: UN2811: *Isolation Distance, Spill*: 25 m/ 75 ft.(NJ). Isolation Distance, Fire: 800 m/0.5 mi[70]. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Do not touch spilled material. Eating and smoking should not be permitted in areas where it is handled, processed or stored. *Small spills:* sweep onto paper or other suitable material. Place in an appropriate container and burn in a safe place. *Large quantities:* may be destroyed by dissolving in a flammable solvent e.g., alcohol) and atomizing in a combustion chamber.

Fire Extinguishing: Warfarin is combustible; however, no flash point can be found. Thermal decomposition products may include oxides of sodium (warfarin sodium) and oxides of carbon for all forms. Extinguish fire using agent suitable for type of surrounding fire. Use alcohol foam, carbon dioxide; or dry chemical. Wear full protective clothing and self-contained breathing apparatus when engaged in firefighting. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform to EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration.

References

(102); (31); (173); (101); (138); (2); (100).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Warfarin, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

United States Environmental Protection Agency, Chemical Hazard Information Profile: Warfarin Sodium, Washington, DC, Chemical Emergency Preparedness Program (November 30, 1987).

X

Xylenes X:0100

Formula: C_8H_{10}; $C_6H_4(CH_3)_2$
Synonyms: *m-isomer:* Benzene, *m*-dimethyl-; Benzene, 1,3-dimethyl-; *m*-Dimethylbenzene; 1,3-Dimethylbenzene; *m*-Methyltoluene; *m*-Xileno (Spanish); *m*-Xylene; 1,3-Xylene; Xylene, *m*-; *m*-Xylol
o-isomer: Benzene-*o*-dimethyl; Benzene-1,2-dimethyl-; *o*-Dimethylbenzene; 1,2-Dimethylbenzene; *o*-Methyltoluene; 1,2-Methyltoluene; *o*-Xileno (Spanish); *o*-Xylene; 1,2-Xylene; Xylene, *o*-; *o*-Xylol
p-isomer: Benzene-*p*-dimethyl; Benzene-1,4-dimethyl; Chromar; *p*-Dimethylbenzene; 1,4-Dimethylbenzene; *p*-Methyltoluene; 4-Methyltoluene; Scintillar; *p*-Xileno (Spanish); *p*-Xylene; 1,4-Xylene; Xylene, *p*-; *p*-Xylol
CAS Registry Number: 108-38-3 (*m*-isomer); 95-47-6 (*o*-isomer); 106-42-3 (*p*-isomer); 1330-20-7 (mixed isomers)
HSDB Number: 135 (*m*-isomer); 134 (*o*-isomer); 136 (*p*-isomer)
RTECS Number: ZE2100000 (mixed isomers); ZE2275000 (*m*-isomer); ZE2450000 (*o*-isomer); ZE2625000 (*p*-isomer)
UN/NA & ERG Number: UN1307 (all isomers)/130
EC Number: 203-576-3 [*Annex I Index No.:* 601-022-00-9] (*m*-isomer); 202-422-2 [*Annex I Index No.:* 601-022-00-9] (*o*-isomer); 203-396-5 [*Annex I Index No.:* 601-022-00-9] (*p*-isomer); 215-535-7 [*Annex I Index No.:* 601-022-00-9] (mixed isomers)

Regulatory Authority and Advisory Information
Carcinogenicity (*m-, o-, and p-isomers*): IARC: Animal, Inadequate Evidence; Human Inadequate Evidence, *not classifiable as carcinogenic to humans*, Group 3, 1999; EPA: Available data are inadequate for an assessment of human carcinogenic potential.
Hazard Alert: Highly flammable liquid, Possible risk of forming tumors, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction).
All isomers and mixtures:
Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)
Clean Water Act: Section 311 Hazardous Substances/RQ 100 lb (45.4 kg); Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)
United States EPA Hazardous Waste Number (RCRA No.): U239
RCRA, 40C FR261, Appendix 8 Hazardous Constituents
RCRA 40C FR268.48; 61FR 15654, Universal Treatment Standards: Wastewater (mg/L), 0.32; Nonwastewater (mg/kg), 30
RCRA 40CFR264, appendix 9; TSD Facilities Ground Water Monitoring List. Suggested methods (PQL μg/L): Total dust 8020 (5); 8240 (5)
United States National Primary Drinking Water Regulations: MCLG = 10 mg/L; MCL = 10 mg/L
Superfund/EPC RA 40 CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 1000 lb (454.0 kg)
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%. (*o*-and *m*-isomers); 0.1%, *p*-isomer
European/International Regulations (*all isomers*): Hazard Symbol: Xn; Risk phrases: R11; R20/21; R36/37/38; R51/53; R60; R62; R63; Safety phrases: S2; S21; S25; S45 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 2-Hazard to waters (*all isomers*)
Description: Xylene exists in three isomeric forms, *ortho*-, *meta*-, and *para*-xylene. Commercial xylene is a mixture of these three isomers and may also contain ethylbenzene as well as small amounts of toluene, trimethylbenzene, phenol, thiophene, pyridine, and other nonaromatic hydrocarbons. *m*-Xylene is predominant in commercial xylene. The physical properties of the three isomers are as follows:
Molecular weight = 106.2 (*m-, o-, & p-isomers*)*o*-; Specific gravity (H_2O:1) = 0.86 @ 20°C (*m-, & p-isomers*); 0.88 @ 20°C (*o-isomer*); Vapor pressure = 7.5 mmHg @ 23°C (*m-& p-isomers*); 7.5 mmHg @ 27°C (*o-isomer*)

Isomer	*Melt Point (°C)*	*Boiling Point (°C)*	*Flash Point (°C)*	*Lower Expl. (%)*	*Upper Expl. (%)*	*Auto-Temp (°C)*
meta-	−48	139	27	1.1	7.0	527
ortho-	−25	145	32	0.9	6.7	463
d*para-*	13	138	27	1.1	7.0	528

NFPA 704M Hazard Identification (all isomers): Health 2, Flammability 3, Reactivity 0. All isomers are practically insoluble in water.
Potential Exposure: Xylene is used as a solvent; as a constituent of paint, lacquers, varnishes, inks, dyes, adhesives, cements, cleaning fluids, and aviation fuels; and as a chemical feed-stock for xylidines, benzoic acid; phthalic anhydride; isophthalic, and terephthalic acids; as well as their esters (which are specifically used in the manufacture of plastic materials and synthetic textile fabrics). Xylene is also used in the manufacture of quartz crystal oscillators, hydrogen peroxide; perfumes, insect repellants; epoxy resins; pharmaceuticals; and in the leather industry. *m*-Xylene is used as an intermediate in preparation of isophthalic acid; *o*-xylene is used in manufacture of phthalic anhydride and in pharmaceutical and insecticide synthesis. *p*-xylene is used in pharmaceutical and insecticide synthesis and in production of polyester.

DOI: http://dx.doi.org/10.1016/B978-0-323-38968-6.00023-5

Incompatibilities: Vapor may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides. Electrostatic charges can be generated from agitation or flow.

Permissible Exposure Limits in Air

NIOSH IDLH = 900 ppm

Conversion factor: 1 ppm = 4.34 milligram per cubic meter *(all isomers)*@ 25°C & 1 atm

Odor threshold = 0.081 to 40 ppm. Odor Threshold values is in quite a broad range. *Caution* is advised in relying on odor alone as a warning of potentially hazardous exposures.

OSHA PEL: 100 pp m/435 milligram per cubic meter TWA

NIOSH REL: 100 ppm/435 milligram per cubic meter TWA; 150 ppm/655 milligram per cubic meter STEL

ACGIH TLV[1]: 100 ppm /434 milligram per cubic meter TWA; 150 ppm/651 milligram per cubic meter STEL, not classifiable as a human carcinogen; BEI: (technical grade) 1.5 g[methylhippuric acids]/g creatinine in urine, end-of-shift.

Protective Action Criteria (PAC)* Ver. 29[138]

1330-20-7, xylenes

PAC-1: $\mathbf{130_A}$ ppm

PAC-2: $\mathbf{920_A}$ ppm

PAC-3: $\mathbf{2500_A}$ ppm

*AEGLs (Acute Emergency Guideline Levels) are marked with a sub script "**A**" and correspond to 60 minute values.

DFG MAK: 100 ppm /440 milligram per cubic meter TWA; Peak Limitation Category II(2) [skin]; Pregnancy Risk Group D; BAT: 1.5 mg[xylene]/L in blood, end-of-shift; 2000 mg[methylhippuric (toluric)acid]/L in urine, end-of-shift.

European OEL: 50 ppm TWA; 100 ppm STEL [skin] (2000)

Austria: MAK 100 ppm (440 milligram per cubic meter), 1999; Denmark: TWA 35 ppm (150 milligram per cubic meter), [skin], 1999; France: VME 100 ppm (435 milligram per cubic meter), VLE 150 ppm (650 milligram per cubic meter), 1999; Japan; 100 ppm (430 milligram per cubic meter), 1999; Norway: TWA 25 ppm (108 milligram per cubic meter), 1999; Switzerland: MAK-W 100 ppm (435 milligram per cubic meter), KZG-W 200 ppm (870 milligram per cubic meter), 1999; United Kingdom: TWA 100 ppm (441 milligram per cubic meter), STEL 150 ppm, [skin], 2000. Russia[43] set a MAC value for ambient air in residential areas of 0.2 milligram per cubic meter (200 μ/m^3) both on a momentary and a daily average basis. Several states have set guidelines or standards for xylenes in ambient air[60] ranging from zero (Colorado); to 0.059 milligram per cubic meter (Massachusetts); to 0.073 milligram per cubic meter (Virginia); to 0.700 milligram per cubic meter (Rhode Island); to 1.45 milligram per cubic meter (New York); to 8.68 milligram per cubic meter (Connecticut); to 8.70 milligram per cubic meter (South Dakota); to 10.357 milligram per cubic meter (Nevada); to 2.6−65.5 milligram per cubic meter (North Carolina).

Determination in Air: Use NIOSH Analytical Method #1501, Hydrocarbons, aromatic, #3800, OSHA Analytical Method 1002.

Permissible Concentration in Water: Safe Drinking Water Act (47FR 9352): MCL, 10 mg/L; MCLG, 10 mg/L as xylenes (total). Russia [43] set a MAC in water both for house-hold and fishery purposes of 0.05 mg/L (50 μg/L). The EPA has determined a lifetime health advisory of 400 μg/L[48]. Several states have set guidelines and standards for xylenes in drinking water[61], ranging from 44.0 μg/L (New Jersey); to 50.0 μg/L (New York); to 440.0 μg/L (Arizona, Kansas, Minnesota); to 620.0 μg/L (Massachusetts, Maine, New Mexico, Vermont, and Wisconsin).

Determination in Water: Octanol-water coefficient: Log $K_{ow} = > 3$. Values above 3.0 are likely to bioaccumulate in aquatic organisms and possibly in the food chain, especially seafood.

Routes of Entry: Inhalation, skin absorption; ingestion; skin and /or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: *Inhalation:* Exposure to vapor can be irritating to the nose and throat. Inhalation of vapor at concentrations *above 200 ppm* or 3−5 minutes can lead to xylene intoxication. Symptoms include headache, dizziness, nausea and vomiting. If exposure should continue, central nervous system depression characterized by shallow breathing and weak pulse can occur. Levels of 230 ppm for 15 minutes may cause lightheadedness without loss of equilibrium. Reversible liver and kidney damage in humans has followed exposure to sudden high concentrations of vapor. Such high levels may also give rise to lung congestion. Exposure to extremely high concentrations (10,000 ppm or more) of xylene vapors can lead to a strong narcotic effect, with symptoms of slurred speech, stupor fatigue; confusion, unconsciousness, coma, and possible death. *Skin:* Contact with vapor or liquid can cause defatting, which may lead to irritation, drying, and cracking. *Eyes:* Vapor and liquid may be irritating to the eye and eyelids at levels of 100 ppm for 15 minutes. *Ingestion:* Swallowing liquid xylene will bring about an immediate burning sensation in the mouth and throat. Irritation of the stomach and intestine can give rise to sharp stomach pains. Symptoms are the same as inhalation, except that lung congestion will not usually develop.

Long-Term Exposure: Inhalation of xylene vapor and skin contact with liquid are the two most probable routes of long-term exposure. Symptoms of inhalation are dizziness, headache, and nausea. Long-term exposure has been associated with liver and kidney damage, intestinal tract disturbances, and central nervous system depression. Prolonged contact with skin can lead to irritation, dryness, and cracking. Repeated exposure can cause poor memory, difficulty in concentration, and other brain effects. It can also cause damage to the eye surface.

Points of Attack: Eyes, skin, respiratory system; central nervous system; gastrointestinal tract; blood, liver, kidneys.

Medical Surveillance: Whole blood (chemical/metabolite); whole blood (chemical/metabolite), end-of-shift; Complete blood count; Complete blood count; hematopoietic Depression, expired air, urine (chemical/metabolite); urine (chemical/metabolite): End-of-shift; urine (chemical/metabolite): End-of-work-week; urine (chemical/metabolite): Last 4 Hours of 8-Hour Exposure; urinalysis (routine). For those with frequent or potentially high exposure (half the TLV or grater, or significant skin contact), the following is recommended before beginning work and at regular times after that: Exam of the eyes by slit lamp. If symptoms develop or overexposure is suspected, the following may be useful: Liver and kidney function tests. Urine concentration of *m-methylhippuric acid* (at the end-of-shift) as an index of overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. If victim is *conscious*, administer water, or milk. Do not induce vomiting. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. *Note to Physician:* May require supportive measures for pulmonary edema. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. Viton, polyvinyl alcohol, and Teflon are among the recommended protective materials. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid unless full-facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *900 ppm:* CcrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)]; or PaprOv (APF = 25) [any powered, air-purifying respirator with organic vapor cartridge(s)]; or Sa (APF = 10) (any supplied-air respirator); or SCB AF (APF = 50) (any self-contained breathing apparatus with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF: Pd,Pp (A PF = 10,000) (any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCBAE (any appropriate escape-type, self-contained breathing apparatus). *Note:* Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code-Red: Flammability Hazard: Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Xylenes must be stored to avoid contact with strong oxidizers (such as chlorine, bromine, and fluorine), since violent reactions occur. Sources of ignition, such as smoking and open flames are prohibited where xylenes are used, handled, or stored in a manner that could create a potential fire or explosion hazard. Use only nonsparking tools and equipment, especially when opening and closing containers of xylenes. Protect storage containers from physical damage.

Shipping: UN1307 Xylenes, Hazard Class: 3; Labels: 3-Flammable liquid.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Oil-skimming equipment and sorbent foams can be applied to slick if done immediately. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors may travel long distances to ignition sources and flashback. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform with EPA regulations governing storage, transportation, treatment, and waste disposal. Incineration.

References

(31); (173); (101); (138); (2); (100).

National institute for Occupational Safety and Health (NIOSH), "Criteria for a Recommended Standard: Occupational Exposure to Xylene," NIOSH Document Number 75-168, Cincinnati OH (1975)

Sax, N. I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 7, 79-81 (1981) (*meta-*) and 3, No. 3, 88-92 (1983) and 4 No. 5, 75-88 (*para-*) and 4, No. 5, 63-75 (1984) (*ortho-*)

New York State Department of Health, *Chemical Fact Sheet:* Xylenes, Bureau of Toxic Substance Assessment, Albany, NY (March 1986 and Version 3)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Xylenes, Trenton, NJ (August 2006)

m-Xylene-α,α′-diamine X:0110

Formula: $C_8H_{12}N_2$; $H_2NCH_2C_6H_4CH_2NH_2$

Synonyms: 1,3-Benzenedimethanamine; 1,3-Bis(aminomethyl)benzene; Methylamine, *m*-phenyleneb is-; MX DA; *m*-Phenyleneb is(methylamine); *m*-Xylylenediamine

CAS Registry Number: 1477-55-0

HSDB Number: 6257 as 1,3-benzenedimethanamine

RTECS Number: PF8970000

UN/NA & ERG Number: UN3267/153; UN2735/153

EC Number: 216-032-5

Regulatory Authority and Advisory Information

Hazard Alert: Corrosive, Sensitization hazard, Primary irritant (w/o allergic reaction), Environmental hazard.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long lasting effects[194]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard Symbols, Risk & Safety statements: Hazard Symbol: T, C, Xi; Risk phrases: R21/22; R23/24/25; R34; R36/37/38; R39; R41; R43; R51/53; Safety phrases: S16; S26; S36/37/S39; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: m-Xylene-α,α′-diamine is a colorless liquid. Molecular weight = 136.22; Specific gravity (H_2O:1) = 1.032 @ 25°C; Boiling point = 273°C; Freezing/Melting point = 14.1°C; Vapor pressure = 0.03 mmHg @ 25°C; Flash point = 117°C; 139°C[101]. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 0, Reactivity 0. Soluble in water.

Potential Exposure: *m*-Xylene-α,α′-diamine is a source of *m*-xylene di-isocyanate and used as an intermediate in the manufacture of epoxy and polyamide resins.

Incompatibilities: Combustible; vapors may form explosive mixture with air. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides.

Permissible Exposure Limits in Air

OSHA PE L: None

NIOSH REL: 0.1 milligram per cubic meter Ceiling Concentration [skin]

ACGIH TLV[1]: 0.1 milligram per cubic meter Ceiling Concentration [skin]

Protective Action Criteria (PAC) not available

DFG MAK: [skin] Danger of skin sensitization

Australia: TWA 1 milligram per cubic meter, 1993; Belgium: STEL 0.1 milligram per cubic meter, 1993; Denmark: TWA 0.02 ppm (0.1 milligram per cubic meter), [skin], 1999; Finland: TWA 0.1 milligram per cubic meter, [skin], 1999; France: VLE 0.1 milligram per cubic meter, 1999; Norway: TWA 0.1 milligram per cubic meter, 1999; Switzerland: MAK-W 0.1 milligram per cubic meter, [skin], 1999; the Netherlands: MAC-0.1 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Ceiling Concentration 0.1 milligram per cubic meter [skin]

Several states have set guidelines or standards for MXDA in ambient air[60] ranging from 0.008 μ/m^3 (Virginia); to 1.0 μ/m^3 (North Dakota); to 2.0 μ/m^3 (Nevada); to 33.0 μ/m^3 (New York).

Determination in Air: Use OSHA Analytical Method 105

Permissible Concentration in Water: No criteria set.

Routes of Entry: Inhalation, skin absorption; ingestion; skin and /or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: *m*-Xylene-α,α′-diamine can affect you when breathed in and by passing through your skin. Contact can severely irritate and burn the skin and eyes. Exposure can irritate the nose and throat. Corrosive to the respiratory tract. Effects may include severe pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. High levels may cause respiratory depression, tiredness, and unconsciousness. The LC_{50} (rat) = 700 ppm/1 hr.

Long-Term Exposure: *m*-Xylene-α,α′-diamine may cause skin and lung allergies. Once this happens, even very small future exposures may cause a skin rash to develop and/or may cause an asthma-like reaction with wheezing, coughing, and shortness of breath. May cause liver and kidney damage. In animals: Liver, kidney, lung damage.

Points of Attack: Eyes, skin, respiratory system; liver, kidneys.

Medical Surveillance: Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a qualified medical professional might consider administering a corticosteroid spray. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, chest X-ray should be considered. Before beginning employment and at regular times after that, the following are recommended. Lung function tests. These may be normal if person is not having an attack at the time of test. If symptoms develop of overexposure is suspected, the following may be useful: Liver and kidney function tests. Evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 30 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid unless full-facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for Exposures over *0.1 milligram per cubic meter*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA (US) or EN149 (Europe)-approved self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code-White: Corrosive or Contact Hazard; Color code-Blue: Health Hazard /Poison: Store in a secure poison location. Store separately in a corrosion-resistant location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates), and strong acids (such as hydro chloride, sulfuric, and nitric). Store in tightly closed containers in a cool, well-ventilated area away from heat. Sources of ignition, such as smoking and open flames are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of five gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical.

Shipping: UN 2735A mines, liquid, corrosive, n.o.s, or Polyamines, liquid, corrosive, n.o.s., Hazard class: 8; Labels: 8-Corrosive material, Technical Name Required. UN3267 Corrosive liquid, basic, organic, n.o.s., Hazard class: 8; Labels: 8-Corrosive material, Technical Name Required.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: *m*-Xylene-α,α′-diamine may burn, but does not readily ignite. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, CO_2, water spray; or foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: m*-Xylene-2,2′-Diamine, Trenton, NJ (December 2006)

3,5-Xylenol X:0120

Formula: $C_8H_{10}O$; $C_6H_3(CH_3)_2OH$

Synonyms: AI3-01553; 3,5-Dimethylphenol; 3,5-DMP; 1-Hydroxy-3,5-dimethylbenzene; Phenol, dimethyl-; *sym, m*-Xylenol; 1,3,5-Xylenol

CAS Registry Number: 108-68-9; 1300-71-6 (mixed isomers)

HSDB Number: 5385

RTECS Number: ZE6475000

UN/NA & ERG Number: UN2261/153

EC Number: 203-606-5 [*Annex I Index No.:* 604-037-00-9]; 215-089-3 [*Annex I Index No.:* 604-006-00-X] (mixed isomers)

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Combustible, Corrosive, Possible risk of forming tumors, Primary irritant (w/o allergic reaction), Environmental hazard.

Mixed isomers:

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CER CLA, see below).

Superfund/EPC RA 40 CFR302.4, Appendix A and Section IV. D.3.b, Reportable Quantity (RQ): 1000 lb (454 kg)

United States DOT Regulated Marine Pollutant (49CFR172.101, appendix B) as xylenols

WHMIS Classifications, E, D2B.

European/International Regulations (*xylenols*): Hazard Symbol: T, C, N; Risk phrases: R10; R24/25; R34; R39/23/24/25; R51; Safety phrases: S1/2; S26; S29/35; S36/37/39; S41; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to waters (*CAS: 108-68-9*)

Description: 3,5-Xylenol is a crystalline solid. Molecular weight = 122.17; Boiling point = 220°C (sublimes); Freezing/Melting point = 64°C; Flash point = 109°C; Autoignition temperature = ~600°C. Explosive limits: LEL: 1.4%; UEL: Unknown; Soluble in water. Hazard Identification (based on NFPA-704 M Rating System): Health 3, Flammability 2, Reactivity 0. Slightly soluble in water; solubility = 0.5%.

Potential Exposure: 3,5-Xylenol is used as an antioxidant, solvent, plasticizer, wetting agent; and in pharmaceuticals. Xylenols are also used in pesticides, fuel, and lubricant additives; as a rubber chemical; in dyestuff manufacture. There are actually six xylenol isomers.

Incompatibilities: A weak organic acid. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides.

Permissible Exposure Limits in Air

No standards or Protective Action Criteria (PAC) available. This substance may still be harmful or dangerous; follow safe work and usage practices.

Permissible Concentration in Water: No criteria set.

Determination in Water: Octanol-water coefficient: Log $K_{ow} = 2.4$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, skin absorption; ingestion; skin and /or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: This compound is highly toxic by inhalation, ingestion, or skin absorption. It is corrosive and extremely destructive to tissue of the mucous membranes, upper respiratory tract, eyes, and skin[136]. Contact can severely burn the eyes and skin. LD_{50} = (oral-rat) 608 mg/kg. Inhalation may cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Long-Term Exposure: Repeated exposure may lead to vomiting, headaches, dizziness, and fainting. Chronic poisoning can cause digestive disturbances; nervous disorders; and skin eruptions. Closely related compounds can cause liver and kidney damage, and even collapse and death. Highly irritating substances can affect the lungs, although it is not known if xylenols cause lung damage.

Points of Attack: Eyes, skin, respiratory system; liver, kidneys.

Medical Surveillance: Medical observation and rest is recommended for 24 to 48 hours after breathing overexposure, as asthma symptoms may be delayed. If signs of allergy are detected, the exposed person(s) should avoid all further contact with this chemical. Cigarette smoking may exacerbate pulmonary injury and should be discouraged for at least 72 hours following exposure. If symptoms develop or overexposure is suspected, the following may be useful:

Urinary phenol test. Liver and kidney function tests. Lung function tests.

First Aid: Get medical attention at once following exposure to this com pound. *Inhalation:* Remove patient immediately to fresh air; irritation of nose or throat may be somewhat relieved by spraying or gargling with water until all odor is gone; 100% oxygen inhalation is indicated for cyanosis or respiratory distress; keep patient warm, but not hot. *Eyes:* Flood with running water for 15 minutes; if physician is not immediately available, continue irrigation for another 15 minutes; 2−3 drops of 0.5% pontocaine or equivalent may be instilled after first 15 minutes; do not use oils or oily ointments unless ordered by physician.

Skin: Wash affected areas with large quantities of water or soapy water until all odor is gone; then wash with alcohol or 20% glycerin solution and more water; keep patient warm, but not hot; cover chemical burns continuously with compresses wet with saturated solution of sodium thiosulfate; apply no salves or ointments for 24 hours after injury. *Ingestion:* Give large quantities of liquid (salt water, weak sodium bicarbonate solution, milk, or gruel) followed by demulcent, such as raw egg white or corn starch paste; if profuse vomiting does not follow immediately, give a mild emetic (such as 1 tbsp mustard in glass of water), or tickle back of throat. Repeat procedure until vomitus is free of the odor. Some demulcent should be left in stomach after vomiting. Keep patient comfortably warm.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/ manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full-facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures to xylenols, use a NIOSH/MSHA (US) or EN149 (Europe)-approved full-facepiece respirator with a high efficiency particulate filter. Greater protection is provided by a powered air-purifying respirator. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous-flow mode; or use a NIOSH/MSHA (US) or EN 149 (Europe)-app roved self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: (1) Color code-Blue: Health Hazard /Poison: Store in a secure poison location. (2) White: Corrosive or Contact Hazard; Store separately in a corrosion-resistant location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from chemical oxidizers. Sources of ignition, such as smoking and open flames, are prohibited where xylenols is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN 2261 Xylenols, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Thermal decomposition products may include oxides of carbon. This chemical is a combustible solid. Use dry chemical, carbon dioxide; water spray; or alcohol foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. All federal, state, and local environmental regulations must be observed.

References

(31); (173); (101); (138); (100).

Sax, N. I., E d., "*Dangerous Properties of Industrial Materials Report*," 1, No. 7, 81-82 (1981) and 4, No. 1, 102-106 (1984)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Xylenol, Trenton, NJ (February 2001).

Xylidines X:0130

Formula: $C_8H_{11}N$; $(CH_3)_2C_6H_3NH_2$

Synonyms: *Mixed isomers:* Aminodimethylbenzene; Aminoxylene; Dimethylaminobenzene; Dimethylaniline; Xylidine isomers

2,6-isomer: 1-Amino-2,6-dimethylbenzene; 2-Amino-1,3-dimethylbenzene; 2-Amino-*m*-xylene; 2-Amino-1,3-xylene; Benzenamine, 2,6-dimethyl-; 2,6-Dimethylaniline; 2,6-Dimethylbenzenamine; 2,6-Dimethylphenylamine; 2,6-Xilidina (Spanish); *o*-Xylidine; 2,6-Xylidine; 2,6-Xylylamine *Note:* Dimethylaniline is also used as a synonym for *N,N*-Dimethylaniline

CAS Registry Number: 1300-73-8 (xylidine, mixed isomers); 87-62-7 (2,6-xylidine); 87-59-2 [*o*-isomer (2,3-xylidine)]; 95-68-1 (2,4-xylidine; *m*-isomer); 95-78-3 (2,5-xylidine); 95-64-7 (3,4-xylidine); 108-69-0 (3,5-xylidine)

HSDB Number: 6464 (1300-73-8)

RTECS Number: ZE8575000 (mixed isomers); ZE9275000 (2,6-; *o*-isomer)

UN/NA & ERG Number: UN1711/153

EC Number: 215-091-4 (mixed isomers); 201-758-7 [*Annex I Index No.:* 612-161-00-X] (2,6-); 201-755-0 (2,3-); 202-440-0 (2,4-); 202-451-0 (2,5-)202-437-4 (3,4-); 203-607-0 (3,5-)

EC Number: [*Annex I Index No.:* 612-027-00-0]

Regulatory Authority and Advisory Information

2,6-isomer; o-isomer;:*

Carcinogenicity: NCI: Carcinogenesis Studies (feed); clear evidence: Rat; IARC: Human Inadequate Evidence; Animal Sufficient Evidence, *possibly carcinogenic to humans*, Group 2B, 1993.

California Proposition 65 Chemical[102]: Cancer 1/1 /1991 (2,6-)

Hazard Alert (2,6-isomer; *o*-isomer): Poison, Combustible, Possible risk of forming tumors, Suspected of causing genetic defects, Environmental hazard.

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%, xylidine (mixed isomers)

*the 2,6-isomer is the only xylidine specifically regulated by the United States EPA.

Hazardous to aquatic life or environment, with possible long lasting effects[293]. Toxic to aquatic life with long lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

European/International Regulations (*87-62-7*): Hazard Symbol: T, F, N; Risk phrases: R10; R23/24/25; R33; R50/53; R60; R61; Safety phrases: S1/2; S28; S29/35; S36/37; S41; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water. (*mixed isomers, dimethylaniline, and 3,5-isomer*). 2-Hazard to waters (*2,6-, 2,3-, 2,4-, 2,5-, and 3,4-isomers*).

Description: There are six xylidine isomers. Xylidine, mixed isomers (principally made up of 2,4-, 2,5-, and 2,6-isomers) is a pale yellow to brown liquid with a weak, aromatic amine odor. Molecular weight = 121.2 (2,3-& 2,6-isomer; *o*-isomer); Specific gravity (H_2O:1) = 0.98 @ 25°C; Boiling point = 222°C (2,3-isomer); 216°C (2,6-isomer; *o*-isomer); 213−226°C (mixed isomers); Freezing/Melting point = 11.2°C (2,6-isomer; *o*-isomer); −36°C; Vapor pressure = 0.13 mmHg (2,6-isomer); <1 mmHg @ 25°C; Flash point (2,6-isomer; *o*-isomer) = 91°C; (mixed isomers) 96.7°C. Explosive limits (2,6-isomer): LEL = 1.0%; 9.000 (2,3-isomer); 11,000 ppm (2,6-isomer; *o*-isomer); UEL-unknown. Hazard Identification (based on NFPA-704 M Rating System) (2,6-isomer; *o*-isomer): Health 3, Flammability 1, Reactivity 0. Insoluble in water.

Potential Exposure: Xylidines are used in dyestuff manufacture; as intermediates in the manufacture of pesticides, antioxidants, pharmaceuticals, and other organic com pounds.

Incompatibilities: Vapor may form explosive mixture with air. Contact with hypo chlorite salts and bleaches form explosive chloroamines. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, and epoxides. A chemical base: Will neutralize acids to form salts plus water with an exothermic reaction. May be incompatible with isocyanates, halogenated organics, peroxides, phenols (acidic), epoxides, anhydrides, and acid halides. Flammable gaseous hydrogen is generated by amines in combination with strong reducing agents such as hydrides, nitrides, alkali metals, and sulfides.

Permissible Exposure Limits in Air

NIOSH IDLH = 50 ppm

Conversion factor: 1 ppm = 4.96 milligram per cubic meter @ 25°C & 1 atm

Odor Threshold = 0.056 ppm.

OSHA PEL: 5 ppm/25 milligram per cubic meter TWA [skin]

NIOSH REL: 2 ppm/10 milligram per cubic meter TWA [skin]

ACGIH TLV[1]: 0.5 ppm/2.5 milligram per cubic meter, inhalable fraction and vapor [skin], confirmed animal carcinogen with unknown relevance to humans; BEI_M issued for methemoglobin inducers

DFG MAK: *(2,3-, 2,5-, 3,4-, 3,5-isomers):* [skin]; Carcinogen Category 3A; *(2,4-& 2,6-isomers):* [skin]; Carcinogen Category 2

87-59-2, o-isomer, 2,3-xylidine; 87-62-7, 2,6-xylidine & 1300-73-8, mixed isomers

Protective Action Criteria (PAC) Ver. 29[138]

PAC-1: 1.5 ppm

PAC-2: 25 ppm

PAC-3: 150 ppm

Mixed isomers

ACG IH TLV[1]: 0.5 ppm, inhalable fraction and vapor [skin], confirmed animal carcinogen with unknown relevance to humans; BEI issued (1999)

DFG MAK: [skin] Carcinogen Category 3A

Arab Republic of Egypt: TWA 5 ppm (25 milligram per cubic meter), [skin], 1993; Australia: TWA 2 ppm (10 milligram per cubic meter), [skin], 1993; Austria: MAK 5 ppm (25 milligram per cubic meter), [skin], 1999; Belgium:

TWA 2 ppm (9.9 milligram per cubic meter), [skin], 1993; Denmark: TWA 0.5 ppm (2.5 milligram per cubic meter), [skin], 1999; Finland: TWA 5 ppm (25 milligram per cubic meter), STEL 10 ppm (50 milligram per cubic meter), [skin], 1999; France: VME 2 ppm (10 milligram per cubic meter), [skin], 1999; the Netherlands: MAC-TGG 2.5 milligram per cubic meter, 2003; Norway: TWA 1 ppm (5 milligram per cubic meter), 1999; the Philippines: TWA 100 ppm (435 milligram per cubic meter), [skin], 1993; Poland: MAC (TWA) 10 milligram per cubic meter, 1999; Russia: STEL 3 milligram per cubic meter, [skin], 1993; Switzerland: MAK-W 2 ppm (10 milligram per cubic meter), [skin], 1999; Turkey: TWA 5 ppm (25 milligram per cubic meter), [skin], 1993; United Kingdom: TWA 2 ppm (10 milligram per cubic meter), STEL 10 ppm, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Confirmed animal carcinogen with unknown relevance to humans. The Czech Republic has set a TWA of 5.0 milligram per cubic meter. Several states have set guidelines or standards for xylidine in ambient air[60] ranging from 1.6 μ/m^3 (Virginia); to 33.3 μ/m^3 (New York); to 50.0 μ/m^3 (South Carolina); to 100.0 μ/m^3 (Connecticut, Florida and North Dakota); to 238.0 μ/m^3 (Nevada).

87-62-7 (2,6-xylidine)

Denmark: TWA 0.5 ppm (2.5 milligram per cubic meter), [skin], 1999; France: VME 2 ppm (10 milligram per cubic meter), [skin], 1999; Poland: MAC (TWA) 10 milligram per cubic meter, 1999; Switzerland: MAK-W 2 ppm (10 milligram per cubic meter), [skin], 1999; United Kingdom: TWA 2 ppm (10 milligram per cubic meter), STEL 10 ppm, [skin], 2000.

Determination in Air: Use NIOSH Analytical Method #2002, amines, aromatic.

Permissible Concentration in Water: No criteria set, but EPA[32] has suggested a permissible ambient concentration of 345 μg/L.

Determination in Water: Octanol-water coefficient: Log K_{ow} = (estimated) <2.0 (mixed isomers). Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, skin absorption; ingestion; skin and /or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Xylidine can affect you when breathed in and by passing through your skin. The effects of exposure may be delayed in case of skin absorption. Irritates the eyes, skin, and respiratory tract. Exposure can cause the formation of methemoglobin causing interference with the ability of the blood to carry oxygen, causing headaches, dizziness, nausea, vomiting, and cyanosis (a bluish color to the skin and lips). Higher levels can cause trouble breathing, collapse, and even death. High or repeated exposure may damage the liver.

Long-Term Exposure: May cause anemia. Affects the kidneys, liver, and blood. 2,6-Xylidine has been shown to cause cancer in animals.

Points of Attack: Respiratory system, blood, liver, kidneys, cardiovascular system. Cancer site in animals: Nose.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend up on the specific compound, its chemical, physical, and toxicity properties, the exposure level, length of exposure, and the route of exposure. United States DHHS PHS CDC NIOSH and United States DOL OSHA list the following tests: Whole blood (chemical/metabolite), methemoglobin; complete blood count. Liver and kidney function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. *Note to Physician:* Treat for methemoglobinemia. Spectrophotometry may be required for precise determination of levels of methemoglobinemia in urine. If symptoms of serious cyanosis develop, *methylene* Blue may be given as an antidote (by a trained medical person only), over 5 minutes. Repeat in 1 hour if not improving. 100% oxygen can be given by a trained person only.

Personal Protective Methods: Wear protective eye protection, gloves and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/ manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid unless full-facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH: *20 ppm:* CCrOv (APF = 10) [any chemical cartridge respirator with organic vapor cartridge(s)]; Sa (APF = 10) (any supplied-air respirator). *50 ppm:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or CCrFOv (APF = 50) [any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s)]; or GmFOv (APF = 50) [any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or PaprOv (APF = 25) [any powered, air-purifying respirator with an organic vapor cartridge(s)]; or SCBAF (APF = 50) (any self-contained breathing apparatus with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:*

SCBAF: Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF: Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* GmFOv (APF = 50) [any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister]; or SCB AE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color code-Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Xylidine must be stored to avoid contact with strong oxidizers, (such as bromine, chlorine, or fluorine), since violent reactions occur. Contact with hypochlorite bleaches may form explosive chloroamines. Store in tightly closed containers in a cool, dry, well-ventilated area away from heat sources. Sources of ignition, such as smoking and open flames are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of five gallons or more of this chemical should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of this chemical. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN1711/Xylidines, solid or liquid, Hazard Class: 6.1; Labels: 6.1-Poisonous materials.

Spill Handling: Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a flammable liquid. Thermal decomposition products may include oxides of nitrogen and carbon. Use dry chemical, carbon dioxide; or alcohol foam extinguishers. Vapors are heavier than air and will collect in low areas. Vapors in confined areas may explode when exposed to fire. Prolonged exposure of the containers to fire or heat may result in the violent rupturing and rocketing of the containers; parts of containers may rocket great distances, in many directions. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Incineration; oxides of nitrogen are removed from the effluent gas by scrubber, catalytic, or thermal device.

References

(102); (31); (173); (101); (138); (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Xylidine*, Trenton, NJ (October 1986)

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: 2,6-Xylidine*, Trenton, NJ (May 2006)

Y

Yttrium & Compounds Y:0100

Formula: Y
Synonyms: Yttria; Yttrium-89; Yttruium, elemental
CAS Registry Number: 7440-65-5; 10025-94-2 (chloride, hexahydrate); 11130-29-3 (oxide); 1314-36-9 (trioxide)
HSDB Number: 7405
RTECS Number: ZG2980000; ZG3150000 (chloride); ZG3675000 (nitrate); ZG3850000 (oxide)
UN/NA & ERG Number: UN3089 (metal powder, flammable, n.o.s.)/170; UN3178 (flammable solid)/133
EC Number: 231-174-8; 233-801-0 (chloride); 233-802-6 (nitrate); 215-233-5 (oxide)

Regulatory Authority and Advisory Information

Hazard Alert: Pyrophoric (powder), Radioactive, Water reactive, Strong reducing agent, Irritant.

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112), as Yttrium, radioactive

CERCLA *Reportable Quantities (RQs) for radionuclides of Yttrium, radioactive compounds*: Persons in charge of vessels or facilities are required to notify the National Response Center (NRC) immediately, when there is a release of this designated hazardous substance, in an amount equal to or greater than its RQ reported in curies (ci)/TBq (terabecquerel):

- Yttrium$_{86}$; Yttrium$_{87}$, Yttrium$_{88}$, Yttrium$_{90}$, Yttrium$_{91}$: RQ ≥ 10 ci/0.37 TBq
- Yttrium$_{90m}$, Yttrium$_{92}$, Yttrium$_{93}$: RQ ≥ 100 ci/3.7 TBq
- Yttrium$_{86m}$, Yttrium$_{90m}$, Yttrium$_{91m}$, Yttrium$_{94}$, Yttrium$_{95}$: RQ ≥ 1000 ci/37 Tbq

The toll free number of the NRC is (800) 424-8802. The rule for determining when notification is required is stated in 40 CFR 302.4 (Section IV. D.3.b).

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%, elemental and compounds.

Hazard symbols, risk, & safety statements: Hazard symbol: C, F, Xi, Xn; risk phrases: R12 (powder); R17; R20/21/22; R34; R29; R36/37/38; R39; R40; R51; safety phrases: S16; S26; S27; S33; S36/37/39; S45; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): No value found. (metal); (oxide) 1-Low hazard to water.

Description: Yttrium is a silvery-white to dark-gray, or black solid or gray powder. Odorless. An element in Group III-B of the Periodic Table. It is very similar to the rare earth metals. Molecular weight = 88.91 (metal); 104.9 (oxide); 225.8 (trioxide); 303.4 (chloride, hexahydrate); specific gravity (H_2O:1) = 4.5 @ 20°C (metal); 4.8 @ 20°C (trioxide); boiling point = 2927°C; 3345°C[138] (metal); freezing/melting point = 1509°C; 1522°C[138] (metal); 2410°C (trioxide). Autoignition temperature (dust and powder) = > 500°C. Explosive limits: LEL = 15,000 ppm (metal and oxide), UEL: unknown. ₩ Soluble in hot water; reacts forming flammable hydrogen gas.

Potential Exposure: Yttrium is used in iron and other alloys, in incandescent gas mantles, and as a deoxidizer for metals. Yttrium metal has a low cross section for neutron capture and is very stable at high temperatures. Further, it is very inert toward liquid uranium and many liquid uranium alloys. Thus, it may well have applications in nuclear power generation. The metal is usually prepared by reduction of the halide with an active metal, such as calcium. To identify and analyze this element, X-ray fluorescence spectroscopy is commonly employed.

Incompatibilities: Flammable in the form of dust; may form explosive mixture with air. A strong reducing agent; reacts violently with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, halogens. Yttrium nitrate is a combustible material.

Permissible Exposure Limits in Air

Note: applies to yttrium and compounds.
NIOSH IDLH = 500 mg[Y]/m^3
OSHA PEL: 1 mg[Y]/m^3 TWA
NIOSH REL: 1 mg[Y]/m^3 TWA
ACGIH TLV[1]: 1 mg[Y]/m^3 TWA

Australia: TWA 1 milligram per cubic meter, 1993; Austria: MAK 1 milligram per cubic meter, 1999; Belgium: TWA 1 milligram per cubic meter, 1993; Denmark: TWA 1 milligram per cubic meter, 1999; Finland: TWA 1 milligram per cubic meter, 1999; Germany: AGS 5 milligram per cubic meter; France: VME 1 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 1 milligram per cubic meter, 2003; the Philippines: TWA 5 ppm (25 milligram per cubic meter), 1993; Poland: MAC (TWA) 1 milligram per cubic meter, 1999; Switzerland: MAK-W 1 milligram per cubic meter, 1999; United Kingdom: TWA 1 milligram per cubic meter, STEL (15 minutes) 3 milligram per cubic meter, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: TWA 1 mg[Y]/m^3. Several states have set guidelines or standards for yttrium in ambient air[60] ranging from 0.16 μ/m^3 (Virginia); to 10.0 μ/m^3 (North Dakota); to 20.0 μ/m^3 (Connecticut); to 24.0 μ/m^3 (Nevada).

Protective Action Criteria (PAC) Ver. 29[138]
7440-65-5, elemental
PAC-1: 3 milligram per cubic meter
PAC-2: 33 milligram per cubic meter
PAC-3: 200 milligram per cubic meter
10025-94-2, chloride, hexahydrate
PAC-1: 10 milligram per cubic meter
PAC-2: 110 milligram per cubic meter
PAC-3: 670 milligram per cubic meter

DOI: http://dx.doi.org/10.1016/B978-0-323-38968-6.00024-7

11130-29-3, oxide
PAC-1: 3.5 milligram per cubic meter
PAC-2: 40 milligram per cubic meter
PAC-3: 240 milligram per cubic meter
1314-36-9, trioxide
PAC-1: 3.8 milligram per cubic meter
PAC-2: 43 milligram per cubic meter
PAC-3: 260 milligram per cubic meter

Determination in Air: Use NIOSH Analytical Method (IV)s #7300, #7301, #7303, #9102, OSHA Analytical Method ID-121.

Permissible Concentration in Water: No criteria set.

Routes of Entry: Inhalation of dusts, ingestion; skin and/or eye contact.

Harmful Effects and Symptoms

Short-Term Exposure: Eye irritation in humans.

Long-Term Exposure: In animals: pulmonary irritation; eye injury; possible liver damage.

Points of Attack: Eyes, respiratory system; liver

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations. Liver function tests.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 5 milligram per cubic meter*: Q_m (APF = 25) (any quarter-mask respirator). *Up to 10 milligram per cubic meter*: 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *Up to 25 milligram per cubic meter*: Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *Up to 50 milligram per cubic meter*: 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any self-contained breathing apparatus with a full facepiece); or SaF (APF = 50) (Any supplied-air respirator with a full facepiece). *Up to 500 milligram per cubic meter*: Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color code—Red Stripe: Flammability Hazard: Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Store flammable solids up to maximum allowable quantity per control area in an approved flammable storage area. Do not store in a basement. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from oxidizers. Where possible, automatically transfer material from storage containers to process containers.

Shipping: UN3089 Metal powders, flammable, n.o.s., Hazard Class: 4.1; Labels: 4.1-Flammable solid. UN3178 Flammable solids, inorganic, n.o.s., Hazard Class: 4.1; Labels: 4.1-Flammable solid.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: This chemical is a noncombustible solid in bulk form; powder and shavings are pyrophoric/extremely flammable. Thermal decomposition products may include metal oxides. Use special mixtures of dry chemicals appropriate for extinguishing metal fires. *Do not use water.* For large fires use extinguishing agents suitable for surrounding fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Recovery is indicated wherever possible. Specifically, processes are available for yttrium oxysulfide recovery from color television tube manufacture.

References

(31); (173); (101); (170); (138); (2); (100).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet*: Yttrium, Trenton, NJ (October 2002).

Z

Zinc & Inorganic Compounds Z:0100

Formula: Zn
Synonyms: Asareo L15; Blue powder; C.I. 77945; C.I. Pigment black 16; C.I. Pigment metal 6; Emanay zinc dust; Jasad; Merrillite (powder); Pasco; Zinc dust; Zinc powder
CAS Registry Number: 7440-66-6 (elemental); 7699-45-8 (Zinc bromide); 3486-35-9 (Zinc carbonate); 5263-02-5 (Zinc carbonate hydroxide); 7646-85-7 (Zinc chloride); 13530-65-9 (Zinc chromate); 557-21-1 (Zinc cyanide); 7783-49-5 (Zinc fluoride); 20427-58-1 (Zinc hydroxide); 7779-88-6 (Zinc nitrate); 10196-18-6 (Zinc nitrate hexahydrate); 10102-02-0 (Zinc nitrite); 1314-13-2 (Zinc oxide); 13637-61-1 (Zinc perchlorate); 7779-90-0 [Zinc phosphate (3:2)]; 7733-02-0 (Zinc sulfate); 7446-20-0 (Zinc sulfate heptahydrate); 1314-98-3 (Zinc sulfide)
HSDB Number: 1344 (elemental); 6912 (zinc compounds)
RTECS Number: ZG8600000
UN/NA & ERG Number: UN1436 (powder or dust)/138; UN1383 (pyrophoric powder)/135
EC Number: 231-175-3 [*Annex I Index No.:* 030-001-00-1]
Regulatory Authority and Advisory Information
Carcinogenicity: EPA: Inadequate Information to assess carcinogenic potential; Available data are inadequate for an assessment of human carcinogenic potential.
1344, elemental
cytogenetics-human lymphocyte
Hazard Alert (including powder & dust): Pyrophoric (dust), Combustible, Water reactive; Strong reducing agent, Possible risk of forming tumors, Suspected of causing genetic defects, Primary irritant (w/o allergic reaction). Listed for Tier 1 screening as an endocrine disruptor[88].
United States National Primary Drinking Water Regulations: SMCL = 5 mg[Zn]/L as Zinc
Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants; 40CFR423, Appendix A, Priority Pollutants
RCRA 40CFR268.48; 61FR15654, Universal Treatment Standards: Wastewater (mg/L), 2.61; Nonwastewater (mg/L), 5.3 TCLP. *Note:* these constituents are not "underlying hazardous constituents" in characteristic wastes, according to the definition at Section 268.2(i).
RCRA 40CFR264, Appendix 9; TSD Facilities Ground Water Monitoring List. Suggested test method(s) (PQL μg/L), total dust 6010 (20); 7950 (50)
Superfund/EPCRA 40CFR302.4, Appendix A and Section IV.D.3.b, Reportable Quantity (RQ): 1000 lb (454 kg)
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
fume or dust:
Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants; Section 313 Water Priority Chemicals (57FR 41331, 9/9/1992). United States National Primary Drinking Water Regulations: SMCL = 5 mg[Zn]/L.
Clean Water Act: Section 307(a)(1) Toxic Pollutants subject to effluent limitations as zinc and compounds
Superfund/EPCRA 40CFR302.4, Appendix A and Section IV.D.3.b, RQ: 1000 lb (454 kg)
EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.
Canada, WH MIS, Ingredients Disclosure List Concentration zinc metal not listed.
Hazardous to aquatic life or environment, with possible long-lasting effects[192] (dust). Do not allow release to the environment unless proper permits are obtained from the federal government.
European/International Regulations (dust, pyrophoric): Hazard symbol: F; risk phrases: R10; R15/29; R17; R18; safety phrases: S2; S7/8; S16; S21 (powder); S43 (see Appendix 4).
WGK[100] (German Aquatic Hazard Class): 2-Hazard to waters (*zinc, grain size = < 1 mm*); Nonwater polluting agent, metal ≥1 mm.
Description: Zinc is a soft silvery colored metal; the dust is odorless and gray. Molecular weight = 65.4 (metal); 189.4 (nitrate); specific gravity (H_2O:1) = 7.1 @ 20°C (metal); 2.1 @ 15°C (nitrate); boiling point = 907°C; freezing/melting point = 420°C; 43°C (nitrate); autoignition temperature = 460°C. Ignition temperature of dust cloud = 600°C; minimum explosive concentration = 0.48 oz/ft^3.[209] Relative explosion hazard of dust: Moderate. Hazard Identification (based on NFPA-704 M Rating System): Health 0, flammability 2, reactivity 0; (*powder*) Health 1, flammability 3, reactivity 2. The metal is insoluble in water. ₩The dust reacts with water releasing flammable hydrogen gas.
Potential Exposure: Zinc is used most commonly as a protective coating of other metals. In addition, it is used in alloys, such as bronze and brass, for electrical apparatus in many common goods; and in organic chemical extractions and reductions. Zinc chloride is a primary ingredient in smoke bombs used by military for screening purposes, crowd dispersal and occasionally in firefighting exercises by both military and civilian communities. In pharmaceuticals, salts of zinc are used as solubilizing agents in many drugs, including insulin.
Incompatibilities: Dust is pyrophoric and may self-ignite in air. A strong reducing agent. Violent reaction with oxidizers, chromic anhydride; manganese chloride; chlorates, chlorine and magnesium. Reacts with water and reacts violently with acids, alkali hydroxides; and bases forming highly flammable hydrogen gas. Reacts violently with sulfur, halogenated hydrocarbons and many other substances, causing fire and explosion hazard.
Permissible Exposure Limits in Air
Protective Action Criteria (PAC) Ver. 29[138]

Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens.
DOI: http://dx.doi.org/10.1016/B978-0-323-38968-6.00025-9

7440-66-6, zinc, elemental
PAC-1: 6 milligram per cubic meter
PAC-2: 21 milligram per cubic meter
PAC-3: 120 milligram per cubic meter
7699-45-8, zinc bromide
PAC-1: 6 milligram per cubic meter
PAC-2: 66 milligram per cubic meter
PAC-3: 400 milligram per cubic meter
3486-35-9, zinc carbonate
PAC-1: 12 milligram per cubic meter
PAC-2: 130 milligram per cubic meter
PAC-3: 750 milligram per cubic meter
5263-02-5, zinc carbonate hydroxide
PAC-1: 13 milligram per cubic meter
PAC-2: 150 milligram per cubic meter
PAC-3: 870 milligram per cubic meter
7646-85-7, zinc chloride
PAC-1: 2 milligram per cubic meter
PAC-2: 800 milligram per cubic meter
PAC-3: 4800 milligram per cubic meter
13530-65-9, zinc chromate
PAC-1: 0.03 milligram per cubic meter
PAC-2: 0.9 milligram per cubic meter
PAC-3: 54 milligram per cubic meter
557-21-1, zinc cyanide
PAC-1: 14 milligram per cubic meter
PAC-2: 18 milligram per cubic meter
PAC-3: 110 milligram per cubic meter
7783-49-5, zinc fluoride
PAC-1: 20 milligram per cubic meter
PAC-2: 230 milligram per cubic meter
PAC-3: 1400 milligram per cubic meter
20427-58-1, zinc hydroxide
PAC-1: 6 milligram per cubic meter
PAC-2: 66 milligram per cubic meter
PAC-3: 400 milligram per cubic meter
7779-88-6, zinc nitrate
PAC-1: 17 milligram per cubic meter
PAC-2: 190 milligram per cubic meter
PAC-3: 1100 milligram per cubic meter
10196-18-6, zinc nitrate hexahydrate
PAC-1: 27 milligram per cubic meter
PAC-2: 300 milligram per cubic meter
PAC-3: 1800 milligram per cubic meter
10102-02-0, zinc nitrite
PAC-1: 14 milligram per cubic meter
PAC-2: 160 milligram per cubic meter
PAC-3: 950 milligram per cubic meter
1314-13-2, zinc oxide
PAC-1: 10 milligram per cubic meter
PAC-2: 15 milligram per cubic meter
PAC-3: 2500 milligram per cubic meter
13637-61-1, zinc perchlorate
PAC-1: 24 milligram per cubic meter
PAC-2: 270 milligram per cubic meter
PAC-3: 1600 milligram per cubic meter
7779-90-0, zinc phosphate
PAC-1: 12 milligram per cubic meter
PAC-2: 36 milligram per cubic meter
PAC-3: 220 milligram per cubic meter
*AEGLs (Acute Emergency Guideline Levels) are marked with a subscript "**A**" and correspond to 60 minute values.
7733-02-0, zinc sulfate
PAC-1: 15 milligram per cubic meter
PAC-2: 97 milligram per cubic meter
PAC-3: 580 milligram per cubic meter
7446-20-0, Zinc sulfate heptahydrate (1:1:7)
PAC-1: 27 milligram per cubic meter
PAC-2: 170 milligram per cubic meter
PAC-3: 1000 milligram per cubic meter
1314-98-3, zinc sulfide
PAC-1: 8.9 milligram per cubic meter
PAC-2: 99 milligram per cubic meter
PAC-3: 590 milligram per cubic meter

DFG MAK (*zinc & zinc inorganic compounds*): 0.1 milligram per cubic meter, respirable fraction; Peak Limitation Category I(4); 2 milligram per cubic meter, inhalable fraction (excluding zinc chloride) TWA; Peak Limitation Category II(2)

Arab Republic of Egypt: 0.1 milligram per cubic meter TWA, 1993.

Several states have set a standard for zinc metal in ambient air[60] ranging from 0.03 μ/m^3 (New York) to 6.55−39.29 μ/m^3 (Montana).

Determination in Air: Use NIOSH Analytical Method (IV)s #7300, Elements, #7030 Zinc and compounds (as Zn), #8005, Elements in blood or tissue, #8310 Metals in urine, OSHA Analytical Methods ID-121; ID-125G

Permissible Concentration in Water: Safe Drinking Water Act (47FR9352): United States National Primary Drinking Water Regulations: SMCL = 5 mg[Zn]/L.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Zinc can affect you when breathed in. Zinc dust particles can irritate the eyes. Exposure to solid zinc is not known to cause acute or chronic health effects, but heated zinc may give off zinc oxide fumes which can cause health effects. Metal fragments can scratch the eyes. When zinc is refined, cadmium is released. *Cadmium* is a cancer causing agent. Inhalation of the dust or fume may cause metal fume fever.

Long-Term Exposure: Repeated contact with the dust or fume may cause dermatitis. Ingestion of high levels of zinc can cause anemia, pancreas damage, and lower levels of high density lipoprotein cholesterol (HDL, the good form of cholesterol). It is not known if high levels of zinc affect human reproduction or cause birth defects. Rats that were fed large amounts of zinc became infertile or had small babies. Zinc is an essential element in our diet. Not enough zinc can cause a loss of appetite; a decrease in the sense of taste and smell; slow wound healing; and skin sores, or a damaged immune system. The recommended dietary allowance (RDA) for zinc is 15 mg/day for men; 12 mg/day for women; 10 mg/day for children; 5 mg/day for infants. Harmful health effects generally begin at levels from 10−15 times the RDA (in the 100−250 mg/day range).

Points of Attack: Skin, blood, pancreas.

Medical Surveillance: Zinc can be measured in the blood or feces.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: For severe poisoning, do not use BAL (British Anti-Lewisite), dimercaprol, dithiopropanol ($C_3H_8OS_2$) as it is contraindicated or ineffective in poisoning from zinc or cadmium.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin contact with the dust. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures to zinc dusts, use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. Where there is potential for high exposure exists, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: (1) Color code—Red Stripe: Dangerous when wet materials release flammable gases on contact with water; Store flammable solids (spontaneously combustible) up to maximum allowable quantity per control area in an approved flammable storage area. Store away from sources of moisture under inert gas. Do not store in a basement. Color code—Yellow Stripe (*powder is a strong reducing agent*): Reactivity Hazard; Store separately in an area isolated from flammables, combustibles, or other yellow coded materials. Store away from moisture under inert gas. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Zinc must be stored to avoid contact with chromic anhydride, manganese chloride; chlorates, chlorine and magnesium, since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from water, acids and alkali hydroxides; because flammable hydrogen gas is produced. Sources of ignition, such as smoking and open flames are prohibited where zinc is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN1436 Zinc powder or zinc dust, Hazard Class: 4.3; Labels: 4.3-Dangerous when wet material, 4.2-Spontaneously combustible material.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Zinc is a combustible solid. Thermal decomposition products may include zinc oxides. Use special mixtures of dry chemicals appropriate for extinguishing metal fires. *Do not use water.* Use dry chemical, sand, or foam extinguishers. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

Disposal Method Suggested: Zinc powder should be reclaimed. Unsalvageable waste may be buried in an approved landfill. Leachate should be monitored for zinc content[22].

References

(31); (173); (101); (170); (138); (2); (80); (100).

Sax, N.I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 7, 82-85 (1981).

United States Public Health Service, *Toxicological Profile for Zinc*, Atlanta, Georgia, agency for Toxic Substances and Disease Registry (December 1988).

New York State Department of Health, *Chemical Fact Sheet: Zinc*, Bureau of Toxic Substance Assessment, Albany, NY (March 1986).

United States Department of Health and Human Services, Agency for Toxic Substances and Disease Registry (ATSDR), *Toxicological Fact Sheet: Zinc*, Atlanta GA (September 1995).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Zinc*, Trenton, NJ (October 2005).

Zinc Bromide Z:0110

Formula: Br_2Zn; $ZnBr_2$

Synonyms: Anhydrous zinc bromide; Bromuro de zinc (Spanish); Zinc bromide, anhydrous; Zinc dibromide

CAS Registry Number: 7699-45-8

HSDB Number: 1047

RTECS Number: ZH1150000

UN/NA & ERG Number: UN3260/154; UN3077 (environmentally hazardous substances, solid, n.o.s.)/171

EC Number: 231-718-4

Regulatory Authority and Advisory Information

Hazard Alert: Suspected of causing genetic defects, Sensitization hazard (skin), Environmental hazard

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR401.15 Section 307 Toxic Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV.D.3.b, RQ: 1000 lb (454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Hazardous to aquatic life or environment, with possible long-lasting effects[293]. Toxic to aquatic life with long-lasting effects. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard Symbol: C, N, Xi; risk phrases: R34; R43; R50/53; safety phrases: S29/35; S36/37/39; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Zinc bromide is an odorless white crystalline solid. Molecular weight = 225.2; specific gravity (H_2O:1) = 4.3 @ 20°C; boiling point = 697°C; freezing/melting point = 394°C. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 0, reactivity 0. Soluble in water.

Potential Exposure: Zinc bromide is used in photography, rayon manufacturing and medicine.

Incompatibilities: Keep away from alkali metals. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides, metallic sodium, or potassium. Store above 32°F/0°C.

Permissible Exposure Limits in Air

PAC Ver. 29[138]

PAC-1: 6 milligram per cubic meter

PAC-2: 66 milligram per cubic meter

PAC-3: 400 milligram per cubic meter

Neither ACGIH nor OSHA has set standards but the state of New York has set a guideline for ambient air of $3.0\mu/m^3$[60].

DFG MAK (*zinc & zinc inorganic compounds*): 0.1 milligram per cubic meter, respirable fraction; Peak Limitation Category I(4); 2 milligram per cubic meter, inhalable fraction (excluding zinc chloride) TWA; Peak Limitation Category II(2)

Permissible Concentration in Water: United States National Primary Drinking Water Regulations: SMCL = 5 mg[Zn]/L as Zinc

Determination in Water: Very Toxic to aquatic organisms. Octanol−water coefficient: Log $K_{ow} = -0.32$. Unlikely to bioaccumulate in marine organisms.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: *Inhalation:* Dust levels of 80 milligram per cubic meter may cause irritation of the mouth, nose and throat resulting in coughing, wheezing, and difficult breathing. *Skin:* Can cause irritation and burns. *Eyes:* Can cause irritation and burns. *Ingestion:* Dust or solution may cause irritation to the mouth, throat and digestive tract. Large doses can cause violent vomiting, severe stomach pain; diarrhea, shock and collapse. Scars may form in the throat and stomach. Long-lasting kidney irritation may occur. Less than an ounce may cause death. Repeated exposure can lead to bromine poisoning, with symptoms of personality changes (such as depression), poor appetite and confusion.

Long-Term Exposure: Can cause headache, personality changes; poor appetite; lethargy, and confusion. Skin rash can occur with repeated exposure. Can irritate the lungs; bronchitis may develop.

Points of Attack: Lungs.

Medical Surveillance: For those with frequent or potentially high exposure, the following are recommended before beginning work and at regular times after that. Lung function tests. If symptoms develop or overexposure is suspected, the following may be useful: blood test for bromide.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek

medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to Physician: Administer prompt and complete gastric lavage, and demulcents. Observe for gastric perforations and late complications, such as pyloric stenosis. For eye exposure rinsing with 0.05 molar neutral sodium edetate may help prevent or reverse corneal opacification.

Note to physician: For severe poisoning, *do not* use BAL, dimercaprol, dithiopropanol ($C_3H_8OS_2$) as it is contraindicated or ineffective in poisoning from zinc.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/ manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures to zinc bromide, use a NIOSH/MSHA (US) or EN149 (Europe)-approved full facepiece respirator with a high efficiency particulate filter. Greater protection is provided by a powered-air purifying respirator. *Where there is potential for high exposures exists*, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA- or European Standard EN149-approved self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from moisture, sources of oxygen and combustible materials.

Shipping: UN3260 Corrosive solid, acidic, inorganic, n.o.s., Hazard class: 8; Labels: 8-Corrosive material, Technical Name Required. UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Zinc bromide itself does not burn. Thermal decomposition products may include hydrogen bromide and oxides of zinc. Extinguish fire using an agent suitable for type of surrounding fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position.

References

(31); (173); (101); (138); (100).

Sax, N.I., Ed., "*Dangerous Properties of Industrial Materials Report*," 4, No. 2, 96−98 (1984).

New York State Department of Health, *Chemical Fact Sheet: Zinc Bromide*, Bureau of Toxic Substance Assessment, Albany, NY (March 1986).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Zinc Bromide*, Trenton, NJ (October 1998).

Zinc Chloride Z:0120

Formula: Cl_2Zn; $ZnCl_2$

Synonyms: Butter of zinc; Chlorure de zinc (French); Cloruro de zinc (Spanish); Tinning glux; Zinc butter; Zinc chloride, anhydrous; Zinc chloride fume; Zinc (chlorure de) (French); Zinc dichloride; Zinc muriate solution; Zinkchlorid (German)

CAS Registry Number: 7646-85-7

HSDB Number: 1050

RTECS Number: ZH1400000

UN/NA & ERG Number: UN2331 (anhydrous)/154; UN1840 (solution)/154

EC Number: 231-592-0 [*Annex I Index No.:* 030-003-00-2]

Regulatory Authority and Advisory Information

Carcinogenicity: EPA (*fume*): Inadequate Information to assess carcinogenic potential; United States EPA Gene-Tox Program, Positive: Cell transformation-SA7/SHE; Host-mediated assay; Positive: Histidine reversion-Ames test; Negative: In vitro cytogenetics-human lymphocyte;

Negative: *B. subtilis* rec assay; Sperm morphology-mouse.

Hazard Alert: Corrosive (skin), Possible risk of forming tumors, Suspected of causing genetic defects, Suspected repro toxic hazard, Environmental hazard, FDA-over the counter drug.

United States National Primary Drinking Water Regulations: SMCL = 5 mg[Zn]/L as Zinc; SMCL = 250 mg[Cl^-]/L as Chloride

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); Clean Water Act: 40CFR401.15 Section 307 Toxic Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 1000 lb (454 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard symbol: T, C, N; risk phrases: R22; R34; R50/53; R62; R63; safety phrases: S1/2; S26; S29; S36/37/39; S41; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Zinc chloride is a white hexagonal, deliquescent crystals or colorless solution. The fume is a white particulate dispersed in air. Molecular weight = 136.3; specific gravity (H_2O:1) = 2.9 @ 20°C; boiling point = 732°C; freezing/melting point = 290°C; vapor pressure = 1 mmHg @ 428°C. Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 1 ₩. Soluble in water; solubility = 435% @ 21°C. Reacts with water forming a strong acid.

Potential Exposure: Zinc chloride is used in iron galvanizing; as a wood preservative; for dry battery cells; as a soldering flux; in textile finishing; in vulcanized fiber; reclaiming rubber; in oil and gas well operations; oil refining; manufacturing of parchment paper; in dyes; activated carbon; in chemical synthesis; in adhesives; dentists' cement; deodorants, disinfecting and embalming solutions; and taxidermy. It is also produced by military screening-smoke.

Incompatibilities: Aqueous solutions are strongly acidic. Incompatible with bases and potassium. Incompatible with strong oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Corrosive to metals.

Permissible Exposure Limits in Air

Fume

NIOSH IDLH = 50 milligram per cubic meter

OSHA PEL: 1 milligram per cubic meter TWA

NIOSH REL: 1 milligram per cubic meter TWA; 2 milligram per cubic meter STEL

ACGIH TLV[1]: 1 milligram per cubic meter TWA; 2 milligram per cubic meter STEL

PAC Ver. 29[138]

PAC-1: 2 milligram per cubic meter

PAC-2: 800 milligram per cubic meter

PAC-3: 4800 milligram per cubic meter

DFG MAK (*fume*): 0.1 milligram per cubic meter, respirable fraction; Peak Limitation Category I(1); 2 milligram per cubic meter, inhalable fraction TWA; Peak Limitation Category I(4)

Arab Republic of Egypt: TWA 1 milligram per cubic meter (fume), 1993; Australia: TWA 1 milligram per cubic meter, STEL 2 milligram per cubic meter (fume), 1993; Belgium: TWA 1 milligram per cubic meter, STEL 2 milligram per cubic meter (fume), 1993; Denmark: TWA 0.5 mg[Zn]/m^3, 1999; Finland: TWA 1 milligram per cubic meter (fume), 1999; France: VME 1 milligram per cubic meter (fume), 1999; Norway: TWA 1 milligram per cubic meter, 1999; the Netherlands: MAC-TGG 1 milligram per cubic meter, 2003; Poland: TWA 1 milligram per cubic meter, STEL 2 milligram per cubic meter, 1999; Sweden: NGV 1 milligram per cubic meter (resp. dust), 1999; Switzerland: MAK-W 1 milligram per cubic meter (fume), 1999; Thailand: TWA 1 milligram per cubic meter (fume), 1993; Turkey: TWA 1 milligram per cubic meter (fume), 1993; United Kingdom: TWA 1 milligram per cubic meter, STEL 2 milligram per cubic meter, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 2 milligram per cubic meter. Several states have set guidelines or standards for zinc chloride in ambient air[60] ranging from 0.16 μ/m^3 (Virginia) to 3.3 μ/m^3 (New York); to 10.0 μ/m^3 (Florida, North Dakota, South Dakota); to 20.0 μ/m^3 (Connecticut); to 24.0 μ/m^3 (Nevada).

Determination in Air: Use OSHA Analytical Method #ID-121, #ID-125G.

Permissible Concentration in Water: United States National Primary Drinking Water Regulations: SMCL = 5 mg[Zn]/L as Zinc

Routes of Entry: Inhalation, ingestion, eye and/or skin contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: *Inhalation:* Corrosive to the respiratory tract. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Symptoms of exposure can include cough, copious sputum; dyspnea (breathing difficulty); chest pain; bronchopneumonia; pulmonary fibrosis;

cor pulmonale; fever; cyanosis, tachypne. No effects were reported from 30 minutes exposure to 0.07−0.04 milligram per cubic meter. Exposure to dust or fumes above 80 milligram per cubic meter for 2 minutes may cause nose and throat irritation, cough, chest pain; cyanosis (bluish skin), fever, nausea and vomiting; shortness of breath; difficult breathing and pneumonia. Breathing difficulties may not appear for several hours. Fume concentrations over 52 milligram per cubic meter may produce symptoms listed above. Fatal accidental exposures have occurred. *Skin:* Corrosive. Dust or solution can cause irritation and chemical burns particularly on areas where skin is broken. *Eyes:* Corrosive. Dust can cause burning irritation. Concentrated solutions are very dangerous to the eyes, causing extreme pain, redness and swelling. Eye damage may result. *Ingestion:* Dust or solution may be irritating and corrosive to the mouth, throat and digestive tract. Other symptoms may include stomach pain; nausea, vomiting, bloody diarrhea; swelling of the throat; blood in the urine; and shock. Less than an ounce has killed an adult, although recovery has been reported after ingestion of 4 oz.

Long-Term Exposure: Repeated or prolonged contact with skin may cause dermatitis. There is limited evidence that zinc chloride is a teratogen in animals. Repeated exposure can lead to delayed permanent lung damage. Prolonged contact can cause skin burns and ulcers.

Points of Attack: Eyes, skin, respiratory system; cardiovascular system.

Medical Surveillance: NIOSH lists the following tests: Blood gas analysis, Whole Blood (chemical/metabolite), biologic tissue/biopsy, chest X-ray, electrocardiogram, pulmonary function tests: forced vital capacity, forced expiratory volume (1-second), sputum cytology, urine (chemical/metabolite), white blood cell count/differential.

First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. *Do not use mouth-to-mouth method if victim ingested or in haled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.* Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a drug or other inhalation therapy.

Note to Physician: Inhalation: bronchodilators, decongestants and oxygen may be used if necessary. Corticosteroids are useful for treating pneumonitis. Ingestion-gastric lavage with 5% sodium bicarbonates; Dimercaprol has been suggested for treatment. *Eyes:* rinsing with 0.05 molar neutral sodium edetate may prevent or reverse corneal opacification.

Note to physician: For severe poisoning, *do not* use BAL, dimercaprol, dithiopropanol ($C_3H_8OS_2$) as it is contraindicated or ineffective in poisoning from zinc.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof goggles and use a face shield when working with powders or dust, unless full facepiece respiratory protection is worn. Wear splash-proof chemical goggles and use a face shield when working with liquid, unless full facepiece, respiratory protection is worn. Where the fume is present wear gas-proof goggles and use face shield, unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *10 milligram per cubic meter:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *25 milligram per cubic meter:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25) (any powered, air-purifying respirator with a high-efficiency particulate filter). *50 milligram per cubic meter:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or PaprTHie (APF = 50)* (any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any self-contained breathing apparatus with a full facepiece); or SaF (APF = 50) (any sup plied-air respirator with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, self-contained breathing apparatus). *Substance reported to cause eye irritation or damage; may require eye protection.

Storage: Color code—White: Corrosive or Contact Hazard; Store separately in a corrosion resistant location. Prior to working with this chemical, personnel should be trained on its proper handling and storage. Store in tightly closed containers in a cool, well-ventilated area away from potassium.
Shipping: UN2331 Zinc chloride, anhydrous, Hazard class: 8; Labels: 8-Corrosive material. UN1840 Zinc chloride, solution, Hazard class: 8; Labels: 8-Corrosive material.
Spill Handling: *Solid:* Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Wash spill area with soap and water. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. *Liquid:* Evacuate and restrict persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Ventilate area of spill or leak. Absorb liquids in vermiculite, dry sand; earth, peat, carbon, or a similar material and deposit in sealed containers. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.
Fire Extinguishing: This chemical is noncombustible. Thermal decomposition products may include hydrogen chloride and oxides of zinc. On large fires use agent suitable for surrounding fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.
Disposal Method Suggested: Dump in water; add soda ash and stir, then neutralize and flush to sewer with water. Alternatively, zinc chloride may be recovered from spent catalysts and used in acrylic fiber spinning solutions.

References

(31); (173); (101); (138); (100).

Sax, N.I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 7, 90−92 (1981), and 5, No. 3, 77−82 (1985).

New York State Department of Health, *Chemical Fact Sheet:* Zinc Chloride, Bureau of Toxic Substance Assessment, Albany, NY (April 1986).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Zinc Chloride*, Trenton, NJ (December 2000).

Zinc Chromate Z:0130

Formula: CrO_4Zn; $ZnCrO_4$
Synonyms: Basic zinc chromate; Basic zinc chromate X-2259; Buttercup yellow; Chromic acid, zinc salt; Chromium zinc oxide; C.I. 77955; C.I. Pigment yellow 36; Citron yellow; C.P. zinc yellow X-883; Primrose yellow; Pure zinc chrome; Pure zinc yellow; Zinc chromate C; Zinc chromate(VI) hydroxide; Zinc chromate O; Zinc chromate T; Zinc chromate Z; Zinc chrome; Zinc chrome (anti-corrosion); Zinc chrome yellow; Zinc chromium oxide; Zinc hydroxychromate; Zinc tetraoxychromate; Zinc tetraoxychromate 76A; Zinc tetraoxychromate 780B; Zinc tetroxychromate; Zinc yellow; Zinc yellow 1; Zinc yellow 1425; Zinc yellow 386N; Zinc yellow 40-9015; Zinc yellow AZ-16; Zinc yellow AZ-18; Zinc yellow KSH
CAS Registry Number: 13530-65-9; 50922-29-7 basic zinc chromate; *(alt.)* 1308-13-0; *(alt.)* 1328-67-2; *(alt.)* 14675-41-3; 11103-86-9; 37300-23-5; 12018-19-8; 14018-95-2; 37224-57-0 (zinc potassium chromate)
HSDB Number: 6188
RTECS Number: GB3290000
UN/NA & ERG Number: UN3288 (toxic solid, inorganic, n.o.s.)/151; UN3077 (environmentally hazardous substances, solid, n.o.s.)/171
EC Number: 236-878-9 [*Annex I Index No.:* 024-007-00-3]
Regulatory Authority and Advisory Information
Carcinogenicity: IARC: Human Sufficient Evidence; Animal Sufficient Evidence, *carcinogenic to humans*, Group 1, 1997; NTP 13th Report on Carcinogens, 2014: Known to be a human carcinogen; EPA *(inhalation)*: Known human carcinogen; EPA *(oral)*: Cannot be Determined; Not Classifiable as to human carcinogenicity. United States EPA Gene-Tox Program, Positive: Carcinogenicity-mouse/rat; Cell transformation-SA7/SHE; NIOSH: Potential occupational carcinogen.
Chromium compounds:
California Proposition 65 Chemical[102]: (*hexavalent chromium*) Cancer 2/27/1987; Developmental/Reproductive toxin (male, female) 12/19*/2008*
Hazard Alert: Poison, Possible risk of forming tumors, Reproductive toxin: Suspected of causing genetic defects, Sensitization hazard (skin), Environmental hazard.
Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

Clean Water Act: Toxic Pollutant (Section 401.15); 40CFR401.15 Section 307 Toxic Pollutants as chromium compounds

EPA Acceptable daily intake (ADI): Chromium(VI) = 0.175 mg/day/man. EPA estimated adequate and safe intake (EASI) levels for chromium: **Infants:** age 0.0−0.5 years: 0.01−0.04 mg/day; age 0.5−1.0 year: 0.02−0.06 mg/day. **Children:** age 1−3 years: 0.02−0.08 mg/day; age 4−6 years: 0.03−0.12 mg/day; age 7−10 years: 0.05−0.20 mg/day; age > or = to 11 years: 0.05−0.20 mg/day. **Adults:** 0.05−0.20 mg/day.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents, D007 (chromium compounds).

EPCRA (Section 313): Includes any unique chemical substance that contains chromium as part of that chemical's infrastructure. Form R *de minimis* concentration reporting level: Chromium(VI) compounds: 0.1%.

Canada, WHMIS, Ingredients Disclosure List concentration Reporting Level: 0.1%, zinc dichromate

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard Symbol: T, N, Xi; risk phrases: R45; R2; R8; R21; R25; R26; R34; R42/43; R46; R48/23; R50/53; R60; R61, R62; safety phrases: S1; S29/35; S53; S45; S60; S61; (*zinc chromates including zinc potassium chromate*): Hazard Symbol: T, N, Xi; risk phrases: R45; R8; R22; R43; R49; R50/53; R60, R61; safety phrases: S17; S29; S53; S45; S53, S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Zinc chromate is a yellow crystalline powder. Molecular weight = 181.4; freezing/melting point = 316°C. Hazard Identification (based on NFPA-704 M Rating System): Health 2, flammability 0, reactivity 0. Soluble in water.

Potential Exposure: Zinc chromate is used as an anticorrosion pigment in primers and as a coloring agent; as a pigment in surface coatings and linoleum; to impart corrosion resistance to epoxy laminates.

Incompatibilities: An oxidizer; reacts with reducing agents; combustibles, organic materials.

Permissible Exposure Limits in Air

NIOSH IDLH = 15 mg[Cr(VI)]/m^3

OSHA PEL: 0.005 mg[Cr(VI)]/m^3 (*13530-65-9 only*) TWA; 0.1 mg[CrO^3]/m^3 (*11103-86-9 and 37300-23-5*) Ceiling Concentration. See 29CFR1910.1026

NIOSH REL: 0.001 mg[Cr]/m^3 TWA, potential carcinogen, limit exposure to lowest feasible level. NIOSH considers all Cr(VI) compounds (including chromic acid, *tert*-butyl chromate, zinc chromate, and chromyl chloride) to be potential occupational carcinogens. See *NIOSH Pocket Guide*, Appendices A and C.

ACGIH TLV[1]: 0.015 mg[Cr]/m^3 TWA, Confirmed Human Carcinogen; BEI issued

PAC Ver. 29[138]

13530-65-9, zinc chromate

PAC-1: 0.03 milligram per cubic meter

PAC-2: 9 milligram per cubic meter

PAC-3: 54 milligram per cubic meter

DFG MAK: [skin] Danger of skin sensitization; Carcinogen Category 1; Pregnancy Risk Category 2; TRK: 0.05 mg [Cr]/m^3; 20 μg/L [Cr] in urine at end-of-shift

Australia: TWA 0.01 milligram per cubic meter, carcinogen, 1993; Austria: carcinogen, 1999; Belgium: TWA 0.01 milligram per cubic meter, carcinogen, 1993; Denmark: TWA 0.02 mg[Cr]/m^3, 1999; France: VME 0.05 mg[Cr]/m^3, 1999; Japan; 0.05 mg[Cr]/m^3, 1999; Norway: TWA 0.02 mg[CrO$_3$]/m^3, 1999; Poland: TWA 0.1 milligram per cubic meter, STEL 0.3 milligram per cubic meter, 1999; Sweden: TWA 0.02 mg[Cr]/m^3, carcinogen, 1999; Switzerland: MAK-W 0.01 mg[Cr]/m^3, carcinogen, 1999; United Kingdom: TWA 0.5 mg[Cr]/m^3, carcinogen, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Confirmed Human Carcinogen. Several states have set guidelines or standards for zinc chromate in ambient air[60] ranging from 0.008 μ/m^3 (Virginia); to 0.5 μ/m^3 (Connecticut); to 1.0 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Methods #7600,#7604, #7605, #7703, #9101; OSHA Analytical Methods ID-103, ID-215, W-4001.

Permissible Concentration in Water: The EPA[6] has designated chromium as a priority toxic pollutant. State Drinking Water Guide lines: California 10 μg[Cr(VI)]/L; Maine 35 μg [Cr(VI)]/L. Since zinc chromate may consist of compounds with various ZnO/Cr$_2$O$_3$ rations, it is best simply to refer to the EPA water quality criteria cited in the sections of the volume dealing with "Chromium" and with "Zinc Chloride." United States National Primary Drinking Water Regulations: SMCL = 5 mg[Zn]/L as Zinc. *As a hexavalent chromium compound:* For the protection of freshwater aquatic life: *Hexavalent chromium:* 0.29 μg/L as a 24-hour average, never to exceed 21.0 μg/L. For the protection of saltwater aquatic life: *Hexavalent chromium:* 18 μg/L as a 24-hour average, never to exceed 1260 μg/L. *To protect human health:* hexavalent chromium 50 μg/L according to EPA[6]. United States EPA[49]. has set a long-term health advisory for adults of 0.84 mg/L and a lifetime health advisory of 0.12 mg/L (120 μg/L) for chromium. EPA's maximum drinking water level (MCL) is 0.1 mg/L[62]. The states of Maine and Minnesota have set guidelines for chromium in drinking water[61] of 50 μg/L for Maine and 120 μg/L for Minnesota. EPA Acceptable daily intake (ADI) = 0.175 mg/day/man for chromium(VI)[72].

Determination in Water: Total chromium may be determined by digestion followed by atomic absorption, or by colorimetry (diphenylcarbazide); or by inductively coupled plasma (CP) optical emission spectrometry. Chromium(VI) may be determined by extraction and atomic absorption or colorimetry (using diphenylhydrazide). Dissolved total Cr or Cr(VI) may be determined by 0.45 μ filtration followed by the above-cited methods[49].

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Zinc chromate can affect you when breathed in and may enter the body through the skin. Zinc chromate is a carcinogen; handle with extreme caution. Zinc chromate can irritate the skin, causing a rash or skin ulcers. It can also trigger a skin allergy.

Long-Term Exposure: Repeated exposure can cause a hole in the nasal septum (bone dividing the inner nose). Nose bleeds and sores are earlier signs. Zinc chromate is a human carcinogen. Repeated exposure may cause skin allergy with rash and itching.

Points of Attack: Skin. Cancer site in humans: Lung and throat.

Medical Surveillance: This chemical is a suspected human carcinogen. Exposed persons should contact a physician for advice regarding the possible long-term health effects and potential recommendation for medical monitoring. Recommendations from the physician may depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. NIOSH lists the following tests for chromates: Blood gas analysis, Complete blood count (CBC), chest X-ray, electrocardiogram, liver function tests; pulmonary function tests; sputum cytology, urine (chemical/metabolite), urinalysis (routine), white blood cell count/differential. Before beginning employment and at regular times after that, the following is recommended: Urine test for *chromates.* This test is most accurate shortly after exposure. If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Note to physician: For severe poisoning, *do not* use BAL, dimercaprol, dithiopropanol ($C_3H_8OS_2$) as it is contraindicated or ineffective in poisoning from zinc.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Prevent skin contact. (as chromic acid and chromates) **8 hours** (more than 8 hours of resistance to breakthrough >0.1 μg/cm/min): polyethylene gloves, suits, boots; polyvinyl chloride gloves, suits, boots; Saranex coated suits; **4 hours** (At least 4 but <8 hours of resistance to breakthrough >0.1 μg/cm^2/min): butyl rubber gloves, suits, boots; Viton gloves, suits. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Eye protection is included in the recommended respiratory protection. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash. Specific engineering controls are recommended in NIOSH Criteria Document #76-129 [Chromium(VI)].

Respirator Selection: NIOSH, as chromates: *at any concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:* SCBAF:Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Store in tightly closed containers in a cool, well-ventilated area away from reducing agents. Where possible, automatically transfer material from other storage containers to process containers. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045.

Shipping: UN3288 Toxic solids, inorganic, n.o.s., Hazard Class: 6.1; Labels: 6.1-Poisonous materials, Technical Name Required. UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until cleanup is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after cleanup is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Nonflammable. Thermal decomposition products may include metal oxides of zinc and chromium. Use agent suitable for surrounding fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(109); (102); (31); (173); (101); (138); (2); (122); (100).

National Institute for Occupational Safety and Health (NIOSH), *Criteria for a Recommended Standard: Occupational Exposure to Chromium*, NIOSH Document Number 76-129, Cincinnati, OH (1976).

Sax, N.I., Ed., "*Dangerous Properties of Industrial Materials Report*," 1, No. 7, 92–94 (1981).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet:* Zinc Chromate, Trenton, NJ (August 2002).

United States Environmental Protection Agency, *Health Assessment Document: Chromium,* EPA 600/8-83-014F, Washington, DC (1984).

Zinc Cyanide Z:0135

Formula: $Zn(CN)_2$

Synonyms: Cianuro de zinc (Spanish); Cyanide of zinc; Cyanure de zinc (French); Zinc dicyanide

CAS Registry Number: 557-21-1

HSDB Number: 1051

RTECS Number: ZH1575000

UN/NA & ERG Number: UN1713/151

EC Number: 209-162-9 [*Annex I Index No.:* 006-007-00-5]

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Releases hydrogen cyanide on contact with moisture including humidity in air; chemically unstable (tends to become explosive in elevated temperatures), Environmental hazard.

CLEAN WATER ACT: Section 311 Hazardous Substances/RQ (same as CERCLA); Section 307 Toxic Pollutants; Section 313 Priority Chemicals.

EPA HAZARDO United States WASTE NUMBER (RCRA No.): P121

RCRA Section 261 Hazardous Constituents.

EPCRA Section 304 RQ: CERCLA, 10 lbs. (4.54 kg).

EPCRA Section 313 (as zinc and/or cyanide compound); Form R *de minimus* concentration reporting level: 1.0%. Form R Toxic Chemical Category Code: N982 (zinc compounds); Form R Toxic Chemical Category Code: N016 (cyanide compounds)

United States DOT Regulated marine pollutant (49CFR 172.101, Appendix B).

Clean Air Act: Hazardous Air Pollutants (Title I, Part A, Section 112)

United States National Primary Drinking Water Regulations: SMCL = 5 mg[Zn]/L as Zinc; MCLG = 0.2 mg[CN^-]/L; MCL = 0.2 mg[CN^-]/L as cyanide

Clean Water Act: 40CFR423, Appendix A, Priority Pollutants as cyanide, total

United States EPA Hazardous Waste Number (RCRA No.): P030 as cyanides soluble salts and complexes, n.o.s.

RCRA, 40CFR261, Appendix 8 Hazardous Constituents. as cyanides, soluble salts and complexes, n.o.s.

EPCRA (Section 313): X + CN-where X = H+ or any other group where a formal dissociation may occur. For example, KCN or $Ca(CN)_2$. Form R *de minimis* concentration reporting level: 1.0%.

United States DOT Regulated Marine Pollutant (49CFR172.101, Appendix B)

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%; National Pollutant Release Inventory (NPRI); CEPA Priority Substance List, Ocean dumping prohibited

Hazardous to aquatic life or environment, with possible long-lasting effects.[192]

Hazard symbols, risk, & safety statements: Hazard Symbol: T2 +, N; risk phrases: R24/25; R26/27/28; R32; R37/38; R40; R41; R48/23; R63; R50/53; safety phrases: S1/2; S7; S26; S28; S29; S36/37/39; S45; S60; 61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Colorless crystalline solid or white powder. Slight, bitter almond odor. Sinks in water; insoluble. Molecular weight = 117.41; specific gravity (water = 1): 1.852 @ 20°C; melting/freezing point: (decomposes) ~800°C.

Hazard identification (based on NFPA-704 M Rating System): Health 3, flammability 0, reactivity 0. Insoluble in water.

Potential Exposure: Used in pharmaceuticals and medicine. Also used in metal plating, and as a laboratory chemical.

Incompatibilities: Releases hydrogen cyanide on contact with moisture including humidity in air. Tends to explosive instability; possible explosion when heated rapidly. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact may cause fires or explosions. Keep away from alkaline materials, strong bases, strong acids, oxoacids, epoxides. Contact with acids and/or acid salts and alcohols will release highly toxic and flammable hydrogen cyanide gas. Incompatible with reducing agents, alcohols, glycols, combustible materials, ethers, hydrazines, organic substances, metal powders. Capable of violent oxidation under certain condition; fusion with metal chlorates, perchlorates, nitrates or nitrites can cause explosions[101].

Permissible Exposure Limits in Air

IDLH = 50 milligram per cubic meter (as cyanide)

OSHA PEL: 5 mg[CN]/m^3 TWA

NIOSH REL: 4.7 ppm/5 mg[CN]/m^3 [10 minutes] Ceiling Concentration

ACGIH TLV[1]: 5 mg[CN]/m^3 [skin] Ceiling Concentration (1993−94)

PAC Ver. 29[138]

PAC-114 milligram per cubic meter

PAC-2: 18 milligram per cubic meter

PAC-3: 110 milligram per cubic meter

DFG MAK: 2 mg[CN]/m^3, inhalable fraction TWA; Peak Limitation Category II(1) [skin]; Pregnancy Risk Group: C

Australia: TWA 5 milligram per cubic meter, [skin], 1993; Austria: MAK 5 mg[CN]/m^3, [skin], 1999; Denmark: TWA 5 milligram per cubic meter, [skin], 1999; France: VME 5 mg[C N]/m^3, [skin], 1999; Poland: TWA 0.3 mg[CN]/m^3, ceiling 10 mg[CN]/m^3, 1999; Switzerland: MAK-W 5 milligram per cubic meter, KZG-W 10 milligram per cubic meter, [skin], 1999; United Kingdom: TWA 5 mg[CN]/m^3, [skin], 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: Ceiling Concentration 5 milligram per cubic meter [skin]. Russia[43] has set MAC values for ambient air in residential areas of 0.009 milligram per cubic meter on a momentary basis and 0.004 milligram per cubic meter on an average daily basis. Several states have set guidelines or standards for cyanides in ambient air[60] ranging from 16.7 μ/m^3 (New York) to 50.0 μ/m^3 (Florida and North Dakota) to 80.0 μ/m^3 (Virginia) to 100 μ/m^3 (Connecticut and South Dakota) to 125 μ/m^3 (South Carolina) to 119.0 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #7904, Cyanides. See also Method #6010, Hydrogen Cyanide[18]. Permissible Concentration in Water: Federal Drinking Water Guidelines: EPA 200 μg[CN]/L; State Drinking Water Standards: California 150 μg[CN]/L; State Drinking Water Guidelines: Arizona 220 μg[CN]/L; Maine. 140 μg[CN]/L; Minnesota 100 μg[CN]/L. United States Army field drinking-water standards for cyanide: 2 mg [CN]/L assuming a water consumption of 15 L/day and 6 mg[CN]/L assuming a water consumption of 5 L/day. United States Army field drinking-water standards for cyanide, long-term consumption 0.5 mg[CN]/L; Short-term consumption; Raw water constituents (maximum) 20 mg [CN]/L. United States National Primary Drinking Water Regulations: SM CL = 5 mg[Zn]/L as Zinc

Determination in Water: Distillation followed by silver nitrate titration or colorimetric analysis using pyridine pyrazolone (or barbituric acid). Zinc is concentrated by some organisms but may not considered to be bioconcentrative in a spill situation.

Routes of Entry: Inhalation, ingestion, skin absorption.

Harmful Effects and Symptoms

Short-Term Exposure: Poison. Breathing the dust may cause permanent injury and possible death. Causes smarting of the skin and first-degree burns on short exposure; second-degree burns on long exposure. Eye irritant-severe; Respiratory irritant-acute, severe, or moderate but not mild irritant effects; Skin irritant-moderate; Central nervous system-acute effects; Narcotic; Nervous system toxin-acute effects; Respiratory toxin-acute effects other than severe or moderate irritation; Heart cardiovascular system-acute effects; Eye-acute effects other than irritation; Gastrointestinal tract-acute effects.[138] Grade 4; LD$_{50}$ = < 50 mg/kg.

Long-Term Exposure: Chronic exposure may cause headache, lack of appetite, weakness and inflammation of the skin with small pimples or blisters.

Points of Attack: Skin, kidneys, eyes, thyroid, CNS, heart.

Medical Surveillance: Preplacement and periodic examinations should include the cardiovascular and central nervous systems, liver and kidney function, blood, history of fainting and dizzy spells. Blood cyanide levels may be useful during acute intoxication. Urinary thiocyanate levels have been used but are nonspecific and are elevated in smokers.

First Aid: *SEEK MEDICAL ATTENTION. Dust: POISONO United States IF INHALED OR IF SKIN IS EXPOSED.* Move to fresh air. *IF BREATHING HAS STOPPED*, give artificial respiration; *avoid mouth-to-mouth resuscitation; use bag/mask apparatus*. IF breathing is difficult, administer oxygen. *Solid: POISONO United States IF SWALLOWED OR IF SKIN IS EXPOSED.* Irritating to eyes. Remove contaminated clothing and shoes. Flush affected areas with plenty of water. *IF IN EYES*, hold eyelids open and flush with plenty of water. *IF SWALLOWED* and victim is *CONSCIO United States AND ABLE TO SWALLOW*, have victim drink 4 to 8 oz of water and have victim induce vomiting. *IF SWALLOWED* and victim is *UNCONSCIO United States OR HAVING CONVULSIONS*, do nothing except keep victim warm. *Note to physician or authorized medical personnel*: Consider the use of amyl nitrite perles if symptoms of cyanide poisoning develop. If symptoms indicate, initial treatment includes the cyanide antidote kit. In all cases, break an amyl nitrite perle in a gauze pad and hold lightly under victim's nose for 15 seconds, repeating 5 times at about 15-second intervals; if necessary (and if sodium nitrite infusions will be delayed), repeat procedure every 3 minutes with fresh pearls until 3 or 4 have been used. Avoid breathing the vapor while administering it to the victim. Administer sodium nitrite IV, ASAP. The usual adult dose is 10 to 20 mL of a 3% solution infused over no less than 5 minutes; the average child dose is 0.15 to 0.20 mL/kg. Monitor blood pressure during administration, and slow the rate of infusion if hypotention develops. Next, infuse sodium thiosulfate IV. The usual adult dose is 50 mL of a 25% solution infused over 10 to 20 minutes; the average child dose is 1.65 mL/kg. Repeat with nitrite and thiosulfate as required.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear splash-proof chemical goggles and face shield when working with liquid, unless full facepiece respiratory protection is worn. Wear dust-proof goggles and face shield when working with powders or dust, unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: NIOSH as cyanides *25 milligram per cubic meter:* SA (any supplied-air respirator); or SCBAF (any self-contained breathing apparatus with full facepiece) *EMERGENCY OR PLANNED ENTRY INTO UNKNOWN CONCENTRATIONS OR IDLH CONDITIONS:* SCBAF: PD,PP (any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SAF:PD,PP:ASCBA (any sup plied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *ESCAPE:* GMFSHiE (any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted canister providing protection against the compound of concern and having a high efficiency particulate filter); or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color code—Blue: Health Hazard/Poison: Store in a secure poison location. Prior to working with cacodylic acid you should be trained on its proper handling and storage. A regulated, marked area should be established where this chemical is handled, used, or stored in compliance with OSHA Standard 1910.1045. Store in tightly closed containers in a cool, well-ventilated area away from oxidizing agents; chemically active metals; strong bases; moisture, fertilizers, seeds, insecticides, and fungicides.

Shipping: UN1713 Zinc cyanide, Hazard Class: 6.1; Labels: 6.1-Poisonous material.

Spill Handling: *Initial isolation and protective action distances:* As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 m/150 ft for liquids and at least 25 m/75 ft for solids. Distances shown are likely to be affected during the first 30 minutes after materials are spilled and could increase with time. If more than one tank car, cargo tank, portable tank, or large cylinder is involved in the incident is leaking, the protective action distance may need to be increased. You may need to seek emergency information from CHEMTREC at (800) 424-9300 or seek professional environmental engineering assistance from the United States EPA Environmental Response Team at (908) 548-8730 (24-hour response line). Keep unauthorized personnel away. Evacuate persons not wearing protective equipment from area of spill or leak until clean-up is complete. Remove all ignition sources. Stay upwind. Keep out of low areas. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Stop leak if you can do it without risk. Prevent entry into waterways, sewers, basements or confine d areas. Cover with plastic sheet to prevent spreading. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. Use hypochlorite solution to destroy the cyanide. Avoid contact with solids, dusts or solutions. Wear chemical protective suit with self-contained breathing apparatus. Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. Do not allow this chemical to enter the environment. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: The substance itself does not burn. Thermal decomposition products may include toxic fumes of hydrogen cyanide and oxides of zinc and nitrogen. Containers may explode when heated. Runoff from fire control or dilution water may be corrosive and/or toxic and may cause pollution. Runoff may pollute waterways. If tank, rail car or tank truck is involved in a fire, ISOLATE for 800 m/0.5 mi in all directions; also, consider initial evacuation for 800 m/0.5 mi in all directions. Small Fire: Use dry chemical, CO_2 or water spray. *Large Fire*: Water spray, fog or regular foam. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal; do not scatter the material. Use water spray or fog; do not use straight streams. *Fire involving Tanks or Car/Trailer Loads:* Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Do not get water inside containers. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. *Always* stay away from tanks engulfed in fire. For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn. *Do not* get water inside containers.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant (≥100 kg/mo) must conform to EPA regulations governing storage, transportation, treatment, and waste disposal. In accordance with 40CFR165, follow recommendations for the disposal of pesticides and pesticide containers. Must be disposed properly by following package label directions or by contacting your local or federal environmental control agency, or by contacting your regional EPA office. Add strong alkaline hypochlorite and react for 24 hours. Then flush to sewer with large volumes of water[22].

References

(31); (173); (101); (138); (2); (100).

United States Environmental Protection Agency, *Cyanides: Ambient Water Quality Criteria*, Washington, DC (1980).

National Institute for Occupational Safety and Health (NIOSH), *Criteria for a Recommended Standard: Occupational Exposure to Hydrogen Cyanide and Cyanide Salts*, NIOSH Document Number 77-108, Cincinnati, OH (1977).

United States Environmental Protection Agency, *Reviews of the Environmental Effects of Pollutants; V: Cyanide*, Report No. EPA-600/1-78-027, Washington, DC (1978).

United States Environmental Protection Agency, *Cyanides, Health and Environmental Effects Profile No. 56*, Office of Solid Waste, Washington, DC (April 30, 1980).

United States Public Health Service, *Toxicological Profile for Cyanide*, Atlanta, Georgia, agency for Toxic Substances and Disease Registry (January, 1988).

New Jersey Department of Health and Senior Services and Senior Services, *Hazardous Substances Fact Sheet: Potassium Cyanide*, Trenton, NJ (June 1998).

Zinc Oxide Z:0140

Formula: OZn; ZnO

Synonyms: Akro-zinc bar 85; Akro zinc bar 90; Amalox; Azo-33; Azo-55; Azo-66; Azo-77; Azodox-55; Calamine; Chinese white; C.I. 77947; C.I. Pigment white 4; Emanay zinc oxide; Emar; Felling zinc oxide; Flowers of zinc; Green seal-8; HC (military designation); Hubbuck's white; Kadox-25; K-zinc; Ozide; Ozlo; Pasco; Perm anent white; Philosopher's wool; Protox type 166; Protox type 167; Protox type 168; Protox type 169; Protox type 267; Protox type 268; Red-seal-9; Snow white; White flower of zinc; White seal-7; Zincite; Zincoid; Zinc oxide fume; Zinc oxide, crude; Zinc peroxide; Zinc white

CAS Registry Number: 1314-13-2; *(alt.)* 8051-03-4; *(alt.)* 78590-82-6

HSDB Number: 5024

RTECS Number: ZH4810000

UN/NA & ERG Number: UN3077 (environmentally hazardous substances, solid, n.o.s.)/171 (crude)

EC Number: 215-222-5 [*Annex I Index No.:* 030-013-00-7]

Regulatory Authority and Advisory Information

Carcinogenicity: EPA: Not Classifiable as to human carcinogenicity; Inadequate Information to assess carcinogenic potential; Available data are inadequate for an assessment of human carcinogenic potential.

Hazard Alert: Combustible, Suspected of causing genetic defects, Suspected reprotoxic hazard, Primary irritant (w/o allergic reaction), Environmental hazard.

FDA-over the counter drug

United States National Primary Drinking Water Regulations: SM CL = 5 mg[Zn]/L as Zinc

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects[291,292]. Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard Symbol: N; risk phrases: R10; R51/53; R62; R63; safety phrases: S29; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 2-Hazard to water.

Description: Zinc oxide is an amorphous, white or yellowish-white powder. Odorless. Molecular weight = 81.4; specific gravity (H_2O:1) = 5.6 @ 20°C; freezing/melting point = 1974°C. Hazard identification (based on NFPA-704 M Rating System) (*powder*): Health 2, flammability 2, reactivity 0 Practically insoluble in water; zinc oxide undergoes slow decomposition; solubility = 0.0004% @ 18°C.

Potential Exposure: Zinc oxide is primarily used as a white pigment in rubber formulations and as a vulcanizing aid. It is also used as an antiinflammatory agent; in photo copying; paints, chemicals, ceramics, lacquers, and varnishes; as a filler for plastic; in cosmetics; pharmaceuticals, and calamine lotion. Exposure may occur in the manufacture and use of zinc oxide and products, or through its formation as a fume when zinc or its alloys are heated. HC may have been used as a Choking/Pulmonary Agent.

Incompatibilities: Incompatible with linseed oil, magnesium. Contact with chlorinated rubber (@ 215°C) may cause a violent reaction. Slowly decomposed by water.

Permissible Exposure Limits in Air

NIOSH IDLH = 500 milligram per cubic meter

OSHA PEL: 15 mg[Zn]/m^3 TWA (*total dust*); 5 milligram per cubic meter TWA (*respirable fraction and fume*)

NIOSH IDLH = 500 mg[Zn]/m^3

NIOSH REL: (*dust only*): 5 mg[Zn]/m^3 TWA; 15 milligram per cubic meter Ceiling Concentration; (*fume*) 5 milligram per cubic meter TWA; 10 milligram per cubic meter Ceiling Concentration

ACGIH TLV[1]: 2 mg[Zn]/m^3, respirable fraction TWA; 10 milligram per cubic meter, respirable fraction STEL
PAC Ver. 29[138]
PAC-1: 10 milligram per cubic meter
PAC-2: 15 milligram per cubic meter
PAC-3: 2500 milligram per cubic meter
DFG MAK (*zinc oxide and fume*): 0.1 mg[ZnO]/m^3, respirable fraction TWA; Peak Limitation Category I(4); 2 milligram per cubic meter, inhalable fraction TWA; Peak Limitation Category I(2)
Arab Republic of Egypt: TWA 5 milligram per cubic meter, 1993; Australia: TWA 10 milligram per cubic meter, 1993; Australia: TWA 5 milligram per cubic meter, STEL 10 milligram per cubic meter (fume), 1993; Belgium: TWA 10 milligram per cubic meter, 1993; TWA 5 milligram per cubic meter, STEL 10 milligram per cubic meter (fume), 1993; Denmark: TWA 4 mg[Zn]/m^3, 1999; Finland: TWA 5 milligram per cubic meter (fume), 1999; the Netherlands: MAC-TGG 5 milligram per cubic meter, 2003; France: VME (fume) 5 milligram per cubic meter, 1999; Hungary: TWA 5 milligram per cubic meter, 1993; Japan; 5 milligram per cubic meter (fume), 1999; Norway: TWA 5 milligram per cubic meter, 1999; the Philippines: TWA 1 milligram per cubic meter, 1993; Poland: MAC (TWA) fume 5 milligram per cubic meter; MAC (STEL) fume 10 milligram per cubic meter, 1999; Sweden: NGV 5 milligram per cubic meter, 1999; Switzerland: MAK-W 5 milligram per cubic meter, 1999; Thailand: TWA 5 milligram per cubic meter (fume), 1993; Turkey: TWA 5 milligram per cubic meter, 1993; United Kingdom: TWA 5 milligram per cubic meter, STEL 10 milligram per cubic meter, fume, 2000; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 10 milligram per cubic meter. Russia[43] set a MAC in ambient air in residential areas of 0.05 milligram per cubic meter on a daily average basis. Several states have set guidelines or standards for zinc oxide fume in ambient air[60] ranging from 0.8 μ/m^3 (Virginia); to 16.7 μ/m^3 (New York); to 50.0 μ/m^3 (Florida); to 50.0–100.0 μ/m^3 (North Dakota); to 100.0 μ/m^3 (Connecticut); to 119.0 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #7303, Elements by ICP, #7502, Zinc and compounds, OSHA Analytical Method #ID-121, #ID1-43.

Permissible Concentration in Water: United States National Primary Drinking Water Regulations: SMCL = 5 mg[Zn]/L as Zinc.

Routes of Entry: Inhalation, ingestion, eye and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: *Note:* Symptoms of metallic or sweet taste and/or throat irritation or dryness may indicate overexposure. *Inhalation:* Irritates the respiratory tract. Exposure to fumes over 52 milligram per cubic meter can cause "metal fume fever." Onset of symptoms may be delayed 4–12 hours. Symptoms include irritation of the nose, mouth and throat, chills, muscle ache; nausea, fever, dry throat; cough; weakness, lassitude (weakness, exhaustion); metallic taste; headache, blurred vision; low back pain; vomiting, fatigue, malaise (vague feeling of discomfort); tightness in chest; dyspnea (breathing difficulty), rales, decreased pulmonary function; stomach pain; chills, fever, pains in the muscles and joints; thirst, bronchitis or pneumonia; and bluish tint to the skin. Higher exposures can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort.

Skin: Dust may cause irritation which can result in rash. *Eyes:* No information available. *Ingestion:* May cause abdominal discomfort, watery diarrhea and cramps.

Long-Term Exposure: Repeated or prolonged contact with skin may cause dermatitis. Repeated or prolonged inhalation exposure may cause asthma. There is limited evidence that zinc oxide may damage the developing fetus. Repeated overexposure may cause ulcer symptoms and affect the liver.

Points of Attack: Respiratory system, liver, skin.

Medical Surveillance: There are no special tests for this chemical. However, if overexposure is suspected or if illness occurs medical attention is recommended. Lung function tests. Liver function tests. GI series. Consider chest X-ray following acute overexposure.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray or other inhalation therapy. If metal fume fever develops, it may last less than 36 hours. *Note to Physician:* In case of fume inhalation, treat pulmonary edema. Give prednisone or other corticosteroid orally to reduce tissue response to fume. Positive pressure ventilation may be necessary. Treat metal fume fever with bed rest, analgesics and antipyretics.

Note to physician: For severe poisoning, *do not* use BAL, dimercaprol, dithiopropanol ($C_3H_8OS_2$) as it is contraindicated or ineffective in poisoning from zinc.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/

manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *Up to 50 milligram per cubic meter:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or Sa (APF = 10) (any supplied-air respirator). *Up to 125 milligram per cubic meter:* Sa:Cf (APF = 25) (any supplied-air respirator operated in a continuous-flow mode); or PaprHie (APF = 25) (any powered, air-purifying respirator with a dust, mist, and fume filter). *Up to 250 milligram per cubic meter:* 100F (APF = 50) (any air-purifying, full facepiece respirator with a high-efficiency particulate filter); or SaT:Cf (APF = 50) (any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode); or PaprTHie (APF = 50) (any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter); or SCBAF (APF = 50) (any self-contained breathing apparatus with a full facepiece); or SaF (APF = 50) (any supplied-air respirator with a full facepiece). *Up to 500 milligram per cubic meter:* Sa:Pd,Pp (APF = 1000) (any supplied-air respirator operated in a pressure-demand or other positive-pressure mode). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any NIOSH/MSHA or European Standard EN 149-approved self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp:ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air-purifying, full facepiece respirator with a high-efficiency particulate filter); or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color code—Green: General storage may be used. Store in tightly closed containers in a cool, well-ventilated area away from chlorinated rubber, magnesium and linseed oil.

Shipping: UN3077 Environmentally hazardous substances, solid, n.o.s., Hazard class: 9; Labels: 9-Miscellaneous hazardous material, Technical Name Required.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Zinc oxide does not burn. Thermal decomposition products may include metal oxides of zinc. Extinguish fire using an agent suitable for type of surrounding fire. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

References

(31); (173); (101); (138); (2); (80); (100).

National Institute for Occupational Safety and Health (NIOSH), *Criteria for a Recommended Standard: Occupational Exposure to Zinc Oxide*, NIOSH Document Number 76-104, Cincinnati, OH (1976).

United States Environmental Protection Agency, *Summary Review of Health Effects Associated with Zinc and Zinc Oxide*, Report EPA/600/8-87/022F, Research Triangle Park, NC (July 1987).

New York State Department of Health, *Chemical Fact Sheet: Zinc Oxide*, Bureau of Toxic Substance Assessment, Albany, NY (March 1986).

New Jersey Department of Health and Senior Services, *Hazardous Substances Fact Sheet: Zinc Oxide*, Trenton, NJ (January 2007).

Zinc Phosphide Z:0150

Formula: P_2Zn_3; Zn_3P_2

Synonyms: Blue-ox; Fosfuro de zinc (Spanish); Kilrat; Mous-con; Phosphure de zinc (French); Phosvin; Ratol; Zinc (phosphure de) (French); Zinc-tox; Zinkphosphid (German); ZP

CAS Registry Number: 1314-84-7; *(alt.)* 39342-49-9

HSDB Number: 1059

RTECS Number: ZH4900000

UN/NA & ERG Number: UN1714/139

EC Number: 215-244-5 [*Annex I Index No.:* 015-006-00-9]

Regulatory Authority and Advisory Information

Hazard Alert: Poison, Pyrophoric (dust), Dangerously water reactive releasing highly flammable gas, Strong reducing agent.

Clean Water Act: Section 311 Hazardous Substances/RQ 40CFR117.3 (same as CERCLA, see below); 40CFR 401.15

Section 307 Toxic Pollutants; Section 313 Water Priority Chemicals (57FR41331, 9/9/1992)

United States EPA Hazardous Waste Number (RCRA No.): P122; U249 (<10%)

RCRA, 40CFR261, Appendix 8 Hazardous Constituents

Superfund/EPCRA 302, Extremely Hazardous Substances: TPQ = 500 lb (227 kg). This material is a reactive solid. The TPQ does not default to 10,000 pounds for nonpowder, nonmolten, nonsolution form.

Superfund/EPCRA 40CFR302.4, Appendix A and Section IV. D.3.b, RQ: 100 lb (45.4 kg)

EPCRA Section 313 Form R *de minimis* concentration reporting level: 1.0%.

Hazardous to aquatic life or environment, with possible long-lasting effects.[291,292] Do not allow release to the environment unless proper permits are obtained from the federal government.

Hazard symbols, risk, & safety statements: Hazard Symbol: T+, F, N; risk phrases: R11; R15/29; R17; R28; R32; R50/53; safety phrases: S1/2; S21; S28; S30; S36/37; S43; S45; S60; S61 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): 3-Severe hazard to water.

Description: Zinc phosphide is a gray crystalline solid. Molecular weight = 258.05; boiling point = 1100°C; freezing/melting point = 420°C. Hazard Identification (based on NFPA-704 M Rating System): Health 3, flammability 3, reactivity 2₩. Insoluble in water; slowly decomposes, releasing phosphine gas.

Potential Exposure: It is used as an acute single feeding rodenticide.

Incompatibilities: Dust may form explosive mixture with air. Heat and contact with water causes decomposition, producing toxic and flammable fumes of phosphorus, zinc oxides; and toxic and flammable phosphine gas. Reacts violently with strong acids, including nitric, hydrochloric acid or sulfuric acid with the evolution of spontaneously flammable phosphine gas. Incompatible with oxidizers (chlorates, nitrates, peroxides, permanganates, perchlorates, chlorine, bromine, fluorine, etc.); contact can cause fires or explosions. Keep away from alkaline materials, strong bases. carbon dioxide, halogenated agents.

Permissible Exposure Limits in Air

PAC* Ver. 29[138]

PAC-1: 0.091 ppm

PAC-2: $\mathbf{1_A}$ ppm

PAC-3: $\mathbf{1.8_A}$ ppm

*AEGLs are marked with a sub script "**A**" and correspond to 60 minute values.

Determination in Air: Use #7502, Zinc and compounds, OSHA Analytical Method #ID-121, #ID1-43.

Permissible Concentration in Water: Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment. United States National Primary Drinking Water Regulations: SMCL = 5 mg[Zn]/L as Zinc·

Routes of Entry: Inhalation, ingestion, eye and/or skin contact. Absorbed through the skin.

Harmful Effects and Symptoms

Short-Term Exposure: Irritates the respiratory tract. Contact with the eyes can cause severe irritation, burns and permanent damage. Skin contact causes irritation. This chemical is a CNS depressant. Inhalation of zinc phosphide dust is followed in several hours by vomiting, diarrhea, cyanosis (bluing of skin), rapid pulse; fever and shock. The breath smells of phosphine. The compound is very caustic and may cause closing of the esophagus. Inhalation of phosphine (formed when zinc phosphide is exposed to flame, water or acids) can cause pulmonary edema, a medical emergency that can be delayed for several hours. This can cause death. The symptoms of pulmonary edema are aggravated by physical effort. Zinc phosphide is very caustic when ingested and forms phosphine. The probable oral lethal dose is 5−50 mg/kg, or between 7 drops and 1 teaspoonful for a 70-kg (150 lb) person. Most patients die after about 30 hours from peripheral vascular collapse secondary to the compound's direct effects. Extensive liver damage and kidney dam age can also occur. Ingestion of 4−5 g has produced death in human adults, but also doses of 25−50 g have been survived. The lowest oral lethal dose reported for women is 80 mg/kg. Symptoms of oral ingestion include nausea, abdominal pain; vomiting, tightness in chest; excitement, agitation and chills; faintness, weakness, dyspnea, fall in blood pressure; change in pulse rate; diarrhea, intense thirst; convulsions, paralysis, and coma. Early labored breathing; shock, halted urinary output; metabolic acidosis; muscle cramps and convulsions are grave prognostic signs.

Long-Term Exposure: The substance may cause effects on the liver, kidneys, heart and nervous system. Repeated exposure to low exposures cause chronic poisoning, anemia, bronchitis; and gastrointestinal, visual, speech, and motor disturbances.

Points of Attack: Lungs, liver, kidneys, heart, blood, nervous system.

Medical Surveillance: Liver and kidney function tests. EKG. Lung function tests. Consider chest X-ray following acute overexposure. CBC.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately.

If this chemical has been inhaled get medical attention for phosphine, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention for phosphine poisoning. Give one tablespoonful of mustard in a glass of warm water; repeat until vomit fluid is clear; avoid use of all oils. Do not make an unconscious person vomit. Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed. As first aid for pulmonary edema, a doctor or authorized paramedic may consider administering a corticosteroid spray or other inhalation therapy.

Note to physician: For severe poisoning, *do not* use BAL, dimercaprol, dithiopropanol ($C_3H_8OS_2$) as it is contraindicated or ineffective in poisoning from zinc.

Personal Protective Methods: Wear protective eye protection, gloves, and clothing to prevent any reasonable probability of skin or eye contact. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: Where there is potential exists for exposures to zinc dusts, use a NIOSH/MSHA (US) or EN149 (Europe)-approved respirator equipped with particulate (dust/fume/mist) filters. Particulate filters must be checked every day before work for physical damage, such as rips or tears, and replaced as needed. Where there is potential for high exposure exists, use a NIOSH/MSHA (US) or EN149 (Europe)-approved supplied-air respirator with a full facepiece operated in the positive-pressure mode, or with a full facepiece, hood, or helmet in the continuous flow mode; or use a NIOSH/MSHA-or European Standard EN 149-approved self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive-pressure mode.

Storage: (1) Color code—Red Stripe: Store under inert gas away from all forms of moisture. Dangerous when wet materials release flammable gases on contact with water. See also "incompatibilities" section. Do not store this material in a room protected by water sprinkler systems. Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Do not store in a basement. (2) Color code—Blue: Health Hazard /Poison: Store in a secure poison location. (2) Color code—Red: Flammability Hazard: Store in a flammable (liquid or solid materials) storage area or approved cabinet away from sources if ignition. Prior to working with this chemical, personnel should be trained on its proper hand ling and storage. Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Store in tightly closed containers in a cool, well-ventilated area separated from strong oxidants, strong bases; strong acids. Metal containers involving the transfer of this chemical should be grounded and bonded. Use only non-sparking tools and equipment, especially when opening and closing containers of this chemical. Sources of ignition, such as smoking and open flames, are prohibited where this chemical is used, handled, or stored in a manner that could create a potential fire or explosion hazard.

Shipping: UN1714 Zinc phosphide, Hazard Class: 4.3; Labels: 4.3-Dangerous when wet material, 6.1-Poisono us materials.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. *Do not use water*. Keep sparks, flames, and other sources of ignition away. Keep material out of water sources and sewers. Keep material dry. Avoid breathing dusts and fumes from burning material. Keep upwind. Avoid bodily contact with the material. Do not handle broken packages without protective equipment. Wash away any material which may have contacted the body with copious amounts of water or soap and water. For a land spill, dig a pit, pond, lagoon, or holding area to contain liquid or solid material. For water spill, neutralize with agricultural lime (slaked lime), crushed limestone, or sodium bicarbonate. Use mechanical dredges or lifts to remove immobilized wastes of pollutants and precipitates. *Small dry spills:* with clean shovel place material into clean, dry container and cover; move containers from spill area. *Large spills:* dike spill for later disposal. Cover powder spill with plastic sheet or tarp to minimize spreading. Clean up only under supervision of an expert. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable. UN1714, zinc phosphide is on the DOT's list of dangerous water-reactive materials which create large amounts of toxic vapor when *spilled in water*. Dangerous from 0.5 to 10 km (0.3−6.0 mi) downwind.

Fire Extinguishing: Thermal decomposition products may include phosphine and metal oxides of zinc and phosphorus. Use special mixtures of dry chemicals appropriate for extinguishing metal fires. *Do not use water. Small fires*: use dry chemical, soda ash or lime. *Large fires:* withdraw from area and let burn. *Do not use water* or any agent with an acid reaction (i.e., carbon dioxide or halogenated agents) as phosphine will be liberated. Wear boots, protective gloves, and goggles. Wear self-contained breathing apparatus when fighting fires involving this material. Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Move container from fire area if you can do so without risk.

Disposal Method Suggested: Consult with environmental regulatory agencies for guidance on acceptable disposal practices. Generators of waste containing this contaminant ($\geq$100 kg/mo) must conform to EPA regulations governing storage, transportation, treatment, and waste disposal.

References

(31); (173); (101); (170); (138); (80); (100).

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Zirconium & Compounds Z:0160

Formula: Zr

Synonyms: Zirconium metal

Other zirconium compounds: Zirconium boride (12045-64-6); Zirconium carbide (12070-14-3); Zirconium chloride (10026-11-6); Zirconium fluoride (7783-64-4); Zirconium hydride (7704-99-6); Zirconium hydroxide (14475-63-9); Zirconium nitrate (13746-89-9); Zirconium nitride (25658-42-8); Zirconium oxide (1314-23-4); Zirconium phosphide (12037-80-8);(Zirconium oxychloride) 7699-43-6; Zirconyl chloride (10026-11-6); Zirconium sulfate tetrahydrate (7446-31-3)

CAS Registry Number: 7440-67-7 (metal)

HSDB Number: 2528

RTECS Number: ZH 7070000 (elemental)

UN/NA & ERG Number: UN2008 (metal powder, dry)/135; UN1358 [Zirconium powder, wetted with not $<$ 25% water (a visible excess of water must be present); (1) mechanically produced, particle size $<$53 μm; (2) chemically produced, particle size $<$840 μm]/170; UN1932 (metal scrap)/135; UN 2858 [dry, coiled wire, finished metal sheets, strip (thinner than 254 μm but not thinner than 18 μm)]/170; UN 2009 [dry, finished sheets, strip or coiled wire]/135

EC Number: 231-176-9 [*Annex I Index No.:* 040-001-00-3]

Regulatory Authority and Advisory Information

Hazard Alert: Pyrophoric (nonstabilized dust); Highly flammable (powder)

The FD A controls zirconium-containing drugs and/or cosmetic products

Canada, WHMIS, Ingredients Disclosure List Concentration Reporting Level: 1.0%.

Hazard symbols, risk, & safety statements: Hazard Symbol (*powder, pyrophoric*): F+; risk phrases: R12; R15; R17; safety phrases: S2; S7/8; S43; (*powder stabilized*) Risk phrases: R17; safety phrases: S2; S7/8; S43 (see Appendix 4).

WGK[100] (German Aquatic Hazard Class): Nonwater polluting agent (*metal*, particle size $\geq$ 1 mm); 1-Low hazard to water. *(acetate, dichloride, dioxide, propionate)*

Description: Zirconium is a grayish-white, lustrous metal in the form of platelets, flakes, or a bluish-black, amorphous powder. Molecular weight = 91.22 (elemental); 123.2 (metal); specific gravity (H_2O:1) = 6.51 @ 25°C; boiling point = 3577°C; freezing/melting point = 1857°C. Hazard identification (based on NFPA-704 M Rating System): Health 1, flammability 4, reactivity 1. Insoluble in water. The powdered metal is an explosive hazard: it may ignite *spontaneously* and can continue burning under water.

Potential Exposure: Zirconium is never found in the free state; the most common sources are the ores zircon and baddeleyite. It is generally produced by reduction of the chloride or iodide. The metal is highly reactive; the process is usually performed under an inert gas blanket. Zirconium metal is used as a "getter" in vacuum tubes, a deoxidizer in metallurgy; a substitute for platinum; it is used in priming of explosive mixtures; flashlight powders; lamp filaments; flash bulbs; and construction of rayon spinnerets. Zirconium or its alloys (with nickel, cobalt, niobium, tantalum) are used as lining materials for pumps and pipes, for chemical processes, and for reaction vessels. Pure zirconium is a structural material for atomic reactor; and alloyed, particularly with aluminum, it is a cladding material for fuel rods in water-moderated nuclear reactors. A zirconium-columbium alloy is an excellent superconductor. Zircon ($ZrSiO_4$) is utilized as a foundry sand, an abrasive; a refractory in combination with zirconia; a coating for casting molds; a catalyst in alkyl and alkenyl hydrocarbon manufacture; a stabilizer in silicone rubbers; and as a gem stone; in ceramics it is used as an opacifier for glazes and enamels and in fritted glass filters. Both zircon and zirconia (zirconium oxide, ZrO_2) bricks are used as linings for glass furnaces. Zirconia itself is used in die extrusion of metals and in spout linings for pouring metals, as a substitute for lime in oxyhydrogen flam; as a pigment; and an abrasive; it is used, too, in incandescent lights; as well as in the manufacture of enamels, white glass; and refractory crucibles. Other zirconium compounds are used in metal cutting tools, thermocouple jackets; waterproofing textiles; ceramics, and in treating dermatitis and poison ivy.

Incompatibilities: Dust may form explosive mixture with air. Violent reactions with oxidizers, air, alkali hydroxides; alkali metal compounds (such as chromates, dichromates, molybdates, salts; sulfates, and tungstates); borax, carbon tetrachloride; lead, lead oxide; phosphorus, potassium compound s. Incompatible with boron, carbon, nitrogen, halogens, lead, platinum, potassium nitrate. Powder may ignite *spontaneously* and can continue burning under water. Explodes if mixed with hydrated borax when heated. Fine powder may be stored completely immersed in water.

Permissible Exposure Limits in Air
NIOSH IDLH = 50 mg[Zr]/m^3
OSHA PEL (compounds): 5 mg[Zr]/m^3 TWA
NIOSH REL: 5 mg[Zr]/m^3 TWA; 10 milligram per cubic meter STEL [The REL applies to all zirconium compounds (as Zr) except Zirconium tetrachloride]
ACGIH TLV[1] (*elemental & zirconium compounds*): 5 mg [Zr]/m^3 TWA; 10 milligram per cubic meter STEL; not classifiable as a human carcinogen
PAC Ver. 29[138]
7440-67-7, metal
PAC-1: 10 milligram per cubic meter
PAC-2: 83 milligram per cubic meter
PAC-3: 500 milligram per cubic meter
1314-23-4 (zirconium oxide)
PAC-1: 14 milligram per cubic meter
PAC-2: 110 milligram per cubic meter
PAC-3: 680 milligram per cubic meter
7446-31-3, Zirconium sulfate tetrahydrate
PAC-1: 39 milligram per cubic meter
PAC-2: 320 milligram per cubic meter
PAC-3: 1900 milligram per cubic meter
DFG MAK: (*elemental and insoluble compounds*): 1 milligram per cubic meter, inhalable fraction TWA; Peak Limitation Category I(1) danger of sensitization of the airways and skin; Pregnancy Risk Group; (*soluble compounds*): danger of sensitization of the airways and skin.

Arab Republic of Egypt: TWA 5 milligram per cubic meter, 1993; Austria: MAK 5 milligram per cubic meter, 1999; Denmark: TWA 5 mg[Zr]/m^3, 1999; Finland: TWA 5 milligram per cubic meter, 1999; Hungary: STEL 5 milligram per cubic meter, 1993; Poland: MAC (TWA) 5 milligram per cubic meter; MAC (STEL) 10 milligram per cubic meter, 1999; Russia: STEL 6 milligram per cubic meter, 1993; the Netherlands: M AC-TGG 5 milligram per cubic meter, 2003; Argentina, Bulgaria, Columbia, Jordan, South Korea, New Zealand, Singapore, Vietnam: ACGIH TLV: STEL 10 milligram per cubic meter. Several states have set guidelines or standards for zirconium compounds in ambient air[60] ranging from 0.8 μ/m^3 (Virginia); to 50.0−100.0 μ/m^3 (North Dakota); to 100.0 μ/m^3 (Connecticut); to 119.0 μ/m^3 (Nevada).

Determination in Air: Use NIOSH Analytical Method (IV) #7300, Elements by ICP, #8005, Elements in blood or tissue. See also OSHA Analytical Method ID-121.

Permissible Concentration in Water: No criteria set.

Routes of Entry: Inhalation of dust or fume, eye and/or skin contact.

Harmful Effects and Symptoms

Short-Term Exposure: Zirconium can affect you when breathed in. The dust can irritate the lungs, causing coughing and/or shortness of breath.

Long-Term Exposure: Contact can cause an allergic skin reaction to develop with small nodules (granulomas). May cause change in chest X-ray; lung granulomas. In animals: irritation skin, mucous membrane; X-ray evidence of retention in lungs

Points of Attack: Skin, respiratory system.

Medical Surveillance: If symptoms develop or overexposure is suspected, the following may be useful: evaluation by a qualified allergist, including careful exposure history and special testing, may help diagnose skin allergy. If breathing problems occur, lung function tests and a chest X-ray should be considered.

First Aid: If this chemical gets into the eyes, remove any contact lenses at once and irrigate immediately for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately. If this chemical contacts the skin, remove contaminated clothing and wash immediately with soap and water. Seek medical attention immediately. If this chemical has been inhaled, remove from exposure, begin rescue breathing (using universal precautions, including resuscitation mask) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Skin protection is not generally necessary, but it is probably advisable especially where there is a history of zircon granuloma from deodorants. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work. Contact lenses should not be worn when working with this chemical. Wear dust-proof chemical goggles and face shield unless full facepiece respiratory protection is worn. Employees should wash immediately with soap when skin is wet or contaminated. Provide emergency showers and eyewash.

Respirator Selection: *25 milligram per cubic meter:* Qm (APF = 25) (any quarter-mask respirator). *50 milligram per cubic meter:* 95XQ (APF = 10) [any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100]; or PaprHie (APF = 25) (any powered, air-purifying respirator with a dust, mist, and fume filter); 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or Sa (APF = 10) (any supplied-air respirator); or SCB AF (APF = 50) (any self-contained breathing apparatus with a full facepiece). *Emergency or planned entry into unknown concentrations or IDLH conditions:* SCBAF:Pd,Pp (APF = 10,000) (any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode); or SaF:Pd,Pp: ASCBA (APF = 10,000) (any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary, self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode). *Escape:* 100F (APF = 50) (any air purifying, full facepiece respirator with and N100, R100, or P100 filter); or SCBAE (any appropriate escape-type, self-contained breathing apparatus).

Storage: Color code—Red Stripe: Flammability Hazard (4.2): Do not store in the same area as other flammable materials; oxidizers and oxidizing gases should have a boundary separation of 8−10 m or a 1-hour fire wall from flammable or reactive materials. Store flammable solids (spontaneously combustible) up to maximum allowable quantity per control area in an approved flammable storage area. Do not store in a basement. Color code—Red: Flammability Hazard: Store in a flammable (liquid or solid materials) storage area or approved cabinet. Zirconium must be stored to avoid contact with oxidizers (such as perchlorates, peroxides, permanganates, chlorates, and nitrates), since violent reactions occur. Store in tightly closed containers in a cool, well-ventilated area away from flammable materials. Sources of ignition, such as smoking and open flames are prohibited where zirconium is handled, used, or stored. Metal containers involving the transfer of 5 gal or more of zirconium should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs; and flame arresters. Use only non-sparking tools and equipment, especially when opening and closing containers of zirconium. Wherever zirconium is used, handled, manufactured, or stored, use explosion-proof electrical equipment and fittings.

Shipping: UN2008 Zirconium powder, dry, Hazard Class: 4.2; Labels: 4.2-Spontaneously combustible material. UN1358 Zirconium suspended in a liquid, Hazard Class: 3; Labels: 3-Flammable liquid. UN1358 Zirconium powder, wetted with not $<25\%$ water (a visible excess of water must be present) (1) mechanically produced, particle size $<53\ \mu m$; (2) chemically produced, particle size $<840\ \mu m$, Hazard Class: 4.1; Labels: 4.1-Flammable solid. UN 1932 Zirconium scrap, Hazard Class: 4.2; Labels: 4.2-Spontaneously combustible material. UN 2009 Zirconium, dry, finished sheets, strip or coiled wire, Hazard Class: 4.2; Labels: 4.2-Spontaneously combustible material. UN2858 Zirconium, dry, coiled wire, finished metal sheets, strip (thinner than 254 μm but not thinner than 18 μm), Hazard Class: 4.1; Labels: 4.1-Flammable solid.

Spill Handling: Evacuate persons not wearing protective equipment from the danger area of spill or leak until clean-up is complete. Remove all ignition sources. Collect powdered material in the most convenient and safe manner and deposit in sealed containers. Ventilate area after clean-up is complete. Keep zirconium out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the build-up of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Contact your local or federal environmental protection agency for specific recommendations. If employees are required to clean-up spills, they must be properly trained and equipped. OSHA 1910.120(q) may be applicable.

Fire Extinguishing: Zirconium powder is flammable Fire may restart after it has been extinguished. Containers may explode in fire. Thermal decomposition products may include metal oxides of zirconium. Use dry chemicals appropriate for extinguishing metal fires; dolomite; dry salt, dry sand. *Do not use water*. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters. Notify local health and fire officials and pollution control agencies. From a secure, explosion-proof location, use water spray to cool exposed containers. If cooling streams are ineffective (venting sound increases in volume and pitch, tank discolors, or shows any signs of deforming), withdraw immediately to a secure position. If employees are expected to fight fires, they must be trained and equipped in OSHA 1910.156. The only respirators recommended for firefighting are self-contained breathing apparatuses that have full facepieces and are operated in a pressure-demand or other positive-pressure mode.

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General Guide to Chemical Resistant Gloves

Material	**Generally Suitable for**
Butyl rubber	Aldehydes Carboxylic acids Glycols and ethers Hydroxyl compounds and alcohols peroxides
Latex	Limit use; see note below Acetone Alcohols Alkalies and caustics Ammonium fluoride Dimethyl sulfoxide (DMSO) Phenol
Natural rubber	Plating solutions Alcohols Alkalies and caustics Cellosolve Degreasing solvents Mineral acids Oils
Neoprene	Plating solutions
Nitrile rubber	Alcohols Ammonium fluoride Freons Hexane Hydrofluoric and hydrochloric acid Perchloric acid Perchloroethylene Phosphoric acid Potassium and sodium hydroxide Water soluble materials, dilute acids, and bases
Vinyl	General prevention of contamination Medical examination Nuisance materials

Important Note: Latex gloves present a risk of irritation, allergic reaction, or sensitization which, for susceptible individuals, can be significant. The latex protein can leach out of the gloves into the user's skin, or into the glove powdering, if powdered gloves are used. This can lead to allergic skin reaction or a potentially more serious reaction if latex protein-contaminated powder is released into the environment and breathed in. The use of any sort of latex gloves should be considered carefully, and they should only be used when no other glove is appropriate. You are strongly advised not to use powdered latex gloves. *Users at University of Oxford should be aware that University Safety Policy statement S3/02 prohibits the use of powdered latex gloves for any purpose and advises that, if use of latex is essential, only latex gloves with low levels of extractable latex protein may be used.*
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Bibliography

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Appendix 1: Oxidizing Materials

Notes: Best efforts have been made to ensure the information below is as accurate as possible. This list is not (and cannot be) comprehensive. Therefore, the absence of an oxidizing material from this list *does not* mean that it is not an oxidizer. The publisher or author cannot accept any responsibility for the use or misuse of this information. Generally, solid oxidizers include the following materials: bromates, chlorates, chlorites, chromates, dichromates, hypochlorites, iodates, nitrates, nitrites, perchlorates, permanganates, peroxides, persulphates, picrates, and chemical oxygen generators (such as potassium superoxide) Also, many fertilizers are oxidizing materials. The asterisk (*) denotes some of those materials with potential for spontaneous ignition.

Oxidizing Materials by Name and CAS

Aluminum nitrate	13473-90-0
Ammonium chloride	7446-70-0
Ammonium chromate	7788-98-9
Ammonium dichromate	7789-09-5
Ammonium nitrate	6484-52-2
Ammonium nitrate−phosphate mixture	57608-40-9
Ammonium nitrate−sulfate mixture	6484-52-2
Ammonium perchlorate	7790-98-9
Ammonium permanganate	13446-10-1
Ammonium persulfate	7727-54-0
Ammonium picrate (wet)	131-74-8
Amyl nitrate	463-04-7
Barium bromate	13967-90-3
Barium carbonate	513-77-9
Barium chlorate	13477-00-4
Barium hypochlorite	13477-10-6
Barium nitrate	10022-31-8
Barium perchlorate trihydrate	10294-39-0
Barium permanganate	7787-36-2
Barium peroxide	1304-29-6
Benzoyl peroxide	94-36-0
Beryllium nitrate	13597-99-4
Bromine	7726-95-6
Bromine chloride	13863-41-7
Bromine pentafluoride	7789-30-2
Bromine trifluoride	7787-71-5
t-Butyl peroxybenzoate	614-45-9
Cadmium nitrate	10325-94-7
Cadmium nitrate tetrahydrate	10022-68-1
Calcium chlorate	10137-74-3
Calcium chlorite	14674-72-7
Calcium hypochlorite*	7778-54-3
Calcium nitrate	10124-37-5
Calcium perchlorate	13477-36-6
Calcium permanganate	10118-76-0
Calcium peroxide	1305-79-9
Cesium nitrate	7789-18-6
Chloric acid solution	7790-93-4
Chlorine	7787-50-5
Chlorine oxide	10049-04-4
Chlorine trifluoride	7790-91-2
Chromic acid*	7738-94-5
Chromic anhydride	11115-74-5
Chromium nitrate	7789-02-8
Chromium trioxide, anhydrous	1333-82-0
Chromium oxychloride	14977-61-8
Cobalt nitrate	10141-05-6
Cobalt(II) chloride	7646-79-9
Cobalt(II) perchlorate, hexahydrate	13478-33-6
Cumene hydroperoxide	80-15-9
Cupric nitrate (copper nitrate)	3251-23-8
Cyclohexanone peroxide	12262-58-7
Diacetone alcohol peroxide	54693-46-8
Dimethylhexane dihydroperoxide	3025-88-5
Di-*t*-butyl peroxide	110-05-4
Dichloro isocyanuric acid	2782-57-2
Ferric nitrate	10421-48-4
Gallium(III) nitrate	13494-90-1
Guanidine nitrate	506-93-4
Hydrogen peroxide (27.5%−52% by weight)*	7722-84-1
Indium nitrate	13770-61-1
Iodine pentafluoride	7783-66-6
Iron(II) nitrate hexahydrate (1:2:6)	13520-68-8
Isopropyl nitrate	1712-64-7
Isopropyl peroxydicarbonate	105-64-6
Lanthanum nitrate	10099-59-9
Lead dioxide	1309-60-0
Lead nitrate	10099-74-8
Lead perchlorate	13637-76-8
Lithium bichromate	13843-81-7
Lithium chromate	14307-35-8
Lithium hypochlorite	13840-33-0
Lithium nitrate	7790-69-4
Lithium peroxide	12031-80-0
Magnesium bromate	7789-36-8
Magnesium chlorate	7791-19-7
Magnesium nitrate	10377-60-3
Magnesium perchlorate	10034-81-8
Magnesium peroxide	14452-57-4
Manganese dioxide	1313-13-9
Manganese nitrate	10377-66-9
Mercuric nitrate	10045-94-0
Mercurous nitrate	10415-75-5
Nickel nitrate	14216-75-2
Nickel nitrite	17861-62-0
Nickel perchlorate	13637-71-3

Nickel(II) nitrate	13138-45-9
Nitrogen dioxide	10102-44-0
Nitrogen trifluoride	7783-54-2
Nitro sylsulfuric acid	7782-78-7
Oxalic acid	6153-56-6
Ozone	10028-15-6
Palladium dinitrate	10102-05-3
Peracetic acid	79-21-0
Perchloric acid	7601-90-3
Perchloryl fluoride	7616-94-6
Potassium bromate*	7758-01-2
Potassium chlorate	1811-04-9
Potassium chromate(VI)	7789-00-6
Potassium dichloroisocyanurate	2244-21-5
Potassium dichromate	7778-50-9
Potassium nitrate	7757-79-1
Potassium nitrite	7758-09-0
Potassium perchlorate	7778-74-7
Potassium permanganate	7722-64-7
Potassium peroxide	17014-71-0
Potassium persulfate	7727-21-1
Potassium superoxide	12030-88-5
n-Propyl nitrate	627-13-4
Pyrosulfuryl chloride	7791-27-7
Silver nitrate	7761-88-8
Sodium dichloro-*s*-triazinetrione	2893-78-9
Sodium bromate	7789-38-0
Sodium chlorate	7775-09-9
Sodium chlorite (>40%)*	7758-19-2
Sodium chromate	7775-11-3
Sodium dichlorocyanurate*	2893-78-9
Sodium dichromate	10588-01-9
Sodium hypochlorite	7681-52-9
Sodium nitrate	7631-99-4
Sodium nitrite	7632-00-0
Sodium percarbonate	15630-89-4
Sodium perchlorate	7601-89-0
Sodium permanganate*	10101-50-5
Sodium peroxide*	1313-60-6
Sodium persulfate	7775-27-1
Sodium superoxide	12034-12-7
Strontium chlorate	7791-10-8
Strontium nitrate	10042-76-9
Strontium perchlorate	13450-97-0
Strontium peroxide	1314-18-7
Tetranitromethane	509-14-8
Thorium(IV) nitrate	13823-29-5
Trichloroisocyanuric acid*	87-90-1
Uranyl nitrate	10102-06-4
Urea peroxide	124-43-6
Vanadium pentoxide	1314-62-1
Ytterbium nitrate	13768-67-7
Yttrium(III) nitrate hexahydrate	13494-98-9
Zinc ammonium nitrite	63885-01-8
Zinc bichromate	7789-12-0
Zinc bromate	13517-27-6
Zinc chromate	13530-65-9
Zinc chlorate	10361-95-2
Zinc nitrate	7779-88-6
Zinc permanganate	23414-72-4
Zinc peroxide	1314-22-3
Zirconium nitrate	13746-89-9

Oxidizing Materials by CAS and Name

54693-46-8	Diacetone alcohol peroxide
13843-81-7	Lithium bichromate
7789-12-0	Zinc bichromate
79-21-0	Peracetic acid
80-15-9	Cumene hydroperoxide
87-90-1	*Trichloroisocyanuric acid
94-36-0	Benzoyl peroxide
105-64-6	Isopropyl peroxydicarbonate
110-05-4	Di-*t*-butyl peroxide
124-43-6	Urea peroxide
131-74-8	Ammonium picrate (wet)
463-04-7	Amyl nitrate
506-93-4	Guanidine nitrate
509-14-8	Tetranitromethane
513-77-9	Barium carbonate
614-45-9	*t*-Butyl peroxybenzoate
627-13-4	*n*-Propyl nitrate
1304-29-6	Barium peroxide
1305-79-9	Calcium peroxide
1309-60-0	Lead dioxide
1313-13-9	Manganese dioxide
1313-60-6	*Sodium peroxide
1314-18-7	Strontium peroxide
1314-22-3	Zinc peroxide
1314-62-1	Vanadium pentoxide
1333-82-0	Chromium trioxide, anhydrous
1712-64-7	Isopropyl nitrate
1811-04-9	Potassium chlorate
2244-21-5	Potassium dichloroisocyanurate
2893-78-9	Sodium dichlorocyanurate
2244-21-5	*Potassium dichloroisocyanurate
2782-57-2	Dichloroisocyanuric acid
2893-78-9	Sodium dichloro-*s*-triazinetrione
3025-88-5	Dimethylhexane dihydroperoxide
3251-23-8	Cupric nitrate (copper nitrate)
3597-99-4	Beryllium nitrate
6153-56-6	Oxalic acid
6484-52-2	Ammonium nitrate
6484-52-2	Ammonium nitrate−sulfate mixture
7446-70-0	Ammonium chloride
7601-89-0	Sodium perchlorate
7601-90-3	Perchloric acid
7616-94-6	Perchloryl fluoride
7631-99-4	Sodium nitrate
7632-00-0	Sodium nitrite
7646-79-9	Cobalt(II) chloride

7681-52-9	Sodium hypochlorite
7722-64-7	Potassium permanganate
7722-84-1	*Hydrogen peroxide (27.5%−52% by weight)
7726-95-6	Bromine
7727-21-1	Potassium persulfate
7727-54-0	Ammonium persulfate
7738-94-5	*Chromic acid
7757-79-1	Potassium nitrate
7758-01-2	*Potassium bromate
7758-09-0	Potassium nitrite
7758-19-2	*Sodium chlorite
7761-88-8	Silver nitrate
7775-27-1	Sodium persulfate
7775-11-3	Sodium chromate
7775-09-9	Sodium chlorate
7778-54-3	*Calcium hypochlorite
7778-50-9	Potassium dichromate
7778-74-7	Potassium perchlorate
7779-88-6	Zinc nitrate
7782-78-7	Nitrosyl sulfuric acid
7783-54-2	Nitrogen trifluoride
7783-66-6	Iodine pentafluoride
7787-36-2	Barium permanganate
7787-50-5	Chlorine
7787-71-5	Bromine trifluoride
7788-98-9	Ammonium chromate
7789-00-6	Potassium chromate(VI)
7789-02-8	Chromium nitrate
7789-09-5	Ammonium dichromate
7789-18-6	Cesium nitrate
7789-30-2	Bromine pentafluoride
7789-36-8	Magnesium bromate
7789-38-0	Sodium bromate
7790-69-4	Lithium nitrate
7790-91-2	Chlorine trifluoride
7790-93-4	Chloric acid solution
7790-98-9	Ammonium perchlorate
7791-10-8	Strontium chlorate
7791-19-7	Magnesium chlorate
7791-27-7	Pyrosulfuryl chloride
10022-31-8	Barium nitrate
10022-68-1	Cadmium nitrate tetrahydrate
10028-15-6	Ozone
10034-81-8	Magnesium perchlorate
10042-76-9	Strontium nitrate
10045-94-0	Mercuric nitrate
10049-04-4	Chlorine oxide
10099-59-9	Lanthanum nitrate
10099-74-8	Lead nitrate
10101-50-5	*Sodium permanganate
10102-05-3	Palladium dinitrate
10102-06-4	Uranyl nitrate
10102-44-0	Nitrogen dioxide
10118-76-0	Calcium permanganate
10124-37-5	Calcium nitrate
10137-74-3	Calcium chlorate
10141-05-6	Cobalt nitrate
10294-39-0	Barium perchlorate trihydrate
10325-94-7	Cadmium nitrate
10361-95-2	Zinc chlorate
10377-60-3	Magnesium nitrate
10377-66-9	Manganese nitrate
10415-75-5	Mercurous nitrate
10421-48-4	Ferric nitrate
10588-01-9	Sodium dichromate
11115-74-5	Chromic anhydride
12030-88-5	Potassium superoxide
12031-80-0	Lithium peroxide
12034-12-7	Sodium superoxide
12262-58-7	Cyclohexanone peroxide
13138-45-9	Nickel(II) nitrate
13446-10-1	Ammonium permanganate
13450-97-0	Strontium perchlorate
13473-90-0	Aluminum nitrate
13477-00-4	Barium chlorate
13477-10-6	Barium hypochlorite
13477-36-6	Calcium perchlorate
13478-33-6	Cobalt(II) perchlorate, hexahydrate
13494-90-1	Gallium(III) nitrate
13494-98-9	Yttrium(III) nitrate hexahydrate
13517-27-6	Zinc bromate
13520-68-8	Iron(II) nitrate hexahydrate (1:2:6)
13530-65-9	Zinc chromate
13637-71-3	Nickel perchlorate
13637-76-8	Lead perchlorate
13746-89-9	Zirconium nitrate
13768-67-7	Ytterbium nitrate
13770-61-1	Indium nitrate
13823-29-5	Thorium(IV) nitrate
13863-41-7	Bromine chloride
13840-33-0	Lithium hypochlorite
13967-90-3	Barium bromate
14216-75-2	Nickel nitrate
14307-35-8	Lithium chromate
14452-57-4	Magnesium peroxide
14674-72-7	Calcium chlorite
14977-61-8	Chromium oxychloride
15630-89-4	Sodium percarbonate
17014-71-0	Potassium peroxide
17861-62-0	Nickel nitrite
23414-72-4	Zinc permanganate
57608-40-9	Ammonium nitrate−phosphate mixture
63885-01-8	Zinc ammonium nitrite

Note: The asterisk (*) denotes some of those materials with potential for spontaneous ignition.

Appendix 2: Carcinogens

Carcinogen Index by Name and CAS

A-α-C (2-Amino-9*H*-pyrido [2,3-*b*]indole)	26148-68-5
Acetaldehyde	75-07-0
Acetamide	60-35-5
2-Acetylaminofluorene	53-96-3
Acifluorfen sodium	62476-59-9
Acrylamide	79-06-1
Acrylo nitrile	107-13-1
Actinomycin D	50-76-0
AF-2;[2-(2-furyl)-3-(5-nitro-2-furyl)] acrylamide	3688-53-7
Aflatoxins	Various CAS
Alachlor	15972-60-8
Alcoholic beverages, when associated with alcohol abuse [Note: see Etanol (E:0330; CAS: 64-17-5)]	See note
Aldrin	309-00-2
Allyl chloride (*delisted 1999*)	107-05-1
2-Aminoanthraquinone	117-79-3
p-Aminoazobenzene	60-09-3
o-Aminoazotoluene	97-56-3
4-Aminobiphenyl (4-Aminodiphenyl)	92-67-1
1-Amino-2,4-dibromo-anthraquinone	81-49-2
3-Amino-9-ethylcarbazole hydrochloride	6109-97-3
2-Aminofluorene	153-78-6
1-Amino-2-methylanthraquinone	82-28-0
2-Amino-5-(5-nitro-2-furyl)-1,3,4-thiadiazole	712-68-5
4-2-Nitrophenol	119-34-6
Amitrole	61-82-5
Amsacrine	51264-14-3
Analgesic mixtures containing phenacetin	Various CAS
Aniline	62-53-3
Aniline hydrochloride	142-04-1
o-Anisidine	90-04-0
o-Anisidine hydrochloride	134-29-2
Antimony oxide (antimony trioxide)	1309-64-4
Anthraquinone	84-65-1
Aramite	140-57-8
Areca nut	No CAS
Aristolochic acids	313-67-7 and Various CAS
Arsenic (inorganic arsenic compounds)	7440-38-2
List of Arsenic compounds, inorganic	
Arsanilic acid [arsonic acid, (4-aminophenyl)-]	98-50-0
Arsenic pentoxide [arsenic oxide(As_2O_5)]	1303-28-2
Arsenic sulfide [arsenic sulfide(As_2S_3)]	1303-33-9
Arsenic trioxide [arsenic oxide (As_2O_3)]	1327-53-3
Arsine	7784-42-1
Calcium arsenate [arsenic acid (H_3AsO_4), calcium salt (2:3)]	7778-44-1
Dimethylarsinic acid (arsinic acid, dimethyl-)	75-60-5
Lead arsenate [arsenic acid (H_3AsO_4), lead(2+) salt (1:1)]	7784-40-9
Methane arsonic acid, disodium salt (arsonic acid, methyl-, disodium salt)	144-21-8
Methane arsonic acid, monosodium salt (arsonic acid, methyl-, monosodium salt)	2163-80-6
Potassium arsenate [arsenic acid (H_3AsO_4), monopotassium salt]	7784-41-0
Potassium arsenite (arsenenous acid, potassium salt)	13464-35-2
Sodium arsenate, sodium salt	7631-89-2
odium arsenite	7784-46-5
Sodium cacodylate (arsinic acid, dimethyl-, sodium salt)	124-65-2
Asbestos	1332-21-4
Asbestos, amosite	12172-73-5
Asbestos, actinolite	77536-66-4
Asbestos, anthophylite	77536-67-5
Asbestos, anthophyllite	17068-78-9
Asbestos, chrysotile	12001-29-5
Asbestos, crocidolite	12001-28-4
Asbestos, tremolite	77536-68-6
Auramine	492-80-8
Azacitidine	320-67-2
Azaserine	115-02-6
Azathioprine	446-86-6
Azobenzene	103-33-3
Benthiavalicarb-isopropyl	177406-68-7
Benz[*a*]anthracene	56-55-3
Benzene	71-43-2
Benzidine [and its salts]	92-87-5
Benzidine-based dyes	Various CAS
Benzo[*b*]fluoranthene	205-99-2
Benzo[*j*]fluoranthene	205-82-3
Benzo[*k*]fluoranthene	207-08-9
Benzofuran	271-89-6
Benzo[*a*]pyrene	50-32-8
Benzotrichloride	98-07-7
Benzyl chloride	100-44-7
Benzyl violet 4B	1694-09-3
Beryllium (and beryllium compounds)	7440-41-7
List of Beryllium compounds	
Beryllium chloride	7787-47-5
Beryllium fluoride	7787-49-7
Beryllium hydroxide	13327-32-7
Beryllium nitrate	13597-99-4
Beryllium oxide	1304-56-9
Beryllium sulfate	13510-49-1
Betel quid with tobacco	No CAS
Betel quid without tobacco	No CAS
2,2-Bis(bromomethyl)-1,3-propanediol	3296-90-0
Bis(2-chloroethyl)ether	111-44-4
N,N-Bis(2-chloroethyl)-2-naphthylamine (chlornapazine)	494-03-1

Bischloroethyl nitrosourea (BCNU) (carmustine)	154-93-8
Bis(chloromethyl)ether	542-88-1
Bis(2-chloro-1-methylethyl)ether, technical grade	No CAS
Bitumens, extracts of steam-refined and air refined	No CAS
Bracken fern	No CAS
Bromate	15541-45-4
Bromochloroacetic acid	5589-96-8
Bromodichloromethane	75-27-4
Bromoethane	74-96-4
Bromo form	75-25-2
1,3-Butadiene	106-99-0
1,4-Butanediol dimethanesulfonate (busulfan)	55-98-1
Butylated hydroxyanisole	25013-16-5
β-Butyrolactone	3068-88-0
Cacodylic acid	75-60-5
Cadmium (and cadmium compounds)	7440-43-9
List of Cadmium compounds	
Cadmium acetate	543-90-8
Cadmium bromide	7789-42-6
Cadmium chloride	10108-64-2
Cadmium cyanide	542-83-6
Cadmium fluoroborate	14486-19-2
Cadmium nitrate	10325-94-7
Cadmium nitrate tetrahydrate	10022-68-1
Cadmium oxide	1306-19-0
Cadmium oxide fume	1306-19-0
Cadmium stearate	2223-93-0
Cadmium succinate	141-00-4
Cadmium sulfate	10124-36-4
Caffeic acid	331-39-5
Captafol	2425-06-1
Captan	133-06-2
Carbaryl	63-25-2
Carbazole	86-74-8
Carbon black (airborne, unbound particles of respirable size)	1333-86-4
Carbon tetrachloride	56-23-5
Carbon-black extracts	No CAS
N-Carboxymethyl-*N*-nitrosourea	60391-92-6
Catechol	120-80-9
Ceramic fibers (airborne particles of respirable size)	No CAS
Certain combined chemotherapy for lymphomas	No CAS
Chlorambucil	305-03-3
Chloramphenicol	56-75-7
Chlordane	57-74-9
Chlordecone (Kepone)	143-50-0
Chlordimeform	6164-98-3
Chlorendic acid	115-28-6
Chlorinated paraffins (average chain length, C12; approximately 60% chlorine by weight)	108171-26-2
p-Chloroaniline	106-47-8
p-Chloroaniline hydrochloride	20265-96-7
Chlorobenzilate	510-15-6

Chlorodibromomethane (*delisted 1999*)	124-48-1
Chloroethane (Ethyl chloride)	75-00-3
1-(2-Chloroethyl)-3-cyclohexylnitrosourea (CCNU) (lomustine)	13010-47-4
1-(2-Chloroethyl)-3-(4-methylcyclohexyl)-1-nitrosourea (Methyl-CCNU)	13909-09-6
Chloroform	67-66-3
Chloromethyl methyl ether (technical grade)	107-30-2
3-Chloro-2-methylpropene	563-47-3
1-Chloro-4-nitrobenzene	100-00-5
4-Chloro-*o*-phenylenediamine	95-83-0
Chloroprene	126-99-8
Chlorothalonil	1897-45-6
p-Chloro-*o*-toluidine	95-69-2
p-Chloro-*o*-toluidine, strong acid salts of	Various CAS
5-Chloro-*o*-toluidine and its strong acid salts	Various CAS
Chlorotrianisene	569-57-3
Chlorozotocin	54749-90-5
Chromium (hexavalent compounds)	Various CAS
Chrysene	218-01-9
C.I. Acid Red 114	6459-94-5
C.I. Basic Red 9 monohydrochloride	569-61-9
C.I. Direct Blue 15	2429-74-5
C.I. Direct Blue 218	28407-37-6
C.I. Solvent Yellow 14	842-07-9
Ciclosporin (Cyclosporin A; Cyclosporine)	59865-13-3; 79217-60-0
Cidofovir	113852-37-2
Cinnamyl anthranilate	87-29-6
Cisplatin	15663-27-1
Citrus Red No. 2	6358-53-8
Clofibrate	637-07-0
Cobalt metal powder	7440-48-4
Cobalt[II] oxide	1307-96-6
Cobalt sulfate	10124-43-3
Cobalt sulfate heptahydrate	10026-24-1
Coke oven emissions	No CAS
Conjugated estrogens	No CAS
Creosotes	Various CAS
p-Cresidine	120-71-8
Cumene	98-82-8
Cupferron	135-20-6
Cycasin	14901-08-7
Cyclophosphamide (anhydrous)	50-18-0
Cyclophosphamide (hydrated)	6055-19-2
Cyclosporin A	59865-13-3
Cytembena	21739-91-3
D&C Orange No. 17	3468-63-1
D&C Red No. 8	2092-56-0
D&C Red No. 9	5160-02-1
D&C Red No. 19	81-88-9
Dacarbazine	4342-03-4
Daminozide	1596-84-5
Dantron (Chrysazin; 1,8-Dihydroxy-anthraquinone)	117-10-2
Daunomycin	20830-81-3

DDD (Dichlorodiphenyl-dichloroethane)	72-54-8
DDE (Dichlorodi-phenyldichloroethylene)	72-55-9
DDT (Dichlorodi-phenyltrichloroethane)	50-29-3
DDVP (Dichlorvos)	62-73-7
Diacetilo (Spanish)	B:0780
N,N′-Diacetylbenzidine	613-35-4
Diacétyle (French)	B:0780
2,3-Dioxobutane	B:0780
2,4-Diaminoanisole	615-05-4
2,4-Diaminoanisole sulfate	39156-41-7
4,4′-Diaminodiphenyl ether(4,4′-Oxydianiline)	101-80-4
2,4-Diaminotoluene	95-80-7
Diaminotoluene (mixed)	No CAS
Diazoaminobenzene	136-35-6
Dibenz[*a,h*]acridine	226-36-8
Dibenz[*a,j*]acridine	224-42-0
Dibenz[*a,h*]anthracene	53-70-3
7*H*-Dibenzo[*c,g*]carbazole	194-59-2
Dibenzo[*a,e*]pyrene	192-65-4
Dibenzo[*a,h*]pyrene	189-64-0
Dibenzo[*a,i*]pyrene	189-55-9
Dibenzo[*a,l*]pyrene	191-30-0
Dibromoacetic acid	631-64-1
1,2-Dibromo-3-chloropropane (DBCP) (male)	96-12-8
2,3-Dibromo-1-propanol	96-13-9
Dichloroacetic acid	79-43-6
p-Dichlorobenzene	106-46-7
3,3′-Dichlorobenzidine	91-94-1
3,3′-Dichlorobenzidine dihydrochloride	612-83-9
1,4-Dichloro-2-butene	764-41-0
3,3′-Dichloro-4,4′-diaminodiphenyl ether	28434-86-8
1,1-Dichloroethane	75-34-3
Dichloromethane (Methylene chloride)	75-09-2
1,2-Dichloropropane	78-87-5
1,3-Dichloropropene	542-75-6
1,3-Dichloro-2-propanol (1,3-DCP)	96-23-1
Diclofop-methyl	51338-27-3
Dieldrin	60-57-1
Dienestrol delisted California Prop. 65 1/1/1990	84-17-3
Diepoxybutane	1464-53-5
Diesel exhaust particulates	No CAS
Di(2-ethylhexyl)phthalate (DEHP)	117-81-7
1,2-Diethylhydrazine	1615-80-1
Diethylstilbestrol (DES)	56-53-1
Diethyl sulfate	64-67-5
Diglycidyl resorcinol ether (DGRE)	101-90-6
Dihydrosafrole	94-58-6
Diisopropyl sulfate	2973-10-6
3,3′-Dimethoxybenzidine (*o*-Dianisidine)	119-90-4
3,3′-Dimethoxybenzidine dihydrochloride (*o*-Dianisidine dihydrochloride)	20325-40-0
3,3′-Dimethoxybenzidine-based dyes metabolized to 3,3′-dimethoxybenzidine	Various CAS
3,3′-Dimethylbenzidine-based dyes metabolized to 3,3′-dimethylbenzidine	Various CAS
4-Dimethylaminoazobenzene	60-11-7
trans-2-[(Dimethylamino)methyl-imino]-5-[2-(5-nitro-2-furyl)vinyl]-1,3,4-oxadiazole	55738-54-0
7,12-Dimethylbenz(*a*)anthracene	57-97-6
3,3′-Dimethylbenzidine (*o*-Tolidine)	119-93-7
3,3′-Dimethylbenzidine dihydrochloride	612-82-8
Dimethylcarbamoyl chloride	79-44-7
1,1-Dimethylhydrazine (UDMH)	57-14-7
1,2-Dimethylhydrazine	540-73-8
Dimethyl sulfate	77-78-1
Dimethylvinyl chloride	513-37-1
3,7-Dinitrofluoranthene	105735-71-5
3,9-Dinitrofluoranthene	22506-53-2
1,6-Dinitropyrene	42397-64-8
1,8-Dinitropyrene	42397-65-9
Dinitrotoluene mixture, 2,4-/2,6-	25321-14-6
2,4-Dinitrotoluene	121-14-2
2,6-Dinitrotoluene	606-20-2
1,4-Dioxane	123-91-1
Diphenylhydantoin (Phenytoin)	57-41-0
Diphenylhyd antoin (Phenytoin), sodium salt	630-93-3
Di-*n*-propyl isocinchomeronate (MGK Repellent 326)	136-45-8
Direct Black 38 (technical grade)	1937-37-7
Direct Blue 6 (technical grade)	2602-46-2
Direct Brown 95 (technical grade)	16071-86-6
Disperse Blue 1	2475-45-8
Diuron	330-54-1
Doxorubicin hydrochloride (Adriamycin)	25316-40-9
Epichlorohydrin	106-89-8
Erionite	12510-42-8; 66733-21-9
Estradiol 17B	50-28-2
Estragole	140-67-0
Estrogens, steroidal	Various CAS
Estrone	53-16-7
Estro pipate	7280-37-7
Ethinylestradiol	57-63-6
Ethoprop	13194-48-4
Ethyl acrylate	140-88-5
Ethylbenzene	100-41-4
Ethyl-4,4′-dichlorobenzilate	510-15-6
Ethylene dibromide	106-93-4
Ethylene dichloride (1,2-dichloroethane)	107-06-2
Ethyleneimine	151-56-4
Ethylene oxide	75-21-8
Ethylene thiourea	96-45-7
Ethyl methane sulfonate	62-50-0
Fenoxycarb	72490-01-8
Folpet	133-07-3
Formaldehyde (gas)	50-00-0
2-(2-Formylhydrazino)-4-(5-nitro-2-furyl)thiazole	3570-75-0
Fumonisin B1	116355-83-0
Furan	110-00-9
Furazolidone	67-45-8
Furmecyclox	60568-05-0
Fusarin C	79748-81-5

Gallium arsenide	1303-00-0
Ganciclovir	82410-32-0
Gasoline engine exhaust (condensates/extracts)	No CAS
Gemfibrozil	25812-30-0
Glasswool fibers (airborne particles of respirable size)	No CAS
Glu-*p*-1 (2-6-methyldipyrido[1,2-*a*:3′, 2′-d]imidazole)	67730-11-4
Glu-*p*-2 (2-dipyrido [1,2-*a*:3′,2′-*d*]imidazole)	67730-10-3
Glycidaldehyde	765-34-4
Glycidol	556-52-5
Griseofulvin	126-07-8
Gyromitrin (acetaldehyde methylformylhydrazone)	16568-02-8
HC Blue 1	2784-94-3
Heptachlor	76-44-8
Heptachlor epoxide	1024-57-3
Herbal remedies containing plant species of the *genus Aristolochia*	No CAS
Hexachlorobenzene	118-74-1
Hexachlorocyclohexane (technical grade)	608-73-1
Hexachlorocyclohexane (other isomers)	No CAS
Hexachlorodibenzodioxin	34465-46-8
Hexachloroethane	67-72-1
2,4-Hexadienal (89% *trans, trans* isomer; 11% *cis, trans* isomer)	No CAS
Hexamethylphosphoramide	680-31-9
Hydrazine	302-01-2
Hydrazine sulfate	10034-93-2
Hydrazobenzene (1,2-diphenylhydrazine)	122-66-7
1-Hydroxyanthraquinone	129-43-1
Indeno[1,2,3-*cd*]pyrene	193-39-5
Indium phosphide	22398-80-7
IQ (2-3-methylimidazo[4,5-*f*] quinoline)	76180-96-6
Iprodione	36734-19-7
Iprovalicarb	140923-17-7/140923-25-7
Iron dextran complex	9004-66-4
Isobutyl nitrite	542-56-3
Isoprene	78-79-5
Isosafrole (*delisted 2006)*	120-58-1
Isoxaflutole	141112-29-0
Lactofen	77501-63-4
Lasiocarpine	303-34-4
Lead (and lead compounds)	7439-92-1
Lead acetate	301-04-2
Lead phosphate	7446-27-7
Lead subacetate	1335-32-6
Lindane (& other hexachlorocyclohexane isomers)	58-89-9
Lynestrenol	52-76-6
Mancozeb	8018-01-7
Maneb	12427-38-2
Me-A-α-C (2-3-methyl-9*H*-pyrido [2,3-*b*]indole)	68006-83-7
Medro xypro gesterone acetate	71-58-9
MeIQ (2-3,4-dimethyl-imidazo [4,5-*f*]quinoline)	77094-11-2
MeIQx (2-3,8-dimethyl-imidazo [4,5-*f*]quinoxaline)	77500-04-0
Melphalan	148-82-3
Mepanipyrim	110235-47-7
Merphalan	531-76-0
Mestranol	72-33-3
Metam potassium	137-41-7
Metham sodium	137-42-8
5-Methoxypsoralen with ultraviolet A therapy	484-20-8
8-Methoxypsoralen with ultraviolet A therapy	298-81-7
2-Methylaziridine (propyleneimine)	75-55-8
Methylazoxymethanol	590-96-5
Methylazoxymethanol acetate	592-62-1
Methyl carbamate	598-55-0
3-Methylcholanthrene	56-49-5
5-Methylchrysene	3697-24-3
4,4′-Methylene bis(2-chloroaniline)	101-14-4
4,4′-Methylene bis(*N,N*-dimethyl)benzenamine	101-61-1
4,4′-Methylene bis(2-methylaniline)	838-88-0
4,4′-Methylenedianiline	101-77-9
4,4′-Methylenedianiline dihydrochloride	13552-44-8
Methyleugenol	93-15-2
Methylhydrazine (and its salts)	60-34-4
4-Methylimidazole	822-36-6
Methyl iodide	74-88-4
Methylmercury compounds	No CAS
Methyl methane sulfonate	66-27-3
2-Methyl-1-nitro anthraquinone (of uncertain purity)	129-15-7
N-Methyl-*N*′-nitr*o*-*N*-nitrosoguanidine	70-25-7
N-Methylolacrylamide	924-42-5
Methylthiouracil	56-04-2
Metiram	9006-42-2
Metronidazole	443-48-1
Michler’s ketone	90-94-8
Milor	M:0235
Mirex	2385-85-5
Mitomycin C	50-07-7
3-Monochloropropane-1,2-diol (3-MCPD)	96-24-2
Monocrotaline	315-22-0
5-(Morpholinomethyl)-3-[(5-nitrofurfuryl-idene)-amino]-2-oxazolidinone	139-91-3
Mustard gas	505-60-2
MX (3-chloro-4-(dichloromethyl)5-hydroxy-2(5*H*)-furanone)	77439-76-0
Nafenopin	3771-19-5
Nalidixic acid	389-08-2
Naphthalene	91-20-3
1-Naphthylamine	134-32-7
2-Naphthylamine	91-59-8
Nickel (Metallic)	7440-02-0
Nickel acetate	373-02-4
Nickel carbonate	3333-67-3
Nickel carbonyl	13463-39-3
Nickel compounds	Various CAS
Nickel hydroxide	12054-48-7; 12125-56-3

Nickelocene	1271-28-9
Nickel oxide	1313-99-1
Nickel refinery dust from the pyrometallurgical process	No CAS
Nickel subsulfide	12035-72-2
Niridazole	61-57-4
Nitrapyrin	1929-82-4
Nitrilotriacetic acid	139-13-9
Nitrilotriacetic acid, trisodium salt monohydrate	18662-53-8
5-Nitroacenaphthene	602-87-9
5-Nitro-*o*-anisidine (*delisted 2006)*	99-59-2
o-Nitro anisole	91-23-6
Nitrobenzene	98-95-3
4-Nitrobiphenyl	92-93-3
6-Nitrochrysene	7496-02-8
Nitrofen (technical grade)	1836-75-5
2-Nitrofluorene	607-57-8
Nitrofurazone	59-87-0
1-[(5-Nitrofurfurylidene)-amino]-2-imidazolidinone	555-84-0
N-[4-(5-Nitr*o*-2-furyl)-2-thiazolyl]acetamide	531-82-8
Nitrogen mustard (mechlorethamine)	51-75-2
Nitrogen mustard hydrochloride (mechlorethamine hydrochloride)	55-86-7
Nitrogen mustard *N*-oxide	126-85-2
Nitrogen mustard *N*-oxide hydrochloride	302-70-5
Nitromethane	75-52-5
2-Nitropropane	79-46-9
1-Nitropyrene	5522-43-0
4-Nitropyrene	57835-92-4
N-Nitrosodi-*n*-butylamine	924-16-3
N-Nitrosodiethanolamine	1116-54-7
N-Nitrosodiethylamine	55-18-5
N-Nitrosodimethylamine	62-75-9
p-Nitrosodiphenylamine	156-10-5
N-Nitrosodiphenylamine	86-30-6
N-Nitrosodi-*n*-propylamine	621-64-7
N-Nitroso-*N*-ethylurea	759-73-9
3-(*N*-Nitro somethylamino)-propionitrile	60153-49-3
4-(*N*-Nitrosomethylamino)-1-(3-pyridyl) 1-butanone	64091-91-4
N-Nitrosomethylethylamine	10595-95-6
N-Nitroso-*N*-methylurea	684-93-5
N-Nitroso-*N*-methylurethane	615-53-2
N-Nitrosomethylvinylamine	4549-40-0
N-Nitrosomorpholine	59-89-2
N-Nitrosonornicotine	16543-55-8
N-Nitrosopiperidine	100-75-4
N-Nitrosopyrrolidine	930-55-2
N-Nitrososarcosine	13256-22-9
o-Nitrotoluene	88-72-2
Nitrosyl radical	N:0490
Norethisterone (norethindrone)	68-22-4
Norethynodrel	68-23-5
Ochratoxin A	303-47-9
Oil Orange SS	2646-17-5
Oral contraceptives, combined	No CAS
Oral contraceptives, sequential	No CAS
Oryzalin	19044-88-3
Oxadiazon	19666-30-9
Oxazepam	604-75-1
Oxymetholone	434-07-1
Oxythioquinox (chinomethionat)	2439-01-2
Palygorskite fibers (>5 μm in length)	12174-11-7
Panfuran S	794-93-4
Persulfate compounds	No CAS
Pentachlorophenol	87-86-5
Phenacetin (and analgesic mixtures containing phenacetin)	62-44-2
Phenazopyridine	94-78-0
Phenazopyridine hydrochloride	136-40-3
Phenesterin	3546-10-9
Phenobarbital	50-06-6
Phenolphthalein	77-09-8; 5768-87-6
Phenoxybenzamine	59-96-1
Phenoxybenzamine hydrochloride	63-92-3
N-2-Phenoxyisopropyl-*N*-benzyl-chloroethylamine hydrochloride	P:0365
N-Phenoxyisopropyl-*N*-benzyl-β-chloroethylamine hydrochloride	P:0365
o-Phenylenediamine and its salts	95-54-5
Phenyl glycidyl ether	122-60-1
Phenylhydrazine and its salts	No CAS
o-Phenylphenate, sodium	132-27-4
o-Phenylphenol	90-43-7
PhiP (2-amino-1-methyl-6-phenylimidazol [4,5-*b*]pyridine)	105650-23-5
Pirimicarb	23103-98-2
Polybrominated biphenyls (PBBs)	Various CAS
List of Polybrominated biphenyl (PBB) compounds	
p-Bromodiphenyl ether	101-55-3
p,p′-Didibromodiphenyl ether	2050-47-7
Decabromobip henyl	13654-09-6
Decabromodiphenyl ether	1163-19-5
Hexabromobiphenyl	59080-40-9
Hexabromo-1,1′-biphenyl	36355-01-8
Hexabromodiphenyl ether	36483-60-0
Nonabromodiphenyl ether	63936-56-1
Octabromobiphenyl	27858-07-7
Octabromobiphenyl	61288-13-9
Octabromodiphenyl ether	32536-52-0
Pentabromodiphenyl ether	32534-81-9
Polybrominated biphenyl	59536-65-1
Polybrominated biphenyl mixture	67774-32-7
Tetrabromodiphenyl ether	40088-47-9
Tribromodiphenyl ether	49690-94-0
Polychlorinated biphenyls (PCBs)	No CAS
List of Polychlorinated biphenyl (PCB) compounds	
Polychlorinated biphenyls	1336-36-3
Biphenyl	92-52-4
2-Chlorobiphenyl	2051-60-7

4-Chlorobiphenyl	2051-62-9
2,2′-Dichloro biphenyl	13029-08-8
2,3′-Dichloro biphenyl	25569-80-6
2,4′-Dichloro biphenyl	34883-43-7
4,4′-Dichloro biphenyl	2050-68-2
2,2′,3,3′,4,6-Hexachloro biphenyl	38380-05-1
2,2′,3,3′,6,6′-Hexachlorobiphenyl	38411-22-2
2,2′,3,4,4′,5-Hexachloro biphenyl	35694-06-5
2,2′,3,4,4′,5′-Hexachlorobiphenyl	35065-28-2
2,2′,3′,4,5,6′-Hexachlorobiphenyl	38380-04-0
2,2′,4,4′,5,5′-Hexachlorobiphenyl	35065-27-1
2,2′,3,3′,4,4′,5-Heptachlorobiphenyl	35065-30-6
2,2′,3,3′,4,5,6′-Heptachlorobiphenyl	38441-25-5
2,2′,3,4,4′,5,5′-Heptachlorobiphenyl	35065-29-3
2,2′,3,3′,6-Pentachlorobiphenyl	52663-60-2
2,2′,3,4,5′-Pentachlorobiphenyl	38380-02-8
2,2′,3′,4,5-Pentachlorobiphenyl	41464-51-1
2,2′,3,4′,6-Pentachlorobiphenyl	No CAS
2,2′,3,5′,6-Pentachlorobiphenyl	38379-99-6
2,2′,4,4′,5-Pentachlorobiphenyl	38380-01-7
2,2′,4,5,5′-Pentachlorobiphenyl	37680-73-2
2,3,3′,4,4′-Pentachlorobiphenyl	32598-14-4
2,3,3′,4′,6-Pentachlorobiphenyl	38380-03-9
2,3′,4,4′,5-Pentachlorobiphenyl	31508-00-6
2,2′3,5′-Tetrachlorobiphenyl	41464-39-5
2,2′,4,5′-Tetrachlorobiphenyl	41464-40-8
2,2′,5,5′-Tetrachlorobiphenyl	35693-99-3
2,3,4,4′-Tetrachlorobiphenyl	33025-41-1
2,3′,4,4′-Tetrachlorobiphenyl	32598-10-0
2,3′,4′,5-Tetrachlorobiphenyl	32598-11-1
3,3′,4,4′-Tetrachlorobiphenyl	32598-13-3
2,2′,3-Trichlorobiphenyl	38444-78-9
2,2′,5-Trichlorobiphenyl	37680-65-2
2,3′,4-Trichlorobiphenyl	No CAS
2′,3,4-Trichlorobiphenyl	38444-86-9
2,4,4′-Trichlorobiphenyl	7012-37-5
2,4′,5-Trichlorobiphenyl	16606-02-3
Polychlorinated biphenyls (containing 60 or more % Cl by molecular weight)	Various CAS
Polychlorinated dibenzo-*p*-dioxins	Various CAS
Polychlorinated dibenzofurans	No CAS
Polygeenan	53973-98-1
Ponceau MX	3761-53-3
Ponceau 3R	3564-09-8
Potassium bromate	7758-01-2
Primidone	125-33-7
Procarbazine	671-16-9
Procarbazine hydrochloride	366-70-1
Procymidone	32809-16-8
Progesterone	57-83-0
Pronamide	23950-58-5
Propachlor	1918-16-7
1,3-Propane sultone	1120-71-4
Propargite	2312-35-8
β-Propiolactone	57-57-8
Propoxur	114-26-1

Propylene glycol mono-*t*-butyl ether	57018-52-7
Propylene oxide	75-56-9
Propylthiouracil	51-52-5
Pyridine	110-86-1
Quinoline and its strong acid salts	No CAS
Radionuclides	No CAS
Reserpine	50-55-5
Residual (heavy) fuel oils	No CAS
Resmethrin	10453-86-8
Riddelliine	23246-96-0
Saccharin (*delisted 2001*)	81-07-2
Saccharin, sodium (*delisted 2003*)	128-44-9
Safrole	94-59-7
Selenium sulfide	7446-34-6
Shale-oils	68308-34-9
Silica, crystalline (airborne particles of respirable size)	No CAS
Soots, tars, and mineral oils (untreated and mildly treated oils and used engine oils)	No CAS
Spirodiclofen	148477-71-8
Spironolactone	52-01-7
Stanozolol	10418-03-8
Sterigmatocystin	10048-13-2
Streptozotocin (streptozocin)	18883-66-4
Strong inorganic acid mists containing sulfuric acid	No CAS
Styrene-7,8-oxide	96-09-3
Sulfallate	95-06-7
Sulfasalazine (salicylazosulfapyridine)	599-79-1
Talc containing asbestiform fibers	No CAS
Tamoxifen and its salts	10540-29-1
Terrazole	2593-15-9
Testosterone and its esters	58-22-0
2,3,7,8-Tetrachlorodibenzo-*p*-dioxin (TCDD)	1746-01-6
1,1,2,2-Tetrachloroethane	79-34-5
Tetrachloroethylene (perchloroethylene)	127-18-4
p-a,a,a-Tetrachlorotoluene	5216-25-1
Tetrafluoroethylene	116-14-3
Tetranitromethane	509-14-8
Thioacetamide	62-55-5
4,4′-Thiodianiline	139-65-1
Thiodicarb	59669-26-0
Thiouracil	141-90-2
Thiourea	62-56-6
Thorium dioxide	1314-20-1
Tobacco, oral use of smokeless products	No CAS
Tobacco smoke	No CAS
Toluene diisocyanate	26471-62-5
o-Toluidine	95-53-4
o-Toluidine hydrochloride	636-21-5
p-Toluidine (*delisted 1999*)	106-49-0
Toxaphene (polychlorinated camphenes)	8001-35-2
Toxins derived from *Fusarium Moniliforme (Fusarium verticillioides)*	No CAS
Treosulfan	299-75-2
Trichlormethine (trimustine hydrochloride)	817-09-4

Trichloroethylene	79-01-6
2,4,6-Trichlorophenol	88-06-2
1,2,3-Trichloropropane	96-18-4
2,4,5-Trimethylaniline (and its strong acid salts)	137-17-7
Trimethyl phosphate	512-56-1
2,4,6-Trinitrotoluene	118-96-7
Triphenyltin hydroxide	76-87-9
Tris(aziridinyl)-*p*-benzoquinone (Triaziquone) (*delisted 2006*)	68-76-8
Tris(1-aziridinyl)phosphine Sulfide (thiotepa)	52-24-4
Tris(2-chloroethyl) phosphate	115-96-8
Tris(2,3-dibromopropyl)phosphate	126-72-7
Trp-*p*-1 (tryptophan-*p*-1)	62450-06-0
Trp-*p*-2 (tryptophan-*p*-2)	62450-07-1
Trypan blue (commercial grade)	72-57-1
Unleaded gasoline (wholly vaporized)	8006-61-9
Uracil mustard	66-75-1
Urethane (ethyl carbamate)	51-79-6
Vanadium pentoxide (orthorhombic crystalline form)	1314-62-1
Vinclozolin	50471-44-8
Vinyl bromide	593-60-2
Vinyl chloride	75-01-4
4-Vinylcyclohexene	100-40-3
4-Vinyl-1-cyclohexene diepoxide (vinyl cyclohexene dioxide)	106-87-6
Vinyl fluoride	75-02-5
Vinyl trichloride (1,1,2-trichloroethane)	79-00-5
Wood dust	No CAS
2,6-Xylidine (2,6-dimethylaniline)	87-62-7
Zalcitabine	7481-89-2
Zidovudine (AZT)	30516-87-1
Zileuton	111406-87-2
Zineb *(delisted 1999)*	12122-67-7

Carcinogen Index by CAS and Name

50-00-0	Formaldehyde (gas)
50-06-6	Phenobarbital
50-07-7	Mitomycin C
50-18-0	Cyclophosphamide (anhydrous)
50-28-2	Estradiol 17B
50-29-3	DDT (Dichlorodi-phenyltrichloroethane)
50-32-8	Benzo[*a*]pyrene
50-55-5	Reserpine
50-76-0	Actinomycin D
51-52-5	Propylthiouracil
51-75-2	Nitrogen mustard (mechlorethamine)
51-79-6	Urethane (ethyl carbamate)
52-01-7	Spironolactone
52-24-4	Tris(1-aziridinyl)phosphine Sulfide (Thiotepa)
52-76-6	Lynestrenol
53-16-7	Estrone
53-70-3	Dibenz[*a*,*h*]anthracene
53-96-3	2-Acetylaminofluorene
55-18-5	*N*-Nitrosodiethylamine
55-86-7	Nitrogen mustard hydrochloride (mechlorethamine hydrochloride)
55-98-1	1,4-Butanediol dimethanesulfonate (Busulfan)
56-04-2	Methylthiouracil
56-23-5	Carbon tetrachloride
56-49-5	3-Methylcholanthrene
56-53-1	Diethylstilbestrol (DES)
56-55-3	Benz[*a*]anthracene
56-75-7	Chloramphenicol
57-14-7	1,1-Dimethylhydrazine (UDMH)
57-41-0	Diphenylhydantoin (phenytoin)
57-57-8	β-Propiolactone
57-63-6	Ethinylestradiol
57-74-9	Chlordane
57-83-0	Progesterone
57-97-6	7,12-Dimethylbenz(*a*)anthracene
58-22-0	Testosterone and its esters
58-89-9	Lindane and other hexachlorocyclohexane isomers
59-87-0	Nitrofurazone
59-89-2	*N*-Nitrosomorpholine
59-96-1	Phenoxybenzamine
60-09-3	*p*-Aminoazobenzene
60-11-7	4-Dimethylaminoazobenzene
60-34-4	Methylhydrazine (and its salts)
60-35-5	Acetamide
60-57-1	Dieldrin
61-57-4	Niridazole
61-82-5	Amitrole
62-44-2	Phenacetin
62-50-0	Ethyl methane sulfonate
62-53-3	Aniline
62-55-5	Thioacetamide
62-56-6	Thiourea
62-73-7	DDVP (Dichlorvos)
62-75-9	*N*-Nitrosodimethylamine
63-25-2	Carbaryl
63-92-3	Phenoxybenzamine hydrochloride
64-17-5	Ehtanol associated with alcoholic beverage consumption
64-67-5	Diethyl sulfate
66-27-3	Methyl methanesulfonate
66-75-1	Uracil mustard
67-45-8	Furazolidone
67-66-3	Chloroform
67-72-1	Hexachloroethane
68-22-4	Norethisterone (norethindrone)
68-23-5	Norethynodrel
68-76-8	Tris(aziridinyl)-*p*-benzoquinone (triaziquone) (*delisted 2006)*
70-25-7	*N*-Methyl-*N*′-nitro-*N*-nitrosoguanidine
71-43-2	Benzene
71-58-9	Medroxyprogesterone acetate
72-33-3	Mestranol
72-54-8	DDD (dichlorodiphenyl-dichloroethane)
72-55-9	DDE (dichlorodi-phenyldichloroethylene)
72-57-1	Trypan blue (commercial grade)

74-88-4	Methyl iodide
74-96-4	Bromo ethane
75-00-3	Chloroethane (Ethyl chloride)
75-01-4	Vinyl chloride
75-02-5	Vinyl fluoride
75-07-0	Acetaldehyde
75-09-2	Dichloromethane (methylene chloride)
75-21-8	Ethylene oxide
75-25-2	Bromo form
75-27-4	Bromo dichloromethane
75-34-3	1,1-Dichloroethane
75-52-5	Nitromethane
75-55-8	2-Methylaziridine (propyleneimine)
75-56-9	Propylene oxide
75-60-5	Cacodylic acid
76-44-8	Heptachlor
76-87-9	Triphenyltin hydroxide
77-09-8; 5768-87-6	Phenolphthalein
77-78-1	Dimethyl sulfate
78-79-5	Isoprene
78-87-5	1,2-Dichloropropane
79-00-5	Vinyl trichloride (1,1,2-Trichloroethane)
79-01-6	Trichloroethylene
79-06-1	Acrylamide
79-34-5	1,1,2,2-Tetrachloroethane
79-43-6	Dichloroacetic acid
79-44-7	Dimethylcarbamoyl chloride
79-46-9	2-Nitropropane
81-07-2	Saccharin (*delisted* 2001)
81-49-2	1-Amin*o*-2,4-dibromo-anthraquinone
81-88-9	D&C Red No. 19
82-28-0	1-Amino-2-methylanthraquinone
84-17-3	Dienestrol
84-65-1	Anthraquinone
86-30-6	*N*-Nitrosodiphenylamine
86-74-8	Carbazole
87-29-6	Cinnamyl anthranilate
87-62-7	2,6-Xylidine (2,6-dimethylaniline)
87-86-5	Pentachlorophenol
88-06-2	2,4,6-Trichlorophenol
88-72-2	*o*-Nitrotoluene
90-04-0	*o*-Anisidine
90-43-7	*o*-Phenylphenol
90-94-8	Michler's ketone
91-20-3	Naphthalene
91-23-6	*o*-Nitro anisole
91-59-8	2-Naphthylamine
91-94-1	3,3′-Dichlorobenzidine
92-67-1	4-Aminobiphenyl (4-aminodiphenyl)
92-87-5	Benzidine (and its salts)
92-93-3	4-Nitrobiphenyl
93-15-2	Methyleugenol
94-58-6	Dihydrosafrole
94-59-7	Safrole
94-78-0	Phenazopyridine
95-06-7	Sulfallate
95-53-4	*o*-Toluidine
95-54-5	*o*-Phenylenediamine and its salts
95-69-2	*p*-Chloro-*o*-toluidine
95-80-7	2,4-Diaminotoluene
95-83-0	4-Chloro-*o*-phenylenediamine
96-09-3	Styrene-7,8-oxide
96-12-8	1,2-Dibromo-3-chloropropane (DBCP) (male)
96-13-9	2,3-Dibromo-1-propanol
96-18-4	1,2,3-Trichloropropane
96-23-1	1,3-Dichloro-2-propanol (1,3-DCP)
96-24-2	3-Monochloropropane-1,2-diol (3-MCPD)
96-45-7	Ethylene thiourea
97-56-3	*o*-Aminoazotoluene
98-07-7	Benzotrichloride
98-82-8	Cumene
98-95-3	Nitrobenzene
99-59-2	5-Nitro-*o*-anisidine (*delisted 2006*)
100-00-5	1-Chloro-4-nitrobenzene
100-40-3	4-Vinylcyclohexene
100-41-4	Ethylbenzene
100-44-7	Benzyl chloride
100-75-4	*N*-Nitrosopiperidine
101-14-4	4,4′-Methylene bis(2-chloroaniline)
101-61-1	4,4′-Methylene bis(*N,N*-dimethyl)benzenamine
101-77-9	4,4′-Methylenedianiline
101-80-4	4,4′-Diaminodiphenyl ether(4,4′-oxydianiline)
101-90-6	Diglycidyl resorcinol ether (DGRE)
103-33-3	Azobenzene
106-46-7	*p*-Dichlorobenzene
106-47-8	*p*-Chloroaniline
106-49-0	*p*-Toluidine (*delisted 1999*)
106-87-6	4-Vinyl-1-cyclohexene diepoxide (vinyl cyclohexene dioxide)
106-89-8	Epichlorohydrin
106-93-4	Ethylene dibromide
106-99-0	1,3-Butadiene
107-05-1	Allyl chloride (*delisted 1999*)
107-06-2	Ethylene dichloride (1,2-dichloroethane)
107-13-1	Acrylonitrile
107-30-2	Chloromethyl methyl ether (technical grade)
110-00-9	Furan
110-86-1	Pyridine
111-44-4	Bis(2-chloroethyl)ether
114-26-1	Propoxur
115-02-6	Azaserine
115-28-6	Chlorendic acid
115-96-8	Tris(2-chloroethyl) phosphate
116-14-3	Tetrafluoroethylene
117-10-2	Dantron (chrysazin;1,8-dihydroxy-anthraquinone)
117-79-3	2-Aminoanthraquinone
117-81-7	Di(2-ethylhexyl)phthalate (DEHP)
118-74-1	Hexachlorobenzene
118-96-7	2,4,6-Trinitrotoluene
119-34-6	4-Amino-2-nitrophenol
119-90-4	3,3′-Dimethoxybenzidine (*o*-Dianisidine)
119-93-7	3,3′-Dimethylbenzidine (*o*-Tolidine)

120-58-1	Isosafrole (*delisted 2006*)
120-71-8	*p*-Cresidine
120-80-9	Catechol
121-14-2	2,4-Dinitrotoluene
122-60-1	Phenyl glycidyl ether
122-66-7	Hydrazobenzene (1,2-diphenylhydrazine)
123-91-1	1,4-Dioxane
124-48-1	Chlorodibromomethane (*delisted 1999*)
125-33-7	Primidone
126-07-8	Griseofulvin
126-72-7	Tris(2,3-dibro mopropyl)phosphate
126-85-2	Nitrogen mustard *N*-oxide
126-99-8	Chloroprene
127-18-4	Tetrachloroethylene (perchloroethylene)
128-44-9	Saccharin, sodium (*delisted 2003*)
129-15-7	2-Methyl-1-nitro anthraquinone (of uncertain purity)
129-43-1	1-Hydroxyanthraquinone
132-27-4	*o*-Phenylphenate, sodium
133-06-2	Captan
133-07-3	Folpet
134-29-2	*o*-Anisidine hydrochloride
134-32-7	1-Naphthylamine
135-20-6	Cupferron
136-35-6	Diazoaminobenzene
136-40-3	Phenazopyridine hydrochloride
136-45-8	Di-*n*-propyl isocinchomeronate (MGK Repellent 326)
137-17-7	2,4,5-Trimethylaniline (and its strong acid salts)
137-41-7	Metam potassium
137-42-8	Metham sodium
139-13-9	Nitrilotriacetic acid
139-65-1	4,4′-Thiodianiline
139-91-3	5-(Morpholinomethyl)-3-[(5-nitrofurfuryl-idene)-amino]-2-oxazolidinone
140-57-8	Aramite
140-67-0	Estragole
140-88-5	Ethyl acrylate
141-90-2	Thiouracil
142-04-1	Aniline hydrochloride
143-50-0	Chlordecone (Kepone)
148-82-3	Melphalan
151-56-4	Ethyleneimine
153-78-6	2-Aminofluorene
154-93-8	Bischloroethyl nitrosourea (BCNU) (Carmustine)
156-10-5	*p*-Nitrosodiphenylamine
189-55-9	Dibenzo[*a*,*i*]pyrene
189-64-0	Dibenzo[*a*,*h*]pyrene
191-30-0	Dibenzo[*a*,*l*]pyrene
192-65-4	Dibenzo[*a*,*e*]pyrene
193-39-5	Indeno[1,2,3-*cd*]pyrene
194-59-2	7*H*-Dibenzo[*c*,*g*]carbazole
205-82-3	Benzo[*j*]fluoranthene
205-99-2	Benzo[*b*]fluoranthene
207-08-9	Benzo[*k*]fluoranthene
218-01-9	Chrysene
224-42-0	Dibenz[*a*,*j*]acridine
226-36-8	Dibenz[*a*,*h*]acridine
271-89-6	Benzofuran
298-81-7	8-Methoxypsoralen with ultraviolet A therapy
299-75-2	Treosulfan
301-04-2	Lead acetate
302-01-2	Hydrazine
302-70-5	Nitrogen mustard *N*-oxide hydrochloride
303-34-4	Lasiocarpine
303-47-9	Ochratoxin A
305-03-3	Chlorambucil
309-00-2	Aldrin
315-22-0	Monocrotaline
320-67-2	Azacitidine
330-54-1	Diuron
331-39-5	Caffeic acid
366-70-1	Procarbazine hydrochloride
373-02-4	Nickel acetate
389-08-2	Nalidixic acid
434-07-1	Oxymetholone
443-48-1	Metronidazole
446-86-6	Azathioprine
484-20-8	5-Methoxypsoralen with ultraviolet A therapy
492-80-8	Auramine
494-03-1	*N*,*N*-Bis(2-chloroethyl)-2-naphthylamine (Chlornapazine)
505-60-2	Mustard Gas
509-14-8	Tetranitromethane
510-15-6	Ethyl-4,4′-dichlorobenzilate
512-56-1	Trimethyl phosphate
513-37-1	Dimethylvinylchloride
531-76-0	Merphalan
531-82-8	*N*-[4-(5-Nitro-2-furyl)-2-thiazolyl]acetamide
540-73-8	1,2-Dimethylhydrazine
542-56-3	Isobutyl nitrite
542-75-6	1,3-Dichloropropene
542-88-1	Bis(chloromethyl)ether
555-84-0	1-[(5-Nitrofurfurylidene)-amino]-2-imidazolidinone
556-52-5	Glycidol
563-47-3	3-Chloro-2-methylpropene
569-57-3	Chlorotrianisene
569-61-9	C.I. Basic Red 9 monohydrochloride
590-96-5	Methylazoxymethanol
592-62-1	Methylazoxymethanol acetate
593-60-2	Vinyl bromide
598-55-0	Methyl carbamate
599-79-1	Sulfasalazine (salicylazosulfapyridine)
602-87-9	5-Nitroacenaphthene
604-75-1	Oxazepam
606-20-2	2,6-Dinitrotoluene
607-57-8	2-Nitrofluorene
608-73-1	Hexachlorocyclohexane (technical grade)
612-82-8	3,3′-Dimethylbenzidine dihydrochloride
612-83-9	3,3′-Dichlorobenzidine dihydrochloride
613-35-4	*N*,*N*′-Diacetylbenzidine

615-05-4	2,4-Diaminoanisole
615-53-2	*N*-Nitroso-*N*-methylurethane
621-64-7	*N*-Nitro sodi-*n*-propylamine
630-93-3	Diphenylhydantoin (Phenytoin), sodium salt
631-64-1	Dibromoacetic acid
636-21-5	*o*-Toluidine hydrochloride
637-07-0	Clofib rate
671-16-9	Procarbazine
680-31-9	Hexamethylphosphoramide
684-93-5	*N*-Nitroso-*N*-methylurea
712-68-5	2-Amino-5-(5-nitro-2-furyl)-1,3,4-thiadiazole
759-73-9	*N*-Nitroso-*N*-ethylurea
764-41-0	1,4-Dichloro-2-butene
765-34-4	Glycidaldehyde
794-93-4	Panfuran S
817-09-4	Trichlormethine (trimustine hydrochloride)
822-36-6	4-Methylimidazole
838-88-0	4,4′-Methylene bis(2-methylaniline)
842-07-9	C.I. Solvent Yellow 14
924-16-3	*N*-Nitrosodi-*n*-butylamine
924-42-5	*N*-Methylolacrylamide
930-55-2	*N*-Nitrosopyrrolidine
1024-57-3	Heptachlor epoxide
1116-54-7	*N*-Nitrosodiethanolamine
1120-71-4	1,3-Propane sultone
1271-28-9	Nickelocene
1303-00-0	Gallium arsenide
1307-96-6	Cobalt[II] oxide
1309-64-4	Antimony oxide (antimony trioxide)
1313-99-1	Nickel oxide
1314-20-1	Thorium dioxide
1314-62-1	Vanadium pentoxide (orthorhombic crystalline form)
1332-21-4	Asbestos
1333-86-4	Carbon black (airborne, unbound particles of respirable size)
1335-32-6	Lead subacetate
1464-53-5	Diepoxybutane
1596-84-5	Daminozide
1615-80-1	1,2-Diethylhydrazine
1694-09-3	Benzyl violet 4B
1746-01-6	2,3,7,8-Tetrachlorodibenzo-*p*-dioxin (TCDD)
1836-75-5	Nitrofen (technical grade)
1897-45-6	Chlorothalonil
1918-16-7	Propachlor
1929-82-4	Nitrapyrin
1937-37-7	Direct Black 38 (technical grade)
2092-56-0	D&C Red No. 8
2312-35-8	Propargite
2385-85-5	Mirex
2425-06-1	Captafol
2429-74-5	C.I. Direct Blue 15
2439-01-2	Oxythioquinox (Chinomethionat)
2475-45-8	Disperse Blue 1
2593-15-9	Terrazole
2602-46-2	Direct Blue 6 (technical grade)
2646-17-5	Oil Orange SS
2784-94-3	HC Blue 1
2973-10-6	Diisopropyl sulfate
3068-88-0	β-Butyrolactone
3296-90-0	2,2-Bis(bromomethyl)-1,3-propanediol
3333-67-3	Nickel carbonate
3468-63-1	D&C Orange No. 17
3546-10-9	Phenesterin
3564-09-8	Ponceau 3R
3570-75-0	2-(2-Formylhydrazino)-4-(5-nitro-2-furyl) thiazole
3688-53-7	AF-2;[2-(2-furyl)-3-(5-nitro-2-furyl)] acrylamide
3697-24-3	5-Methylchrysene
3761-53-3	Ponceau MX
3771-19-5	Nafenopin
4342-03-4	Dacarbazine
4549-40-0	*N*-Nitrosomethylvinylamine
5160-02-1	D&C Red No. 9
5216-25-1	*p-a*,*a*,*a*-Tetrachlorotoluene
5522-43-0	1-Nitropyrene
5589-96-8	Bromochloroacetic acid
6055-19-2	Cyclophosphamide (hydrated)
6109-97-3	3-Amino-9-ethylcarbazole hydrochloride
6164-98-3	Chlordimeform
6358-53-8	Citrus Red No. 2
6459-94-5	C.I. Acid Red 114
7280-37-7	Estropipate
7439-92-1	Lead (and lead compounds)
7440-02-0	Nickel (metallic)
7440-38-2	Arsenic (inorganic arsenic compounds)
7440-41-7	Beryllium (and beryllium compounds)
7440-43-9	Cadmium (and cadmium compounds)
7440-48-4	Cobalt metal powder
7446-27-7	Lead phosphate
7446-34-6	Selenium sulfide
7481-89-2	Zalcitabine
7496-02-8	6-Nitrochrysene
7758-01-2	Potassium bromate
8001-35-2	Toxaphene (polychlorinated camphenes)
8006-61-9	Unleaded gasoline (wholly vaporized)
8018-01-7	Mancozeb
9004-66-4	Iron dextran complex
9006-42-2	Metiram
10026-24-1	Cobalt sulfate heptahydrate
10034-93-2	Hydrazine sulfate
10048-13-2	Sterigmatocystin
10124-43-3	Cobalt sulfate
10418-03-8	Stanozolol
10453-86-8	Resmethrin
10540-29-1	Tamoxifen and its salts
10595-95-6	*N*-Nitrosomethylethylamine
12035-72-2	Nickel subsulfide
12054-48-7; 12125-56-3	Nickel hydroxide
12122-67-7	Zineb *(delisted 1999)*
12174-11-7	Palygorskite fibers (>5 μm in length)

12427-38-2	Maneb
12510-42-8; 66733-21-9	Erionite
13010-47-4	1-(2-Chloroethyl)-3-cyclohexylnitrosourea (CCNU) (Lomustine)
13194-48-4	Ethoprop
13256-22-9	*N*-Nitrososarcosine
13463-39-3	Nickel carbonyl
13552-44-8	4,4′-Methylenedianiline dihydrochloride
13909-09-6	1-(2-Chloroethyl)-3-(4-methylcyclohexyl)-1-nitrosourea (Methyl-CCNU)
14901-08-7	Cycasin
15541-45-4	Bromate
15663-27-1	Cisplatin
15972-60-8	Alachlor
16071-86-6	Direct Brown 95 (technical grade)
16543-55-8	*N*-Nitrosonornicotine
16568-02-8	Gyromitrin (Acetaldehyde methylformylhydrazone)
18662-53-8	Nitrilotriacetic acid, trisodiumsalt monohydrate
18883-66-4	Streptozotocin (streptozocin)
19044-88-3	Oryzalin
19666-30-9	Oxadiazon
20265-96-7	*p*-Chloroaniline hydrochloride
20325-40-0	3,3′-Dimethoxybenzidine dihydrochloride (*o*-Dianisidine dihydrochloride)
20830-81-3	Daunomycin
21739-91-3	Cytembena
22398-80-7	Indium phosphide
22506-53-2	3,9-Dinitrofluoranthene
23103-98-2	Pirimicarb
23246-96-0	Riddelliine
23950-58-5	Pronamide
25013-16-5	Butylated hydroxyanisole
25316-40-9	Doxo rubicin hydrochloride (Adriamycin)
25321-14-6	Dinitrotoluene mixture, 2,4-/2,6-
25812-30-0	Gemfibrozil
26148-68-5	A-α-C (2-Amino-9*H*-pyrido [2,3-*b*]indole)
26471-62-5	Toluene diisocyanate
28407-37-6	C.I. Direct Blue 218
28434-86-8	3,3′-Dichloro-4,4′-diaminodiphenyl ether
30516-87-1	Zidovudine (AZT)
32809-16-8	Procymidone
34256-82-1	Acetochlor
34465-46-8	Hexachlorodibenzodioxin
36734-19-7	Iprodione
39156-41-7	2,4-Diamino anisole sulfate
42397-64-8	1,6-Dinitropyrene
42397-65-9	1,8-Dinitropyrene
50471-44-8	Vinclozolin
51264-14-3	Amsacrine
51338-27-3	Diclofop-methyl
53973-98-1	Polygeenan
54749-90-5	Chlorozotocin
55738-54-0	*trans*-2-[(Dimethylamino)methyl-imino]-5-[2-(5-nitro-2-furyl)vinyl]-1,3,4-oxadiazole
57018-52-7	Propylene glycol mono-*t*-butyl ether
57835-92-4	4-Nitropyrene
59669-26-0	Thiodicarb
59865-13-3; 79217-60-0	Ciclosporin (Cyclosporin A; Cyclosporine)
60153-49-3	3-(*N*-Nitro somethylamino)-propionitrile
60391-92-6	*N*-Carboxymethyl-*N*-nitrosourea
60568-05-0	Furmecyclox
62450-06-0	Trp-*p*-1 (Tryptophan-*p*-1)
62450-07-1	Trp-*p*-2 (Tryptophan-*p*-2)
62476-59-9	Acifluorfen sodium
64091-91-4	4-(*N*-Nitrosomethylamino)-1-(3-pyridyl) 1-butanone
67730-10-3	Glu-*p*-2(2-Aminodipyrido[1,2-*a*:3′,2′-d] imidazole)
67730-11-4	Glu-*p*-1(2-Amino-6-methyldipyrido [1,2-*a*:3′,2′-*d*]imidazole)
68006-83-7	Me-A-α-C (2-Amino-3-methyl-9*H*-pyrido[2,3-*b*]indole)
68308-34-9	Shale-oils
72490-01-8	Fenoxycarb
76180-96-6	IQ (2-Amino-3-methylimidazo[4,5-*f*] quinoline)
77094-11-2	MeIQ (2-Amino-3,4-dimethyl-imidazo[4,5-*f*] quinoline)
77439-76-0	MX (3-chloro-4-(dichloromethyl)5-hydroxy-2(5*H*)-furanone)
77500-04-0	MeIQx (2-Amino-3,8-dimethyl-imidazo [4,5-*f*]quinoxaline)
77501-63-4	Lactofen
79748-81-5	Fusarin C
82410-32-0	Ganciclovir
105650-23-5	PhiP (2-Amino-1-methyl-6-phenylimidazol [4,5-*b*]pyridine)
105735-71-5	3,7-Dinitrofluoranthene
108171-26-2	Chlorinated paraffins (Average Chain length, C12; approximately 60% chlorine by weight)
110235-47-7	Mepanipyrim
111406-87-2	Zileuton
113852-37-2	Cidofovir
116355-83-0	Fumonisin B1
140923-17-7 /140923-25-7	Iprovalicarb
141112-29-0	Isoxaflutole
148477-71-8	Spirodiclofen
177406-68-7	Benthiavalicarb-isopropyl
No CAS	Silica, crystalline (airborne particles of respirable size)
No CAS	Soots, tars, and mineral oils(untreated and mildly treated oils and used engine oils)
No CAS	Strong inorganic acid mists containing sulfuric acid
No CAS	Phenylhydrazine and its salts
No CAS	Toxins derived from *Fusarium Moniliforme (Fusarium verticillioides)*
No CAS	Nickel refinery dust from the pyrometallurgical process

No CAS	Oral contraceptives, combined
No CAS	Diesel exhaust particulates
No CAS	Wood dust
No CAS	Ceramic fibers (airborne particles of respirable size)
No CAS	Oral contraceptives, sequential
No CAS	Residual (heavy) fuel oils
No CAS	Radionuclides
No CAS	Certain combined chemotherapy for lymphomas
No CAS	Talc containing asbestiform fibers
No CAS	Aflatoxins
No CAS	Diaminotoluene (mixed)
No CAS	Alcoholic beverages, when associated with alcohol abuse
No CAS	Bracken fern
No CAS	Bitumens, extracts of steam-refined, and air efined
No CAS	Bis(2-chloro-1-methylethyl)ether, technical grade
No CAS	Tobacco smoke
No CAS	2,4-Hexadienal (89% *trans, trans* isomer; 11% *cis*, *trans* isomer)
No CAS	Tobacco, oral use of smokeless products
No CAS	Betel quid without tobacco
No CAS	5-Chloro-*o*-toluidine and its strong acid salts
No CAS	Herbal remedies containing plant species of the *genus Aristolochia*
No CAS	Hexachlorocyclohexane (other isomers)
No CAS	Creosotes
No CAS	Polychlorinated dibenzo furans
No CAS	Betel quid with tobacco
No CAS	Methylmercury compounds
No CAS	Conjugated estrogens
No CAS	Chromium (hexavalent compounds)
No CAS	Glasswool fibers (airborne particles of respirable size)
No CAS	Gasoline engine exhaust (condensates/extracts)
No CAS	Coke oven emissions
No CAS	Quinoline and its strong acid salts
No CAS	Areca nut
No CAS	Carbon-black extracts
No CAS	Benzidine-based dyes
No CAS	3,3′-Dimethoxybenzidine-based dyes metabolized to 3,3′-dimethylbenzidine
No CAS	3,3′-Dimethoxybenzidine-based dyes metabolized to 3,3′-dimethoxybenzidine
Various CAS	Nickel compounds
Various CAS	*p*-Chloro-*o*-toluidine, strong acid salts of
Various CAS	Analgesic mixtures containing phenacetin
Various CAS	Polybrominated biphenyls (PBBs)
Various CAS	Polychlorinated dibenzo-*p*-dioxins
Various CAS	Polychlorinated biphenyls (containing 60 or more percent Cl by molecular weight)
Various CAS	Polychlorinated biphenyls
Various CAS	Estrogens, steroidal

Appendix 3: Glossary

A

Absorbent material: Commercially packaged clay, kitty litter, or other material used to soak up liquid hazardous materials.

Absorption: Penetration of a substance across a biologic barrier (such as the skin) and into either the lymphatic system or bloodstream.

Acaricide: A chemical substance used to kill ticks and mites.

Accident: An unplanned energy transfer causing property damage and/or human injury. See also "incident."

Accumulative effect: The effect of a chemical substance on a biologic system when the substance is being absorbed at a rate that exceeds the body's ability to eliminate it from the system. Excessive accumulation of the substance in the system can lead to toxicity.

Acid: Any compound containing hydrogen replaceable by metals, and having a pH of 0–6. Strong acids in the pH range of 0–2 are corrosive and will cause chemical burns to the skin, eyes, and mucous membranes. Acids turn litmus red. See also "pH" and "strong acids."

Acid gas: A gas that forms an acid when dissolved in water.

Acidosis: A pathologic condition resulting from accumulation of acid in, or loss of base from, the body.

Acrid: Having a biting taste; sharp; pungent.

Active ingredient: The component that actually performs the primary function of a product. Products generally contain both active and inert ingredients, and both may be harmful. For example, insecticides in spray cans contain both chemicals having pesticidal action (active) and propellant gas (inert). Active ingredients are listed on product labels as percentage by weight or as pounds per gallon of concentrate.

Acute: The clinical term for a disease having a short and relatively severe course, measured in seconds, minutes, hours, or days, following expo sure to a health hazard. Also, in animal testing, pertains to administration of an agent in a single dose.

Acute effect: Refers to an adverse health effect that usually occurs rapidly, sometimes immediately, as a result of a single, short significant exposure to a health hazard, without implying a degree of severity. Acute effects may include irritation, corrosivity, narcosis, and death. See also "chronic."

Acute exposure: Refers to a single exposure to a toxic substance that results in death or severe biological harm. Acute exposures are characterized as lasting no longer than 1 day.

Acidosis: A pathologic condition resulting from accumulation of acid in, or loss of base from, the body.

Adrenal gland: A hormone-secreting organ located above each kidney.

AEGL: Acronym for Acute Emergency guideline Levels. Acute Emergency Guideline Levels (AEGLs) represent threshold airborne exposure limits for the general public and are applicable to emergency exposures ranging from 10 minutes to 8 hours. Three levels—AEGL-1, AEGL-2, AEGL-3—are developed for each of five exposure periods (10 minutes, 30 minutes, 1 hour, 4 hours, and 8 hours) and are distinguished by varying degrees of severity of toxic effects. The U.S. Department of Energy guidance is to use the 1 hour AEGL values, which appear in this database [138]. AEGL values are developed and published by the United States Environmental Protection Agency[88]. See also "How to Use this Book" in the front matter of this book.

Aerosol: A dispersed suspension of fine particles suspended in air (dispersed in a gas), the particle size often being in the 0.01–100 μm range. Natural aerosols include smoke (solid particles) and fog (liquid particles). Man-made aerosols are manufactured by filling a valved container, usually a can, with a suspension (e.g., paint, insecticides, cosmetics) in a gas under pressure.

Aliphatic: Pertaining to an open-chain hydrocarbon compound. Substances such as methane and ethane are typical aliphatic hydrocarbons.

Alkali: Any ACID destroying compound having a pH of 8–14. Strong alkalis (or bases) in the pH range of 12–14 are considered corrosive and will cause chemical burns to the skin, eyes, and mucous membranes. Alkalis turn litmus blue. Widely used industrial alkali substances include sodium hydroxide, sodium carbonate, potassium hydroxide and potassium carbonate. Common household products include DRANO and lye. See also "acid," "base," and "pH."

Alkaloid: An organic nitrogen base, of vegetable origin, usually toxic.

Allergen: A substance that causes the body to produce an antibody and which results in an allergy in hypersensitive people.

Allergy: A hypersensitive reaction of body tissues to specific substances. In similar concentrations and circumstances, these same substances do not affect other persons. Allergic reactions in the workplace tend to affect the skin (see dermatitis) and lungs (see asthma).

Ambient air concentration: The concentration of a material in environmental air outside of buildings, that is, air to which the general public is exposed.

Amine: An organic compound that may be derived from ammonia (NH_3) by the replacement of one or more hydrogen atoms (H) by hydrocarbon groups or other chemical moieties; replacing one, two, or three hydrogen atoms gives primary, secondary, or tertiary amines, respectively; if a fourth group is added to a tertiary amine (R_3N), the compound formed is called a quaternary amine (R_4N+) and the nitrogen carries a positive charge.

Anaerobic conditions: Refers to the absence of oxygen.

Amnesia: Total or partial memory loss.

Analgesia: A pain-relieving agent that causes insensibility to pain without loss of consciousness.

Analogue: A compound that resembles another in structure; may be an isomer, but not necessarily.

Analytical grade: The highest available purity of a chemical.

Anemia: A deficiency of the blood caused by reduced red blood cell count or a reduction in the amount of hemoglobin per unit volume of blood.

Anesthesia: Total or partial loss of sensation with or without loss of consciousness.

Angina pectoris: Pain in chest cause by inadequate supply of blood to the heart.

Anhydrous: Containing no water.

Anorexia: Loss or reduction of appetite for food.

Anosmia: Total or partial loss of the sense of smell.

Anoxia: A reduction in the quantity of oxygen sup plied by blood to cells or tissues.

Anticonvulsant: A substance that lessens the severity of convulsions.

Antidote: A remedy to relieve, prevent or counteract the effects of a poison; that which counteracts anything noxious.

Antiepileptic: A substance that lessens the severity of epileptic seizures.

Anuria: Absence of urine in the bladder caused by the failure of the kidneys to produce urine. This is a possible symptom of chlorate or inorganic mercury poisoning.

Apathy: Reduced emotions with lack of interest in outside stimuli.

Apnea: Temporary cessation of breathing. A possible symptom of poisoning.

Aquatic toxicology: A branch of toxicology that deals with water pollution and its ecological effects.

Aqueous: Watery or water like.

Aromatic compound: Pertaining to a molecular ring structure hydrocarbon compound, characterized by the presence of the benzene nucleus.

Aromatic hydrocarbon: An organic chemical compound formed primarily from carbon (C) and hydrogen (H) atoms with a structure based on benzene rings *and* resembling benzene in chemical behavior; substituents on the rings(s) may contain atoms other than C or H.

Arrhythmia: Disturbed heartbeat.

Arsenical: A compound containing arsenic.

Arylamine: An organic compound formed from an aromatic hydrocarbon that has at least one amine group joined to it.

Ataxia: Unsteady walk or shaky movements due to neurological problems. May be a symptom of poisoning.

Asphyxia: Difficulty in breathing or respiratory arrest; suffocation.

Asphyxiant: Refers to a substance, usually a vapor or gas, that can cause suffocation, unconsciousness or death by preventing the blood from carrying oxygen. Most simple asphyxiants (which have no inherent toxicity) are harmful to the body only when they become so concentrated that oxygen in the air is reduced (normally about 21%) to dangerous levels (18% or lower).

Asthenia: Reduced physical and psychological strength.

Asthma: Respiratory problem characterized by attacks of wheezing, shortness of breath, and/or coughing and resulting in difficult breathing due to contraction of air passages.

Ataxia: Loss or failure of muscular coordination, voluntary movement, or muscle control.

Atrophy: A loss of weight, volume, and activity of an organ, tissue, or cell; shrinkage.

Autoignition temperature: The minimum temperature at which a substance will ignite spontaneously, or cause self-sustained combustion in the absence of any heated element, spark, or flame. The closer the autoignition temperature is to room temperature, the greater the risk of fire.

Awareness level (trained): First responders at the awareness level are those persons who, in the course of their normal duties, may be the first on the scene of emergency involving hazardous materials. First responders at the awareness level are expected to recognize hazardous materials presence, protect themselves, call for trained personnel, and secure the area (ANSI/NFPA 472).

Azide: A compound that contains the monovalent $-N_3$ group.

Azo: A prefix denoting the presence in a molecule of the group $-N=N-$. See also diazo.

B

Bactericidal: Destructive to bacteria. An agent (e.g., heat, light, or osmotic pressure) or a chemical, such as a pesticide, that kills bacteria or inhibits their growth is called a bactericide.

Barbiturate: A drug used as a sedative or hypnotic.

Base: A substance that reacts with acids to form salts and water. All bases create solutions having a pH of more than 7.0, the neutral point, and may be corrosive to skin and other human tissue. The terms alkali and caustic are closely related in meaning. See also “acid,” “alkali,” and “pH.”

BEI: Biological Exposure Index. The maximum recommended value of a substance in blood, urine, or exhaled air, recommended by the ACGIH. See “Threshold Limit Values and Biological Exposure Indices,” published by the ACGIH, for an explanation.

Benign: Not harmful.

Bile: A yellow-green, bitter fluid secreted by the liver. Also called gall.

Bioaccumulation: The process by which a material in an organism’s environment progressively concentrates within the organism.

Bioassay: The determination of the potency or concentration of a compound by its effect upon animals, isolated tissues, or microorganisms, as compared with a chemical or physical assay.

Biodegradation: Biotransformation; the conversion within an organism of molecules from one form to another, a change often associated with change in pharmacologic activity.

Bld: Blood effects. A toxicology term describing the effect on all blood elements including oxygen carrying or releasing capacity, pH, protein, and electrolytes.

Blepharospasm: Abnormal contraction of eyelid muscles.

BOD: Bio logical oxygen demand. A test that measures the dissolved oxygen consumed by microbial life while assimilating and oxidizing the organic matter present in organic waste discharges. This test permits calculation of the effect of the discharges on the oxygen resources of the receiving water.

Boiling point: The temperature at which a product changes from a liquid to a vapor at normal atmospheric pressure (760 mmHg). Mixtures may not have a specific boiling point. As a general rule, material safety data sheets (MSDS) carry the initial boiling point or a boiling range for a mixture.

Bowel: The intestine, or the part of the digestive tract extending from the stomach to the anus.

Bradycardia: A decrease in the heartbeat rate to less than 60 beats per minute.

Breakthrough time: The time from initial chemical contact to detection.

Breathing zone sample: An air sample collected from the area around the nose of a worker to assess exposure to airborne contaminants.

Bronchoconstriction: Contraction with narrowing of bronchia.

Bronchospasm: Spasmodic contraction of the muscles surrounding the bronchia.

Bulk density: Mass of powdered or granulated solid material per unit of volume.

By-product: Any material, other than the principal pro duct, generated as a consequence of an industrial process.

C

C Symbol for Celsius or Centigrade, a unit of temperature in which the interval between the freezing point of water and the boiling point is divided into 100 units, or degrees, with 0°C representing the freezing point and 100°C the boiling point.

Cancer: A general term used to indicate any of various types of malignant neoplasms.

Canister: A personal air cleaning device usually worn by the user. The canister contains sorbents, catalysts, or other filter materials designed to remove gases, vapors, and liquid and so lid particles from air drawn through it.

Carcinogen: Any substance causing the promotion or initiation of malignant or benign neoplasia (cancer) in humans or animals. A material is considered carcinogenic if, (1) it has found to be a carcinogen or potential carcinogen by the International Agency for Research on Cancer (IARC); or, (2) if it is listed in the latest edition of the "Annual Report on Carcinogens," published by the National Toxicology Program (NTP); or, (3) it is regulated by OSHA as a carcinogen.

Carcinogenesis: The process by which normal tissue becomes cancerous.

Carcinogenicity: The power, ability, or tendency to produce cancerous tissue from normal tissue.

Carcinoma: A malignant neoplasm of the epithelium.

Carcinoma in situ: Noninvasive cancer.

Carcinoma: A malignant tumor; a type of cancer.

Cardio: A medical prefix that refers to the heart.

Cardiovascular: A medical term that refers to the heart and blood vessel system.

Catalyst: A substance that affects the rate of a chemical reaction, but that is neither changed nor consumed by the reaction.

Cataract: A disease of the eye in which the lens becomes gray-white and loses its clearness.

Cathartic: Substance that aids bowel movement and stimulates evacuation of the intestine.

Cation: An ion that carries a positive charge, e.g., sodium ($N+$), (calcium Ca_2+), and ammonium (NH_4+); the corresponding hydroxide is formed when combined with hydroxyl ($OH-$) ions.

Caustic: Any strongly alkaline substance that has a corrosive effect on living tissue. See also "alkali."

Ceiling limit: The concentration of a substance that should not be exceeded, even for an instant. Also called ceiling concentration.

Central nervous system (CNS): Refers to the brain and spinal cord, the main network of coordination and control for the entire body. Chemicals acting on the brain may cause CNS depression with symptoms of dizziness, headache, and drowsiness; higher exposure may cause unconsciousness, coma, and death.

Characteristic hazardous waste: An RCRA regulated waste classified as "hazardous" because of its ignitability, corrosivity, reactivity, or toxicity as determined by the Toxicity Characteristic Leachate Procedure (TCLP). It has an EPA Waste Code ranging from "D001" to "D043."

Chelation: A complex formation involving a metal ion and two or more polar groupings of a single molecule; chelation can be used to remove an ion from participation in biological reactions, as in the chelation of Ca^2+ in blood by EDTA.

Chemical: Any element, chemical compound, or mixture of elements and/or compounds.

Chemical burn: Similar to a thermal burn from heat or fire, but caused by contact with a chemical substance.

Chemical family: A group of single elements or groups of compounds having a common chemical structure and name. Also known as chemical class. As used on a Material Safety Data Sheet (MSDS), more than one chemical family may be used if applicable.

Chemical formula: The chemical makeup of a substance using accepted written symbols. Although several kinds of formulas are used to indicate chemical constitution and physical structure, the *molecular formula* showing the actual kinds and numbers of atoms that comprise a molecule of chemical substance is most commonly used in Material Safety Data Sheet (MSDS).

Chemical hygiene plan: A written action plan required by OSHA's regulation 29CFR1910, Occupational Exposures to Hazardous Chemicals in Laboratories.

Chemical intermediate A chemical formed or used during the process of producing another chemical.

Chemically active metals: Usually refers (but not restricted) to chemicals such as sodium, potassium, beryllium, calcium, powdered aluminum, zinc, and magnesium. These metals can cause violent reactions with certain other substances and materials.

Chemical name: The scientific designation of a chemical as outlined by the Chemical Abstract Service (CAS) rules of nomenclature and the nomenclature system developed by the International Union of Pure and Applied Chemistry. Also defined by the OSHA Hazard Communication Standard (HCS) as a name which will clearly identify the chemical for the purpose of conducting a hazard evaluation. By this definition, more than one valid name for many chemicals is permitted. However, when chemicals with more than one valid name appears on the OSHA (29CFR1910 Table Z-1) or CERCLA (40 CFR302.4) lists, this name is generally used as the chemical name on material safety data sheets (MSDS). If a chemical does not appear on these lists, then the most common chemical name should be used. Trade names that adequately identify a chemical may be used.

Chemical manufacturer: Defined in the OSHA Hazard Communication Standard (HCS) as an employer with a workplace where chemical(s) are produced for use or distribution.

Chemical reaction: Any chemical change, regardless of rate, or whether it occurs naturally or induced by man. There are many types of chemical reactions including decomposition, explosion, combustion, condensation, polymerization, neutralization.

Chemical resistance: The ability of a material to resist chemical reaction.

Chemosterilant: A chemical compound that causes an organism to become sterile after exposure to it.

Chlorofluorocarbons (CFCs): A group of chemicals that depletes the earth's protective ozone layer. Chemical substance often used as refrigerants, solvents, and propellants as propellants in spray cans. CFCs are not destroyed in the lower atmosphere; they drift into the upper atmosphere where their chlorine components are released and destroy the ozone layer.

Chloracne: A severe acne-like affliction of the skin resulting from excessive exposure to certain chlorinated or halogenated chemical compounds, such as carbon tetrachloride, chloroform, trichloroethylene, biphenyls, dioxins, napthalenes, and DDT.

Chronic: Refers to a change to an organism over a long period of time, measured in weeks, months, or years following repeated exposure to a health hazard.

Chronic effect of overexposure: Refers to an adverse health effect that develops slowly over a long period of time or from prolonged exposure to a health hazard without implying a degree of severity.

Chronic toxicity: Refers to permanent and irreversible health effects resulting from prolonged exposure to a toxic substance.

Circulatory system: The system consisting of the blood, blood vessels, lymph vessels, and heart; involved in circulating blood and lymph throughout the body.

Cirrhosis: Chronic progressive illness affecting the structure and function of the liver. Replacement of normal liver tissue with bands of fibrous tissue surrounding nodules of regenerating liver tissue.

Closed cup: Test for the flash point of a substance.

Coagulant: An agent that causes, stimulates, or accelerates coagulation, especially with reference to blood.

Cocarcinogen: Any substance, not itself carcinogenic, capable of enhancing the carcinogenic effect of another substance.

Code of Federal Regulations (CFR): A publication of the regulations promulgated under United States federal law. Changes to CFR are published in the "Federal Register" (FR). The CFR is divided into titles as follows:

Title 29: OSHA regulations, including the Hazard Communication Standard (HCS).

Title 40: EPA regulations, including TSCA.

Title 49: DOT regulations.

Colic: A sharp, crampy, and possibly painful disorder of the abdomen resulting from blockage, twisting, or muscle spasm.

Collapsus: Rapid decrease in strength or collapse of an organ.

Coma: A state of deep unconsciousness from which a victim cannot be wakened by external stimulants.

Combustible liquid: A material having a flash point at or above 37.8°C/100°F, but below 93.3°C/200°F, except that this term does not include any liquid mixture that has one or more components with a flash point above 93.3°C/200°F, which make up 99% or more of the total volume of the mixture as determined by tests listed in 49C FR173.115(d). Exceptions to this are found in 49C FR173.115(b).

Commercial grade: Less than the purest available form of a chemical; the purity normally produced for and adequate for commercial uses.

Common name: Any designation or identification such as a code name, code number, trade name, or generic name used to identify a chemical other than by its chemical name (OSHA).

Component: An ingredient or constituent part.

Compound: A substance consisting of two or more elements that have united chemically.

Compressed gas: Any material or mixture having in the container a pressure exceeding 40 psi at 70°F/21.1°C, or a pressure exceeding 104 psi at 130°F/54.4°C, regardless of the pressure at 70°F/21.1°C; or any liquid flammable material having a vapor pressure exceeding 40 psi absolute pressure at 100°F/37.8°C as determined by the American National Standard Method of Tests for Vapor Pressure of Petroleum Products (Reid Method) Z11.44-1973 (ASTM—American Society for Testing Materials D 323-72).

Congenital: A condition that begins to develop in the uterus and is existing at birth.

Congestion: Abnormal accumulation of blood in the vessels of tissue, an organ or other part of the body.

Conjugated: Bound together; in organic chemistry, conjugated refers to a molecular structure or substructure containing alternating double and single bonds between pairs of adjacent atoms.

Conjunctivitis: Irritation and inflammation of the conjunctiva, a part of the inner lining of the eyelids.

Container: Defined by OSHA as any bag, barrel, bottle, box, can, cylinder, drum, reaction vessel, storage tank, or the like that contains a hazardous chemical. Pipes and piping systems and engines, fuel tanks or other operating systems in a vehicle, are not considered containers (29CFR).

Contaminant: An impurity; in the environment, a chemical that is not ordinarily present and that may have deleterious effects.

Contraindication: Any condition that renders some particular treatment of disease improper or undesirable.

Convulsions: Violent, involuntary spasms or muscle contractions.

Copolymer: A chemical (polymer) made up of repetitive subunits (monomers) that are not all alike.

Corrosive material: Any liquid or solid with pH ranges of 2–6 or 12–14, and that cause visible destruction or irreversible alteration of living tissue, or a liquid that has a severe corrosion rate on steel. To determine whether a material is destructive or to cause irreversible alteration of human skin, refer to the method described in Appendix A of 49CFR173. A liquid is considered to have a severe corrosion rate if its corrosion rate exceeds

0.250 in. per year (IPY) on steel [Society of Automotive Engineers (SAE) 1020] at a test temperature of 130°F/54.4°C. Also see test described in NACE Standard TM-01-69.

Cryogenic liquid: Defined by DOT as a refrigerated liquefied gas having a boiling point colder than-130°F/-90°C at one atmosphere, absolute.

Cutaneous: Pertaining to the skin. See also "dermal."

Cyanosis: A bluish discoloration of the skin, lips, and mucous membrane, resulting from lack of oxygen in the blood hemoglobin, or excessive concentration of reduced hemoglobin in the blood.

Cytotoxic: Having a poisonous effect on cells.

D

Decomposition: Breakdown of a material or substance into parts, elements or simpler compounds that may be caused by heat, chemical reaction, electrolysis, decay, biodegradation, or other process.

Decontamination: The removal of hazardous substances from employees and their equipment to the extent necessary to preclude the occurrence of foreseeable adverse health effects.

Degradation: The destructive effect a chemical may have on chemical-protective clothing, reducing its strength and flexibility and permitting a direct route to skin contact.

Defoliant: A chemical spray or dust that causes leaves to drop off plants prematurely.

Dermal penetration: The act of entering the body by penetrating the layers of the skin.

Dermatitis: An inflammation of the skin.

Delayed hazard: The potential to cause an adverse effect which may not appear until after a long period of time. Carcinogenicity, teratogenicity and certain target organ/system effects are examples of delayed hazards.

Deliquescent: Substance which absorbs moisture from the air to the point of becoming liquid.

Delirium: A mental state of great excitement or confusion marked by confusion, speech disorders, anxiety, and often hallucinations.

Density: The mass (weight) per unit volume of a substance. For example, lead has much greater density than aluminum.

Dermal: Pertaining to the skin. See also "cutaneous."

Dermatitis: Inflammation of the skin from any cause.

Dermatosis: Generic name for all skin disorders.

Desquamation: Abnormal elimination of surficial layers of skin in small flakes.

Diabetes: A disease in which the body's ability to use sugar is impaired and which usually involves the abnormal appearance of sugar in the urine; characterized by excessive urination.

Diamine: An organic compound containing two amine groups, e.g., ethylenediamine, $H_2NCH_2CH_2NH_2$.

Diarrhea: Abnormally frequent discharge of loose, watery feces from the large intestine (colon). May be a symptom of poisoning.

Diazo: A prefix denoting a compound containing the $-N'N-$ or $-N.N+$ group. See also "azo-."

Dimer: A compound or unit produced by the combination of two like molecules.

Diuretic: That which increases volume of urine.

DL Used separately, prefixes of D—for dextrorotary (rotated to the right) and L—for levorotary (rotated to the left) before the same chemical name refer to designations for optically active isomers that are chemically identical but that rotate plane polarized light in opposite directions; the isomers are mirror images of each other; when used together, DL—designates a racemic mixture of the two isomers, whose optical activities cancel each other.

Dose: The amount of a chemical substance or drug to which a person has been exposed or absorbed into the body.

Dysplasia: Malformation; abnormal development.

Dyspnea: Difficulty or labored breathing. Shortness of breath. A possible symptom of poisoning.

Dysuria: Painful or difficulty in urinating.

E

Easily oxidized materials: A broad range of materials that includes combustible materials, organic materials, paper, wood, sulfur, aluminum, acetic acid, alcohols, fuels, oils, plastics, hydrazine, acetic anhydride, sulfuric acid, and many other chemicals. Easily oxidized materials can cause violent reactions with other substances and materials. See also "oxidizer," "strong oxidizers."

Eczema: Not a distinct disease but a general medical description for swelling of the skin, or rash of unknown cause. An inflammation of the outer layer of skin, characterized by redness, itching, crusting, and scaling.

Edema: Swelling caused by infiltration of fluid into the tissues or intercellular spaces.

Effluent: Wastewater discharged from a treatment plant, sewer, or industrial outfall into the environment, usually to surface waters.

Effluent guidelines (listed as a toxic pollutant): Under the Clean Water Act, pollutants that are subject to technology-based standards (application of best available techno logy) developed for selected groups of industries.

Electrolyte: A substance, such as sodium chloride (NaCl), that dissociates into ions when fused (melted) or in solution, thereby becoming capable of conducting an electric current.

EIS: Environmental Impact Statement. The results of a study to determine the probable effects of a proposed activity on the surrounding environment.

Element: The simplest form of a pure substance that cannot be broken down into simpler substances by chemical means.

Embryotoxic: Toxic effect on the embryo.

Emphysema: A condition of the lungs characterized by dilation or destruction of the pulmonary areola. An illness characterized by plugged passageways and a difficulty in exhaling.

Employer: Defined by OSHA as a person (including contractor or subcontractor) engaged in business, where chemicals are either used, distributed, or produced for use or distribution.

Encephalopathy: Generic name given to illnesses affecting the brain in general.

Environment: Includes water, air, and land and their interrelationship which exists among and between water, air, and land and all living things[88].

EP: Extraction Procedure toxicity characteristics. Toxicity test performed on RCRA wastes.

Environmental fate: The distribution and transformation of a chemical from its first release until its ultimate removal from or recycling through the environment.

Enzyme: A protein produced in organisms capable of accelerating a particular biochemical reaction; a biological catalyst.

Epidemiology: Science concerned with the study of disease in a general population. Determination of the incidence (rate of occurrence) and distribution of a particular disease (as by age, sex, or occupation), which may provide information about the cause of the disease.

Ergonomics: The activity dealing with interactions between workers and their total working environment and their stresses relating to the elements of the environment, their tools and equipment.

ERPG: Acronym for Emergency Response Planning Guidelines. Exposure limit values produced by the American Industrial Hygiene Association (AIHA). See also “Using this Book” in the front matter of this book.

Erythema: Abnormal flushing or redness of the skin due to increase in blood flow.

Etiologic agents: Airborne microorganisms capable of causing disease. These agents are the only nonchemical materials regulated by the United States Department of Transportation (DOT).

Etiology: The science and study of all the factors that contribute to the development of a disease.

Euphoria: Intense feeling of well-being or elation.

Evaporation rate: A measure of the time required for a given amount of a substance to evaporate, compared with the time required for an equal amount of butyl acetate or ether to evaporate.

Exothermic: Heat producing.

Expectoration: Expulsion from the mouth of secretions from the respiratory tract.

Explosive: Any chemical compound, mixture, or device that produces a sudden, almost instantaneous release of pressure, gas, and heat when subjected to sudden shock, ignition source, pressure, or high temperature.

Explosive limits: Defined by the NFPA as the boundary-line mixture of vapor or gas with air, which, if ignited will just propagate the flame. They are known as the “lower and upper explosive limits,” and are usually expressed in terms of percentage by volume of gas or vapor in air. Same as flammable limits. See also “LEL” and “UEL.”

Exposure: People, property or the environment that are subjected to the harmful effects of a hazardous material. Defined by OSHA as meaning an employee subjected to a hazardous chemical in the course of employment through a ROUTE OF ENTRY (e.g., ingestion, inhalation, skin contact or absorption) and includes potential (e.g., accidental or possible) exposure.

Exposure limits: Concentrations of substances and conditions under which it is believed that nearly all workers may be repeatedly exposed, day after day, without adverse effects. Standard limits are established by ACGIH and OSHA.

F

F: Degree Fahrenheit, a unit for measuring temperature. On the Fahrenheit scale, water boils at 100°C or greater.

Federal Register (FR): A daily publication of all United States government documents required by law. It is the daily supplement to the Code of Federal Regulations (CFR).

Fibrillation: Rapid and chaotic contractions of many individual muscle fibers of the heart in the area of the ventricles, capable of causing cardiac arrest.

Fibrosis: Chronic lung affliction or scarring of the lung caused by an unusual increase of fibrous tissue, causing progressive respiratory problems, and often occurring after exposure to certain chemical substances.

Fire diamond: A visual hazard rating system of the National Fire Protection Association (NFPA). Provides general information about inherent hazards of materials: Health, Flammability, Reactivity, and Special.

Flammable: Catches on fire and burns rapidly. The National Fire Protection Association and the United States Department of Transportation define a flammable liquid as having a flash point below 100°F/37.8°C.

Flammable aerosol: An aerosol that, when tested by the method described in 16CFR1500.45, yields a flame projection exceeding 18 in. at full valve opening, or a flashback (a flame extending back to the valve) at any degree of valve opening (29CFR).

Flammable limits: Range of gas or vapor concentrations (percent by volume) in air which will burn or explode if an ignition source is present. See also “LEL” and “UEL.”

Flash back: A phenomenon characterized by vapor ignition and flame traveling back to the source of the vapor.

Flash point: The minimum temperature at which a substance gives off flammable vapors that in contact with spark or flame will easily ignite and burn rapidly. The flash point is established by one of the two following methods: in a closed cup (see also “Pensky−Martens”), or inside its container; or in an open cup, or near the surface of the liquid. The lower the flash point of a liquid, the higher the risk of fire.

Flatulence: Accumulation of gas in the digestive tract.

Fluorosis: Characteristic chronic intoxication caused by fluorine and its derivatives.

Foreseeable emergency: Any potential occurrence such as, but not limited to, equipment failure, rupture of containers, or failure of control equipment, that could result in an uncontrolled release of a hazardous chemical into the workplace (OSHA).

Form R: Forms that must be completed annually for the EPA by reporting industrial facilities for chemicals used above the threshold amount.

Fume: A suspension of very fine solid particles in air, or vapors from a volatile liquid.

Fumigant: A pesticide in vapor or gaseous form used to kill pests or disinfect materials.

Fungicide: A pesticide used to control, prevent, or kill fungi.

Fungus: A lower plant that feeds on other organic matter and lacks the chlorophyll and tissue differentiation of higher plants.

G

Gas: An air-like, formless fluid having the property of uniformly distributing itself throughout a space in air. A state of matter.

Gastric lavage: Washing out the stomach.

Gastrointestinal (GI): Refers to the organs of stomach, intestines and/or other organs from mouth to anus.

Gene: Heredity-carrying material that is part of the chromosome.

Genotoxic: Causing genetic damage.

Gestation: The development of the fetus in the uterus from conception to birth; during pregnancy.

GHS: (Globally Harmonized System) a system for classification, labeling and packaging of chemicals. Adopted by UN in 2001 with a the goal to get all countries, worldwide, to implement the GHS system to insure uniform methods for evaluation and communication of chemical hazards.

Glycosuria: Abnormal presence of glucose in the urine.

Granulomatosis: Pulmonary lesion characterized by the formation of small nodules.

Granulometry: Indicates the size of powder, and usually expressed in microns (1 μm is 0.000001 m, or about 1000 times smaller than a grain of sand). Particles of less than 10 μm are capable of deep penetration and becoming deposited in the respiratory tract. Larger particles can deposit in the upper respiratory area such as the bronchia, and although they may be expulsed, they can be dissolved by the organism. Particle size makes it possible to deduce the method to be adopted for corrective action (e.g., ventilation, respirator).

H

Halogens: Refers to inorganic compounds containing astatine, bromine, chlorine, fluorine, and iodine.

Hazardous classes: A collection of terms established the United Nations Committee of Experts to categorize hazardous materials. The specific categories are: flammable liquids, explosives, gases, oxidizers, radioactive materials, corrosives, flammable solids, poisonous and infectious substances, and dangerous substances.

Hazardous constituent of waste: A list of chemicals which is referenced under certain Conservation and Recovery Act (RCRA) provisions to determine if a solid waste is a hazardous waste.

Hazardous materials: Refers generally to hazardous substances, petroleum, natural gas, synthetic gas, acutely toxic chemicals, and other toxic chemicals. Substances or materials which have been determined to be capable of posing an unreasonable risk to health, safety, and property.

Hazardous waste: Defined by RCRA as any solid or combination of solid wastes, which because of its physical, chemical or infectious properties, may pose a health hazard when improperly managed. It must possess at least one of four characteristics—ignitability, corrosivity, reactivity, or toxicity—or appears on special EPA lists.

Hazardous waste code: The number assigned to every hazardous waste listed under the Resource Conservation and Recovery Act (RCRA); the code is used for notification, record keeping, and reporting requirements.

Hazard warning: The OSHA definition means any words, pictures, symbols, or combination thereof appearing on a label or other appropriate form of warning that conveys the hazards of the chemical(s) in the container(s).

Health hazard: Evidence based on scientific data (human or animal) that acute or chronic effects may occur. (29CGR1910.1200).

Hematoma: Localized bleeding into tissue.

Hematuria: Presence of blood in the urine.

Heme: The prosthetic, oxygen-carrying, color-furnishing constituent of hemoglobin.

Hemoglobin: The red, respiratory protein of erythrocytes; transports oxygen from the lungs to the tissues.

Hemolysis: Destruction of red blood cells, releasing hemoglobin.

Hematopoietic system: System responsible for formation of blood cells (includes bone marrow and lymphatic organs).

Hemorrhage: Loss of a significant amount blood. Can be external or internal bleeding.

Hepatic: Referring to the liver.

Hepatitis: An inflammation of the liver.

Hepatoma: Tumor of the liver.

Hepatomegalia: Increase in liver volume.

Hepatotoxic: Refers to a substance that is toxic to the liver.

Hormone: Any of various chemical substances that are produced by the endocrine glands and that have specific regulatory effects on the activity of certain organs.

Hydrolysis: A chemical process whereby a compound is cleaved into two or more simpler compounds with the uptake of the H and OH parts of a water molecule on either side of the chemical bond cleaved.

Hydrolyze: To subject to hydrolysis.

Hydroxyl: The atom group or radical, OH.

Hypnotic: Sleep-inducing. Also, a drug that induces sleep.

Hot zone: The area immediately surrounding the incident site. Appropriate protective clothing and equipment must be worn by all personnel in the Hot Zone. AWARENESS LEVEL and OPERATIONAL LEVEL trained personel are not permitted in the Hot Zone.

Hydrate: Chemical substance combined with water in a specific proportion.

Hydrocarbons: Chemical compounds that consist entirely of carbon and hydrogen.

Hydrochlorofluorocarbons (HCFCs): A group of chemicals having a weaker negative impact on the ozone layer and developed as temporary substitutes for ozone-depleting chemicals, such as CFCs.

Hydrolysis: Chemical change to a substance in an aqueous environment leading to the formation of new products.

Hygroscopic: Substances with a tendency to absorb moisture from the air.

Hyperkeratosis: Increased thickness of the cornified layer of the epidermis such as a corn.

Hyperpigmentation: Excessive pigmentation of the skin.

Hyperplasia: Abnormal growth of normal tissue.

Hyperreflexia: Excessive reflexes.

Hypertension: Increased blood pressure.

Hypotension: Decreased blood pressure.

Hypothermia: Lowering of body temperature to below normal.

I

Icterus: Yellow coloration of the skin and mucosa.

Ignition temperature: The minimum temperature required to initiate or cause self-sustained combustion independent of a heat source.

Incident: An unplanned event that could have resulted in an accident or which diminishes efficiency or production. Also see accident.

Inhibitor: A chemical that is added to another substance to prevent unwanted chemical change from occurring.

Immediate hazard: A hazard with immediate effects. See "acute effect."

Immediate use: The hazardous chemical that will only be used by the individual who transfers it from a labeled container. (29CFR1910.1200)

Immunosuppression: Decrease in the immune response. Artificial prevention or diminution of the (natural) immune response, e.g., by irradiation or by administration of substances such as pharmaceutical antimetabolites or specific antibodies to prevent sensitization; immunosuppression or immuno-deficiency may also be used to describe the condition of acquired or congenital lowered immune response.

Incompatibility: Indicates whether a material can be placed in contact with certain other products or materials. The direct contact of incompatible materials can cause dangerous reactions and give off heat and toxic vapors.

Inflammation: The response of the tissues of the body to injury, infection or irritation. Its chief symptoms are redness, heat, swelling, and pain.

Ingestion: Taking in by the mouth; swallowing.

Inhalation: Breathing into the lungs of a (contaminated) substance in the form of a gas, vapor, fume, mist, or dust.

Initiator: A chemical that permanently alters a cell or group of cells and, in the case of carcinogens, is tumor-producing.

Inorganic chemical: Those chemical substances not containing carbon.

Insoluble: Products that cannot be dissolved in each other.

Interaction: Modification of the toxic effects of one substance by another. Depending on the substances involved, the effects of interaction can be amplified or mitigated.

Irritant: A substance or material capable of causing irritation to organs and body parts.

Irritating material: Any substance that upon contact with fire or air produces irritating fumes.

Invasive: Spreading beyond specific body tissues.

Isomer: One of two or more variations of a chemical, each of which has the same chemical formula but a different structural arrangement.

J

Jaundice: Yellowing of the skin or eyes caused by too much bilirubin in the blood, and indication of liver diseases, biliary obstructions, and hemolysis.

K

Keratitis: Inflammation of the cornea of the eye.

Keratoconjunctivitis: Inflammation of the cornea and the conjunctiva of the eye.

K_{ow} See "partition coefficient."

L

Laryngitis: Inflammation of the larynx.

Lacrimation: Production or discharge of excess tears from the eyes.

Lacrimator: A chemical substance that causes the secretion of excess tears from the eyes.

Latency period: A seemingly inactive period, as that between the exposure of tissue to an injurious agent and a manifest response; often used to identify the period between exposure to a carcinogen and development of a tumor.

LEL: Lower Explosive Limit of a vapor or gas; the lowest concentration (lowest percentage of the substance in air) that will produce a flash of fire when an ignition source (heat, arc, or flame) is present. At lower concentrations, the mixture is too "lean" to burn. Also see UEL.

Lethargy: Deep and prolonged sleep, or extreme indifference.

Leukemia: A cancer of the blood-forming tissues that is characterized by a marked increase in the number of abnormal white blood cells (leukocytes).

Listed hazardous waste: Under the Resource Conservation and Recovery Act (RCRA), wastes from generic industrial processes, wastes from certain sectors of industry, and unused pure chemical products that have been shown to generally contain toxic chemicals that could pose a threat to human health and the environment, or that generally exhibit one of the characteristics of ignitability, corrosivity, reactivity, or toxicity are considered hazardous and must adhere to RCRA provisions.

Lymph: A clear liquid that is collected from the tissues throughout the body and that flows in lymphatic vessels.

Lymphatic: A medical term describing a small sac or node in which lymph is stored; pertaining to the lymph, lymph nodes, or vascular channels that transport lymph to the lymph nodes.

M

Malaise: A feeling of general discomfort, distress or uneasiness; an out-of-sorts feeling.

Malignant: Tending to become progressively worse; life-threatening.

Manganism: Chronic intoxication caused by manganese and its derivatives.

Maximum contaminant levels (MCLs): The maximum level of a contaminant permissible in a public water system.

MCL: The Maximum Contaminant Level; the maximum allowable of a contaminant in public drinking water supplies under the Safe Drinking Water Act.

Melanoma: A neoplasm derived from cells that are capable of forming the pigment melanin.

Meta: In chemistry, a prefix denoting that a compound is formed by two substitutions in the benzene ring separated by one carbon atom, i.e., linked to the first and third, second and fourth, etc., carbon atoms of the ring; usually abbreviated *m*.

Metastasis: The appearance of a neoplasm in a part of the body remote from the site of its origin.

Methemoglobinemia: Presence of an abnormal concentration and form of hemoglobin which will not carry oxygen to the blood, resulting in anemia or cyanosis.

Miscible: Products capable of being completely mixed and staying mixed with each other (without separation into distinct components) under normal conditions.

Mist: Liquid droplets suspended in air.

Molecular weight: Weight (mass) of a molecule based on the sum of the atomic weights of the atoms that make up the molecule.

Mucous membranes: Membranes lining body cavities and covered by a viscous substance called mucus.

Myosis: Reduction in diameter of pupils of the eye.

Melting point: The temperature at which a product changes from the solid to liquid state at normal atmospheric pressure (760 mmHg).

Montreal protocol: A 1987 agreement made by 25 countries to reduce the production and consumption of ozone depleting chemicals. Since 1987, additional countries have joined this agreement.

Mutagen: A chemical substance or physical effect capable of inducing transmissible changes in the genetic material of a living cell that results in physical and functional changes in the descend ants. Depending on the type of cells affected, ova or spermazoids, both male and female can be affected. Mutations can lead to birth defects, miscarriage, or cancer.

Mutagenic Capable of causing mutations.

Mutagenicity The cap ability to induce mutation, or permanent change, in genetic material.

N

Narcosis: A stupor, drowsiness, arrested activity or unconsciousness produced by the influence of narcotics or other chemical substances. Artificially induced sleep.

Narcotic: Any substance that induces narcosis.

National Fire Protection Association (NFPA): This international membership organization promotes/improves fire protection and prevention and establishes safeguards against loss of life and property by fire. Best known in industry for the National Fire Codes. Among these codes is the NFPA 704M, the code for classifying substances according to their fire and explosion hazard (as they might be encountered under fire or related emergency conditions) using the familiar diamond -shaped label or placard with appropriate color, numbers, or symbols.

Nausea: The urge to vomit; a feeling of sickness in the stomach.

Necrosis: Cellular or tissue death.

Neonatal: Relating to or affecting the first four weeks after birth.

Neoplasm: Presence of a new growth of abnormal cells. A tumor.

Nephritis: Inflammation of the kidney.

Nephropathy: Any affliction of the kidneys.

Nephrotoxic: Toxic to the kidneys.

NESHAP (National Emission Standards for Hazardous Air Pollutants): Under the Clean Air Act, regulations set for industries that emit one of more of the listed hazardous air pollutants in significant quantities.

Neuropathy: Any affliction of the nervous system.

Neurotoxic: Toxic to nerve cells and the nervous system. The effect may produce emotional or behavioral abnormalities.

Neuritis: Inflammation of a nerve.

Neural: Refers to a nerve or the nervous system.

Neutralize: To eliminate potential hazards by inactivating strong acids, caustics, and oxidizers. For example, acid spills can be neutralized by adding an appropriate amount of caustic or alkali substances.

NIOSH: National Institute for Occupational Safety and Health. Tests equipment, evaluates and approves respirators, conducts studies of workplace hazards, and proposes standards to OSHA.

Nitrogen mustard: A substituted mustard gas in which sulfur is replaced by an amino nitrogen.

Nitrogen oxides (NO_x): Gasses associated with the breakdown of the earth's protective ozone layer that are released primarily from the burning of fossil fuels.

Nitroparaffin: An organic compound in which one or more hydrogen molecules of an alkane are replaced by a nitro group.

Nitrosamine: A class of organic compounds that contain a $-NH_2$ and a $-NO$ radical.

Nonliquefied compressed gas: DOT describes as a gas, other than gas in solution, which under the charged pressure is entirely gaseous at a temperature of 21°C. (Code of Federal Regulations, Title 49, Department of Transportation).

O

Oncogenicity: The capacity to induce tumors.

Operations level (trained): First responders at the operational level are those persons who respond to releases or potential releases of hazardous materials as part of the initial response to the incident for the purpose of protecting nearby persons, the environment, or property from the effects of the release. They shall be trained to respond in a defensive fashion to control the release from a safe distance and keep it from spreading (ANSI/NFPA 472).

Optic nerve: Nerve running from the eye to the centers of vision in the brain.

Oral: Used or taken into the body through the mouth.

Organic compound: A class of chemical compounds containing mainly carbon atoms.

Organic peroxide: An organic compound containing the bivalent −O−O− structure and which may be considered a structural derivative of hydrogen peroxide where one or more of the hydrogen atoms have been replaced by organic radicals (49CFR173.151).

Ortho: In chemistry, denoting that a compound has two substitutions on adjacent carbon atoms in a benzenering; usually abbreviated *o*.

Oxidant: The substance that is reduced and that, therefore, oxidizes the other component of an oxidation-reduction system.

Oxidase: One of a group of enzymes now termed oxidoreductases that bring about oxidation by the addition of oxygen to a metabolite or by the removal of hydrogen or of one or more electrons.

Oxidation: The act of combining or causing to combine with oxygen or to lose electrons.

Oxidize: Oxygenize; to combine or cause an element or radical to combine with oxygen or to lose electrons.

Oxidizing agent or oxidizer: A substance other than a blasting agent or explosive such as chlorate, permanganate, inorganic peroxide, or a nitrate, that yields oxygen or other gases readily, thereby causing fire of other, usually organic, materials. Perchlorates, peroxides, permanganates, chlorates and nitrates are examples of oxidizers.

Ozone layer: The protective layer of molecules surrounding the earth. The ozone layer reduces the amount of high-energy ultraviolet radiation that reaches the earth's surface.

P

PAC: Acronym for Protective Action Criteria exposure limits developed by the United States Department of Energy (DOE) for hazardous chemicals. These exposure limits include TEELs (Temporary Emergency Exposure Limits), AEGLs (Acute Emergency Guideline Levels), and ERPGs (Emergency Response Planning Guidelines). are used to estimate the consequence of uncontrolled releases of hazardous materials and to plan for emergency response. See also definitions elsewhere in the glossary.

Para: In chemistry, a prefix designating two substitutions in the benzene ring arranged symmetrically, i.e., linked to opposite carbon atoms in the ring; usually abbreviated *p*.

Particulate: Fine liquid or solid particles such as dust, smoke, mist, fumes, or smog suspended in air or atmospheric emissions.

Partition coefficient: The ratio of a substance's distribution between oil and water when they are in contact. A value of less than 1 indicates better solubility of the substance in oils and greases. Such a product is therefore likely to be absorbed by the skin. A value greater than 1 indicates a better solubility in water; and, therefore, be absorbed by the mucosa. This information can be useful in assessing first aid requirements, and can help in the selection of proper protective equipment. Also known as the coefficient of water/oil distribution. Usually abbreviated K_{ow}.

Palpitation: Perception of one's own heartbeat. A racing, irregular beat, or pounding of the heart.

Paralysis: The loss of function and/or feeling.

Pathology: The study of the nature of diseases, especially of the structural and functional changes in body tissues, organs, or fluids caused by disease, physical and biological agents, and toxic substances.

Pensky−Martens: A closed cup method for determining flashpoint.

Percutaneous absorption: Absorption through the skin.

Peritonitis: Inflammation of the peritoneum or the membrane lining the abdominal cavity and the organs contained within it.

Permissible exposure limit (PEL): A legal occupational limit of exposure established and defined by OSHA. The limit of allowable exposure to a chemical contaminant expressed as a Time-Weighted Average (TWA) concentration during a work-day of 8 hours within, or as a maximum concentration never to be exceeded either instantaneously (ceiling) or a Short Term Exposure Limit (STEL) during any maximum period of 15 minutes. The exposure, inhalation or dermal permissible exposure limit specified in 29C FR1910, Subparts G and Z. These concentrations are expressed in parts per million (ppm) and or milligrams of the product per cubic meter of air (mg/m^3) at 25°C. Exposure limits published in 29CFR1910.1000.

Peroxide: Compounds containing two oxygen atoms bound together. That oxide of any series that contains the greatest number of oxygen atoms; applied most correctly to compounds containing an −O−O− link, as in hydrogen peroxide (H−O−O−H).

Peroxy: Prefix denoting the presence of an extra O atom, as in peroxides, peroxy acids (e.g., hydrogen peroxide, peroxyformic acid).

Pesticide: As defined by the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA), a pesticide includes "any substance or mixture of substances intended for preventing, killing, repelling, or mitigating any pest, and any substance or mixture of substances intended for use as a plant regulator, defoliant, or desiccant."

Petroleum distillate: A material produced by a combination of vaporization and condensation of petroleum.

Personal protection equipment (PPE): Safety equipment designed to protect parts or all of the body from workplace hazards. Such protective equipment includes chemical resistant clothing, gloves, respirators, and eye protection.

pH: A symbol representing the concentration in hydrogen ions (H+) in aqueous solution. This logarithmic scale is expressed as a numerical value usually between 0 and 14. A pH of 7 indicates a neutral or noncorrosive substance. A pH between 0 and 7 indicates greater acidity. A pH between 7 and 14 indicates greater alkalinity. A pH of 0 (very acid), or 14 (very basic) are highly corrosive. The symbol is useful in the identification of the appropriate type of protective equipment necessary for handling a chemical material.

Pharyngitis: Inflammation of the throat or pharynx.

Phlegm: Thick mucus produced in the breathing passages.

Photophobia: Unpleasant to painful feeling in the eyes, caused by light.

Photosensitive: Substances that change in the presence of light.

Photosensitization: Abnormal reaction of the skin to sunlight.

Physical hazard: A chemical for which there is scientifically valid evidence that it is a combustible liquid, a compressed gas, explosive, flammable, an organic peroxide, an oxidizer, pyrophoric, unstable (reactive) or water-reactive.

Pituitary gland: A small gland at the base of the brain that secretes several important hormones.

Plasma: The fluid part of blood or lymph, as distinguished from suspended material.

Platelet: An irregularly shaped disk found in blood, containing granules in the central part and, peripherally, clear protoplasm, but no definite nucleus; it is about one-third to one-half the size of an erythrocyte, and contains no hemoglobin.

Pneumoconiosis: Chronic affliction of the lungs due to the inhaling of certain types of dust.

Pneumonia: Acute infection of the lung, characterized by inflammation.

Pneumonitis (chemical): Inflammation of the lungs, resulting from chemical irritation.

Pneumopathy: Any pulmonary affliction.

Point source contamination: Contamination to the environment from a specific source such as a smokestack or sewer pipe.

Polychlorinated biphenyl (PCBs): A pathogenic and teratogenic industrial compound used as a heat-transfer agent, primarily in transformers. PCBs may accumulate in human or animal tissue. PCBs are banned from production in the United States.

Polymer: A chemical formed by the joining together of similar chemical subunits.

Polymerization: A chemical reaction in which one or more small molecules combine to form larger molecules. A hazardous polymerization is a reaction that takes place at a rate that releases large amounts of energy. If hazardous polymerization can occur with a given material, the MSDS usually will list conditions that could start the reaction and—since the material usually will list conditions that could start the reaction, and since the material usually contains a polymerization inhibitor—the length of time during which the inhibitor will be effective. The heat given off or the expansion in volume, or both, caused by the polymerization reaction could cause the container holding the product to break and the unpolymerized residual product to be spilled.

Polyneuritis: Inflammation of several nerves.

Polyuria: Elimination of an abnormally large amount of urine over a given period.

Procarcinogen: Product that must be changed by the organism in order to become a carcinogen.

Promoter (of carcinogenesis): Substance capable of enhancing the carcinogenic effect of another substance.

Prostration: Extreme exhaustion, physical or mental.

Pulmonary: Pertaining to the lungs.

Pulmonary edema: A buildup of fluid in the lungs caused by congestive heart failure, lung damage, side effects of drugs, infections or kidney failure.

Pyrophoric: Any chemical substance or mixture that ignites spontaneously in dry or moist air at or below 130°F/54.4°C.

Pyrolysis: Thermal decomposition of a substance by heat in the absence of air.

Psychosis: A group of mental illnesses characterized by a change in personality and loss of contact with reality.

Q

Quaternary: In chemistry, the term used to describe a substance with four chemical groups attached to a central atom; when the central atom is a trivalent nitrogen atom (N), adding the fourth group places a positive charge on N; compounds thus formed are called quaternary ammonium compounds.

R

Racemate: A mixture of equal parts of isomers of opposite rotation.

Racemic: Denoting a mixture that is optically inactive, being composed of an equal number of dextro- and levorotary substances (see DL-), which are separable.

Radioactive: Having the property of emitting radiation (such as alpha, beta, or *gamma* rays) from an atomic nucleus.

Radioactive material: Any material, or combination of materials, that spontaneously emits ionizing, and having a specific activity greater than 0.002 μCi/g.

Radionuclides: Radioactive-decay particles emitted from natural and manufactured sources, including cosmic rays, X-rays, radon, and coal-fired utilities.

Radon: A colorless, naturally occurring, radioactive, inert gaseous element formed by radioactive decay of radium atoms in soil or rocks.

Reactive: Unstable.

Reactivity: Chemical reaction with the release of energy. Undesirable effects such as pressure buildup, temperature increase, formation of noxious, toxic or corrosive by-product, may occur because of the reactivity of a substance to heating, burning, direct contact with other materials, or other conditions in use or in storage.

Recommended Exposure Limit (REL): A 10-hour average exposure limit during a 40-hour work-week recommended by the National Institute for Occupational Safety and Health (NIOSH) for occupational exposures.

Reducing agent: In a reducing reaction (which occurs simultaneously with an oxidation reaction) the reducing agent is the chemical or substance which (1) combines with oxygen or (2) loses electrons to the reaction. Reducing agents react violently with oxidizing agents or oxidizers.

Registry of Toxic Effects of Chemical Substances (RTECS): Published by NIOSH, RTECS is a compendium of the known toxic and biological effects of many chemical substances.

Regulated material: A substance or material that is subject to regulations promulgated by any government agency.

Relative density: The ratio of the density of a material to the density of a standard material, such as water at a specified temperature.

Remedial action: The actual construction or implementation phase of a Superfund site cleanup that follows remedial design.

Renal: Pertaining to the kidney.

Reportable quantity (RQ): An amount of a hazardous substance or “extremely hazardous substance” that, if released, requires notification to the National Response Center (800/424-8802) under the emergency release reporting requirements of the Emergency Planning and Community Right-to-Know Act (EPCRA) or under those of CERCLA (Superfund). For the purposes of the Department of Transportation, RQ means the quantity specified for the substance in the Appendix to the Hazardous Materials Table. For the purposes of SARA Title III, RQ means, for any CERCLA hazardous substance the reportable quantity established therein for such a substance, for any other substance the RQ is one pound.

Respirator: A devise worn by a person to filter dust particles or gas out of surrounding air before inhalation of air.

Respiratory tract: The structures and organs involved in breathing; includes the nose, larynx, trachea, bronchi, bronchioli, and lungs.

Respiratory tract filters: Those anatomical structures that remove particles from inhaled air.

Responsible party: Someone who can provide additional information on the substance if needed. (29CFR1910.1200).

Rhinitis: Inflammation of mucosa of the nasal passages.

Rheumatoid arthritis: A chronic disease of the joints, marked by inflammatory changes of joint structures.

Rodenticide: Chemical substances used to kill mice, rats, and other rodents.

Route of entry: The means or natural route by which hazardous chemicals or other contaminants can penetrate the body. For example, the skin (by cutaneous absorption), the digestive system (by ingestion), or the respiratory system (by inhalation).

Routes of exposure: Also known as Routes of Entry, any one of the ways by which substances enters the body, such as through the skin, ingestion, eye contact, or by breathing.

S

Sensitization: Defense reaction by the organism following exposure to a contaminant, resulting in an allergy.

Sentitizer: A chemical that causes a substantial proportion of exposed people or animals to develop an allergic reaction in normal tissue after repeated exposure to the chemical.

Shock: An abnormal condition resulting from not enough blood flowing through the body causing reduced blood pressure and interference with bodily functions.

Short Term Exposure Limit (STEL): A 15-minute time-weighted-average exposure limit that should not be exceeded at any time during a work-day, recommended by the National Institute for Occupational Safety and Health (NIOSH) or a concentration that it is believed a worker can be exposed to continuously for a short period of time without suffering from irritation, chronic or irreversible tissue damage, or narcosis of sufficient degree to increase the likelihood of accidental injury, impair self-rescue, or materially reduce work efficiency, recommended by the American Conference of Governmental Industrial Hygienists (ACGIH).

Silicosis: Chronic disease of the lungs (fibrosis) provoked by inhaling dust of crystalline silica. See pneumoconiosis.

Solid waste: Any garbage, refuse or sludge, including solid, liquid, semi-solid, or contained gaseous material resulting from industrial, commercial, agricultural, and mining operations, and community activities (excluding material in domestic sewage); discharges subject to regulation as point sources under the Federal Water Pollution Control Act, or any nuclear material or by product regulated under the Atomic Energy Act of 1954.

Solubility: The property of a substance describing the degree to which one material may be completely mixed or dissolved in another material. The degree of solubility of most substances increases with the rise in temperature; however, in the case of organic salts of calcium the substance may be more soluble in cold than in hot solvents.

Solution: Any homogeneous liquid mixture of two or more chemical compounds or elements that will not undergo any segregation normal to transportation (CFR, Title 49, DOT).

Solvent: A chemical liquid, capable of dissolving another substance. A term generally used to describe organic solvents.

Spasm: Involuntary muscle contraction.

Specific gravity: The weight of a material compared to the weight of an equal volume of water is an expression of the density (or heaviness) of a material. Insoluble materials with specific gravity of less than 1.0 will float in (or on water). Insoluble materials with specific gravity greater than 1.0 will sink in water. Most (but not all) flammable liquids have specific gravity less than 1.0 and, if not soluble, will float on water—an important consideration for fire suppression.

Spill: Another name for a leak. The methods, equipment, and precautions that should be used to control or clean up a leak or spill.

Stability: Relates to a material's ability to resist change in form or chemical nature (e.g., xylene decomposes when strongly heated, and gives off toxic fumes). For MSDS purposes, a material is stable if it remains in the same form under expected and reasonable conditions of storage or use. Conditions that may cause instability (dangerous change) are stated; for example, temperature above 150°F/66°C; shock from dropping.

Stabilized: Containing a small amount of another substance included to keep the first material from changing form.

Stool: Discharge from the bowels.

Stratosphere: That part of the earth's atmosphere, located above the troposphere, containing the ozone layer.

Strong acids: Refers, but not restricted, to chemicals such as hydrochloric, sulfuric and nitric acids. Strong acids can cause violent reactions with certain other substances and materials.

Strong bases: Refers, but not restricted, to chemicals such as sodium hydroxide and potassium hydroxide. Strong bases can cause violent reactions with certain other substances and materials.

Strong oxidizers: Refers, but not restricted, to chemicals such as chlorine, bromine and fluorine and many of their compounds Strong oxidizers can cause violent reactions with certain other substances and materials. See also "oxidizers," "oxidizing agent," "easily oxidized materials."

Sublimate: To go directly from the solid to the gaseous state without passing through the liquid state.

Superfund Amendments and Reauthorization Act (SARA) Title III of SARA establishes the first national program of emergency planning for dealing with hazardous chemicals. Includes detailed provisions for community planning and annual submission of information about hazardous chemicals to the EPA, states and local communities.

Suspected carcinogen: A substance which is known to cause cancer in test animals, but is only suspected of causing cancer in humans. Also referred to as an experimental or potential carcinogen.

Systemic toxicity: Adverse effects caused by a substance that affects the body as a whole rather than local or individual parts or organs.

T

Tachycardia: Increased speed of heart beat.

Tachypnea: Abnormally rapid breathing.

Target organ: The body affected by a specific chemical in a specific species.

TCLP: (toxicity characteristics leaching procedure) Under the Resource Conservation and Recovery Act (RCRA), wastes are subject to this laboratory procedure to determine if they can be disposed of in Subtitle D landfills or if they require Subtitle C disposal (i.e., considered a hazardous waste).

Technical grade: A purity standard applied to a chemical that may contain multiple impurities.

TEEL: Acronym for Temporary Emergency Exposure Limit. Airborne exposure limits, TEELs are intended for use until AEGLs or ERPGs are adopted for chemicals. Temporary emergency exposure limit (TEEL) values developed by the Subcommittee on Consequence Assessment and Protective Actions (SCAPA) which provides the United States Department of Energy (DOE)/National Nuclear Security Administration (NNSA) and its contractors with technical information and recommendations for emergency preparedness to assist in safeguarding the health and safety of workers and the public. See also "How to Use this Book" in the front matter of this book.

Teratogen: A substance that has been demonstrated to cause birth defects by causing malformations in the fetus. Teratogenic contaminants can be qualified as being "proven" when an effect has been shown in humans, "possible" when an effect has been shown in animals, or suspected in humans, and "suspected" when an effect is suspected in animals.

Tetanic: Refers to persistence in a muscle contraction.

***Threshold Limit Value−Time-Weighted Average limit (TLV−*TWA*)** An 8-hour average exposure limit during a 40-hour work-week recommended by the American Conference of Governmental Industrial Hygienists (ACGIH) for occupational exposures.

Threshold Planning Quantity (): Under the Emergency Planning and Community Right-to-Know-Act, the presence of a chemical at or above this level requires certain emergency planning activities to be conducted. The quantity of a SARA extremely hazardous substance present at a facility above which the facility's owner/operator must give emergency planning notification to the SERC and LEPC.

Tier I or Tier II: Describes hazardous substances inventory forms required under SARA Title III. These forms report quantities and locations of hazardous substances to various state agencies and planning committees.

Time-Weighted Average (TWA): The average concentration of a substance in air over the total time of expo sure, usually expressed as an 8-hour day.

Tinnitus: Ringing in one or both ears. May be a sign of hearing injury.

Title III: The third part of SARA, also known as EPCRA, the Emergency Planning and Community Right-to-Know Act of 1986. Specifies requirements for organizing the planning process at the State and local levels for extremely hazardous substances; minimum plan content; requirements for fixed facility owners and operators to inform officials about extremely hazardous substances present at the facilities; and mechanisms for making information about extremely hazardous substances available to citizens.

Tolerance: Under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), the amount of pesticide residues allowed to remain in or on each treated food commodity.

Topical: Designed for direct application to a specific part of the body.

Toxic: Any substance capable of causing human injury or damage to living body tissue, impairment to the central nervous system, severe illness, and, in severe cases, death. A poison.

Toxicology: The branch of chemistry that deals with poisons.

Toxicologist: One who studies the nature, effects, and detection of poisons and the treatment of poisoning.

Toxic pollutant: Pollutants, that after discharge and upon exposure, cause adverse health effects.

Toxic Release Inventory (TRI): (listed substance subject to reporting requirements) An EPA database of release quantities by facilities of a growing list of chemicals and chemical categories into the nation's air, water, and land, and transfers to off-site locations for treatment or disposal, or for recycling and energy recovery. Under the Emergency Planning and Community Right-to-Know Act, certain industries are required on an annual basis to complete a Toxic Chemical Release Inventory Form for these chemicals.

Trade name: The manufacturer's commercial name for a chemical substance or product. A registered trade name contains the symbol "®."

Trade secret: Any confidential formula or information used to give the manufacturer, etc. an (economic) advantage over others who do not have the information (29CFR 1910.1200).

Tumor A neoplasm; a mass of new tissue that persists and grows independently of its surrounding structures and that has no physiological use; it may be benign or malignant.

Tumorigenic: That which causes or produces tumors.

U

UEL: Upper Explosive Limit of a vapor or gas; the highest concentration (highest percentage of the substance in air) that will produce a flash of fire when an ignition source (heat, arc, or flame) is present. At higher concentrations, the mixture is too "rich" to burn. See also "LEL."

UN identification number: An international four digit number assigned to all hazardous materials regulated by the United Nations. Used world-wide in transportation.

Unstable: A chemical in the pure state which will become self-reactive under conditions of shocks, pressure, or temperature (29CFR1910.1200).

UST: Underground Storage Tank regulated under RCRA. A tank used to store CERCL A-regulated chemicals or petroleum products, with 10% or more of its volume underground, having connected piping.

Ulceration: Creation of an ulcer.

Urban air toxics: Under the Clean Air Act, the 33 air toxics that have been identified as posing the greatest potential health threat in urban areas.

V

Vapor density: Indicator of the number of times that the vapors of a substance are heavier or lighter than air. Vapor density measurement is taken at the boiling point. If the vapor density is greater than 1, the vapor will tend to collect at floor level. If the vapor density is less than 1, the vapor will rise in air.

Vapor pressure: When a substance evaporates, its vapors create a pressure in the surrounding atmosphere; therefore, vapor pressure is a measurement of how readily a liquid or a solid mixes with air at its surface. This measurement is expressed in millimeters of mercury (mmHg), at 68°F/20°C and normal atmospheric pressure (760 mmHg). A vapor pressure above 760 mm indicates a substance in the gaseous state. The higher a product's vapor pressure, the more it tends to evaporate, resulting in a higher concentration of the substance in air and therefore increases the likelihood of breathing it in.

Vascular: Pertaining to vessels or ducts that convey fluids such as blood, lymph, or sap; in human or veterinary medicine, vascular pertains to blood vessels.

Vascular constriction: Constriction with narrowing of blood vessels.

Vascular dilation: Dilation of the blood vessels.

Vertigo: Dizziness; giddiness.

Volatiles: A substance, usually a liquid, that easily vaporizes or evaporates to form a gas or vapor.

W

Waste code: Identifier assigned by the EPA consisting of a single letter (D, F, P, U, K) and three numbers in the format "Dxxx." This code identifies the type of hazardous waste stream being reported.

Waste management: Describes activities undertaken by facilities to treat, recycle or otherwise manage generated waste, including disposal and energy recovery.

Waste stream: Under RCRA, solid or liquid materials containing hazardous materials and generated as waste.

Water reactive: A chemical which reacts with water to release flammable or hazardous gas (29CF R1910.1200).

Work area: A defined space where hazardous substances are produced or used when employees are present (29CFR 1910.1200).

Appendix 4: International Hazard Codes, Risk Phrases, and Safety Phrases

Note: **Followed by the GLOBALLY HARMONIZED SYSTEM OF CLASSIFICATION AND LABELING OF CHEMICALS (GHS)**

Hazard Codes

Explosive (E)
Oxidizing (O)
Highly flammable (F)
Extremely flammable (F +)
Toxic (T)
Very toxic (T +)
Harmful (Xn)
Irritant (Xi)
Corrosive (C)
Dangerous to the environment (N)

(List of R-phrases) Risk Precaution Codes and Statements

R1—Explosive when dry.
R2—Risk of explosion by shock, friction, fire, or other sources of ignition.
R3—Extreme risk of explosion by shock, friction, fire, or other sources of ignition.
R4—Forms very sensitive metallic compounds.
R5—Heating may cause an explosion.
R6—Explosive when mixed with combustible materials.
R7—May cause fire.
R8—Contact with combustible material may cause fire.
R9—Explosive when mixed with combustible material.
R10—Flammable.
R11—Highly flammable.
R12—Extremely flammable.
R13—Extremely flammable liquefied gas.
R14—Reacts violently with water.
R14/15—Reacts violently with water, liberating extremely flammable gases.
R14/15—Reacts violently with water, liberating highly flammable gases.
R14/15—Reacts violently with water, liberating extremely flammable gases.
R15—Contact with water liberates highly flammable gases.
R15/29—Contact with water liberates toxic, highly flammable gas.
R16—Explosive when mixed with oxidizing substances.
R17—Spontaneously flammable in air.
R18—In use, may form flammable/explosive vapor−air mixture.
R19—May form explosive peroxides.
R20—Harmful by inhalation.
R20/21—Harmful by inhalation and in contact with the skin.
R20/21/22—Harmful by inhalation, in contact with skin and if swallowed.
R20/22—Harmful by inhalation and if swallowed.
R21—Harmful in contact with skin.
R21/22—Harmful in contact with the skin and if swallowed.
R22—Harmful if swallowed.
R23—Toxic by inhalation.
R23/24—Toxic by inhalation and in contact with skin.
R23/24/25—Toxic by inhalation, in contact with skin and if swallowed.
R23/25—Toxic by inhalation and if swallowed.
R24—Toxic in contact with skin.
R24/25—Toxic in contact with skin and if swallowed.
R25—Toxic if swallowed.
R26—Very toxic by inhalation.
R26/27—Very toxic by inhalation and in contact with the skin.
R26/27/28—Very toxic by inhalation, in contact with the skin and if swallowed.
R26/28—Very toxic by inhalation and if swallowed.
R27—Very toxic in contact with skin.
R27/28—Very toxic in contact with skin and if swallowed.
R28—Very toxic if swallowed.
R29—Contact with water liberates toxic gas.
R30—Can become highly flammable in use.
R31—Contact with acids liberates toxic gas.
R32—Contact with acids liberates very toxic gas.
R33—Danger of cumulative effects.
R34—Causes burns.
R35—Causes severe burns.
R36—Irritating to eyes.
R36/37—Irritating to eyes and respiratory system.
R36/37/38—Irritating to eyes, respiratory system, and skin.
R36/38—Irritating to eyes and skin.
R37—Irritating to respiratory system.
R37/38—Irritating to respiratory system and skin.
R38—Irritating to skin.
R39—Danger of very serious irreversible effects.
R39/23—Toxic: danger of very serious irreversible effects through inhalation.
R39/23/24—Toxic: danger of very serious irreversible effects through inhalation and in contact with skin.
R39/23/24/25—Toxic: danger of very serious irreversible effects through inhalation, in contact with skin and if swallowed.

R39/23/25—Toxic: danger of very serious irreversible effects through inhalation and if swallowed.
R39/24—Toxic: danger of very serious irreversible effects in contact with skin.
R39/24/25—Toxic: danger of very serious irreversible effects in contact with skin and if swallowed.
R39/25—Toxic: danger of very serious irreversible effects if swallowed.
R39/26—Very toxic: danger of very serious irreversible effects through inhalation.
R39/26/27—Very toxic: danger of very serious irreversible effects through inhalation and in contact with skin.
R39/26/27/28—Very toxic: danger of very serious irreversible effects through inhalation, in contact with skin and if swallowed.
R39/26/28—Very toxic: danger of very serious irreversible effects through inhalation and if swallowed.
R39/27—Very toxic: danger of very serious irreversible effects in contact with skin.
R39/27/28—Very toxic: danger of very serious irreversible effects in contact with skin and if swallowed.
R39/28—Very toxic danger of very serious irreversible effects if swallowed
R40—Possible risks of irreversible effects.
R40/20—Harmful: possible risk of irreversible effects through inhalation.
R40/20/21—Harmful: possible risk of irreversible effects through inhalation and in contact with skin.
R40/20/21/22—Harmful: possible risk of irreversible effects through inhalation, in contact with skin and if swallowed.
R40/20/22—Harmful: possible risk of irreversible effects through inhalation and if swallowed.
R40/21—Harmful: possible risk of irreversible effects in contact with the skin.
R40/21/22—Harmful: possible risk of irreversible effects in contact with skin and if swallowed.
R40/22—Harmful: possible risk of irreversible effects if swallowed.
R41—Risk of serious danger to eyes.
R42—May cause sensitization by inhalation.
R42/43—May cause sensitization by inhalation and skin contact.
R43—May cause sensitization by skin contact.
R44—Risk of explosion if heated under confinement.
R45—May cause cancer.
R46—May cause heritable genetic damage.
R47—May cause birth defects.
R48—Danger of serious damage to health by prolonged exposure.
R48/20—Harmful: danger of serious damage to health by prolonged exposure through inhalation.
R48/20/21—Harmful: danger of serious damage to health by prolonged exposure through inhalation and in contact with skin.
R48/20/21/22—Harmful: danger of serious damage to health by prolonged through inhalation, in con tact with skin and if swallowed.
R48/20/22—Harmful: danger of serious damage to health by prolonged exposure through inhalation and in contact with skin.
R48/21—Harmful: danger of serious damage to health by prolonged exposure in contact with skin.
R48/21/22—Harmful: danger of serious damage to health by prolonged exposure in contact with skin and if swallowed.
R48/22—Harmful: danger of serious damage to health by prolonged exposure if swallowed.
R48/23—Toxic: danger of serious damage to health by prolonged exposure through inhalation.
R48/23/24—Toxic: danger of serious damage to health by prolonged exposure through inhalation and in contact with skin.
R48/23/24/25—Toxic: danger of serious damage to health by prolonged exposure through inhalation, in contact with skin and if swallowed.
R48/23/25—Toxic: danger of serious damage to health by prolonged exposure through inhalation and if swallowed
R48/24—Toxic: danger of serious damage to health by prolonged exposure in contact with skin.
R48/24/25—Toxic: danger of serious damage to health by prolonged exposure in contact with skin and if swallowed.
R48/25—Toxic: danger of serious damage to health by prolonged exposure if swallowed.
R49—May cause cancer by inhalation.
R50—Very toxic to aquatic organisms.
R50/53—Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.
R51—Toxic to aquatic organisms.
R51/53—Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.
R52—Harmful to aquatic organisms.
R52/53—Harmful to aquatic organisms, may cause long-term adverse effects in the aquatic environment.
R53—May cause long-term adverse effects in the aquatic environment.
R54—Toxic to flora.
R55—Toxic to fauna.
R56—Toxic to soil organisms.
R57—Toxic to bees.
R58—May cause long-term adverse effects in the environment.
R59—Dangerous to the ozone layer.
R60—May impair fertility.
R61—May cause harm to the unborn child.
R62—Possible risk of impaired fertility.
R63—Possible risk of harm to the unborn child.
R64—May cause harm to breast-fed babies.
R65—Harmful: may cause lung damage if swallowed.
R66—Repeated exposure may cause skin dryness or cracking.

R67—Vapors may cause drowsiness and dizziness.
R68—Possible risk of irreversible effects.
R68/20/21—Harmful: possible risk of irreversible effects through inhalation and in contact with skin.
R68/20/22—Harmful: possible risk of irreversible effects through inhalation and if swallowed.
R68/20/21/22—Harmful: possible risk of irreversible effects through inhalation, in contact with skin and if swallowed.
R68/21/22—Harmful: possible risk of irreversible effects in contact with skin and if swallowed.

(List of S-phrases) Safety Precautions

S1—Keep locked up.
S1/2—Keep locked up and out of the reach of children.
S2—Keep out of the reach of children.
S3—Keep in a cool place.
S3/7—Keep container tightly closed in a cool place.
S3/7/9—Keep container tightly closed in a cool, well-ventilated place.
S3/9—Keep in a cool, well-ventilated place.
S3/9/14—Keep in a cool well-ventilated place away from __?__ (incompatible materials to be indicated by the manufacturer).
S3/9/14/49—Keep only in the original container in a cool, well-ventilated place away from __?__ (incompatible materials to be indicated by the manufacturer).
S3/9/49—Keep only the original container in a cool, well-ventilated place.
S3/14—Keep in a cool place away from __?__ (incompatible materials to be indicated by the manufacturer).
S4—Keep away from living quarters.
S5—Keep contents under __?__ (appropriate liquid to be specified by the manufacturer).
S6—Keep under __?__ (inert gas to be specified by the manufacturer).
S7—Keep containers tightly closed.
S7/8—Keep container tightly closed and dry.
S7/9—Keep in a container tightly closed and in a well-ventilated place.
S7/47—Keep container tightly closed and at temperature not exceeding __?__°C (*to be specified by the manufacturer*).
S8—Keep containers dry.
S8/10—Keep container wet, but keep the contents dry.
S9—Keep containers in a well-ventilated place.
S12—Do not keep container sealed.
S13—Keep away from food, drink and animal foodstuffs.
S14—Keep away from __?__ (incompatible materials to be indicated by the manufacturer).
S15—Keep away from heat.
S16—Keep away from sources of ignition-No smoking.
S17—Keep away from combustible material.
S18—Handle and open containers with care.
S20—When using do not eat or drink.
S20/21—When using do not eat, drink or smoke.
S21—When using do not smoke.
S22—Do not breathe dust.
S23—Do not breath gas/fumes/vapor/spray (appropriate wording to be specified by the manufacturer).
S24—Avoid contact with skin.
S24/25—Avoid contact with the kin or eyes.
S25—Avoid contact with eyes.
S26—In case of contact with the eyes, rinse immediately with plenty of water and seek medical advice.
S27—Take off immediately all contaminated clothing.
S27/28—After contact with skin, take off immediately all contaminated clothing, and wash immediately with plenty of __?__ (*to be specified by the manufacturer*).
S28—After contact with skin, wash immediately with plenty of __?__ (to be specified by the manufacturer).
S29—Do not empty into drains.
S29/35—Do not empty into drains; dispose of this material and its container in a safe way.
S29/56—Do not empty into drains, dispose of this material and its container at hazardous or special waste collection point.
S30—Never add water to this product.
S33—Take precautionary measures against static discharge.
S34—Avoid shock and friction.
S35—This material and its container must be disposed of in a safe way.
S36—Wear suitable protective clothing.
S36/37—Wear suitable protective clothing and gloves.
S36/37/39—Wear suitable protective clothing, gloves and eye/face protection.
S36/39—Wear suitable protective clothing and eye/face protection.
S37—Wear suitable gloves.
S37/39—Wear suitable gloves and eye/face protection.
S38—In case of insufficient ventilation, wear suitable respiratory equipment.
S39—Wear eye/face protection.
S40—To clean the floor and all objects contaminated by this material, use __?__ (appropriate wording to be specified by the manufacturer).
S41—In case of fire and/or explosion, do not breathe fumes.
S42—During fumigation/spraying wear suitable respiratory equipment (appropriate wording to be specified by the manufacturer).
S43—In case of fire, use __?__ (indicate in the space the precise type of fire-fighting equipment. If water increases the risk, add "Never use water").
S44—If you feel unwell, seek medical advice (show the label where possible).
S45—In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).

S46—If swallowed, seek medical advice immediately and show this container or label.
S47—Keep at temperature not exceeding °C (to be specified by the manufacturer).
S47/49—Keep only in the original container at temperatures not exceeding __?__°C (to be specified by the manufacturer).
S48—Keep wetted with __?__ (appropriate material to be specified by the manufacturer).
S49—Keep only in the original container.
S50—Do not mix with __?__ (to be specified by the manufacturer).
S51—Use only in well-ventilated areas.
S52—Not recommended for interior use on large surface areas.
S53—Avoid exposure-obtain special instructions before use.
S54—Obtain the consent of pollution control authorities before discharging to wastewater treatment plants.
S55—Treat using the best available techniques before discharge into drains or the aquatic environment.
S56—Do not discharge into drains or the environment, dispose to an authorized waste collection point.
S57—Use the appropriate containment to avoid environmental contamination.
S58—To be disposed of as a hazardous waste.
S59—Refer to manufacturer/supplier for information on recovery/recycling.
S60—This material and/or its container must be disposed of as hazardous waste.
S61—Avoid release to the environment. Refer to special instructions/safety data sheet.
S62—If swallowed, do not induce vomiting; seek medical advice immediately and show this container or label.
S63—In case of accident by inhalation; remove casualty to fresh air and keep at rest.
S64—If swallowed, rinse mouth with water (only if the person is conscious).

Globally Harmonized System of Classification and Labeling of Chemicals (GHS)

Hazard statements are an essential element under the globally harmonized system and will eventually replace the currently used R-phrases. In addition to hazard statements, containers and Material Safety Data Sheets (MSDS) will include, where necessary, the following: one or multiple pictograms, a signal word such as "Warning" or "Danger," and precautionary statements. The precautionary statements will indicate proper handling procedures aimed at protecting the user and other people who might come in contact with the substance during an accident or in the environment. The container and MSDS will also contain the name of the supplier, manufacturer, or importer.

Each hazard statement contains a four digit co de, starting with the letter H (Hxxx). Statements appear under various headings grouped together by code number. The purpose of the four digit code is for reference only; however, following the code is exact *phrase* as it should appear on labels and MSDS.

Hazard Statements

Physical Hazards Codes and Statements

H200—Unstable explosive.
H201—Explosive; mass explosion hazard.
H202—Explosive; severe projection hazard.
H203—Explosive; fire, blast, or projection hazard.
H204—Fire or projection hazard.
H205—May mass explode in fire.
H220—Extremely flammable gas.
H221—Flammable gas.
H222—Extremely flammable material.
H223—Flammable material.
H224—Extremely flammable liquid and vapor.
H225—Highly flammable liquid and vapor.
H226—Flammable liquid and vapor.
H227—Combustible liquid.
H228—Flammable solid.
H240—Heating may cause an explosion.
H241—Heating may cause a fire or explosion.
H242—Heating may cause a fire.
H250—Catches fire spontaneously if exposed to air.
H251—Self-heating; may catch fire.
H252—Self-heating in large quantities; may catch fire.
H260—In contact with water releases flammable gases which may ignite spontaneously.
H261—In contact with water releases flammable gas.
H270—May cause or intensify fire; oxidizer.
H271—May cause fire or explosion; strong oxidizer.
H272—May intensify fire; oxidizer.
H280—Contains gas under pressure; may explode if heated.
H281—Contains refrigerated gas; may cause cryogenic burns or injury.
H290—May be corrosive to metals.

Health Hazards

H300—Fatal if swallowed.
H301—Toxic if swallowed.
H302—Harmful if swallowed.
H303—May be harmful if swallowed.
H304—May be fatal if swallowed and enters airways.
H305—May be harmful if swallowed and enters airways.
H310—Fatal in contact with skin.
H311—Toxic in contact with skin.
H312—Harmful in contact with skin.
H313—May be harmful in contact with skin.
H314—Causes severe skin burns and eye damage.
H315—Causes skin irritation.
H316—Causes mild skin irritation.
H317—May cause an allergic skin reaction.

H318—Causes serious eye damage.
H319—Causes serious eye irritation.
H320—Causes eye irritation.
H330—Fatal if inhaled.
H331—Toxic if inhaled.
H332—Harmful if inhaled.
H333—May be harmful if inhaled.
H334—May cause allergy or asthma symptoms or breathing difficulties if inhaled.
H335—May cause respiratory irritation.
H336—May cause drowsiness or dizziness.
H340—May cause genetic defects.
H341—Suspected of causing genetic defects.
H350—May cause cancer.
H351—Suspected of causing cancer.
H360—May damage fertility or the unborn child.
H361—Suspected of damaging fertility or the unborn child.
H362—May cause harm to breast-fed children.
H370—Causes damage to organs.
H371—May cause damage to organs.
H372—Causes damage to organs through prolonged or repeated exposure.
H373—May cause damage to organs through prolonged or repeated exposure.

Environmental Hazards

H400—Very toxic to aquatic life.
H401—Toxic to aquatic life.
H4 02—Harmful to aquatic life.
H410—Very toxic to aquatic life with long lasting effects.
H411—Toxic to aquatic life with long lasting effects.
H412—Harmful to aquatic life with long lasting effects.
H413—May cause long lasting harmful effects to aquatic life.

Prevention Precautionary Codes and Statements

P201—Obtain special instructions before use.
P202—Do not handle until all safety precautions have been read and understood.
P210—Keep away from heat/sparks/open flames/hot surfaces—NO SMOKING.
P211—Do not spray on an open flame or other ignition source.
P220—Keep/Store away from clothing/. . ./combustible materials.
P221—Take any precaution to avoid mixing with combustibles.
P222—Do not allow contact with air.
P223—Keep away from any possible contact with water, because of violent reaction and possible flash fire.
P230—Keep wetted with __?__.
P231—Handle under inert gas.
P232—Protect from moisture.
P233—Keep container tightly closed.
P234—Keep only in original container.
P235—Keep cool.
P240—Ground/bond container and receiving equipment.
P241—Use explosion-proof electrical/ventilating/light/. . ./ equipment.
P242—Use only nonsparking tools.
P243—Take precautionary measures against static discharge.
P244—Keep reduction valves free from grease and oil.
P250—Do not subject to grinding/shock/. . ./friction.
P251—Pressurized container—Do not pierce or burn, even after use.
P260—Do not breathe dust/fume/gas/mist/vapors/spray.
P261—Avoid breathing dust/fume/gas/mist/vapors/spray.
P262—Do not get in eyes, on skin, or on clothing.
P263—Avoid contact during pregnancy/while nursing.
P264—Wash __?__ thoroughly after handling.
P270—Do not eat, drink, or smoke when using this product.
P271—Use only outdoors or in a well-ventilated area.
P272—Contaminated work clothing should not be allowed out of the workplace.
P273—Avoid release to the environment.
P280—Wear protective gloves/protective clothing/eye protection/face protection.
P281—Use personal protective equipment as required.
P282—Wear cold insulating gloves/face shield/eye protection.
P283—Wear fire/flame resistant/retardant clothing.
P284—Wear respiratory protection.
P285—In case of inadequate ventilation wear respiratory protection.
P231 + 232—Handle under inert gas. Protect from moisture.
P235 + 410—Keep cool. Protect from sunlight.

Response Precautionary Codes and Statements

P301—IF SWALLOWED –
P302—IF ON SKIN –
P303—IF ON SKIN (or hair) –
P304—IF INHALED –
P305—IF IN EYES –
P306—IF ON CLOTHING –
P307—IF exposed –
P308—IF exposed or concerned –
P309—IF exposed or you feel unwell –
P310—Immediately call a POISON CENTER or doctor/ physician.
P311—Call a POISON CENTER or doctor/physician.
P312—Call a POISON CENTER or doctor/physician if you feel unwell.
P313—Get medical advice/attention.
P314—Get Medical advice/attention if you feel unwell.
P315—Get immediate medical advice/attention.
P320—Specific treatment is urgent (see__ ?__ on this label).
P321—Specific treatment (see __?__ on this label).

P322—Specific measures (see __?__ on this label).
P330—Rinse mouth.
P331—Do NOT induce vomiting.
P332—If skin irritation occurs –
P333—If skin irritation or a rash occurs –
P334—Immerse in cool water/wrap in wet bandages.
P335—Brush off loose particles from skin.
P336—Thaw frosted parts with lukewarm water. Do not rub affected areas.
P337—If eye irritation persists –
P338—Remove contact lenses if present and easy to do continue rinsing.
P340—Remove victim to fresh air and keep at rest in a position comfortable for breathing.
P341—If breathing is difficult, remove victim to fresh air and keep at rest in a position comfortable for breathing.
P342—If experiencing respiratory symptoms –
P350—Gently wash with soap and water.
P351—Rinse continuously with water for several minutes.
P352—Wash with soap and water.
P353—Rinse skin with water/shower.
P360—Rinse immediately contaminated clothing and skin with plenty of water before removing clothes.
P361—Remove/Take off immediately all contaminated clothing.
P362—Take off contaminated clothing and wash before reuse.
P363—Wash contaminated clothing before reuse.
P370—In case of fire –
P371—In case of major fire and large quantities –
P372—Explosion risk in case of fire.
P373—DO NOT fight fire when fire reaches explosives.
P374—Fight fire with normal precautions from a reasonable distance.
P375—Fight fire remotely due to the risk of explosion.
P376—Stop leak if safe to do so.
P377—Leaking gas fire—do not extinguish un less leak can be stopped safely.
P378—Use __?__ for extinction.
P380—Evacuate area.
P381—Eliminate all ignition sources if safe to do so.
P301 + 310—IF SWALLOWED—Immediately call a POISON CENTER or doctor/physician.
P301 + 312—IF SWALLOWED—Call a POISON CENTER or doctor/physician if you feel unwell.
P301 + 330 + 331—IF SWALLOWED—Rinse mouth. Do NOT induce vomiting.
P302 + 334—IF ON SKIN—Immerse in cool water/wrap in wet bandages.
P302 + 350—IF ON SKIN—Gently wash with soap and water.
P302 + 352—IF ON SKIN—Wash with soap and water.
P303 + 361 + 353—IF ON SKIN (or hair)—Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower.
P304 + 312—IF INHALED—Call a POISON CENTER or doctor/physician if you feel unwell.
P304 + 340—IF INHALED—Remove victim to fresh air and keep at rest in a position comfortable for breathing.
P304 + 341—IF INHALED—If breathing is difficult, remove victim to fresh air and keep at rest in a position comfortable for breathing.
P305 + 351 + 338—IF IN EYES—Rinse continuously with water for several minutes. Remove contact lenses if present and easy to do—continue rinsing.
P306 + 360—IF ON CLOTHING—Rinse immediately contaminated clothing and skin with plenty of water before removing clothes.
P307 + 311—IF exposed—Call a POISON CENTER or doctor/physician.
P308 + 313—IF exposed or concerned—Get medical advice/attention.
P309 + 311—IF exposed or you feel unwell—Call a POISON CENTER or doctor/physician P332 + 313—If skin irritation occurs—Get medical advice/attention.
P333 + 313—If skin irritation or a rash occurs—Get medical advice/attention.
P335 + 334—Brush off loose particles from skin. Immerse in cool water/wrap in wet bandages P337 + 313—Get medical advice/attention.
P342 + 311—Call a POISON CENTER or doctor/physician.
P370 + 376—In case of fire—Stop leak if safe to do so.
P370 + 378—In case of fire—Use __?__ for extinction.
P370 + 380—In case of fire—Evacuate area.
P370 + 380 + 375—In case of fire—Evacuate area. Fight fire remotely due to the risk of explosion.
P371 + 380 + 375—In case of major fire and large quantities—Evacuate area. Fight fire remotely due to the risk of explosion.

Storage Precautionary Codes and Statements

P401—Store __?__.
P402—Store in a dry place.
P403—Store in a well-ventilated place.
P404—Store in a closed container.
P405—Store locked up.
P406—Store in a corrosive resistant/... container with a resistant inner liner.
P407—Maintain air gap between stacks/pallets.
P410—Protect from sunlight.
P411—Store at temperatures not exceeding __?__ °C/ __?__ °F.
P412—Do not expose to temperatures exceeding 50°C/ 122°F.
P420—Store away from other materials.
P422—Store contents under __?__.
P402 + 404—Store in a dry place. Store in a closed container.

P403 + 233—Store in a well-ventilated place. Keep container tightly closed.
P403 + 235—Store in a well-ventilated place. Keep cool.
P410 + 403—Protect from sunlight. Store in a well-ventilated place.
P410 + 412—Protect from sunlight. Do not expose to temperatures exceeding 50°C/122°F P411 + 235—Store at temperatures not exceeding __?__°C/ __?__ °F. Keep cool.

Disposal Precautionary Codes and Statements

P501—Dispose of contents/container to __?__.

Appendix 5: Synonym and Trade Name-Cross Index

***Note*: All trademarks and company names mentioned herein are the registered property of their respective owners**

Appendix 6: CAS Number-Cross Index

Note: CAS Registry Number is a Registered Trademark of the American Chemical Society.

CAS Number and Record Number

61076-97-9 see A:1590
61117-05-3 see A:1515
61288-13-9 see P:0810
61373-95-3 see T:0840
61788-32-7 see T:0210
61788-32-7 see H:0410
61788-38-8 see T:0210
61789-51-3 see C:1330
61790-53-2 see S:0220
61790-53-2 see D:0260
61840-45-7 see P:0450
61891-42-7 see V:0150
62139-95-1 see D:0690
62476-59-9 see A:0360
62476-59-9 see L:0050
62497-63-6 see S:0670
62591-87-1 see P:0580
62642-07-3 see C:0160
62869-69-6 see Q:0120
63150-68-5 see M:1310
63705-05-5 see S:0730
63908-52-1 see A:0410
63936-56-1 see P:0810
64070-92-4 see F:0130
64093-79-4 see N:0180
64441-70-9 see D:1250
64475-85-0 see N:0110
64684-45-3 see P:0450
64741-53-3 see M:1385
64742-47-8 see K:0100
64742-54-7 see M:1385
64742-89-8 see N:0110
64902-72-3 see C:1077
64969-34-2 see D:0470
65544-34-5 see M:0310
65931-45-5 see C:1570
65982-50-5 see P:0150
65996-92-1 see C:1290
65996-93-2 see C:1290
65997-17-3 see F:0240
66039-27-8 see S:0250
66173-72-6 see T:0520
66230-04-4 see E:0207
66368-96-5 see H:0280
66441-23-4 see F:0105
66841-24-5 see C:1831
67016-73-3 see S:0220
67016-73-3 see D:0260
67256-35-3 see S:0220
67375-30-8 see C:1831
67485-29-4 see H:0365
67757-43-1 see M:0310
67774-32-7 see P:0810
68135-69-3 see S:0550
68157-60-8 see F:0405
68359-37-5 see C:1806
68379-55-5 see M:0310
68476-85-7 see L:0270
68855-54-9 see S:0220
68923-44-4 see I:0390
69012-64-2 see S:0220
69020-37-7 see M:1460
69098-86-8 see S:0410
69327-76-0 see B:0745
69377-81-7 see F:0395
69409-94-5 see F:0398
69771-31-9 see A:1610
69806-50-4 see F:0244
69865-47-0 see C:1830
70371-19-6 see M:0310
70377-94-4 see C:0680
70426-60-7 see B:0216
70630-17-0 see M:0475
71751-04-7 see A:0710
72178-02-0 see F:0399
72514-83-1 see C:1360
73413-06-6 see D:1460
73468-61-8 see C:0535
74051-80-2 see S:0205
74115-24-5 see C:1265
74223-64-6 see M:1345
74315-47-2 see C:1388
74552-83-3 see T:0720
76578-14-8 see Q:0130
75635-23-3 see T:0840
75881-82-2 see P:1125
77501-63-4 see L:0050
77536-66-4 see A:1590
77536-67-5 see A:1590
78006-92-5 see I:0420
78587-05-0 see H:0355
78590-82-6 see Z:0140
78642-65-6 see M:0850
78733-32-1 see E:0710
79217-60-0 see C:1804
79241-46-6 see F:0244
79637-11-9 see S:0660
79956-36-8 see M:1385
80751-51-5 see N:0360
81133-20-2 see A:1590
81235-32-7 see P:0270
81335-37-7 see I:0084
81335-47-9 see I:0084
81335-77-5 see I:0090
81362-49-4 see L:0050
81405-85-8 see I:0078
81406-37-3 see F:0395
81777-89-1 see C:1266
82041-23-4 see V:0150
82560-54-1 see B:0227
82657-04-3 see B:0474
83008-56-4 see S:0750
83046-05-3 see M:1385
83164-33-4 see D:0939
83589-40-6 see F:0360
83730-60-3 see D:1520
84948-57-2 see E:0710
86290-81-5 see G:0100
86479-06-3 see H:0248
86752-99-0 see C:1830
86753-92-6 see C:1830
87674-68-8 see D:1033
87701-64-2 see E:0540
87701-65-3 see E:0540
88161-75-5 see C:1830
88671-89-0 see M:1470
89125-89-3 see S:0750
89830-27-3 see S:0410
90043-99-5 see C:1310
90452-29-2 see N:0350
90640-80-5 see A:1380
90880-94-7 see N:0350
90982-32-4 see C:0658
91465-08-6 see C:1808
91829-63-9 see S:0410
92046-46-3 see I:0390
92355-34-5 see M:0430
92786-62-4 see M:0430
93196-73-7 see T:0520
93460-77-6 see E:0710
93616-39-8 see A:1610
94361-06-5 see C:1850
94449-58-8 see M:1310
94551-77-6 see F:0240
94624-12-1 see A:1310
94977-27-2 see M:0310
95507-03-2 see A:1624
95737-68-1 see P:1360
95828-55-0 see D:0690
96231-36-6 see E:0280
96489-71-3 see P:1342
96638-28-7 see R:0135
97955-44-7 see C:1830
97955-44-7 see C:1831
98201-60-6 see A:0340
98967-40-9 see F:0255
99129-21-2 see C:1263
99638-63-8 see T:0120
99932-75-9 see E:0660
101917-66-2 see I:0090
102851-06-9 see F:0398
103842-90-6 see P:0255
104233-53-6 see C:1263
104250-72-8 see C:1804
104512-57-4 see D:1500
105269-70-3 see S:0230
105827-78-9 see I:0092
106602-80-6 see P:1260
107231-30-1 see A:0610
107569-51-7 see B:0840
108731-70-0 see F:0399
108736-71-6 see P:0255
110429-62-4 see C:1263
110488-70-5 see D:1045
110540-41-5 see T:0120
110616-89-2 see P:0170
111991-09-4 see N:0295
112068-71-0 see F:0410
112388-78-0 see D:1520
112926-00-8 see S:0220
112945-52-5 see S:0220
113136-77-9 see C:1663
116788-91-1 see D:0690
118855-02-0 see A:1624
119446-68-3 see D:0934
119540-51-1 see S:0770
120068-37-3 see F:0243
121448-83-7 see N:0110
121552-61-2 see C:1860
123334-20-3 see V:0140
123542-79-0 see R:0120
123720-03-6 see M:0430
127529-01-5 see S:0770
130565-62-7 see A:0650
131860-33-8 see A:1680
131883-55-1 see B:0216
132207-33-1 see A:1590
133317-06-3 see M:0240
134788-15-1 see A:1624
134788-16-2 see A:1624
136338-65-3 see P:0150
137322-20-4 see T:0150
138261-41-3 see I:0092
139411-96-4 see H:0240
141112-29-0 see I:0560
153233-91-1 see E:0848
154670-12-9 see B:0640
161050-58-4 see M:0603
162744-63-0 see D:1100
163515-14-8 see D:1033
168153-21-7 see D:1100
171745-67-8 see D:1100
175446-71-6 see M:1280
205105-68-6 see P:0150
220713-25-7 see B:0840
247050-57-3 see P:0150

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